QUALITY ASSURANCE PROJECT PLAN

CITY OF TUCSON, ARIZONA

2022 Brownfields Revolving Loan Fund (RLF)

BF-98T42201

PREPARED FOR:

U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 9

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EEC Project No. 15015.115

Report Date: October 5, 2023

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DISTRIBUTION LIST

The following individuals will receive copies of the approved Quality Assurance Project Plan (QAPP):

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In addition, the City of Tucson will provide a copy of the QAPP to future environmental consultants contracted to perform the work addressed by the QAPP.

TABLE OF CONTENTS

FIGURES

TABLES

APPENDIX

LIST OF ACRONYMS USED

AAI	All Appropriate Inquiry
ACRES	Assessment, Cleanup and Redevelopment Exchange System
ADEQ	Arizona Department of Environmental Quality
AWQS	Arizona Water Quality Standard
CCV	Continuing Calibration Verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chain of Custody
DQO	Data Quality Objective
EPA	Environmental Protection Agency
ESA	Environmental Site Assessment
FID	Flame Ionization Detector
GC	Gas Chromatography
GPS	Global Positioning System
HASP	Health and Safety Plan
HAZWOPER	Hazardous Workers Operations and Emergency Response
ICP	Inductively Coupled Plasma
ID	Identification
IDW	Investigation-Derived Waste
LCS	Laboratory Control Sample
LDCS	Laboratory Duplicate Control Sample
LLP	Landowner Liability Protections
MDL	Method Detection Limit
MS	Mass Spectrometry
MSD	Matrix Spike Duplicate
NIST	National Institute of Standards and Technology
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PE	Performance Evaluation
PID	Photoionization Detector
PPE	Personal Protective Equipment
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
REC	Recognized Environmental Condition
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SRL	Soil Remediation Level
SVOC	Semi-Volatile Organic Compound
TPH-GRO	Total Petroleum Hydrocarbons Gasoline Range Organics
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound

INTRODUCTION

The City of Tucson, Arizona (City) has entered into a Cooperative Agreement with EPA (Assistance ID No. BF-98T42201) for a Revolving Loan Fund (RLF), the terms of which dictate how the City will use associated funds. This RLF assistance agreement will provide cleanup assistance within the City's limits, with particular attention on four high-priority, focus areas: La Doce; Thrive in the 05; Barrio Centro/Julia Keen Neighborhood; and Downtown Tucson/Historic Barrios. These areas were chosen because of their economic and cultural significance to the community and their redevelopment potential. Priority sites include a vacant former fueling station, a vacant former private school, and a transit center and its adjacent parking lot. Most of the grant funds will be used for cleanup loans and subgrants.

This agreement provides full federal funds of $1,000,000. Activities include developing the loan program, marketing the program, actively managing the program, obtaining contractor services including a Fiscal Agent, conducting public outreach, and preparing outreach materials relevant to the RLF program.

This Quality Assurance Project Plan (QAPP) will serve as a master document for site cleanup activities conducted by the City of Tucson, its consultants, and subcontractors using RLF funds. However, because specific sites and cleanup activities have not been identified, site-specific Sampling and Analysis Plan (SAP) will be prepared to complement the QAPP. Guidelines followed in the preparation of this QAPP are described in the following documents:

- Guidance for Quality Assurance Project Plans (EPA QA/G-5)
- EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)
- 2 Code of Federal Regulations (CFR) 1500.12
- American National Standard ASQ/ANSI E4:2014 Quality Management Systems for Environmental Information and Technology Programs
- EPA Region 9 guidance for Quality Assurance Program Plans (March 2012)
- EPA 540-R-98-038 Quality Assurance Guidance for Conducting Brownfields Site Assessments
- EPA/240/B-6/001 Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4)

The QAPP will be distributed to those individuals who will participate in the project, including those with EPA, City of Tucson, City of Tucson's environmental consultants, the selected analytical laboratory, and any other significant subcontractors involved in the project. Addenda and/or revisions to the QAPP can be initiated by EPA, City of Tucson, City of Tucson's environmental consultants, or the analytical laboratory. In general, an addendum will be written when unforeseen or significant changes have occurred. A revision will not be required for minor changes in scope.

1 PROJECT MANAGEMENT

1.1 Project Organization

The individuals responsible for implementing this program, along with their organizational affiliations, are shown on the Project Organization Chart contained in Figure 1. Not all individuals are identified in the Project Organization Chart because of the undefined nature of the specific projects. The Project Organization Chart will be updated and included in the site-specific SAP which shall utilize the EPA Region 9 SAP Template provided in Appendix A. An extended contact list of consultants and laboratories to be used is provided in Appendix B. The City of Tucson is responsible for ensuring that each project member has access to the most current version of the project QAPP, including all subsequent addenda or revisions. The project members include, but may not be limited to, EPA, City of Tucson, City of Tucson's environmental consultant, and the analytical laboratory QA manager.

This QAPP has been prepared for the City of Tucson City Environmental Services, which is the principal data user for data collected. The City is responsible for maintaining and updating the plan, but may delegate such authority to the City's Environmental Consultant, as needed. Changes to the QAPP will not be made without City approval.

As the provider of EPA funding, the EPA Region IX Brownfields Program shall review and approve the QAPP to ensure appropriate content and level of detail. Changes to the QAPP can be requested by the Brownfields Project Manager and/or the EPA QA Manager, or reviewer authorized by the EPA in writing.

1.2 Problem Definition and Background

The City received a Revolving Loan Fund grant regulated under 2CFR 200, 2 CFR 1500, and 40 CFR 33. The RLF will provide cleanup assistance within the specified focus areas within the City limits (See Figure 2 for Tucson area vicinity map). The City intends to focus on potential brownfield sites located within the four high-priority, focus areas:

- *La Doce* - This area is the 12th Avenue corridor within an area identified as a barrio and well known for its restaurants, retail stores and strong Mexican heritage.
- *Thrive in the 05* - This area is poised for a resurgence as the northern gateway to Tucson. The neighborhood is home to the essential building blocks of a thriving, multigenerational community.
- *Barrio Centro/Julia Keen Neighborhood* - This area is a mainly Mexican suburban neighborhood and the Historic Barrios are comprised of preserved historical buildings in Tucson.
- *Downtown Tucson/Historic Barrios* – This area consists of the unique architecture of downtown Tucson and the historic neighborhood immediately south of the Convention Center, which is one of the best-preserved barrios.

The Brownfields RLF provides low interest loans to local governments, non-profits, tribes and private businesses undertaking clean-up of contaminated properties. Site-specific activities utilizing the RLF may include:

- Verifying site and borrower/subaward recipient eligibility
- Preparing loan documents
- Preparing EPA Site Eligibility Determination
- Conducting site-specific public relations activities
- Preparing Analyses of Brownfields Cleanup Alternatives (ABCA) reports
- Consulting with and enrolling sites in the ADEQ Voluntary Remediation Program (VRP)
- Cleanup activities at Brownfield sites
- Cleanup verification sampling
- Cleanup documentation and reporting

Existing analytical data will be used to analyze cleanup alternatives for a specific site. This data must be collected prior to any site being accepted into the RLF program. Site-specific SAPs will be prepared as required for cleanup verification sampling and for the characterization of investigation derived waste. The site-specific SAPs will refer to the grant wide QAPP and will follow the EPA Region 9 SAP template provided in Appendix A. RLF funds can be used for the collection and analysis of environmental samples for cleanup verification and for profiling investigation derived waste for disposal. A conceptual remediation cost estimate will be developed using all analytical and survey data generated at the subject site.

1.3 Project Description

The primary tasks under this RLF assistance will be to determine site eligibility and conduct review/oversight of remediation and cleanup activities as discussed below.

Review Phase I and Phase II ESAs

A key task component will be the review of Phase I and Phase II Environmental Site Assessment Reports (ESAs) or their equivalent that have already been performed. In general, this review will consider the following:

- Sites where there is a presence or potential presence of contamination by a hazardous substance as defined in Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) § 101(14) or a pollutant or contaminant as defined in CERCLA § 101(33).
- Sites contaminated by petroleum or a petroleum product.
- Sites contaminated by controlled substances.
- Mine-scarred lands.

Some sites excluded from the general definition of a “brownfield site” may be eligible for RLF funds if EPA makes a property-specific determination to allow their use.

Review & Oversight of Remediation and Cleanup
Tasks items for the review and oversight of remediation projects may include, but are not limited to:

- Review of Brownfields Cleanup Alternatives (ABCA).
- Review of Remedial Action Workplans.
- Monitoring cleanup of brownfield sites.
- Review of cleanup verification and sampling.
- Confirm investigative derived waste determination and final disposition.

Project tasks may include other cleanup associated activities deemed eligible by EPA.

1.4 Data Quality Objectives

DQOs have been developed as part of this QAPP to outline the overall purpose and approach that the analytical data are intended to support. DQOs have been prepared according to the United States Environmental Protection Agency (EPA) "seven-step" process and are detailed below. To achieve these objectives, a data quality management program will be an integral part of any cleanup activity. Sections of the DQO are designed to assist third party consultants whom will assist the City of Tucson in reviewing submitted environmental documents (Phase I and II ESAs) as part of the RLF process.

Step 1: State the Problem
The first step in the DQO process is to define the problem that has initiated cleanup requirements. The problem should be identified early within the Phase I ESA process as an REC or certain data gaps at the project site that have been adequately evaluated through completion of a Phase II ESA or equivalent assessment. RLF applicants will submit all environmental assessments completed at the subject property as part of the loan/subgrant application. RLF funds may not be used for assessment activities, including Phase I and Phase II ESAs. The City's consultant will review the environmental assessments to evaluate whether the sampling data conforms with data quality objectives and whether the subject property has been adequately assessed and is ready for cleanup.

It is anticipated that mostly private property will be remediated using RLF funds, although public property and easements may be included. This project also assumes a variety of aboveground or below ground use of petroleum or hazardous substances that were misused or mishandled in manner constituting a release on or adjacent to the property has occurred.

Consultant Review of Phase I and II ESAs
Consultants reviewing Phase I and II ESA, or other similar assessment documents, shall at a minimum consider the following for each:

- Phase I ESA review shall identify the American Society for Testing and Materials (ASTM) standard which the assessment was performed under and if the report adequately documents if any environmental conditions (RECs), Historical Recognized Environmental Condition (HREC) and Controlled Recognized Environmental Conditions (CRECs) have been identified for the site. Additionally, the Phase I ESA should adequately identify any significant data gaps that would limit the ability of the environmental professional to identify a REC.

- Phase II ESA (or other related assessment) review should determine if the investigation adequately identified one or more of the following:
    - Whether there has been a release of hazardous substances within the meaning of CERCLA, for the purposes including landowner liability protections (i.e., innocent and owner, bona fide prospective purchaser, and contiguous property owner).
    - Information relevant to identifying, defining and implementing landowner "continuing obligations" or criteria established under CERCLA (e.g. taking reasonable steps to prevent or limit exposures to previously released hazardous substances) for maintaining the CERCLA landowner liability protections.
    - Developed threshold knowledge of the presence of substances on properties within the scope of the CERCLA definition of a "brownfield site" and as required for qualifying for brownfields remediation grants from the EPA Brownfields Program.
    - Provided the information relevant to identifying, defining, and evaluating property conditions that may pose risk to human health or the environment, or risk of bodily injury to persons on the property and thereby give rise to potential liability in tort.
    - Provided information relevant to evaluating and allocating business environmental risk in transactional and contractual contexts, including transferring, financing, and insuring properties, and due diligence relating thereto.
    - Provide information to support disclosure of liabilities and contingent liabilities in financial statements and securities reporting.
    - Adequately identified the full horizontal and later extent of a known or suspected release to include soil and groundwater.

Documentation of the ESA review shall be in a format acceptable to the City of Tucson and/or EPA for review.

Step 2: Identify the Goal of the Study

The principal objective of any cleanup conducted under the RLF process is to clearly identify the goals and what decisions are to be made. The goals should be clearly spelled out in the site-specific SAP on how environmental data will be used in meeting the objectives, identify study questions and define alternative outcomes. Some example questions to be answered during this process may include:

- Does the site contamination pose an unacceptable risk to human health or the environment?

- Where do the contaminant concentrations exceed identified standards or exceed contaminant concentrations corresponding to the preliminary remediation goal for the site?
- Is the remedial technology performing at a level that will ensure remedial objectives are met?
- Has the final remediation level or removal action level been achieved?

Some examples of alternative actions and outcomes to be addressed as part of this process may include:

- Recommend that the site requires no further evaluation.
- Recommend that the site warrants consideration of further assessment or a possible response action.
- Recommend that the current remedial technology continues operation
- Recommend that a new remedial technology or modifications to the current technology be considered.
- Recommend that the site has achieved cleanup goals and proceed with delisting procedures.
- Recommend that further response is appropriate for the site.

If several separate decision statements are required to address the cleanup goals, the site-specific SAP should identify the relationships among the decisions and the sequence in which the decisions should be resolved. This process may be regarded as placing the decision statements in an order of relative priority. It may be necessary to document the decision resolution sequence and relationships in a diagram or flowchart within the SAP.

Step 3: Identify Information Inputs

Select appropriate sampling and analysis methods for generating the information needed in later steps of the DQS proves. Confirmation samples should be collected with some bias to areas known or presumed to have use or appurtenances that have a higher potential for a release, since the primary goal is to determine cleanup activities have been successful. Target analytes should include contaminants that are both:

- Likely to be present in relative abundance based on the presumed source, and
- Likely to persist in the environment so as to be detectable over time.

It is also presumed target analytes represent potential contaminants with some risk to human health and the environment.

While the recommended analyses for a particular site will be included in a site-specific SAP, the general classes of analysis that may be present include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, polychlorinated biphenyls (PCBs), petroleum hydrocarbons, organic metals (e.g. tetraethyl lead), pesticides, herbicides and/or other potential contaminants from soil. Most of the sites likely to be investigated under this QAPP will be former service stations and/or garages and will have analyses limited to VOCs and poly-nuclear aromatic hydrocarbons (PAHs). Analyses beyond VOCs and PAHs may be included in site-specific SAPs but may not be cost-effective for the primary goal of evaluating if a release has occurred. Considerations for their inclusion in a site-specific SAP may include:

- Does the analyte typically have a background concentration that would make it less useful in evaluating if a release has occurred (e.g. metals)?
- Does the analyte lack an applicable and relevant standard for comparison (e.g. no Arizona Soil Remediation Level for total petroleum hydrocarbons)?
- Does the analyte increase the likelihood of detecting a release in a cost-effective manner (e.g. the cost of analysis for tetraethyl lead is significant for one analyte that is not necessarily more likely to be present than some VOCs or PAHs, and is therefore not cost-effective)?

Groundwater and surface water sampling are included within the scope of this QAPP.

Step 4: Define the Boundaries of the Study

The boundaries of any cleanup activities should be accurately identified and should also include the boundaries of the property and other practical constraints associated with sample/data collection. Items to consider are the spatial boundaries of the area to be studied, generally where samples will be collected, the time frame that the study will represent and when the samples should be collected.

Under the RLF it is assumed that mostly private property will be cleaned as part of this process, although public property and easements could be included. The boundaries of the study are not anticipated to exceed the boundaries of the property to be assessed. These boundaries constitute the sampling unit for each property to be assessed and will be identified in the SAP for that site.

As stated above, some bias (within the sample unit) will be given to areas known or presumed to have use or appurtenances that have a higher potential for a release. Additionally, existing utilities will be avoided during subsurface sampling. As such, basic geophysical methods (ground penetrating radar, electromagnetic location, etc.) will be employed (typically by a private utility locator) to identify areas to target and avoid within the sampling unit. The depth of any cleanup will not be limited and will be based on known site conditions, observed field activities and future intended use of the property.

Step 5: Develop the Analytic Approach

The analytical approach of any cleanup should identify the appropriate parameters to assist in making conclusions from the final results. The purpose of the correct parameter list is to determine if the identified contamination has been appropriately cleaned up and goals in Step 2 achieved. To assist in this process, the site-specific SAP should clearly identify the predetermined action levels for achieving the goal. It is likely the action levels will be defined in one of the following:

- Arizona Soil Remediation Levels (SRLs)

- Arizona Aquifer Water Quality Standards (AWQS)
- Arizona Surface Water Quality Standards (SWQS)
- US EPA Vapor Intrusion Screening Level (VISL)
- Soil Gas Human Health Screening Levels (SGHHSLs)
- EPA Indoor Air Regional Screening Levels (IARSLs)

The required detection limits for each potential measurement method should be identified in Step 3. If the detection limit for a measurement method exceeds or is very close to the Action Level, then a more sensitive method should be specified or a different analytical approach should be used. In the event a SRL goal is exceeded and a Risk Based Closure Assessment considered reasonable to achieve the specified goals, that should be discussed within the site-specific SAP.

Step 6: Specify Performance or Acceptance Criteria

This step in the DQO process to be included in the site-specific SAP should identify the types of error that would contribute to the total study error. The types of potential error are sampling error (field variability) and measurement error (measurement variability) which each contribute to the total error and discussed below:

- Sampling (field) error – This error is influenced by the inherent variability of the pollutant over geographic space and time, the sample collection design, and the number of samples. It is usually impractical to measure the entire space, and limited sampling may miss some features of the natural variation of the measurement. Sampling design error occurs when the sampling design does not capture the complete variability within the environment, to the extent appropriate for making conclusions. Sampling design error can lead to random error (i.e., variability or imprecision) and systematic error (bias) in estimates of pollutant concentrations.
- Measurement error – This error is the result of imperfections in the measurement and analysis system. Random and systematic measurement errors are introduced in the measurement process during sample collection, sample handling, sample preparation, sample analysis, data reduction, transmission, and storage.

These errors can be limited and should be addresses within the SAP to include, but not limited to:

- Collect a sufficient number of samples, sample duplicates, and field blanks to evaluate the sampling and measurement error.
- Analyze a sufficient number of QC Standards, blanks and duplicate samples in the Laboratory environment to effectively evaluate results against numerical QA goals established for precision and accuracy.
- Implement sampling techniques in such a manner that the analytical results are representative of the media and conditions being sampled.

The SAP should specify how data collection will generate the level of analytical data needed, the number of samples needed to have a statistically valid set of data, and the type of sampling needed (e.g., how precise).

<u>Step 7: Develop the Plan for Obtaining Data</u>

A detailed plan for data acquisition will be documented in individual SAPs for each site. The SAP will be constructed as follows:

1) The data generated in Steps 1 through 6 will be used to create an appropriate sampling design for the specific site.
2) Details of the design implementation and a contingency plan will be documented.
3) Description of the QA and QC procedures to be conducted to detect and correct problems and ensure defensible results will be documented.

Considerations for data acquisition in the SAP include the following:

- Data acquisition will favor resource-effectiveness over data volume – fixed time expenditures are assumed for field efforts in cleanup verification.
- Focused sampling design will be used – the focus of the study is to confirm cleanup activities, which favors biased sampling locations, and limited opportunity for statistical analysis of the data is anticipated.
- The number of samples will be based on specific site conditions.
- Individual samples versus composite samples – the focus of this sampling is on cleanup confirmation and sampling approaches may vary from site to site and must be considered on a site by site basis with input from the ADEQ VRP.
- Physical sample requirements (i.e. volume) will be designed to meet laboratory requirements and recommendations in accordance with the laboratory's Quality Management Plan.
- Sample locations will be selected based on:
    - Areas available for sampling (in most cases there should be no limit to available area unless due to utilities or other limiting factors).
    - Biased toward the cleanup activities conducted but optimizing coverage as well. This will also take into account any limiting issues of a site (building or other structures and appurtenances).
    - Avoidance of public and private utilities.
- Hold times for sample extraction and analysis after collection will be based on method requirements.
- Analytical methods will be selected for identified contaminants.
- Since the focus of this sampling is to verify cleanup, sampling design will not consider the

optimal number of samples or methods to reduce natural variability and/or other statistical design considerations.

1.5 Data Quality Indicators for Measurement of Data

This section identifies the data quality indicators for the DQOs; defines the elements of the QC program for field operations and laboratory analyses; and defines the requirements for precision, accuracy, completeness, representativeness, comparability, and sensitivity. Acceptable results are those values that fall within the acceptable range specified. Corrective actions for unacceptable results for specific testing methods are detailed in the Work Plan and this QAPP.

1.5.1 Precision

Precision measures the reproducibility of repetitive measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the sample process under similar conditions. Precision is evaluated by measuring the agreement among individual measurements of the same property under similar conditions. Duplicate results are assessed using the relative percent difference (RPD) between duplicate measurements. The RPD will be calculated as follows:

$$RPD = \frac{|X_1 - X_2|}{(X_1 + X_2)/2} \times 100$$

where X1 is the value of Sample 1 and X2 is the value of Sample 2; and X is the mean value of *X1* and *X2*.

Field precision is measured through the collection and analysis of field duplicate samples. Field duplicates will be collected at a frequency of 10 percent of field samples. Water matrix samples can be readily duplicated due to their homogeneous nature; however, the duplication of solid (e.g., soil, fill, sediment) samples is much more difficult due to their non-homogeneous nature. Consequently, target water and soil (or other solids) RPDs will be within 35% and 50%, respectively, of the original result. Duplicate recoveries beyond these ranges may require further qualification of associated data, but data will not be rejected unless determined unusable by data validation.

Laboratory precision is measured through the analysis of laboratory duplicate control samples (LDCS), matrix spike/matrix spike duplicates (MS/MSD), or sample duplicates. The laboratory will perform MS/MSD analyses at a rate of one for every 20 samples. RPD values within 35% will be considered precise without further discussion. If one or more sample results fall outside the acceptance criteria, they will be flagged. Samples will not be re-extracted and analyzed unless the results also fall outside the laboratory-derived limits based on historical data and EPA recommended limits. Acceptance criteria for laboratory precision will be consistent with current (August 2014) National Functional Guidelines for Superfund Organic Methods Data Review and National Functional Guidelines for Inorganic Superfund Data Review as applicable for the data type, as well as laboratory-specific precision objectives for MSD and

LCSD results.

1.5.2 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systematic error. It reflects the total error associated with a measurement. Simply put, accuracy is the measure of closeness of data to their true values. A measurement is accurate when the value reported does not differ beyond acceptable limits from the true value or known concentration of the spike or standard. Accuracy is expressed as the percent recovery (%R). Percent recovery is used to evaluate accuracy of laboratory control samples (LCS), matrix spikes (MS), and surrogate recovery. LCS and surrogate recovery is the ratio of the measured value versus the known value expressed as a percentage, which is calculated as follows:

$$\%R = \frac{X}{K} \times 100$$

where X is the measured value of the spike, and K is the known value of the spike.

Matrix spike recovery is calculated as follows:

$$\%R = \frac{(A - B)}{K} \times 100$$

where A is the measured value of the spiked sample, B is the measured value of the unspiked sample, and K is the true value of the spike solution added.

The EPA defines bias as the systematic or persistent distortion of a measurement process that causes error in one direction. Low bias would be indicated by consistently low recoveries and high bias by consistently high recoveries.

Analytical laboratory accuracy will be calculated at a rate of not less than one for every 10 confirmation samples collected (per batch). Acceptance criteria for laboratory precision will be consistent with current (August 2014) National Functional Guidelines for Superfund Organic Methods Data Review and National Functional Guidelines for Inorganic Superfund Data Review as applicable for the data type, as well as laboratory-specific accuracy objectives.

1.5.3 Completeness

Completeness is the amount of valid data obtained compared to the amount that could be expected under ideal conditions. The number of valid results divided by the number of possible results, expressed as a percentage, determines the completeness of the data set. The formula for calculation of completeness is, as follows:

$$\%C = \frac{N}{T} \times 100$$

where N is the number of usable results, and T is the target number of results.

Acquiring 100 percent of the data planned is difficult due to unexpected circumstances, adverse weather conditions, equipment problems, laboratory error, and loss of samples or samples that are invalid because they do not meet all of the laboratory sample acceptance criteria. Field completeness will be 80% or better for non-critical samples and 90% or better for critical samples. Samples will be considered critical if they are subject to definitive analyses and compared to cleanup levels. Non-critical samples will involve field-screening samples used to direct the exploration in the field. The laboratory completeness objective is for 100% of the field samples to be analyzed, with greater than 90% meeting QA/QC objectives. Where a specified number of samples planned for collection is not specified, completeness will be evaluated based on the number of valid samples versus the number of collected samples.

1.5.4 Representativeness

Representativeness is the degree to which data accurately and precisely represent selected characteristics of the media sampled. The following factors determine the representativeness of the data: sampling location, sampling frequency, sample type, sample collection methods, sample preservation, sample holding times, and analytical methods used. The representativeness of data collection is addressed by careful preparation of sampling and analysis programs.

This QAPP, together with the SAP, addresses representativeness of field data by specifying sufficient and proper numbers and locations of samples incorporating appropriate sampling methodologies specifying proper sample collection techniques and decontamination procedures and establishing proper field QA/QC procedures. Proper field techniques and procedures will be followed. Any deviation from the Work Plan will be noted in the field notes. Acceptance criteria for some of the factors discussed above are necessarily qualitative and will be based on professional judgement.

Quantitative assessment of representativeness includes analysis of equipment blanks, field blanks and trip blanks. At least one equipment blank or field blank will be collected per 20 regular samples, with equipment blanks being preferred. The Project Manager or his/her designee will decide which sample is collected based on professional opinion. Equipment blanks will be collected at least once per project. Trip blanks may be submitted for analysis at the rate of one trip blank per shipping container containing water or solid samples for VOC analysis if no other blank type is submitted, or if high concentrations of VOCs are suspected. The analysis of the trip blanks will monitor errors associated with the field contamination, sample preservation, and sample handling. Acceptance criteria with respect to blank results will be consistent with current (August 2014) National Functional Guidelines for Superfund Organic Methods Data Review and National Functional Guidelines for Inorganic Superfund Data Review as applicable for the data type, as well as laboratory-specific accuracy objectives.

Representativeness in the laboratory is ensured by using proper analytical procedures and appropriate methods, meeting analytical holding times, and meeting QC criteria for each method. It is the laboratory project and QA manager's responsibility to ensure that the proper methods and criteria are employed by the laboratory. Any deviation from the QAPP or laboratory SOPs will be noted in the case narrative.

1.5.5 Comparability

Comparability is an expression of confidence with which one data set can be compared to another. The objective of comparability is to ensure that data developed during the investigation are comparable to site knowledge and adequately address applicable criteria or standards established by the appropriate regulatory agency.

The comparability goal is achieved through the use of standard field techniques. These include, but are not limited to, the project prescribed techniques for sample collection and field parameter measurements. A detailed description of field techniques is given in the SAP. Proper field techniques and procedures will be adhered to, and any deviation from the Work Plan will be noted in the field notes. Additionally, consistent analytical methods should be used to ensure comparability. The comparability of laboratory data will be ensured by the laboratory personnel having reviewed the QAPP and having a working knowledge of the analytical standard operating procedures (SOPs). The laboratory QA manager (or designee) will also ensure comparable data by reviewing all data generated and verifying the correct methods have been used. The data reviewer will also review the data to ensure compliance with the various method requirements.

1.5.6 Sensitivity

Sensitivity is a measure of analytical detection or quantification limits. A detection is the minimum amount of analyte that can be consistently measured and reported with a high degree of confidence that the analyte concentration is above background response. A quantification limit is that amount that can be consistently quantified with acceptable precision and accuracy. This is also referred to as a practical quantitation limit (PQL).

The analytical laboratory reporting limits will be established and verified as outlined in the analytical methods and in accordance with licensure rules. The site-specific SAP must include compound lists with corresponding detection limits and appropriate action limits. Where applicable, the laboratory quantitation limits required for this project must be at or below the SRLs or AWQS. Failure of the analytical laboratory to achieve the quantitation limits specified in this QAPP may result in the qualification or rejection of data and initiate re-sampling/re-analysis.

2.0 DOCUMENTATION AND RECORDS

This section identifies the process and responsibilities for documenting project activities and record requirements. It also provides guidance for ensuring the appropriate project personnel have the most current approved version of the QAPP and other project documents noted, including revisions and addenda.

2.1 Analytical Laboratory Data Reporting Format and Content

Analytical data will contain the necessary sample results and quality control data to evaluate the DQOs defined for this project. Data generated by the analytical laboratory will be retained in hardcopy and electronic format at the laboratory. Data generated by the analytical laboratory will be submitted to the City of Tucson's environmental consultant in hardcopy and electronic format. Analytical results will include appropriate elements identified in the EPA Region 9 document entitled Laboratory Documentation Requirements for Data Validation (R9QA/004.2) and will include, at a minimum the following:

- Analytical laboratory name and ADHS license number
- Case narrative
- Cross-reference of sample identification number and analytical laboratory number
- Chain of custody
- Dates of sample collection and analysis
- Analytical results and method references
- Analytical method detection limits and reporting limits
- Surrogate recoveries (as applicable), method blanks, laboratory duplicates
- Calibration summary
- MS/MSD, LCS, and blank spike references
- Data outlier summary
- Analytical laboratory approval

The analytical laboratory will typically provide the analytical reports within 15 working days of sample receipt. Omissions or insufficient levels of detail will be corrected by the analytical laboratory.

2.2 Field Operations Records

Field notes will be kept in bound field logbooks. Logbooks will be used to record pertinent field activity information. The City of Tucson's environmental consultant will have a dedicated field logbook that will not be used for other projects. Documentation in the field logbook will be sufficient to reconstruct the sampling situation without relying on memories of the field team members. Field data will be recorded in field notebooks and/or on required field forms. While being used in the field, the field notebook and logs will remain with field personnel. The field data will be reviewed to evaluate the completeness of the field records and appropriateness of the field methods employed. At the completion of the project, field records will be retained in the project files for the required time.

Information recorded at the beginning of the day will include, but not be limited to the following:

- Project name
- Date and time
- Name and signature of field personnel entering information on each respective page
- Weather conditions
- Names of personnel on site, including subcontractors and site visitors
- Health and safety information, including personal protective equipment (PPE) level
- Field calibration information
- Deviations from SAP, QAPP, or Health and Safety Plan (HASP)

Information recorded during each sampling point will include, as applicable, but not be limited to the following:

- Sampling location (sampling point identification)
- Sample identification
- Sample depth
- Sample media
- Description of sample
- Chemical analysis requested, sample container, and preservative
- Any modifications to the sampling plan
- Sampling observations (if applicable)
- Field equipment readings
- QC samples collected (if applicable)
- Field sketches or maps, when appropriate
- Photographic log

All entries will be made in blue or black indelible ink and no erasures will be allowed. If an incorrect entry is made, the information will be crossed out with a single strike mark and the change initialed and dated by the team member making the logbook change. Each page in the field logbook will be signed and dated at the bottom of the page by any team member making entries on the page. The field logbooks will be identified on the cover by the project name, project number, and logbook number. The logbooks will be stored in the field project files when not in use. At completion of the field activities, the original field logbooks will be retained in the project file. Office data management will involve establishing and maintaining a project file.

2.3 Records Disposition

All project files and records will be stored on site by the City’s environmental consultant for 2 years following the completion of any cleanup activities. The project files will then be moved to a storage facility identified by the City of Tucson for permanent storage.

The analytical laboratory will store the original hardcopy and electronic raw data of the analytical data packages produced for this project for 5 years. The level of information regarding sample analyses (calibration records, run logs, etc.) will be such that the analytical processes can be reconstructed within that time.

3.0 DATA GENERATION AND ACQUISITION

3.1 Confirmation Sample Collection

The sample collection rationale and plan will be developed independently for each site and the process design will be described in the site-specific SAP. Confirmation sampling will be conducted in accordance with the procedures described in the site-specific SAP and this QAPP to meet the project DQOs. In general, the sample process design will include the factors described in the following paragraphs.

Parameters to be measured will be based on the findings of the Phase I and Phase II ESAs, the conceptual site model, the ABCAs and/or previous phases of investigation. Specific parameters will be identified by research of compounds normally associated with land uses or features of concern; materials identified by review of records or materials inventories; documented releases or spills; and contaminants identified by previous sampling.

Media to be sampled will be based on the nature of the contaminant. Soil will normally be sampled to evaluate whether contamination is present within the proposed redevelopment area. In some cases, soil vapor may be sampled to evaluate whether volatile organic compounds have been released to the subsurface. Groundwater may be sampled if soil contamination is suspected to extend to groundwater.

Sampling locations will be determined on a judgmental basis constrained by spatial limitations, taking into account:

- Areas available for sampling (in most cases there should be no limit to available area unless due to utilities or other limiting factors).
- Aerial sample coverage will be determined by the conceptual site model, the selected remediation technique, and the remediation goal.
- Avoidance of public and private utilities.

The depth of sampling will not be limited and will be based on the nature of the property being cleaned up and future land use. Additionally, the number of samples will not be constrained by available space for sampling unless precluded due to utilities.

The sample media (to include soil, groundwater and soil-vapor), locations, and quantities along with the associated analytical methods will be listed in the site-specific SAP. The number and types of field QC samples to be collected will also be listed in the site-specific SAP. The analytical methods for the parameters reasonably expected to be performed for this program are presented in Table 1. The sample container, preservative, and holding time for these parameters will be provided in the SAP. The analytical laboratory will provide new, pre-preserved sample bottles as needed for sample collection. In addition, the analytical laboratory will maintain the "certificate of cleanliness" for the containers should any questions arise in the future.

Samples that require preservation will be preserved according to established EPA requirements for each EPA method used for analysis. Suitable measures will be taken to ensure that storage requirements (i.e., temperature) are maintained in the field, during transport to the laboratory, and during storage at the laboratory. Sample temperature will be recorded by the laboratory upon receipt.

TABLE 1
ANALYTICAL METHODS

ANALYTE	ANALYTICAL METHOD
Volatile Organic Compounds	8260/624
Semi-Volatile Organic Compounds	8270/625
Priority Pollutant Metals (PPMs)	6010/6020/7470
RCRA 8 Metals	6010/7470
Polychlorinated Biphenyls	8082
Polynuclear Aromatic Hydrocarbons (PAHs)	8310
Pesticides (organochlorine)	8081
Pesticides (organophosphorous)	8141
Herbicides (organochlorine)	8151
BTEX + MTBE	8021/602
Total Petroleum Hydrocarbons – AZ GRO	8015
TCLP VOCs	1311/8260
TCLP SVOCs	1311/8270
TCLP Metals	1311/6010/7470
TCLP Herbicides (organochlorine)	1311/8151
TCLP Pesticides (organochlorine)	1311/8081
TCLP Pesticides (organophosphorous)	1311/8141
Corrosivity	9040A
Ignitability	1010
Asbestos	600/R93/116

3.2 Sampling Methods

The universe of potential sample methods for cleanup verification is numerous and indeterminate for this project. Samples may potentially be collected from a large number of media types and using differing collection methods, depending on contaminant location. It is impractical to include a complete compilation of SOPs for sample methods that may be used at brownfield sites. Therefore, specific SOPs will be included in the site-specific SAP.

3.3 Sample Labeling

A sample designation system will be defined in the site-specific SAP for proper identification and tracking in the field and the analytical laboratory. This sample designation system will be designed such that each sample receives a unique sample number. A sample label will be affixed to the sample container and will include the project name, sample designation, sample collection date and time, requested analysis, preservative, and sample collector’s name.

3.4 Sample Chain-of-Custody (COC) Procedures

This section describes the procedures for field and laboratory sample custody, requirements and provisions for sample handling and transport, and sample disposal criteria.

3.4.1 Field Custody Procedures

Custody of samples will be maintained and documented from the time of sample collection to completion of the analyses. A sample is considered to be under a person's custody if one or more of the following conditions are met if the sample is:

- In the person's physical possession
- In view of the person after that person has taken possession
- Secured by that person so that no one can tamper with the sample
- Secured by that person in an area that is restricted to authorized personnel

Upon collection, samples will be considered to be in the sampler's custody. The sampler will be responsible for the care and custody of the samples until they are relinquished for delivery to the laboratory or accepted by the laboratory.

The analytical laboratory will provide COC forms, cooler custody seals, and sample labels, which will be completed by the field technician.

The COC will be submitted to the analytical laboratory with all samples and will contain the following information:

- Project name
- Date and time of sample collection
- Sample matrix description
- Analyses requested for each sample
- Preservation method, if applicable
- Number and type of containers used
- Any special handling or analysis requirements
- Signature of person collecting the samples
- Signature(s) of persons involved in the sample custody
- Sample numbers

The COC form will be filled out in indelible ink. When the samples are transferred from one party to another, the individuals will sign, date, and note the time on the form. The original form will accompany the sample delivery to the laboratory in the shipping cooler. The sampling personnel will retain a copy of the form.

The following procedures will be used (as applicable) when packing and transporting samples to the laboratory:

- Use of waterproof ice chests and coolers
- Use of frozen water (e.g., cubes, shaved) to maintain proper refrigeration of the samples (4°C)
- Cushioning material placed within the cooler

- Paperwork placed inside a waterproof bag inside the cooler
- Cooler lid taped closed with packaging tape

Samples will be transported as soon as possible after sample collection to the laboratory for analysis. The analytical laboratory will be notified in advance of sample delivery. Sample coolers will be delivered to the laboratory or sent via commercial carrier. A copy of the COC will be retained by the environmental consultant performing the sample collection.

The COC will identify all collected samples and QC samples. For field duplicates and co-located samples, a separate sample number will be assigned and submitted blind to the analytical laboratory. Equipment blanks will be identified as “EB” followed by the date of sample collection. Soil samples collected for QC purposes will be specified for QC analysis by a notation on the sample container label and the COC. Trip blanks will be prepared and labeled by the analytical laboratory, recorded on the COC, and will travel with the sample volatile organic analysis (VOA) vials, but will not be opened in the field.

3.4.2 Laboratory Custody Procedures

Upon arrival at the analytical laboratory, the analytical laboratory will check samples for label identifications and complete, accurate COC documentation. The sample condition will be checked and the temperature will be measured immediately after the cooler is opened and recorded on the COC. Any discrepancies between the COC documentation and sample labels, or any problem encountered that may affect the sample integrity must be noted and communicated to the person delivering the samples. Problems that may affect the sample integrity include:

- Inaccurate or incomplete sample preservation
- Sample containers broken, leaking, or containing insufficient volume
- Holding time exceeded
- Cooler temperature above 10°C
- Temperature blank less than 2°C or greater than 6°C (when time since sample was collected is greater than 2 hours)

A unique laboratory identification (ID) number will be assigned. This number will be cross referenced to the field sample ID in an attempt to deter the possibility of mislabeling. Analytical reports will contain both ID numbers for sample results. Access to the sample control area will be restricted to prevent any unauthorized contact with samples, extracts, or documentation.

3.5 Sample Handling and Packaging

Samples will be sealed in zip-lock plastic bags and stored in a portable cooler preserved with wet ice (not blue ice) at 4^{O}C until transported to the laboratory. Under standard COC procedures, samples will be taken to the laboratory within 48 hours of their collection. Samples to be stored overnight will be sealed in a manner which would facilitate the detection of tampering. Upon receipt of samples by the laboratory, the laboratory will record sample (or temperature blank) temperature and any other observations regarding sample integrity. For samples that are shipped, all sample containers will be placed in a rigid shipping container (thermally insulated cooler). The following outlines the packaging procedures that will be followed for shipment of samples.

- If the cooler has a drain plug, it will be sealed to prevent melting ice from leaking out of the cooler.
- The bottom of the cooler will be lined with padding, such as bubble wrap, to prevent breakage during shipment.
- Screw caps will be checked for tightness.
- Glass sample containers will be wrapped in bubble wrap to prevent breakage.
- Sample containers will be sealed in heavy-duty plastic zip-lock bags.
- Sample identifiers will be written on the outside of the plastic bags with indelible ink.
- Samples will be placed in sturdy coolers lined with large plastic bags that will serve as secondary containment. The appropriate chain-of-custody forms will be enclosed in a plastic zip-lock bag placed outside the secondary containment.
- Empty space in the cooler will be filled with padding to prevent movement and breakage during shipment.
- Ice used to cool samples will be double sealed in two plastic zip-lock bags and placed on top and around the samples to chill them to the correct temperature.
- If samples are shipped via commercial carrier, each cooler will be securely taped shut with packing tape, and custody seals will be affixed to each cooler in a manner that would allow for indication of tampering.

If methanol-preserved VOC samples are shipped, the amount of methanol in any one package will not exceed 1 liter. Absorbent material in an amount adequate to absorb the entire volume of methanol in the container will be placed within the secondary containment bag when shipping such samples.

For shipped samples, the following information will be recorded and maintained:

- Name and location of the site or sampling area
- Project number
- Total number of samples shipped to the laboratory
- Carrier, air bill numbers, method of shipment (e.g., priority next day)
- Shipment date and when it should be received by lab
- Irregularities or anticipated problems associated with the samples
- Whether additional samples will be shipped or if this is the last shipment.

Appropriate shipping regulations and guidelines will be followed when shipping samples.

3.6 Analytical Methods

Table 1 includes a list of standard method numbers and corresponding analytes for anticipated analytical methods. If other analytical methods are required, the site-specific SAP will include tables providing this information.

The analytical laboratory(ies) to be used for specific projects are not known at this time. The SAP for each project will specify the name(s) of the laboratory(ies) and the specific analytical methods for which they are responsible. The laboratory(ies) will be certified by the Arizona Department of Health Services. The laboratory must review this QAPP and the site-specific SAP will include a statement that the laboratory has reviewed these documents and will be able to meet the performance criteria specified in these documents. If the laboratory cannot meet one or more of these criteria, the site-specific SAP will include a list or table of proposed variances, and a statement that the Project QA Manager has reviewed and approved these variances.

3.7 Regulatory Standards and Guidance

The following regulatory standards will be used to evaluate whether further site assessment and/or remediation is required:

- AAC R18-7-210 - Soil Remediation Levels (SRLs); See Appendix C
- Minimum Groundwater Protection Limits for Organic Contaminants; See Appendix D
- A.A.C. R18-11 Article 4 - Aquifer Water Quality Standards; See Appendix E
- ADEQ's Soil Vapor Sampling Guidance, July 10, 2008 (rev. May 19, 2011 & April 21, 2017); See Attachment F
- EPA's Vapor Instruction Screening Level Calculator; See web link: https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-level-calculator

Consultants will identify regulatory targets in a site-specific SAP prior to conducting assessment activities.

3.8 Consultant and Laboratory SOPs

Consultants and laboratories to be utilized as part of the City's Brownfields program shall provide their Standard Operating Procedures (SOPs). These SOPs include basic written, step-by-step instructions that describe how to perform routine activities that would likely be conducted for clean-up activities. These SOPs shall be provided as part of this QAPP and/or part of the SAP.

3.9 Investigative Derived Waste

Investigative Derived Waste (IDW) may include soil and water generated from soil cores and sampling; well development, purging, and sampling; and equipment decontamination activities. These IDW materials will be separately collected, containerized, labeled, and staged on site pending analytical analyses for appropriate disposal. The IDW characterization shall be identified within the SAP to include, the analytical parameter, method, and sample collection requirements. Disposable materials generated during data collection activities (i.e., disposable bladders, gloves, paper towels, etc.) will be collected and contained for proper disposal as municipal solid waste.

4.0 QUALITY CONTROL

The overall QA objective is to implement QC procedures during field and laboratory activities that will provide data with the degree of quality consistent with the intended use. Internal QC checks are used to determine if analytical activities are in control and to determine the effect that sample matrix may have on data being collected. This section describes both the field and laboratory QC checks that will be used for the evaluation of data collected.

4.1 Field Quality Control Checks

The data quality indicators for the measurement of field data including the field objectives for precision, accuracy, completeness, representativeness, comparability, and sensitivity are outlined in Section 1.5.

As part of the QC requirement for the field sampling program, the field parameters (pH and temperature) will be measured a minimum of two times during the groundwater sampling process. The meters used to measure pH and temperature will be calibrated daily, due to the extreme temperature changes in southern Arizona, which can cause drift in the meters.

In accordance with EPA Region 9 policy, only one type of blank will be collected on each day of sampling, in the following order of preference: equipment blank, field blank, and trip blank. The Project Manager or his/her designee will decide which sample is collected based on professional opinion. If elevated VOC concentrations are suspected to be present in the samples, then the trip blank will be collected.

4.1.1 Trip Blanks

The primary purpose of trip blanks is to detect potential additional sources of contamination that could potentially influence contaminant values reported in field samples, both quantitatively and qualitatively. Trip blanks serve as a mechanism of control for sample bottle preparation, blank water quality, and sample handling. are applicable for analysis of VOCs and may be submitted as one type of blank for QC purposes.

The trip blank consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water. The trip blank travels to the site with the empty sample bottles and returns from the site with the collected field samples in an effort to simulate sample handling conditions. One trip blank will be included in each shipping container transporting samples for VOC analysis. The following are potential sources of contamination in trip blanks:

- Laboratory reagent water
- Sample containers
- Cross-contamination during shipment
- Ambient air, or contact with analytical instrumentation during preparation and analysis at the laboratory
- Laboratory reagents used in analytical procedures

4.1.2 Field Duplicate Samples

A field duplicate is a second sample collected at the same location as the original (primary) sample. Duplicate samples are collected simultaneously or in immediate succession, following identical collection procedures, and treated in the same manner during sample shipment, storage, and analysis.

Field duplicate samples will be collected and analyzed to evaluate sampling and analytical precision. Agreement between duplicate sample results will indicate good sampling and analytical precision. Specific locations will be designated for collection of field duplicates prior to the start of field activities. Field duplicates will be collected at a frequency of 10 percent of the primary samples or once per sampling day, whichever is more frequent. The duplicate sample will be analyzed for all laboratory analyses requested for the primary sample collected.

The duplicate and original samples will be compared and the RPD will be calculated. The RPD will then be compared to the RPD for each analyte. If the RPD is exceeded, corrective action will be conducted by reviewing the field notebook to evaluate whether the soil was heterogeneous and reviewing the analytical laboratory quality control data. The original result will be used for assessment activities.

4.1.3 Split Samples

For projects involving analysis of more than ten samples of a particular matrix, split soil samples may be collected and analyzed by a second laboratory. In these cases, split soil samples will be collected from 20 percent of the sample locations. These samples will be collected, numbered, packaged and sealed in the same manner as the other samples, and will be analyzed for the same target analytes.

The results from split soil or aqueous samples will typically be compared by the Consultant to the original sample, and the difference will be calculated as a RPD. This RPD will be compared to the same RPD specified for use for duplicate or co-located samples. If this criterion is exceeded, corrective action will include review of field notes to evaluate whether the compared sample matrices are unusually heterogeneous. Laboratory quality control data may also be reviewed. In most cases, the higher result will be used in decision making, but the variation will be noted for subsequent sampling or remediation rationale.

4.1.4 Equipment Cleaning Blanks

Sampling equipment that is used repeatedly for collection of samples throughout the project will be cleaned between sample collection events. A sample of the deionized water used for the final rinse during the cleaning process will be collected and submitted to the analytical laboratory for analysis of the target compounds.

4.1.5 Inspection and Acceptance Requirements for Supplies and Consumables

Field sampling supplies and consumables will be inspected and evaluated for use by the environmental consultant. Sample jars provided by the laboratory will be provided in a box sealed by the manufacturer and the seal will be visually inspected to ensure its integrity. The environmental consultant will verify that preserved containers obtained from the laboratory have not been tampered with since preservation and that such containers will be used within 7 days of preservation by the laboratory. Potable and deionized decontamination water will be inspected to ensure the supplier's seal is intact.

To ensure supplies and consumables are free of defects and/or are acceptable for use in the project, all supplies and consumables will be received in their original packaging and visually inspected by the field technician for defects and/or tampering. Where applicable, laboratory or vendor calibration sheets will be reviewed and placed in the job file.

4.2 Laboratory Quality Control Checks

The data quality indicators for the measurement of laboratory data including the objectives for precision, accuracy, completeness, representativeness, comparability, and sensitivity are outlined in Section 1.5. The laboratory QC samples have been selected based on the DQOs for this project and the established analytical method requirements. The required laboratory QC samples are outlined below. However, additional QC samples may be required by the analytical laboratory in order to satisfy the laboratory internal QC policies.

4.2.1 Method Blank

A method blank is a sample of ASTM Type II or analyte-free (deionized) water that is carried through each step of the preparation and analytical method. Method blank samples are used to assess potential contamination attributed to laboratory operations during sample preparation and analysis. A method blank sample is required for each analytical batch of 20 or fewer samples.

4.2.2 Instrument Blank

An instrument blank is a sample of ASTM Type H or analyte-free (deionized) water or non-contaminated solid that is analyzed with associated calibrations of laboratory instruments. Instrument blank results are used to assess potential contamination attributed to specific instrument calibration procedures.

4.2.3 Surrogate Spikes

Surrogate spikes (also known as System Monitoring Compounds) are compounds added to every blank, standard, sample, and matrix spike sample as specified in the analytical methodology. Surrogate compounds are generally brominated, fluorinated, or isotopically labeled compounds not expected to be present in environmental samples. The results of the surrogate spike compounds are used to evaluate the accuracy of the analytical measurement on a sample-specific basis. Surrogate spikes are generally added for organic analyses only.

4.2.4 Internal Standards

An internal standard is a standard of known concentration added to each sample and carried through the entire determination procedure as a reference for calibrating and controlling the precision bias of the analytical method. Internal standards are generally used for organic analyses only.

4.2.5 Matrix Spikes and Matrix Spike Duplicates

Matrix spikes are known concentrations of analytes added to a sample and carried through each step of the preparation and analytical method. Matrix spikes are typically analyzed in duplicate for organic analyses. The results of matrix spikes are reported in %R and are evaluated to assess potential matrix interferences. The results of matrix spike duplicates are reported as RPD and are evaluated to assess laboratory and method precision.

Additional sample volume will be collected for matrix spike and matrix spike duplicate analyses of VOCs and Total Petroleum Hydrocarbons Gasoline Range Organics (TPH-GRO).

4.2.6 Matrix Duplicates

A matrix duplicate (or laboratory duplicate) is a separate aliquot of a sample taken from the sample container and carried through each step of the preparation and analytical method. The results of matrix duplicates are reported as RPD and are evaluated to assess laboratory and method precision. Additional sample volume will be collected for matrix spike and matrix spike duplicate analyses of VOCs.

4.2.7 Laboratory Control Samples/Laboratory Control Sample Duplicate

LCS and LDCS are well-characterized, laboratory-generated samples used to monitor the laboratory's day-to-day performance of analytical methods (sensitivity, calibration, and memory effects). The LCS may be a purchased standard or a method blank spiked with known concentrations of target analytes. The LCS is carried through each step of the preparation and analytical method. LCS should be reported in %R and used to assess the accuracy and precision (use of LDCS) of the analytical process independent of matrix effects. Controlling lab operations with LCS (rather than surrogates or MS) offers the advantage of being able to differentiate low recoveries due to procedural errors with those due to matrix effects.

4.2.8 Continuing Calibration Verification

Continuing-calibration verification (CCV) is achieved by the routine analysis of a standard of known concentration. The verification standard concentration is usually at or near the midpoint of the linear calibration curve. CCV for linear calibrations involves the calculation of the percent drift or percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard.

4.2.9 Performance Evaluation Samples

Double blind performance evaluation (PE) samples may be submitted to the analytical laboratory at the direction of EPA or the City. QC issues that may trigger the need for the submission of PE samples include confirmed quality issues detected through the data verification/validation process or unexpected or unexplained sample results.

If requested, double blind PE samples will be prepared in similar sample containers as the project field samples and shipped from the field to the laboratory for analysis. The double-blind PE samples will be prepared using National Institute of Standards and Technology (NIST) and/or EPA certified standards. The project-specific PE samples will contain known concentrations of the analytes of interest. Laboratory results will be evaluated against the original Certificates of Analyses for precision and accuracy.

5.0 INSTRUMENT/EQUIPMENT PREVENTATIVE MAINTENANCE

Preventative maintenance of field and laboratory equipment and instrumentation is completed to prevent loss of data due to malfunctions or delay, and to ensure that analytical data are reliable.

5.1 Field Instrument Testing, Inspection and Maintenance

Specific field instruments cannot be specified at this time. General inspection, testing, and maintenance requirements will be included in the Standard Operating Procedures provided in the site-specific SAP.

5.2 Laboratory Instrument Preventative Maintenance

The QA/QC plan for the selected analytical laboratory will outline a formal preventative maintenance program, including contingencies for sending samples to an EPA-approved back-up analytical laboratory if samples requiring analysis within holding times are going to be compromised. Preventative maintenance will be performed for each analytical instrument to minimize improper performance or interruption of the analytical process. General inspection and maintenance will be conducted in accordance with the manufacturer's recommendations. Designated laboratory personnel or outside service contracted firms will be responsible for this maintenance. The laboratory will maintain a stock of spare parts and consumables for analytical equipment. All routine maintenance and specialized repairs will be documented in a bound maintenance notebook with sequentially numbered pages. Each analytical instrument will have its own maintenance notebook. Entries will be initialed, dated, and periodically reviewed.

6.0 INSTRUMENT/EQUIPMENT CALIBRATION PROCEDURES AND FREQUENCY

6.1 Field Instrument Calibration

Field instrumentation is anticipated to include photoionization detectors (PID), flame ionization detectors (FID), pH/conductivity meters, geophysical equipment, and other instruments. Field monitoring equipment will be calibrated each day prior to the beginning of fieldwork (at a minimum) in accordance with manufacturer directions. Calibration information will be recorded on calibration logs, which will be maintained in the project files. The site-specific SAP will include a description of calibration procedures for that instrument.

Field instrument calibrations will be documented in the field logbook. The following information will be maintained in the field logbook:

- Equipment type (e.g., PID, pH meter)
- Manufacturer and model number
- Recommended calibration frequency
- Date of latest calibration
- Calibration solution type, concentration, manufacturer lot number, date, pressure (if gas)
- Dates of field measurement (use)
- Name of person who calibrated instrument
- Corrective action as deemed necessary

Entries in the field logbook will be made when each instrument is calibrated. Entries will be made in ink. Corrections will be made by crossing a line through the error and entering the correct information. Changes will be dated and initialed. No entries will be obliterated or rendered unreadable. Records will be kept for instruments requiring calibration.

6.2 Laboratory Instrument Calibration

Instrumentation and equipment used during sample analysis will be operated, calibrated, and maintained according to the manufacturer's guidelines and recommendations, as well as criteria set forth in the applicable analytical methodology references. Operation, calibration, and maintenance will be performed by personnel properly trained in these procedures. Analytical laboratory capabilities will be demonstrated initially for instrument and reagent/standards performance as well as accuracy and precision of analytical methodology.

Calibration will be required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet required reporting limits. Instruments will be calibrated with standard solutions appropriate to the type of instrument and the linear range required for the DQOs of this project. The frequency of initial calibration and calibration verification will meet the requirements of the analytical method. Samples must be bracketed by passing calibration check standards where required by the method.

Calibration standards and acceptance criteria vary depending on the instrument and analytical method. The general principles of calibration will apply uniformly. Initial calibration will demonstrate the reporting limits, the dynamic range of the detection system, and the retention windows. EPA procedures outline each system's acceptance criteria for calibration prior to analyses. Initial calibration consists of the analysis of at least five calibration standards at varying concentrations. The low calibration standard will be at a concentration below or at the reporting limit. The other standards will be at concentrations in the expected range of the detection system. The results will be used to determine a calibration curve and response factors for each analyte. The sample concentration (diluted or undiluted) will not exceed the linear range determined by the initial calibration.

CCV standards are analyzed before analysis of field samples and after every 10 samples to verify the initial calibration curve and response factors or at a frequency as required in the method. Initial calibration and CCV standards will contain all analytes of interest and must meet all calibration criteria. The ending or bracketing calibration standards also must meet the criteria required by the method.

6.3 Standard Reagent Preparation

A critical element in the generation of quality data is the purity/quality and traceability of the standard solutions and reagents used in the analytical operations. The preparation and maintenance of standards and reagents will be performed per the analytical methods requirements and those described below. Standards preparation will incorporate the following items:

- Documentation and labeling of date received, lot number, date opened, and expiration date
- Documentation of traceability certificates
- Preparation, storage, and labeling of stock and working solutions
- Establishing and documenting expiration dates and disposal of unusable standards

Primary reference standards and initial calibration standard solutions used by the laboratory will be obtained from commercial sources supplying the highest purity possible, (i.e., NIST traceable with Certificates of Analysis). Standards and standard solutions will be catalogued to identify how to the supplier, lot number, purity/concentration, receipt/preparation date, preparer's name, method of preparation, expiration date, and other pertinent information.

7.0 ASSESSMENT AND OVERSIGHT

7.1 Assessments and Response Actions

The following section identifies the corrective actions necessary to address field, laboratory, and data verification/validation problems. In general, corrective actions will be initiated whenever data quality indicators suggest that DQOs have not been met. Corrective actions will begin with identifying the source of the problem. Potential problem sources include failure to adhere to method procedures, improper data reduction, equipment malfunctions, or systemic contamination. The first level of responsibility for identifying the problems and initiating corrective action lies with the analyst/field personnel. The second level of responsibility lies with any person reviewing the data. Corrective actions may include more intensive staff training, equipment repair followed by a more intensive preventive maintenance program, or removal of the source of systemic contamination. Once resolved, the corrective action procedure will be fully documented, and if DQOs were not met, the samples in question may need to be recollected and/or reanalyzed using a properly functioning system.

Any corrective action that requires changes to the SAP or QAPP are defined as major corrective actions. Major corrective actions include, but are not limited to, measures that significantly change the number of samples collected, significantly alter previously selected sampling locations, or significantly impact the project QC objectives. In addition, some re-sampling activities may be considered a major corrective action (e.g., re-sampling of a complete monitoring round). The City’s environmental consultant will be responsible for contacting the EPA Project Manager and discuss all major corrective actions. Major corrective actions will be approved by the EPA Project Manager before implementation by the City’s environmental consultant.

7.2 Reports to Management

The City of Tucson Program Manager may request status reports on the performance of specific SAPs as necessary during performance of these tasks. Report contents may include, as applicable:

- Changes to the QAPP
- Summary of quality assurance/quality control programs, training, and accomplishments
- Results of technical systems and performance evaluation audits
- Significant QA/QC problems, recommended solutions, and results of corrective actions
- Summary of data quality assessment for precision, accuracy, representativeness, completeness, comparability, and method detection limits
- Discussion of whether quality assurance objectives were met and the resulting impact on technical and enforcement issues
- Limitations on the use of data and discussion of the effects of such limitations on the defensibility of the data

8.0 DATA VALIDATION AND USABILITY

8.1 Data Review, Verification and Validation

The principal criteria used to check data integrity during field activities are inspection and calibration of sampling equipment, supervision of field personnel and subcontractors by qualified staff, adherence to specifications, completion and review of daily field reports in field notebooks, and proper completion of the COCs associated with this project.

The principal criteria to assure data integrity during analytical laboratory and report activities are those detailed in this QAPP. These criteria include, but are not limited to:

- Verbal and written communication between the environmental consultant and the analytical laboratory
- Completion and review of the Quality Control Summary Report
- Review and validation of the data generated from the sample analysis
- Referencing of the COCs with the associated data package to check that the appropriate analysis was performed.

8.2 Data Review

The analytical laboratory data will be reviewed for compliance with meeting the QA/QC specifications outlined in the analytical methods and this QAPP. The review of data packages will include an evaluation of the information provided on the analytical data sheets and required sample documentation of all sample analysis and the supporting sample collection documentation, including chain-of-custody. Data will be accepted, rejected, or qualified based on the data review. The following summarizes the areas of data review, where applicable:

- Data completeness including COC documentation
- Holding times and sample preservation
- Blanks
- LCS
- MS/MSD
- Laboratory duplicates
- Surrogates
- Field duplicate samples
- Other QA/QC issues documented in the data deliverable.

The review of field data will include an evaluation of the information provided in the field notebook and required support documentation for all sample analyses, including chain-of-custody and field instrument calibration and/or performance check documentation.

8.3 Verification and Validation Methods

The analytical laboratory will internally perform data review and reporting. Data verification will be performed by qualified member of the consultant team who will not otherwise be involved in the sampling activities. The data verification will consist of the elements discussed below and will be performed on 100 percent of the data. Other QA/QC assessments (such as surveillance, peer review, management systems review, readiness review, technical systems audit, performance evaluation, etc.) will not be performed for this project since sampling activities are of limited scope and duration.

8.3.1 Completeness Check

A completeness check will be performed upon receipt of the data and will include a review of:

- Case narrative;
- COC documentation;
- Sample condition upon receipt; and
- The completeness check will ensure that:
    - All compounds and environmental samples are present
    - QC is present for every environmental sample
    - The most technically valid result is reported for each compound, which may result in full validation for a sample.

8.3.2 Data Verification Criteria

Data verification will include, but is not limited to, reviewing the:

- Completeness, as defined above
- Case narrative, including but not limited to, a description of non-conformances and corrective actions that were taken, plus anomalies, deficiencies, and QC problems that have been identified
- COC documentation and original COC forms with identification numbers and laboratory receipt signatures, dates, and times
- Sample condition upon receipt, including cooler temperature, and shipping documentation
- Timeliness and a check for errors, including requested deliverables, preservation and holding times
- Sample analysis results, with quantitation limits and checking reporting limits checked against the contract required limits, and verifying dry weights, and dilutions
- QC summary including but not limited to, method blanks, continuing calibration blanks, and preparation blanks, surrogate percent recoveries, spike percent recoveries and relative percent differences, and laboratory QC check sample and LCS recoveries;
- Field duplicates, if identified, for which reproducibility will be evaluated

- RLs
- Laboratory duplicates

8.3.3 Data Validation Criteria

If performed, data validation will include, but is not limited to, reviewing the:

- Completeness, as defined above;
- Case narrative, including but not limited to any corrective actions taken. The case narrative will be reviewed for anomalies, deficiencies, and QC problems that have been identified;
- Original COC forms with identification numbers and laboratory receipt signatures and copies of any internal tracking documents;
- Sample condition upon receipt, including cooler temperature, and shipping documentation;
- Sample analysis results with quantitation limits (including dilutions and reanalysis);
- QC summary including, but not limited to:
    - Initial and continuing calibrations
    - Method blanks, continuing calibration blanks, and preparation blanks
    - Surrogate percent recoveries
    - Internal Standard percent recoveries and retention times
    - Accuracy percent recoveries
    - Precision relative percent differences
    - Laboratory QC check sample, laboratory control sample recoveries
    - Field duplicates, if identified, reproducibility will be evaluated
    - Gas chromatograph breakdown products
    - Retention times and acceptance windows
    - Method detection limits (MDLs)
- Raw data, chromatograms and area/quantitation reports, sequential measurement readout records for inductively-coupled plasma (ICP), graphite furnace atomic absorption, flame atomic absorption, cold vapor mercury atomic absorption, cyanide, and/or other inorganic analyses including, but not limited to:
    - Environmental samples results including dilutions and reanalysis
    - Instrument tuning, for analyses by gas chromatography/mass spectrometry (GC/MS)
    - Initial calibration and continuing calibrations
    - Method blanks, continuing calibration and preparation blanks
    - Surrogate recoveries and internal standard recoveries, where applicable
    - Matrix spikes
    - Laboratory duplicate or matrix spike duplicate results
    - Laboratory QC check sample, or laboratory control samples, as applicable
    - Retention time windows
- Sample extraction and clean-up logs enhanced spectra of target analytes and

tentatively identified compounds (TICs) with the associated best match spectra for MS data

- Sample digestion and/or sample preparation logs
- Instrument analysis log for each instrument used
- Post digestion spikes, where applicable
- Method of standard additions, when applicable
- ICP serial dilution
- Instrument tuning for ICP/MS, when applicable
- Items specifically reviewed will include but not be limited to:
    - Timeliness and a check for errors, including requested deliverables, preservation, holding times, and Chain of Custody
    - Duplicate sample/MS/MSD/post-digest spikes, reviewed against precision and accuracy criteria specified by the method or by project DQOs
    - Compound quantitation and CRDLs, checking reporting limits against the contract required limits, verifying dry weights, calculations, and dilutions
    - Target list compound identification, indicating proper identification of analytes
    - Sample result verification, in which the final reports are reviewed against all raw instrumental data and logs and all applicable worksheets to check anomalies, data reduction/calculations, transcription, linear ranges, and dilutions
- A review, if needed for GC/MS testing, will include a review to ensure:
    - TICs are not a result of the laboratory or field process
    - Qualitative identification criteria as defined in the method and EPA Functional Guidelines are met
    - The most technically valid result is reported for each compound

8.3.4 Data Qualifier Flags

The guidance used for data verification is taken from the USEPA Contract Laboratory Program National Function Guidelines for Organic Data Review, as revised, and USEPA Contract Laboratory Program National Function Guidelines for Inorganic Data Review, as revised. The data qualification scheme is the basis for determining whether sample results should be qualified, but the reviewer's judgment is also critical in determining whether data quality and usability have been systematically influenced and whether data points require qualification. The staff performing the assessment must understand the analytical procedures being reviewed, understand how the data will be used, and be an experienced chemist. If QC results are out of criteria, the data will be qualified using the standard Contract Laboratory Program data flags, i.e., B, J, UJ, NJ and R.

Problems or questions about analytical data quality that may require corrective action will be brought to the attention of the laboratory in writing from the consultant or the data reviewer. The data verification Project Manager may initiate the request if QC results exceed method or project criteria, if reporting or flagging errors are identified, or to request information that has not been reported. The laboratory's response will include a written explanation of the problem, a plan and a schedule for corrective action, and/or a re-issuance of laboratory reports or electronic data files. If significant data quality problems have occurred and the data are critical to decision making, samples may be required to be reanalyzed, or recollected and reanalyzed at the discretion of the consultant.

The State of Arizona (through the Arizona Department of Health Services and Arizona Department of Environmental Quality) has published standardized data qualifier flags (Appendix G) that will be used by the laboratory in qualifying analytical results for use in Arizona. Any data that is associated with a quality control exceedance must be designated by the laboratory using the Arizona Data Qualifier flags to flag the sample results associated with the exceedance. For example, if a LCS is out of criteria for iron, then, in addition to the LCS result being flagged, iron in all of the samples associated with that LCS must also be flagged.

8.3.5 Data Verification and Validation Reports

The reviewer will prepare a data review report for each sample delivery group that will include:

- A case narrative, including but not limited to, a list of recommended flags; a listing of the items reviewed and the criteria used to evaluate them; a discussion of any problems or quality control exceedances associated with the actual analysis which might impact the sample integrity or data quality; and a summary of all laboratory contacts in which all communications with the laboratory, if any, would be identified; and
- The marking of recommended qualifier flags on the laboratory reports and/or in electronic data deliverables. Flags that are marked on hard copy will be marked directly on copies of the laboratory reports in a contrasting color for ease in performing data entry.

8.4 Reconciliation with User Requirements

Based upon the data verification or validation, an evaluation of the project may be performed to determine if the data satisfy the DQIs and are usable for the purposes for which they were intended.

8.5 Data Reporting

The results of the data review, verification, and validation will be documented and summarized in the Project Report. Data reporting will be in a clear a format and will contain the following information:

- A general discussion of the sample types received, tests performed, problems encountered, and general comments, along with a table of sample data and any failed QC parameters
- Analytical data presented by sample number or by test

- Calibration verification information
- Laboratory performance and matrix-specific information including surrogates, matrix spike results, laboratory control samples, and laboratory duplicate results
- Any other pertinent information, including cooler receipt forms and corrective action forms

Raw data will be stored in the analytical laboratory according to the requirements of its QC Manual. Raw data will be made available upon request by EPA.

9.0 CORRECTIVE ACTIONS

The following section identifies the corrective actions necessary to address field, laboratory, and data verification/validation problems. In general, corrective actions will be initiated whenever data quality indicators suggest that DQOs have not been met. Corrective actions will begin with identifying the source of the problem. Potential problem sources include failure to adhere to method procedures, improper data reduction, equipment malfunctions, or systemic contamination. The first level of responsibility for identifying the problems and initiating corrective action lies with the analyst/field personnel. The second level of responsibility lies with any person reviewing the data. Corrective actions may include more intensive staff training, equipment repair followed by a more intensive preventive maintenance program, or removal of the source of systemic contamination. Once resolved, the corrective action procedure will be fully documented, and if DQOs were not met, the samples in question may need to be recollected and/or reanalyzed using a properly functioning system.

Any corrective action that requires changes to the SAP or QAPP are defined as major corrective actions. Major corrective actions include, but are not limited to, measures that change the number of samples collected, alter previously selected sampling locations, or impact the project QC objectives. In addition, some re-sampling activities may be considered a major corrective action (e.g., re-sampling of a complete monitoring round). The ADEQ VRP and/or EPA Project Officer shall be notified in the event a corrective action change is required to the SAP or QAPP .

9.1 Field Corrective Action

Corrective action in the field relates to inspection of equipment, procedures, and problems found during data review. The City of Tucson’s environmental consultant is responsible for the initiation and implementation of corrective actions with respect to the field sampling operations and is responsible for assuring that field sampling procedures are followed. Corrective actions may include training field personnel, modifying field procedures, and/or re-sampling project sample locations.

9.2 Laboratory Corrective Action

Corrective action will be taken in the analytical laboratory if method-specific QC or project-specific DQOs are not met or as a result of problems identified during data review. The analytical laboratory will notify the City’s environmental consultant if a transportation problem (e.g., broken sample container, nonconforming temperature blanks) has occurred. The analytical laboratory’s QA officer, in consultation with the City’s environmental consultant, is responsible for implementing corrective actions in the laboratory (from sample receipt to final data deliverable). It is their combined responsibility to see that analytical and sampling procedures are followed as specified and that the data generated meet the acceptance criteria. Corrective actions for the laboratory may include the following:

- Reanalyzing and/or re-extracting samples
- Correcting laboratory procedures
- Recalibrating instruments using freshly prepared standards

- Replacing solvents or other reagents that give unacceptable blank values
- Training laboratory personnel in correct sample preparation and analysis procedures.

Whenever corrective action is deemed necessary, the analytical laboratory will check that the following steps are taken:

- The problem is defined
- The cause of the problem is investigated and determined
- Appropriate corrective action is determined
- Corrective action is implemented, and its effectiveness verified
- Control is reestablished to the noncompliant QC parameter(s)

The corrective actions will be documented according to the analytical laboratory's QAPP and SOPs.

9.3 Corrective Action During Data Review and Validation

During data review, results may be encountered that do not correlate well with expectations, with other results, or with results from other methods performed on the same samples. Such situations may trigger inquiries into raw data. The City of Tucson's environmental consultant is responsible for initiating, overseeing implementation, and documenting any corrective actions required during the data verification/validation process. Some examples of discrepancies noted during data verification/validation include missed holding time, QC samples outside evaluation criteria, and sample dilution problems. Corrective actions may require re-sampling by field personnel or re extraction/re- analysis by the laboratory. All corrective action must be documented.

Prior to the beginning of fieldwork, the consultant's Project Manager will review the project QAPP, SAP, and HASP and will assemble the necessary field gear, including the field notebook and logs, copies of the project SAP and HASP, field screening instruments and calibration gases, sampling and decontamination equipment, sample containers and labels, chain of custody forms and seals, sample shipping coolers and materials, and any other equipment and materials necessary for the fieldwork. The consultant's Project Manager will contact the analytical laboratory in advance to schedule the mobile laboratory and fixed-base laboratory sample analyses and will arrange for shipping or delivery of samples to the fixed-base laboratory.

The consultant's Project Manager will be responsible for ensuring that fieldwork is performed in accordance with the QAPP and SAP, including sampling activities; documentation accuracy, completeness, and consistency; packaging and shipping of samples to the laboratory; and field instrument monitoring and calibration.

The consultant's Project Manager will communicate daily to the Project Director and/or QA Manager regarding field activities, and any changes or corrections will be implemented. During and following the fieldwork, the Project Director will review field documentation and laboratory data for accuracy and completeness and will provide the information to the Project Director and QA Manager for additional review.

The QA Manager will audit field activities during the initial day of field activities. This audit will evaluate adherence to specified methods for sample collection, decontamination, documentation, packaging, and other field activities. The analytical laboratory report will be reviewed by the Project and QA Managers to ensure that the sample information is correct and complete. The QA Manager is granted the corporate and project-specific authority to ensure corrective actions, if necessary, are implemented.

9.4 Reports to Management

The City of Tucson Brownfields Manager may request status reports on the performance of specific SAPs as necessary during performance of these tasks. Report contents may include, as applicable:

- Changes to the QAPP
- Summary of quality assurance/quality control programs, training, and accomplishments
- Results of technical systems and performance evaluation audits
- Significant QA/QC problems, recommended solutions, and results of corrective actions
- Summary of data quality assessment for precision, accuracy, representativeness, completeness, comparability, and method detection limits
- Discussion of whether quality assurance objectives were met and the resulting impact on technical and enforcement issues
- Limitations on the use of data and discussion of the effects of such limitations on the defensibility of the data

10.0 PERFORMANCE AND SYSTEM AUDITS

Audit activities are established and directed by the City of Tucson's environmental consultant to ensure that field and laboratory activities are performed in compliance with project controlling documents. This section describes responsibilities, requirements, and methods for scheduling, conducting, and documenting audits of field and laboratory activities.

10.1 Field Performance and Systems Audits

The property owner's environmental consultant will be responsible for data integrity during field sampling activities. Corrective actions and the results (effectiveness) of those actions will be documented in the field log book. The logbook will be stored in the project files.

Principal criteria to ensure data integrity during confirmation sampling events are those detailed in this QAPP. These activities include, but are not limited to, the following inspections:

- Field analytical activities
- Decontamination procedures and appropriate frequency
- Sample collection and handling (e.g., method of collecting samples, use of PPE, sample packing)
- Chain-of-custody documents for completeness.

Field audits are not required but may be performed in the event significant discrepancies are identified that warrant evaluation of field practices. These discrepancies may include continued field contamination problems and/or continued sample handling (i.e., temperature upon receipt) problems.

All sampling activities and associated corrective action, if any, will be documented by the City's environmental consultant. EPA may elect, at their discretion, to inspect and/or assess any field activities performed during this site investigation.

10.2 Laboratory Performance and Systems Assessments

Analytical laboratory audits generally include reviews of sample handling procedures, internal sample tracking, SOPs, analytical data documentation, QA/QC protocols, and data reporting. The analytical laboratory will be responsible for the policy, procedure, and documentation of internal assessment conducted by the analytical laboratory, including data review procedures. The analytical laboratory's QA manager is responsible for the initiation, implementation, and documenting of all internal assessment activities and the associated corrective actions, if any. It is not anticipated that a project-specific analytical laboratory audit will be performed as a function of this project.

11.0 TRAINING AND CERTIFICATION

Sample collectors are required to successfully complete a 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) site safety course in accordance with 40 CFR Part 311, which references 29 CFR 1910.120. Staff are also expected to be trained on sampling for hazardous materials as well as read and be familiar with the QAPP, SAP and Work Plan prior to performing actual sample collection. All personnel will ensure and provide for the protection of the personal safety and health of all workers on site, including the selection, provision, testing, decontamination, and disposal of all PPE and any required medical monitoring. All personnel will comply with all applicable worker safety and health laws and regulations. At all times during performance of the project, personnel will exercise reasonable professional judgment regarding safety and will use professional judgment as a criterion for cessation of services for safety reasons.

Persons performing UST closures (removals) must be prequalified by the Arizona Department of Environmental Quality (ADEQ). Those performing other tasks associated with USTs, to include remediation activities and documentation submittals to the ADEQ, shall have the appropriate level of knowledge and training.

Documents containing interpretation of results and conclusions will be sealed by an Arizona-registered professional qualified to perform the subject work.

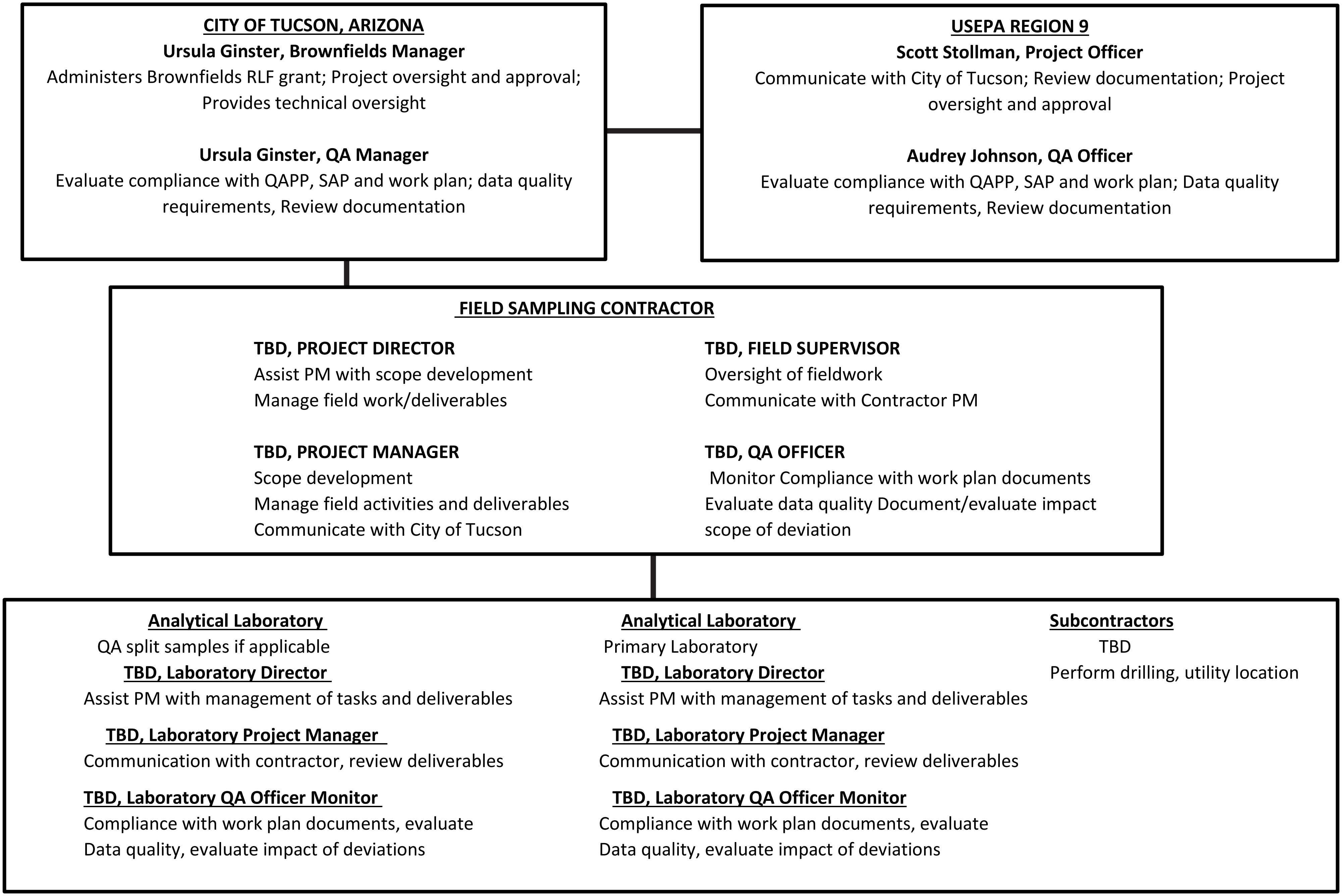
Specific training requirements may be necessary for personnel operating field analytical or sampling equipment or specialized equipment, such as the PID, global positioning system (GPS), or other instruments. Manufacturer’s requirements and recommendations should be followed.

Other training requirements or certifications will be dependent upon the specific tasks that are performed for specific project sites. Such requirements or certifications will be specified in the SAP.

FIGURES

FIGURE 1

ORGANIZATIONAL CHART



CITY OF TUCSON, ARIZONA

Ursula Ginster, Brownfields Manager

Administers Brownfields RLF grant; Project oversight and approval; Provides technical oversight

Ursula Ginster, QA Manager

Evaluate compliance with QAPP, SAP and work plan; data quality requirements, Review documentation

USEPA REGION 9

Scott Stollman, Project Officer

Communicate with City of Tucson; Review documentation; Project oversight and approval

Audrey Johnson, QA Officer

Evaluate compliance with QAPP, SAP and work plan; Data quality requirements, Review documentation

FIELD SAMPLING CONTRACTOR

TBD, PROJECT DIRECTOR

Assist PM with scope development

Manage field work/deliverables

TBD, PROJECT MANAGER

Scope development

Manage field activities and deliverables

Communicate with City of Tucson

TBD, FIELD SUPERVISOR

Oversight of fieldwork

Communicate with Contractor PM

TBD, QA OFFICER

Monitor Compliance with work plan documents

Evaluate data quality Document/evaluate impact scope of deviation

Analytical Laboratory

QA split samples if applicable

TBD, Laboratory Director

Assist PM with management of tasks and deliverables

TBD, Laboratory Project Manager

Communication with contractor, review deliverables

TBD, Laboratory QA Officer Monitor

Compliance with work plan documents, evaluate Data quality, evaluate impact of deviations

Analytical Laboratory

Primary Laboratory

TBD, Laboratory Director

Assist PM with management of tasks and deliverables

TBD, Laboratory Project Manager

Communication with contractor, review deliverables

TBD, Laboratory QA Officer Monitor

Compliance with work plan documents, evaluate Data quality, evaluate impact of deviations

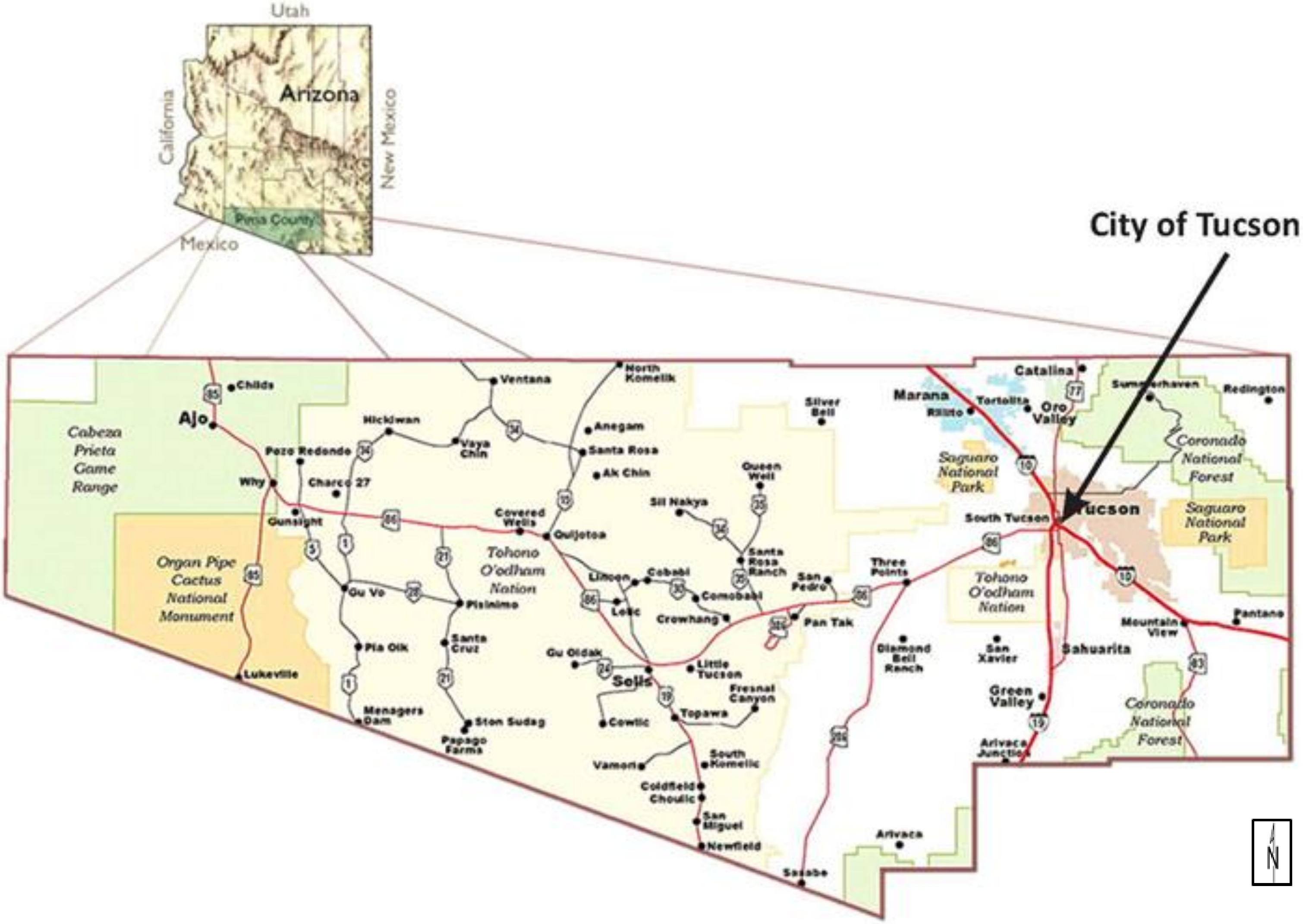
Subcontractors

TBD

Perform drilling, utility location

FIGURE 2

CITY of TUCSON, ARIZONA VICINITY MAP


City of Tucson

APPENDIX A

EPA Region 9 Sampling and Analysis Plan and Guidance Template Version 4

SAMPLING AND ANALYSIS PLAN

GUIDANCE AND TEMPLATE

VERSION 4, Brownfields Assessment Projects

August 2018

This Sampling and Analysis Plan (SAP) guidance and template is intended to assist organizations in documenting the procedural and analytical requirements for Brownfields Assessment projects involving the collection of water, soil, sediment, or other samples taken to characterize areas of potential environmental contamination. It combines, in a short form, the basic elements of a Quality Assurance Project Plan (QAPP) and a Field Sampling Plan (FSP). Once prepared and approved it will meet the requirements for any U.S. Environmental Protection Agency (EPA) Region 9 Brownfields project in which environmental measurements are to be taken.

The format is designed to accommodate projects of limited scope and presumes that the work will be going to a laboratory whose analytical services are not funded directly by EPA. This might include, but not be limited to, a private or commercial laboratory, a state laboratory, an in-house laboratory or any other laboratory under contract to the organization writing the SAP. It is intended to be used for projects generating a limited number of samples to be collected over a relatively short time. This template is not intended to be used for on-going monitoring events, or for remediation or removal activities. Exceptions to these requirements will be considered on a case-by-case basis, but they should be discussed with Region 9 QA Section staff before the template is used and before the SAP is submitted for approval. This template may be used by state, municipal and local agencies, contractor, non-profit organizations, and by EPA staff.

This guidance - template provides item-by-item instructions for each section of a SAP. If the sections are appropriate for the project, they may be used verbatim, or modified as needed to reflect project- and sampling-specific requirements. Not all sections will apply to every organization or to every project.

Some sections, such as those describing sampling procedures, contain example language which may be used with or without modification. If these procedures do not meet project needs, the organization may substitute a specific description of sampling procedures or provide copies of the sampling standard operation procedures (SOPs). Other alternatives should be discussed with QA Section staff.

An electronic version of the template is available and may be used to prepare the SAP. The format of the template is as follows:

The two types of shaded text are to be deleted from the final SAP:

1. Tutorial information presented in *italic* type. This information includes definitions and background information pertaining to a given section of the SAP.
2. Specific instructions given inside brackets [in normal type].

Suggested text which may be included in the SAP is presented in normal type. This text can be used, modified, or deleted depending on the nature of the project. For example, if only groundwater will be sampled, delete the discussion of sampling other matrices. If more than one option is presented, pick the appropriate one and delete the others.

If the use of a Standard Operating Procedure (SOP) is appropriate, the SOP should be included as an appendix to the final SAP and referenced in the appropriate section.

An underlined blank area [____________] indicates that text should be added. Examples or choices may be provided in [brackets] following the blank. If appropriate, select one and delete the others. The underlining should be deleted.

If a given section does not apply, it is recommended that the section state “Not applicable” or “Does not apply” under the section heading. By including the section, the writer avoids having to renumber sections. However, sections can be removed altogether and the remaining sections renumbered.

Example forms are located in Attachment 1. They should be deleted and organization appropriate ones included in the final SAP.

The U.S. EPA Region 9 Quality Assurance Section is available to provide assistance in completing the SAP. Contact Audrey L. Johnson at 415-972-3431, or Mr. Derrick Williamson at 415-972-3698.

Sampling and Analysis Plan [Title of Project] SITE [Address]

Prepared for:

[Name of Organization]

[Date]

Prepared by:

[Name of Organization] [Address]

APPROVAL PAGE

Approved by: ______________________________________ ________________

[Grantee Name] Project Manager **Date**

Approved by: ______________________________________ ________________

[Contractor Name] Project Manager **Date**

Approved by: ______________________________________ ________________

[Contractor Name] Quality Assurance Officer **Date**

Approved by: ______________________________________ ________________

Project Officer, USEPA Region IX **Date**

Approved by: ______________________________________ ________________

Quality Assurance Manager, USEPA Region IX **Date**

TABLE OF CONTENTS

APPROVAL PAGE
DISTRIBUTION LIST
ACRONYMS AND ABBREVIATIONS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

Include a list of figures referred to in the report. The following list can be used as a starting point. Add or delete figures as appropriate.

LIST OF TABLES

Include a list of tables referred to in the report. The following list can be used as a starting point. Add or delete tables as appropriate.

LIST OF APPENDICES

Include a list of appendices referred to in the report. The following list can be used as a starting point. Add or delete appendices as appropriate.

DISTRIBUTION LIST

Add additional names as appropriate.

[Grantee Name, Title]
[Grantee Address]

[Contractor Name, Title]
[Contractor Address]

[Name, USEPA Project Officer]
[Division or Section]
US EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

[Name, USEPA QA Manager]
Quality Assurance Section
US EPA Region 9
75 Hawthorne Street
San Francisco, CA 94105

ABBREVIATIONS AND ACRONYMS

Include and define all acronyms and abbreviations used throughout the plan. The following list can be used as a starting point. Add or delete acronyms and abbreviations as appropriate.

ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Cleanup, and Liability Act
CFR	Code of Federal Regulations
CHHSL	California Human Health Screening Levels
CLP	Contract laboratory program
CWA	Clean Water Act
DQA	Data quality assessment
DQI	Data quality indicators
DQO	Data quality objectives
EPA	U.S. Environmental Protection Agency
ESA	Environmental site assessment
ESL	Environmental Screening Levels
FSP	Field sampling plan
GC/MS	Gas chromatography and mass spectrometry
IDW	Investigation-derived waste
LCS	Laboratory control sample
MDL	Method detection limit
MQO	Measurement quality objective
MS/MSD	Matrix spike and matrix spike duplicate
mg/L	Milligrams per liter
µg/L	Micrograms per liter
PARCCS	Precision, accuracy, representativeness, completeness, comparability, and sensitivity
PE	Performance evaluation
PRQL	Project-required quantitation limit
QA	Quality assurance
QA/QC	Quality assurance/quality control

ABBREVIATIONS AND ACRONYMS (Continued)

QAPP	Quality assurance project plan
QC	Quality control
QL	Quantitation limit
RCRA	Resource Conservation and Recovery Act
RPD	Relative percent difference
RSL	Regional Screening Level
%R	Percent recovery
SAP	Sampling and analysis plan (an integrated FSP and QAPP)
SOP	Standard operating procedures
SOW	Statement of work
SVOC	Semi-volatile organic compound
TNI	The NELAC Institute
VOC	Volatile organic compound

1. INTRODUCTION

1.1 SITE HISTORY

This section should include a brief description of the project, including the history, problem to be investigated, scope of sampling effort, and types of analyses required. These topics will be covered in depth later so do not include a detailed discussion here. Include tentative sampling dates.

For Brownfields projects, the type of grant (Assessment, Cleanup, Revolving Loan Fund or 128(a)) should be specified and whether it is for hazardous substances or petroleum products. Assessment grants should also state whether it is an area-wide or site-specific grant.

1.2 SITE NAME OR SAMPLING AREA

Provide the most commonly used name of the site or sampling area. Also include the name or abbreviation ("the Site"), if any, that will be used throughout the plan.

1.3 SITE OR SAMPLING AREA LOCATION

Provide a general description of the region (residential, commercial, light industrial, mixed, etc.), state or tribal area in which the site or sampling area is located. Include street address, city, state, and postal code, if appropriate. Detailed information should be provided later in Section 2.

1.4 RESPONSIBLE ORGANIZATION

Provide a description of the organization conducting the sampling.

1.5 PROJECT ORGANIZATION

Table 1-1 should be completed. Provide the name, phone number and email address of the person(s) and/or contractor working on the sampling project as listed in the table. The table can be modified to include titles or positions appropriate to the specific project. Delete personnel or titles not appropriate to the project. A brief description of the roles and responsibilities for each key position should be included either in the table (as shown) or within the text of this section.

An Organization Chart should be included showing the lines of communication. The above information may also be included on the Organization Chart, if appropriate.

It is the responsibility of the Quality Assurance (QA) Officer to oversee the implementation of the Sampling and Analysis Plan, including whether specified quality control (QC) procedures are being followed a described. Ideally, this individual should discuss QA issues with the Project Manager, but should not be involved in the data collection/analysis/interpretation/reporting process except in a review or oversight capacity. If the project is small, another technical person may fulfill this role.

Table 1-1
Key Project Personnel Contact Information and Responsibilities

Title	Name	Phone Number Email Address	Responsibilities
EPA Project Manager			
EPA Quality Assurance Officer (QAO)			
Grantee Project Manager			
Contractor Project Manager (include Company Name)			
Contractor QAO			
Contractor Field Team Leader			
Laboratory Quality Assurance Officer (include Laboratory Name)			

2. BACKGROUND

This section provides an overview of the location, previous investigations, and the apparent problem(s) associated with the site or sampling area.

2.1 SITE OR SAMPLING AREA DESCRIPTION

Two maps of the area should be provided: the first, on a larger scale, should place the area within its geographic region; the second, on a smaller scale, should mark the sampling site or sampling areas within the local area. Additional maps may be provided, as necessary, for clarity. Maps should include a North arrow, a surface and/or ground water directional flow arrow (if appropriate), buildings or former buildings, spill areas, etc. If longitude or latitude information is available, such as from a Global Positioning System (GPS), provide it.

Fill in the blanks.

The site or sampling area occupies_________________*[acres or square feet*] in a/an ________________ [*urban, commercial, industrial, residential, agricultural, or undeveloped*] area. The site or sampling area is bordered on the north by_____________, on the west by______________________, on the south by__________________, and on the east by _________________. The specific location of the site or sampling area is shown in Figure 2.2.

The next paragraph(s) should describe historic and current on-site structures. These should be shown on one of the figures.

Depending on the nature of the project, some of the following sections may not be applicable. If this is the case, do not delete the section. Instead enter "Not Applicable" or other text to indicate that the section does not apply or that the information is not available.

2.2 OPERATIONAL HISTORY

As applicable, describe in as much detail as possible (i.e., use several paragraphs) the past and present activities at the site or sampling area. The discussion might include the following information:

- *a description of the owner(s) and/or operator(s) of the site or areas near the site or sampling area (present this information chronologically);*
- *a description of past and current operations or activities that may have contributed to suspected contamination;*
- *a description of the processes involved in the operation(s) and the environmentally detrimental substances, if any, used in the processes;*
- *a description of any past and present waste management practices.*

2.3 PREVIOUS INVESTIGATIONS/REGULATORY INVOLVEMENT

Summarize all previous sampling efforts at the site or sampling area, including:

- *the sampling date(s);*
- *name of the party(ies) that conducted the sampling;*
- *local, tribal, state or federal government agency for which the sampling was conducted;*
- *a rationale for the sampling;*
- *the type of media sampled (e.g., soil, sediment, water, soil vapor);*
- *laboratory methods that were used;*
- *a discussion of what is known about data quality and usability.*

The summaries should be presented in subsections chronologically. Attach reports or summary tables of results, or include in appendices, if necessary. See Table 2-1 for an example. Previous sampling locations can be shown on one of the figures, or additional figures can be included.

If results from previous sampling events are being used in a general nature, the results can be summarized (e.g., report the highest hits or the range of the results). If specific results are being used to direct the current sampling effort, those specific results must be reported on an analyte- by-analyte basis.

2.4 SCOPING MEETING

Summarize the scoping meeting and/or site visit, including:

- *the date the meeting was held*
- *who attended*
- *what was discussed*

- *what decisions were made*

If more than one scoping meeting/site visit was conducted, include the above information for each.

2.5 GEOLOGICAL/METEOROLOGICAL INFORMATION

For surface and/or ground water sampling: Provide a description of the hydrogeology of the area. Indicate the direction of flow and include a directional flow arrow on the appropriate figure.

For soil sampling: Provide a description of the geology of the area.

For air sampling: Provide prevailing wind direction, temperature, etc.

2.6 IMPACT ON HUMAN HEALTH AND/OR THE ENVIRONMENT

Discuss what is known about the possible and actual impacts of the potential environmental problem at the site on human health and/or the environment.

Table 2-1
Contaminants of Concern, Previous Investigations
Matrix = xx

Analytical Parameter (Contaminants of Concern)	Date of sampling	Sampling contractor	Laboratory Analytical Results (units)	Regulatory Limit (specify)[1]

Specify the source of the regulatory limit(s). For example:

DTSC = Calif. Department of Toxic Substances Control
RWQCB = Regional Water Quality Control Board
RSLs = EPA Region IX Regional Screening Levels
CHHSLs = California Human Health Screening Levels
ESLs = Environmental Screening Levels

3. PROJECT AND DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements for establishing criteria for data quality and for developing data collection designs. This section is crucial to SAP approval, since it defines what the data will be used for and what quality of data are needed to make decisions. EPA’s Guidance for Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4, February 2006) should be consulted for more information. The DQO section should cover the following items:

- Concisely describe the problem to be investigated.
- Identify what questions the investigation will attempt to resolve, what actions (decisions) may result, and who the primary decision maker is.
- Identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement(s).
- Define study boundaries and when and where data should be collected.

Most projects utilizing this template are small. Therefore, defining action levels and measurement quality objectives (MQOs) for field and laboratory measurements used on the project are usually sufficient. MQOs define criteria for calibration and quality control (QC) for field and laboratory methods. MQOs are discussed more thoroughly below.

3.1 PROJECT TASK AND PROBLEM DEFINITION

Describe the purpose of the environmental investigation in qualitative terms and how the data will be used. Discuss how the site history relates to the problem to be investigated, scope of sampling effort, and types of analyses that will be required. Include all measurements to be made on an analyte specific basis in whatever media (soil, sediment, water, etc.) is to be sampled. This discussion should relate to how this sampling effort will support the specific decisions described in Section 3.2, DQOs, below.

Redevelopment plans, if known, should be included. If the future use of the site is not known, this should be stated.

3.2 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are quantitative and qualitative criteria that establish the level of uncertainty associated with a set of data. They answer the question: How sure are you that the values of the data are what the analyses have determined them to be? All the elements of the sampling event, from the sampling design through laboratory analysis and reporting, affect the quality of the data. The project manager, or other decision maker identified earlier in the project organization section, must make the decision as to what level of uncertainty is acceptable or appropriate. Depending on what the contaminants of concern are, what effect they may have on human and environmental health, and at what level, data quality may need to be legally defensible or capable of answering only a simple "presence-absence" question. More sophisticated DQO discussions involve defining null testing hypotheses and confidence intervals. These should be considered depending on project decision making needs, but such discussions are generally not expected in one-time event SAPs. (A description of the "Seven Step DQO Process" is included in Attachment A).

This section should describe decisions to be made based on the data and provide criteria on which these decisions will be made. Inclusion of one or more tables is recommended. Tables should contain, at a minimum, the main contaminants of concern, their associated action levels and detection limits, and the source of the action level (regulation, health based criteria, water quality standards, etc.) If a contaminant does not have an action level, or will not be used in decision making, the text should discuss how the data for that contaminant will be used. (See Attachment B for a discussion of the relationship between project action limits (PALs), detection limits (DLs) and quantitation limits (QLs).)

The use of "If...then" statements are recommended. Decisions do not have to involve regulatory or legal action (and for Brownfields projects, few are expected to). Some examples: "If contaminants of concern are not detected above the action limits, then no further action is required." or: "If one or more contaminants of concern are found above the action level, then recommendations for further action, such as additional assessment, remediation, or removal will be evaluated."

Discuss Data Quality Objectives, action levels, and decisions to be made based on the data. A table should be constructed which includes the analytes of concern, action limits and detection limits. See Table 3-1 for an example. A separate table should be prepared for each matrix/media to be sampled.

3.3 MEASUREMENT QUALITY OBJECTIVES

Measurement Quality Objectives are criteria established to assess the viability and usability of data. These are based on both field and laboratory protocols that examine whether the data quality indicators (DQIs), i.e., precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS), meet criteria established for various aspects of data gathering, sampling, or analysis activity. In defining MQOs specifically for the project, the level of uncertainty associated with each measurement is defined. Some DQIs are quantitative, others are more qualitative. (See Attachment C for a discussion of the PARCCS parameters.)

The values that are to be assigned to the quantitative data quality indicators (precision, accuracy, completeness and sensitivity) and statements concerning the qualitative indicators (representativeness and comparability) are determined by the answers to the questions in Section 3.2.

Project specific requirements for precision, accuracy, representativeness, completeness, comparability and sensitivity (PARCCS) should be discussed here. Where applicable, precision and accuracy acceptance limits, for both laboratory and field measurements, may be presented in a tabular format. A separate table should be prepared for each matrix or media to be sampled. Otherwise, MQO tables or laboratory SOPs should be included as appendices and referenced. This is discussed in greater detail in Section 5.2.

3.4 DATA REVIEW AND VALIDATION

Region 9 has adopted a tiered approach to data review. Details on validation are available from the QA Office, but a brief summary follows:

- Tier 1 involves a cursory review of the QC data for the project. This is sometimes referred to as a “Summary Forms” review. At a minimum, all data should receive a Tier 1 review.
- Tier 2 involves a selected validation based on several factors which should be defined in the DQOs for the project. Candidates might be a specific area within the sampling area, specific analytes or analyses of concern critical to decision making, or some other factor(s). The review may also focus on anomalies noted during the Tier 1 review.
- Tier 3 involves a traditional full validation. Data reviewed include the raw data, standards log books, extractions logs, instrument printouts, chromatograms (if applicable), mass spectra (if applicable), etc. Calibration data, sample analysis data, and quality control data are all evaluated. Typically, this is a “3rd party review” and isbased on strict protocols, such as the National Functional Guidelines.

There is no requirement that all data adhere to the same Tier; the project can mix and match depending on project needs and requirements. It is recommended that if validation will be a part of the data review process, that SOP(s) from the organization which will perform the validation be attached.

Discuss data review and data validation including what organizations or individuals will be responsible for what aspects of data review and what the review will include. This section should also discuss how data that do not meet data quality objectives will be designated, flagged, or otherwise handled. Possible corrective actions associated with the rejection of data, such as reanalysis or resampling, also need to be addressed.

3.5 DATA MANAGEMENT

Provide a list of the steps that will be taken to ensure that data are transferred accurately from collection to analysis to reporting. Discuss the measures that will be taken to review the data collection processes, including field notes or field data sheets; to obtain and review complete laboratory reports; and to review the data entry system, including its use in reports. A checklist is acceptable.

3.6 ASSESSMENT OVERSIGHT

Describe the procedures which will be used to implement the QA Program. This would include oversight by the Quality Assurance Manager or the person assigned QA responsibilities. Indicate how often a QA review of the different aspects of the project, including audits of field and laboratory procedures, use of performance evaluation samples, review of laboratory and field data, etc., will take place. Describe what authority the QA Manager or designated QA person has to ensure that identified field and analytical problems will be corrected and the mechanism by which this will be accomplished.

Table 3-1

Contaminants of Concern, Laboratory, and Screening or Action Levels Matrix = xx

Analytical Parameter (Contaminants of Concern)	Laboratory Reporting or Quantitation Limits	Screening or Action Levels		

4. SAMPLING DESIGN AND RATIONALE

For each sampling event, the SAP must describe the sampling locations, the media tobe sampled, and the analytes of concern at each location. A rationale should then be provided justifying these choices. This information may be presented in a tabular format. (See Tables 4-1and 4-2 for examples.) This section is crucial to plan approval and should be closely related to previously discussed DQOs.

The following subsections are subdivided on a media specific basis among soil, sediment, and water. Other media should be added as needed. Appropriate figures should be included showing proposed sampling locations.

Information regarding the collection of field duplicates may be included in these sections. Provide a rationale for the selection of these locations. If locations will be determined in the field, the criteria that will be used to make these selections should be provided. Alternatively, field duplicates may be discussed in Section 10.1.2.

Do not include sampling procedures, preservation, etc., as these topics are covered in later sections.

4.1 SOIL SAMPLING

Provide a general overview of the soil sampling event. Present a rationale for choosing each sampling location at the site or sampling area and the depths at which the samples are to be taken, if relevant. If decisions will be made in the field, provide details concerning the criteria that will be used to make these decisions (i.e., the decision tree to be followed). List the analytes of concern at each location and provide a rationale for why the specific chemical or group of chemicals (e.g., organochlorine pesticides) was chosen. Include a figure showing sampling locations.

4.2 SEDIMENT SAMPLING

Provide a general overview of the sediment sampling event. Present a rationale for choosing each sampling location at the site or sampling area and the depths or area of the river, stream or lake at which the samples are to be taken, if relevant. If decisions will be made in the field, provide details concerning the criteria that will be used to make these decisions (i.e., the decision tree to be followed). List the analytes of concern at each location and provide a rationale for why the specific chemical or group of chemicals (e.g., organochlorine pesticides) was chosen. Include a figure showing sampling locations.

4.3 WATER SAMPLING

Provide a general overview of the water sampling event. For groundwater, describe the wells to be sampled or how the samples will be collected (e.g., hydro punch), including the depths at which the samples are to be taken. For surface water, describe the depth and nature of the samples to be collected (fast or slow-moving water, stream traverse, etc.). Present a rationale for choosing each sampling location or sampling area. If decisions will be made in the field, provide details concerning the criteria that will be used to make these decisions (i.e., the decision tree to be followed). List the analytes of concern at each location and provide a rationale for why the specific chemical or group of chemicals (e.g., organochlorine pesticides) was chosen. Include a figure showing sampling locations.

4.4 SOIL VAPOR SAMPLING

Describe soil vapor considerations and discuss whether soil vapor may be a potential concern, and if sampling may be warranted at the site. All assessments should consider the potential for vapor intrusion to ensure that any redevelopment activities protect the health of current and future site occupants. Evaluate the site conditions and determine the potential soil vapor intrusion. concerns. State if soil vapor intrusion is a concern at the site based on the flowchart provided below, and if warranted, describe any soil vapor sampling activities.

Below is some suggested language:

Vapor intrusion is defined as the migration of chemical vapors from contaminated soil and groundwater into existing or planned buildings. Vapor intrusion exposes building occupants to potentially toxic levels of vapors when volatile organic compounds (VOCs) present in contaminated soil or groundwater emit vapors that migrate into overlying buildings. VOCs in contaminated soil and groundwater emit vapors that rise through the pore space of the unsaturated zone above the water table. These vapors can move laterally as well as vertically from the source of contamination. Generally, soil or groundwater contamination within 100 feet (laterally or vertically) of any current or future on-site or off-site buildings contains the potential for releasing hazardous vapors to the indoor air. Any passageway, such as a sand or gravel layer, buried utility line, or animal burrow, may facilitate the flow of soil vapor. Properties with a higher potential for soil vapor intrusion include industrial and commercial areas, such as former manufacturing and chemical processing plants, warehouses, train yards, dry cleaners, and gas stations.

4.5 OTHER SAMPLING

Describe other media that may be sampled. Present a rationale for choosing each sampling location at the site or sampling area and the depths at which the samples are to be taken, if relevant. If decisions will be made in the field, provide details concerning the criteria that will be used to make these decisions (i.e., the decision tree to be followed). List the analytes of concern at each location and provide a rationale for why the specific chemical or group of chemicals was chosen. Include a figure showing sampling locations.

4.6 CULTURAL RESOURCE DISCOVERIES

The disturbance of site soils carries the potential of unanticipated discovery of cultural resources. Cultural resources are artifacts, relics, or other physical traces, regardless of condition, that may be associated with prehistoric or indigenous occupation and use of the site and may possess archeological significance or be of importance to existing tribes. Information describing the steps to be implemented if cultural resources are discovered should be included in this section. Different regions, municipalities, agencies, states, or other organizations, such as a local tribe, may already have an appropriate plan developed. If so, a copy should be included with this document and referenced here.

Table 4-1
Sampling Design and Rationale Matrix = Soil

Sampling Location/ID Number	Depth (feet)	Analytical Parameter	Rationale *

* Include rationale for location, depth and analysis.

Table 4-2
Sampling Design and Rationale
Matrix = Groundwater

Sampling Location/ID Number	Analytical Parameter	Rationale *

* Include rationale for location and analysis.

5. REQUEST FOR ANALYSES

This section should discuss the following analytical support for the project: the analyses requested, analytes of concern, turnaround times, available resources, available laboratories, etc. The use of tables is highly recommended. If samples will be sent to more than one organization, it should be clear which samples will be sent to each laboratory. Field analyses for pH, conductivity, turbidity, or other field tests should be discussed in the sampling section. Field measurements in a mobile laboratory should be discussed here and differentiated from samples to be sent to a fixed laboratory. Field screening tests (for example, immunoassay tests) should be discussed in the sampling section, but the confirmation tests should be discussed here and the totals included in the tables.

5.1 ANALYSES NARRATIVE

Complete this subsection concerning the analyses for each matrix. An analytical services table is recommended for each matrix to be sampled. See Tables 5-1 and 5-2 for examples. Each table must include the analytical parameters for each type of sample. Quality Control (QC) samples, such as blanks, duplicates, splits, and laboratory QC samples, should be indicated in the column titled “Special Designation.” The selected analyses must be consistent with earlier discussions concerning DQOs and analytes of concern.

Information on container types, sample volumes, preservatives, special handling, and analytical holding times for each parameter may be included here or on a separate table. See Tables 5-3 and 5-4 for examples.

Include any special requests, such as fast turn-around time (2 weeks or less), specific QC requirements, or modified sample preparation techniques in this section. Provide information for each analysis requested.

Note: Rationale for the selection of duplicate and laboratory QC sample locations is to be provided in Section 10.0.

5.2 ANALYTICAL LABORATORY

When an organization contracts for analytical work it has two options. In Option 1, MQOs for laboratory work are defined in the SAP. The MQOs are provided to the laboratory which then acknowledges that it is capable of meeting these criteria, and also states it is willing to do so. In Option 2, the sampling organization reviews the information from the laboratory on its QA/QC Program and C criteria and determines whether the laboratory can meet project needs.

If the first approach is taken, the organization writing the SAP should include the appropriate QC tables in the SAP. The Region 9 QA Office has MQO tables available for most routine analyses. These tables can be attached to the SAP and referenced in this section. Plan preparers are free to request these tables, review them for their appropriateness for the project, and incorporate all or some of them in original or modified form into their SAP.

If the second approach is taken, the sampling organization must acknowledge that it understands and agrees to the MQOs defined by the contract laboratory which will be used for the project. MQOs or QC criteria for work performed by the laboratory will be found in either the laboratory's QA Plan and/or its SOPs, which must be included with the sampling plan for review.

Field analyses for pH, conductivity, turbidity, or other field tests should be discussed in the sampling section. Field measurements in a mobile laboratory (for example, the Field Analytical Support Program (FASP) laboratory) should be discussed here and differentiated from samples to be sent to a fixed laboratory. Field screening tests (for example, immunoassay tests) should be discussed in the sampling section, but the confirmation tests should be discussed here and the totals included in the tables.

The narrative subsection concerning laboratory analytical requirements should be completed. Appropriate MQO tables, or the laboratory QA Plan and relevant SOPs for the methods to be performed, must accompany the SAP. EPA does not approve or certify laboratories; however, it will review the laboratory's QA Plan and provide comments to the SAP's originator concerning whether the laboratory's QA/QC program appears to be adequate to meet project objectives. It is recommended that any issues raised be discussed with the laboratory and resolved before work commences. Note that the more the SAP "defaults" to laboratory capabilities, the greater emphasis will be placed on the adequacy of the laboratory's QA program. If MQO tables, or the equivalent, are used, less emphasis will be placed on the laboratory's QA Program.

Table 5-1 Analytical Services Matrix = Soil

Sample Number	Sample Location	Depth (feet)	Special Designation	Analytical Methods			
Total number of Soil Samples, excluding QC:							
Total number of Soil Samples, including QC:							

Table 5-2

Analytical Services
Matrix = Groundwater

Sample Number	Sample Location	Special Designation	Analytical Methods			
Total number of samples, excluding QC						
Total number of samples, including QC						

6. FIELD METHODS AND PROCEDURES

In the general introductory paragraph to this section, there should be a description of the methods and procedures that will be used to accomplish the sampling goals, e.g., "...collect soil, sediment and water samples." It should be noted that personnel involved in sampling must wear clean, disposable gloves of the appropriate type. The sampling discussion should track the samples identified in Section 4.0 and Analytical Services table(s). A general statement should be made that refers to the sections containing information about sample tracking and shipping (Section 7). Provide a description of the sampling procedures. Example procedures are provided below, but the organization's own procedures can be used instead. In that case, attach a copy of the applicable SOP. Some sampling procedures are available from EPA. Contact the QA Office or visit the Region 9 laboratory's web page.

6.1 FIELD EQUIPMENT

6.1.1 List of Equipment Needed

List all the equipment that will be used in the field to collect samples, including decontamination equipment, if required. Discuss the availability of back-up equipment and spare parts. This information can be presented in a tabular format. See Table 6-1 for an example.

6.1.2 Calibration of Field Equipment

Describe the procedures by which field equipment is prepared for sampling, including calibration standards used, frequency of calibration and maintenance routines. Indicate where the equipment maintenance and calibration record(s) for the project will be kept. See Table 6-2 for an example.

6.2 FIELD SCREENING

In some projects a combination of field screening using a less accurate or sensitive method may be used in conjunction with confirmation samples analyzed in a fixed laboratory. This section should describe these methods or reference attached SOPs. Analyses such as XRF or immunoassay kits are two examples. Describe any field screening methods to be used on the project, including how samples will be collected, prepared, and analyzed in the field. Include in an appendix, as appropriate, SOPs covering these methods. Confirmation of screening results should also be described. The role of field screening in decision making for the site should also be discussed here if it has not been covered previously.

6.3 SOIL SAMPLING

6.3.1 Surface Soil Sampling

Use this subsection to describe the collection of surface soil samples that are to be collected within 6-12 inches of the ground surface. Specify the method (e.g., hand trowels) that will be used to collect the samples and then transfer samples to the appropriate containers, or reference the appropriate sections of a Soil Sampling SOP. If SOPs are referenced, they should be included in an appendix.

If exact soil sampling locations will be determined in the field, this should be stated. The criteria that will be used to determine sampling locations, such as accessibility, visible signs of potential contamination (e.g., stained soils, etc.), and topographical features which may indicate the location of hazardous substance disposal (e.g., depressions that may indicate a historic excavation) should be provided.

Include this paragraph first if exact sampling locations are to be determined in the field; otherwise delete.

Exact soil sampling locations will be determined in the field based on accessibility, visible signs of potential contamination (e.g., stained soils), and topographical features which may indicate location of hazardous substance disposal (e.g., depressions that may indicate a historic excavation). Soil sample locations will be recorded in the field logbook as sampling is completed. A sketch of the sample location will be entered into the logbook and any physical reference points will be labeled. If possible, distances to the reference points will be given.

If surface soil samples are to be analyzed for volatile organic compounds (VOCs), use this paragraph; otherwise delete. It is Region 9 policy that soils collected for volatile and gasoline analyses be collected in hermetically sealed sampling devices (such as EnCore samplers) and analyzed within the holding time specified in EPA Method 5035, or immediately preserved by one of the processes specified in EPA Method 5035. A rationale should be provided if more than one preservation method is specified. Collection in brass tubes, even if subsequently preserved, is not acceptable.

Samples to be analyzed for volatile organic compounds will be collected first. Surface soil samples for VOC analyses will be collected as grab samples (independent, discrete samples) from a depth of 0 to ____ inches below ground surface (bgs). Surface soil samples will be collected using [specify the type of sampling device], and will be collected in triplicate. Samples will be sealed and placed in a zip lock bag. See Section 7.1 for preservation and shipping procedures.

If surface soil samples are to be analyzed for compounds other than volatiles, use this paragraph; otherwise delete.

Surface soil samples will be collected as grab samples (independent, discrete samples) from a depth of 0 to inches below ground surface (bgs). Surface soil samples will be collected using a stainless-steel hand trowel. Samples to be analyzed for__________________________________[list all analytical methods for soil samples except for volatile organic compounds] will be placed in a sample-dedicated disposable pail and homogenized with a trowel. Material in the pail will be transferred with a trowel from the pail to the appropriate sample containers. Sample containers will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being closed to prevent potential contaminant migration to or from the sample. [Alternatively, samples will be retained in the brass sleeves in which collected until samples preparation begins.] See Section 7.1 for preservation and shipping procedures.

6.3.2 Subsurface Soil Sampling

Use this subsection for subsurface soil samples that are to be collected 12 inches or more below the surface. Specify the method (e.g., hand augers) that will be used to access the appropriate depth and then state the depth at which samples will be collected and the method to be used to collect and then transfer samples to the appropriate containers, or reference the appropriate sections of a Soil Sampling SOP. If SOPs are referenced, they should be included in an Appendix.

If exact soil sampling locations will be determined in the field, this should be stated. The criteria that will be used to determine sampling locations, such as accessibility, visible signs of potential contamination (e.g., stained soils), and topographical features which may indicate the location of hazardous substance disposal (e.g., depressions that may indicate a historic excavation) should be provided. There should also be a discussion concerning possible problems, such as subsurface refusal.

Include this paragraph first if exact sampling locations are to be determined in the field; otherwise delete.

Exact soil sampling locations will be determined in the field based on accessibility, visible signs of potential contamination (e.g., stained soils), and topographical features which may indicate location of hazardous substance disposal (e.g., depressions that may indicate a historic excavation). Soil sample locations will be recorded in the field logbook as sampling is completed. A sketch of the sample location will be entered into the logbook and any physical reference points will be labeled. If possible, distances to the reference points will be given.

If subsurface samples are to be analyzed for volatile organic compounds, use this paragraph; otherwise delete It is Region 9 policy that soils collected for volatile and gasoline analyses be collected in hermetically sealed sampling devices (such as EnCore samplers) and analyzed within the holding time specified in EPA Method 5035, or immediately preserved by one of the processes specified in EPA Method 5035. A rationale should be provided if more than one preservation method is specified. Collection in brass tubes, even if subsequently preserved, is not acceptable.

Samples to be analyzed for volatile organic compounds will be collected first. Subsurface samples will be collected by boring to the desired sample depth using ______________________. Once the desired sample depth is reached, soil samples for VOC analyses will be collected as independent, discrete samples. Surface soil samples will be collected using [specify the type of sampling device], and will be collected in triplicate. Samples will be sealed using the Encore sampler and placed in a zip lock bag. See Section 7.1 for preservation and shipping procedures.

If subsurface soil samples are being collected for compounds other than volatiles, use these paragraphs; otherwise delete.

Subsurface samples will be collected by boring to the desired sample depth using _______________. Once the desired sample depth is reached, the ____ [hand- or power-operated device, such as a shovel, hand auger, hollow-stem auger or split-spoon sampler] will be inserted into the hole and used to collect the sample. Samples will be transferred from the ____________________________[sampling device] to a sample-dedicated disposable pail and homogenized with a trowel. Material in the pail will be transferred with a trowel from the pail to the appropriate sample containers. Sample containers will be filled to the top taking care to prevent soil from remaining in the lid threads prior to being sealed to prevent potential contaminant migration to or from the sample. See Section 7.1 for preservation and shipping procedures.

Include this as the final paragraph for subsurface soil samples.

Excess set-aside soil from the above the sampled interval will then be repacked into the hole.

6.4 SEDIMENT SAMPLING

Use this subsection if sediment samples are to be collected. Specify the method (e.g., dredges) that will be used to collect the samples and at what depth samples will be collected. Describe how samples will be homogenized and the method to be used to transfer samples to the appropriate containers, or reference the appropriate sections of a Soil Sampling SOP. If SOPs are referenced, they should be included in an appendix.

If exact sediment sampling locations will be determined in the field, this should be stated. Describe where sediment samples will be collected, e.g., slow moving portions of streams, lake bottoms, washes, etc.

Include this paragraph first if exact sampling locations are to be determined in the field; otherwise delete.

Exact sediment sampling locations will be determined in the field, based on _________________ [describe the criteria to be used to determine sampling locations]. Care will be taken to obtain as representative a sample as possible. The sample will be taken from areas likely to collect sediment deposits, such as slow-moving portions of streams or from the bottom of the lake at a minimum depth of 2 feet.

The final paragraph describes sample homogenization, which is especially important if the sample is to be separated into solid and liquid phases, and container filling. Include this paragraph, or a modified form of it, for all sediment sampling. It is assumed that sediment samples will not be analyzed for volatile compounds. If sediment is to be analyzed for volatile organic compounds, the samples to be analyzed for volatile compounds should not be homogenized, but rather transferred directly from the sampler into the sample container. If feasible, a hermetically sealed sampling device should be used.

Material in the sampler will be transferred to a sample-dedicated disposable pail and homogenized with a trowel. Material from the pail will be transferred with a trowel from the bucket to the appropriate sample containers. Sample containers will be filled to the top taking care to prevent soil from remaining in the lid groves prior to being sealed in order to prevent potential contamination migration to or from the sample containers. See Section 7.2 for preservation and shipping procedures.

6.5 WATER SAMPLING

6.5.1 Surface Water Sampling

Use this subsection if samples are to be collected in rivers, streams, lakes and reservoirs, or from standing water in runoff collection ponds, gullies, drainage ditches, etc. Describe the sampling procedure, including the type of sample (grab or composite - see definitions below), sample bottle preparation, and project-specific directions for taking the sample. State whether samples will be collected for chemical and/or microbiological analyses. Alternatively, reference the appropriate sections of attached SOPs.

Grab: Samples will be collected at one time from one location. The sample should be taken from flowing, not stagnant water, and the sampler should be facing upstream in the middle of the stream. Samples will be collected by hand or with a sample bottle holder. For samples taken at a single depth, the bottle should be uncapped and the cap protected from contamination. The bottle should be plunged into the water mouth down and filled 6 to 12 inches below the surface of the water. If it is important to take samples at depths, special samplers (e.g., Niskin or Kemmerer Depth Samplers) may be required.

Time Composite: Samples are collected over a period of time, usually 24 hours. If a composite sample is required, a flow- and time-proportional automatic sampler should be positioned to take samples at the appropriate location in a manner such that the sample can be held at 4^{o}C for the duration of the sampling.

Spatial Composite: Samples are collected from different representative positions in the water body and combined in equal amounts. A Churn Splitter or equivalent device will be used to ensure that the sample is homogeneously mixed before the sample bottles are filled. Volatile organic compound samples will be collected as discrete samples and not composited.

If exact surface water sample locations will be determined in the field, this should be stated. Describe the criteria that will be used to determine where surface water samples will be collected.

Include this paragraph first if exact sampling locations are to be determined in the field; otherwise delete.

Exact surface water sampling locations will be determined in the field based on __________________ [describe the criteria to be used to determine sampling locations]. Sample locations will be recorded in the field logbook as sampling is completed. A sketch of the sample location will be entered into the logbook and any physical reference points will be labeled. If possible, distances to the reference points will be given.

Use this paragraph if samples are to be collected in rivers, streams, lakes and reservoirs, or from standing water in runoff collection ponds, gullies, drainage ditches, etc. Describe the sampling procedure, sample bottle preparation, and project-specific directions for taking the sample, or reference the appropriate sections of a Water Sampling SOP. If SOPs are referenced, they should be included in an appendix.

Samples will be collected from_______________[describe the sampling location]. The sample will be taken from flowing, not stagnant water. The sampler will face upstream in the middle of the stream. Samples will be collected by hand or with a sample bottle holder. For samples taken at a single depth, the bottle should be uncapped and the cap protected from contamination. The bottle should be plunged into the water mouth down and filled 6 to 12" below the surface of the water. If it is important to take samples at depths, special samplers (e.g., Niskin or Kemmerer Depth Samplers) may be required. See Section 7.3 for preservation and shipping procedures.

6.5.2 Groundwater Sampling

This subsection contains procedures for water level measurements, well purging, and well sampling. Relevant procedures should be described under this heading with any necessary site- specific modifications, or reference sections of an appropriate SOP. If SOPs are referenced, they should be included in an appendix.

6.5.3 Water-Level Measurements

The following language may be used as is or modified to meet project needs.

All field meters will be calibrated according to manufacturer's guidelines and specifications before and after every day of field use. Field meter probes will be decontaminated before and after use at each well.

If well heads are accessible, all wells will be sounded for depth to water from top of casing and total well depth prior to purging. An electronic sounder, accurate to the nearest ±0.01 feet, will be used to measure depth to water in each well. When using an electronic sounder, the probe is lowered down the casing to the top of the water column; the graduated markings on the probe wire or tape are used to measure the depth to water from the surveyed point on the rim of the well casing. Typically, the measuring device emits a constant tone when the probe is submerged in standing water and most electronic water level sounders have a visual indicator consisting of a small light bulb or diode that turns on when the probe encounters water. Total well depth will be sounded from the surveyed top of casing by lowering the weighted probe to the bottom of the well. The weighted probe will sink into silt, if present, at the bottom of the well screen. Total well depths will be measured by lowering the weighted probe to the bottom of the well and recording the depth to the nearest 0.1 feet.

Water-level sounding equipment will be decontaminated before and after use in each well. Water levels will be measured in wells which have the least amount of known contamination first. Wells with known or suspected contamination will be measured last.

6.5.4 Purging

Describe the method that will be used for well purging (e.g., dedicated well pump, bailer, hand pump), or reference the appropriate sections in a Ground Water SOP. If SOPs are referenced, they should be included in an Appendix. Note: A combination of purging methods may be used.

Include this paragraph if dedicated well pumps will be used; otherwise delete.

All wells will be purged prior to sampling. If the well casing volume is known, a minimum of three casing volumes of water will be purged using the dedicated well pump.

Include this paragraph if hand pumps, submersible pumps, bailers, or other sampling methods will be used; otherwise delete.

All wells will be purged prior to sampling. If the well casing volume is known, a minimum of three casing volumes of water will be purged using [specify sampling method]. When a submersible pump is used for purging, clean flexible Teflon tubes will be used for groundwater extraction. All tubes will be decontaminated before use in each well. Pumps will be placed 2 to 3 feet from the bottom of the well to permit reasonable draw down while preventing cascading conditions.

The following paragraphs should be included in all sample plans.

Water will be collected into a measured bucket to record the purge volume. Casing volumes will be calculated based on total well depth, standing water level, and casing diameter. One casing volume will be calculated as:

$$\mathbf{V = \pi d^2 h / 77.01}$$

where: **V** is the volume of one well casing of water ($1 ft^3 = 7.48$ gallons);

d is the inner diameter of the well casing (in inches);

h is the total depth of water in the well (in feet).

It is most important to obtain a representative sample from the well. Stable water quality parameter (temperature, pH and specific conductance) measurements indicate representative sampling is obtainable. Water quality is considered stable if for three consecutive readings:

- temperature range is no more than ±1°C;
- pH varies by no more than 0.2 pH units;
- specific conductance readings are within 10% of the average.

The water in which measurements were taken will not be used to fill sample bottles.

If the well casing volume is known, measurements will be taken before the start of purging, in the middle of purging, and at the end of purging each casing volume. If the well casing volume is NOT known, measurements will be taken every 2.5 minutes after flow starts. If water quality parameters are not stable after 5 casing volumes or 30 minutes, purging will cease, which will be noted in the logbook, and ground water samples will be taken. The depth to water, water quality measurements and purge volumes will be entered in the logbook.

If a well dewaters during purging and three casing volumes are not purged, that well will be allowed to recharge up to 80% of the static water column and dewatered once more. After water levels have recharged to 80% of the static water column, groundwater samples will be collected.

6.5.5 Well Sampling

Describe the method that will be used to collect samples from wells. (This will probably be the same method as was used to purge the wells.) Specify the sequence for sample collection (e.g., bottles for volatile analysis will be filled first, followed by semivolatiles, etc.). State whether samples for metals analysis will be filtered or unfiltered. Include the specific conditions, such as turbidity, that will require samples to be filtered. Alternatively, reference the appropriate sections in the Ground Water SOP and state in which appendix the SOP is located.

The following paragraph should be included in all sample plans.

At each sampling location, all bottles designated for a particular analysis (e.g., volatile organic compounds) will be filled sequentially before bottles designated for the next analysis are filled (e.g., semivolatile organic compounds). If a duplicate sample is to be collected at this location, all bottles designated for a particular analysis for both sample designations will be filled sequentially before bottles for another analysis are filled. In the filling sequence for duplicate samples, bottles with the two different sample designations will alternate (e.g., volatile organic compounds designation GW-2, volatile organic compounds designation GW-4 (duplicate of GW-2), metals designation GW-2, and metals designation GW-4 (duplicate of GW-2). Groundwater samples will be transferred directly into the appropriate sample containers with preservative, if required, chilled if appropriate, and processed for shipment to the laboratory.

If samples are to be collected for <u>volatiles analysis</u>, the following paragraph should be added; otherwise delete.

Samples for volatile organic compound analyses will be collected using a low flow sampling device. A [specify type] pump will be used at a flow rate of________________. Vials for volatile organic compound analysis will be filled first to minimize the effect of aeration on the water sample. See Section 7.3 for preservation and shipping procedures.

If some samples for <u>metals (or other) analysis</u> are to be filtered, depending upon sample turbidity, the following paragraph should be added; otherwise delete.

After well purging and prior to collecting groundwater samples for metals analyses, the turbidity of the groundwater extracted from each well will be measured using a portable turbidity meter. A small quantity of groundwater will be collected from the well, transferred to a disposable vial, and a turbidity measurement will be taken. The results of the turbidity measurement will be recorded in the field logbook. The water used to measure turbidity will be discarded after use. If the turbidity of the groundwater from a well is above 5 Nephelometric Turbidity Units (NTUs), both a filtered and unfiltered sample will be collected. A [specify size]-micron filter will be used to remove larger particles that have been entrained in the water sample. A clean, unused filter will be used for each filtered sample collected. Groundwater samples will be transferred from the filter directly into the appropriate sample containers with a preservative and processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the filter to the sample container. After the filtered sample has been collected, an unfiltered sample will be collected. A sample number appended with an “Fl” will represent a sample filtered with a [specify size]-micron filter. See Section 7.3 for preservation and shipping procedures.

If samples are to be filtered for metals (or other) analysis regardless of sample turbidity, the following paragraph should be added; otherwise delete.

Samples designated for metals analysis will be filtered. A [specify size]-micron filter will be used to remove larger particles that have been entrained in the water sample. A clean, unused filter will be used for each filtered sample collected. Groundwater samples will be transferred from the filter directly into the appropriate sample containers to which preservative has been added and processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the filter to the sample container. After the filtered sample has been collected, an unfiltered sample will be collected. A sample number appended with an “Fl” will represent a sample filtered with a [specify size]-micron filter. See Section 7.3 for preservation and shipping procedures.

6.6 OTHER SAMPLING

Describe the collection of other media, if any.

6.7 DECONTAMINATION PROCEDURES

Specify the decontamination procedures that will be followed if non-dedicated sampling equipment is used. Alternatively, reference the appropriate sections in the organization’s Decontamination SOP and state in which appendix the SOP is located.

The decontamination procedures that will be followed are in accordance with approved procedures. Decontamination of sampling equipment must be conducted consistently as to assure the quality of samples collected. All equipment that comes into contact with potentially contaminated soil or water will be decontaminated. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Decontamination will occur prior to and after each use of a piece of equipment. All sampling devices used, including trowels and augers, will be steam-cleaned or decontaminated according to EPA Region 9 recommended procedures.

The following, to be carried out in sequence, is an EPA Region IX recommended procedure for the decontamination of sampling equipment.

Use the following decontamination procedures; edit as necessary.

- Non-phosphate detergent and tap water wash, using a brush if necessary
- Tap-water rinse
- 0.1 N nitric acid rinse [For inorganic analyses, include an acid rinse. Otherwise, delete.]
- Deionized/distilled water rinse
- Pesticide-grade solvent (reagent grade hexane) rinse in a decontamination bucket [For organic analyses, include a solvent rinse. Otherwise, delete.]
- Deionized/distilled water rinse (twice)

Equipment will be decontaminated in a pre-designated area on pallets or plastic sheeting, and clean bulky equipment will be stored on plastic sheeting in uncontaminated areas. Cleaned small equipment will be stored in plastic bags. Materials to be stored more than a few hours will also be covered.

NOTE: If a different decontamination procedure is used; a rationale for using the different approach should be provided.

Table 6-1
Field and Sampling Equipment

Description of Equipment	Material (if applicable)	Dedicated (Yes/No)

Table 6-2
Field Equipment/Instrument Calibration, Maintenance, Testing, and Inspection

Analytical Parameter	Field Equipment/ Instrument	Calibration Activity	Maintenance and Testing/ Inspection Activity	Frequency	Acceptance Criteria	Corrective Action

7. SAMPLE CONTAINERS, PRESERVATION, PACKAGING AND SHIPPING

This section describes the types of containers to be used and the procedures for preserving, packaging and shipping samples. Some of this information may have been presented in tabular form previously. See Tables 5-1 and 5-2 for examples. The organization responsible for adding preservatives should be named.

The number and type of sample containers, volumes, and preservatives are listed in [specify table(s)]. The containers are pre-cleaned and will not be rinsed prior to sample collection. Preservatives, if required, will be added by________________________________[name of agency/organization doing the sampling] to the containers prior to shipment of the samples to the laboratory.

7.1 SOIL SAMPLES

Include this subsection if collecting soil samples; otherwise delete.

Include the following paragraphs, as appropriate; otherwise delete. Modify if necessary.

VOLATILE ORGANIC COMPOUNDS: Soil samples to be analyzed for volatile organic compounds will be stored in their sealed Encore samplers for no more than two days prior to analysis. Samples will be chilled to 4°C immediately upon collection.

Include these sentences if samples will be frozen or preserved; otherwise delete. Frozen Encore sampler samples will be stored for no more than 4 days prior to analysis. If samples are preserved by ejecting into either methanol or sodium bisulfate solution the holding time is two weeks.

OTHER ORGANIC COMPOUNDS: Soil samples for_______________[include all requested analysis(ses)] will be homogenized and transferred from the sample-dedicated homogenization pail into 8-ounze wide-mouth glass jars using a trowel. A separate container will be collected for each laboratory. [Alternatively, samples will be retained in the brass sleeve in which collected until sample preparation begins.] The samples will be chilled to 4°C immediately upon collection.

METALS: Surface soil samples to be analyzed for metals will be homogenized and transferred from the sample-dedicated homogenization pail into 8-oz, wide-mouth glass jars. A separate container will be collected for each laboratory. Samples will not be chilled. Subsurface samples will be retained in their original brass sleeves or other container unless transferred to bottles.

7.2 SEDIMENT SAMPLES

Include this subsection if collecting sediment samples; otherwise delete.

Include the following paragraphs, as appropriate; otherwise delete. Modify if necessary.

VOLATILE ORGANIC COMPOUNDS: Sediment samples to be analyzed for volatile organic compounds will be stored in their sealed Encore samplers for no more than two days prior to analysis. Samples will be chilled to 4°C immediately upon collection.

Include these sentences if samples will be frozen or preserved; otherwise delete. Frozen EnCore samples will be stored for no more than 4 days prior to analysis. If samples are preserved by ejecting into either methanol or sodium bisulfate solution the holding time is two weeks.

OTHER ORGANIC COMPOUNDS: Soil samples for________________[include all requested analysis(ses)] will be homogenized and transferred from the sample-dedicated homogenization pail into 8-ounze wide-mouth glass jars using a trowel. A separate container will be collected for each laboratory. [Alternatively, samples will be retained in the brass sleeve in which collected until sample preparation begins.] The samples will be chilled to 4°C immediately upon collection.

METALS: Sediment samples, with rocks and debris removed, which are to be analyzed for metals will be homogenized and transferred from the sample-dedicated homogenization pail into 8-ounze, wide-mouth glass jars. A separate container will be collected for each laboratory. Samples will not be chilled.

7.3 WATER SAMPLES

Include this subsection if collecting water samples; otherwise delete.

Include the following paragraphs, as appropriate; otherwise delete. Modify if necessary.

VOLATILE ORGANIC COMPOUNDS: Low concentration water samples to be analyzed for volatile organic compounds will be collected in 40-ml glass vials. 1:1 hydrochloric acid (HCl) will be added to the vial prior to sample collection. During purging, a test vial will be filled with sample at each sample location and the pH will be measured using a pH meter or pH paper to ensure that sufficient acid is present to result in a pH of less than 2. If the pH is greater than 2, additional HCl will be added to the sample vials. Another vial will be pH tested to ensure the pH is less than 2. The tested vial(s) will be discarded. The sample vials will be filled so that there is no headspace. The vials will be inverted and checked for air bubbles to ensure zero headspace. If a bubble appears, the vial will be discarded and a new sample will be collected. The samples will be chilled to 4°C immediately upon collection. Three vials of each water sample are required for each laboratory.

METALS: Water samples collected for metals analysis will be collected in 1-liter polyethylene bottles. The samples will be preserved by adding nitric acid (HNO_3) to the sample bottle. The bottle will be capped and lightly shaken to mix in the acid. A small quantity of sample will be poured into the bottle cap where the pH will be measured using pH paper. The pH must be $\leq$2. The sample in the cap will be discarded, and the pH of the sample will be adjusted further if necessary. The samples will be chilled to 4°C immediately upon collection. One bottle of each water sample is required for each laboratory.

OTHER PARAMETERS: [e.g., Anions, Pesticides, Semivolatile Organic Compounds]

If requested analyses require preservation, include this paragraph; otherwise delete. A separate paragraph should be included for each bottle type.

Water samples to be analyzed for__[specify what parameters are included] will be collected in [specify size and type of container]. The [specify analysis(ses)] samples will be preserved by adding [describe preservative appropriate to each sample type] to the sample bottle. The bottle will be capped and lightly shaken to mix in the preservative. A small quantity of sample will be poured into the bottle cap where the pH will be measured using pH paper. The pH must be within the appropriate range. The sample in the cap will be discarded, and the pH of the sample will be adjusted further if necessary. Samples will be chilled to 4°C immediately upon collection.

If requested analyses do not require preservation, include this paragraph; otherwise delete. A separate paragraph should be included for each bottle type.

Water samples to be analyzed for________________[specify analysis(ses)] will be collected in ____________ [specify bottle type]. No preservative is required for these samples. The samples will be chilled to 4°C immediately upon collection. Two bottles of each water sample are required for each laboratory.

7.4 OTHER SAMPLES

If samples of other media (e.g., soil gas) are to be collected, specify the analyses that will be performed and the containers and preservatives required.

7.5 PACKAGING AND SHIPPING

The following paragraphs provide a generic explanation and description of how to pack and ship samples. They may be incorporated as is, if appropriate, or modified to meet any project-specific conditions.

All sample containers will be placed in a strong-outside shipping container .The following outlines the packaging procedures that will be followed for low concentration samples.

1. When ice is used, pack it in zip-lock, double plastic bags. Seal the drain plug of the cooler with fiberglass tape to prevent melting ice from leaking out of the cooler.

2. The bottom of the cooler should be lined with bubble wrap to prevent breakage during shipment.

3. Check screw caps for tightness and, if not full, mark the sample volume level of liquid samples on the outside of the sample bottles with indelible ink.

4. Secure bottle/container tops with clear tape and custody seal all container tops.

5. Affix sample labels onto the containers with clear tape.

6. Wrap all glass sample containers in bubble wrap to prevent breakage.

7. Seal all sample containers in heavy duty plastic zip-lock bags. Write the sample numbers on the outside of the plastic bags with indelible ink.

8. Place samples in a sturdy cooler(s) lined with a large plastic trash bag. Enclose the appropriate COC(s) in a zip-lock plastic bag affixed to the underside of the cooler lid.

9. Fill empty space in the cooler with bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment. Vermiculite should also be placed in the cooler to absorb spills if they occur.

10. Ice used to cool samples will be double sealed in two zip lock plastic bags and placed on top and around the samples to chill them to the correct temperature.

11. Each ice chest will be securely taped shut with fiberglass strapping tape, and custody seals will be affixed to the front, right and back of each cooler.

8. DISPOSAL OF RESIDUAL MATERIALS

This section should describe the type(s) of investigation-derived wastes (IDW) that will be generated during this sampling event. EPA recognizes that IDW may not be generated in all sampling events, in which case this section would not apply. Use the language below or reference the appropriate sections in a Disposal of Residual Materials SOP and state in which appendix the SOP is located. Depending upon site-specific conditions and applicable federal, state, and local regulations, other provisions for IDW disposal may be required. If any analyses of IDW are required, these should be discussed. If IDW are to be placed in drums, labeling for the drums should be discussed in this section.

In the process of collecting environmental, the sampling team will generate different types of potentially contaminated IDW that include the following:

- Used personal protective equipment (PPE)
- Disposable sampling equipment
- Decontamination fluids
- Soil cuttings from soil borings [Include this bullet when sampling soils; otherwise delete.]
- Purged groundwater and excess groundwater collected for sample container filling [Include this bullet when sampling groundwater; otherwise delete.]

The EPA's National Contingency Plan (NCP) requires that management of IDW generated during sampling comply with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable. The sampling plan will follow the *Office of Emergency and Remedial Response (OERR) Directive 9345.3-02* (May 1991), which provides the guidance for the management of IDW. In addition, other legal and practical considerations that may affect the handling of IDW will be considered.

Listed below are the procedures that should be followed for handling the IDW. The procedures have enough flexibility to allow the sampling team to use its professional judgment as to the proper method for the disposal of each type of IDW generated at each sampling location. The following bullet is generally appropriate for site or sampling areas with low levels of contamination or for routine monitoring. If higher levels of contamination exist at the site or sampling area, other disposal methods (such as the drumming of wastes) should be used to dispose of used PPE and disposable sampling equipment.

- Used PPE and disposable equipment will be double bagged and placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. Any

PPE and disposable equipment that is to be disposed of which can still be reused will be rendered inoperable before disposal in the refuse dumpster.

Include this bullet if sampling for both metals and organics; otherwise delete.

- Decontamination fluids that will be generated in the sampling event will consist of dilute nitric acid, pesticide-grade solvent, deionized water, residual contaminants, and water with non-phosphate detergent. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal at the site or sampling area. The water (and water with detergent) will be poured onto the ground or into a storm drain. Pesticide-grade solvents will be allowed to evaporate from the decontamination bucket. The nitric acid will be diluted and/or neutralized with sodium hydroxide and tested with pH paper before pouring onto the ground or into a storm drain.

Include this bullet if sampling for metals but not organics; otherwise delete.

- Decontamination fluids that will be generated in the sampling event will consist of nitric acid, deionized water, residual contaminants, and water with non-phosphate detergent. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal at the site or sampling area. The water (and water with detergent) will be poured onto the ground or into a storm drain. The nitric acid will be diluted and/or neutralized with sodium hydroxide and tested with pH paper before pouring onto the ground or into a storm drain.

Include this bullet if sampling for organics but not metals; otherwise delete.

- Decontamination fluids that will be generated in the sampling event will consist of pesticide-grade solvent, deionized water, residual contaminants, and water with non- phosphate detergent. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal at the site or sampling area. The water (and water with detergent) will be poured onto the ground or into a storm drain. Pesticide- grade solvents will be allowed to evaporate from the decontamination bucket.

Include this bullet if sampling soils; otherwise delete.

  - Soil cuttings generated during the subsurface sampling will be disposed of in an appropriate manner.

Include this bullet if sampling groundwater; otherwise delete.

- Purged groundwater will be _______________

Depending upon the degree of groundwater contamination, site-specific conditions, and applicable federal, state, and local regulations, disposal methods will vary. Disposal methods can also vary for purge water from different wells sampled during the same sampling event.

9. SAMPLE DOCUMENTATION

9.1 FIELD NOTES

This section should discuss record keeping in the field. This may be through a combination of logbooks, preprinted forms, photographs, or other documentation. Information to be maintained is provided below.

9.1.1 Field Logbooks

Describe how field logbooks will be used and maintained.

Use field logbooks to document where, when, how, and from whom any vital project information was obtained. Logbook entries should be complete and accurate enough to permit reconstruction of field activities. Maintain a separate logbook for each sampling event or project. Logbooks should have consecutively numbered pages. All entries should be legible, written in black ink, and signed by the individual making the entries. Use factual, objective language.

At a minimum, the following information will be recorded during the collection of each sample:

Edit this list as necessary.

- Sample location and description
- Site or sampling area sketch showing sample location and measured distances
- Sampler's name(s)
- Date and time of sample collection
- Designation of sample as composite or grab
- Type of sample (soil, sediment or water)
- Type of sampling equipment used
- Field instrument readings and calibration
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.)
- Preliminary sample descriptions (e.g., for soils: clay loam, very wet; for water: clear water with strong ammonia-like odor)
- Sample preservation
- Lot numbers of the sample containers, sample identification numbers and any explanatory codes, and chain-of-custody form numbers

- Shipping arrangements (overnight air bill number)
- Name(s) of recipient laboratory(ies)

In addition to the sampling information, the following specific information will also be recorded in the field logbook for each day of sampling:

Edit this list as necessary.

- Team members and their responsibilities
- Time of arrival/entry on site and time of site departure
- Other personnel on site
- Summary of any meetings or discussions with tribal, contractor, or federal agency personnel
- Deviations from sampling plans, site safety plans, and QAPP procedures
- Changes in personnel and responsibilities with reasons for the changes
- Levels of safety protection
- Calibration readings for any equipment used and equipment model and serial number

A checklist of the field notes, following the suggestions above, using only those that are appropriate, should be developed and included in project field notes.

9.1.1 Photographs

If photographs will be taken, the following language may be used as is or modified as appropriate.

Photographs will be taken at the sampling locations and at other areas of interest on site or sampling area. They will serve to verify information entered in the field logbook. For each photograph taken, the following information will be written in the logbook or recorded in a separate field photography log:

- Time, date, location, and weather conditions
- Description of the subject photographed
- Name of person taking the photograph

9.2 SAMPLE LABELING

The following paragraph provides a generic explanation and description of the use of labels. It may be incorporated as is, if appropriate, or modified to meet any project-specific conditions.

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. A copy of the sample label is included in [specify appendix]. The samples will have pre-assigned, identifiable, and unique numbers. At a minimum, the sample labels will contain the following information: station location, date of collection, analytical parameter(s), and method of preservation. Every sample, including samples collected from a single location but going to separate laboratories, will be assigned a unique sample number.

9.3 SAMPLE CHAIN-OF-CUSTODY FORMS AND CUSTODY SEALS

The following paragraphs provide a generic explanation and description of the use of chain-of- custody forms and custody seals. They may be incorporated as is, if they are appropriate, or modified to meet any project-specific conditions.

All sample shipments for analyses will be accompanied by a chain-of-custody record. A copy of the form is found in [specify appendix]. Form(s) will be completed and sent with the samples for each laboratory and each shipment (i.e., each day). If multiple coolers are sent to a single laboratory on a single day, form(s) will be completed and sent with the samples for each cooler.

The chain-of-custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is in someone's custody if it is either in someone’s physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel. Until the samples are shipped, the custody of the samples will be the responsibility of________________ [name of agency/ organization conducting sampling]. The sampling team leader or designee will sign the chain-of-custody form in the “relinquished by” box and note date, time, and air bill number.

A self-adhesive custody seal will be placed across the lid of each sample. A copy of the seal is found in [specify appendix]. For VOC samples, the seal will be wrapped around the cap. The shipping containers in which samples are stored (usually a sturdy picnic cooler or ice chest) will be sealed with self-adhesive custody seals any time they are not in someone’s possession or view before shipping. All custody seals will be signed and dated.

10. QUALITY CONTROL

This section should discuss the quality control samples that are being collected to support the sampling activity. This includes field QC samples, confirmation samples, background samples, laboratory QC samples, and split samples. Wherever possible, the locations at which the samples will be collected should be identified and a rationale provided for the choice of location. Frequency of collection should be discussed. All samples, except laboratory QC samples, should be sent to the laboratory blind, wherever possible. Laboratory QC samples should be identified and additional sample (e.g., a double volume) collected for that purpose.

10.1 FIELD QUALITY CONTROL SAMPLES

Field quality control samples are intended to help evaluate conditions resulting from field activities and are intended to accomplish two primary goals, assessment of field contamination and assessment of sampling variability. The former looks for substances introduced in the field due to environmental or sampling equipment and is assessed using blanks of different types. The latter includes variability due to sampling technique and instrument performance as well as variability possibly caused by the heterogeneity of the matrix being sampled and is assessed using replicate sample collection. The following sections cover field QC.

10.1.1 Assessment of Field Contamination (Blanks)

Field contamination is usually assessed through the collection of different types of blanks. Equipment blanks are obtained by passing distilled or deionized water, as appropriate, over or through the decontaminated equipment used for sampling. They provide the best overall means of assessing contamination arising from the equipment, ambient conditions, sample containers, transit, and the laboratory. Field blanks are sample containers filled in the field. They help assess contamination from ambient conditions, sample containers, transit, and the laboratory. Trip blanks are prepared by the laboratory and shipped to and from the field. They help assess contamination from shipping and the laboratory and are for volatile organic compounds only.

Region 9 recommends that equipment blanks be collected, where appropriate (e.g., where neither disposable nor dedicated equipment is used). Field blanks are next in priority and trip blanks next. Only one blank sample per matrix per day should be collected. If equipment blanks are collected, field blanks and trip blanks are not required under normal circumstances.

10.1.1.1 Equipment Blanks

In general, equipment (rinsate) blanks should be collected when reusable, non-disposable sampling equipment (e.g., trowels, hand augers, and non-dedicated groundwater sampling pumps) are being used for the sampling event. Equipment blanks can be collected for soil, sediment, and ground water samples. A minimum of one equipment blank is prepared each day for each matrix when equipment is decontaminated in the field. These blanks are submitted "blind" to the laboratory, packaged like other samples and each with its own unique identification number. Note that for samples which may contain VOCs, water for blanks should be purged prior to use to ensure that it is organic free. HPLC water, which is often used for equipment and field blanks, can contain VOCs if it is not purged.

If equipment blanks are to be collected describe how they are to be collected and the analyses that will be performed. A maximum of one blank sample per matrix per day should be collected, but at a rate to not exceed one blank per 10 samples. The 1:10 ratio overrides the one per day requirement. If equipment rinsate blanks are collected, field blanks and trip blanks are not required under normal circumstances. Use the language below or reference the appropriate sections in a Quality Control SOP and state in which appendix the SOP is located.

Include this subsection if equipment blanks are to be collected, otherwise, delete.

Include this paragraph if blanks will be analyzed for both metals and organic compounds; otherwise delete.

Equipment rinsate blanks will be collected to evaluate field sampling and decontamination procedures by pouring High Performance Liquid Chromatography (HPLC) organic-free (for organics) or deionized water (for inorganics) over the decontaminated sampling equipment. One equipment rinsate blank will be collected per matrix each day that sampling equipment is decontaminated in the field. Equipment rinsate blanks will be obtained by passing water through or over the decontaminated sampling devices used that day. The rinsate blanks that are collected will be analyzed for [include names of target analytes, e.g., metals, total petroleum hydrocarbons, volatile organic compounds, etc.].

Include this paragraph if blanks will be analyzed only for organic compounds; otherwise delete.

Equipment rinsate blanks will be collected to evaluate field sampling and decontamination procedures by pouring High Performance Liquid Chromatography (HPLC) organic-free water over the decontaminated sampling equipment. One equipment rinsate blank will be collected per matrix each day that sampling equipment is decontaminated in the field. Equipment rinsate blanks will be obtained by passing water through or over the decontaminated sampling devices used that day. The rinsate blanks that are collected will be analyzed for____[include names of target analytes, e.g., volatile organic compounds, total petroleum hydrocarbons, etc.].

Include this paragraph if blanks will be analyzed only for metals; otherwise delete.

Equipment rinsate blanks will be collected to evaluate field sampling and decontamination procedures by pouring deionized water over the decontaminated sampling equipment. One equipment rinsate blank will be collected per matrix each day that sampling equipment is decontaminated in the field. Equipment rinsate blanks will be obtained by passing deionized water through or over the decontaminated sampling devices used that day. The rinsate blanks that are collected will be analyzed for metals.

Always include this paragraph.

The equipment rinsate blanks will be preserved, packaged, and sealed in the manner described for the environmental samples. A separate sample number and station number will be assigned to each sample, and it will be submitted blind to the laboratory.

10.1.1.2 Field Blanks

Field blanks are collected when sampling water or air and equipment decontamination is not necessary or sample collection equipment is not used (e.g., dedicated pumps). A methanol field blanks should also be collected when methanol is used as a preservative. A minimum of one field blank is prepared each day sampling occurs in the field, but equipment is not decontaminated. These blanks are submitted “blind” to the laboratory, packaged like other samples and each with its own unique identification number. Note that for samples which may contain VOCs, water for blanks should be purged prior to use to ensure that it is organic free. HPLC water which is often used for equipment and field blanks can contain VOCs if it is not purged.

Include this subsection if field blanks will be collected; otherwise delete. Only one blank sample per matrix per day should be collected. If field blanks are prepared, equipment rinsate blanks and trip blanks are not required under normal circumstances.

Include this paragraph if blanks will be analyzed for both metals and organic compounds; otherwise delete.

Field blanks will be collected to evaluate whether contaminants have been introduced into the samples during the sampling due to ambient conditions or from sample containers. Field blank samples will be obtained by pouring High Performance Liquid Chromatography (HPLC) organic-free water (for organics) and/or deionized water (for inorganics) into a sampling container at the sampling point. The field blanks that are collected will be analyzed for

_________ [include names of target analytes, e.g., metals, volatile organic compounds, etc.].

Include this paragraph if blanks will be analyzed only for organic compounds; otherwise delete.

Field blanks will be collected to evaluate whether contaminants have been introduced into the samples during the sampling due to ambient conditions or from sample containers. Field blank samples will be obtained by pouring High Performance Liquid Chromatography (HPLC) organic-free water into a sampling container at the sampling point. The field blanks that are collected will be analyzed for_[include names of target analytes, e.g., volatile organic compounds, total petroleum hydrocarbons, etc.].

Include this paragraph if blanks will be analyzed only for metals; otherwise delete.

Field blanks will be collected to evaluate whether contaminants have been introduced into the samples during the sampling due to contamination from sample containers. Field blank samples will be obtained by pouring deionized water into a sampling container at the sampling point. The field blanks that are collected will be analyzed for metals.

Always include this paragraph.

The field blanks will be preserved, packaged, and sealed in the manner described for the environmental samples. A separate sample number and station number will be assigned to each sample, and it will be submitted blind to the laboratory.

10.1.1.3 Trip Blanks

Trip blanks are required only if no other type of blank will be collected for volatile organic compound analysis. If trip blanks are required, one is submitted to the laboratory for analysis with every shipment of samples for VOC analysis. These blanks are submitted "blind" to the laboratory, packaged like other samples and each is assigned its own unique identification number. Note that for samples which may contain VOCs, water for blanks should be purged prior to use to ensure that it is organic free. HPLC water, which is often used for trip blanks, can contain VOCs if it is not purged.

Include this subsection if trip blanks will be collected; otherwise delete. Only one blank sample per matrix per day should be collected. Trip blanks are only relevant to volatile organic compound (VOC) sampling efforts.

Trip blanks will be prepared to evaluate if the shipping and handling procedures are introducing contaminants into the samples, and if cross contamination in the form of VOC migration has occurred between the collected samples. A minimum of one trip blank will be submitted to the laboratory for analysis with every shipment of samples for VOC analysis. Trip blanks are 40-ml vials that have been filled with HPLC-grade water that has been purged so it is VOC free and shipped with the empty sampling containers to the site or sampling area prior to sampling. The sealed trip blanks are not opened in the field and are shipped to the laboratory in the same cooler with the samples collected for volatile analyses. The trip blanks will be preserved, packaged, and sealed in the manner described for the environmental samples. A separate sample number and station number will be assigned to each trip sample and it will be submitted blind to the laboratory.

10.1.1.4 Temperature Blanks

Include this paragraph with all plans.

For each cooler that is shipped or transported to an analytical laboratory a 40-ml VOA vial will be included that is marked "temperature blank." This blank will be used by the sample custodian to check the temperature of samples upon receipt.

10.1.2 Assessment of Field Variability (Field Duplicate or Collocated Samples

Duplicate samples are collected simultaneously with a standard sample from the same source under identical conditions into separate sample containers. Field duplicates will consist of a homogenized sample divided in two or else a collocated sample. Each duplicate portion should be assigned its own sample number so that it will be blind to the laboratory. A duplicate sample is treated independently of its counterpart in order to assess laboratory performance through comparison of the results. At least 10% of samples collected per event should be field duplicates. At least one duplicate should be collected for each sample matrix, but their collection can be stretched out over more than one day (e.g., if it takes more than one day to reach 10 samples). Every group of analytes for which a standard sample is analyzed will also be tested for in one or more duplicate samples. Duplicate samples should be collected from areas of known or suspected contamination. Since the objective is to assess variability due to sampling technique and possible sample heterogeneity, source variability is a good reason to collect collocated samples, not to avoid their collection.

Duplicate soil samples will be collected at sample locations___________________[identify soil sample locations from which duplicate or collocated samples will be collected]. Duplicate samples will be collected from these locations because____. Add sentence(s) here explaining a rationale for collecting duplicate samples from these locations; e.g., samples from these locations are suspected to exhibit moderate concentrations of contaminants or previous sampling events have detected moderate levels of contamination at the site or sampling area at these locations.

Include this paragraph if collecting soil samples and analyzing for compounds other than volatiles; otherwise delete.

Soil samples to be analyzed for____[list all analytical methods for this sample event except for volatiles] will be homogenized with a with a trowel in a sample-dedicated 1-gallon disposable pail. Homogenized material from the bucket will then be transferred to the appropriate wide-mouth glass jars for both the regular and duplicate samples. All jars designated for a particular analysis (e.g., semivolatile organic compounds) will be filled sequentially before jars designated for another analysis are filled (e.g., metals).

Include this paragraph if collecting soil samples and analyzing for volatiles; otherwise delete.

Soil samples for volatile organic compound analyses will not be homogenized. Equivalent Encore samples from a collocated location will be collected identically to the original samples, assigned unique sample numbers and sent blind to the laboratory.

Include these paragraphs if collecting sediment samples. If volatile organic compound analysis will be performed on sediment samples, modify the above paragraph for soil sample volatile analyses by changing “soil” to “sediment.”

Duplicate sediment samples will be collected at sample locations[identify_______________ sediment sample locations from which duplicate or collocated samples for duplicate analysis will be obtained]. Duplicate samples will be collected from these locations because_________________. Add sentence(s) here explaining a rationale for collecting duplicate samples from these locations; e.g., samples from these locations are suspected to exhibit moderate concentrations of contaminants or previous sampling events have detected moderate levels of contamination at the site or sampling area at these locations.

Sediment samples will be homogenized with a trowel in a sample-dedicated 1-gallon disposable pail. Homogenized material from the bucket will then be transferred to the appropriate wide- mouth glass jars for both the regular and duplicate samples. All jars designated for a particular analysis (e.g., semivolatile organic compounds) will be filled sequentially before jars designated for another analysis are filled (e.g., metals).

Include this paragraph if collecting water samples.

Duplicate water samples will be collected for water sample numbers_______________[water sample numbers which will be split for duplicate analysis]. Duplicate samples will be collected from these locations because___. Add sentence(s) here explaining a rationale for collecting duplicate samples from these locations; e.g., samples from these locations are suspected to exhibit moderate concentrations of contaminants or previous sampling events have detected moderate levels of contamination at the site or sampling area at these locations.

When collecting duplicate water samples, bottles with the two different sample identification numbers will alternate in the filling sequence (e.g., a typical filling sequence might be, VOCs designation GW-2, VOCs designation GW-4 (duplicate of GW-2); metals, designation GW-2, metals, designation GW-4, (duplicate of GW-2) etc.). Note that bottles for one type of analysis will be filled before bottles for the next analysis are filled. Volatiles will always be filled first.

Always include this paragraph.

Duplicate samples will be preserved, packaged, and sealed in the same manner as other samples of the same matrix. A separate sample number and station number will be assigned to each duplicate, and it will be submitted blind to the laboratory.

10.2 BACKGROUND SAMPLES

Background samples are collected in situations where the possibility exists that there are native or ambient levels of one or more target analytes present or where one aim of the sampling event is to differentiate between on-site and off-site contributions to contamination. One or more locations are chosen which should be free of contamination from the site or sampling location itself, but have similar geology, hydrogeology, or other characteristics to the proposed sampling locations that may have been impacted by site activities. For example, an area adjacent to but removed from the site, upstream from the sampling points, or up gradient or cross gradient from the groundwater under the site. Not all sampling events require background samples.

Specify the sample locations that have been designated as background. Include a rationale for collecting background samples from these locations and describe or reference the sampling and analytical procedures which will be followed to collect these samples.

10.3 FIELD SCREENING, INCLUDING CONFIRMATION SAMPLES, AND SPLIT SAMPLES

For projects where field screening methods are used (typically defined as testing using field test kits, immunoassay kits, or soil gas measurements or equivalent, but not usually defined as the use of a mobile laboratory which generates data equivalent to a fixed laboratory), two aspects of the tests should be described.

First, the QC which will be run in conjunction with the field screening method itself, and, second, any fixed laboratory confirmation tests which will be conducted. QC acceptance criteria for these tests should be defined in these sections rather than in the DQO section.

10.3.1 Field Screening Samples

For projects where field screening methods are used, describe the QC samples which will be run in the field to ensure that the screening method is working properly. This usually consists of a combination of field duplicates and background samples. The discussion should specify acceptance criteria and corrective action to be taken if results are not within defined limits. Discuss confirmation tests below.

10.3.2 Confirmation Samples (Field Screening)

If the planned sampling event includes a combination of field screening and fixed laboratory confirmation, this section should describe the frequency with which the confirmation samples will be collected and the criteria which will be used to select confirmation locations. These will both be dependent on the use of the data in decision making. It is recommended that the selection process be at a minimum of 10% and that selection criteria include checks for both false positives (i.e., the field detections are invalid or the concentrations are not accurate) and false negatives (i.e., the analyte was not detected in the field). Because many field screening techniques are less sensitive than laboratory methods false negative screening is especially important unless the field method is below the action level for any decision making. It is recommended that some “hits” be chosen and that other locations be chosen randomly.

Describe confirmation sampling. Discuss the frequency with which samples will be confirmed and how location will be chosen. Define acceptance criteria for the confirmation results (e.g., RPD$\leq$25%) and corrective actions to be taken if samples are not confirmed.

10.4 LABORATORY QUALITY CONTROL SAMPLES

Laboratory quality control (QC) samples are analyzed as part of standard laboratory practice. The laboratory monitors the precision and accuracy of the results of its analytical procedures through analysis of QC samples. In part, laboratory QC samples consist of matrix spike/matrix spike duplicate samples for organic analyses, and matrix spike and duplicate samples for inorganic analyses. The term “matrix” refers to use of the actual media collected in the field (e.g., routine soil and water samples).

Laboratory QC samples are an aliquot (subset) of the field sample. They are not a separate sample, but a special designation of an existing sample.

Include the following language if soil samples are to be collected for other than volatiles; otherwise delete.

A routinely collected soil sample (a full 8-oz sample jar or two 120-mL sample vials) contains sufficient volume for both routine sample analysis and additional laboratory QC analyses. Therefore, a separate soil sample for laboratory QC purposes will not be collected.

Include the following language if soil samples are to be collected for volatiles; otherwise delete.

Soil samples for volatile organic compound analyses for laboratory QC purposes will be obtained by collecting double the number of equivalent Encore samples from a collocated location in the same way as the original samples, assigned a unique sample numbers and sent blind to the laboratory.

Include the following language if water samples are to be collected. Otherwise delete.

For water samples, double volumes of samples are supplied to the laboratory for its use for QC purposes. Two sets of water sample containers are filled and all containers are labeled with a single sample number. *For volatile samples this would result in 6 vials being collected instead of 3, for pesticides and semivolatile samples this would be 4 liters instead of 2, etc.*

The laboratory should be alerted as to which sample is to be used for QC analysis by a notation on the sample container label and the chain-of-custody record or packing list.

At a minimum, one laboratory QC sample is required per 14 days or one per 20 samples (including blanks and duplicates), whichever is greater. If the sample event lasts longer than 14 days or involves collection of more than 20 samples per matrix, additional QC samples will be designated.

For this sampling event, samples collected at the following locations will be the designated laboratory QC samples:

If a matrix is not being sampled, delete the reference to that matrix.

- For soil, samples______________[List soil sample locations and numbers designated for QA/QC.]
- For sediment, samples______________[List sediment sample locations and numbers designated for QA/QC.]

- For water, samples________________[List water sample locations and numbers designated for QA/QC.]

11. FIELD VARIANCES

It is not uncommon to find that, on the actual sampling date, conditions are different from expectations such that changes must be made to the SAP once the samplers are in the field. The following paragraph provides a means for documenting those deviations, or variances. Adopt the paragraph as is, or modify it to project-specific conditions.

As conditions in the field may vary, it may become necessary to implement minor modifications to sampling as presented in this plan. When appropriate, the QA Office will be notified and a verbal approval will be obtained before implementing the changes. Modifications to the approved plan will be documented in the sampling project report.

12. FIELD HEALTH AND SAFETY PROCEDURES

Describe any agency-, program- or project-specific health and safety procedures that must be followed in the field, including safety equipment and clothing that may be required, explanation of potential hazards that may be encountered, and location and route to the nearest hospital or medical treatment facility. A copy of the organization health and safety plan may be included as an Appendix and referenced in this section.

EXAMPLE FORMS

Table 1-1
Key Project Personnel Contact Information and Responsibilities

Title	Name	Phone Number Email Address	Responsibilities
EPA Quality Assurance Officer (QAO)			
EPA Project Manager			
Grantee Project Manager			
Contractor Project Manager (include Company Name)			
Contractor QAO			
Contractor Field Team Leader			
Laboratory Quality Assurance Officer (include Laboratory Name)			

Table 2-1
Contaminants of Concern, Previous Investigations Matrix = Soil

Analytical Parameter (Contaminants of Concern)	Date of sampling	Sampling contractor	Laboratory Analytical Results (units [µg/kg])	Regulatory Limit (specify)[1]
Benzene	06/24/01	ABC, Co.	200	50

µg/kg = micrograms per kilogram

[1] DTSC = Calif. Department of Toxic Substances Control

Table 3-1
Contaminants of Concern, Laboratory, and Screening or Action Levels Matrix = Soil

Analytical Parameter (Contaminants of Concern)	**Laboratory Reporting or Quantitation Limits**	**Screening or Action Levels**		
		EPA Residential RSLs	**DTSC Residential RSLs**	**RWQCB Residential ESLs**
Volatile Organic Compounds by Method 8260 (µg/kg)				
Benzene	10	640	NA	440
Tetrachloroethylene (PCE)	10	480	NA	87
Toluene	10	520000	NA	3300
Metals by Method 6010/7470 (mg/kg)				
Arsenic	1	0.07	0.07	Background
Chromium	2	210	0	1000
Lead	2	150	150	150

RL = Reporting Limit

EPA = US Environmental Protection Agency

DTSC = Calif. Department of Toxic Substances Control

RWQCB = Regional Water Quality Control Board

µg/kg = micrograms per kilogram mg/kg = milligrams per kilogram

RSLs = Regional Screening Levels

ESLs = Environmental Screening Levels

NA = Not available or Not applicable

Table 4-1
Sampling Design and Rationale Matrix = Soil

Sampling Location/ID Number	**Depth (feet)**	**Analytical Parameter**	**Rationale ***
SB1	0-1.5 2-4, 6-8	TPH-g/d, metals TPH-g/d, VOA & metals	Assess environmental conditions at the former UST and former fuel pump island locations. Volatiles will not be collected from the shallow soil due to probable weathering effects.
SB2	0-1.5 2-4, 6-8	TPH-g/d, metals TPH-g/d, VOA & metals	Assess the potential presence of contaminants in undocumented fill materials at the Site. Volatiles will not be collected from the shallow soil due to probable weathering effects.

* Include rationale for location, depth and analysis.

TPH –g/d = total petroleum hydrocarbons as gasoline and diesel VOA = volatile organic analyses

Table 4-2
Sampling Design and Rationale
Matrix = Groundwater

Sampling Location/ID Number	**Analytical Parameter**	**Rationale ***
SB1	TPH-g/d, VOA, metals	Assess the potential migration of contaminants to the groundwater at the former UST and former fuel pump island locations.
SB2	TPH-g/d, VOA, metals	Assess the potential migration of contaminants to the groundwater from the fill materials located on the Site.

*Include rationale for location and analysis.

TPH –g/d = total petroleum hydrocarbons as gasoline and diesel

VOA = volatile organic analyses

Table 5-1
Analytical Services
Matrix = Soil

				Analytical Methods			
Sample Number	**Sample Location**	**Depth (feet)**	**Special Designation**	**SW846 Method 8015B (TPH as gasoline)**	**SW846 Method 8015B (TPH as diesel)**	**SW846 Method 8260B (volatiles)**	**SW846 Method 6010/7470 (metals)**
SB-01-05	SB1	0-1.5		X	X		X
SB-01-24	SB1	2-4	MS/MSD	X	X	X	X
SB-01-68	SB1	6-8		X	X	X	X
SB-02-05	SB2	0-1.5		X	X		X
SB-02-24	SB2	2-4		X	X	X	X
SB-02-68	SB2	6-8		X	X	X	X
SB-01-10	SB2	6-8	Duplicate of SB-02-68	X	X	X	X
Total number of Soil Samples, excluding QC:				6	6	4	6
Total number of Soil Samples, including QC:				7	7	5	7

TPH = total petroleum hydrocarbons

MS/MSD = matrix spike/ matrix spike duplicate

Table 5-2
Analytical Services
Matrix = Groundwater

			Analytical Methods			
Sample Number	**Sample Location**	**Special Designation**	**SW846 Method 8015B (TPH as gasoline)**	**SW846 Method 8015B (TPH as diesel)**	**SW846 Method 8260B (Volatiles)**	**SW846 Method 6010/7470 (Metals)**
SB-01	SB1	MS/MSD	X	X	X	X
SB-02	SB2		X	X	X	X
SB-03	SB2	Duplicate of SB-02-68	X	X	X	X
Total number of Soil Samples, excluding QC:			2	2	2	2
Total number of Soil Samples, including QC:			3	3	3	3

TPH = total petroleum hydrocarbons
MS/MSD = matrix spike/ matrix spike duplicate

Table 5-3
Analytical Method, Container, Preservation, and Holding Time Requirements
Matrix = Soil

Analytical Parameter and/or Field Measurements	Analytical Method Number	Containers (number, type, size/volume)	Preservation Requirements (chemical, temperature, light protection)	Maximum Holding Times
Volatiles	SW-846 Method 8260B	Two EnCore Samplers	Chill with ice to 4^{o}C	48 hours
Metals	SW-846 Method 6010/7470	4 oz glass jar	Chill with ice to 4^{o}C	<180 days/<28 days for Hg

Table 5-4
Analytical Method, Container, Preservation, And Holding Time Requirements
Matrix = Groundwater

Analytical Parameter and/or Field Measurements	**Analytical Method Number**	**Containers (number, type, size/volume)**	**Preservation Requirements (chemical, temperature, light protection)**	**Maximum Holding Times**
Volatiles	SW-846 Method 8260B	3 x 40-ml VOA	Chill with ice to 4^{o}CpH<2 with HCl	14 days
Metals	SW-846 Method 6010/7470	1 L HDPE	Chill with ice to 4^{o}C pH<2 with HNO_3	6 months

VOA = volatile organic analysis
HDPE = high density polyethylene Hg = mercury
HCL = hydrochloric acid
HNO_3 = nitric acid

Table 6-1
Field and Sampling Equipment

Description of Equipment	Material (if applicable)	Dedicated (Yes/No)
Sampling sleeves	Acetate or equivalent	Yes
Hand auger	Hardened steel	No
EnCore® samplers	Plastic	Yes
Sampling trowel	Plastic or stainless steel	Yes
Bailer	Plastic or stainless steel	Yes
Conductivity meter	NA	No
Peristaltic pump with dedicated tubing	Tygon or HDPE tubing	no

NA = not applicable
HDPE = high density polyethylene

Table 6-2
Field Equipment/Instrument Calibration, Maintenance, Testing, and Inspection

Analytical Parameter	Field Equipment/ Instrument	Calibration Activity	Maintenance and Testing/ Inspection Activity	Frequency	Acceptance Criteria	Corrective Action
Temperature (sensor)	Multimeter Manufacturer X, Model Y	Annual check of endpoints of desired temperature range (0^oC to 40^oC) versus NIST thermometer	See manufacturer's manual	Annually	±0.2^oC of true value at both endpoints (i.e., manufacturer's listed accuracy for the sensor)	Remove from use if doesn't pass calibration criteria
pH (electrode)	Multimeter Manufacturer X, Model Y	Initial: two-point calibration bracketing expected range (using 7.0 and either 4.0 or 10.0 pH buffer, depending on field conditions); followed by one-point check with 7.0 pH buffer Post: single-point check with 7.0 pH buffer	See manufacturer's manual	Initial: beginning of each day Post: end of each day	Initial: two-point calibration done electronically; one-point check (using 7.0 pH buffer) ±0.1 pH unit of true value Post:) ±0.5 pH unit of true value with both 7.0 pH and other "bracketing" buffer (and either 4.0 or 10.0 pH)	Recalibrate Qualify data

Attachment A

Seven Step DQOs Process

The following information can be found in “Guidance on Systematic Planning Using the Data Quality Objectives Process” (EPA QA/G-4, February 2006).

“The U.S. Environmental Protection Agency (EPA) has developed the Data Quality Objectives (DQO) Process as the Agency’s recommended planning process when environmental data are used to select between two alternatives or derive an estimate of contamination. The DQO Process is used to develop performance and acceptance criteria (or data quality objectives) that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.”

“Various government agencies and scientific disciplines have established and adopted different variations to systematic planning, each tailoring their specific application areas. For example, the Observational Method is a variation on systematic planning that is used by many engineering professions. The Triad Approach, developed by EPA’s Technology Innovation Program, combines systematic planning with more recent technology advancements, such as techniques that allow for results of early sampling to inform the direction of future sampling. However, it is the Data Quality Objectives (DQO) Process that is the most commonly-used application of systematic planning in the general environmental community. Different types of tools exist for conducting systematic planning. The DQO Process is the Agency’s recommendation when data are to be used to make some type of decision (e.g., compliance or non-compliance with a standard) or estimation (e.g., ascertain the mean concentration level of a contaminant).”

“The DQO Process is used to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study. The DQO Process consists of seven iterative steps. Each step of the DQO Process defines criteria that will be used to establish the final data collection design.”

Step 1 - State the Problem

- Give a concise description of the problem
- Identify the leader and members of the planning team
- Develop a conceptual model of the environmental hazard to be investigated

Step 2 - Identify the Goal of the Study

- Identify the principal sturdy question(s)
- Consider alternative outcomes or actions that can occur upon answering the question(s)
- For decision problems, develop decision statements, organize multiple decisions
- For estimation problems, state what needs to be estimated and key assumptions

Step 3 - Identify Information Inputs

- Identify types and sources of information needed to resolve decisions or produce estimates
- Identify the basis of information that will guide or support choices to be made in later steps of the DQO Process
- Select appropriate sampling and analysis methods for generating the information

Step 4 - Define the Boundaries of the Study

- Define the target population of interest and its relevant spatial boundaries
- Define what constitutes a sampling unit

- Specify temporal boundaries and other practical constraints associated with sample/data collection
- Specify the smallest unit on which decision or estimates will be made

Step 5 - Develop the Analytical Approach

- Specify appropriate population parameters for making decisions or estimates
- For decision problems, choose a workable Action Level and generate an “If… then…else” decision rule which involves it
- For estimation problems, specify the estimator and the estimation procedure

Step 6 - Specify Performance or Acceptance Criteria

- For decision problems, specify the decision rule as a statistical hypothesis test, examine the consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors
- For estimation problems, specify acceptable limits on estimation uncertainty

Step 7 - Develop the Detailed Plan for Obtaining Data

- Compile all information and outputs generated in Steps 1 through 6
- Use this information to identify alternative sampling and analysis designs that are appropriate for your intended use
- Select and document a design that will yield data that will best achieve your performance or acceptance criteria

Attachment B

Project Action Levels (PALs), Detection Limits (DLs), and Quantitation Limits (QLs)

The Project Action Limits (PALs), as introduced and defined in Section 1.7, will help target the selection of the most appropriate method, analysis, laboratory, etc. (the analytical operation) for your project. One important consideration in this selection is the type of decision or action you may wish to make with the data, depending on whether you generate results in concentrations below, equal to, or above the PALs. In order to ensure some level of certainty of the decisions or actions, it is recommended that you consider choosing an analytical operation capable of providing quality data at concentrations less than the PALs.

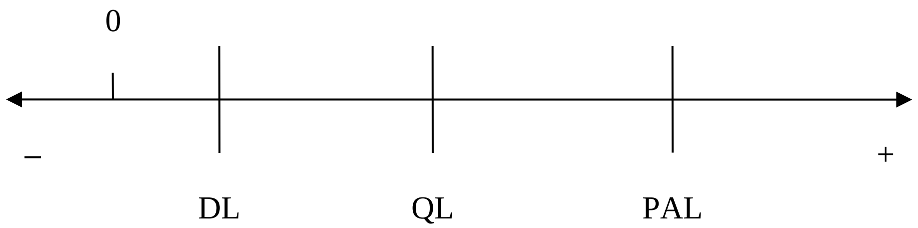
When choosing an analytical operation, you will come across terms such as Detection Limit (DL) and Quantitation Limit (QL). These terms are frequently expressed by other terminology, but the two key words to look for are “detection” and “quantitation” (sometimes referred to as “quantification”). The following describes the differences between these terms:

- **Detection Limit** or **DL** - This is the minimum concentration that can be <u>detected</u> above background or baseline/signal noise by a specific instrument and laboratory for a given analytical method. It is not recognized as an accurate value for the reporting of project data. If a parameter is detected at a concentration less than the QL (as defined below) but equal to or greater than the DL, it should be qualified as an estimated value.

- **Quantitation Limit** or **QL** - This is the minimum concentration that can be <u>identified</u> and <u>quantified</u> above the DL within some specified limits of precision and accuracy/bias during routine analytical operating conditions. It is matrix and media-specific, that is, the QL for a water sample will be different than for a sediment sample. It is also recommended that the QL is supported by the analysis of a standard of equivalent concentration in the calibration curve (typically, the lowest calibration standard).

(Note: The actual "real time" sample Reporting Limit or RL is the QL adjusted for any necessary sample dilutions, sample volume deviations, and/or extract/digestate volume deviations from the standard procedures. It is important to anticipate potential deviations to minimize excursions of the RL above the PAL, whenever possible.)

For any analytical operation, the relationship between the PAL, QL, and DL terms can be represented as:

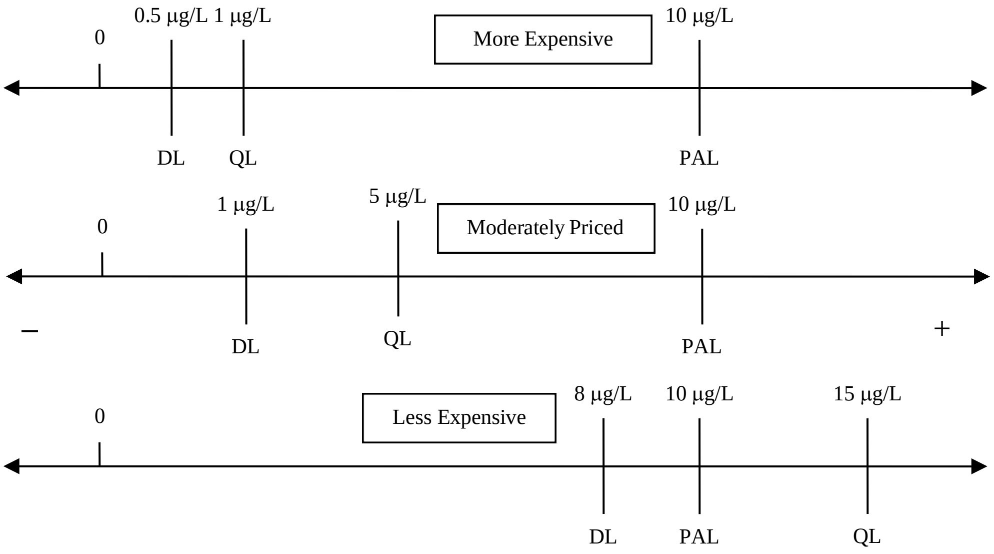


A standard general rule of thumb is to select an analytical operation capable of providing a QL in the range of 3-10 times lower than the PAL and 3-10 times higher than the DL. Some additional considerations for selecting an analytical operation with the most appropriate relationship for your data needs may include the following:

- When critical decisions will be made with project data exceeding the PALs, you may wish to have a greater level of certainty at the PAL concentration level. To accomplish this, you may want to select an analytical operation capable of providing a QL towards the lower end of the range (closer to values 5-10 times lower than the PAL). This would result in a greater distribution of concentrations that could be reported with certainty, both less than and approaching the PAL.
- When you're looking to minimize uncertainty of the project data reported at the QL, you may choose to select an analytical operation where the QL is much greater than the DL (closer to values 5-10 times higher than the DL). This would help to ensure less background noise impacts on the data.

Careful consideration of the PAL/QL/DL relationship should be given when balancing your data quality needs with project resources to get the most appropriate data quality for the least cost.

For example, the PAL for one analytical parameter may be 10 μg/l based on the Federal Water Quality Standard, and you have a choice between an expensive state-of-the-art analytical technology providing QL = 1 μg/l and DL = 0.5 μg/l, a moderately-priced standard method with QL = 5 μg/l and DL = 1 μg/l, or an inexpensive field measurement with QL = 15 μg/l and DL = 8 μg/l. These choices may be represented as follows:



If you are attempting to identify whether the analytical parameter exceeds the Federal Standard, the moderately priced method may serve your needs. However, if the parameter is known to be present and you're attempting to further identify the boundaries of those areas minimally impacted by low levels (for example, you're suspecting lower concentrations may pose a risk to some aquatic species of concern in the area), you may opt for the more expensive analysis with the lower QL and DL. In both of these examples, the inexpensive field measurement may not be appropriate to meet your project needs, as the lowest concentration that would be reported (15 μg/l) exceeds the PAL. However, if you are just trying to get a handle on whether some specific locations within your study region grossly exceed the PAL, data generated from the inexpensive field measurement may suit your project needs.

Attachment C

Data Quality Indicators (DQIs) and Measurement Performance Criteria (MPC) for Chemical Data

Identifying Data Quality Indicators (DQIs) and establishing Quality Control (QC) samples and Measurement Performance Criteria (MPC) to assess each DQI, as introduced in Section 1.7, are key components of project planning and development. These components demonstrate an understanding of how “good” the data need to be to support project decisions, and help to ensure there is a well-defined system in place to assess that data quality once data collection/generation activities are complete.

When faced with addressing data quality needs in your QA Project Plan, one of the first terms you may come across is Data Quality Indicators (DQIs). DQIs include both quantitative and qualitative terms. Each DQI is defined to help interpret and assess specific data quality needs for each sample medium/matrix and for each associated analytical operation. The principal DQIs and a brief summary of information related to assessing each DQI is as follows:

<u>Precision</u>

<u>Questions answered</u>: How reproducible do the data need to be? How good do I need to be at doing something (such as sample collection, sample prep/analysis, etc.) the same way two or more times?

Expressed in terms of “*relative percent difference*” (for the comparison of 2 data points).

<u>Quantitative vs. Qualitative term</u>: Quantitative.

<u>QC samples (may include</u>):

- Field duplicates - To duplicate all steps from sample collection through analysis;

- Laboratory duplicates - To duplicate inorganic sample preparation/analysis methodology; and/or
- Matrix spike/matrix spike duplicates - To duplicate organic sample preparation/analysis methodology; to represent the actual sample matrix itself.

Acceptance criteria or MPC: May be expressed in terms of Relative Percent Difference (RPD) between two data points representing duplicates and defined by the following equation:

$$RPD = \frac{\left| X_1 - X_2 \right|}{\left(X_1 + X_2 \right)/2} \times 100$$

where,

RPD = Relative Percent Difference (as %)

$\left| X_1 - X_2 \right|$ = Absolute value (always positive) of $X_1 - X_2$

X_1 = Original sample concentration

X_2 = Duplicate sample concentration

For field duplicate precision, an RPD of ≤20% might serve as a standard rule of thumb for aqueous samples.

For laboratory QC sample precision, information provided in the analytical methods might be found to be adequate to meet your data quality needs.

Expressed in "*relative standard deviation*" or other statistical means for comparison of 3 or more data points - Follow a similar thought process as described above and include appropriate calculations.

Accuracy/Bias

Questions answered: How well do the measurements reflect what is actually in the sample? How far away am I from the accepted or "true" value, and am I above this value or below it?

Expressed in terms of *"Recovery"*

Quantitative vs. Qualitative term: Quantitative.

QC samples (may include)

- Matrix spikes - To monitor sample preparation/analysis methodology, as well as, to represent the actual sample matrix itself;
- Standard reference materials and/or laboratory control samples - To monitor sample preparation/analysis methodology and often of a similar media (such as water, soil, sediment) as the field samples; and/or
- Performance Evaluation (PE) samples – (may be appropriate for complex analyses) To serve as an external check on sample preparation/analysis methodology, as samples of known concentration are prepared external to the laboratory and submitted for analysis as "blind" or unknown samples.

(NOTE: The concentrations of these QC samples are typically near the middle of the calibration range.)

Acceptance criteria or MPC: MPC are typically expressed in terms of % Recovery of a known or accepted/true amount and defined by the following equation:

$$\%R = \frac{X}{K} \times 100$$

where,

$\%R$ = Recovery (as %)

X = Measured value or concentration

K = Known or accepted/true value or concentration

For matrix spikes, the % Recovery calculation typically takes into account correcting the matrix spike concentration for the naturally occurring amounts (as measured in the unspiked sample). The calculation may be represented by the following equation:

$$\%R = \frac{(A - B)}{K} \times 100$$

where,

$\%R$ = Recovery (as %)

A = Measured value or concentration in the matrix spike

B = Measured value or concentration in the unspiked sample

K = Known or accepted/true value or concentration in the matrix spike without native amounts present

For laboratory QC sample accuracy/bias, information provided in the analytical methods might be found to be adequate to meet your data quality needs.

For PE sample accuracy/bias, information is available from the PE sample vendor.

Expressed in terms of *"Contamination"*

Quantitative vs. Qualitative term: Quantitative.

QC samples (may include):

- Field blanks - To assess the effect of any potential sample collection contaminant sources on the associated sample data; and
- Laboratory blanks - To assess the effect of any potential laboratory preparation/analysis contaminant sources on the associated sample data.

Acceptance criteria or MPC: MPC are typically expressed in reference to the QL (as defined in Appendix A). MPC are often set at <QL for field blanks and <QL or some fraction of the QL (such as <1/2 QL) for laboratory blanks.

Representativeness

Questions answered: How well do the sample data reflect the environmental conditions? Is my 500mL sample representative of all the water in that lake? Is my sample still the same after that hot, bumpy truck ride to the laboratory?

Quantitative vs. Qualitative term: May include both.

If quantitative:

QC samples (may include):

- QC samples for other DQIs - To serve as overall checks of representativeness; and/or
- Temperature blanks (water samples that travel with samples from transport in the field to the laboratory) - To serve as a QC check for temperature-related sample preservation.

Acceptance criteria or MPC: For temperature blanks, MPC may be expressed in relation to an acceptable temperature range. For example, for field samples requiring preservation at 4°C, the MPC may be 4°C +/- 2°C.

If qualitative:

QC samples (may include): None.

Acceptance criteria or MPC: Assessing this DQI may include plans to verify that documented sample collection and analytical methods (including sample handling & chain-of-custody procedures, sample preservation, and sample holding times protocols) were followed to ensure the data reflects the environmental conditions. Assessing may also include a review of the sampling design to determine whether samples collected were representative of the environmental conditions and extent of physical boundaries, especially if the sampling design was based on judgmental sampling and not on statistical means.

Comparability

Questions answered: How similar do the data need to be to those from other studies or from similar locations of the same study, same sampling locations but at different times of the year, etc.? Are similar field sampling and analytical methods followed to ensure comparability? If variations are noted in field conditions (such as a stream bed being somewhat dry resulting in more turbid water samples), do these observations support poor comparability of associated data?

Quantitative vs. Qualitative: Qualitative.

QC samples (may include): None.

Acceptance criteria or MPC: Assessing this DQI may include plans to compare sample collection and handling methods, analytical procedures, and QA/QC protocols between studies, study locations, sampling time of year, etc. along with the associated data. Additionally, comparison of concentration units, types of equipment used, and weather/seasonal variations may be assessed.

Completeness

Questions answered: What amount (typically expressed in percentage) of the data you plan to collect is necessary to meet your project objectives? And, are there any data points that are absolutely critical and therefore may warrant re-sampling and/or re-analysis if not attained? After all the things that went wrong do I still have enough acceptable information and data to make a decision?

Quantitative vs. Qualitative: May include both.

If quantitative:

QC samples (may include): None.

Acceptance criteria or MPC: MPC are typically expressed in terms % Completeness between the amount of usable data collected versus the amount of data planned to be collected for the study. Completeness is defined by the following equation:

$$\%C = \frac{N}{T} \times 100$$

where,

$\%C$ = Completeness (as %)

N = Number of usable results

T = Targeted number of samples planned to be collected

Typical MPC may fall somewhere in the range of 75 - 90% completeness, depending on how critical it is to supporting project decisions.

If qualitative:

QC samples (may include): None.

Acceptance criteria or MPC: Assessing this DQI may include ensuring that any data points (locations and/or analyses) that were defined as being absolutely critical to the project have in fact produced usable data and, if not, have set plans in motion to re-sample and/or re-analyze.

Sensitivity

Questions answered: Are the field and/or laboratory methods sensitive enough to “see” or quantify your parameters of concern at or below the regulatory standards or your PALs? Are the QLs low enough to answer the question(s) you are asking? How low can I measure and still have confidence in the results?

Quantitative vs. Qualitative: Quantitative.

QC samples (may include):

- Calibration verification - To assess the ability to accurately quantify data at the low end of the calibration curve; and/or
- Laboratory QC samples (such as laboratory control samples, laboratory fortified blanks, etc.) - To ensure accurate quantifying of data at the QL.
- (NOTE: The concentrations of these samples are typically at or near the QL which is typically defined by the lowest point on a calibration range.)

Acceptance criteria or MPC: MPC may be expressed in terms of the laboratory’s acceptable performance criteria for their QC checks. This is typically expressed as QL +/- some defined acceptable concentration value deviation.

Another way of approaching this material is through a systematic process broken down into several steps (for each sample medium and associated analytical operation:

Step 1 - Identify the most critical Data Quality Indicators (DQIs) for your project. (For example, sensitivity may be more critical than another DQI and would drive your selection of a sampling or analytical method.) DQIs should be associated with each sample medium/matrix and each sampling & measurement/analysis scheme planned. The principal DQIs include: precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity (as described above).

Step 2 - Determine which of the DQIs will be assessed quantitatively (typically, these may include precision, accuracy/bias, and sensitivity) and which are more qualitative in nature (typically, these may include representativeness, comparability, and completeness).

Step 3 - Describe how each DQI will be assessed. Identify pertinent quality control (QC) samples that will serve as checks on data quality, and discuss how these QC samples will be evaluated.

Step 4 - For the DQIs that can be assessed quantitatively:

- Identify the QC samples selected for assessing each DQI. The QC samples, as discussed previously, may include both field QC samples (such as field duplicates, field/equipment blanks, etc.) and measurement/analysis QC samples (such as laboratory duplicates, method blanks, matrix spikes/matrix spike duplicates, laboratory control samples, etc.).
- Provide the calculation(s) that will be used to define the acceptance criteria or Measurement Performance Criteria (MPC) for each DQI.

(NOTE: These equations are generally included in Section 1.7 of the QA Project Plan. If they are presented in another section, Section 1.7 should clearly state where they will be found.)

- Identify the Measurement Performance Criteria (MPC) for each DQI and the associated QC samples selected for assessing whether the MPC was met. The MPC for your project may be defined by several options. The two primary options include:
- Project team defines project-specific criteria; or
- Project team defaults to QC criteria already defined by a sampling, field measurement, or analytical method once reviewed and deemed acceptable to meet the data needs of the project.

Types of QC Samples and MPC to consider include:

Field QC Samples - MPC to be assessed by field QC samples are generally defined by the project team. For example: If analyzing sodium in a surface water sample, you may collect field duplicate samples at a frequency of 1 duplicate for every set of 20 samples or less. These QC samples would be used to assess the precision encompassing both sample collection and analytical methods. In this case, the analytical parameter is sodium, the sample matrix is surface water, the DQI is precision of field plus analytical methods, and the MPC set might be Relative Percent Difference (RPD) < 20% between the results of the field duplicate pair.

Field Measurement QC – MPC and associated QC samples are generally defined by the project team in conjunction with any information provided in the associated field instrument manuals.

Analytical QC - For laboratory measurements, the selected laboratory is often helpful in providing information on its internal quality control (QC) measures and criteria that may be “accepted” by (or defaulted to) the project team. It’s important that the project team reviews the laboratory information and decides whether the criteria are rigorous enough for its use. To do this, you will need to identify a lab, make contact with it, and ask for its QA Manual and relevant standard operating procedures (SOPs). Within the QA Manual and SOPs, you will need to look for QC acceptance criteria usually in the form of numerical values. (NOTE: Some lab QA plans lack specific QC acceptance criteria. Instead, these plans may provide marketing information and simply “say” the laboratory is good for the reasons they will list. In this case, the pertinent QC information is probably included in the SOPs.) Alternatively, you may choose to specify the criteria you’re expecting the laboratory to meet. If you choose to do this, you will need to have the associated laboratory contract criteria ready to insert into the QA Project Plan.

(NOTE: The MPC and associated field, measurement, and/or analytical QC samples are generally provided in Section 1.7 of the QA Project Plan. If they are presented in another section of the QA Project Plan, Section 1.7 should clearly state where they will be found. This information can very easily be combined with Section 2.5 Quality Control Requirements and summarized in a table similar to Table 2-4 of the QA Project Plan Template included in Module 2. If the project team has reviewed the QC acceptance limits summarized in Table 2-4 and has selected to accept these as the MPC meeting the data quality needs of the project, this needs to be clearly stated within Section 1.7.)

Step 5 - For the DQIs that will be assessed qualitatively, discuss the plans to assess each DQI and support the assurance that the quality of the data generated will be acceptable for making project decisions. Some examples to consider include:

<u>Representativeness</u> - Discuss how you will follow standardized and well-accepted sampling and analytical methods for ensuring the data collected reflects the environmental conditions. Describe the importance of any pertinent chain-of-custody procedures, sample preservation, and/or maximum sample holding times.

<u>Comparability</u> - Discuss if/how similar the project data need to be to those from other studies, similar locations within the same study, same sampling locations at different times of the year, etc. Compare sample collection and handling methods, analytical procedures, and QA/QC protocols as pertinent.

Completeness - Describe the amount, usually expressed in percentage, of data you plan to collect that is essential/necessary to meet your project objectives. Identify any data points (locations and/or measurements/analyses) that are absolutely critical and therefore may warrant re-sampling and/or re-analysis if not attained.

Attachment D

Selecting an Environmental Laboratory

In order for an environmental monitoring program or single sampling event project to be successful, it is usually necessary to locate and hire an environmental laboratory. The guidance in this module is designed to provide perspective on a number of the areas you may want to consider in selecting a laboratory to support the data quality needs of your project. The information is presented as a starting point. For additional assistance, feel free to consult with the Region’s U.S. EPA QA staff, talk with other Grantees regarding laboratories they may be familiar with, and/or, if necessary, consider hiring a consultant.

Careful selection of laboratories and analytical methods is critical to the success of your project. Many routine laboratory procedures may not be able to support your data quality needs and/or report data to low enough limits to support decisions for your specific project. Following a review of a laboratory’s qualifications and credentials, you may end up selecting a different laboratory and/or analytical method than originally considered. This decision point is critical to the success of your project. If an inappropriate laboratory and/or analytical procedure are selected, you may end up having to repeat your entire study.

There are several factors to consider when selecting a commercial laboratory including:

Technical and Logistical Qualification

- Experience with sample media/matrices and analyses
- State certification and/or TNI accreditation
- Laboratory capacity
- Laboratory location and support services
- Experience with other tribal projects

- Cost

Quality System Documentation

- Laboratory Quality Assurance Plan (or Manual)
- Standard operating procedures
- Personnel resumes
- Cost of QC
- Chain-of-custody
- Archiving data

Other Factors

- Data review procedures
- Laboratory report content
- Sample retention and disposal
- Laboratory subcontracts

Additional guidance on these factors is provided in the subsections that follow.

Technical and Logistical Qualifications:

<u>Experience with sample media/matrices and analyses</u> - *Does the laboratory have experience analyzing the types of samples* (e.g., water, drinking water, waste water, sediment, soil, fish tissue, plant materials, etc.) *that you want analyzed? Does the laboratory perform the specific analyses that you require?* Some laboratories may specialize in analyses based on either a particular matrix (e.g., drinking water, fish tissue, etc.) or a particular type of analysis (e.g., pesticides, dioxin, etc.). Others are full service organizations that can handle many types of matrices/media and analyses.

It is important that you determine what matrices/media and analyses you require while you are planning your project (and prior to writing your QA Project Plan). Usually laboratories have a business manager, client services manager, sales representative, etc. who will work with you to determine whether they can provide the particular analyses required for your project. Most laboratories will perform routine surface or ground water analyses. Two types of water analyses not always available at every laboratory include: organic chemistry methods for drinking water compliance analyses (as these methods require a laboratory to handle reporting at the low detection limits); and dioxin analyses (as these methods require special reagents, instruments, and expertise).

Lack of prior experience should not necessarily disqualify a laboratory, but should lead to a more thorough investigation of the laboratory's qualifications.

State certification and/or TNI accreditation - *Does the laboratory have state certification in the state in which your grantee resides? Does the certification include the types of sample media/matrices and analyses of interest for your project?* It is important to note that all states do not run their certification program the same way. Some state certifications include only drinking water, while others may include many different media (e.g., waste water, hazardous waste, tissue, etc.). Even laboratories within a given state seldom are certified for exactly the same media or analytical parameters. Laboratories are certified for specific media and analyses depending on their interest to pursue specific certification categories, as well as their ability to demonstrate compliance with the associated qualifications. State certification by itself does not guarantee that good quality work will be produced, but it may provide a good starting point to help you evaluate a laboratory's ability to support your project needs.

Does the laboratory have TNI accreditation? Does the accreditation include the types of sample media/matrices and analyses of interest for your project? Many states, independent of size, also participate in TNI (The NELAC Institute).

This program attempts to ensure a national uniformity in accreditations (similar in intent to certifications), and involves a more detailed review than that provided historically by many state certification programs.

Has the laboratory successfully analyzed all recent performance evaluation (PE) samples? Usually state certification and/or TNI accreditation requires regular participation in some kind of PE program. Although these PE programs do not cover all analyses or all possible analytes, they usually cover many of the most common analytes of interest to water monitoring programs. It is recommended that you request the laboratory's most recent (last two years is good) PE results. If there have been recent problems, you should inquire about the results of the laboratory's investigation of the problem and its corrective actions to ensure the problem was fixed.

Do you know the current status the laboratory's state certification or TNI accreditation? You may want to request the certification/accreditation audit reports, although the laboratory is not obligated to share them with you (as their availability may be dictated by company or laboratory confidentiality policy). The state certification/TNI accreditation agency will, however, tell you the media/matrices, analytes, and methods the laboratory is certified/accredited for, as well as whether the laboratory is in good standing with regards to its certification/accreditation.

<u>Laboratory capacity</u> - *Does the laboratory have the capacity to handle your samples (and all related sample preparation and analyses) on the schedule you need?* Do they have sufficient instruments (and back-up instruments in case of instrument failure) and personnel to handle the anticipated sample load?

If you are not generating a large number (typically, less than 40) of samples, most laboratories can handle this sample load without problem. However, if your project will generate a large number samples at one time and/or you have samples to be analyzed for a variety of analytical parameters, you need to ensure that the laboratory can handle the work load in all of its departments. For example, a laboratory may have capacity to analyze 60 metals analyses (as these are relatively fast and involve minimal preparation), but they might not be able to analyze 60 pesticide or semivolatile organic compound analyses (as these require more time consuming sample preparation steps, as well as longer analysis time) in a specific time frame.

Make sure you discuss sample capacity loads, sampling holding times, and data deliverables with the laboratory and then make plans to schedule your sample collection accordingly; or, find a different laboratory that can handle your samples when they need to be analyzed, if you cannot be flexible in your sample collection and shipping schedule.

<u>Laboratory location and support services</u> - *Is the laboratory location convenient?* A local laboratory may be advantageous to your project as it may more easily facilitate transferring your samples directly to the laboratory the same day as collected, either hand-delivered by a project team member or picked up by a laboratory courier service. This may be especially critical if your project's analytical methods require that your samples be analyzed within a short time frame (after collection) to ensure sample integrity. However, with overnight courier services, shipping samples within a state or even to another state doesn't necessarily mean that processing of the samples will start any later than if they were delivered to a local laboratory.

What support services does the laboratory provide, and what is its sample receipt policy? You also need to discuss with the laboratory how it typically receives samples and what support it might provide in this regard. For example, the laboratory may provide coolers for shipping, chain-of-custody forms, free pre-cleaned/certified sample bottles and preservatives, courier service, etc. Some laboratories have staff available to receive samples after hours or on Saturdays, but not all do.

<u>Cost</u> - *Are the laboratory's prices reasonable?* Shop around and find the laboratory that best meets your needs and look for a competitive price. Sometimes there are economies by making a longer-term commitment (e.g., for all four quarterly monitoring events in a year) or in sending all your samples to one laboratory facility (e.g., rather than splitting up samples submitted for various analyses to two or more individual laboratories).

Quality System Documentation:

<u>Laboratory Quality Assurance Plan (or Manual)</u> - *Does the laboratory have a written Quality Assurance (QA) Plan, and is it adequate to meet your project's data quality needs?* Almost all laboratories will have some form of QA Plan, but these documents may vary considerably in terms of their content.

Some QA Plans are designed to provide general information as a form of marketing tool. These plans might describe the laboratory's capabilities, identify any state certifications or accreditations, discuss the QA program in place (in a general sense), list the methods it performs, describe the matrices it typically handles, list personnel and their qualifications, and provide an overview of the organization. This type of QA Plan may be supplemented with additional information available in other laboratory documentation, such as standard operating procedures (SOPs). However, acquiring this additional information may require you to "dig deeper" and ask more questions.

The other end of the spectrum might be a QA Plan containing similar types of information (as discussed above), while being much more detailed in scope. For example, this type of QA Plan might include lists of analytes associated with each method (rather than just listing the methods alone), as well as the reporting limits and/or method detection limits for each analyte for each method. Rather than merely stating it has a QA program, this type of plan might provide specifics with respect to: the types of QC samples run; the frequency with which they are run; the sources and concentrations of specific spiking solutions that are used (in preparing surrogate spikes, matrix spikes, and/or laboratory control sample mixtures); the acceptance criteria associated with each type of QC check (on an analyte-specific basis); and the corrective actions taken when these criteria are not met. Details on calibration criteria and associated corrective action criteria may also be included in this type of plan.

Standard operating procedures - *Does the laboratory have written standard operating procedures (SOPs) for all of its operations?* Most full-service laboratories are divided up into departments or sections that include: sample receipt; organic sample preparation; inorganic sample preparation; metals analysis; general chemistry analyses; gas chromatography/mass spectrometry (GC/MS) analyses (often including separate volatile and semivolatile organic compound analysis areas); and gas chromatography (GC) analyses (often including separate pesticide, polychlorinated biphenyl (PCB), and total petroleum hydrocarbon analysis areas). Some laboratories also offer microbiological analyses or toxicity testing, while others may provide analysis of tissue or foliage samples.

Each laboratory department or section should document its procedures in written SOPs. SOPs for each analytical method should include detailed step-by-step procedures, as well as specific QC requirements, frequency, acceptance criteria, and corrective actions (to be taken if these criteria are exceeded) associated with that method. It is important to remember that a “published method” is not an SOP. In general, published methods such as EPA methods or those in Standard Methods vary considerably in their method description and may need to be supplemented with specific QC requirements, calibration criteria, reporting limits and/or method detection limits, etc. At times, the published methods may be modified to improve performance if necessary to meet a project objective.

Personnel resumes - *Are the resumes of key personnel available for review, if necessary?* Sometimes this information is found in the laboratory’s QA Plan, while other times resumes are kept confidential unless requested specifically. State certification agencies typically have minimum experience and/or educational requirements for management and supervisory positions, and they may review the laboratory’s general qualifications as part of the certification process. However, you may want to review specific resumes if there are concerns related to a critical analysis area, especially for the more complex analyses.

Cost of QC - *What QC samples are analyzed and typically reported by the laboratory on a routine basis, and what QC samples may will require an additional cost to the grantee?*

Unless requested otherwise, most laboratories will perform their QC analyses on a batch basis. A batch is a set number of samples (frequently, 20) of a similar matrix/medium. The batch may be comprised of samples from a single client or include small groups of samples from multiple clients. The intent of batching samples is for the laboratory to avoid performing an overall disproportionate number of QC sample analyses. For example, a grantee may submit 5 samples and another client may submit 10 samples for the same type of analysis. But, as the laboratory typically performs analysis of the associated QC check samples (that may include a laboratory blank, a matrix spike, laboratory duplicate and possibly a laboratory control sample) at a rate of one for every 20 samples, the laboratory may combine the grantees samples and the other clients' samples into one batch and report the same batch QC results to both clients. This is logical from a laboratory perspective, as the laboratory typically absorbs the cost of these QC samples. But, this batching could result in generating results of matrix spike and lab duplicate samples that may not be representative of the grantees samples. Thus, they provide information about the laboratory's performance, but not necessarily about the grantees sample matrix/medium. In most cases, batch QC is sufficient for tribal purposes, but in some cases having one of the grantees samples designated to serve as the matrix spike, laboratory duplicate, and/or matrix spike duplicate may be desirable. Some laboratories may batch an individual client samples together (even if just a small group) and not combine samples from different clients. If that is the case, they may use the grantees samples as a basis for the QC samples without any additional charge.

It is recommended that you engage the laboratory in discussions regarding what QC samples it runs routinely for each analysis (as they may differ from method to method), the frequency of those QC sample analyses, as well as which are performed at client versus laboratory expense. Samples sent blind to the laboratory, such as field duplicates and field blanks, will always be at client expense.

<u>Chain-of-custody</u> - *If there are legal considerations to the data, does the laboratory have a well-documented, internal chain-of-custody system?* Oftentimes this is done electronically or with a combination of electronic and logbook documentation.

<u>Archiving data</u> - *Does the laboratory have a system in place to track, store, and archive raw data and old data reports?* Most laboratories have retention policies, but you should know and understand what they might be. With the increasing use of electronic data, but ever changing formats, a permanent hard copy may be the only way to ensure data is available for any future use (such as if the client loses their data, a complete data package including raw data was not requested by the client but needed later on, etc.).

Other Factors:

<u>Data review procedures</u> - *Does the laboratory have defined procedures in place covering administrative tasks such as sample receipt and check in, as well as for the reporting and processing of data?* It is important to understand the level of review associated with these tasks. Most laboratories will have SOPs in place covering these tasks. Some specific questions to consider include:

- Does the QA Officer (or some individual independent of performing the actual activity) review all data or a fraction of the data in real time (prior to providing the data to the client)?
- Is there an automated data review system in place? Does the data review SOP describe the review system satisfactorily?
- Are data flagged for the client to review? How are data flagged? Is the system clear?
- Will all data reports contain a narrative explaining any problems?

<u>Laboratory report contents</u> - *What are the contents of a typical laboratory report?* It is recommended that you request to see a typical data report (to ensure the laboratory will provide the information you will need) prior to selecting your laboratory, and that you specify the laboratory QC data you need to be reported with its data (so that you will have the information necessary to perform at least a minimum QC check on your project data). You should ensure you have a clear understanding of the criteria by which the QC data were evaluated for inclusion in

your QA Project Plan (especially if this is not to be summarized in the data report). For example, seeing a matrix spike recovery of 50% might look unacceptable, but for certain difficult compounds this may be an excellent recovery justified by the laboratory QA Plan and/or analytical SOP.

In some cases, it may be desirable or necessary to have the laboratory provide a complete data package, sometimes called a data validation package. Basically, this data package includes all the data and sample information used to generate a sample result. It may include, but not be limited to, chain-of-custody and sample receipt records, sample preparation logs, analysis logs, standards logs, raw data from the instrument for both sample and QC sample analyses, calibration information for initial and continuing calibration analyses, sample analysis results, QC sample results, and all information related to sample processing (for example, results of manual integrations of results, etc.). (Note: For an example of items to consider for inclusion in a complete data package, visit the EPA Region 9 QA website at: http://www.epa.gov/region9/qa and download the document entitled *Draft Laboratory Documentation Requirements for Data Validation, R9QA/004.2, August 2001*) “Complete” data packages are typically required for litigation. This type of data package may cost an additional $50-100 or more per sample batch, if they are even offered as an option from a given laboratory (which is information you would want to know about up front). Such packages are usually considerably cheaper if ordered when the samples are analyzed. Asking the laboratory to generate this data package after the fact may cost considerably higher.

Sample retention and disposal - *What are the laboratory’s policies with respect to retention and disposal of samples?* The grantee should be reassured that there is no future liability associated with providing samples to the laboratory.

Laboratory subcontracts - *What are the laboratory’s policies with respect to subcontracts, and what samples might be subcontracted for your project?* The laboratory should have a system in place to evaluate its subcontractor’s quality system. It should be reviewing subcontractor data as if it was its own, since it will be reported as such. It is important to note that a subcontractor does introduce another variable into the quality system, one that you may not be able to evaluate directly. Thus, it is important that you are comfortable with whatever samples might be sent out.

If considered critical to a project’s success, you may need to request documentation (such as an SOP) from the subcontract laboratory, so that it too can be evaluated.

APPENDIX B

Consultant and Laboratory Contact List

Organization	Name	Title	Contact Information
City of Tucson (Grantee)	Frank Bonillas	Project Manager	frank.bonillas@tucsonaz.gov (520) 972-3175
	Ursula Ginster	Quality Assurance Manager Brownfields Manager	ursula.ginster @tucsonaz.gov (520) 791-3175
Environmental Protection Agency (Grantor)	Scott Stollman	Project Officer	stollman.scott@epa.gov (415) 972-3729
	Audrey Johnson	Quality Assurance Officer	johnson.audreyl@epa.gov (415) 972-3431

Environmental Company Name	Name	Title	Contact Information
TBD	TBD	TBD	TBD
	TBD	TBD	TBD
TBD	TBD	TBD	TBD
	TBD	TBD	TBD
TBD	TBD	TBD	TBD
	TBD	TBD	TBD
TBD	TBD	TBD	TBD
	TBD	TBD	TBD

Laboratory Company Name	Name	Title	Contact Information
Airtech Environmental Laboratories	Dave Schreiner	Quality Assurance Manager	aeldave@gmail.com (480) 968-5888
	James Jones	Project Chemist	Jjones@azairlab.com (480) 968-5888
Pace Analytical	Daphne Richards	Project Manager	drichards@esclabsciences.com (615) 773-9662
	Blake Judge	Quality Assurance Manager	bjudge@pacelabs.com (615) 773-9770
McCampbell Analytical, Inc. Laboratory	Angela Rydelius	Laboratory Manager	Angela@mccampbell.com (877) 252-9262
	Theresa Johnson	Quality Assurance Manager	Theresa.johnson@mccampbell.com (877) 252-9262

Orange Coast Analytical, Inc.	Tara Touvell	Project Manager	tarat@ocalab.com (480) 736-0960
	Chris Tisserat	Quality Assurance Manager	christ@ocalab.com (714) 832-0064
Eurofins (Formerly TestAmerica, Inc.)	Emily Petrunia	Project Manager	emily.petrunia@et.eurofinsus.com (602) 659-7629
	Tony Genco	Quality Assurance Manager	Tony.genco@et.eurofinsus.com (602) 659-7613
Turner Laboratories, Inc	Elizabeth Kasik	Project Manager	ekasik@turnerlabs.com (520) 882-5880
	Karri Warnock	Quality Assurance Manager	kwarnock@turnerlabs.com (520) 882-5880
Fiberquant Analytical Services	Michael Breu	Project Manager	michaelb@fiberquant.com (602) 276-6139
	Dr. Larry Pierce	Quality Assurance Manager	lspierce@fiberqquant.com (602) 276-6139
Beacon Environmental Services, Inc.	Ryan Schneider	Project Manager	ryan.schneider@beacon-usa.com (410) 838-8780
	Pete Kelly	Quality Assurance Manager	pete.kelly@beacon-usa.com (410) 838-8780
International Asbestos Testing Laboratories (iATL)	John Napolitan	Quality Assurance Manager	johnnapolitan@iatl.com (856) 231-9449

APPENDIX C

Arizona Soil Remediation Levels

TITLE 18. ENVIRONMENTAL QUALITY

CHAPTER 7. DEPARTMENT OF ENVIRONMENTAL QUALITY REMEDIAL ACTION

Editor's Note: The Office of the Secretary of State publishes all Code Chapters on white paper (01-4).

Editor's Note: The proposed summary action amending the heading of Chapter 7 was remanded by the Governor's Regulatory Review Council (August 4, 1999), which revoked the interim effectiveness of the change as of January 22, 1999. The heading of Chapter 7 before the proposed summary action has been restored (Supp. 99-3).

Editor's Note: Chapter 7 heading repealed; new heading adopted; both by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4).

Editor's Note: At the request of the Department of Environmental Quality, interim rules removed in Articles 1 & 2 (Supp. 97-3) by the emergency expiring were reinstated. The Department determined these emergency rules were in effect until permanent rules were adopted pursuant to Laws 1995, Ch. 232, § 5, and Laws 1996, Chapter 151, § 9. Under these Laws the Department was required to "adopt risk based remediation standards formally by rule pursuant to A.R.S. § 49-152(A) ... no later than August 1, 1997."; and the "interim standards adopted pursuant to A.R.S. § 49-152(A)(1)(a) and (b) ... as emergency rules shall remain in effect until the formally established rules are adopted." The interim rules have not been reprinted because permanent final rules have now been filed. Refer to Supp. 97-1 for interim emergency rules (Supp. 97-4).

Editor's Note: A Section of this Chapter was adopted under an exemption from the Arizona Administrative Procedure Act (A.R.S. Title 41, Chapter 6) pursuant to Laws 1997, Ch. 296, §§ 3(E) and (G), (10) and (11). Although exempt from certain provisions of the rulemaking process, the Department was required to submit notice of proposed rulemaking with the Secretary of State for publication in the Arizona Administrative Register and conduct a public hearing (Supp. 97-3).

Editor's Note: Some Sections of Chapter 7 were exempt from the rulemaking process (Laws 1995, Ch. 232, § 5). However the Department was required to provide a notice of hearing and public hearing before adoption of the emergency rules. The emergency rules were approved by the Attorney General (Supp. 96-1). Editor's note added to clarify exemptions of emergency adoptions (Supp. 97-1).

ARTICLE 1. EXPIRED

Article 1, consisting of Section R18-7-110, expired under A.R.S. § 41-1056(E) at 8 A.A.R. 4298, effective August 31, 2002 (Supp. 02-3).

The proposed summary action renumbering Section R18-7-110 to R18-7-101 was remanded by the Governor's Regulatory Review Council (August 4, 1999), which revoked the interim effectiveness of the changes as of January 22, 1999. The numbering of Article 1 before the proposed summary action has been restored (Supp. 99-3).

Article 1, consisting of Sections R18-7-101 thru R18-7-109 repealed; R18-7-110 renumbered to R18-7-101; both by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4).

Article 1 consisting of Sections R18-7-101 through R18-7-110 adopted as permanent rules effective December 22, 1987.

Article 1 consisting of Sections R18-7-101 through R18-7-110 adopted as an emergency effective September 17, 1987 pursuant to A.R.S. § 41-1026, valid for only 90 days. Emergency expired.

Article 1 consisting of Sections R18-7-101 through R18-7-110 adopted as an emergency effective June 17, 1987 pursuant to A.R.S. § 41-1026, valid for only 90 days. Emergency expired.

Article 1 consisting of Sections R9-20-102, R9-20-104 through R9-20-106 and R9-20-111 adopted as an emergency effective March 6, 1987 pursuant to A.R.S. § 41-1026, valid for only 90 days. Emergency expired.

Article 1 consisting of Sections R9-20-102, R9-20-104 through R9-20-106 and R9-20-111 adopted as an emergency effective December 5, 1986 pursuant to A.R.S. § 41-1003, valid for only 90 days. Emergency expired.

ARTICLE 2. SOIL REMEDIATION STANDARDS

Article 2, consisting of interim Sections R18-7-201 through R18-7-209 and Appendices A through C, replaced by new permanent Sections, adopted effective December 4, 1997. Appendix D emergency expired (Supp. 97-4).

Article 2, consisting of Sections R18-7-201 through R18-7-209 and Appendices A through D, removed in Supp. 97-3 reinstated at the request of the Department. Refer to Supp. 97-1 for interim rules. Introduction stating the emergency expired has been removed for clarity (Supp. 97-4).

Article introduction revised below to clarify exemptions of emergency adoption (Supp. 97-1).

Article 2, consisting of Sections R18-7-201 through R18-7-209 and Appendices A through D, adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5. The Sections are in effect until permanent rules are adopted and in place by August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1).

ARTICLE 3. PROSPECTIVE PURCHASER AGREEMENT

Article 3, consisting of Section R18-7-301, adopted effective January 14, 1997 (Supp. 97-1).

Section

ARTICLE 4. REPEALED

Article 4, consisting of Section R18-7-401, repealed by final rulemaking at 15 A.A.R. 232, effective March 7, 2009 (Supp. 09-1).

Article 4, consisting of Section R18-7-401, repealed. New Article 4, consisting of Section R18-7-401, adopted effective October 21, 1998 (Supp. 98-1).

Article 4, consisting of Section R18-7-401, adopted under an exemption from A.R.S. Title 41, Chapter 6 effective August 5, 1997 (Supp. 97-3).

Section

ARTICLE 5. VOLUNTARY REMEDIATION PROGRAM

Article 5, consisting of Sections R18-7-501 through R18-5-507, adopted by exempt rulemaking at 7 A.A.R. 814, effective February 9, 2001 (Supp. 01-1).

Section

ARTICLE 6. DECLARATION OF ENVIRONMENTAL USE RESTRICTION FEE

Article 6, consisting of R18-7-601 through R18-7-606, made by exempt rulemaking at 10 A.A.R. 573, effective February 20, 2004 (Supp. 04-1).

Section

ARTICLE 1. EXPIRED

Article 1, consisting of Section R18-7-110, expired under A.R.S. § 41-1056(E) at 8 A.A.R. 4298, effective August 31, 2002 (Supp. 02-3).

R18-7-101. Repealed

Historical Note

Adopted as an emergency effective December 5, 1986, pursuant to A.R.S. § 41-1003, valid for only 90 days (Supp. 86-6). Emergency expired. Adopted, without change, as an emergency effective March 6, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-1). Emergency expired. Former Section R9-20-102 was renumbered as Section R18-7-101, amended and readopted as an emergency effective June 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). R18-7-101 repealed; new Section renumbered from R18-7-110; both by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Summary renumbering action revoked; former numbering of Sections R18-7-101 and R18-7-110 restored effective January 22, 1999. Adopted summary rules filed August 10, 1999; interim effective date of January 22, 1999 now the permanent effective date (Supp. 99-3).

R18-7-102. Repealed

Historical Note

Adopted as an emergency effective December 5, 1986, pursuant to A.R.S. § 41-1003, valid for only 90 days (Supp. 86-6). Emergency expired. Amended and adopted as an emergency effective March 6, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-1). Emergency expired. Former Section R9-20-104 was renumbered as Section R18-7-102, amended and readopted as an emergency effective June 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). R18-7-102 repealed by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Adopted summary rules filed August 10, 1999; interim effective date of January 22, 1999 now the permanent effective date (Supp. 99-3).

R18-7-103. Repealed

Historical Note

Adopted as an emergency effective June 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). R18-7-103 repealed by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Adopted summary rules filed August 10, 1999; interim effective date of January 22, 1999 now the permanent effective date (Supp. 99-3).

R18-7-104. Repealed

Historical Note

Adopted as an emergency effective June 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-

2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). R18-7-104 repealed by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Adopted summary rules filed August 10, 1999; interim effective date of January 22, 1999 now the permanent effective date (Supp. 99-3).

R18-7-105. Repealed

Historical Note

Adopted as an emergency effective December 5, 1986, pursuant to A.R.S. § 41-1003, valid for only 90 days (Supp. 86-6). Emergency expired. Amended and adopted as an emergency effective March 6, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-1). Emergency expired. Former Section R9-20-105 was renumbered as Section R18-7-105, amended and readopted as an emergency effective June 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). R18-7-105 repealed by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Adopted summary rules filed August 10, 1999; interim effective date of January 22, 1999 now the permanent effective date (Supp. 99-3).

R18-7-106. Repealed

Historical Note

Adopted as an emergency effective December 5, 1986, pursuant to A.R.S. § 41-1003, valid for only 90 days (Supp. 86-6). Emergency expired. Amended and adopted as an emergency effective March 6, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-1). Emergency expired. Former Section R9-20-106 was renumbered as Section R18-7-106, amended and readopted as an emergency effective June 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). R18-7-106 repealed by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Adopted summary rules filed August 10, 1999; interim effective date of January 22, 1999 now the permanent effective date (Supp. 99-3).

R18-7-107. Repealed

Historical Note

Adopted as an emergency effective June 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). R18-7-107 repealed by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Adopted summary rules filed August 10, 1999; interim effective date of January 22, 1999 now the permanent effective date (Supp. 99-3).

R18-7-108. Repealed

Historical Note

Adopted as an emergency effective June 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). R18-7-108 repealed by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Adopted summary rules filed August 10, 1999; interim effective date of January 22, 1999 now the permanent effective date (Supp. 99-3).

Editor's Note: Emergency amendment R18-7-109, removed in Supp. 97-3, was reinstated at the request of the Department. Refer to Supp. 97-1 for emergency rule. This Section was subsequently amended under the regular rulemaking process effective (Supp. 97-4). This Section was repealed by summary action (Supp. 98-4).

R18-7-109. Repealed

Historical Note

Adopted as an emergency effective December 6, 1986, pursuant to A.R.S. § 41-1003 valid for only 90 days. Emergency expired. Amended and adopted as an emergency effective March 6, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-1). Emergency expired. Former Section R9-20-111 was renumbered as Section R18-7-109, amended and readopted as an emergency effective June 18, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). Section amended by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Amendment adopted permanently effective December 4, 1997 (Supp. 97-4). R18-7-109 repealed by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Adopted summary rules filed August 10, 1999; interim effective date of January 22, 1999 now the permanent effective date (Supp. 99-3).

R18-7-110. Expired

Historical Note

Adopted as an emergency effective June 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-2). Emergency expired. Readopted without change as an emergency effective September 17, 1987, pursuant to A.R.S. § 41-1026, valid for only 90 days (Supp. 87-3). Emergency expired. Amended and adopted as a permanent rule effective December 22, 1987 (Supp. 87-4). R18-7-110 renumbered by summary action with an interim effective date of January 22, 1999; filed in the Office of the Secretary of State December 29, 1998 (Supp. 98-4). Summary renumbering action revoked; former numbering of Sections R18-7-101 and R18-7-110 restored effective January 22, 1999 (Supp. 99-3). Section expired under A.R.S. § 41-1056(E) at 8 A.A.R. 4298, effective August 31, 2002 (Supp. 02-3).

Editor's Note: Emergency adopted Article 2 removed in Supp. 97-3, was reinstated at the request of the Department. Refer to Supp. 97-1 for emergency Sections. New Sections were subsequently adopted under the regular rulemaking process (Supp. 97-4).

ARTICLE 2. SOIL REMEDIATION STANDARDS

R18-7-201. Definitions

In addition to the definitions provided in A.R.S. §§ 49-151 and 49-152, the following definitions apply in this Article:

1. "Aquifer Protection Permit Program" means the system of requirements prescribed in A.R.S. Title 49, Chapter 2, Article 3 and A.A.C. Title 18, Chapter 9, Articles 1 through 7.
2. "Background" means a concentration of a naturally occurring contaminant in soils.
3. "Carcinogen" or "carcinogenic" means the potential of a contaminant to cause cancer in humans as determined by lines of evidence in accordance with a narrative classification in "Guidelines for Carcinogen Risk Assessment", EPA/630/P-03/001F, March 2005, (and no future editions), which is incorporated by reference. "Guidelines for Carcinogen Risk Assessment" is available from ADEQ and at http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=116283.
4. "Child care facility" means any permanent facility on a property or portion of property in which care or supervision is provided for children below the age of 18, unaccompanied by a parent or guardian, for periods of less than 24 hours per day. Child care facility does not include private homes or facilities that care for fewer than five children.
5. "Contact" means exposure to a contaminant through ingestion, inhalation, or dermal absorption.
6. "Contaminant" means a substance regulated by the programs listed in R18-7-202(A) or R18-7-202(B) or defined in A.R.S. § 49-171(2).
7. "Department" means the Arizona Department of Environmental Quality.
8. "Deterministic risk assessment methodology" means a site-specific human health risk assessment, performed using a specific set of input variables, exposure assumptions, and toxicity criteria, represented by point estimates for each receptor evaluated, which results in a point estimate of risk.
9. "Declaration of Environmental Use Restriction" or "DEUR" means a restrictive covenant as described in A.R.S. § 49-152.
10. "Ecological community" means an assemblage of populations of different species within a specified location in space and time.
11. "Ecological receptor" means a specific ecological community, population, or individual organism, protected by federal or state laws and regulations, or a local population that provides an important natural or economic resource, function, and value.
12. "Ecological risk assessment" means a scientific evaluation of the probability of an adverse effect to ecological receptors from exposure to specific types and concentrations of contaminants. An ecological risk assessment contains four components: identification of potential contaminants; an exposure assessment; a toxicity assessment; and a risk characterization.
13. "Engineering control" means a remediation method, such as a barrier or cap, which is used to prevent or minimize exposure to contaminants, and includes technologies that reduce the mobility or migration of contaminants.
14. "Excess lifetime cancer risk" means the increased risk of developing cancer above the background cancer occurrence levels due to exposure to contaminants.
15. "Exposure" means contact between contaminants and organisms.
16. "Exposure pathway" means the course a contaminant takes from a source to an exposed organism. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, transport/exposure media (that is, air, water) are also included.
17. "Exposure point" means a location of potential contact between a contaminant and an organism.
18. "Exposure route" means the way a contaminant comes into contact with an organism (that is, by ingestion, inhalation, or dermal contact).
19. "Groundwater" means water in an aquifer as defined in A.R.S. § 49-201(2).
20. "Hazard Index" means the sum of hazard quotients for multiple substances and/or multiple exposure pathways, or the sum of hazard quotients for chemicals acting by a similar mechanism and/or having the same target organ.
21. "Hazardous Waste Management Program" means the system of requirements prescribed in A.R.S. Title 49, Ch. 5, Article 2 and 18 A.A.C. 8, Article 2.
22. "Hazard quotient" means the value which quantifies noncarcinogenic risk for one chemical for one receptor population for one exposure pathway over a specified exposure period. The hazard quotient is equal to the ratio of a chemical-specific intake to the reference dose.
23. "Imminent and substantial endangerment to the public health or the environment" has the meaning found in A.R.S. § 49-282.02(C)(1).
24. "Institutional control" means a legal or administrative tool or action taken to reduce the potential for exposure to contaminants.
25. "Letter of Completion" means a Departmental statement that indicates whether the property in question has met the soil remediation standards in this Article.
26. "Migrate" or "migration" means the movement of contaminants from the point of release, emission, discharge, or spillage: through the soil profile; by volatilization from soil to air and subsequent dispersion to air; and by water, wind, or other mechanisms.
27. "Non-carcinogen" means a contaminant that has the potential upon exposure to an individual to cause adverse health effects other than cancer.

28. "Non-residential site-specific remediation level" means a level of contaminants remaining in soil after remediation that results in a cumulative excess lifetime cancer risk between 1 x 10^{-6} and 1 x 10^{-4} and a Hazard Index no greater than 1 based on non-residential exposure assumptions.
29. "Nuisance" means the activities or conditions that may be subject to A.R.S. § 49-141.
30. "Person" means any public or private corporation, company, partnership, firm, association, or society of persons, the federal government and any of its departments or agencies, this state or any of its agencies, departments, political subdivisions, counties, towns, municipal corporations, as well as a natural person.
31. "Population" means an aggregate of individuals of a species within a specified location in space and time.
32. "Probabilistic risk assessment methodology" means a site-specific human health risk assessment, performed using probability distributions of input variables and exposure assumptions that take into account the variability and uncertainty of these values, which results in a range or distribution of possible risk estimates.
33. "Reasonable Maximum Exposure" or "RME" means the highest human exposure case that is greater than the average, but is still within the range of possible exposures to humans at a site.
34. "Remediate" or "remediation" has the meaning found in A.R.S. § 49-151.
35. "Reference dose" means the toxicity factor expressed as a threshold level in units of (mg/kg-day) at which non-cancer effects are not expected to occur.
36. "Repository" means the Department's database, established under A.R.S. § 49-152(E), from which the public may view information pertaining to remediation projects.
37. "Residential site-specific remediation level" means a level of contaminants remaining in the soil after remediation that results in a cumulative excess lifetime cancer risk between 1 x 10^{-6} and 1 x 10^{-4} and a Hazard Index no greater than 1 based on residential exposure assumptions.
38. "Residential use" has the meaning found in A.R.S. § 49-151.
39. "School" means any public institution under the jurisdiction of the Arizona State Board of Education or the Arizona State Board for Charter Schools, or any non-public institution, established for the purposes of offering instruction to children attending any grade from preschool through grade 12.
40. "Site-specific human health risk assessment" means a scientific evaluation of the probability of an adverse effect to human health from exposure to specific types and concentrations of contaminants. A site-specific human health risk assessment contains four components: identification of potential contaminants; an exposure assessment; a toxicity assessment; and a risk characterization.
41. "Soil" means all earthen materials, including moisture and pore space contained within earthen material, located between the land surface and groundwater including sediments and unconsolidated accumulations produced by the physical and chemical disintegration of rocks.
42. "Soil remediation level" or "SRL" means a pre-determined risk-based standard based upon the total contaminant concentration in soil, developed pursuant to A.R.S. § 49-152(A)(1) and listed in Appendix A or, as applicable, in Appendix B.
43. "Solid Waste Management Program" means the system of requirements prescribed in A.R.S. Title 49, Ch. 4, and the rules adopted under those statutes.
44. "Special Waste Management Program" means the system of requirements prescribed in A.R.S. Title 49, Ch. 4, Article 9 and 18 A.A.C. 13, Articles 13 and 16.
45. "Underground Storage Tank Program" or "UST Program" means the system of requirements prescribed in A.R.S. Title 49, Ch. 6, Article 1 and 18 A.A.C. 12.
46. "Water Quality Assurance Revolving Fund" or "WQARF" means the system of requirements prescribed in A.R.S. Title 49, Ch. 2, Article 5 and 18 A.A.C. 16.

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-201 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Amended by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

R18-7-202. Applicability

A. This Article applies to a person legally required to conduct soil remediation by any of the following regulatory programs administered by the Department:
   1. The Aquifer Protection Permit Program.
   2. The Hazardous Waste Management Program.
   3. The Solid Waste Management Program.
   4. The Special Waste Management Program.
   5. The Underground Storage Tank Program.
   6. The Water Quality Assurance Revolving Fund.
   7. Any other program under A.R.S. Title 49 that regulates soil remediation.

B. This Article also applies to a person who is not legally required to conduct soil remediation, but who chooses to do so under any program administered by the Department.

C. The requirements of this Article apply in addition to any specific requirements of the programs described in subsections (A) or (B).

D. This Article is limited to soil remediation.

E. A person who is remediating a site shall comply with the numeric soil remediation standards identified in either Appendix A or Appendix B if both of the following conditions are met. If either subsection (1) or subsection (2) is not met, a person who is remediating a site shall comply with the numeric soil remediation standards identified in Appendix A.
   1. The site was characterized before May 5, 2007. A site is considered characterized when the laboratory analytical results of the soil samples delineating the nature, degree, and extent of soil contamination have been received by the person conducting the remediation.
   2. The site was remediated or a risk assessment completed before May 5, 2010. A risk assessment or remediation is considered completed when site closure, that meets the conditions in R18-7-209, has been requested.

F. Nothing in this Article limits the Department's authority to establish more stringent soil remediation levels in response to:
   1. A nuisance.
   2. An imminent and substantial endangerment to the public health or the environment.

G. This Article does not apply to persons remediating soil to numeric soil remediation levels specified in the following documents and entered into, issued, or approved before May 5, 2007:

1. Orders of the Director;
2. Orders of any Court;
3. Work agreements approved by the Director pursuant to A.R.S. § 49-282.05;
4. Closure plans approved by the Director pursuant to R18-8-265;
5. Post-closure permits approved by the Director pursuant to R18-8-270;
6. Records of Decision approved by the Director pursuant to R18-16-410;
7. Records of Decision approved by the Director pursuant to R18-16-413; and
8. Records of Decision approved by the Director pursuant to 40 CFR 300.430(f)(5).

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-202 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Amended by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

R18-7-203. Remediation Standards

A. A person subject to this Article shall remediate soil so that any concentration of contaminants remaining in the soil after remediation is less than or equal to one of the following:

1. The background remediation standards prescribed in R18-7-204.
2. The pre-determined remediation standards prescribed in R18-7-205.
3. The site-specific remediation standards prescribed in R18-7-206.

B. A person who conducts a soil remediation based on the standards in R18-7-205, R18-7-206, R18-7-207 shall remediate soil so that any concentration of contaminants remaining in the soil after remediation does not:

1. Cause or threaten to cause a violation of Water Quality Standards prescribed in 18 A.A.C. 11. If the remediation level for a contaminant in the soil is not protective of aquifer water quality and surface water quality, the person shall remediate soil to an alternative soil remediation level that is protective of aquifer water quality and surface water quality.
2. Exhibit a hazardous waste characteristic of ignitability, corrosivity, or reactivity as defined in R18-8-261(A). If the remediation level for a contaminant in the soil results in leaving soils that exhibit a hazardous waste characteristic other than toxicity, the person shall remediate soil to an alternative soil remediation level such that the soil does not exhibit a hazardous waste characteristic other than toxicity.
3. Cause or threaten to cause an adverse impact to ecological receptors. If the Department determines that the remediation level for a contaminant in soil may impact ecological receptors based on the existence of ecological receptors and complete exposure pathways, the person shall conduct an ecological risk assessment. If the ecological risk assessment indicates that any concentration of contaminants remaining in the soil after remediation causes or threatens to cause an adverse impact to ecological receptors, the person shall remediate soil to an alternative soil remediation level, derived from the ecological risk assessment, that is protective of ecological receptors.

C. Soil vapor concentration may be used to estimate the total contaminant concentration in soil if the Department determines that the soil vapor concentration methodology will not be invalidated by the soil, hydrogeology, or other characteristics of the site.

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 59; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-203 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Amended by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

R18-7-204. Background Remediation Standards

A. A person may elect to remediate to a background concentration for a contaminant.

B. A person who conducts a remediation to a background concentration for a contaminant shall establish the background concentration using all of the following factors:

1. Site-specific historical information concerning land use.
2. Site-specific sampling of soils unaffected by a release, but having characteristics similar to those of the soils affected by the release.
3. Statistical analysis of background concentrations using the 95th percentile upper confidence limit.

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-204 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Amended by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

R18-7-205. Pre-determined Remediation Standards

A. A person may elect to remediate to the residential or non-residential soil remediation levels (SRLs) in Appendix A. If allowed under R18-7-202(E), a person may also elect to remediate to the residential or non-residential SRLs in Appendix B.

B. A person who conducts remediation pursuant to this Article shall remediate to the residential SRL on any property where there is residential use at the time remediation is completed.

C. A pre-determined contaminant standard established by federal law or regulation may be used for polychlorinated biphenyl cleanups regulated pursuant to the Toxic Substances Control

Act (TSCA) at 40 CFR 761.120 et seq., however, the Department has no regulatory authority to issue a Letter of Completion in TSCA-regulated cleanups.

D. A person who elects to utilize a residential or non-residential SRL for the following known human carcinogens shall remediate to a 1 x 10^{-6} excess lifetime cancer risk: benzene, benzidine, bis (chloromethyl) ether, chromium VI, diethylstilbestrol, direct black 38, direct blue 6, direct brown 95, nickel subsulfide, and vinyl chloride.

E. Except as provided below, a person who elects to remediate to a residential SRL may utilize a 1 x 10^{-5} excess lifetime cancer risk for any carcinogen other than a known human carcinogen. If the current or currently intended future use of the contaminated site is a child care facility or school where children below the age of 18 are reasonably expected to be in frequent, repeated contact with the soil, the person conducting remediation shall remediate to a 1 x 10^{-6} excess lifetime cancer risk.

F. For contaminants that exhibit both carcinogenic and non-carcinogenic effects, the numeric standard that is lower (more protective) shall apply.

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-205 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Amended by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

R18-7-206. Site-specific Remediation Standards

A. A person may elect to remediate to a residential or a non-residential site-specific remediation level derived from a site-specific human health risk assessment.

B. A person who conducts a remediation to a residential or a non-residential site-specific remediation level shall use one of the following site-specific human health risk assessment methodologies:

1. A deterministic methodology. If a deterministic methodology is used, reasonable maximum exposures shall be evaluated for future use scenarios.
2. A probabilistic methodology. If a probabilistic methodology is used, it shall be no less protective than the 95th percentile upper bound estimate of the distribution.
3. An alternative methodology commonly accepted in the scientific community. An alternative methodology is considered accepted in the scientific community if it is published in peer-reviewed literature, such as a professional journal or publication of standards of general circulation, and there is general consensus within the scientific community that the methodology is sound.

C. A person who conducts a remediation to a site-specific remediation level shall remediate to the residential site-specific remediation level on any property where there is residential use at the time remediation is completed.

D. A person conducting a remediation to a residential or a non-residential site-specific remediation level shall remediate the contaminants in soil to a Hazard Index no greater than 1 and a cumulative excess lifetime cancer risk from 1 x 10^{-6} to 1 x 10^{-4}. The following site-specific factors shall be evaluated when determining the cumulative excess lifetime cancer risk:

1. The presence of multiple contaminants.
2. The existence of multiple pathways of exposure.
3. The uncertainty of exposure.
4. The sensitivity of the exposed population.
5. Other program-related laws and regulations that may apply.

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-206 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Amended by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

R18-7-207. Site-specific Remediation Standards for Nitrates and Nitrites

A person who conducts remediation of nitrates or nitrites shall remediate to a site-specific remediation level pursuant to R18-7-203(B)(1), (2), and (3).

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-207 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Section repealed; new Section made by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

R18-7-208. Declaration of Environmental Use Restriction (DEUR)

A property owner who elects to leave contamination on a property that exceeds the applicable residential standard for the property under R18-7-205 or R18-7-206, or elects to use an institutional control or an engineering control to meet the requirements of R18-7-205, R18-7-206, or R18-7-207, shall record a DEUR pursuant to A.R.S. § 49-152 and comply with the related provisions of that statute and applicable rules.

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-208 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Former R18-7-208 renumbered to R18-7-209; new R18-7-208 made by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

R18-7-209. Letter of Completion or Alternative Closure Document

A. If a person requests a Letter of Completion or an alternative closure document, a person shall submit, at a minimum, the following information to the applicable Departmental program listed in R18-7-202(A) or described in R18-7-202(B):

1. A description of the actual activities, techniques, and technologies used to remediate soil at the site, including the legal mechanism in place to ensure that any institutional and engineering controls are maintained.
2. Documentation that requirements prescribed in R18-7-203(A) and R18-7-203(B)(1) and (2) have been satisfied.
3. If the Department determines pursuant to R18-7-203(B)(3) that an ecological risk assessment is required, documentation that the requirements prescribed in R18-7-203(B)(3) have been satisfied.
4. Soil sampling analytical results that are representative of the area remediated, including documentation that the laboratory analysis of samples has been performed by a laboratory licensed by the Arizona Department of Health Services under A.R.S. § 36-495 et seq. and 9 A.A.C. 14, Article 6.
5. A statement signed by the person conducting the remediation certifying the following: I certify under penalty of law that this document and all attachments are, 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 a fine and imprisonment for knowing violations.

B. The applicable Departmental program described in R18-7-202(A) or R18-7-202(B) shall evaluate the information described in R18-7-209(A). The Department may request additional information, or if the Department verifies compliance with the soil remediation standards set forth under this Article and closure requirements of the applicable program or programs identified in R18-7-202(A) or described in R18-7-202(B), the Department shall issue a Letter of Completion, or an alternative closure document provided for by statute or rule that certifies the soil standards in this Article have been achieved.

C. The applicable Departmental program described in R18-7-202(A) or R18-7-202(B) may revoke or amend any Letter of Completion or alternative closure document described in R18-7-209(B) if any of the information submitted pursuant to R18-7-208 or R18-7-209(A) is inaccurate or if any condition was unknown to the Department when the Department issued the Letter of Completion or alternative closure document.

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-208 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Former R18-7-209 renumbered to R18-7-210; new R18-7-209 renumbered from R18-7-208 and amended by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

R18-7-210. Notice of Remediation and Repository

A. A person conducting soil remediation shall submit a Notice of Remediation to the applicable Departmental program listed in R18-7-202(A) or R18-7-202(B) before beginning remediation. A person conducting a soil remediation to address an immediate and substantial endangerment to public health or the environment and who has notified the Department in accordance with notification requirements prescribed in A.R.S. § 49-284 is not required to submit a Notice of Remediation before beginning remediation. Any person who continues soil remediation after the immediate and substantial endangerment has been abated shall submit a Notice of Remediation. A Notice of Remediation shall include all of the following information:

1. The name and address of the real property owner;
2. The name and address of the remediating party;
3. A legal description and street address of the property;
4. A list of each contaminant to be remediated;
5. The background concentration, SRL, or site-specific remediation level selected to meet the remediation standards;
6. A description of the current and post-remediation property use as either residential or non-residential;
7. The rationale for the selection of residential or non-residential remediation; and
8. The proposed technologies for remediating the site.

B. The Department shall maintain a repository available to the public for information regarding sites where soil is remediated. The Repository shall include a listing of sites for which a Notice of Remediation has been submitted or a Letter of Completion or alternative closure document has been issued.

1. For sites where a Notice of Remediation has been filed, the Repository shall contain the date the notice was filed and the information submitted as described in subsection (A).
2. For sites where a Letter of Completion or alternative closure document has been issued, the Repository shall contain the following:
    a. The name and address of the real property owner;
    b. The name and address of the remediating party;
    c. A legal description and street address of the property;
    d. A listing of each contaminant that was remediated;
    e. The background concentration, SRL, or site-specific remediation level selected to meet the remediation standard;
    f. A description whether the residential or non-residential standard was achieved;
    g. A description of any engineering or institutional control used to remediate the site; and
    h. The date when the Letter of Completion or alternative closure document was issued.

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency amendment reinstated at the request of the Department (see Supp. 97-1); historical note from Supp. 97-3 stating emergency expired removed for clarity. Section R18-7-208 adopted permanently effective December 4, 1997, replacing emergency rule (Supp. 97-4). Section R18-7-210 renumbered from R18-7-209 and amended by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

Appendix A. Soil Remediation Levels (SRLs)

CONTAMINANT	CASRN	Class	Residential (mg/kg) Carcinogen 10^{-6} Risk	Residential (mg/kg) Carcinogen 10^{-5} Risk	Residential (mg/kg) Non-carcinogen	Non-residential (mg/kg)
Acephate	30560-19-1	ca, nc	63	630	240	2,000
Acetaldehyde	75-07-0	ca, nc	11	110	50	160
Acetochlor	34256-82-1	nc			1,200	12,000
Acetone	67-64-1	nc			14,000	54,000
Acetone cyanohydrin	75-86-5	nc			49	490
Acetonitrile	75-05-8	nc			420	1,800
Acrolein	107-02-8	nc			0.10	0.34
Acrylamide	79-06-1	ca, nc	0.12	1.2		3.8
Acrylic acid	79-10-7	nc			29,000	270,000
Acrylonitrile	107-13-1	ca, nc	0.21	2.1		4.9
Alachlor	15972-60-8	ca, nc	6.8	68		210
Alar	1596-84-5	nc			9,200	92,000
Aldicarb	116-06-3	nc			61	620
Aldicarb sulfone	1646-88-4	nc			61	620
Aldrin	309-00-2	ca, nc	0.032	0.32		1.0
Ally	74223-64-6	nc			15,000	150,000
Allyl alcohol	107-18-6	nc			310	3,100
Allyl chloride	107-05-1	nc			18	180
Aluminum	7429-90-5	nc			76,000	920,000
Aluminum phosphide	20859-73-8	nc			31	410
Amdro	67485-29-4	nc			18	180
Ametryn	834-12-8	nc			550	5,500
Aminodinitrotoluene	1321-12-6	nc			12	120
m-Aminophenol	591-27-5	nc			4,300	43,000
4-Aminopyridine	504-24-5	nc			1.2	12
Amitraz	33089-61-1	nc			150	1,500
Ammonium sulfamate	7773-06-0	nc			12,000	120,000
Aniline	62-53-3	ca, nc	96	960	430	3,000
Antimony and compounds	7440-36-0	nc			31	410
Apollo	74115-24-5	nc			790	8,000
Aramite	140-57-8	ca, nc	22	220		690
Arsenic[1]	7440-38-2	ca, nc	10	10	10	10
Assure	76578-12-6	nc			550	5,500

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
Asulam	3337-71-1	nc			3,100	31,000
Atrazine	1912-24-9	ca, nc	2.5	25		78
Avermectin B1	71751-41-2	nc			24	250
Azobenzene	103-33-3	ca	5.0	50		160
Barium and compounds	7440-39-3	nc			15,000	170,000
Baygon	114-26-1	nc			240	2,500
Bayleton	43121-43-3	nc			1,800	18,000
Baythroid	68359-37-5	nc			1,500	15,000
Benefin	1861-40-1	nc			18,000	180,000
Benomyl	17804-35-2	nc			3,100	31,000
Bentazon	25057-89-0	nc			1,800	18,000
Benzaldehyde	100-52-7	nc			6,100	62,000
Benzene	71-43-2	ca, nc	0.65	NA		1.4
Benzidine	92-87-5	ca, nc	0.0024	NA		0.0075
Benzoic acid	65-85-0	nc			240,000	1,000,000 **
Benzotrichloride	98-07-7	ca	0.042	0.42		1.3
Benzyl alcohol	100-51-6	nc			18,000	180,000
Benzyl chloride	100-44-7	ca, nc	0.92	9.2		22
Beryllium and compounds	7440-41-7	ca, nc			150	1,900
Bidrin	141-66-2	nc			6.1	62
Biphenthrin (Talstar)	82657-04-3	nc			920	9,200
1,1-Biphenyl	92-52-4	nc			350 *	350 *
Bis(2-chloroethyl)ether	111-44-4	ca	0.23	2.3		5.8
Bis(2-chloroisopropyl)ether	39638-32-9	nc			790 *	790 *
Bis(chloromethyl)ether	542-88-1	ca	0.00020	NA		0.00043
Bis(2-chloro-1-methylethyl)ether	108-60-1	ca, nc	3.0	30		74
Bis(2-ethylhexyl)phthalate (DEHP)	117-81-7	ca, nc	39	390		1200
Bisphenol A	80-05-7	nc			3,100	31,000
Boron	7440-42-8	nc			16,000	200,000
Bromate	15541-45-4	ca, nc	0.78	7.8		25
Bromobenzene	108-86-1	nc			28	92
Bromodichloromethane	75-27-4	ca, nc	0.83	8.3		18
Bromoform (tribromomethane)	75-25-2	ca, nc	69	690		2,200
Bromomethane (methyl bromide)	74-83-9	nc			3.9	13
Bromophos	2104-96-3	nc			310	3,100

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
Bromoxynil	1689-84-5	nc			1,200	12,000
Bromoxynil octanoate	1689-99-2	nc			1,200	12,000
1,3-Butadiene	106-99-0	ca, nc	0.058	0.58		1.2
1-Butanol	71-36-3	nc			6,100	61,000
Butylate	2008-41-5	nc			3,100	31,000
n-Butylbenzene	104-51-8	nc			240 *	240 *
sec-Butylbenzene	135-98-8	nc			220 *	220 *
tert-Butylbenzene	98-06-6	nc			390 *	390 *
Butyl benzyl phthalate	85-68-7	nc			12,000	120,000
Butylphthalyl butylglycolate	85-70-1	nc			61,000	620,000
Cadmium and compounds	7440-43-9	ca, nc			39	510
Caprolactam	105-60-2	nc			31,000	310,000
Captafol	2425-06-1	ca, nc	64	640	120	1,200
Captan	133-06-2	ca, nc	160	1,600		4,900
Carbaryl	63-25-2	nc			6,100	62,000
Carbazole	86-74-8	ca	27	270		860
Carbofuran	1563-66-2	nc			310	3,100
Carbon disulfide	75-15-0	nc			360	720 *
Carbon tetrachloride	56-23-5	ca, nc	0.25	2.5	2.2	5.5
Carbosulfan	55285-14-8	nc			610	6,200
Carboxin	5234-68-4	nc			6,100	62,000
Chloral hydrate	302-17-0	nc			6,100	62,000
Chloramben	133-90-4	nc			920	9,200
Chloranil	118-75-2	ca	1.4	14		43
Chlordane	12789-03-6	ca, nc	1.9	19		65
Chlorimuron-ethyl	90982-32-4	nc			1,200	12,000
Chloroacetic acid	79-11-8	nc			120	1,200
2-Chloroacetophenone	532-27-4	nc			0.033	0.11
4-Chloroaniline	106-47-8	nc			240	2,500
Chlorobenzene	108-90-7	nc			150	530
Chlorobenzilate	510-15-6	ca, nc	2.0	20		64
p-Chlorobenzoic acid	74-11-3	nc			12,000	120,000
4-Chlorobenzotrifluoride	98-56-6	nc			1,200	12,000
2-Chloro-1,3-butadiene	126-99-8	nc			3.6	12
1-Chlorobutane	109-69-3	nc			480 *	480 *

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
1-Chloro-1,1-difluoroethane	75-68-3	nc			340 *	340 *
Chlorodifluoromethane	75-45-6	nc			340 *	340 *
Chloroethane	75-00-3	ca, nc	3.0	30		65
Chloroform	67-66-3	ca, nc	0.94	9.4		20
Chloromethane	74-87-3	nc			48	160
4-Chloro-2-methylaniline	95-69-2	ca	0.94	9.4		30
4-Chloro-2-methylaniline hydrochloride	3165-93-3	ca	1.2	12		37
beta-Chloronaphthalene	91-58-7	nc			110 *	110 *
o-Chloronitrobenzene	88-73-3	ca, nc			1.4	4.5
p-Chloronitrobenzene	100-00-5	ca, nc			10	37
2-Chlorophenol	95-57-8	nc			63	240
2-Chloropropane	75-29-6	nc			170	590
Chlorothalonil	1897-45-6	ca, nc	50	500		1600
o-Chlorotoluene	95-49-8	nc			160	510 *
Chlorpropham	101-21-3	nc			12,000	120,000
Chlorpyrifos	2921-88-2	nc			180	1,800
Chlorpyrifos-methyl	5598-13-0	nc			610	6,200
Chlorsulfuron	64902-72-3	nc			3,100	31,000
Chlorthiophos	60238-56-4	nc			49	490
Chromium III	16065-83-1	nc			120,000	1,000,000 **
Chromium VI	18540-29-9	ca, nc	30	NA		65
Cobalt	7440-48-4	ca, nc	900	9,000	1,400	13,000
Copper and compounds	7440-50-8	nc			3,100	41,000
Crotonaldehyde	123-73-9	ca	0.0053	0.053		0.11
Cumene (isopropylbenzene)	98-82-8	nc			92 *	92 *
Cyanazine	21725-46-2	ca, nc	0.65	6.5		21
Cyanide (free)[2]	57-12-5	nc			1,200	12,000
Cyanide (hydrogen)[3]	74-90-8	nc			11	35
Cyanogen	460-19-5	nc			130	430
Cyanogen bromide	506-68-3	nc			290	970
Cyanogen chloride	506-77-4	nc			160	540
Cyclohexane	110-82-7	nc			140 *	140 *
Cyclohexanone	108-94-1	nc			310,000	1,000,000 **
Cyclohexylamine	108-91-8	nc			12,000	120,000
Cyhalothrin/Karate	68085-85-8	nc			310	3,100

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
Cypermethrin	52315-07-8	nc			610	6,200
Cyromazine	66215-27-8	nc			460	4,600
Dacthal	1861-32-1	nc			610	6,200
Dalapon	75-99-0	nc			1,800	18,000
Danitol	39515-41-8	nc			1,500	15,000
DDD	72-54-8	ca	2.8	28		100
DDE	72-55-9	ca	2.0	20		70
DDT	50-29-3	ca, nc	2.0	20		70
Decabromodiphenyl ether	1163-19-5	nc			610	6,200
Demeton	8065-48-3	nc			2.4	25
Diallate	2303-16-4	ca	9.0	90		280
Diazinon	333-41-5	nc			55	550
Dibenzofuran	132-64-9	nc			140 *	140 *
1,4-Dibromobenzene	106-37-6	nc			610	6,200
Dibromochloromethane	124-48-1	ca, nc	1.1	11		26
1,2-Dibromo-3-chloropropane	96-12-8	ca, nc	0.53	5.3	1.5	6.5
1,2-Dibromoethane	106-93-4	ca, nc	0.029	0.29		0.63
Dibutyl phthalate	84-74-2	nc			6,100	62,000
Dicamba	1918-00-9	nc			1,800	18,000
1,2-Dichlorobenzene	95-50-1	nc			600 *	600 *
1,3-Dichlorobenzene	541-73-1	nc			530	600 *
1,4-Dichlorobenzene	106-46-7	ca, nc	3.5	35		79
3,3-Dichlorobenzidine	91-94-1	ca	1.2	12		38
4,4'-Dichlorobenzophenone	90-98-2	nc			1,800	18,000
1,4-Dichloro-2-butene	764-41-0	ca	0.0080	0.080		0.18
Dichlorodifluoromethane	75-71-8	nc			94	310
1,1-Dichloroethane	75-34-3	nc			510	1,700 *
1,2-Dichloroethane (DCA)	107-06-2	ca, nc	0.28	2.8		6.0
1,1-Dichloroethylene (DCE)	75-35-4	nc			120	410
1,2-Dichloroethylene (cis)	156-59-2	nc			43	150
1,2-Dichloroethylene (trans)	156-60-5	nc			69	230
2,4-Dichlorophenol	120-83-2	nc			180	1,800
4-(2,4-Dichlorophenoxy)butyric acid	94-82-6	nc			490	4,900
2,4-Dichlorophenoxyacetic Acid (2,4-D)	94-75-7	nc			690	7,700
1,2-Dichloropropane	78-87-5	ca, nc	0.34	3.4		7.4

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
1,3-Dichloropropane	142-28-9	nc			100	360
1,3-Dichloropropene	542-75-6	ca, nc	0.79	7.9		18
2,3-Dichloropropanol	616-23-9	nc			180	1,800
Dichlorvos	62-73-7	ca, nc	1.9	19		59
Dicofol	115-32-2	ca	1.2	12		39
Dicyclopentadiene	77-73-6	nc			0.54	1.8
Dieldrin	60-57-1	ca, nc	0.034	0.34		1.1
Diethylene glycol, monobutyl ether	112-34-5	nc			610	6,200
Diethylene glycol, monomethyl ether	111-90-0	nc			3,700	37,000
Diethylformamide	617-84-5	nc			24	250
Di(2-ethylhexyl)adipate	103-23-1	ca, nc	460	4,600		14,000
Diethyl phthalate	84-66-2	nc			49,000	490,000
Diethylstilbestrol	56-53-1	ca	0.00012	NA		0.0037
Difenzoquat (Avenge)	43222-48-6	nc			4,900	49,000
Diflubenzuron	35367-38-5	nc			1,200	12,000
Diisononyl phthalate	28553-12-0	nc			1,200	12,000
Diisopropyl methylphosphonate	1445-75-6	nc			4,900	49,000
Dimethipin	55290-64-7	nc			1,200	12,000
Dimethoate	60-51-5	nc			12	120
3,3'-Dimethoxybenzidine	119-90-4	ca	39	390		1,200
Dimethylamine	124-40-3	nc			0.067	0.25
N-N-Dimethylaniline	121-69-7	nc			120	1,200
2,4-Dimethylaniline	95-68-1	ca	0.73	7.3		23
2,4-Dimethylaniline hydrochloride	21436-96-4	ca	0.94	9.4		30
3,3'-Dimethylbenzidine	119-93-7	ca	0.24	2.4		7.5
N,N-Dimethylformamide	68-12-2	nc			6,100	62,000
Dimethylphenethylamine	122-09-8	nc			61	620
2,4-Dimethylphenol	105-67-9	nc			1,200	12,000
2,6-Dimethylphenol	576-26-1	nc			37	370
3,4-Dimethylphenol	95-65-8	nc			61	620
Dimethyl phthalate	131-11-3	nc			610,000	1,000,000 **
Dimethyl terephthalate	120-61-6	nc			6,100	62,000
4,6-Dinitro-o-cyclohexyl phenol	131-89-5	nc			120	1,200
1,2-Dinitrobenzene	528-29-0	nc			6.1	62
1,3-Dinitrobenzene	99-65-0	nc			6.1	62

CONTAMINANT	CASRN	Class	Residential (mg/kg)			Non-residential (mg/kg)
			Carcinogen		Non-carcinogen	
			10^{-6} Risk	10^{-5} Risk		
1,4-Dinitrobenzene	100-25-4	nc			6.1	62
2,4-Dinitrophenol	51-28-5	nc			120	1,200
Dinitrotoluene mixture	25321-14-6	ca	0.81	8.1		25
2,4-Dinitrotoluene	121-14-2	nc			120	1,200
2,6-Dinitrotoluene	606-20-2	nc			61	620
Dinoseb	88-85-7	nc			61	620
di-n-Octyl phthalate	117-84-0	nc			2,400	25,000
1,4-Dioxane	123-91-1	ca	50	500		1,600
Dioxin (2,3,7,8-TCDD)	1746-01-6	ca	0.0000045	0.000045		0.00016
Diphenamid	957-51-7	nc			1,800	18,000
Diphenylamine	122-39-4	nc			1,500	15,000
N,N-Diphenyl-1,4 benzenediamine (DPPD)	74-31-7	nc			18	180
1,2-Diphenylhydrazine	122-66-7	ca	0.68	6.8		22
Diphenyl sulfone	127-63-9	nc			180	1,800
Diquat	85-00-7	nc			130	1,400
Direct black 38	1937-37-7	ca	0.064	NA		0.20
Direct blue 6	2602-46-2	ca	0.068	NA		0.21
Direct brown 95	16071-86-6	ca	0.059	NA		0.19
Disulfoton	298-04-4	nc			2.4	25
1,4-Dithiane	505-29-3	nc			610	6,200
Diuron	330-54-1	nc			120	1,200
Dodine	2439-10-3	nc			240	2,500
Dysprosium	7429-91-6	nc			7,800	102,000
Endosulfan	115-29-7	nc			370	3,700
Endothall	145-73-3	nc			1,200	12,000
Endrin	72-20-8	nc			18	180
Epichlorohydrin	106-89-8	ca, nc			7.6	26
1,2-Epoxybutane	106-88-7	nc			350	3,500
EPTC (S-Ethyl dipropylthiocarbamate)	759-94-4	nc			1,500	15,000
Ethephon (2-chloroethyl phosphonic acid)	16672-87-0	nc			310	3,100
Ethion	563-12-2	nc			31	310
2-Ethoxyethanol	110-80-5	nc			24,000	250,000
2-Ethoxyethanol acetate	111-15-9	nc			18,000	180,000
Ethyl acetate	141-78-6	nc			19,000	37,000 *
Ethyl acrylate	140-88-5	ca	0.21	2.1		4.5

CONTAMINANT	CASRN	Class	Residential (mg/kg)			Non-residential (mg/kg)
			Carcinogen		Non-carcinogen	
			10^{-6} Risk	10^{-5} Risk		
Ethylbenzene	100-41-4	nc			400 *	400 *
Ethyl chloride	75-00-3	ca, nc	3.0	30		65
Ethylene cyanohydrin	109-78-4	nc			18,000	180,000
Ethylene diamine	107-15-3	nc			5,500	55,000
Ethylene glycol	107-21-1	nc			120,000	1,000,000 **
Ethylene glycol, monobutyl ether	111-76-2	nc			31,000	310,000
Ethylene oxide	75-21-8	ca	0.14	1.4		3.4
Ethylene thiourea (ETU)	96-45-7	ca, nc			4.9	49
Ethyl ether	60-29-7	nc			1,800 *	1,800 *
Ethyl methacrylate	97-63-2	nc			140 *	140 *
Ethyl p-nitrophenyl phenylphosphorothioate	2104-64-5	nc			0.61	6.2
Ethylphthalyl ethyl glycolate	84-72-0	nc			180,000	1,000,000 **
Express	101200-48-0	nc			490	4,900
Fenamiphos	22224-92-6	nc			15	150
Fluometuron	2164-17-2	nc			790	8,000
Fluoride	16984-48-8	nc			3,700	37,000
Fluoridone	59756-60-4	nc			4,900	49,000
Flurprimidol	56425-91-3	nc			1,200	12,000
Flutolanil	66332-96-5	nc			3,700	37,000
Fluvalinate	69409-94-5	nc			610	6,200
Folpet	133-07-3	ca, nc	160	1,600		4,900
Fomesafen	72178-02-0	ca	2.9	29		91
Fonofos	944-22-9	nc			120	1,200
Formaldehyde	50-00-0	ca, nc			9,200	92,000
Formic Acid	64-18-6	nc			110,000	1,000,000 **
Fosetyl-al	39148-24-8	nc			180,000	1,000,000 **
Furan	110-00-9	nc			2.5	8.5
Furazolidone	67-45-8	ca	0.14	1.4		4.5
Furfural	98-01-1	nc			180	1,800
Furium	531-82-8	ca	0.011	0.11		0.34
Furmecyclox	60568-05-0	ca	18	180		570
Glufosinate-ammonium	77182-82-2	nc			24	250
Glycidaldehyde	765-34-4	nc			24	250
Glyphosate	1071-83-6	nc			6,100	62,000
Haloxyfop-methyl	69806-40-2	nc			3.1	31

CONTAMINANT	CASRN	Class	Residential (mg/kg)			Non-residential (mg/kg)
			Carcinogen		Non-carcinogen	
			10^{-6} Risk	10^{-5} Risk		
Harmony	79277-27-3	nc			790	8,003
Heptachlor	76-44-8	ca, nc	0.12	1.2		3.8
Heptachlor epoxide	1024-57-3	ca, nc	0.060	0.60		1.9
Hexabromobenzene	87-82-1	nc			120	1,200
Hexachlorobenzene	118-74-1	ca, nc	0.34	3.4		11
Hexachlorobutadiene	87-68-3	ca, nc	7.0	70	18	180
HCH (alpha)	319-84-6	ca, nc	0.10	1.0		3.6
HCH (beta)	319-85-7	ca, nc	0.36	3.6		13
HCH (gamma) Lindane	58-89-9	ca, nc	0.50	5.0		17
HCH-technical	608-73-1	ca	0.36	3.6		13
Hexachlorocyclopentadiene	77-47-4	nc			370	3,700
Hexachloroethane	67-72-1	ca, nc	39	390	61	620
Hexachlorophene	70-30-4	nc			18	180
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	ca, nc	5.0	50		160
1,6-Hexamethylene diisocyanate	822-06-0	nc			0.17	1.8
n-Hexane	110-54-3	nc			110 *	110 *
Hexazinone	51235-04-2	nc			2,020	20,000
Hydrazine, hydrazine sulfate	302-01-2	ca	0.18	1.8		5.7
Hydrazine, monomethyl	60-34-4	ca	0.18	1.8		5.7
Hydrazine, dimethyl	57-14-7	ca	0.18	1.8		5.7
p-Hydroquinone	123-31-9	ca, nc	9.8	98		310
Imazalil	35554-44-0	nc			790	8,000
Imazaquin	81335-37-7	nc			15,000	150,000
Iprodione	36734-19-7	nc			2,400	25,000
Isobutanol	78-83-1	nc			13,000	40,000 *
Isophorone	78-59-1	ca, nc	580	5,800		18,000
Isopropalin	33820-53-0	nc			920	9,200
Isopropyl methyl phosphonic acid	1832-54-8	nc			6,100	62,000
Isoxaben	82558-50-7	nc			3,100	31,000
Kepone	143-50-0	ca, nc	0.068	0.68		2.2
Lactofen	77501-63-4	nc			120	1,200
Lead	7439-92-1	ca, nc			400	800
Lead (tetraethyl)	78-00-2	nc			0.0061	0.062
Linuron	330-55-2	nc			120	1,200
Lithium	7439-93-2	nc			1,600	20,000

CONTAMINANT	CASRN	Class	Residential (mg/kg)			Non-residential (mg/kg)
			Carcinogen		Non-carcinogen	
			10^{-6} Risk	10^{-5} Risk		
Londax	83055-99-6	nc			12,000	120,000
Malathion	121-75-5	nc			1,200	12,000
Maleic anhydride	108-31-6	nc			6,100	62,000
Maleic hydrazide	123-33-1	nc			1,700	2,400 *
Malononitrile	109-77-3	nc			6.1	62
Mancozeb	8018-01-7	nc			1,800	18,000
Maneb	12427-38-2	ca, nc	9.1	91		290
Manganese	7439-96-5	nc			3,300	32,000
Mephosfolan	950-10-7	nc			5.5	55
Mepiquat	24307-26-4	nc			1,800	18,000
2-Mercaptobenzothiazole	149-30-4	ca, nc	19	190		590
Mercury and compounds	7487-94-7	nc			23	310
Mercury (methyl)	22967-92-6	nc			6.1	62
Merphos	150-50-5	nc			1.8	18
Merphos oxide	78-48-8	nc			1.8	18
Metalaxyl	57837-19-1	nc			3,700	37,000
Methacrylonitrile	126-98-7	nc			2.1	8.4
Methamidophos	10265-92-6	nc			3.1	31
Methanol	67-56-1	nc			31,000	310,000
Methidathion	950-37-8	nc			61	620
Methomyl	16752-77-5	nc			44	150
Methoxychlor	72-43-5	nc			310	3,100
2-Methoxyethanol	109-86-4	nc			61	620
2-Methoxyethanol acetate	110-49-6	nc			120	1,200
2-Methoxy-5-nitroaniline	99-59-2	ca	12	120		370
Methyl acetate	79-20-9	nc			22,000	92,000
Methyl acrylate	96-33-3	nc			70	230
2-Methylaniline (o-toluidine)	95-53-4	ca	2.3	23		72
2-Methylaniline hydrochloride	636-21-5	ca	3.0	30		96
2-Methyl-4-chlorophenoxyacetic acid	94-74-6	nc			31	310
4-(2-Methyl-4-chlorophenoxy) butyric acid (MCPB)	94-81-5	nc			610	6,200
2-(2-Methyl-4-chlorophenoxy) propionic acid	93-65-2	nc			61	620
2-(2-Methyl-1,4-chlorophenoxy) propionic acid (MCPP)	16484-77-8	nc			61	620

CONTAMINANT	CASRN	Class	Residential (mg/kg)			Non-residential (mg/kg)
			Carcinogen		Non-carcinogen	
			10^{-6} Risk	10^{-5} Risk		
Methylcyclohexane	108-87-2	nc			230 *	230 *
4,4'-Methylenebisbenzeneamine	101-77-9	ca	2.2	22		69
4,4'-Methylene bis(2-chloroaniline)	101-14-4	ca, nc	4.2	42		130
4,4'-Methylene bis(N,N'-dimethyl) aniline	101-61-1	ca	12	120		370
Methylene bromide	74-95-3	nc			67	230
Methylene chloride	75-09-2	ca, nc	9.3	93		210
4,4'-Methylenediphenyl diisocyanate	101-68-8	nc			10	110
Methyl ethyl ketone (MEK)	78-93-3	nc			23,000	34,000 *
Methyl isobutyl ketone (MIBK)	108-10-1	nc			5,300	17,000 *
Methyl mercaptan	74-93-1	nc			35	350
Methyl methacrylate	80-62-6	nc			2,200	2,700 *
2-Methyl-5-nitroaniline	99-55-8	ca	17	170		520
Methyl parathion	298-00-0	nc			15	150
2-Methylphenol	95-48-7	nc			3,100	31,000
3-Methylphenol	108-39-4	nc			3,100	31,000
4-Methylphenol	106-44-5	nc			310	3,100
Methyl phosphonic acid	993-13-5	nc			1,200	12,000
Methyl styrene (mixture)	25013-15-4	nc			130	540
Methyl styrene (alpha)	98-83-9	nc			680 *	680 *
Methyl tertbutyl ether (MTBE)	1634-04-4	ca, nc	32	320		710
Metolaclor (Dual)	51218-45-2	nc			9,200	92,000
Metribuzin	21087-64-9	nc			1,500	15,000
Mirex	2385-85-5	ca, nc	0.30	3.0		9.6
Molinate	2212-67-1	nc			120	1,200
Molybdenum	7439-98-7	nc			390	5,100
Monochloramine	10599-90-3	nc			6,100	62,000
Naled	300-76-5	nc			120	1,200
Napropamide	15299-99-7	nc			6,100	62,000
Nickel and compounds	7440-02-0	nc			1,600	20,000
Nickel subsulfide	12035-72-2	ca	5,200	NA		11,000
2-Nitroaniline	88-74-4	nc			180	1,800
3-Nitroaniline	99-09-2	ca, nc			18	180
4-Nitroaniline	100-01-6	ca, nc	26	260	180	820
Nitrobenzene	98-95-3	nc			20	100
Nitrofurantoin	67-20-9	nc			4,300	43,000

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
Nitrofurazone	59-87-0	ca	0.37	3.7		11
Nitroglycerin	55-63-0	ca	39	390		1,200
Nitroguanidine	556-88-7	nc			6,100	62,000
2-Nitropropane	79-46-9	ca, nc	0.0028	0.028		0.061
N-Nitrosodi-n-butylamine	924-16-3	ca	0.025	0.25		0.58
N-Nitrosodiethanolamine	1116-54-7	ca	0.20	2.0		6.2
N-Nitrosodiethylamine	55-18-5	ca	0.0037	0.037		0.11
N-Nitrosodimethylamine	62-75-9	ca, nc	0.011	0.11		0.34
N-Nitrosodiphenylamine	86-30-6	ca, nc	110	1,100		3,500
N-Nitroso di-n-propylamine	621-64-7	ca	0.078	0.78		2.5
N-Nitroso-N-methylethylamine	10595-95-6	ca	0.025	0.25		0.78
N-Nitrosopyrrolidine	930-55-2	ca	0.26	2.6		8.2
m-Nitrotoluene	99-08-1	nc			730	1,000 *
o-Nitrotoluene	88-72-2	ca, nc	0.93	9.3		22
p-Nitrotoluene	99-99-0	ca, nc	13	130		300
Norflurazon	27314-13-2	nc			2,400	25,000
NuStar	85509-19-9	nc			43	430
Octabromodiphenyl ether	32536-52-0	nc			180	1,800
Octahydro-1357-tetranitro-1357-tetrazocine (HMX)	2691-41-0	nc			3,100	31,000
Octamethylpyrophosphoramide	152-16-9	nc			120	1,200
Oryzalin	19044-88-3	nc			3,100	31,000
Oxadiazon	19666-30-9	nc			310	3,100
Oxamyl	23135-22-0	nc			1,500	15,000
Oxyfluorfen	42874-03-3	nc			180	1,800
Paclobutrazol	76738-62-0	nc			790	8,000
Paraquat	4685-14-7	nc			270	2,800
Parathion	56-38-2	nc			370	3,700
Pebulate	1114-71-2	nc			3,100	31,000
Pendimethalin	40487-42-1	nc			2,400	25,000
Pentabromo-6-chloro cyclohexane	87-84-3	ca	24	240		750
Pentabromodiphenyl ether	32534-81-9	nc			120	1,200
Pentachlorobenzene	608-93-5	nc			49	490
Pentachloronitrobenzene	82-68-8	ca, nc	2.1	21		66
Pentachlorophenol	87-86-5	ca, nc	3.2	32		90
Perchlorate	7601-90-3	nc			55	720

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
Permethrin	52645-53-1	nc			3,100	31,000
Phenmedipham	13684-63-4	nc			15,000	150,000
Phenol	108-95-2	nc			18,000	180,000
Phenothiazine	92-84-2	nc			120	1,200
m-Phenylenediamine	108-45-2	nc			370	3,700
o-Phenylenediamine	95-54-5	ca	12	120		370
p-Phenylenediamine	106-50-3	nc			12,000	120,000
Phenylmercuric acetate	62-38-4	nc			4.9	49
2-Phenylphenol	90-43-7	ca	280	2,800		8,900
Phorate	298-02-2	nc			12	120
Phosmet	732-11-6	nc			1,200	12,000
Phosphine	7803-51-2	nc			18	180
Phosphorus (white)	7723-14-0	nc			1.6	20
p-Phthalic acid	100-21-0	nc			61,000	620,000
Phthalic anhydride	85-44-9	nc			120,000	1,000,000 **
Picloram	1918-02-1	nc			4,300	43,000
Pirimiphos-methyl	29232-93-7	nc			610	6,200
Polybrominated biphenyls (PBBs)	NA	ca, nc	0.062	0.62	0.43	1.9
Polychlorinated biphenyls (PCBs), low-risk mixture[4]	12674-11-2	ca, nc			3.9	37
Polychlorinated biphenyls (PCBs), high-risk mixture[5]	11097-69-1	ca, nc	0.25	2.5	1.1	7.4
Polychlorinated terphenyls	61788-33-8	ca	0.12	1.2		3.8
Polynuclear aromatic hydrocarbons						
Acenaphthene	83-32-9	nc			3,700	29,000
Anthracene	120-12-7	nc			22,000	240,000
Benz[a]anthracene	56-55-3	ca	0.69	6.9		21
Benzo[b]fluoranthene	205-99-2	ca	0.69	6.9		21
Benzo[k]fluoranthene	207-08-9	ca	6.9	69		210
Benzo[a]pyrene	50-32-8	ca	0.069	0.69		2.1
Chrysene	218-01-9	ca	68	680		2,000
Dibenz[ah]anthracene	53-70-3	ca	0.069	0.69		2.1
Fluoranthene	206-44-0	nc			2,300	22,000
Fluorene	86-73-7	nc			2,700	26,000
Indeno[1,2,3-cd]pyrene	193-39-5	ca	0.69	6.9		21
Naphthalene	91-20-3	nc			56	190

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
Pyrene	129-00-0	nc			2,300	29,000
Prochloraz	67747-09-5	ca, nc	3.7	37		110
Profluralin	26399-36-0	nc			370	3,700
Prometon	1610-18-0	nc			920	9,200
Prometryn	7287-19-6	nc			240	2,500
Pronamide	23950-58-5	nc			4,600	46,000
Propachlor	1918-16-7	nc			790	8,000
Propanil	709-98-8	nc			310	3,100
Propargite	2312-35-8	nc			1,200	12,000
Propargyl alcohol	107-19-7	nc			120	1,200
Propazine	139-40-2	nc			1,200	12,000
Propham	122-42-9	nc			1,200	12,000
Propiconazole	60207-90-1	nc			790	8,000
n-Propylbenzene	103-65-1	nc			240 *	240 *
Propylene glycol	57-55-6	nc			30,000	290,000
Propylene glycol, monoethyl ether	52125-53-8	nc			43,000	430,000
Propylene glycol, monomethyl ether	107-98-2	nc			43,000	430,000
Propylene oxide	75-56-9	ca, nc	2.2	22		66
Pursuit	81335-77-5	nc			15,000	150,000
Pydrin	51630-58-1	nc			1,500	15,000
Pyridine	110-86-1	nc			61	620
Quinalphos	13593-03-8	nc			31	310
Quinoline	91-22-5	ca	0.18	1.8		5.7
RDX (Cyclonite)	121-82-4	ca, nc	5.0	50		160
Resmethrin	10453-86-8	nc			1,800	18,000
Ronnel	299-84-3	nc			3,100	31,000
Rotenone	83-79-4	nc			240	2,500
Savey	78587-05-0	nc			1,500	15,000
Selenious Acid	7783-00-8	nc			310	3,100
Selenium	7782-49-2	nc			390	5,100
Selenourea	630-10-4	nc			310	3,100
Sethoxydim	74051-80-2	nc			5,500	55,000
Silver and compounds	7440-22-4	nc			390	5,100
Simazine	122-34-9	ca, nc	4.6	46		140
Sodium azide	26628-22-8	nc			310	4,100

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
Sodium diethyldithiocarbamate	148-18-5	ca, nc	2.0	20		64
Sodium fluoroacetate	62-74-8	nc			1.2	12
Sodium metavanadate	13718-26-8	nc			61	620
Strontium, stable	7440-24-6	nc			47,000	610,000
Strychnine	57-24-9	nc			18	180
Styrene	100-42-5	nc			1,500 *	1,500 *
1,1'-Sulfonylbis-(4-chlorobenzene)	80-07-9	nc			310	3,100
Systhane	88671-89-0	nc			1,500	15,000
Tebuthiuron	34014-18-1	nc			4,300	43,000
Temephos	3383-96-8	nc			1,200	12,000
Terbacil	5902-51-2	nc			790	8,000
Terbufos	13071-79-9	nc			1.5	15
Terbutryn	886-50-0	nc			61	620
1,2,4,5-Tetrachlorobenzene	95-94-3	nc			18	180
1,1,1,2-Tetrachloroethane	630-20-6	ca, nc	3.2	32		73
1,1,2,2-Tetrachloroethane	79-34-5	ca, nc	0.42	4.2		9.3
Tetrachloroethylene (PCE)	127-18-4	ca, nc	0.51	5.1		13
2,3,4,6-Tetrachlorophenol	58-90-2	nc			1,800	18,000
p,a,a,a-Tetrachlorotoluene	5216-25-1	ca	0.027	0.27		0.86
Tetrachlorovinphos	961-11-5	ca, nc	23	230		720
Tetraethyldithiopyrophosphate	3689-24-5	nc			31	310
Tetrahydrofuran	109-99-9	ca, nc	9.5	95		210
Thallium and compounds	7440-28-0	nc			5.2	67
Thiobencarb	28249-77-6	nc			610	6,200
Thiocyanate	NA	nc			3,100	31,000
Thiofanox	39196-18-4	nc			18	180
Thiophanate-methyl	23564-05-8	nc			4,900	49,000
Thiram	137-26-8	nc			310	3,100
Tin	7440-31-5	nc			47,000	610,000
Titanium	7440-32-6	nc			310,000	1,000,000 **
Toluene	108-88-3	nc			650 *	650 *
Toluene-2,4-diamine	95-80-7	ca	0.17	1.7		5.4
Toluene-2,5-diamine	95-70-5	nc			37,000	370,000
Toluene-2,6-diamine	823-40-5	nc			12,000	120,000
p-Toluidine	106-49-0	ca	2.9	29		91

CONTAMINANT	**CASRN**	**Class**	**Residential (mg/kg)**			**Non-residential (mg/kg)**
			Carcinogen		**Non-carcinogen**	
			10^{-6} Risk	**10^{-5} Risk**		
Toxaphene	8001-35-2	ca	0.50	5.0		16
Tralomethrin	66841-25-6	nc			460	4,600
Triallate	2303-17-5	nc			790	8,000
Triasulfuron	82097-50-5	nc			610	6,200
1,2,4-Tribromobenzene	615-54-3	nc			310	3,100
Tributyl phosphate	126-73-8	ca, nc	60	600		1,900
Tributyltin oxide (TBTO)	56-35-9	nc			18	180
2,4,6-Trichloroaniline	634-93-5	ca	16	160		510
2,4,6-Trichloroaniline hydrochloride	33663-50-2	ca	19	190		590
1,2,4-Trichlorobenzene	120-82-1	nc			62	220
1,1,1-Trichloroethane	71-55-6	nc			1,200 *	1,200 *
1,1,2-Trichloroethane	79-00-5	ca, nc	0.74	7.4		16
Trichloroethylene (TCE)	79-01-6	ca, nc	3.0	30	17	65
Trichlorofluoromethane	75-69-4	nc			390	1,300
2,4,5-Trichlorophenol	95-95-4	nc			6,100	62,000
2,4,6-Trichlorophenol	88-06-2	ca, nc			6.1	62
2,4,5-Trichlorophenoxyacetic Acid	93-76-5	nc			610	6,200
2-(2,4,5-Trichlorophenoxy) propionic acid	93-72-1	nc			490	4,900
1,1,2-Trichloropropane	598-77-6	nc			15	51
1,2,3-Trichloropropane	96-18-4	ca, nc	0.0050	0.050		0.11
1,2,3-Trichloropropene	96-19-5	nc			0.71	2.3
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	nc			5,600 *	5,600 *
Tridiphane	58138-08-2	nc			180	1,800
Triethylamine	121-44-8	nc			23	86
Trifluralin	1582-09-8	ca, nc	71	710	460	2,200
Trimellitic Anhydride (TMAN)	552-30-7	nc			8.6	86
1,2,4-Trimethylbenzene	95-63-6	nc			52	170
1,3,5-Trimethylbenzene	108-67-8	nc			21	70
Trimethyl phosphate	512-56-1	ca	15	150		470
1,3,5-Trinitrobenzene	99-35-4	nc			1,800	18,000
Trinitrophenylmethylnitramine	479-45-8	nc			610	6,200
2,4,6-Trinitrotoluene	118-96-7	ca, nc	18	180	31	310
Triphenylphosphine oxide	791-28-6	nc			1,200	12,000
Tris(2-chloroethyl) phosphate	115-96-8	ca, nc	39	390		1,200
Tris(2-ethylhexyl) phosphate	78-42-2	ca, nc	170	1,700		5,400

CONTAMINANT	CASRN	Class	Residential (mg/kg)			Non-residential (mg/kg)
			Carcinogen		Non-carcinogen	
			10^{-6} Risk	10^{-5} Risk		
Uranium (chemical toxicity only)	7440-61-0	nc			16	200
Vanadium and compounds	7440-62-2	nc			78	1,000
Vernam	1929-77-7	nc			61	620
Vinclozolin	50471-44-8	nc			1,500	15,000
Vinyl acetate	108-05-4	nc			430	1,400
Vinyl bromide	593-60-2	ca, nc	0.19	1.9		4.2
Vinyl chloride	75-01-4	ca, nc	0.085	NA		0.75
Warfarin	81-81-2	nc			18	180
Xylenes	1330-20-7	nc			270	420 *
Zinc	7440-66-6	nc			23,000	310,000
Zinc phosphide	1314-84-7	nc			23	310
Zineb	12122-67-7	nc			3,100	31,000
NA indicates not applicable.						
Class is the classification of the chemical. “ca” indicates carcinogenic effects; “nc” indicates non-carcinogenic effects. Chemicals that have both carcinogenic and non-carcinogenic effects are classified “ca, nc”.						
* Indicates SRL is based on the chemical-specific saturation level in soil for volatile organic chemicals only.						
** Indicates SRL is based on a 100% saturation ceiling limit for non-volatile organic chemicals.						
[1] Arsenic standards are not risk-based standards, but based on background.						
[2] Cyanide (free): Free cyanide is a subset of total cyanides. If any ADHS approved method for total cyanide reports a concentration exceeding this standard, further analyses to differentiate free cyanide from other cyanide metal complexes is required.						
[3] Cyanide (hydrogen): If the cyanide concentrations using any method exceed the hydrogen cyanide standard, then hydrogen cyanide vapor samples should be collected at the site.						
[4] PCBs, low-risk mixture: Use if laboratory analysis confirms that the total PCB concentration consists of 0.5 percent or less of congeners that contain five or more chlorines and that no dioxin-like congeners are present.						
[5] PCBs, high-risk mixture: Use if only total PCB concentration is reported by any ADHS licensed analytical method, or if laboratory analysis confirms that the total PCB concentration consists of more than 0.5 percent congeners that contain five or more chlorines or that dioxin-like congeners are present.						
Bold indicates adequate evidence to classify the chemical as a known human carcinogen.						
CASRN is the Chemical Abstract System Registry Number.						

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency appendix reinstated at the request of the Department; historical note from Supp. 97-3 stating emergency expired removed for clarity. Appendix A adopted permanently effective December 4, 1997, replacing emergency appendix (Supp. 97-4). Amended to correct measurement units in columns 5 and 6 from “mg/k” to “mg/kg” (Supp. 01-4). Former Appendix A renumbered to Appendix B; new Appendix A made by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

Appendix B. 1997 Soil Remediation Levels (SRLs)

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
	A				
1	Acenaphthene	83-32-9	D	3900.0	41000.0
2	Acephate	30560-19-1	C	260.0	2200.0
3	Acetaldehyde	75-07-0	B2	39.0	150.0
4	Acetochlor	34256-82-1	D	1300.0	14000.0
5	Acetone	67-64-1	D	2100.0	8800.0
6	Acetone cyanohydrin	75-86-5	D	52.0	550.0
7	Acetonitrile	75-05-8	D	220.0	1200.0
8	Acetophenone	98-86-2	D	0.49	1.6
9	Acifluorfen	62476-59-9	D	850.0	8900.0
10	Acrolein	107-02-8	C	0.10	0.34
11	Acrylamide	79-06-1	B2	0.98	4.2
12	Acrylic acid	79-10-7	D	31000.0	290000.0
13	Acrylonitrile	107-13-1	B1	1.9	4.7
14	Alachlor	15972-60-8	B2	55.0	240.0
15	Alar	1596-84-5	D	9800.0	100000.0
16	Aldicarb	116-06-3	D	65.0	680.0
17	Aldicarb sulfone	1646-88-4	D	65.0	680.0
18	Aldrin	309-00-2	B2	0.26	1.1
19	Ally	74223-64-6	D	16000.0	170000.0
20	Allyl alcohol	107-18-6	D	330.0	3400.0
21	Allyl chloride	107-05-1	C	3200.0	33000.0
22	Aluminum	7429-90-5	D	77000.0	1000000.0
23	Aluminum phosphide	20859-73-8	D	31.0	680.0
24	Amdro	67485-29-4	D	20.0	200.0
25	Ametryn	834-12-8	D	590.0	6100.0
26	m-Aminophenol	591-27-5	D	4600.0	48000.0
27	4-Aminopyridine	504-24-5	D	1.3	14.0
28	Amitraz	33089-61-1	D	160.0	1700.0
29	Ammonia	7664-41-7	D	2200.0	58000.0
30	Ammonium sulfamate	7773-06-0	D	13000.0	140000.0
31	Aniline	62-53-3	B2	19.0	200.0
32	Anthracene	120-12-7	D	20000.0	200000.0
33	Antimony and compounds	7440-36-0	D	31.0	680.0
34	Antimony pentoxide	1314-60-9	D	38.0	850.0
35	Antimony potassium tartrate	28300-74-5	D	69.0	1500.0
36	Antimony tetroxide	1332-81-6	D	31.0	680.0
37	Antimony trioxide	1309-64-4	D	31.0	680.0
38	Apollo	74115-24-5	C	850.0	8900.0
39	Aramite	140-57-8	B2	180.0	760.0
40	~Arsenic	7440-38-2	A	10.0	10.0
41	Assure	76578-14-8	D	590.0	6100.0
42	Asulam	3337-71-1	D	3300.0	34000.0
43	Atrazine	1912-24-9	C	20.0	86.0
44	Avermectin B1	71751-41-2	D	26.0	270.0
45	Azobenzene	103-33-3	B2	40.0	170.0
	B				
46	Barium and compounds	7440-39-3	D	5300.0	110000.0
47	Barium cyanide	542-62-1	D	7700.0	170000.0
48	Baygon	114-26-1	D	260.0	2700.0
49	Bayleton	43121-43-3	D	2000.0	20000.0
50	Baythroid	68359-37-5	D	1600.0	17000.0
51	Benefin	1861-40-1	D	20000.0	200000.0
52	Benomyl	17804-35-2	D	3300.0	34000.0
53	Bentazon	25057-89-0	D	160.0	1700.0
54	Benzaldehyde	100-52-7	D	6500.0	68000.0
55	Benz[a]anthracene	56-55-3	B2	6.1	26.0
56	Benzene	71-43-2	A	0.62	1.4

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
57	Benzidine	92-87-5	A	0.0019	0.0083
58	Benzo[a]pyrene	50-32-8	B2	0.61	2.6
59	Benzo[b]fluoranthene	205-99-2	B2	6.1	26.0
60	Benzoic acid	65-85-0	D	260000.0	1000000.0
61	Benzo[k]fluoranthene	207-08-9	B2	61.0	260.0
62	Benzotrichloride	98-07-7	B2	0.34	1.5
63	Benzyl alcohol	100-51-6	D	20000.0	200000.0
64	Benzyl chloride	100-44-7	B2	8.0	20.0
65	Beryllium and compounds	7440-41-7	B2	1.4	11.0
66	Bidrin	141-66-2	D	6.5	68.0
67	Biphenthrin (Talstar)	82657-04-3	D	980.0	10000.0
68	1,1-Biphenyl	92-52-4	D	3300.0	34000.0
69	Bis(2-chloroethyl)ether	111-44-4	B2	0.43	0.97
70	Bis(2-chloroisopropyl)ether	39638-32-9	C	25.0	67.0
71	Bis(chloromethyl)ether	542-88-1	A	0.0002	0.0004
72	Bis(2-chloro-1-methylethyl)ether	108-60-1	C	63.0	270.0
73	Bis(2-ethylhexyl)phthalate (DEHP)	117-81-7	B2	320.0	1400.0
74	Bisphenol A	80-05-7	D	3300.0	34000.0
75	Boron	7440-42-8	D	5900.0	61000.0
76	Bromodichloromethane	75-27-4	B2	6.3	14.0
77	Bromoform (tribromomethane)	75-25-2	B2	560.0	2400.0
78	Bromomethane	74-83-9	D	6.8	23.0
79	Bromophos	2104-96-3	D	330.0	3400.0
80	Bromoxynil	1689-84-5	D	1300.0	14000.0
81	Bromoxynil octanoate	1689-99-2	D	1300.0	14000.0
82	1,3-Butadiene	106-99-0	B2	0.064	0.14
83	1-Butanol	71-36-3	D	6500.0	68000.0
84	Butylate	2008-41-5	D	3300.0	34000.0
85	Butyl benzyl phthalate	85-68-7	C	13000.0	140000.0
86	Butylphthalyl butylglycolate	85-70-1	D	65000.0	680000.0
	C				
87	Cacodylic acid	75-60-5	D	200.0	2000.0
88	Cadmium and compounds	7440-43-9	B1	38.0	850.0
89	Calcium cyanide	592-01-8	D	3100.0	68000.0
90	Caprolactam	105-60-2	D	33000.0	340000.0
91	Captafol	2425-06-1	C	130.0	1400.0
92	Captan	133-06-2	D	1300.0	5500.0
93	Carbaryl	63-25-2	D	6500.0	68000.0
94	Carbazole	86-74-8	B2	220.0	950.0
95	Carbofuran	1563-66-2	E	330.0	3400.0
96	Carbon disulfide	75-15-0	D	7.5	24.0
97	Carbon tetrachloride	56-23-5	B2	1.6	5.0
98	Carbosulfan	55285-14-8	D	650.0	6800.0
99	Carboxin	5234-68-4	D	6500.0	68000.0
100	Chloral (hydrate)	302-17-0	D	130.0	1400.0
101	Chloramben	133-90-4	D	980.0	10000.0
102	Chloranil	118-75-2	C	11.0	47.0
103	Chlordane	12789-03-6	B2	3.4	15.0
104	Chlorimuron-ethyl	90982-32-4	D	1300.0	14000.0
105	Chlorine cyanide	506-77-4	D	3800.0	85000.0
106	Chloroacetic acid	79-11-8	D	130.0	1400.0
107	2-Chloroacetophenone	532-27-4	D	0.56	5.9
108	4-Chloroaniline	106-47-8	D	260.0	2700.0
109	Chlorobenzene	108-90-7	D	65.0	220.0
110	Chlorobenzilate	510-15-6	B2	16.0	71.0
111	p-Chlorobenzoic acid	74-11-3	D	13000.0	140000.0
112	4-Chlorobenzotrifluoride	98-56-6	D	1300.0	14000.0
113	2-Chloro-1,3-butadiene	126-99-8	D	3.6	12.0
114	1-Chlorobutane	109-69-3	D	710.0	2400.0

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
115	* 1-Chloro-1,1-difluoroethane	75-68-3	D	2800.0	2800.0
116	* Chlorodifluoromethane	75-45-6	D	2800.0	2800.0
117	Chloroform	67-66-3	B2	2.5	5.3
118	Chloromethane	74-87-3	C	12.0	26.0
119	4-Chloro-2-methylaniline	95-69-2	B2	7.7	33.0
120	4-Chloro-2-methylaniline hydrochloride	3165-93-3	B2	9.7	41.0
121	beta-Chloronaphthalene	91-58-7	D	5200.0	55000.0
122	o-Chloronitrobenzene	88-73-3	B2	180.0	760.0
123	p-Chloronitrobenzene	100-00-5	B2	250.0	1100.0
124	2-Chlorophenol	95-57-8	D	91.0	370.0
125	2-Chloropropane	75-29-6	D	170.0	580.0
126	Chlorothalonil	1897-45-6	B2	400.0	1700.0
127	* o-Chlorotoluene	95-49-8	D	160.0	550.0
128	Chlorpropham	101-21-3	D	13000.0	140000.0
129	Chlorpyrifos	2921-88-2	D	200.0	2000.0
130	Chlorpyrifos-methyl	5598-13-0	D	650.0	6800.0
131	Chlorsulfuron	64902-72-3	D	3300.0	34000.0
132	Chlorthiophos	602-38-56-4	D	52.0	550.0
133	Chromium, Total (1/6 ratio Cr VI/Cr III)	N/A	D	2100.0	4500.0
134	Chromium III	16065-83-1	D	77000.0	1000000.0
135	Chromium VI	7440-47-3	A	30.0	64.0
136	Chrysene	218-01-9	B2	610.0	2600.0
137	Cobalt	7440-48-4	D	4600.0	97000.0
138	Copper and compounds	7440-50-8	D	2800.0	63000.0
139	Copper cyanide	544-92-3	D	380.0	8500.0
140	Crotonaldehyde	123-73-9	C	0.052	0.11
141	Cumene	98-82-8	D	19.0	62.0
142	Cyanazine	21725-46-2	D	5.3	23.0
143	Cyanide, Free	57-12-5	D	1300.0	14000.0
144	Cyanogen	460-19-5	D	2600.0	27000.0
145	Cyanogen bromide	506-68-3	D	5900.0	61000.0
146	Cyanogen chloride	506-77-4	D	3300.0	34000.0
147	Cyclohexanone	108-94-1	D	330000.0	1000000.0
148	Cyclohexylamine	108-91-8	D	13000.0	140000.0
149	Cyhalothrin/Karate	68085-85-8	D	330.0	3400.0
150	Cypermethrin	52315-07-8	D	650.0	6800.0
151	Cyromazine	66215-27-8	D	490.0	5100.0
	D				
152	Dacthal	1861-32-1	D	650.0	6800.0
153	Dalapon	75-99-0	D	2000.0	20000.0
154	Danitol	39515-41-8	D	1600.0	17000.0
155	DDD	72-54-8	B2	19.0	80.0
156	DDE	72-55-9	B2	13.0	56.0
157	DDT	50-29-3	B2	13.0	56.0
158	Decabromodiphenyl ether	1163-19-5	C	650.0	6800.0
159	Demeton	8065-48-3	D	2.6	27.0
160	Diallate	2303-16-4	B2	73.0	310.0
161	Diazinon	333-41-5	E	59.0	610.0
162	Dibenz[ah]anthracene	53-70-3	B2	0.61	2.6
163	Dibenzofuran	132-64-9	D	260.0	2700.0
164	1,4-Dibromobenzene	106-37-6	D	650.0	6800.0
165	Dibromochloromethane	124-48-1	C	53.0	230.0
166	1,2-Dibromo-3-chloropropane	96-12-8	B2	3.2	14.0
167	1,2-Dibromoethane	106-93-4	B2	0.049	0.2
168	Dibutyl phthalate	84-74-2	D	6500.0	68000.0
169	Dicamba	1918-00-9	D	2000.0	20000.0
170	* 1,2-Dichlorobenzene	95-50-1	D	1100.0	3900.0
171	* 1,3-Dichlorobenzene	541-73-1	D	500.0	2000.0
172	1,4-Dichlorobenzene	106-46-7	C	190.0	790.0

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
173	3,3-Dichlorobenzidine	91-94-1	B2	9.9	42.0
174	1,4-Dichloro-2-butene	764-41-0	B2	0.074	0.17
175	Dichlorodifluoromethane	75-71-8	D	94.0	310.0
176	1,1-Dichloroethane	75-34-3	C	500.0	1700.0
177	1,2-Dichloroethane (EDC)	107-06-2	B2	2.5	5.5
178	1,1-Dichloroethylene	75-35-4	C	0.36	0.8
179	1,2-Dichloroethylene (cis)	156-59-2	D	31.0	100.0
180	1,2-Dichloroethylene (trans)	156-60-5	D	78.0	270.0
181	1,2-Dichloroethylene (mixture)	540-59-0	D	35.0	120.0
182	2,4-Dichlorophenol	120-83-2	D	200.0	2000.0
183	4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	94-82-6	D	520.0	5500.0
184	2,4-Dichlorophenoxyacetic Acid (2,4-D)	94-75-7	D	650.0	6800.0
185	1,2-Dichloropropane	78-87-5	B2	3.1	6.8
186	1,3-Dichloropropene	542-75-6	B2	2.4	5.5
187	2,3-Dichloropropanol	616-23-9	D	200.0	2000.0
188	Dichlorvos	62-73-7	B2	15.0	66.0
189	Dicofol	115-32-2	C	10.0	43.0
190	Dieldrin	60-57-1	B2	0.28	1.2
191	Diethylene glycol, monobutyl ether	112-34-5	D	370.0	3900.0
192	Diethylene glycol, monoethyl ether	111-90-0	D	130000.0	1000000.0
193	Diethylformamide	617-84-5	D	720.0	7500.0
194	Di(2-ethylhexyl)adipate	103-23-1	C	3700.0	16000.0
195	Diethyl phthalate	84-66-2	D	52000.0	550000.0
196	Diethylstilbestrol	56-53-1	A	0.0001	0.0004
197	Difenzoquat (Avenge)	43222-48-6	D	5200.0	55000.0
198	Diflubenzuron	35367-38-5	D	1300.0	14000.0
199	Diisopropyl methylphosphonate	1445-75-6	D	5200.0	55000.0
200	Dimethipin	55290-64-7	C	1300.0	14000.0
201	Dimethoate	60-51-5	D	13.0	140.0
202	3,3'-Dimethoxybenzidine	119-90-4	B2	320.0	1400.0
203	Dimethylamine	124-40-3	D	0.07	0.24
204	N-N-Dimethylaniline	121-69-7	D	130.0	1400.0
205	2,4-Dimethylaniline	95-68-1	C	5.9	25.0
206	2,4-Dimethylaniline hydrochloride	21436-96-4	C	7.7	33.0
207	3,3'-Dimethylbenzidine	119-93-7	B2	0.48	2.1
208	1,1-Dimethylhydrazine (Hydrazine, dimethyl)	57-14-7	B, C	1.7	7.3
209	1,2-Dimethylhydrazine	540-73-8	B2	0.12	0.52
210	N,N-Dimethylformamide	68-12-2	D	6500.0	68000.0
211	2,4-Dimethylphenol	105-67-9	D	1300.0	14000.0
212	2,6-Dimethylphenol	576-26-1	D	39.0	410.0
213	3,4-Dimethylphenol	95-65-8	D	65.0	680.0
214	Dimethyl phthalate	131-11-3	D	650000.0	1000000.0
215	Dimethyl terephthalate	120-61-6	D	6500.0	68000.0
216	4,6-Dinitro-o-cyclohexyl phenol	131-89-5	D	130.0	1400.0
217	1,3-Dinitrobenzene	99-65-0	D	6.5	68.0
218	1,2-Dinitrobenzene	528-29-0	D	26.0	270.0
219	1,4-Dinitrobenzene	100-25-4	D	26.0	270.0
220	2,4-Dinitrophenol	51-28-5	D	130.0	1400.0
221	Dinitrotoluene mixture	25321-14-6	B2	6.5	28.0
222	2,4-Dinitrotoluene	121-14-2	D	130.0	1400.0
223	2,6-Dinitrotoluene	606-20-2	D	65.0	680.0
224	Dinoseb	88-85-7	D	65.0	680.0
225	di-n-Octyl phthalate	117-84-0	D	1300.0	14000.0
226	1,4-Dioxane	123-91-1	B2	400.0	1700.0
227	Diphenamid	957-51-7	D	2000.0	20000.0
228	Diphenylamine	122-39-4	D	1600.0	17000.0
229	1,2-Diphenylhydrazine	122-66-7	B2	5.6	24.0
230	Diquat	85-00-7	D	140.0	1500.0

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
231	Direct black 38	1937-37-7	A	0.052	0.22
232	Direct blue 6	2602-46-2	A	0.055	0.24
233	Direct brown 95	16071-86-6	A	0.048	0.21
234	Disulfoton	298-04-4	E	2.6	27.0
235	1,4-Dithiane	505-29-3	D	650.0	6800.0
236	Diuron	330-54-1	D	130.0	1400.0
237	Dodine	2439-10-3	D	260.0	2700.0
	E				
238	Endosulfan	115-29-7	D	390.0	4100.0
239	Endothall	145-73-3	D	1300.0	14000.0
240	Endrin	72-20-8	D	20.0	200.0
241	Epichlorohydrin	106-89-8	B2	7.5	25.0
242	1,2-Epoxybutane	106-88-7	D	370.0	3900.0
243	EPTC (S-Ethyl dipropylthiocarbamate)	759-94-4	D	1600.0	17000.0
244	Ethephon (2-chloroethyl phosphonic acid)	16672-87-0	D	330.0	3400.0
245	Ethion	563-12-2	D	33.0	340.0
246	2-Ethoxyethanol	110-80-5	D	26000.0	270000.0
247	2-Ethoxyethanol acetate	111-15-9	D	20000.0	200000.0
248	* Ethyl acetate	141-78-6	D	18000.0	39000.0
249	Ethyl acrylate	140-88-5	B2	2.1	4.5
250	* Ethylbenzene	100-41-4	D	1500.0	2700.0
251	Ethylene cyanohydrin	109-78-4	D	20000.0	200000.0
252	Ethylene diamine	107-15-3	D	1300.0	14000.0
253	Ethylene glycol	107-21-1	D	130000.0	1000000.0
254	Ethylene glycol, monobutyl ether	111-76-2	D	370.0	3900.0
255	Ethylene oxide	75-21-8	B1	1.3	3.2
256	Ethylene thiourea (ETU)	96-45-7	B2	5.2	55.0
257	* Ethyl chloride	75-00-3	D	1100.0	4200.0
258	* Ethyl ether	60-29-7	D	3800.0	3800.0
259	* Ethyl methacrylate	97-63-2	D	210.0	690.0
260	Ethyl p-nitrophenyl phenylphosphorothioate	2104-64-5	D	0.65	6.8
261	Ethylphthalyl ethyl glycolate	84-72-0	D	200000.0	1000000.0
262	Express	101200-48-0	D	520.0	5500.0
	F				
263	Fenamiphos	22224-92-6	D	16.0	170.0
264	Fluometuron	2164-17-2	D	850.0	8900.0
265	Fluoranthene	206-44-0	D	2600.0	27000.0
266	Fluorene	86-73-7	D	2600.0	27000.0
267	Fluorine (soluble fluoride)	7782-41-4	D	3900.0	41000.0
268	Fluoridone	59756-60-4	D	5200.0	55000.0
269	Flurprimidol	56425-91-3	D	1300.0	14000.0
270	Flutolanil	66332-96-5	D	3900.0	41000.0
271	Fluvalinate	69409-94-5	D	650.0	6800.0
272	Folpet	133-07-3	B2	1300.0	5500.0
273	Fomesafen	72178-02-0	C	23.0	100.0
274	Fonofos	944-22-9	D	130.0	1400.0
275	Formaldehyde	50-00-0	B1	9800.0	100000.0
276	Formic Acid	64-18-6	D	130000.0	1000000.0
277	Fosetyl-al	39148-24-8	C	200000.0	1000000.0
278	Furan	110-00-9	D	2.5	8.5
279	Furazolidone	67-45-8	B2	1.2	5.0
280	Furfural	98-01-1	D	200.0	2000.0
281	Furium	531-82-8	B2	0.089	0.38
282	Furmecyclox	60568-05-0	B2	150.0	640.0
	G				
283	Glufosinate-ammonium	77182-82-2	D	26.0	270.0
284	Glycidaldehyde	765-34-4	B2	26.0	270.0
285	Glyphosate	1071-83-6	D	6500.0	68000.0
	H				

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
286	Haloxyfop-methyl	69806-40-2	D	3.3	34.0
287	Harmony	79277-27-3	D	850.0	8900.0
288	Heptachlor	76-44-8	B2	0.99	4.2
289	Heptachlor epoxide	1024-57-3	B2	0.49	2.1
290	Hexabromobenzene	87-82-1	D	130.0	1400.0
291	Hexachlorobenzene	118-74-1	B2	2.8	12.0
292	Hexachlorobutadiene	87-68-3	C	13.0	140.0
293	HCH (alpha)	319-84-6	B2	0.71	3.0
294	HCH (beta)	319-85-7	C	2.5	11.0
295	HCH (gamma) Lindane	58-89-9	B2-C	3.4	15.0
296	HCH-technical	608-73-1	B2	2.5	11.0
297	Hexachlorocyclopentadiene	77-47-4	D	450.0	4600.0
298	Hexachlorodibenzo-p-dioxin mixture (HxCDD)	19408-74-3	B2	0.00072	0.0031
299	Hexachloroethane	67-72-1	C	65.0	680.0
300	Hexachlorophene	70-30-4	D	20.0	200.0
301	Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	C	40.0	170.0
302	* n-Hexane	110-54-3	D	120.0	400.0
303	Hexazinone	51235-04-2	D	2200.0	22000.0
304	Hydrazine, hydrazine sulfate	302-01-2	B2	1.5	6.4
305	Hydrocarbons (C_{10} to C_{32})	N/A	N/A	4100.0	18000.0
306	Hydrogen chloride	7647-01-0	D	370.0	3900.0
307	Hydrogen cyanide	74-90-8	D	11.0	35.0
308	p-Hydroquinone	123-31-9	D	2600.0	27000.0
	I				
309	Imazalil	35554-44-0	D	850.0	8900.0
310	Imazaquin	81335-37-7	D	16000.0	170000.0
311	Indeno[1,2,3-cd]pyrene	193-39-5	B2	6.1	26.0
312	Iprodione	36734-19-7	D	2600.0	27000.0
313	* Isobutanol	78-83-1	D	11000.0	42000.0
314	Isophorone	78-59-1	C	4700.0	20000.0
315	Isopropalin	33820-53-0	D	980.0	10000.0
316	Isopropyl methyl phosphonic acid	1832-54-8	D	6500.0	68000.0
317	Isoxaben	82558-50-7	C	3300.0	34000.0
	K				
318	Kepone	143-50-0	B, C	0.25	1.1
	L				
319	Lactofen	77501-63-4	D	130.0	1400.0
320	#Lead	7439-92-1	B2	400.0	2000.0
321	Lead (tetraethyl)	78-00-2	D	0.0065	0.068
322	Linuron	330-55-2	C	130.0	1400.0
323	Lithium	7439-93-2	D	1500.0	34000.0
324	Londax	83055-99-6	D	13000.0	140000.0
	M				
325	Malathion	121-75-5	D	1300.0	14000.0
326	Maleic anhydride	108-31-6	D	6500.0	68000.0
327	Maleic hydrazide	123-33-1	D	33000.0	340000.0
328	Malononitrile	109-77-3	D	1.3	14.0
329	Mancozeb	8018-01-7	D	2000.0	20000.0
330	Maneb	12427-38-2	D	330.0	3400.0
331	Manganese and compounds	7439-96-5	D	3200.0	43000.0
332	Mephosfolan	950-10-7	D	5.9	61.0
333	Mepiquat	24307-26-4	D	2000.0	20000.0
334	Mercuric chloride	7487-94-7	C	23.0	510.0
335	Mercury (elemental)	7439-97-6	D	6.7	180.0
336	Mercury (methyl)	22967-92-6	D	6.5	68.0
337	Merphos	150-50-5	D	2.0	20.0
338	Merphos oxide	78-48-8	D	2.0	20.0
339	Metalaxyl	57837-19-1	D	3900.0	41000.0

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
340	Methacrylonitrile	126-98-7	D	2.0	8.1
341	Methamidophos	10265-92-6	D	3.3	34.0
342	Methanol	67-56-1	D	33000.0	340000.0
343	Methidathion	950-37-8	C	65.0	680.0
344	Methomyl	16752-77-5	D	1600.0	17000.0
345	Methoxychlor	72-43-5	D	330.0	3400.0
346	2-Methoxyethanol	109-86-4	D	65.0	680.0
347	2-Methoxyethanol acetate	110-49-6	D	130.0	1400.0
348	2-Methoxy-5-nitroaniline	99-59-2	C	97.0	410.0
349	Methyl acetate	79-20-9	D	21000.0	88000.0
350	Methyl acrylate	96-33-3	D	69.0	230.0
351	2-Methylaniline (o-toluidine)	95-53-4	B2	19.0	79.0
352	2-Methylaniline hydrochloride	636-21-5	B2	25.0	110.0
353	Methyl chlorocarbonate	79-22-1	D	65000.0	680000.0
354	2-Methyl-4-chlorophenoxyacetic acid	94-74-6	D	33.0	340.0
355	4-(2-Methyl-4-chlorophenoxy) butyric acid (MCPB)	94-81-5	D	650.0	6800.0
356	2-(2-Methyl-4-chlorophenoxy) propionic acid	93-65-2	D	65.0	680.0
357	2-(2-Methyl-1,4-chlorophenoxy) propionic acid (MCPP)	16484-77-8	D	65.0	680.0
358	Methylcyclohexane	108-87-2	D	56000.0	590000.0
359	4,4’-Methylenebisbenzeneamine	101-77-9	D	18.0	76.0
360	4,4’-Methylene bis(2-chloroaniline)	101-14-4	B2	34.0	150.0
361	4,4’-Methylene bis(N,N’-dimethyl)aniline	101-61-1	B2	97.0	410.0
362	Methylene bromide	74-95-3	D	650.0	6800.0
363	Methylene chloride	75-09-2	B2	77.0	180.0
364	Methyl ethyl ketone	78-93-3	D	7100.0	27000.0
365	Methyl hydrazine	60-34-4	B, C	4.0	17.0
366	Methyl isobutyl ketone	108-10-1	D	770.0	2800.0
367	* Methyl methacrylate	80-62-6	D	760.0	2800.0
368	2-Methyl-5-nitroaniline	99-55-8	C	130.0	580.0
369	Methyl parathion	298-00-0	D	16.0	170.0
370	2-Methylphenol	95-48-7	C	3300.0	34000.0
371	3-Methylphenol	108-39-4	C	3300.0	34000.0
372	4-Methylphenol	106-44-5	C	330.0	3400.0
373	Methyl styrene (mixture)	25013-15-4	D	120.0	520.0
374	* Methyl styrene (alpha)	98-83-9	D	890.0	3100.0
375	Methyl tertbutyl ether (MTBE)	1634-04-4	D	320.0	3300.0
376	Metolaclor (Dual)	51218-45-2	D	9800.0	100000.0
377	Metribuzin	21087-64-9	D	1600.0	17000.0
378	Mirex	2385-85-5	B2	2.5	11.0
379	Molinate	2212-67-1	D	130.0	1400.0
380	Molybdenum	7439-98-7	D	380.0	8500.0
381	Monochloramine	10599-90-3	D	6500.0	68000.0
	N				
382	Naled	300-76-5	D	130.0	1400.0
383	Naphthalene	91-20-3	D	2600.0	27000.0
384	Napropamide	15299-99-7	D	6500.0	68000.0
385	Nickel and compounds	7440-02-0	D	1500.0	34000.0
386	Nickel subsulfide	12035-72-2	A	5100.0	11000.0
387	Nitrapyrin	1929-82-4	D	98.0	1000.0
388	Nitrate	14797-55-8	D	100000.0	1000000.0
389	Nitrite	14797-65-0	D	6500.0	68000.0
390	2-Nitroaniline	88-74-4	D	3.9	41.0
391	Nitrobenzene	98-95-3	D	18.0	94.0
392	Nitrofurantoin	67-20-9	D	4600.0	48000.0
393	Nitrofurazone	59-87-0	B2	3.0	13.0
394	Nitroguanidine	556-88-7	D	6500.0	68000.0
395	N-Nitrosodi-n-butylamine	924-16-3	B2	0.22	0.55

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
396	N-Nitrosodiethanolamine	1116-54-7	B2	1.6	6.8
397	N-Nitrosodiethylamine	55-18-5	B2	0.03	0.13
398	N-Nitrosodimethylamine	62-75-9	B2	0.087	0.37
399	N-Nitrosodiphenylamine	86-30-6	B2	910.0	3900.0
400	N-Nitroso di-n-propylamine	621-64-7	B2	0.63	2.7
401	N-Nitroso-N-methylethylamine	10595-95-6	B2	0.20	0.87
402	N-Nitrosopyrrolidine	930-55-2	B2	2.1	9.1
403	m-Nitrotoluene	99-08-1	D	650.0	6800.0
404	p-Nitrotoluene	99-99-0	D	650.0	6800.0
405	Norflurazon	27314-13-2	D	2600.0	27000.0
406	NuStar	85509-19-9	D	46.0	480.0
	O				
407	Octabromodiphenyl ether	32536-52-0	D	200.0	2000.0
408	Octahydro-1357-tetranitro-1357-tetrazocine (HMX)	2691-41-0	D	3300.0	34000.0
409	Octamethylpyrophosphoramide	152-16-9	D	130.0	1400.0
410	Oryzalin	19044-88-3	C	3300.0	34000.0
411	Oxadiazon	19666-30-9	D	330.0	3400.0
412	Oxamyl	23135-22-0	E	1600.0	17000.0
413	Oxyfluorfen	42874-03-3	D	200.0	2000.0
	P				
414	Paclobutrazol	76738-62-0	D	850.0	8900.0
415	Paraquat	4685-14-7	C	290.0	3100.0
416	Parathion	56-38-2	C	390.0	4100.0
417	Pebulate	1114-71-2	D	3300.0	34000.0
418	Pendimethalin	40487-42-1	D	2600.0	27000.0
419	Pentabromo-6-chloro cyclohexane	87-84-3	C	190.0	830.0
420	Pentabromodiphenyl ether	32534-81-9	D	130.0	1400.0
421	Pentachlorobenzene	608-93-5	D	52.0	550.0
422	Pentachloronitrobenzene	82-68-8	C	17.0	73.0
423	Pentachlorophenol	87-86-5	B2	25.0	79.0
424	Permethrin	52645-53-1	D	3300.0	34000.0
425	Phenmedipham	13684-63-4	D	16000.0	170000.0
426	Phenol	108-95-2	D	39000.0	410000.0
427	m-Phenylenediamine	108-45-2	D	390.0	4100.0
428	p-Phenylenediamine	106-50-3	D	12000.0	130000.0
429	Phenylmercuric acetate	62-38-4	D	5.2	55.0
430	2-Phenylphenol	90-43-7	C	2300.0	9800.0
431	Phorate	298-02-2	E	13.0	140.0
432	Phosmet	732-11-6	D	1300.0	14000.0
433	Phosphine	7803-51-2	D	20.0	200.0
434	Phosphorus, white	7723-14-0	D	1.5	34.0
435	Phthalic anhydride	85-44-9	D	130000.0	1000000.0
436	Picloram	1918-02-1	D	4600.0	48000.0
437	Pirimiphos-methyl	23505-41-1	D	650.0	6800.0
438	Polybrominated biphenyls (PBBs)	N/A	B2	0.46	2.1
439	Polychlorinated biphenyls (PCBs)	1336-36-3	B2	2.5	13.0
440	Potassium cyanide	151-50-8	D	3300.0	34000.0
441	Potassium silver cyanide	506-61-6	D	13000.0	140000.0
442	Prochloraz	67747-09-5	C	30.0	130.0
443	Profluralin	26399-36-0	D	390.0	4100.0
444	Prometon	1610-18-0	D	980.0	10000.0
445	Prometryn	7287-19-6	D	260.0	2700.0
446	Pronamide	23950-58-5	C	4900.0	51000.0
447	Propachlor	1918-16-7	D	850.0	8900.0
448	Propanil	709-98-8	D	330.0	3400.0
449	Propargite	2312-35-8	D	1300.0	14000.0
450	Propargyl alcohol	107-19-7	D	130.0	1400.0
451	Propazine	139-40-2	C	1300.0	14000.0

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
452	Propham	122-42-9	D	1300.0	14000.0
453	Propiconazole	60207-90-1	D	850.0	8900.0
454	Propylene glycol	57-55-6	D	1000000.0	1000000.0
455	Propylene glycol, monoethyl ether	111-35-3	D	46000.0	480000.0
456	Propylene glycol, monomethyl ether	107-98-2	D	46000.0	480000.0
457	Propylene oxide	75-56-9	B2	19.0	79.0
458	Pursuit	81335-77-5	D	16000.0	170000.0
459	Pydrin	51630-58-1	D	1600.0	17000.0
460	Pyrene	129-00-0	D	2000.0	20000.0
461	Pyridine	110-86-1	D	65.0	680.0
	Q				
462	Quinalphos	13593-03-8	D	33.0	340.0
463	Quinoline	91-22-5	C	0.37	1.6
	R				
464	RDX (Cyclonite)	121-82-4	C	40.0	170.0
465	Resmethrin	10453-86-8	D	2000.0	20000.0
466	Ronnel	299-84-3	D	3300.0	34000.0
467	Rotenone	83-79-4	D	260.0	2700.0
	S				
468	Savey	78587-05-0	D	1600.0	17000.0
469	Selenious Acid	7783-00-8	D	330.0	3400.0
470	Selenium	7782-49-2	D	380.0	8500.0
471	Selenourea	630-10-4	D	330.0	3400.0
472	Sethoxydim	74051-80-2	D	5900.0	61000.0
473	Silver and compounds	7440-22-4	D	380.0	8500.0
474	Silver cyanide	506-64-9	D	6500.0	68000.0
475	Simazine	122-34-9	C	37.0	160.0
476	Sodium azide	26628-22-8	D	260.0	2700.0
477	Sodium cyanide	143-33-9	D	2600.0	27000.0
478	Sodium diethyldithiocarbamate	148-18-5	C	16.0	71.0
479	Sodium fluoroacetate	62-74-8	D	1.3	14.0
480	Sodium metavanadate	13718-26-8	D	65.0	680.0
481	Strontium, stable	7440-24-6	D	46000.0	1000000.0
482	Strychnine	57-24-9	D	20.0	200.0
483	* Styrene	100-42-5	C	3300.0	3300.0
484	Systhane	88671-89-0	D	1600.0	17000.0
	T				
485	2,3,7,8-TCDD (dioxin)	1746-01-6	B2	0.000038	0.00024
486	Tebuthiuron	34014-18-1	D	4600.0	48000.0
487	Temephos	3383-96-8	D	1300.0	14000.0
488	Terbacil	5902-51-2	E	850.0	8900.0
489	Terbufos	13071-79-9	D	1.6	17.0
490	Terbutryn	886-50-0	D	65.0	680.0
491	1,2,4,5-Tetrachlorobenzene	95-94-3	D	20.0	200.0
492	1,1,1,2-Tetrachloroethane	630-20-6	C	23.0	54.0
493	1,1,2,2-Tetrachloroethane	79-34-5	C	4.4	11.0
494	Tetrachloroethylene (PCE)	127-18-4	B2	53.0	170.0
495	2,3,4,6-Tetrachlorophenol	58-90-2	D	2000.0	20000.0
496	p,a,a,a-Tetrachlorotoluene	5216-25-1	B2	0.22	0.95
497	Tetrachlorovinphos	961-11-5	C	190.0	790.0
498	Tetraethyldithiopyrophosphate	3689-24-5	D	33.0	340.0
499	Thallic oxide	1314-32-5	D	5.4	120.0
500	Thallium acetate	563-68-8	D	6.9	150.0
501	Thallium carbonate	6533-73-9	D	6.1	140.0
502	Thallium chloride	7791-12-0	D	6.1	140.0
503	Thallium nitrate	10102-45-1	D	6.9	150.0
504	Thallium selenite	12039-52-0	D	6.9	150.0
505	Thallium sulfate	7446-18-6	D	6.1	140.0
506	Thiobencarb	28249-77-6	D	650.0	6800.0

	Chemical Name	CAS Number	Cancer Group	Residential (mg/kg)	Non-residential (mg/kg)
507	2-(Thiocyanomethylthio)- benzothiazole (TCMTB)	3689-24-5	D	2000.0	20000.0
508	Thiofanox	39196-18-4	D	20.0	200.0
509	Thiophanate-methyl	23564-05-8	D	5200.0	55000.0
510	Thiram	137-26-8	D	330.0	3400.0
511	Tin and compounds	7440-31-5	D	46000.0	1000000.0
512	* Toluene	108-88-3	D	790.0	2700.0
513	Toluene-2,4-diamine	95-80-7	B2	1.4	6.0
514	Toluene-2,5-diamine	95-70-5	D	39000.0	410000.0
515	Toluene-2,6-diamine	823-40-5	C	13000.0	140000.0
516	p-Toluidine	106-49-0	C	23.0	100.0
517	Toxaphene	8001-35-2	B2	4.0	17.0
518	Tralomethrin	66841-25-6	D	490.0	5100.0
519	Triallate	2303-17-5	D	850.0	8900.0
520	Triasulfuron	82097-50-5	D	650.0	6800.0
521	1,2,4-Tribromobenzene	615-54-3	D	330.0	3400.0
522	Tributyltin oxide (TBTO)	56-35-9	D	2.0	20.0
523	2,4,6-Trichloroaniline	634-93-5	C	130.0	560.0
524	2,4,6-Trichloroaniline hydrochloride	33663-50-2	C	150.0	660.0
525	* 1,2,4-Trichlorobenzene	120-82-1	D	570.0	4700.0
526	* 1,1,1-Trichloroethane	71-55-6	D	1200.0	4800.0
527	1,1,2-Trichloroethane	79-00-5	C	6.5	15.0
528	Trichloroethylene (TCE)	79-01-6	B2	27.0	70.0
529	Trichlorofluoromethane	75-69-4	D	380.0	1300.0
530	2,4,5-Trichlorophenol	95-95-4	D	6500.0	68000.0
531	2,4,6-Trichlorophenol	88-06-2	B2	400.0	1700.0
532	2,4,5-Trichlorophenoxyacetic acid	93-76-5	D	650.0	6800.0
533	2-(2,4,5-Trichlorophenoxy) propionic acid	93-72-1	D	520.0	5500.0
534	1,1,2-Trichloropropane	598-77-6	D	15.0	50.0
535	1,2,3-Trichloropropane	96-18-4	B2	0.014	0.03
536	1,2,3-Trichloropropene	96-19-5	D	11.0	38.0
537	* 1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	D	10000.0	10000.0
538	Tridiphane	58138-08-2	D	200.0	2000.0
539	Triethylamine	121-44-8	D	23.0	84.0
540	Trifluralin	1582-09-8	C	490.0	2500.0
541	Trimethyl phosphate	512-56-1	B2	120.0	520.0
542	1,3,5-Trinitrobenzene	99-35-4	D	3.3	34.0
543	Trinitrophenylmethylnitramine	479-45-8	D	650.0	6800.0
544	2,4,6-Trinitrotoluene	118-96-7	C	33.0	340.0
	V				
545	Vanadium	7440-62-2	D	540.0	12000.0
546	Vanadium pentoxide	1314-62-1	D	690.0	15000.0
547	Vanadium sulfate	13701-70-7	D	1500.0	34000.0
548	Vernam	1929-77-7	D	65.0	680.0
549	Vinclozolin	50471-44-8	D	1600.0	17000.0
550	Vinyl acetate	108-05-4	D	780.0	2600.0
551	Vinyl bromide	593-60-2	B2	1.9	4.1
552	Vinyl chloride	75-01-4	A	0.016	0.035
	W				
553	Warfarin	81-81-2	D	20.0	200.0
	X				
554	* Xylene (mixed)	1330-20-7	D	2800.0	2800.0
	Z				
555	Zinc	7440-66-6	D	23000.0	510000.0
556	Zinc phosphide	1314-84-7	D	23.0	510.0
557	Zinc cyanide	557-21-1	D	3300.0	34000.0
558	Zineb	12122-67-7	D	3300.0	34000.0

* = 1% free-phase analysis
\# = Based on IEUBK Model

~ = Based on natural background
N/A = Not Applicable
CARCINOGENICITY CLASSIFICATIONS:
A = Known human carcinogen
B1 = Probable human carcinogen, with limited data indicating human carcinogenicity.
B2 = Probable human carcinogen, with inadequate or no evidence of carcinogenicity in humans. Sufficient evidence for carcinogenicity in laboratory animals.
C = Possible human carcinogen.
D = Not classifiable as to human carcinogenicity.
E = Evidence of noncarcinogenicity in humans.

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency appendix reinstated at the request of the Department; historical note from Supp. 97-3 stating emergency expired removed for clarity. Appendix B adopted permanently effective December 4, 1997, replacing emergency appendix (Supp. 97-4). Former Appendix B repealed; new Appendix B renumbered from Appendix A and amended by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

Appendix C. Repealed

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Interim emergency appendix reinstated at the request of the Department; historical note from Supp. 97-3 stating emergency expired removed for clarity. Appendix C adopted permanently effective December 4, 1997, replacing emergency appendix (Supp. 97-4). Appendix C repealed by final rulemaking at 13 A.A.R. 971, effective May 5, 2007 (Supp. 07-1).

Appendix D. Emergency Expired

Historical Note

Adopted by emergency action effective March 29, 1996, pursuant to A.R.S. § 41-1026 and Laws 1995, Ch. 232, § 5; in effect until permanent rules are adopted and in place no later than August 1, 1997, pursuant to A.R.S. § 49-152 and Laws 1995, Ch. 232, § 5 (Supp. 96-1). Historical note revised to clarify exemptions of emergency adoption (Supp. 97-1). Historical note from Supp. 97-3 stating emergency expired removed for clarity; interim emergency rule reinstated at the request of the Department. Emergency expired effective December 4, 1997 (Supp. 97-4).

ARTICLE 3. PROSPECTIVE PURCHASER AGREEMENT

R18-7-301. Prospective Purchaser Agreement Fee

A. An applicant for a prospective purchaser agreement with the Department under A.R.S. § 49-285.01 shall pay to the Department the fee prescribed in this Article. The Department shall not refund a fee once it accepts an application.

B. An applicant for a prospective purchaser agreement shall pay a fee for each prospective purchaser agreement application submitted to the Department for review. The fee includes:
1. An initial charge as prescribed in subsection (C);
2. An hourly charge, if the conditions of subsection (D)(1) apply;
3. The publication costs for the legal notice as prescribed in subsection (F); and
4. A charge, as prescribed in subsection (D)(2), if an applicant requests a settlement.

C. An applicant shall pay an initial charge of $2,500 for an application for a prospective purchaser agreement requiring minimal review for property within a site that is listed in the Water Quality Assurance Revolving Fund (WQARF) registry under A.R.S. § 49-287.01. For property that is not on the WQARF registry, an applicant shall pay an initial charge of $3,600 for an application for a prospective purchaser agreement. The initial charge covers direct and indirect Department costs. An application for a prospective purchaser agreement requiring minimal review is one that requires 34 or fewer hours of review time for a site on the WQARF registry or 49 or fewer hours for a site not on the WQARF registry.

D. In addition to the initial charge described in subsection (C), the applicant shall pay the following charges, if applicable:
1. An hourly charge for reviewing a prospective purchaser agreement that requires more than the hours for review covered by the initial charge in subsection (C). The additional charge is $73 per hour for Department staff time and Assistant Attorney General time.
2. A charge in the amount of $2,000, to accompany a request for a settlement that includes immunity from contribution claims for existing contamination, if requested under A.R.S. § 49-285.01. If costs for the settlement exceed $2,000, the remainder of the costs will be paid for through the terms of the settlement.

E. The applicant may agree in writing to pay charges that exceed the initial charge described in subsection (C). Unless the applicant has so agreed, when the Department believes that the costs associated with the prospective purchaser agreement have begun to exceed the initial charge, the Department shall stop work on the prospective purchaser agreement and notify the applicant in writing. The applicant shall notify the Department in writing, within 30 days of the Department's notification under this subsection, whether the applicant wishes the Department to continue work on the application and to incur additional costs. The Department shall terminate the application if the applicant does not provide written confirmation within 30 days that it wishes the Department to continue work on the application.

F. The Department shall publish a legal notice announcing an opportunity for public comment on the prospective purchaser agreement. The legal notice shall include:
1. A general description of the contents of the agreement;

2. The location where information regarding the agreement can be obtained;
3. The name and address of the Department contact where comments may be sent; and
4. The time and date that the comment period closes.

G. The initial charge described in subsection (C) is due when the applicant submits the prospective purchaser agreement application to the Department. The publication cost specified in subsection (B)(3), and any hourly charge described in subsection (D)(1), are due within 30 days of the date the invoice is sent by the Department. Fee charges are payable to the state of Arizona, and shall be paid in full before the Department executes a prospective purchaser agreement.

Historical Note

Adopted effective February 7, 1997; filed with the Office of the Secretary of State January 14, 1997 (Supp. 97-1). Amended by final rulemaking at 12 A.A.R. 345, effective March 11, 2006 (Supp. 06-1).

Editor's Note: The heading for the following Article was amended by exempt rulemaking at 7 A.A.R. 814, effective February 9, 2001 (Supp. 01-1).

Editor's Note: The following Article was originally adopted under an exemption from the Arizona Administrative Procedure Act (A.R.S. Title 41, Chapter 6) pursuant to Laws 1997, Ch. 296, §§ 3(E) & (G), 10 & 11. Although exempt from certain provisions of the rulemaking process, the Department was required to submit notice of proposed rulemaking with the Secretary of State for publication in the Arizona Administrative Register and conduct a public hearing (Supp. 97-3).

ARTICLE 4. REPEALED

R18-7-401. Repealed

Historical Note

Adopted effective August 5, 1997, under an exemption from certain provisions of the Administrative Procedure Act pursuant to Laws 1997, Ch. 296, §§ 3(E) & (G), 10 & 11 (Supp. 97-3). Section R18-7-401 repealed; new Section R18-7-401 adopted effective October 21, 1998 (Supp. 98-4). Repealed by final rulemaking at 15 A.A.R. 232, effective March 7, 2009 (Supp. 09-1).

Editor's Note: The rules in the following Article were adopted as interim rules under an exemption from the Arizona Administrative Procedure Act (A.R.S. Title 41, Chapter 6) pursuant to Laws 2000, Ch. 225, § 13. Although exempt from certain provisions of the rulemaking process, the Department is required to submit notice of proposed rulemaking with the Secretary of State for publication in the Arizona Administrative Register and conduct a public hearing (Supp. 01-1).

ARTICLE 5. VOLUNTARY REMEDIATION PROGRAM

R18-7-501. Definitions

The following definitions shall apply in this Article, unless the context otherwise requires:

"Applicant" means a person who participates in the Voluntary Remediation Program. Participation in the Voluntary Remediation Program begins when the Department receives an application under A.R.S. § 49-173 and continues until any one of the following occurs:

The Department grants the applicant's request for a no further action determination.

The applicant provides the Department with notice of the applicant's intent to withdraw from the program.

The Department terminates the applicant's participation under A.R.S. § 49-178(B).

"Department" means the Arizona Department of Environmental Quality.

"Voluntary Remediation Program" means the program authorized under A.R.S. Title 49, Chapter 1, Article 5.

Historical Note

New Section adopted as interim rules, under an exemption from certain provisions of the Administrative Procedure Act pursuant to Laws 2000, Ch. 225, § 13, at 7 A.A.R. 814, effective February 9, 2001 (Supp. 01-1).

R18-7-502. Application Fee

A. At the time of filing an application to participate in the Voluntary Remediation Program, the applicant shall pay a nonrefundable application fee in the amount of $2,000.00.

B. The application fee shall be in the form of a company check, cashier's check, certified check, or money order made payable to the Arizona Department of Environmental Quality.

C. Except as provided in subsection (D), an application does not meet the requirements in A.R.S. § 49-173 unless accompanied by the application fee. The Department shall not review an application until the application fee is paid in full.

D. At the request of an applicant that is a small business as defined under A.R.S. § 41-1001, the Department may review and approve an application upon receipt of a partial payment of the application fee in an amount approved by the Department and an agreement to pay the remainder of the fee in scheduled installments.

E. An applicant that withdraws or is terminated from participation in the Voluntary Remediation Program may reapply to the program by submitting an application that meets the requirements of A.R.S. § 49-173, including payment of the application fee.

Historical Note

New Section adopted as interim rules, under an exemption from certain provisions of the Administrative Procedure Act pursuant to Laws 2000, Ch. 225, § 13, at 7 A.A.R. 814, effective February 9, 2001 (Supp. 01-1).

R18-7-503. Deposit

A. At the time that an applicant submits a work plan under A.R.S. § 49-175 or a report under A.R.S. § 49-181, the applicant shall submit to the Department an initial deposit of $4,000.00.

B. The deposit shall be in the form of a company check, cashier's check, certified check, or money order made payable to the Arizona Department of Environmental Quality.

C. The Department shall begin review of the applicant's work plan or the report submitted under A.R.S. § 49-181 upon receipt of the initial deposit.

D. Upon receipt of the initial deposit, the Department shall establish a site-specific deposit account identified by a unique account number. The Department shall charge all incurred reimbursable costs attributable to the applicant's site against the site-specific deposit account.

E. If, at any time during the applicant's participation in the program, the balance in the site-specific deposit account falls below $1,000.00 and the Department reasonably estimates that the reimbursable costs chargeable to the account will exceed the amount available in the account, the Department shall mail or fax a written request that the applicant submit an additional deposit in an amount not to exceed $4,000.00. The Department may request any number of additional deposits, in amounts of $4,000.00 or less, at any time that the conditions of this subsection are met.

F. If any requested additional deposit is not received within 30 days after the Department mails or faxes the request in subsection (E) and the Department determines that the applicant's site specific account balance is insufficient to support continued program participation, the Department shall mail a written notice of deficiency under A.R.S. § 49-178 and shall notify the applicant that work on the site may be suspended until the additional deposit is received. If the Department does not receive the requested additional deposit within 60 days after the notice of deficiency is mailed or faxed and the applicant does not dispute the Department's determination that the site specific account balance is insufficient to support continued program participation, the Department may terminate the applicant's participation in the program. An applicant whose participation is terminated under this subsection may reapply to the program as provided in R18-7-502(E).

Historical Note

New Section adopted as interim rules, under an exemption from certain provisions of the Administrative Procedure Act pursuant to Laws 2000, Ch. 225, § 13, at 7 A.A.R. 814, effective February 9, 2001 (Supp. 01-1).

R18-7-504. Voluntary Remediation Program Reimbursement

A. The applicant shall reimburse the Department, at an hourly reimbursement rate established under R18-7-505, for time spent by Voluntary Remediation Program staff on activities specifically related to the applicant's site, including the following:
   1. Review of the application submitted under A.R.S. § 49-173, including review of any modifications requested by the Department or the applicant or additional information submitted by the applicant.
   2. Review of the work plan submitted under A.R.S. § 49-175, including review of any modifications requested by the Department under A.R.S. § 49-177 or by the applicant or the Department under A.R.S. § 49-180.
   3. Review of progress reports submitted as part of a work plan under A.R.S. § 49-175 or as requested by the Department under A.R.S. § 49-177 or A.R.S. § 49-180.
   4. Consideration by the Department under A.R.S. § 49-176(D) of written comments submitted in response to a public notice providing an opportunity to comment or a public meeting.
   5. Participation in public hearings required by the Department under A.R.S. § 49-176(D).
   6. Site inspections under A.R.S. § 49-177 and site investigations under A.R.S. § 49-181, including time spent in travel to and from the site.
   7. Review of the report and request for a no further action determination submitted under A.R.S. § 49-181, including review of any modifications requested by the applicant or the Department.
   8. Time spent in reviewing a request submitted by an applicant under A.R.S. § 49-182 for approval of a remedial action under A.R.S. § 49-285.
   9. Time spent in meetings or discussions requested by the applicant or the Department.

B. The applicant shall reimburse the Department for the site-specific costs of goods and services contracted by the Department including:
   1. Reasonable and necessary attorneys' fees billed to the Department by the Attorney General for legal services, including legal fees billed for representation in regard to appeals or dispute resolution under A.R.S. § 49-185.
   2. Costs incurred by the Department for work provided under a contract described in A.R.S. § 49-179(D)(1) or A.R.S. § 49-179(D)(2).
   3. Reasonable and necessary travel costs incurred in the performance of activities described in subsections (A)(5), (A)(6), or (A)(9) or performed at the request of the applicant.
   4. Other reasonable site related expenses documented in writing by the Department.

Historical Note

New Section adopted as interim rules, under an exemption from certain provisions of the Administrative Procedure Act pursuant to Laws 2000, Ch. 225, § 13, at 7 A.A.R. 814, effective February 9, 2001 (Supp. 01-1).

R18-7-505. Hourly Reimbursement Rate

The hourly reimbursement rate is $110.00 per hour.

Historical Note

New Section adopted as interim rules, under an exemption from certain provisions of the Administrative Procedure Act pursuant to Laws 2000, Ch. 225, § 13, at 7 A.A.R. 814, effective February 9, 2001 (Supp. 01-1).

R18-7-506. Voluntary Remediation Program Accounting

Within a reasonable time after the end of each calender quarter, the Department shall mail or fax each applicant a statement itemizing reimbursable costs charged against the site-specific deposit account and a summary of account activity during that quarter. The statement shall be in a form consistent with generally accepted accounting principles.

Historical Note

New Section adopted as interim rules, under an exemption from certain provisions of the Administrative Procedure Act pursuant to Laws 2000, Ch. 225, § 13, at 7 A.A.R. 814, effective February 9, 2001 (Supp. 01-1).

R18-7-507. Account Reconciliation

A. Within a reasonable time after completion of the remediation work at the site, or after termination or withdrawal of the applicant from participation in the program, the Department shall prepare and mail or fax to the applicant a final statement which shall include:
   1. An itemization of site-specific reimbursable costs incurred by the Department but not previously reported in a quarterly statement.
   2. The total amount of site-specific reimbursable costs incurred by the Department during the course of the project, including the costs reported in subsection (A)(1).
   3. The total amount submitted as deposits by the applicant and applied by the Department to the applicant's site-specific deposit account during the course of the project, plus the amount paid by the applicant as an application fee.

B. If the final statement shows that the amounts submitted or paid during the course of the project are less than the Department's reimbursable costs, the applicant shall be responsible for and shall pay, within 30 days after receipt of the final statement, the difference between the costs incurred and the amounts submitted or paid.

C. If the final statement shows that the amounts submitted or paid during the course of the project are more than the Department's reimbursable costs and the Department's reimbursable costs exceed $2,000.00, the Department shall return to the applicant, within a reasonable time period, the difference between the amounts submitted or paid and the costs incurred.

D. If the final statement shows that the amounts submitted or paid during the course of the project are more than the Department's reimbursable costs and the Department's reimbursable costs total $2,000.00 or less, the Department shall retain the applicant's nonrefundable application fee of $2,000.00 and shall return to the applicant the amount of any deposits submitted.

E. The Department may withhold any program approval or no further action determination until the applicant has paid any amount due and payable under the final statement.

Historical Note

New Section adopted as interim rules, under an exemption from certain provisions of the Administrative Procedure Act pursuant to Laws 2000, Ch. 225, § 13, at 7 A.A.R. 814, effective February 9, 2001 (Supp. 01-1).

ARTICLE 6. DECLARATION OF ENVIRONMENTAL USE RESTRICTION FEE

Article 6, consisting of R18-7-601 through R18-7-606, made by exempt rulemaking at 10 A.A.R. 573, effective February 20, 2004 (Supp. 04-1).

R18-7-601. Definitions

The following definitions shall apply in this Article, unless the context otherwise requires:

"APP mine sites" means mining facilities which are subject to the aquifer protection permit provisions of Arizona Revised Statutes Title 49, Chapter 2, Article 3.

"Department" means the Arizona Department of Environmental Quality.

"DEUR" means declaration of environmental use restriction, as described in A.R.S. §§ 49-152 and 49-158. It is an institutional control and a restrictive covenant that runs with and burdens the property, binds the owner and the owner's heirs, successors and assigns, and inures to the benefit of the Department and the state.

"Fee" means the fee authorized by A.R.S. §§ 49-152(K) and 49-158(G).

"Engineering control" has the meaning in A.R.S. § 49-151.

"Institutional control" has the meaning in A.R.S. § 49-151.

"Modification" means modification of a DEUR that continues to address the same spill or release, and the same contaminants, as in the original DEUR. No other changes are considered a modification of a DEUR, but would be the subject of a separate DEUR.

"One-time activities" includes reviewing and/or approving legal descriptions, control areas, contaminants, institutional or engineering controls, and draft DEUR documents.

"Ongoing activities" includes reviewing written reports, conducting site inspections, or otherwise verifying maintenance of institutional or engineering controls.

"Underground storage tanks" means those underground storage tanks defined and regulated under A.R.S. Title 49, Chapter 6, Article 1.

"WQARF sites" means sites that are listed on the site registry specified in A.R.S. § 49-287.01 and are the subject of remedial action pursuant to A.R.S. Title 49, Chapter 2, Article 5. A property that is within a registry site boundary, but does not involve a contaminant of concern identified for that registry site and is not the subject of remedial action pursuant to the above Chapter 2, is not a WQARF site for the purpose of this Section.

Historical Note

New Section made by exempt rulemaking at 10 A.A.R. 573, effective February 20, 2004 (Supp. 04-1).

R18-7-602. Applicability

The provisions of this Article apply to properties where the owner has elected to use an institutional control and/or an engineering control to reduce the potential for exposure to contaminants on the property, or to leave contamination on the property that exceeds the applicable residential soil standard for the property. The owner of such property shall record, in each county where the property is located, a restrictive covenant labeled "declaration of environmental use restriction," that contains the information required by A.R.S. §§ 49-152 or 49-158, as approved by the Department. The owner shall submit the information on a form provided by the Department.

Historical Note

New Section made by exempt rulemaking at 10 A.A.R. 573, effective February 20, 2004 (Supp. 04-1).

R18-7-603. Fee

Except as provided in R18-7-605, before recording the DEUR or DEUR modification, property owners shall pay to the Department a fee as provided in R18-7-604 by company, cashier, or certified check, or money order, or other method approved by the Department.

Historical Note

New Section made by exempt rulemaking at 10 A.A.R. 573, effective February 20, 2004 (Supp. 04-1).

R18-7-604. Fee Calculation

A. Property owners who use only an institutional control shall pay to the Department a fee that is the sum of the following:
  1. $825, representing Department costs to perform one-time activities;
  2. An amount representing the costs of ongoing activities performed by the Department that is one of the following:
     a. For properties contaminated only by a petroleum release from one or more underground storage tanks: $110 multiplied by the number of years the Department projects the property will require ongoing activities, not to exceed 30 years; or
     b. For all other properties: $220 multiplied by the number of years the Department projects the property will require ongoing activities, not to exceed 30 years;
  3. $770, representing Department costs to review and render a decision on a request to release a DEUR, and to record the release, pursuant to A.R.S. §§ 49-152(D) or 49-158(L);
  4. $1,985 per site, representing the property owner's pro-rata share of Department costs to oversee and coordinate its DEUR-related activities; plus
  5. $550 per site, representing the property owner's pro-rata share of Department costs to administer the repository under A.R.S. § 49-152(E).

B. Property owners who use an engineering control without groundwater monitoring shall pay a fee to the Department that is the sum of the following:
  1. $1,595, representing Department costs to perform one-time activities;
  2. $660, representing Department costs of annual ongoing activities, multiplied by the number of years the Department projects the property will require ongoing activities, not to exceed 30 years;
  3. $1,320, representing Department costs to review and render a decision on a request to release a DEUR, and to record the release, pursuant to A.R.S. §§ 49-152(D) or 49-158(L);

4. $1,985 per site, representing the property owner's pro-rata share of Department costs to oversee and coordinate its DEUR-related activities; plus
5. $550 per site, representing the property owner's pro-rata share of Department costs to administer the repository under A.R.S. § 49-152(E).

C. Property owners who use an engineering control with groundwater monitoring, and owners of WQARF sites and APP mine sites, shall pay to the Department a fee that is the sum of the following:

1. $3,740, representing Department costs for performing one-time activities;
2. A component of the fee to be determined on a case-by-case basis, at $55 per hour, based on both:
    a. The number of hours per year that the Department projects will be required for ongoing activities performed by the Department for the property, not to exceed 70 hours per year; and
    b. The number of years that the Department projects the property will require ongoing activities, not to exceed 30 years;
3. $1,870, representing Department costs to review and render a decision on a request to release a DEUR, and to record the release, pursuant to A.R.S. §§ 49-152(D) or 49-158(L);
4. $1,985 per site, representing the property owner's pro-rata share of Department costs to oversee and coordinate its DEUR-related activities; plus
5. $550 per site, representing the property owner's pro-rata share of Department costs to administer the repository under A.R.S. § 49-152(E).

Historical Note

New Section made by exempt rulemaking at 10 A.A.R. 573, effective February 20, 2004 (Supp. 04-1).

R18-7-605. Postponement of the Release Portion of the DEUR Fee

Property owners may elect to postpone payment of the portion of the fee to release the DEUR, described in R18-7-604(A)(3), R18-7-604(B)(3), or R18-7-604(C)(3), on the condition that payment of the reasonable and necessary costs of releasing the DEUR is made with the request to the Department to release the DEUR from the property. Property owners electing to use this option acknowledge that the future amount of the release portion of the DEUR fee will be the amount established by this Article at the time the request for the release of the DEUR is filed with the Department, which may be greater than the amount described in R18-7-604(A)(3), R18-7-604(B)(3), or R18-7-604(C)(3) at the time the DEUR is recorded.

Historical Note

New Section made by exempt rulemaking at 10 A.A.R. 573, effective February 20, 2004 (Supp. 04-1).

R18-7-606. DEUR Modification Fee

A property owner who wishes to request a modification to an existing DEUR pursuant to A.R.S. §§ 49-152(I)(2), 49-152(J)(2), 49-158(E), or 49-158(F) shall pay to the Department a fee, representing Department costs to review and render a decision on the request to modify the DEUR. The fee shall accompany the proposed modification, and shall be in the form of company, cashier, or certified check, or money order, or other method approved by the Department. The fee shall be the amount specified in R18-7-604(A)(3), R18-7-604(B)(3), or R18-7-604(C)(3), as appropriate for the category of site as described in R18-7-604(A), R18-7-604(B), or R18-7-604(C).

Historical Note

New Section made by exempt rulemaking at 10 A.A.R. 573, effective February 20, 2004 (Supp. 04-1).

APPENDIX D

Arizona Minimum Groundwater Protection Limits

A SCREENING METHOD
TO DETERMINE SOIL CONCENTRATIONS
PROTECTIVE OF GROUNDWATER QUALITY

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Prepared by the Leachability Working Group

of the

Cleanup Standards/Policy Task Force

September 1996

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In September 1994, the Arizona Department of Environmental Quality (ADEQ) formed a Cleanup Standards Task Force to establish consistent remediation standards for all programs administered by ADEQ. The Task Force's work led to passage of legislation in 1995, A.R.S. 49-151 and 49-152, which mandated the development of consistent soil remediation standards based on the risk to human health and the environment and required ADEQ to establish these standards in rule. The Interim Soil Remediation Standards Rule (Interim Rule) was certified March 29, 1996.

Under the Interim Rule, a party conducting a soil remediation may use one of two approaches for determining the appropriate soil cleanup standard. The party may simply elect to use Health-Based Guidance Levels (HBGLs) developed by the Arizona Department of Health Services (ADHS) as cleanup standards. Residential and non-residential HBGLs for hundreds of chemicals are listed in the Interim Rule. Alternatively, a risk assessment may be used to develop site-specific cleanup standards based on either residential or non-residential use of the property. No matter which approach is selected, the residual concentration of a contaminant in soil cannot (1) cause or threaten contamination of groundwater to exceed the Aquifer Water Quality Standard (AWQS) at a program-specific point of compliance; (2) create a nuisance; (3) cause or threaten to cause a violation of a surface Water Quality Standard; or (4) exhibit the ignitability, corrosivity or reactivity characteristic of hazardous waste.

The Leachability Working Group of the Cleanup Standards Task Force (the Working Group) was assigned the task of developing a screening method to determine if residual contaminant concentrations could cause or threaten to cause contamination of groundwater. In fulfillment of this assignment, the Working Group prepared this report.

Approach for Organic Contaminants

In order to provide a scientific basis for the screening process, the Working Group determined that a contaminant fate-and-transport model would be needed to calculate potential impacts on groundwater quality due to residual soil contamination. The Working Group evaluated several vadose zone contaminant fate-and-transport models for organic chemicals, eventually selecting a one-dimensional model developed by ADEQ. As opposed to other commonly used vadose zone models, such as VLEACH and SESOIL, the ADEQ model was developed specifically to determine the level of residual contaminant concentrations in soil that would be protective of groundwater quality at a point of compliance in the underlying aquifer. The ADEQ model simulates transport of a contaminant undergoing three-phase partitioning using an analytical approach for the unsaturated zone (based on solutions developed by Dr. William A. Jury, University of California-Riverside) and a mixing-cell model for the saturated zone. The ADEQ model integrates groundwater transport of organic chemicals, a significant advantage over the other models reviewed. Using the ADEQ model, numerous simulations for different organic chemicals were run using conservative, but realistic, default values for the model input parameters. Based on the modeling results, Groundwater Protection Levels ("GPLs"), which are soil cleanup levels protective of groundwater quality, were developed for commonly occurring organic compounds with an AWQS.

Based on evaluation of the model results, three options for determining GPLs for organic contaminants were developed. As an initial screening step, the list of chemicals present at the cleanup site can be compared with a short list of organic compounds with limited mobility in the subsurface. If any of the chemicals is on the short list (Table 2), the threat of groundwater contamination from that chemical is considered negligible and the HBGL or a site-specific risk assessment level may serve as the cleanup standard. For other organic compounds with an AWQS, Minimum GPLs (Table 3) are provided. The Minimum GPLs are based on a "worst-case" situation (where the whole soil profile is contaminated from surface to groundwater). The Minimum GPL can be used as the soil remediation level without detailed site-specific information.

The second and third options require site-specific soil and contaminant characterization. The second screening step requires that the site-specific depth to groundwater and the vertical extent of contamination in the vadose zone be determined. The Working Group developed graphs which provide Alternative GPLs for commonly occurring organic compounds with an AWQS. The graphs show Alternative GPLs based on the depth to groundwater and the depth of incorporation in soil of the contaminant of concern. These graphs (Figures 2 through 22) depict the maximum soil concentrations that can remain in soil without potentially raising groundwater concentrations above the relevant AWQS at the default point-of-compliance. The third option allows GPLs to be determined by vadose zone and groundwater modeling using site-specific data collected and documented for the site in question. The use of the ADEQ model is not required, but it is recommended that any other model be pre-approved by ADEQ. Use of the ADEQ model could speed issuance of a close-out document. The second and third options may be used at any time.

Approach for Inorganic Contaminants

Vadose and saturated zone fate and transport of inorganic chemicals, such as metals, are not adequately described by organic contaminant partitioning models such as the ADEQ model. Therefore, for inorganic chemicals, the Working Group adopted an approach which combines a simple groundwater mixing cell calculation and the theoretical "worst case" correlation between total metals in soil and the corresponding leachable fraction of those metals. The Minimum GPLs for inorganic chemicals are based on this worst-case scenario. The Minimum GPLs are conservative because of the assumption that all metal leaches to groundwater regardless of the depth to groundwater.

A second screening step is available to calculate Alternative GPLs for metals if site-specific data are available on the relationship between total metals and the site-specific leachable fraction of those metals. As a third option, a party may choose to use a modeling method to develop site-specific cleanup levels for inorganics but ADEQ approval of the model is recommended prior to use.

Conclusion

This report offers parties performing remedial actions a process to determine if a soil cleanup standard, either a pre-determined level (an HBGL) or a site-specific level developed through a risk assessment, will adequately protect groundwater and, if not, how a groundwater protective soil cleanup level may be determined. This process is illustrated in Figure 1. If a pre-determined or site-specific soil cleanup standard is not protective of groundwater quality, a Minimum GPL can be used to ensure groundwater protection. As a second option, the Alternative GPL graphs for selected organic chemicals can be used to determine the soil cleanup level, or the correlation method described in this report may be used to determine Alternative GPLs for inorganic contaminants. For organic chemicals, this second option may be used if the site has been adequately characterized for depth to groundwater and depth of incorporation of the contaminant. For inorganic chemicals, this method may be used if an adequate site-specific correlation has been developed between total metals and the corresponding leachable fraction of those metals for soils at the site. Finally, ADEQ can approve a cleanup standard generated by a contaminant fate-and-transport model for either organic or inorganic contaminants. This third option can only be used if sufficient site characterization is performed to ensure that the input parameters to the model are adequately specified.

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LIST OF TABLES AND FIGURES

TABLES **Page**

Appendix A

Appendix C

FIGURES

Appendix B

I. INTRODUCTION

In September 1994, the Arizona Department of Environmental Quality (ADEQ) formed a Cleanup Standards Task Force to establish consistent remediation standards for all programs administered by ADEQ. The Task Force's work led to passage of legislation in 1995, A.R.S. 49-151 and 49-152, which mandated the development of consistent soil remediation standards based on the risk to human health and the environment. The legislation also required ADEQ to establish these standards in rule. Prior to rule development, ADEQ issued an Interim Soil Remediation Policy in July 1995 (the Interim Policy) to permit the prompt use of consistent soil remediation standards. The Interim Soil Remediation Standards Rule (Interim Rule) was certified March 29, 1996.

Under the Interim Rule, a party conducting a soil remediation may use one of two approaches for determining the appropriate soil cleanup standard. The party may simply elect to use Health-Based Guidance Levels (HBGLs) developed by the Arizona Department of Health Services (ADHS) as cleanup standards. Residential and non-residential HBGLs for hundreds of chemicals are listed in the Interim Rule. Alternatively, a risk assessment may be used to develop site-specific cleanup standards based on either residential or non-residential use of the property. No matter which approach is selected, the residual concentration in soil cannot (1) cause or threaten contamination of groundwater to exceed an aquifer water quality standard (AWQS) at a program-specific point of compliance; (2) create a nuisance; (3) cause or threaten to cause a violation of a surface water quality standard; or (4) exhibit the ignitability, corrosivity or reactivity characteristic of hazardous waste.

The responsibility for demonstrating that these screening criteria have been met lies with the party conducting the cleanup, an allocation of responsibility essentially consistent with historical practice. To develop guidance on these screening criteria, the Task Force created Working Groups to draw upon the technical expertise necessary to address each of these complex issues. The Leachability Working Group was assigned the task of developing a screening method to determine if a selected soil cleanup standard will be protective of groundwater quality.

The work of the Leachability Working Group, as documented in this report, offers parties performing remedial actions a process to determine if a soil cleanup level, either a pre-determined level (an HBGL) or a site-specific level developed through a risk assessment, will adequately protect groundwater quality. Minimum GPLs have been developed as a first level of screening for groundwater protection. As a second alternative, the Working Group has provided graphs for selected organic chemicals and a correlation method for inorganics which may be used to determine Alternative GPLs. For organic chemicals, this option may be used if the site has been adequately characterized for depth to groundwater and depth of incorporation in soil of the contaminant. For inorganic chemicals, this method may be used if the relationship between total metals and the corresponding leachable fraction has been adequately determined for soils at the site. As a third option, ADEQ can approve a cleanup standard generated by a contaminant fate-and-transport model. This option can only be used if sufficient site characterization has been performed to ensure that the input parameters to the model are adequately specified.

II. APPROACH TO PROBLEM

After formation, the Leachability Working Group adopted the following mission statement:

> Develop recommendations for soil cleanup policies and standards that consider the mobility of soil contaminants and their potential to migrate to and contaminate groundwater. The recommendations should address:
>
> - Initial screening mechanisms, based upon site and contaminant characteristics, to identify levels of soil contamination that, without additional sampling and analyses, do not pose a significant risk of groundwater contamination, and that take into account existing conditions.
> - Secondary screening mechanisms for soil contamination that fails the initial screening mechanism, but does not pose a significant risk of groundwater contamination, including simplified modeling or analytical procedures with conservative default standards, assumptions, or predictions.
> - For soil contamination that fails the first and second screening mechanisms, site-specific modeling or other more extensive site evaluations of the soil contamination to evaluate for actual threats to groundwater.
> - After completion of site-specific modeling or more-extensive site evaluation, negotiated soil standards with ADEQ based upon site-specific risk assessment results.
> - Incentives and administrative mechanisms for timely response to soil contamination that poses a significant threat of groundwater contamination.

The Leachability Working Group explored four options for achieving these goals: (1) tables or graphs of residual soil concentrations calculated based on the potential for leaching, (2) checklists of simple screening criteria, (3) a more complex matrix using site-specific data, and (4) screening models using site-specific data (Table 1). The Working Group eventually adopted an approach combining elements of (1) and (4). A contaminant fate-and-transport model was used to determine what residual soil concentrations remaining after cleanup would be protective of groundwater quality. Conservative, but realistic, parameters for the soil-aquifer system were used as inputs to the model, and outputs were developed in both tabular and graphical forms.

The Working Group largely achieved the mission stated above. First and second level screening methodologies were developed through the use of a one-dimensional model developed by ADEQ for organic chemicals. A third option was preserved for any facility wishing to use site-specific modeling to develop soil cleanup levels protective of groundwater quality. For metals, an approach was developed relying on the correlation between total metals concentration in soil and the corresponding leachate concentration. These approaches, which provide numerical endpoints for cleanups to be protective of groundwater, should encourage both timely and effective remediations.

Table 1. GROUNDWATER SCREENING APPROACHES

OPTIONS	RESPONSIBILITY	CONSTRAINTS	EASE-OF-USE	ADEQ OVERSIGHT
Fixed soil concentrations that consider leachability a. Tables b. Graphs	Working Group develops; RP compares	Upfront time to develop -then easy to apply -may be difficult to determine one (or few) concentration levels	Easy	At end of process; optional earlier in process
Checklist of simple screening criteria	Working Group develops criteria; RP applies to site	Less upfront time -more exceptions to consider	Easy	At end of process; optional earlier
Screening matrix using site-specific data	Working Group develops criteria; RP applies to site	Difficult to set up -other states may serve as model	Moderate	Moderate at end; optional earlier
Screening model using site-specific data	RP performs model runs; ADEQ reviews results	Many models available	Difficult	Considerable ADEQ review

III. SCREENING APPROACH FOR ORGANIC CONTAMINANTS

Once the ADEQ model was selected and input parameters defined, model simulations were performed. The modeling showed that for all organic compounds with a promulgated AWQS, those listed in Table 2 have low enough mobility (corresponding to a high K_{oc} value) that they are not a threat to groundwater quality. For more mobile compounds, graphs were generated showing contaminant concentration needed to protect groundwater versus depth to groundwater and depth of incorporation of the contaminant in the soil.

The input parameters used in the model were selected to provide conservative default GPLs. Analysis of the modeling results indicates that the model is more sensitive to certain parameters than others (see Appendix A). Consequently, if site-specific parameters, especially recharge rate or release width, greatly exceed the default parameters used to develop the screening levels, consultation with ADEQ is recommended and site-specific modeling may be necessary. This would be true, for example, if future site use includes irrigation which implies the recharge input parameter may be greatly exceeded. Additionally, the modeled vadose zone is assumed to comprise alluvial basin sediments thus, neither the GPLs nor the model can be used if the site is located in an area of consolidated or fractured rock.

Based on evaluation of the model results, a hierarchy of three screening levels was devised and is described below. Figure 1 is a flow diagram showing the steps in the screening process.

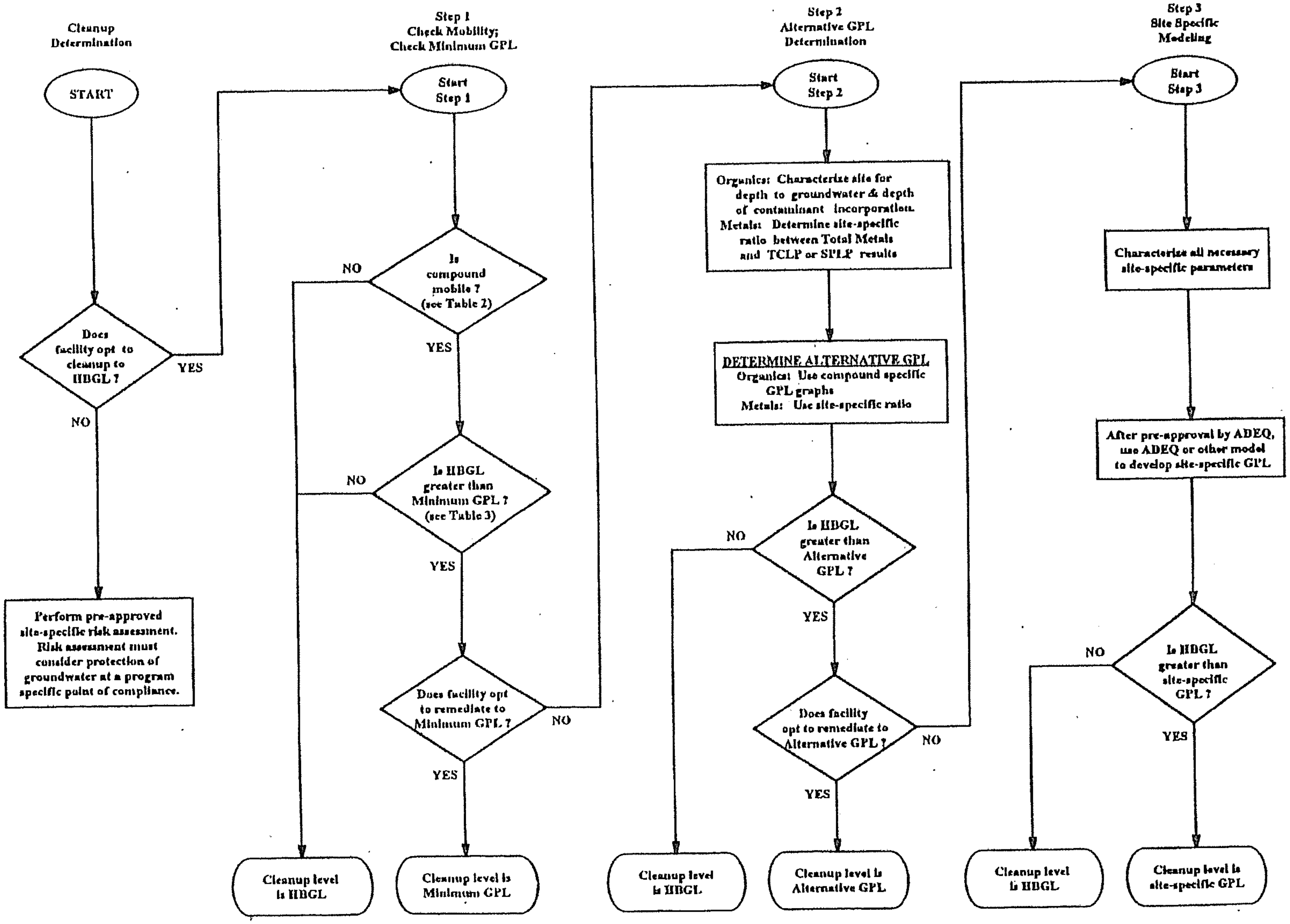
Step 1

The initial screening step determines whether the organic chemical of interest has such limited mobility in the subsurface that it poses little threat to groundwater quality. If the organic compound appears on the following list (Table 2), the residential HBGL or site-specific standard developed from a risk assessment is an appropriate remediation standard that is protective of groundwater quality.

Table 2. Soil Contaminants With Limited Mobility in the Vadose Zone

Chlordane	Methoxychlor
Heptachlor	Polychlorinated Biphenyls
Heptachlor Epoxide	Toxaphene

Figure 1. GROUNDWATER PROTECTION SCREENING PROCESS FOR SOIL REMEDIATIONS



For those organic chemicals not listed in Table 2, Minimum GPLs have been generated. These Minimum GPLs represent soil concentrations protective of groundwater quality in a "worst-case" situation - where the whole soil profile is contaminated from the surface to groundwater. For a specific organic chemical, the Minimum GPL as generated by the ADEQ model is constant regardless of the depth to groundwater, hence the single value. Table 3 lists the Minimum GPL and the Residential Soil HBGL for organic compounds with promulgated Aquifer Water Quality Standards. The Minimum GPL may be used as an alternative cleanup standard if the party performing the remedial action chooses not to undertake further site characterization activities.

Step 2

If the organic chemical of concern is not listed in Table 2 and the party chooses not to use the Minimum GPL as the cleanup standard, a second screening level is available. This step requires site-specific information on the depth to groundwater and the vertical extent of the soil contamination (depth of incorporation) to determine a GPL. The depth of incorporation is defined as the greatest depth at which a soil concentration above the applicable Minimum GPL is detected. Site characterization must be sufficiently deep to verify the depth of incorporation. Based on numerous model runs, the Working Group developed a series of graphs for commonly occurring organic compounds with AWQSs. From these graphs, a GPL may be determined based on the depth to groundwater and the depth of contaminant incorporation for the site in question. If the concentration in soil of a contaminant at the site is below the Alternative GPL determined from the graph, soil remediation is not required unless the Alternative GPL is greater than the applicable HBGL or the cleanup standard determined from a site-specific risk assessment. In addition, the cleanup level also must satisfy the other screening criteria. If the contaminant concentration is higher than the Alternative GPL, the Alternative GPL may be selected as an alternative cleanup standard, or the next level of screening may be performed.

Step 3

A third screening level is provided to allow determination of a soil cleanup standard protective of groundwater quality based entirely on site-specific characteristics. This option entails collecting and documenting site-specific data and calculating a soil cleanup level using a vadose and saturated zone contaminant fate-and-transport model. Use of the ADEQ model is not required; however, it is recommended that the contaminant fate-and-transport model selected for the modeling be pre-approved by ADEQ.

The third option, to determine soil concentrations that will be protective of groundwater quality based on site-specific conditions, may be chosen without carrying out the first two steps.

Data Requirements

Sampling of the vadose zone must be conducted at a site to obtain results of laboratory chemical analyses for comparison to the GPLs for organic compounds. A sampling and analysis plan designed to meet site-specific needs should be prepared. Planning for sample collection and handling to minimize loss of volatiles is critical to this process. In addition, there have been cases where organic compounds in the vadose zone were alternately detected and then not detected at varying depths in a well or boring, depending on the presence of layers of fine-grained sediments. Therefore, to properly evaluate the potential occurrence of an organic contaminant in the vadose zone that may represent a continuing source of groundwater contamination, it is necessary to obtain depth-specific lithologic data for the vadose zone to the maximum depth practicable. Each sampling program designed to screen for leachability of organic compounds in the vadose zone should include data from at least one deep boring to verify that the selected cleanup level is appropriate.

The minimum data necessary to apply the described screening process include results of laboratory chemical analyses for the organic compounds of concern at the site. However, if there is any doubt that a site would not pass the initial screening steps, the sampling program should also consider collection of additional data that would be necessary to conduct site-specific modeling using the ADEQ model or an acceptable alternative model. Redundant field investigations can be avoided if collection of these additional data is not postponed to a later time.

Table 3. Minimum GPLs for Organic Contaminants

	Residential Soil HBGL (mg/kg)	Minimum GPL (mg/kg)
Benzene	47	0.71
Carbon Tetrachloride	10	1.6
o-Dichlorobenzene	11,000	72
p-Dichlorobenzene	57	9.3
1,2-Dichloroethane (1,2-DCA)	15	0.21
1,1-Dichloroethylene (1,1-DCE)	2.3	0.81
cis-1,2-Dichloroethylene (*cis*-1,2-DCE)	1200	4.9
trans-1,2-Dichloroethylene (*trans*-1,2-DCE)	2300	8.4
1,2-Dichloropropane	20	0.28
Ethylbenzene	12,000	120
Monochlorobenzene	2300	22
Styrene	2300	36
Tetrachloroethylene (PCE)	27	1.3
Toluene	23,000	400
Trihalomethanes (Total)[1]	220	6.8
1,1,1-Trichloroethane (TCA)[2]	11,000	1.0
Trichloroethylene (TCE)	120	0.61
Xylenes (Total)[3]	230,000	2200
Alachlor	17	0.11
Atrazine	6.1	0.11
Carbofuran	580	2.1
1,2-Dibromo-3-chloropropane (DBCP)	0.97	.015
Ethylene dibromide (EDB)	0.02	.0033
Endrin	35	45

Lindane	1	0.088
2,4-Dichlorophenoxyacetic acid (2,4-D)	1200	6.7
Trichlorophenoxypropionic acid (2,4,5-TP) or Silvex)	940	42

FOOTNOTES:

1. Based on chloroform.
2. Based on meeting 1,1-DCE Aquifer Water Quality Standard of 7 μg/l. Degradation of 1,1,1-TCA to 1,1-DCE is assumed to occur at the water table.
3. Based on sorption and volatilization for *o*-xylene, which is the most mobile of the three xylene isomers.

General Notes:

1. Minimum GPLs for BTEX were calculated assuming a 1000 day half-life. Minimum GPLs for all other compounds were calculating assuming a 100,000 day half-life.

2. Minimum GPL calculations were performed for all organic compounds with established Aquifer Water Quality Standards.

Alternative Groundwater Protection Levels

Alternative GPLs were calculated for seven common organic contaminants. For each contaminant, three figures are provided in this report:

a. Graph of Alternative GPLs plotted for various depths to groundwater and depths of incorporation of the contaminant in soil

b. Table of the plotted values

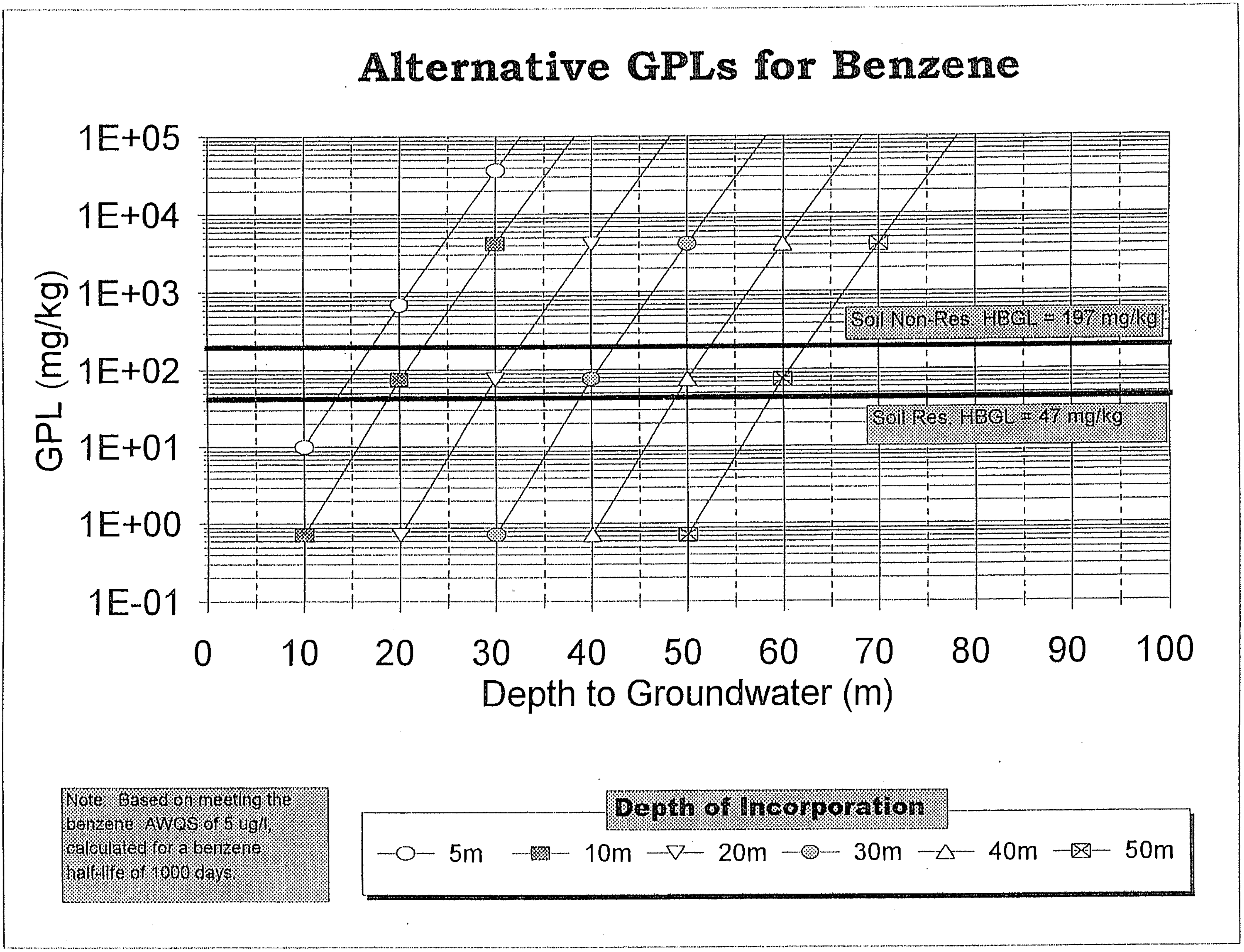
c. Representative printed output from the ADEQ model

The seven contaminants for which Alternative GPLs were developed are:

Benzene	Figures 2-4
Toluene	Figures 5-7
Ethylbenzene	Figures 8-10
Xylene	Figures 11-13
1,1,1-Trichloroethane (TCA)	Figures 14-16
Trichloroethylene (TCE)	Figures 17-19
Tetrachloroethylene (PCE)	Figures 20-22

Note: Alternative GPLs for BTEX were calculated assuming a 1000-day half-life. Alternative GPLs for TCE, 1,1,1-TCA, PCE, and chloroform were calculated assuming a 100,000 day half-life.

Alternative GPLs for Benzene



Note: Based on meeting the benzene AWQS of 5 ug/l, calculated for a benzene half-life of 1000 days.

Alternative GPLs for BENZENE

(Numbers in table are GPLs in mg/kg)

Depth to Water (m)	Depth of Incorporation (m)					
	5m	**10m**	**20m**	**30m**	**40m**	**50m**
0m						
10m	10	0.707				
20m	678	74.8	0.707			
30m	35,930	4,095	74.3	0.707		
40m	1,751,000	202,000	4,033	74.3	0.707	
50m			197,700	4,033	75.2	0.707
60m				197,700	4,033	84.0
70m					197,700	4,032
80m						197,700
90m						
100m						

Half-Life = 1000 days

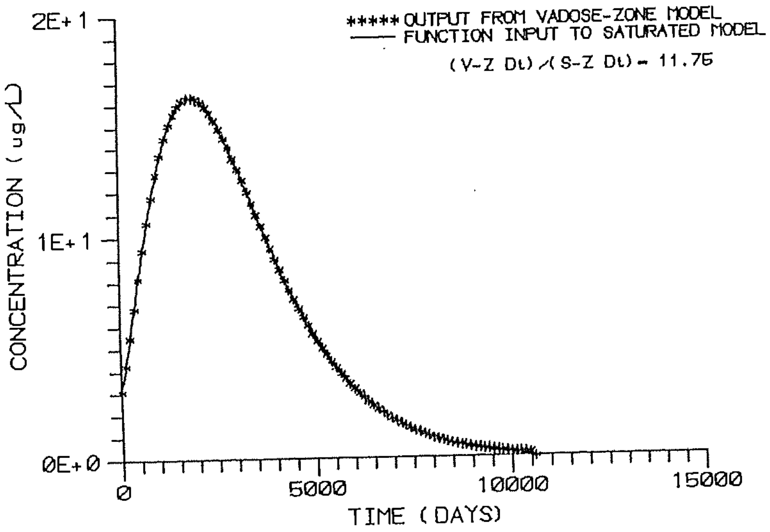
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

GROUNDWATER PROTECTION LEVEL MODEL

9/25/96

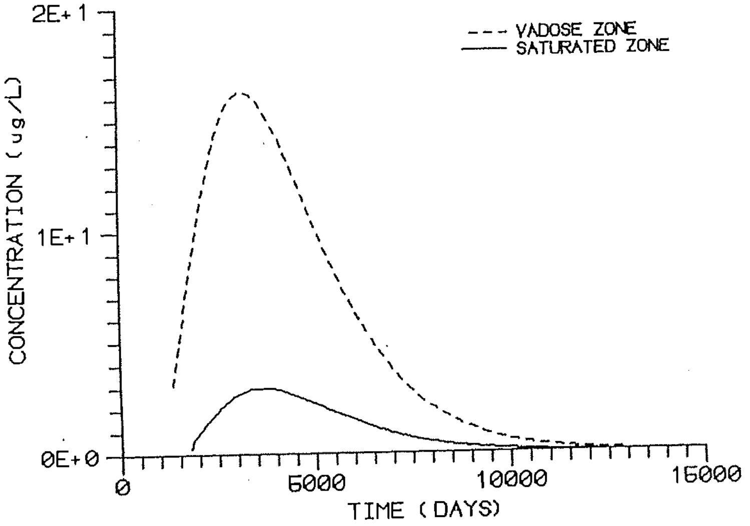
SITE NAME / ID ____________________

LIQUID-PHASE CONCENTRATION VS TIME
(CORRECTED TO INITIAL BREAKTHROUGH)



14

LIQUID-PHASE CONCENTRATION VS TIME
FOR VADOSE-ZONE AND SATURATED-ZONE MODELS



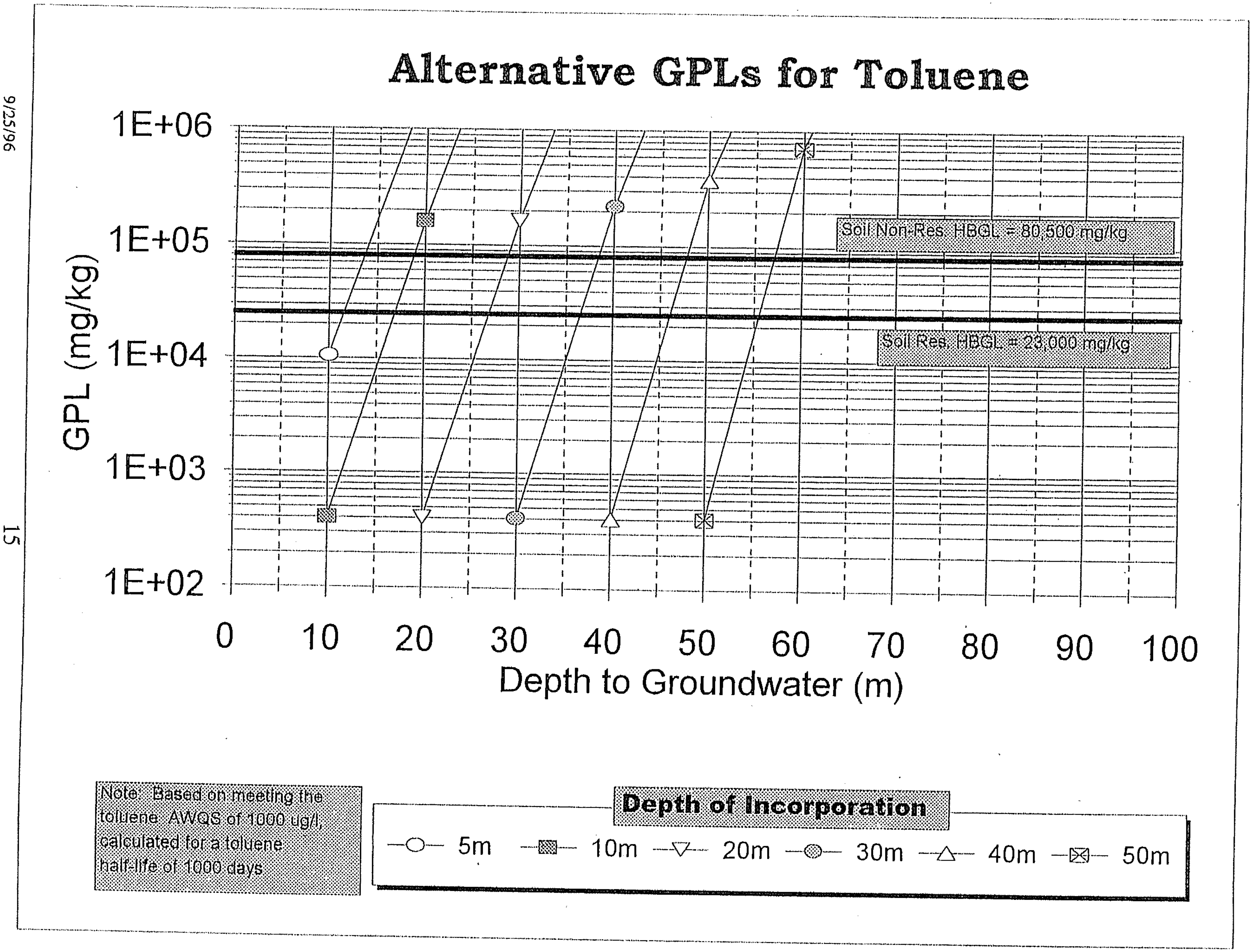
BENZENE

KOC = .6450E+02 cm³/g
KH = .2210E+00
HALF-LIFE (IN VADOSE ZONE) = .10E+04 days
HALF-LIFE (IN SATURATED ZONE) = .10E+04 days
GROUNDWATER STANDARD = 5.0000 ug/L
SOIL HEALTH-BASED GUIDANCE LEVEL = 47.00 mg/kg

DEPTH TO GROUNDWATER = 20.0 m
AQUIFER MIXING-CELL FACTOR = 1.0
DISTANCE TO COMPLIANCE POINT = 30.5 m
BULK DENSITY = 1.50 g/cm³
POROSITY = .25
SOIL FOC= .0010
AQUIFER FOC = .0010
SOIL MOISTURE CONTENT = .15
MOISTURE FLUX THROUGH WASTE CELL= .70E-02 cm/day
MOISTURE FLUX OUTSIDE WASTE CELL= .70E-02 cm/day
GROUNDWATER VELOCITY = 10.00 cm/day
DIFFUSION LAYER THICKNESS = .50 cm
DEPTH OF INCORPORATION = 10.000 m
RELEASE WIDTH = 10.0 m
AIR DIFFUSION COEF. = .7000E+04 cm²/day
WATER DIFFUSION COEF. = .7000E+00 cm²/day
INITIAL CONTAMINANT CONCENTRATION IN SOIL = 1 ug/cm³

VADOSE-ZONE TIME TO PEAK = .3196E+04 DAYS
VADOSE-ZONE PEAK CONCENTRATION = .1630E+02 ug/L
SATURATED-ZONE TIME TO PEAK = .3626E+04 DAYS
SATURATED-ZONE PEAK CONCENTRATION = .2966E+01 ug/L
CELL THICKNESS AT COMPLIANCE POINT = 11.2 cm
CELL GPL = .1022E+01 mg/kg

GPL = .7481E+02 mg/kg
(adjusted for .820E+01m perforated interval)



Alternative GPLs for Toluene

Note: Based on meeting the toluene AWQS of 1000 ug/l, calculated for a toluene half-life of 1000 days

Alternative GPLs for TOLUENE

(Numbers in table are GPLs in mg/kg)

Depth to Water (m)	Depth of Incorporation (m)					
	5m	10m	20m	30m	40m	50m
0m						
10m	10480	402				
20m	2,534,000	159,800	402			
30m		32,140,000	162,700	402		
40m			32,040,000	219,100	402	
50m				32,030,000	371,000	402
60m					33,090,000	711,900
70m						41,620,000
80m						
90m						
100m						

Half-Life = 1000 days

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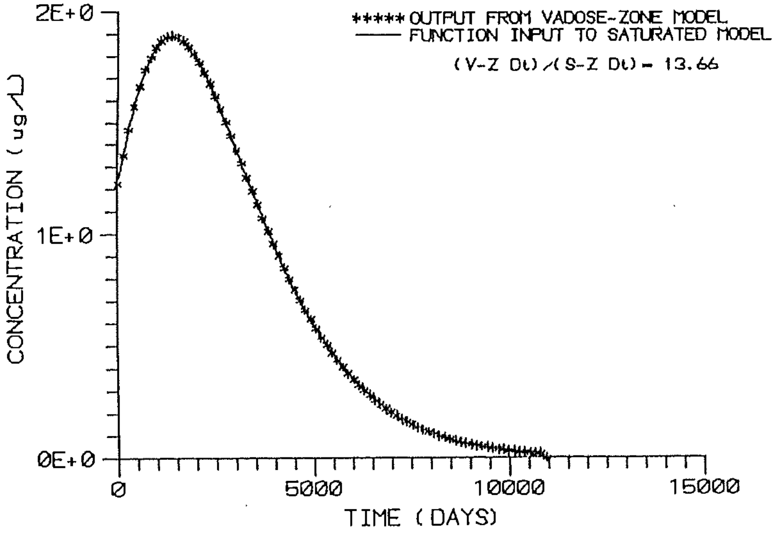
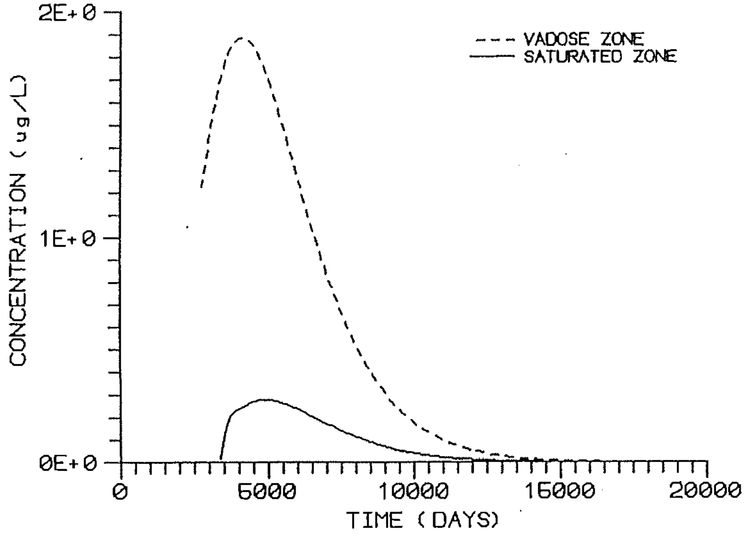
GROUNDWATER PROTECTION LEVEL MODEL

9/25/96


LIQUID-PHASE CONCENTRATION VS TIME
(CORRECTED TO INITIAL BREAKTHROUGH)

17


LIQUID-PHASE CONCENTRATION VS TIME
FOR VADOSE-ZONE AND SATURATED-ZONE MODELS

SITE NAME / ID ______________________

TOLUENE

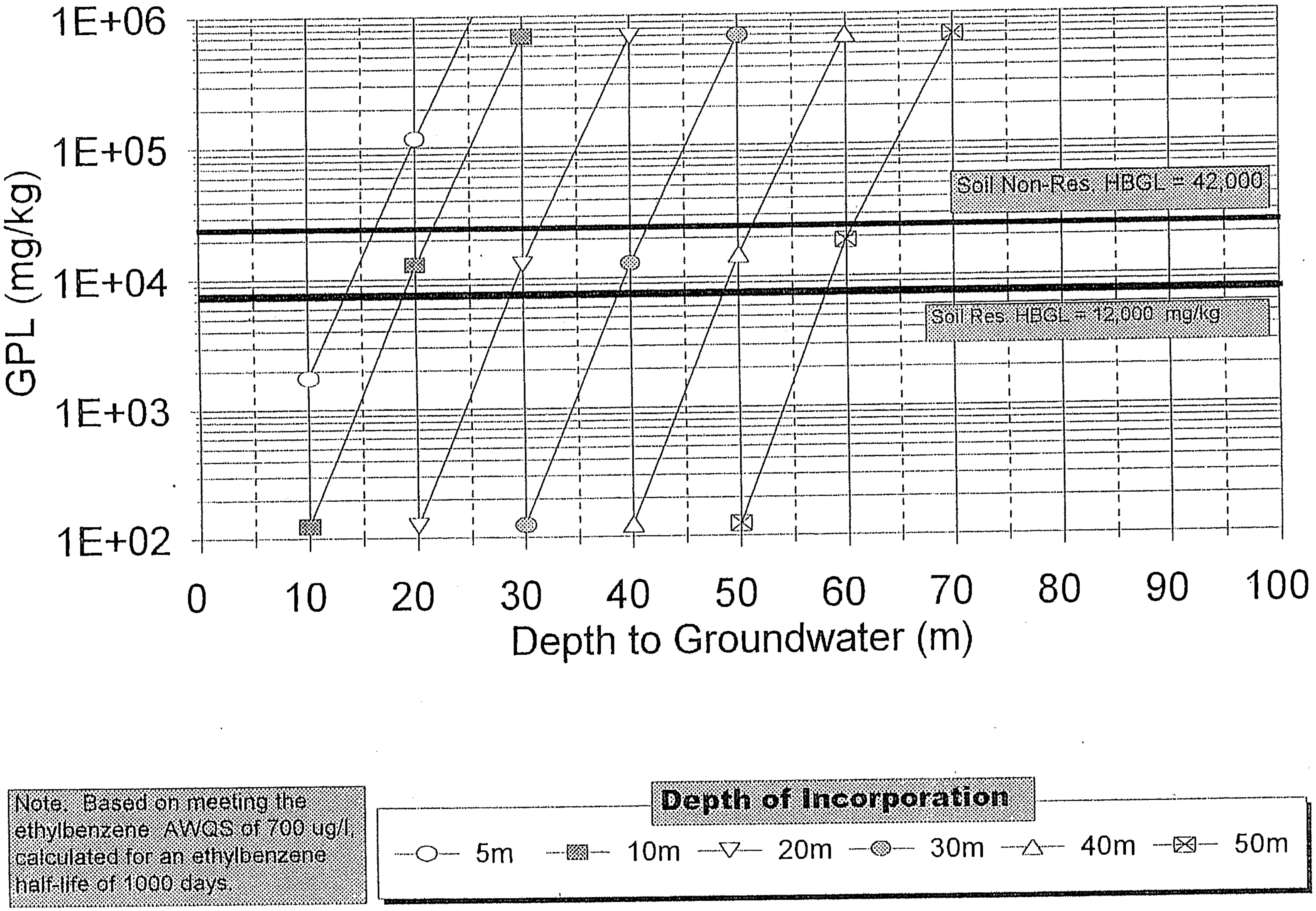
KOC = .2570E+03 cm^3/g
KH = .2690E+00
HALF-LIFE (IN VADOSE ZONE) = .10E+04 days
HALF-LIFE (IN SATURATED ZONE) = .10E+04 days
GROUNDWATER STANDARD = 1000.0000 ug/L
SOIL HEALTH-BASED GUIDANCE LEVEL = 23000.00 mg/kg

DEPTH TO GROUNDWATER = 20.0 m
AQUIFER MIXING-CELL FACTOR = 1.0
DISTANCE TO COMPLIANCE POINT = 30.5 m
BULK DENSITY = 1.50 g/cm^3
POROSITY = .25
SOIL FOC= .0010
AQUIFER FOC = .0010
SOIL MOISTURE CONTENT = .15
MOISTURE FLUX THROUGH WASTE CELL= .70E-02 cm/day
MOISTURE FLUX OUTSIDE WASTE CELL= .70E-02 cm/day
GROUNDWATER VELOCITY = 10.00 cm/day
DIFFUSION LAYER THICKNESS = .50 cm
DEPTH OF INCORPORATION = 10.000 m
RELEASE WIDTH = 10.0 m
AIR DIFFUSION COEF. = .7000E+04 cm^2/day
WATER DIFFUSION COEF. = .7000E+00 cm^2/day
INITIAL CONTAMINANT CONCENTRATION IN SOIL = 1 ug/cm^3

VADOSE-ZONE TIME TO PEAK = .4107E+04 DAYS
VADOSE-ZONE PEAK CONCENTRATION = .1887E+01 ug/L
SATURATED-ZONE TIME TO PEAK = .4862E+04 DAYS
SATURATED-ZONE PEAK CONCENTRATION = .2777E+00 ug/L
CELL THICKNESS AT COMPLIANCE POINT = 11.2 cm
CELL GPL = .2183E+04 mg/kg

GPL = .1598E+06 mg/kg
(adjusted for .820E+01m perforated interval)

Alternative GPLs for Ethylbenzene



Note: Based on meeting the ethylbenzene AWQS of 700 ug/l, calculated for an ethylbenzene half-life of 1000 days.

Alternative GPLs for ETHYLBENZENE

(Numbers in table are GPLs in mg/kg)

Depth to Water (m)	Depth of Incorporation (m)					
	5m	10m	20m	30m	40m	50m
0m						
10m	1,731	124				
20m	117,100	12,900	124			
30m	6,183,000	704,200	12,820	124		
40m			693,200	12,890	124	
50m				693,200	14,640	124
60m					693,100	18,730
70m						693,200
80m						
90m						
100m						

Half-Life = 1000 days

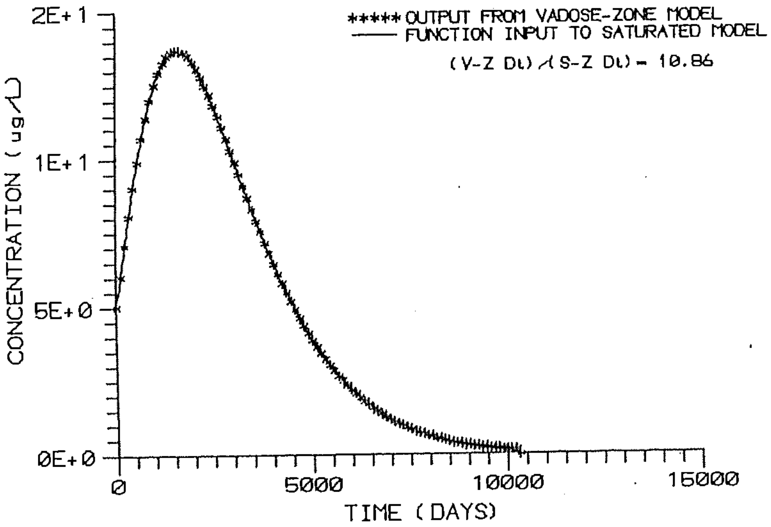
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

GROUNDWATER PROTECTION LEVEL MODEL

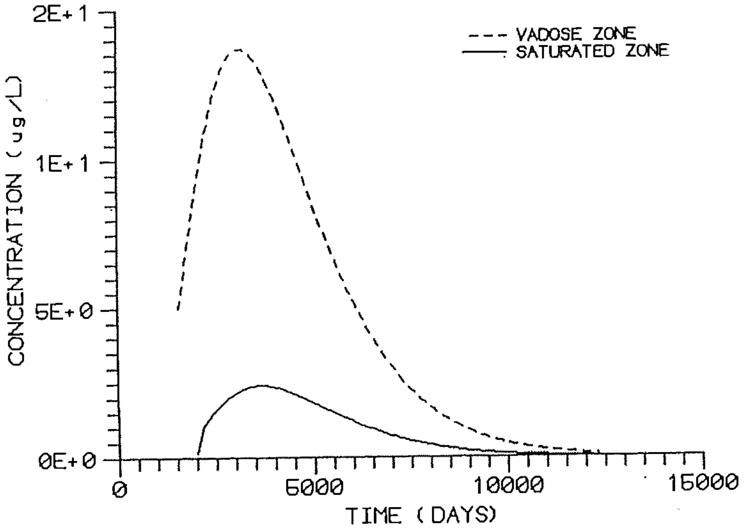
SITE NAME / ID ____________________

9/25/96

LIQUID-PHASE CONCENTRATION VS TIME
(CORRECTED TO INITIAL BREAKTHROUGH)



LIQUID-PHASE CONCENTRATION VS TIME
FOR VADOSE-ZONE AND SATURATED-ZONE MODELS



ETHYLBENZENE

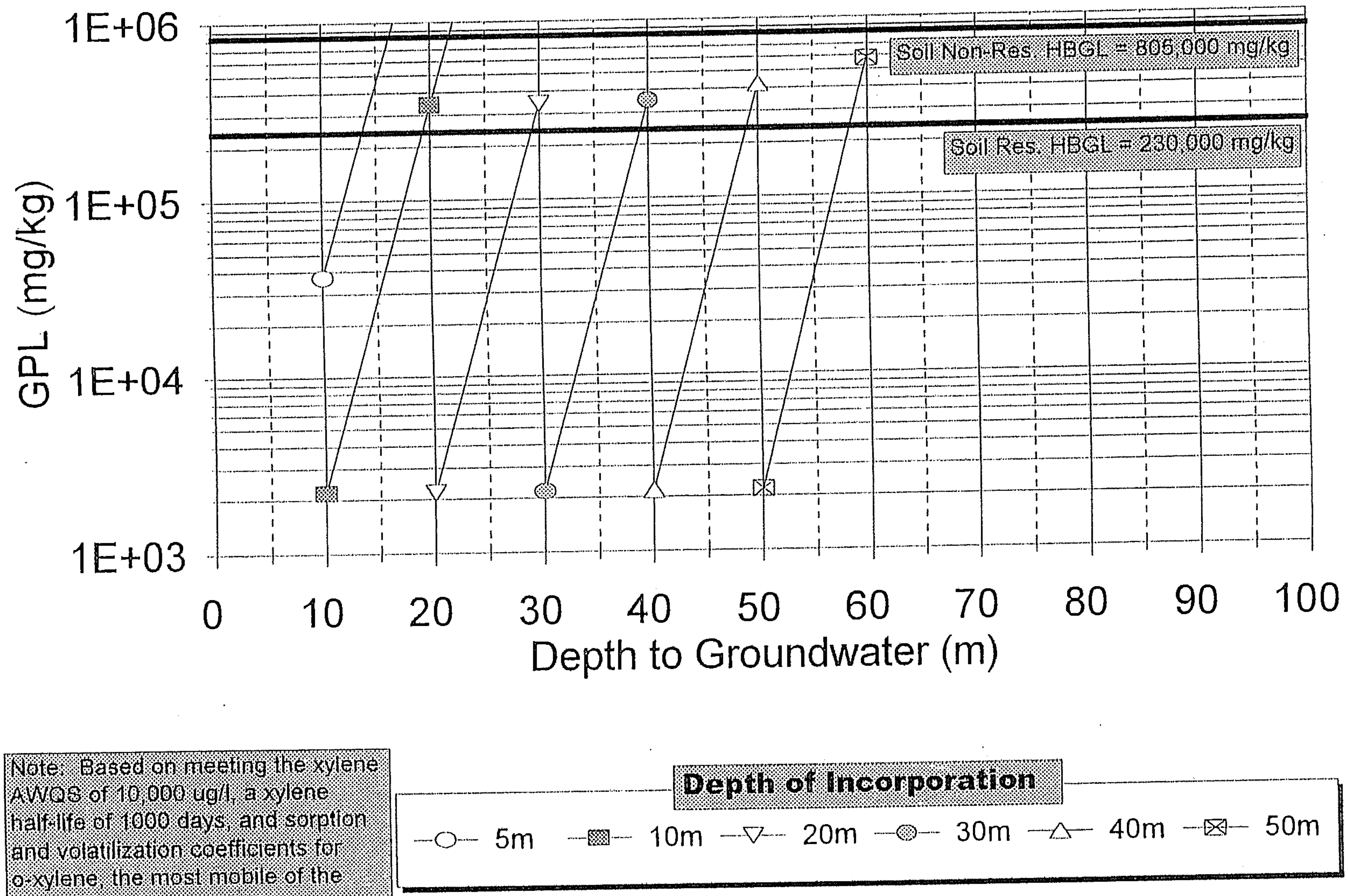
KOC = .9500E+02 cm^3/g
KH = .2700E+00
HALF-LIFE (IN VADOSE ZONE) = .10E+04 days
HALF-LIFE (IN SATURATED ZONE) = .10E+04 days
GROUNDWATER STANDARD = 700.0000 ug/L
SOIL HEALTH-BASED GUIDANCE LEVEL = 12000.00 mg/kg

DEPTH TO GROUNDWATER = 20.0 m
AQUIFER MIXING-CELL FACTOR = 1.0
DISTANCE TO COMPLIANCE POINT = 30.5 m
BULK DENSITY = 1.50 g/cm^3
POROSITY = .25
SOIL FOC= .0010
AQUIFER FOC = .0010
SOIL MOISTURE CONTENT = .15
MOISTURE FLUX THROUGH WASTE CELL= .70E-02 cm/day
MOISTURE FLUX OUTSIDE WASTE CELL= .70E-02 cm/day
GROUNDWATER VELOCITY = 10.00 cm/day
DIFFUSION LAYER THICKNESS = .50 cm
DEPTH OF INCORPORATION = 10.000 m
RELEASE WIDTH = 10.0 m
AIR DIFFUSION COEF. = .7000E+04 cm^2/day
WATER DIFFUSION COEF. = .7000E+00 cm^2/day
INITIAL CONTAMINANT CONCENTRATION IN SOIL = 1 ug/cm^3

VADOSE-ZONE TIME TO PEAK = .3083E+04 DAYS
VADOSE-ZONE PEAK CONCENTRATION = .1368E+02 ug/L
SATURATED-ZONE TIME TO PEAK = .3632E+04 DAYS
SATURATED-ZONE PEAK CONCENTRATION = .2408E+01 ug/L
CELL THICKNESS AT COMPLIANCE POINT = 11.2 cm
CELL GPL = .1762E+03 mg/kg

GPL = .1290E+05 mg/kg
(adjusted for .820E+01m perforated interval)

Alternative GPLs for Xylene



Note: Based on meeting the xylene AWQS of 10,000 ug/l, a xylene half-life of 1000 days, and sorption and volatilization coefficients for o-xylene, the most mobile of the three xylene isomers.

Alternative GPLs for o-XYLENE

(Numbers in table are GPLs in mg/kg)

Depth to Water (m)	Depth of Incorporation (m)					
	5m	10m	20m	30m	40m	50m
0m						
10m	36,570	2,161				
20m	3,642,000	341,000	2,161			
30m		27,720,000	339,800	2,161		
40m				348,000	2,161	
50m					420,800	2,161
60m						577,400
70m						
80m						
90m						
100m						
Half-Life = 1000 days						

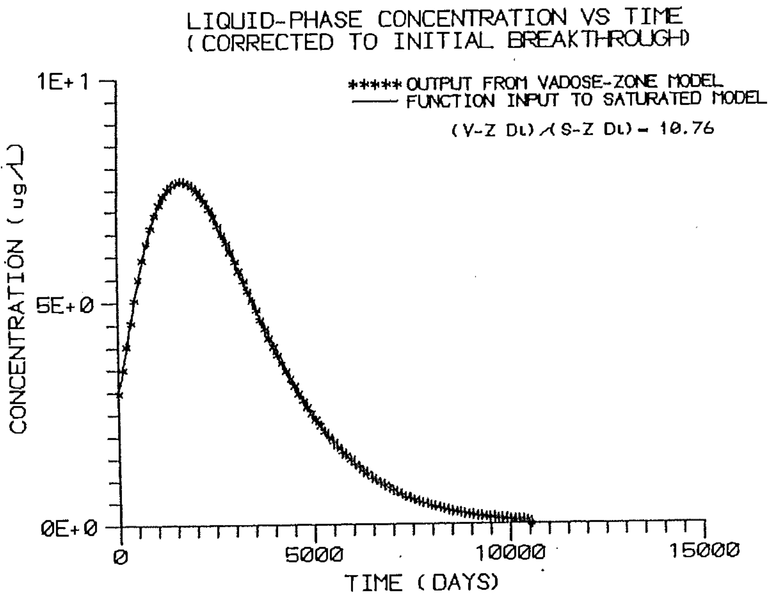
GNT = Groundwater Not Threatened

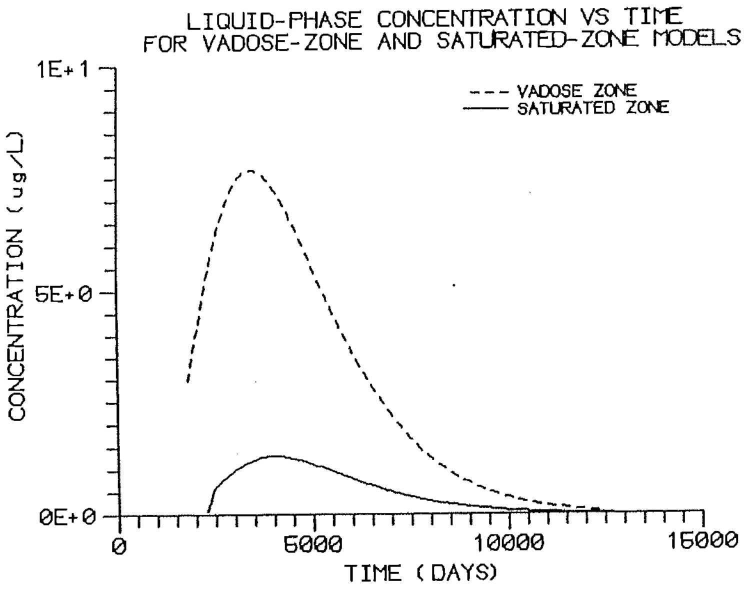
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

GROUNDWATER PROTECTION LEVEL MODEL

9/25/96

SITE NAME / ID ____________________





O-XYLENE

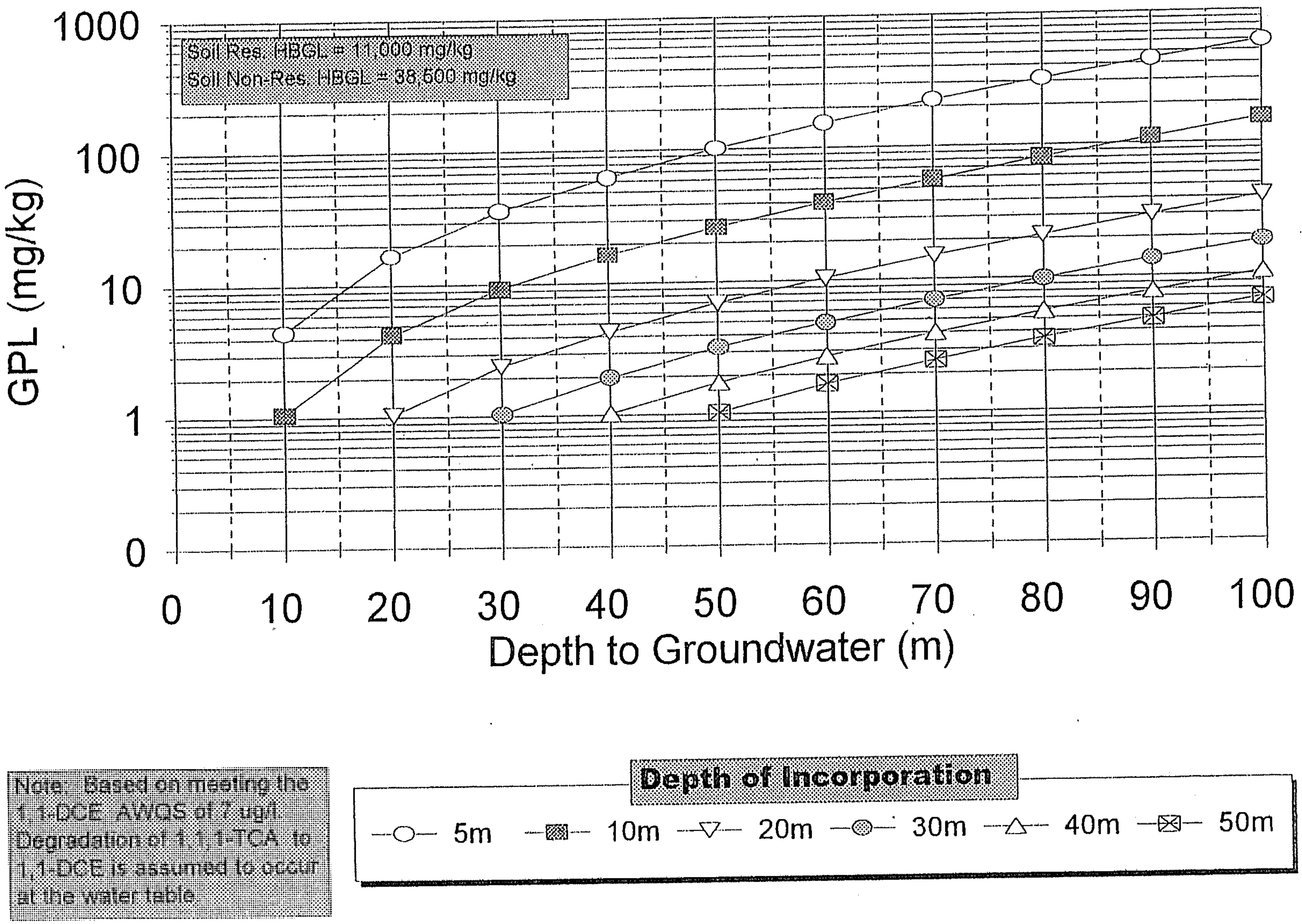
KOC = .1290E+03 cm^3/g
KH = .2560E+00
HALF-LIFE (IN VADOSE ZONE) = .10E+04 days
HALF-LIFE (IN SATURATED ZONE) = .10E+04 days
GROUNDWATER STANDARD = 10000.0000 ug/L
SOIL HEALTH-BASED GUIDANCE LEVEL = 230000.00 mg/kg

DEPTH TO GROUNDWATER = 20.0 m
AQUIFER MIXING-CELL FACTOR = 1.0
DISTANCE TO COMPLIANCE POINT = 30.5 m
BULK DENSITY = 1.50 g/cm^3
POROSITY = .25
SOIL FOC= .0010
AQUIFER FOC = .0010
SOIL MOISTURE CONTENT = .15
MOISTURE FLUX THROUGH WASTE CELL= .70E-02 cm/day
MOISTURE FLUX OUTSIDE WASTE CELL= .70E-02 cm/day
GROUNDWATER VELOCITY = 10.00 cm/day
DIFFUSION LAYER THICKNESS = .50 cm
DEPTH OF INCORPORATION = 10.000 m
RELEASE WIDTH = 10.0 m
AIR DIFFUSION COEF. = .7000E+04 cm^2/day
WATER DIFFUSION COEF. = .7000E+00 cm^2/day
INITIAL CONTAMINANT CONCENTRATION IN SOIL = 1 ug/cm^3

VADOSE-ZONE TIME TO PEAK = .3416E+04 DAYS
VADOSE-ZONE PEAK CONCENTRATION = .7678E+01 ug/L
SATURATED-ZONE TIME TO PEAK = .4003E+04 DAYS
SATURATED-ZONE PEAK CONCENTRATION = .1301E+01 ug/L
CELL THICKNESS AT COMPLIANCE POINT = 11.2 cm
CELL GPL = .4658E+04 mg/kg

GPL = .3410E+06 mg/kg
(adjusted for .820E+01m perforated interval)

Alternative GPLs for Trichloroethane



Soil Res. HBGL = 11,000 mg/kg
Soil Non-Res. HBGL = 38,600 mg/kg

Note: Based on meeting the 1,1-DCE AWQS of 7 ug/l. Degradation of 1,1,1-TCA to 1,1-DCE is assumed to occur at the water table.

9/25/96

Alternative GPLs for 1,1,1-TRICHLOROETHANE

(Numbers in table are GPLs in mg/kg)

Depth to Water (m)	Depth of Incorporation (m)					
	5m	10m	20m	30m	40m	50m
0m						
10m	4.4	1.06				
20m	16.7	4.3	1.05			
30m	36	9.4	2.43	1.04		
40m	64.2	16.6	4.3	1.96	1.04	
50m	102	26.6	7	3.2	1.77	1.04
60m	155	40	10.5	4.8	2.71	1.69
70m	224	58	15.2	6.96	3.95	2.48
80m	317	81.7	21.5	9.83	5.58	3.54
90m	438	113	29.7	13.6	7.74	4.9
100m	596	154	40.5	18.6	10.6	6.72

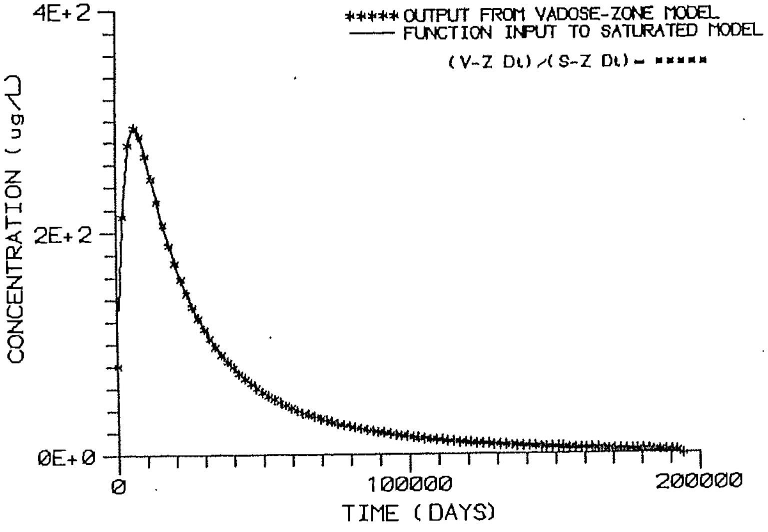
Half-Life = 100,000 days

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

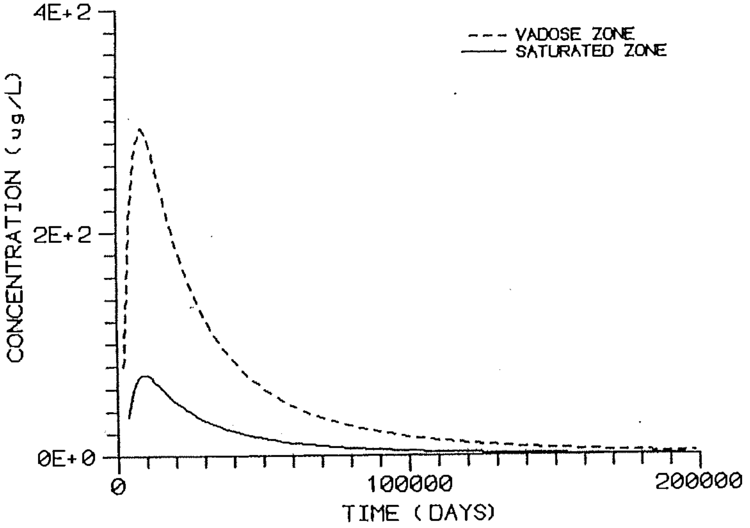
GROUNDWATER PROTECTION LEVEL MODEL

9/25/96 --

LIQUID-PHASE CONCENTRATION VS TIME
(CORRECTED TO INITIAL BREAKTHROUGH)



LIQUID-PHASE CONCENTRATION VS TIME
FOR VADOSE-ZONE AND SATURATED-ZONE MODELS



SITE NAME / ID ____________________

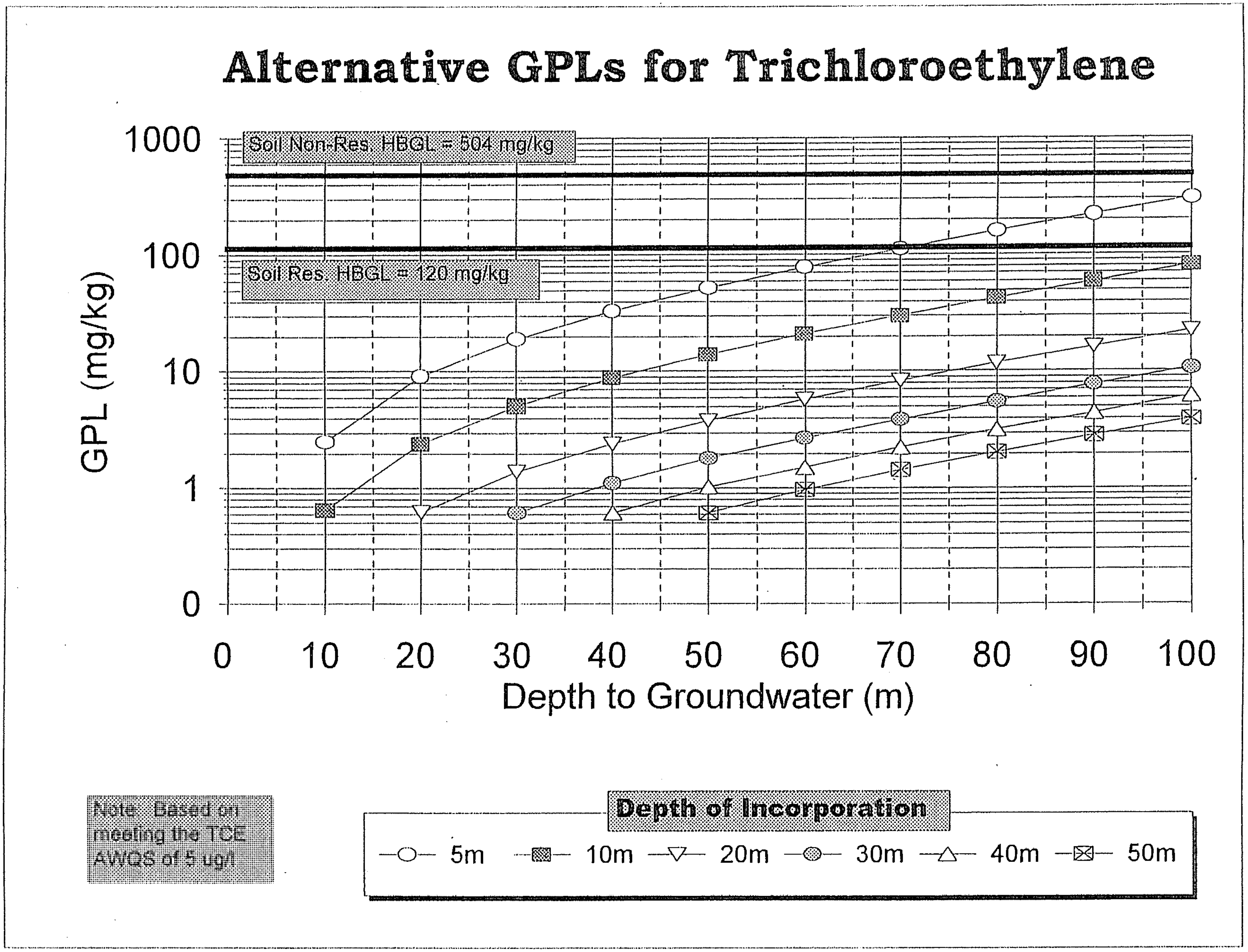
TCA/DCE

KOC = .1520E+03 cm^3/g
KH = .5600E+00
HALF-LIFE (IN VADOSE ZONE) = .10E+06 days
HALF-LIFE (IN SATURATED ZONE) = .10E+06 days
GROUNDWATER STANDARD = 7.0000 ug/L
SOIL HEALTH-BASED GUIDANCE LEVEL = 4000.00 mg/kg

DEPTH TO GROUNDWATER = 20.0 m
AQUIFER MIXING-CELL FACTOR = 1.0
DISTANCE TO COMPLIANCE POINT = 30.5 m
BULK DENSITY = 1.50 g/cm^3
POROSITY = .25
SOIL FOC= .0010
AQUIFER FOC = .0010
SOIL MOISTURE CONTENT = .15
MOISTURE FLUX THROUGH WASTE CELL= .70E-02 cm/day
MOISTURE FLUX OUTSIDE WASTE CELL= .70E-02 cm/day
GROUNDWATER VELOCITY = 10.00 cm/day
DIFFUSION LAYER THICKNESS = .50 cm
DEPTH OF INCORPORATION = 10.000 m
RELEASE WIDTH = 10.0 m
AIR DIFFUSION COEF. = .7000E+04 cm^2/day
WATER DIFFUSION COEF. = .7000E+00 cm^2/day
INITIAL CONTAMINANT CONCENTRATION IN SOIL = 1 ug/cm^3

VADOSE-ZONE TIME TO PEAK = .8063E+04 DAYS
VADOSE-ZONE PEAK CONCENTRATION = .2933E+03 ug/L
SATURATED-ZONE TIME TO PEAK = .8688E+04 DAYS
SATURATED-ZONE PEAK CONCENTRATION = .7292E+02 ug/L
CELL THICKNESS AT COMPLIANCE POINT = 11.2 cm
CELL GPL = .5818E-01 mg/kg

GPL = .4259E+01 mg/kg
(adjusted for .820E+01m perforated interval)


Alternative GPLs for Trichloroethylene
Soil Non-Res. HBGL = 504 mg/kg
Soil Res. HBGL = 120 mg/kg
GPL (mg/kg)
1000
100
10
1
0
0
10
20
30
40
50
60
70
80
90
100
Depth to Groundwater (m)
Note: Based on meeting the TCE AWQS of 5 ug/l
Depth of Incorporation
5m
10m
20m
30m
40m
50m

Alternative GPLs for TRICHLOROETHYLENE

(Numbers in table are GPLs in mg/kg)

Depth to Water (m)	**Depth of Incorporation (m)**					
	5m	**10m**	**20m**	**30m**	**40m**	**50m**
0m						
10m	2.6	0.64				
20m	9	2.4	0.61			
30m	19	5	1.37	0.61		
40m	33	8.7	2.4	1.1	0.61	
50m	51.9	13.8	3.8	1.8	1.01	0.61
60m	77.6	20.6	5.7	2.7	1.5	0.97
70m	112	29.8	8.2	3.87	2.24	1.43
80m	159	42.2	11.6	5.48	3.17	2.04
90m	221	58.7	16.1	7.62	4.42	2.84
100m	303	80.6	22.2	10.5	6.08	3.92

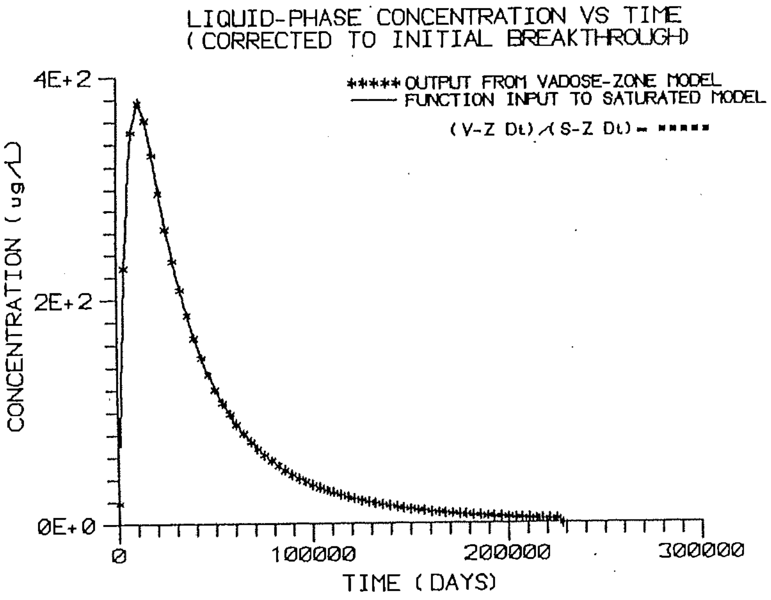
Half-Life = 100,000 days

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

GROUNDWATER PROTECTION LEVEL MODEL

9/25/96 --

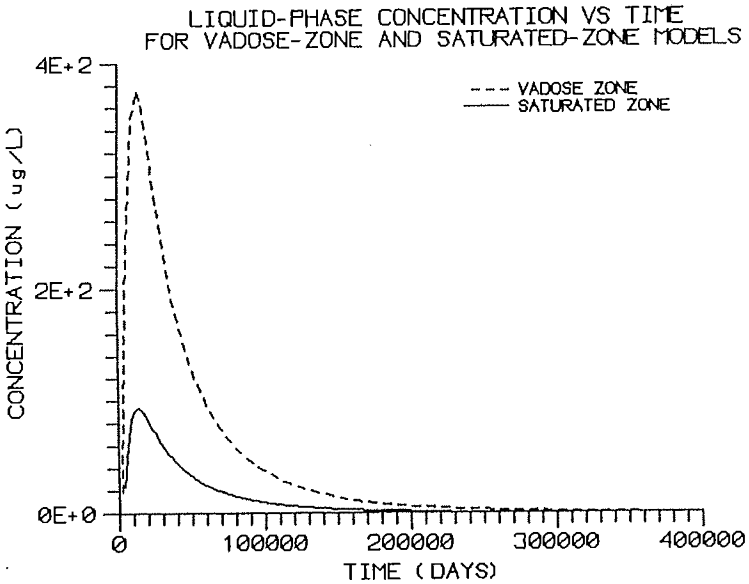
SITE NAME / ID ______________________


LIQUID-PHASE CONCENTRATION VS TIME
(CORRECTED TO INITIAL BREAKTHROUGH)

TRICHLOROETHYLENE

KOC = .1260E+03 cm^3/g
KH = .3000E+00
HALF-LIFE (IN VADOSE ZONE) = .10E+06 days
HALF-LIFE (IN SATURATED ZONE) = .10E+06 days
GROUNDWATER STANDARD = 5.0000 ug/L
SOIL HEALTH-BASED GUIDANCE LEVEL = 120.00 mg/kg

DEPTH TO GROUNDWATER = 20.0 m
AQUIFER MIXING-CELL FACTOR = 1.0
DISTANCE TO COMPLIANCE POINT = 30.5 m
BULK DENSITY = 1.50 g/cm^3
POROSITY = .25
SOIL FOC= .0010
AQUIFER FOC = .0010
SOIL MOISTURE CONTENT = .15
MOISTURE FLUX THROUGH WASTE CELL= .70E-02 cm/day
MOISTURE FLUX OUTSIDE WASTE CELL= .70E-02 cm/day
GROUNDWATER VELOCITY = 10.00 cm/day
DIFFUSION LAYER THICKNESS = .50 cm
DEPTH OF INCORPORATION = 10.000 m
RELEASE WIDTH = 10.0 m
AIR DIFFUSION COEF. = .7000E+04 cm^2/day
WATER DIFFUSION COEF. = .7000E+00 cm^2/day
INITIAL CONTAMINANT CONCENTRATION IN SOIL = 1 ug/cm^3

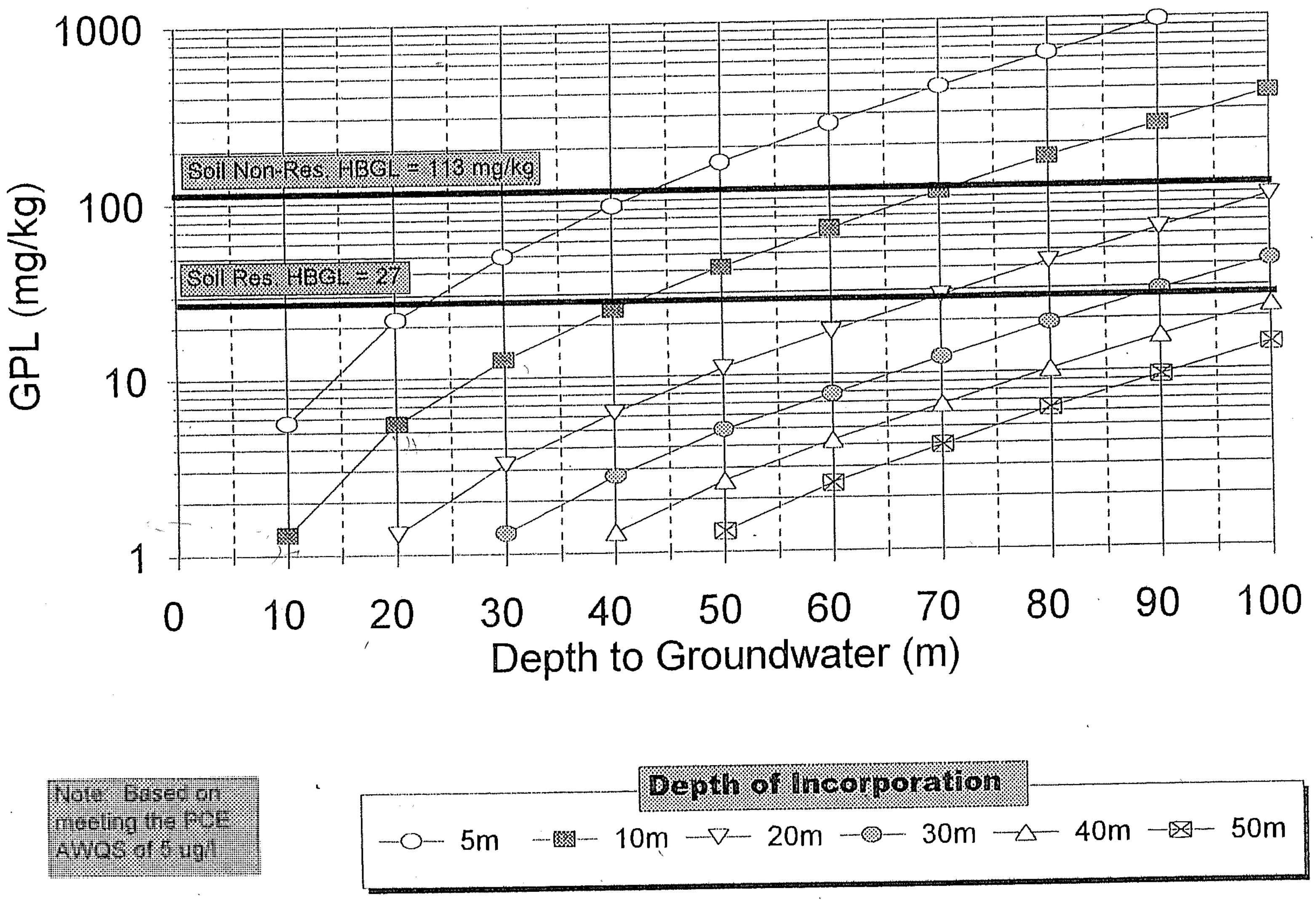

LIQUID-PHASE CONCENTRATION VS TIME
FOR VADOSE-ZONE AND SATURATED-ZONE MODELS

VADOSE-ZONE TIME TO PEAK = .1250E+05 DAYS
VADOSE-ZONE PEAK CONCENTRATION = .3762E+03 ug/L
SATURATED-ZONE TIME TO PEAK = .1308E+05 DAYS
SATURATED-ZONE PEAK CONCENTRATION = .9361E+02 ug/L
CELL THICKNESS AT COMPLIANCE POINT = 11.2 cm
CELL GPL = .3237E-01 mg/kg

GPL = .2370E+01 mg/kg
(adjusted for .820E+01m perforated interval)

9/25/96

Alternative GPLs for Tetrachloroethylene



Alternative GPLs for TETRACHLOROETHYLENE

(Numbers in table are GPLs in mg/kg)

Depth to Water (m)	Depth of Incorporation (m)					
	5m	10m	20m	30m	40m	50m
0m						
10m	5.6	1.3				
20m	21.5	5.5	1.3			
30m	49	12.7	3.2	1.3		
40m	93.4	24	6.2	2.7	1.3	
50m	161	41.4	11	4.7	2.5	1.3
60m	263	67.7	17.5	7.7	4.2	2.4
70m	415	107	27.6	12.2	6.6	4
80m	638	164	42.4	18.9	10.3	6.2
90m	966	249	64.2	28.6	15.6	9.4
100m	1444	372	95.9	43	23.3	14.1

Half-Life = 100,000 days

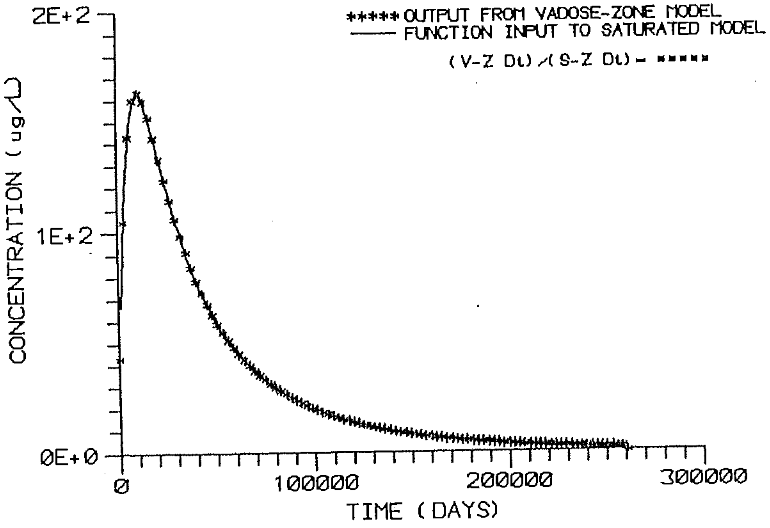
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

GROUNDWATER PROTECTION LEVEL MODEL

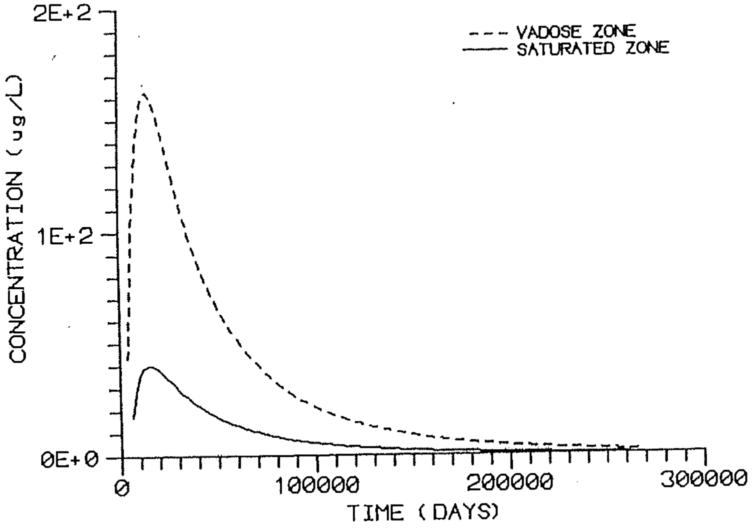
9/25/96 --

SITE NAME / ID ______________________

LIQUID-PHASE CONCENTRATION VS TIME
(CORRECTED TO INITIAL BREAKTHROUGH)



LIQUID-PHASE CONCENTRATION VS TIME
FOR VADOSE-ZONE AND SATURATED-ZONE MODELS



TETRACHLOROETHYLENE

KOC = .3640E+03 cm^3/g
KH = .5450E+00
HALF-LIFE (IN VADOSE ZONE) = .10E+06 days
HALF-LIFE (IN SATURATED ZONE) = .10E+06 days
GROUNDWATER STANDARD = 5.0000 ug/L
SOIL HEALTH-BASED GUIDANCE LEVEL = 64.00 mg/kg

DEPTH TO GROUNDWATER = 20.0 m
AQUIFER MIXING-CELL FACTOR = 1.0
DISTANCE TO COMPLIANCE POINT = 30.5 m
BULK DENSITY = 1.50 g/cm^3
POROSITY = .25
SOIL FOC= .0010
AQUIFER FOC = .0010
SOIL MOISTURE CONTENT = .15
MOISTURE FLUX THROUGH WASTE CELL= .70E-02 cm/day
MOISTURE FLUX OUTSIDE WASTE CELL= .70E-02 cm/day
GROUNDWATER VELOCITY = 10.00 cm/day
DIFFUSION LAYER THICKNESS = .50 cm
DEPTH OF INCORPORATION = 10.000 m
RELEASE WIDTH = 10.0 m
AIR DIFFUSION COEF. = .7000E+04 cm^2/day
WATER DIFFUSION COEF. = .7000E+00 cm^2/day
INITIAL CONTAMINANT CONCENTRATION IN SOIL = 1 ug/cm^3

VADOSE-ZONE TIME TO PEAK = .1430E+05 DAYS
VADOSE-ZONE PEAK CONCENTRATION = .1630E+03 ug/L
SATURATED-ZONE TIME TO PEAK = .1522E+05 DAYS
SATURATED-ZONE PEAK CONCENTRATION = .4046E+02 ug/L
CELL THICKNESS AT COMPLIANCE POINT = 11.2 cm
CELL GPL = .7490E-01 mg/kg

GPL = .5484E+01 mg/kg
(adjusted for .820E+01m perforated interval)

IV. SCREENING APPROACH FOR INORGANIC CONTAMINANTS

Screening levels were developed for metals with AWQS using a simplified approach based on a mixing cell model and the ratio between the site-specific total and leachable metal concentrations. See Appendix C for a detailed explanation. This simplified approach was used because of the complex nature of modeling fate and transport of metals in the vadose zone. The input parameter values are the same as those used in the organic contaminant modeling. Calculations show that the Residential HBGL is sufficient to protect groundwater quality for five metals (arsenic, barium, beryllium, chromium and thallium). The Non-Residential HBGL for arsenic and beryllium is also protective of groundwater quality. For other metals, soil concentrations needed to protect groundwater quality were developed.

The screening approach for inorganics incorporates three steps and is similar to that for organic contaminants. Figure 1 is a flow diagram showing the steps in the screening process.

Step 1

The initial screening step determines whether the metal of concern at the site poses a threat to groundwater quality. Minimum GPLs are provided (Table 4) that represent soil contaminant concentrations protective of groundwater quality in a "worst-case" situation - where all the metals in the soil leach completely to groundwater regardless of the depth to groundwater. If the Minimum GPL is less than the HBGL, the Minimum GPL may be used as the alternative soil cleanup standard if the party performing the remedial action chooses not to undertake further site characterization.

Step 2

If the Minimum GPL is less than the HBGL and the party chooses not to use the Minimum GPL as the soil cleanup standard, a second screening level is available. This step requires site-specific information on the relationship between the total metals concentration in the contaminated soil and the leachable fraction of that metal determined using either EPA Method 1311 Toxicity Characteristic Leaching Procedure (TCLP), EPA Method 1312 Synthetic Precipitation Leaching Procedure (SPLP) or an alternative approved leaching procedure appropriate for site conditions. If sufficient site-specific data have been collected to determine the ratio between the total metals concentration and leachate concentration, an Alternative GPL may be calculated using the following equation:

$$X_s = (292.9)RC_w$$

R is defined as the ratio between the total metals content in a soil and the TCLP or SPLP leachate result. C_w is the maximum groundwater concentration in the mixing cell across the perforated interval of the monitor well and is equivalent to the AWQS. The constant, 292.9, results from calculations involving the mixing cell dimensions, groundwater flow rate and infiltration rate for the base case conditions. X_s represents the maximum allowable total metals concentration in soil which achieves protection of groundwater quality.

Consider the following example for six soil samples tested for chromium at a site:

	SAMPLE #1	SAMPLE #2	SAMPLE #3	SAMPLE #4	SAMPLE #5	SAMPLE #6
Total (mg/kg)	78	103	8.5	1900	100	550
Leachable (mg/l)	1.8	1.9	ND	4	3	8
R	43.3	54.2	∞	475	33.3	68.8

For this set of samples, R=33.3 would be selected because it represents the most severe leaching potential determined at the site. Based on this R-value, an Alternative GPL of 980 mg/kg would be calculated for the site, replacing the otherwise applicable Minimum GPL of 590 mg/kg.

Step 3

A third screening level is provided to allow determination of a soil cleanup standard protective of groundwater quality based entirely on site-specific characteristics. This option entails collecting and documenting site-specific data and calculating a soil cleanup level using a vadose zone fate-and-transport model. It is recommended that the selected model be pre-approved by ADEQ. This third option may be chosen without carrying out the first two steps.

Data Requirements

If the Minimum GPL is not used as the cleanup standard for inorganic constituents, sampling of the vadose zone must be conducted at a site to develop the total metals/leachable metals ratio required to calculate an Alternative GPL. A leaching analysis is required only for a representative number of these samples. A sampling and analysis plan designed to meet site-specific needs should be prepared. The minimum data necessary to apply the inorganic screening include the results of laboratory chemical analyses for the inorganic constituents of concern at the site. However, if there is any doubt that a site would not pass the initial screening steps, design of the sampling program should also consider collection of additional data needed to perform site-specific modeling. Redundant field investigations can be avoided if collection of these additional data is not postponed to a later time.

Table 4. Minimum GPLs for Metals

Metal	**Minimum GPL, X_{20} (mg/kg)**	Residential HBGL (mg/kg)	Non-Residential HBGL (mg/kg)
Antimony	**35**	47*	165*
Arsenic	**290**	0.91	3.82
Barium	**12,000**	8200	28,700*
Beryllium	**23**	0.32	1.34
Cadmium	**29**	58*	244*
Chromium	**590**	580	2436*
Lead	**290**	400*	1400*
Mercury	**12**	35*	123*
Nickel	**590**	2300*	8050*
Selenium	**290**	580*	2030*
Thallium	**12**	8.2	28.7*

* HBGL is not sufficiently low to prevent groundwater contamination

NOTE: Minimum GPLs have been rounded to two significant digits.

APPENDIX A

DESCRIPTION OF APPROACH FOR ORGANIC CONTAMINANTS

A-I. CONCEPTUAL MODEL FOR ORGANIC CONTAMINANTS

The conceptual model for transport of organic compounds in the vadose zone was developed to be as simple and straightforward as possible, without neglecting the important conditions and processes that affect transport of organic compounds through the vadose zone. A simple conceptual model can be applied to a large number of sites with different characteristics, whereas input data required for more complex vadose zone transport models can be difficult or expensive to attain and may not substantially increase the accuracy of the modeling results.

The conceptual model is based on hydrogeologic characteristics common to unconsolidated sediments in the alluvial basins of Arizona. The conceptual model, and therefore the screening levels developed via vadose zone transport modeling, may not be appropriate for sites where the vadose zone consists chiefly of consolidated rock. The conceptual model comprises two distinct units, the vadose zone and the saturated zone.

Screening levels for organic compounds in soil were developed based on modeling the transport of organic compounds through the vadose zone and saturated zone to a downgradient groundwater compliance point (groundwater monitoring well). Screening levels consist of concentrations of organic compounds detected in soil in the vadose zone that are projected to result in concentrations in groundwater at the compliance point equal to the AWQS for those compounds. Screening levels for organic compounds are variable, depending on mobility of the compound, depth of occurrence of the compound in the vadose zone, and the depth to groundwater below land surface.

A. <u>Conceptual Model for the Vadose Zone</u>

The conceptual model for the vadose zone is a single layer of unconsolidated, poorly sorted, basin-fill deposits consisting chiefly of sand and silt. Organic compounds are assumed to occur in the vadose zone from land surface to some depth. The chief processes assumed to affect transport of organic compounds in the vadose zone conceptual model are: 1) advection of organic compounds dissolved in recharge water, which moves downward through the vadose zone and eventually reaches the groundwater table (dissolved-phase advection); 2) diffusion of organic compounds in the vapor phase (vapor-phase diffusion); 3) adsorption of organic compounds to solid-phase organic carbon (solid-phase adsorption); and 4) degradation of organic compounds. The presence and movement of non-aqueous phase liquids (NAPLs) are not included in the conceptual model.

DISSOLVED-PHASE ADVECTION: One of the important processes for downward transport of organic compounds in the vadose zone is dissolved-phase advection. Infiltration of precipitation at land surface results in a small amount of water moving downward through the vadose zone and eventually reaching the saturated zone. The rate of water movement in the vadose zone is very slow; recharge to the saturated zone from precipitation infiltrating at land surface may require many years. As the water slowly moves downward, organic compounds may evaporate out of this water phase or adsorb to the solid phase according to partitioning relationships between organic compound concentrations in the dissolved phase, the vapor phase, and the solid phase. Because water movement in the vadose zone is slow, the partitioning relationships are assumed to be equilibrium relationships. These equilibrium relationships are incorporated into the conceptual model.

VAPOR-PHASE DIFFUSION: Another important process for transport of organic contaminants, particularly volatile organic compounds (VOCs), in the vadose zone is vapor-phase diffusion. VOCs diffuse in the vapor phase in all directions from zones of higher VOC concentrations to zones of lower VOC concentrations. For simplification, the conceptual model is limited to one dimension and, therefore, only considers movement upward and downward. Unlike diffusion of solutes in groundwater, vapor-phase diffusion of VOCs can be relatively rapid. Because concentrations of VOCs in the atmosphere above land surface are essentially maintained at zero, the atmosphere functions as an "infinite sink" for VOCs and provides a constant upward gradient for vapor-phase diffusion.

SOLID-PHASE ADSORPTION: The mobility of solutes in the vadose zone is affected by solid-phase adsorption. Because adsorption of organic compounds from the dissolved phase to the solid phase is generally considered to occur chiefly to the organic carbon fraction of the solid phase sediments, the conceptual model only considers the fraction of organic carbon for solid-phase adsorption. The Freundlich sorption model, with a linear adsorption isotherm for partitioning of dissolved-phase organic compounds to solid-phase organic carbon, is appropriate for the hydrogeologic conditions and organic compounds considered in the conceptual model.

DEGRADATION: Many organic compounds undergo some degree of degradation, usually biodegradation, in the vadose zone. Degradation reactions may transform toxic organic compounds into non-toxic components or other toxic compounds. Rates of biodegradation of organic compounds in the vadose zone are described using first-order decay equations and appropriate degradation half-lives for the modeled compounds.

B. Conceptual Model for the Saturated Zone

The conceptual model for the saturated zone is a single aquifer or aquifer zone dominated by horizontal flow, with a groundwater compliance point located 100 feet downgradient from the source of organic compounds in the vadose zone. Organic compounds are assumed to enter the saturated zone solely from the vadose zone. The principal process assumed to affect transport of organic compounds in the saturated zone is advective-dispersive transport. A typical application for groundwater flow modeling may include advective-dispersive transport and diffusive transport of dissolved constituents. However, due to the short distance between the point of entry of organic compounds to the saturated zone and the groundwater compliance point, the simulation of solute transport in groundwater can be simplified. Therefore, the conceptual model for transport processes in groundwater comprises a mixing zone in which organic compounds reaching the groundwater table from the vadose zone mix instantaneously with the groundwater.

A-II. MODEL SELECTION

After an initial screening of available models, the Working Group further evaluated three vadose zone transport modeling programs for potential use in developing the proposed screening levels: SESOIL, VLEACH, and the ADEQ model, which is a computer code based on Dr. William Jury's well-documented and accepted Behavior Assessment Model. All of these models simulate the principal organic chemical transport processes that occur in the vadose zone. The principal conclusions from comparison of the models are summarized as follows:

1. SESOIL has been used as a screening tool by several other states, including California, Wisconsin, and Massachusetts. SESOIL and VLEACH have been extensively reviewed and approved for use at several hazardous waste sites to evaluate threats to groundwater of vadose zone contaminants. The ADEQ model was recently developed by ADEQ and has not been as extensively tested or reviewed, but the ADEQ model is based on the reviewed and tested theories and methods developed by Dr. Jury, who is widely recognized as an expert in vadose zone transport processes and modeling.

2. The "state-of-the-art" in vadose zone transport modeling is not as well developed as for groundwater modeling, and the flow and transport processes for the vadose zone are more difficult to measure and to simulate than for groundwater. SESOIL is the most complex of the three models and is more versatile than VLEACH or the ADEQ model, but requires more site-specific input parameters and assumptions about vadose zone conditions. Because vadose zone conditions vary substantially from site to site and because site conditions are not likely to be characterized completely, results from a relatively complex model, such as SESOIL, may not be more accurate or representative of actual transport processes than results from a simpler model. Therefore, a simple vadose zone transport model may be as suitable or more suitable than a complex model for the screening process.

3. The ADEQ model includes a groundwater model and was developed specifically to compute concentrations for organic compounds in soil based on simulated concentrations of organic compounds in groundwater. The ADEQ model calculates a groundwater protection level (GPL) that is the maximum soil concentration that will not cause an AWQS to be exceeded at a specified point of compliance in the aquifer. SESOIL and VLEACH are vadose zone transport models that do not include groundwater models. Numerous trial-and-error model runs must be conducted using SESOIL or VLEACH to develop a single vadose zone screening level. Therefore, the ADEQ model is much easier and faster to use for the development of vadose zone screening levels.

Based on the suitability of the ADEQ model for simulating the critical vadose zone and groundwater transport processes and based on the ease of use, the Leachability Working Group selected the ADEQ model to develop vadose zone screening levels for organic compounds. The ADEQ model, which was first developed in June 1993 and has been modified only slightly since then, is available at no charge from ADEQ; no license is required to use or copy the ADEQ model. However, the ADEQ model incorporates links to a commercial program, GRAPHER, into the code. Therefore, ownership of a licensed copy of GRAPHER is a prerequisite to possession or use of the ADEQ model.

A-III. ASSIGNMENT OF MODEL INPUT PARAMETER VALUES

The model input parameters were selected to be reasonable and without bias regarding effects on resulting screening levels. The Working Group agreed that using conservative values for every input parameter would be inappropriate because effects of multiple biased input parameters tend to be multiplicative and would result in projected screening levels several orders of magnitude smaller than necessary to protect groundwater resources. Three general categories of model input parameters are required for the ADEQ model: 1) vadose zone input parameters; 2) groundwater input parameters; and 3) chemical input parameters.

A. Vadose Zone Input Parameters

DEPTH TO GROUNDWATER AND DEPTH OF INCORPORATION: The relationship between depth to groundwater and depth of incorporation (maximum depth where concentrations of organic compounds meet or exceed Minimum GPLs in the vadose zone) was found to be a critical site-specific variable. Therefore, for each organic compound, graphs of screening levels were developed based on the input of several values to the ADEQ model for depth to groundwater and depth of contaminant incorporation.

These graphs provide a method for determining "site-specific" screening levels based on the actual depth of occurrence of organic compounds and depth to groundwater at a site. Only these two vadose zone parameters were varied during modeling to develop the screening levels.

RELEASE WIDTH: The release width is the horizontal dimension of the contaminated zone parallel to the direction of groundwater movement. The value for release width input to the model was 10 meters (33 feet). This width is considered to be typical of most accidental releases of organic compounds (underground storage tank leaks, for example).

BULK DENSITY OF SOIL: The value input to the model for dry bulk soil density was 1.5 grams per cubic centimeter (g/cm^3). Bulk densities for basin-fill deposits typically are in the range from 1.3 to 1.8 g/cm^3. Therefore, 1.5 g/cm^3 is considered to be a reasonable value for model soil bulk density.

POROSITY OF SOIL: Porosity is used in model calculations for: (1) average interstitial groundwater velocity in the saturated zone; (2) contaminant mass partitioning to the vapor and dissolved phases in the vadose zone; and (3) vapor-phase diffusive flux in the vadose zone. A single porosity value is input to the model; no distinction is made in the model between total porosity and effective porosity. The value input to the model for soil porosity was 25 percent. Porosities for basin-fill deposits typically are in the range from 20 to 35 percent. Therefore, 25 percent is considered to be a reasonable value for model soil porosity.

FRACTION OF ORGANIC CARBON IN SOIL: The value input to the model for fraction of organic carbon in soil was 0.001 (0.1 percent). Organic carbon fractions in basin-fill deposits are very small and typically are in the range from 0.0005 to 0.005. Therefore, 0.001 is considered to be a reasonable value for model fraction of organic carbon.

VOLUMETRIC MOISTURE CONTENT: The value input to the model for volumetric moisture content of soil was 15 percent. Volumetric moisture contents in basin-fill deposits typically are in the range from 5 to 25 percent. Therefore, 15 percent is considered to be a reasonable value for model soil moisture content.

RECHARGE RATE: This parameter is variable and difficult to measure; therefore, a conservative recharge rate was intentionally selected to yield conservative soil screening levels. The model requires input of two infiltration rates--one for the contaminated area and one for the area between the contaminated area and the downgradient compliance point. However, a single value of 0.007 cm/day (1 inch per year) was input to the model for both recharge variables. Diffuse recharge rates for desert alluvial basins of the Southwest are believed to be less than about 0.0035 cm/day (0.5 in/yr). Rates of recharge at mountain fronts and in stream channels likely are generally larger than diffuse recharge rates. The model's recharge rate of 0.007 cm/day is larger than most estimates of recharge rate for desert alluvial basins.

DIFFUSION LAYER THICKNESS: The model simulates mass transfer from the gas phase in the vadose zone to the atmosphere using a diffusion layer. The value input to the model for diffusion layer thickness was 0.5 cm (0.2 in). The Working Group adopted the same numerical value used by Jury in his Behavior Assessment Model.

B. Groundwater Input Parameters

DISTANCE TO MONITOR WELL (GROUNDWATER COMPLIANCE POINT): The horizontal distance from the point of vadose zone contamination to the downgradient groundwater compliance point input to the model was set at 30.5 meters (100 feet). This distance is consistent with a variety of setbacks established in environmental regulations (such as the distance a septic tank must be set back from a domestic well), and likely is as close to a waste site as a drinking-water well would be constructed.

AQUIFER MIXING CELL FACTOR: Aqueous dispersion of organic compounds in groundwater is crudely simulated in the model by an aquifer mixing cell factor. This factor increases the vertical thickness of successive mixing cells used by the model to simulate transport of organic compounds in the aquifer. The aquifer mixing cell factor input to the model was 1.0; therefore, each mixing cell increases in thickness equivalent to the amount of recharge impinging on the mixing cell during each time step. Further discussion of the aquifer mixing cell factor is presented in Appendix B. It should be noted that due to the small recharge rate and the relatively large monitor well perforated interval input to the ADEQ model, only an unreasonably large increase in the aquifer mixing cell factor affects model results.

FRACTION OF ORGANIC CARBON IN THE AQUIFER: The value input to the model for fraction of organic carbon in the aquifer was 0.001 (0.1 percent). Organic carbon fractions in Arizona's basin-fill deposits are very small and typically are in the range from 0.0005 to 0.005. Therefore, 0.001 is considered to be a reasonable value for model fraction of organic carbon.

AVERAGE LINEAR GROUNDWATER VELOCITY: The average linear velocity--not Darcian velocity or specific discharge--input to the model was 10 cm/day (120 ft/yr). Groundwater velocities in aquifers in Arizona's basin-fill deposits range widely, but are commonly in the range from about 1 to 100 cm/day. Therefore, 10 cm/day is considered to be a reasonable order-of-magnitude value for groundwater velocity.

PERFORATED INTERVAL OF MONITOR WELL: The perforated interval of the downgradient groundwater monitor well (compliance point) input to the model was set at 8.2

meters (27 feet). A perforated interval of 5 to 10 meters (15 to 30 feet) is typical for groundwater monitor wells in Arizona's basin-fill aquifers. Therefore, 8.2 meters is believed to be a reasonable value for the perforated interval of the downgradient groundwater monitor well. The perforated interval is directly proportional to resultant screening levels; for example, if the perforated interval input to the model were doubled to 16.4 meters (54 feet), all soil screening levels also would double.

GROUNDWATER STANDARD: The model requires input of the groundwater standard that must be achieved at the compliance point. The model uses the AWQSs, which are identical to EPA MCLs for drinking water. The model calculates maximum soil concentrations of organic compounds that will result in groundwater concentrations equal to the groundwater standards.

SOIL HEALTH-BASED GUIDANCE LEVEL (HBGL): This parameter is input solely for reference purposes, to compare the HBGL with the screening level projected by the model. This parameter is not used in any model calculations.

C. Chemical Input Parameters

The ADEQ model requires the input of several parameters for each organic compound modeled. Chemical-specific values for these parameters are available in standard reference literature; values from reference literature were input to the model for organic-carbon partitioning coefficient (K_{OC}) and Henry's constant (K_H), and are summarized later in this report.

Values for aqueous diffusion coefficient and free-air diffusion coefficient in water also are required. For the compounds modeled, the variation in these values is small and has little effect on model results. Therefore, a single value for each of these parameters was input to the ADEQ model for all of the organic compounds modeled.

AQUEOUS DIFFUSION COEFFICIENT: The model input value for aqueous diffusion coefficient for organic compounds was 0.7 cm^2/day. Reported values for aqueous diffusion coefficient for most of the organic compounds modeled are in the range from about 0.6 to 0.9 cm^2/day. It should be noted that the ADEQ model is nearly insensitive to the value input for aqueous diffusion coefficient.

FREE-AIR DIFFUSION COEFFICIENT: The model input value for free-air diffusion coefficient for organic compounds was 7,000 cm^2/day. Reported values for free-air diffusion coefficient for most of the organic compounds modeled are in the range from about 6,000 to 9,000 cm^2/day.

<u>DEGRADATION HALF-LIFE:</u> The model input value for the degradation half-life for benzene, toluene, ethylbenzene, and xylene (BTEX compounds) was 1,000 days (2.7 years). These compounds are present in fuels and, therefore, are among the most common organic compounds released in the vadose zone. The model input value for degradation half-life for the other organic compounds, most of which are chlorinated, was 100,000 days (270 years). Reported degradation half-lives for BTEX compounds in laboratory studies are generally less than 1,000 days, and reported degradation half-lives for the other organic compounds range from 100 to over 10,000 days. It should be noted that degradation half-lives vary substantially, are highly dependent on local site conditions, and are difficult to determine in the field. In addition, many chlorinated organic compounds are very persistent or degrade to other toxic compounds. Therefore, a 1,000-day degradation half-life for BTEX compounds and a 100,000-day degradation half-life for the other organic compounds modeled are considered to be conservative input values for the model. The degradation half-life is the most sensitive factor in affecting the model results.

Table A-1. Sorption and Volatilization Constants Used in Developing GPLs

	Soil Organic Carbon Partition Coefficient, K_{oc}	Dimensionless Henry's Law Constant, K_H
Benzene	64.5	0.221
Carbon Tetrachloride	439	0.96
o-Dichlorobenzene	186	0.050
para-Dichlorobenzene	158	0.13
1,2 Dichloroethane	14	0.038
1,1 Dichloroethylene	65	0.87
cis-1,2-Dichloroethylene	49	0.12
trans-1,2-Dichloroethylene	59	0.22
1,2-Dichloropropane	27	0.096
Ethylbenzene	95	0.27
Monochlorobenzene	330	0.15
Styrene	741	0.019
Tetrachloroethylene (PCE)	364	0.545
Toluene	257	0.269
Trihalomethanes (Total)	44	0.12
1,1,1,-Trichloroethane (TCA)	152	0.56
Trichloroethylene (TCE)	126	0.3
Xylenes (Total)	129	0.256
Alachlor	**101.7**	**8.31×10^{-7}**
Atrazine	**38.5**	**1.03×10^{-7}**
Carbofuran	95.4	**4.4×10^{-8}**
1,2-Dibromo-3-chloropropane (DBCP)	126	0.0104
Ethylene dibromide (EDB)	44	0.104

Endrin	34,000	3.13×10^{-4}
Lindane	1388	7.52×10^{-5}
2,4-Dichlorophenoxyacetic acid (2,4-D)	30.5	0.811
Trichlorophenoxypropionic acid (2,4,5-TP or Silvex)	2600	5.45×10^{-7}

Bolded data were supplied to ADEQ by pesticide manufacturers. All other K_{oc} and K_H values are from general groundwater chemical references.

A-IV. MODEL REVIEW AND VERIFICATION

The ADEQ model code was peer reviewed by Dr. William A. Jury. In addition, the results of ADEQ model simulations were compared to Jury's Behavior Assessment Model results. The comparison indicated that the model yielded identical results to the Behavior Assessment Model under the selected conditions.

The Leachability Working Group conducted verification simulations to compare soil screening levels projected by the ADEQ model for eight VOCs to soil screening levels developed by the Massachusetts Department of Environmental Protection (MDEP) using SESOIL and AT123D (a simple groundwater transport model). Results of the MDEP's work are presented in ***"BACKGROUND DOCUMENTATION FOR THE DEVELOPMENT OF THE MCP NUMERICAL STANDARDS,"*** published by the MDEP in April 1994. Where possible, input parameters similar to those used by MDEP were input into the ADEQ model, although the modeling procedures and input requirements for SESOIL are substantially different from those required for the ADEQ model. Despite the different formats used by SESOIL and the ADEQ model, soil screening levels projected by the two models are similar. The VOCs compared and the screening levels projected by each model are summarized as follows:

COMPOUND	PROJECTED SCREENING LEVEL (micrograms per kilogram) SESOIL	PROJECTED SCREENING LEVEL (micrograms per kilogram) ADEQ MODEL
Benzene	280	222
Ethylbenzene	84,800	70,600
Toluene	80,600	88,000
o-Xylene	833,300	781,100
Trichloroethene (TCE)	380	318
Tetrachloroethene (PCE)	430	290
Trichloroethane (TCA)	33,800	30,100
Naphthalene	62,200	32,300

In summary, results of review and verification of the ADEQ model indicate that it adequately simulates the chief vadose zone transport processes and it produces results comparable to those generated by a widely-accepted model (BAM) and an EPA-approved model (SESOIL). Therefore, the ADEQ model is acceptable for the purpose of developing screening levels for organic compounds in the vadose zone.

A-V. SENSITIVITY ANALYSIS

A sensitivity analysis was conducted in order to evaluate the effect of changes in several key input parameters on the model projections. The sensitivity analysis consisted of a series of model simulations in which the selected parameter was varied over a reasonable range while all other parameters remained constant. Input parameters included in this sensitivity analysis were contaminant half life, depth to groundwater, soil bulk density/porosity, recharge rate, release width, soil moisture content, fraction organic carbon, and air diffusion layer thickness.

Some of the sensitivity analysis simulations were carried out during the process of evaluating the model, prior to the selection of the final "base-case" parameter estimates. As a result, some of the sensitivity analysis simulations were run with slightly different sets of "base-case" parameters. Because the focus of the sensitivity analysis was to determine the change in model projections associated with a change in an individual parameter, it was not necessary that all sensitivity analysis simulations include the same set of base-case parameters.

A summary of the sensitivity analysis is presented in Table 2. The last column in Table 2 presents the ratio of the change in model results to the change in input parameter value. This ratio, which we have referred to as the Sensitivity Quotient, provides a general measure of the relative model sensitivity to different parameters. The higher the ratio, the more sensitive the parameter. Based on this analysis, the model is most sensitive to the half-life of the contaminant and the depth to groundwater. The model is less sensitive to changes in bulk density/porosity, recharge rate, initial water content and fraction of organic carbon. The model is insensitive to changes in the air diffusion layer thickness. The following sections provide additional observations regarding the sensitivity of the model to selected parameters.

A. Half-Life

The model provides for first-order degradation of contaminants. The degradation rate is input in the form of a half-life. For the sensitivity analysis, the half-life was varied from 1,000 days to 100,000 days. The value of 100,000 days was sufficiently long to minimize the effect of degradation on the model results. There is no provision in the model code for disabling the contaminant degradation; however, assigning a half-life that is much longer than the time simulated has the effect of making degradation negligible.

The results of this analysis showed that the effects of degradation are most pronounced for simulations with a shallow depth of incorporation and a large depth to groundwater. The half-life data presented in Table 2 represent a 20 meter depth of incorporation and a 50 meter depth to groundwater. The effect of a change in half-life was much less pronounced when the depth of incorporation was assumed to be the same as the depth to groundwater. This is due to the fact that degradation is a time-dependent process, so that when contaminants migrate a large distance to groundwater, there is sufficient time for degradation to be effective in removing contaminant mass from the system.

B. Depth to Groundwater

The model requires input for the depth to groundwater and the depth of incorporation of the contaminants in the soil profile. For the worst-case analysis, the depth of incorporation equals the depth to groundwater. Varying the depth to groundwater from 20 meters to 100 meters while maintaining a depth of contaminant incorporation of 20 meters, resulted in a 25-fold increase in the GPL due mainly to dispersion and adsorption of the contaminant into the uncontaminated portion of the vadose zone between the contaminated zone and the underlying groundwater table. The sensitivity analysis for this parameter used a 100,000 day half-life to minimize the concurrent effect that degradation would have on the model results.

The model results were sensitive only to the difference between the depth of incorporation and depth to groundwater. For example, simulations with a 20 meter depth of incorporation and 40 meter depth to groundwater produced the same results as simulations with a 40 meter depth of incorporation and 60 meter depth to groundwater.

The depth of contaminant incorporation and depth to groundwater are key site-specific parameters that are relatively easy to measure and have a significant effect on model results. Unless it is assumed that contaminants extend from the surface to the groundwater table, site-specific data should be used for depth of incorporation and depth to groundwater.

C. Bulk Density and Porosity

Bulk density and porosity are related parameters. Soils with higher porosity contain more air spaces and therefore have lower bulk density. The average grain density in most soils is approximately 2.65. Based on this correlation, the bulk density and porosity were varied jointly in the sensitivity analysis. For the base-case scenario, the bulk density was assumed to be 1.5 g/cm^3 and the porosity was assumed to be 25%. In the sensitivity analysis runs, the bulk density ranged 1.5 to 2.25 g/cm^3 and porosity concurrently ranged from 43% to 15%. This is considered to be approximately the maximum reasonable range for soils in the desert basins of Arizona. The parameter used for comparison in the sensitivity analysis was the ratio of bulk density to porosity (Table 2).

The model results were only moderately sensitive to changes in bulk density and porosity. For simulations where the contaminant was assumed to extend all the way to the groundwater table, the Sensitivity Quotient was approximately 2. For simulations where there were 30 meters of clean soil between the bottom of the contaminated zone and the groundwater table, the Sensitivity Quotient was approximately 3.

D. Recharge Rate

In the base-case scenario, the recharge rate was estimated at one inch per year, which is considered to be representative of the maximum value for the desert basins of Arizona. The recharge rate affects the velocity of the contaminant migration through the vadose zone, and to a lesser extent the dilution of the contaminant in the saturated zone. Increasing the recharge rate results in more rapid transport of contaminants to groundwater. Changes in recharge have a nearly linear affect on the model results. For the sensitivity analysis, a 60-fold increase in the recharge rate resulted in a 63-fold decrease in the GPL.

E. Release Width

The release width is the distance over which contaminants are present parallel to the principal direction of groundwater flow. A longer release width indicates a larger contaminated area and consequently more mass of a contaminant reaching groundwater. The release width was set at 10 meters (approximately 33 feet) for the base-case simulations, consistent with an "average" release width for smaller sites such as underground storage tanks.

In the sensitivity analysis, the release width was increased by a factor of four from 10 to 40 meters. This change resulted in a four-fold decrease in the projected GPL. These simulations were run with TCE as the contaminant. Simulations with a more-degradable compound such as benzene may not result in a direct one-to-one relationship due to degradation of the contaminant in the longer groundwater flow paths.

F. Volumetric Water Content

The volumetric water content is the fraction of the soil volume that is occupied by water. This parameter is held constant throughout the simulation and primarily affects the velocity of water flow through the vadose zone. A higher moisture content results in a lower velocity of water flow through the unsaturated zone, and also affects the partitioning of volatile contaminants between the liquid and vapor phases. In the sensitivity analysis, the total porosity was assumed to be the highest reasonable value of 43%, the depth of incorporation was set at 20 meters and depth to groundwater was set at 30 meters. When the volumetric water content was varied from 0.001 to 0.43 (0.2% to 100% of the total porosity), the resultant GPL varied from 3.3 to 2.0. The maximum GPL occurred at a moisture content of 0.25 (58% of porosity) and the minimum GPL occurred at a moisture content of 0.41 (95% of the porosity).

In running the model, the GPL first increases with increasing initial moisture content and then decreases when the moisture content increases beyond 0.41. The initial moisture content was the only parameter evaluated in the sensitivity analysis that produced a non-monotonic response in model results.

Moisture content varies according to soil type and availability of recharge. The model assumes a constant, uniform value for moisture content over the entire soil profile and throughout the entire simulation time. The moisture content should not be changed from the base-case value unless it can be shown from site-specific data that a different moisture content is appropriate for the entire soil profile.

G. Fraction of Organic Carbon

The fraction of organic carbon (FOC) in the soil determines the amount of an organic contaminant that will adsorb onto the soil. For the base-case scenario, the FOC was assumed to be 0.1%, which is considered a reasonable value for desert soils. Increasing the FOC results in slower contaminant transport and a higher GPL. In the sensitivity analysis, the FOC was varied from 0.1% to 1%. Increasing the FOC by a factor of 10 resulted in an 8.8 fold increase in the projected GPL.

H. Diffusion Layer Thickness

The diffusion layer thickness is the thickness of the layer of air above the soil surface in which the contaminant is assumed to be present. This parameter was included in Dr. Jury's original Behavior Assessment Model which was developed to assess the behavior of pesticides applied at shallow depths to crops. Decreasing the diffusion layer thickness results in a steeper concentration gradient at the soil surface and an increase in the loss of contaminants to the atmosphere.

In the base-case scenario, the diffusion layer thickness was set to 0.5 cm which is the value suggested in the original Behavior Assessment Model documentation. In the sensitivity analysis, varying the diffusion layer thickness from 0.5 cm to 5 cm had no significant effect on the projected GPL. The contaminant properties used in this analysis were those of vinyl chloride, which is one of the most volatile of the common organic contaminants and should therefore diffuse most rapidly to the atmosphere. The insensitivity of the model is probably due to the relatively large depth of incorporation and the relatively high infiltration rate used in these simulations. The results indicate that the mass of contaminants diffusing upwards is insignificant compared to the mass migrating downwards.

A-VI. SENSITIVITY ANALYSIS CONCLUSIONS

The sensitivity analysis was conducted over reasonable assumed ranges of values for important, site-specific input parameters. Of the parameters evaluated, the model was most sensitive to the half-life of the contaminant and the depth to groundwater. The model was moderately sensitive to bulk density/porosity, recharge rate, release width, volumetric water content and fraction of organic carbon. The model was insensitive to the diffusion layer thickness.

For the purposes of site screening, a base-case scenario has been developed that incorporates a set of parameter values considered to be conservative but reasonable. The base-case scenario is not considered to be a worst-case scenario. Site-specific data may support adjustments to any of the base-case parameters, but any adjustment of the more-sensitive input parameters based on site-specific data should require adjustment of all the other more-sensitive input parameters based on site-specific data as well.

Table A-2. Results of Sensitivity Analysis

PARAMETER	PARAMETER INPUT RANGE	MODEL OUTPUT RANGE (ADJ. GPL)	SENSITIVITY QUOTIENT[1]
Half-Life	1,000 to 100,000 days	197,700 to 2.27 mg/kg	8.7
Depth to Groundwater	20 to 100 meters	0.43 to 10.8 mg/kg	5.0
Bulk Density/Porosity	0.28 to 0.06	1.31 to 0.17 mg/kg	1.9
Recharge Rate	0.1 to 6 in/yr	12.96 to 0.2 mg/kg	1.1
Release Width	10 to 40 meters	1.4 to 0.34 mg/kg	0.97
Volumetric Moisture Content	58 to 100 percent porosity	3.47 to 2.03 mg/kg	0.94
Fraction Organic Carbon	0.1 to 0.01 percent	69.0 to 609 mg/kg	0.88
Diffusion Layer Thickness	0.5 to 5.0 cm	4.9 mg/kg	0.0

[1] Calculated as the ratio of Percent Change in Output to Percent Change in Input.

APPENDIX B

ADEQ MODEL
FOR DEVELOPING
GROUNDWATER PROTECTION LEVELS

TABLE OF CONTENTS

ACKNOWLEDGEMENT

The model described in this document is primarily the effort of Wyn Ross, Hydrologist, Arizona Department of Environmental Quality. Mr. Ross conceptualized, programmed and tested the model and drafted the essence of this report. His work was substantially completed in June 1993. Charles Graf, ADEQ Section Manager, guided the development of the model and reviewed the original report. Charles Hains, ADEQ Hydrologist, reviewed and tested the code, eliminated bugs that were identified, and revised the draft by Mr. Ross.

After the Leachability Working Group began evaluating the ADEQ model in 1995 for possible use in developing soil cleanup levels, Mr. Eric Zugay, Basin & Range Hydrogeologists, Inc., made many useful suggestions as part of his review of the model code and report. In 1996, Lyn Conner, working as a volunteer for ADEQ, improved file management aspects of the model and eliminated several bugs identified by the Leachability Working Group. Michele Robertson of ADEQ compiled all of the reviewer's comments and produced this final version of the document.

The framework of the fate and transport model in the vadose zone is the Behavior Assessment Model developed by Dr. William A. Jury of the University of California at Riverside.

ADEQ MODEL FOR DEVELOPING GROUNDWATER PROTECTION LEVELS

1 INTRODUCTION

In this document, the Arizona Department of Environmental Quality (ADEQ) outlines a methodology for estimating concentrations of organic contaminants that can remain in soil yet be protective of groundwater quality. ADEQ has termed these concentrations "Groundwater Protection Levels" or "GPLs." ADEQ's intent in developing this methodology was to answer the question: At what approximate concentration can an organic compound be left in soil such that an applicable Aquifer Water Quality Standard (AWQS) will not be exceeded at an appropriate compliance point within the aquifer underlying the contaminated soil? Because the methodology described in this document incorporates some of the basic chemical and hydrogeological principles that govern the transport of fluids and contaminants through the subsurface, the derived GPLs should prove useful in answering this question.

ADEQ completed the Fortran computer program in June 1993. This model processes the large amounts of numerical data that are generated while solving the contaminant fate and transport equations. The model simulates one-dimensional advective transport of organic compounds in the vadose zone and one-dimensional transport in the mixing cell flow domain of the saturated zone, allowing for adsorption, biodegradation, volatilization, and diffusion.

Since the model development, ADEQ has established soil cleanup standards in the Interim Soil Remediation Standards Rule which became effective March 29, 1996. For the interim rule, Health-Based Guidance Levels (HBGLs) for ingestion of soil were adopted as pre-determined risk-based cleanup standards. The rule also allows an alternative cleanup standard developed from a site-specific risk assessment. Either approach requires that, following remediation, remaining concentrations of contaminants in soil will not cause or threaten to cause groundwater contamination to exceed an AWQS at a point of compliance in the aquifer. The ADEQ model provides a method for calculating concentrations of organic contaminants in soil - the GPLs - that will be protective of groundwater quality.

2 A SYNOPSIS OF TRANSPORT AND FATE PROCESSES

The question of whether contaminant leaching from soil will cause a groundwater standard to be exceeded at some point (the compliance point) cannot be answered with certainty. In general, far too many unknowns exist regarding the hydraulic and retention properties of the medium, fate processes affecting the transformation of the contaminant, heterogeneity in the aquifer and vadose zone, and past and future conditions at the system boundaries for a complete and definitive analysis to be performed. However, as more resources are invested, more information about the system can be obtained to improve predictive capabilities. Therefore, any methodology developed to answer this question is necessarily a compromise between accuracy, simplicity, and cost.

Fate and transport processes significantly affect the dissolved-phase concentration at the compliance point. These processes depend on the properties of the chemical, the physical and biological characteristics of medium, and the environmental conditions that determine the state of soil moisture and soil air.

Most contaminant movement in the soil occurs via the following mechanisms: mass flow of dissolved solute within moving soil water, diffusion and dispersion in the dissolved and vapor phases, convective flow of the vapor phase, and gravity-driven flow of non-aqueous phase liquid (NAPL). The relative importance of these mechanisms depends primarily on the volumetric air and water contents of the soil, the flux of moisture through the system, the phase partitioning of the chemical, and the nature of the contaminant release (e.g., NAPL vs. dissolved phase, constant-head ponding vs. zero-head ponding). The magnitude and temporal distribution of extrinsic events (e.g., irrigation or precipitation), together with the hydraulic and moisture retention characteristics of the system will determine the state of water in the transport volume.

An organic chemical in the soil will partition between the liquid, solid and vapor phases. Some chemicals can be expected to remain in solution and move at a velocity approximately equal to the bulk water velocity. Other chemicals will tend to partition to the vapor phase and move readily in that phase by convection and diffusion. Nonpolar organic chemicals adsorb primarily to natural organic carbon; adsorption usually causes the attenuation of movement of organic chemicals in the vadose and saturated zones. For chemicals that are very strongly adsorbed (e.g., DDT) sorption to sediments and soil with subsequent surface runoff and erosion are often the principal means of transport. The phase distribution of organic compounds in the environment depends on the state of the soil (e.g., degree of water saturation, temperature, barometric pressure), characteristics of the chemical (e.g., solubility, vapor pressure, organic carbon partition coefficient, dynamic viscosity, surface tension), and properties of the medium (e.g., organic carbon content, bulk density, porosity).

The persistence of a chemical will determine the time distribution of mass available for transport. Some organic compounds break down readily in the aerobic soil environment (e.g., benzene), while others can remain relatively unchanged for long periods of time (e.g., ethylene dibromide). Important transformation and degradation processes include biotransformation, chemical hydrolysis, oxidation-reduction, and photolysis.

Path length also has an effect on the concentrations observed at the compliance point. The vertical distance from the point of release to the saturated zone, and the lateral distance traveled in the saturated zone to the compliance point are important, especially for non-conservative species.

3 RANGE OF MODELING OPTIONS

Options for analysis range from simple to complex. The simplest approach would generate guidance levels without consideration of representative site or chemical property data. For example, soil cleanup levels have sometimes been calculated by multiplying the 10^{-6} excess cancer risk level for ingestion of water by a factor of 100. This approach has its advantages: the analysis is quick, inexpensive, and not subject to personal bias or error.

However, the disadvantages are numerous. Neither the mobility nor the persistence of the contaminant are considered. Immobile chemicals would be treated the same as highly mobile chemicals. Chemicals that degrade readily in the soil environment would be treated the same as persistent chemicals. Further, the travel distance of the chemical from source to the compliance point is not considered, nor important environmental characteristics such as the hydraulic input to the system (i.e., amounts and temporal distribution of precipitation or irrigation).

The level of analysis needed to simulate the transport of contaminants from soil to groundwater is based on both technical and financial considerations, which themselves are dependent on the degree of accuracy required in calculating concentration levels pertinent to human health and the environment.
Technical limitations greatly affect the selection of a method of analysis. For example, the physical and chemical processes occurring in the soil may be too complex to describe with existing analytical tools. Similarly, it may not be economically feasible to adequately characterize the system with a reasonable number of non-destructive measurements using existing hardware.

To simulate the transport of contaminants from a surface release to a compliance point in the saturated zone generally requires solving flow and transport equations for a transient, variably-saturated, heterogeneous system. Boundary conditions (such as the flux of moisture through the soil surface) are generally time-dependent. The distribution of soil moisture in the vadose zone is generally nonuniform and transient. Solutes often undergo complex chemical and physical transformations due to interactions with micro-organisms, soil particles, soil air and water, and other solutes. The extent of these transformations depends on the nature of the soil and solute(s), the number and types of soil organisms, and the physical environment (e.g., temperature, oxygen content) of the transport volume.

The first step in simulation is to develop a conceptual model of the system. The conceptual model consists of a set of assumptions that reduce the real system to a simplified system that can be described mathematically. These assumptions consider temporal variability of the system, relevant physical and chemical processes, geometry of the transport volume, dimensionality of flow, material properties and state variables (and the areas or volumes over which they can be averaged), and the location and nature of the system boundaries. The conceptual model must then be expressed as a mathematical model that, unless the system is very simple, must be analyzed with numerical methods.

For the ADEQ model, the desired output of the simulation is contaminant concentration in the aquifer at the compliance point as a function of time. Inputs to the model would include the properties of the contaminant, properties of the medium, boundary conditions, and because it is a transient system, initial conditions.

If it is assumed that the contaminant concentrations are low enough that density and viscosity effects are negligible, then the input properties of the contaminant can be limited to those relating to phase partitioning and degradation/transformation. Linear, equilibrium partitioning is often assumed for simplicity. Parameters needed to describe how a solute partitions between the solid, liquid, and vapor phase (Henry's constant and distribution coefficient if linear partitioning is assumed) are generally available or can be calculated from available properties of the solute. Degradation and transformation processes are generally much more difficult to describe and quantify. Chemical reactions between contaminants and between a contaminant and the soil/air/water transport medium are extremely difficult to quantify at the field scale. Chemical reactions, reaction rates, and the nature of the degradation products depend on the physical and biological environment of the transport volume. This environment is complex and can be expected to vary in time and space making a mathematical description of degradation/transformation processes difficult at best. In addition, rate expressions for many chemical processes occurring in the soil have not been developed from first principles. For simplicity, all degradation/transformation processes are sometimes lumped together into a single first order decay term.

Solution of the variably saturated, transient flow equation requires a knowledge of the hydraulic and moisture retention properties of the medium, the initial distribution of moisture, and conditions at the system boundaries.

In an unsaturated soil, a functional relationship --the water characteristic function-- exists between matric potential and water content. The water characteristic function is non-unique due to hysteretic effects; however, field and laboratory measurement of the water characteristic function are generally made during a single wetting or drying cycle, without attention to hysteresis. Data from these tests are often used to determine the curve fitting parameters of models that relate soil moisture to matric potential in numerical analysis (van Genuchten, 1980).

Unsaturated hydraulic conductivity is not single valued as in saturated analysis, but is instead a non-linear function of water content or matric potential. A relatively small change in moisture content can result in a several orders of magnitude change in the hydraulic conductivity of an unsaturated soil. Measurement of unsaturated hydraulic conductivity is time consuming and error prone. Many studies have shown that laboratory tests on soil cores yield different results than in situ measurements (e.g., the instantaneous profile method)(Rose, 1955, as referenced by Jury in Hern, 1986). As with the water characteristic function, field and laboratory measurements of unsaturated hydraulic conductivity are sometimes used to determine curve fitting parameters of models that relate conductivity to water content in the flux calculations of numerical simulations (Mualem, 1976). In unsaturated flow, the main effect of hydraulic conductivity is to regulate at what water content the flow will occur (Jury in Hern, 1986). Many aspects of solute transport are strongly influenced by water content. Phase partitioning, particle path length, and liquid and vapor diffusion are affected by the amount of water in the pore space of the transport volume. As a result, estimation of this parameter is potentially a source of significant error in variably saturated flow and transport analysis.

Many studies show that solute transport under uniform conditions can be described with reasonable accuracy with deterministic models. However, field soils are quite variable in both the vertical and horizontal direction. Textural, mineral, and structural variations make a description of transport and retention properties throughout every part of the transport volume an insurmountable task. Transport properties, such as hydraulic conductivity, are generally more variable than retention properties. Coefficients of variation of transport properties of field soils are extremely large, exceeding 100% for parameters such as saturated hydraulic conductivity (Jury, 1985). Methods of characterizing the spatial correlation structure of field soils based on probability theory, such as the variogram and kriging, continue to be the focus of research.

Numerical simulation also requires the specification of conditions at the boundaries of the solution domain. Perhaps the most important boundary condition in our contaminant transport simulation is the boundary representing the source area (probably the upper surface of the transport volume). Here the hydraulic head or moisture flux, and the solute concentration must be specified at each time step. Due to the nature of contaminant investigations (generally in response to an accidental release or releases in an unmonitored environment), sufficient data to accurately characterize this boundary are rarely available. These data are often estimated from the chemical properties of the contaminant together with information from such sources as meteorological data, irrigation records, production records, or waste manifests. Consequently, there is often a great deal of uncertainty associated with the source-area boundary.

Transient simulations also require that the initial distribution of moisture (or matric potential) and the initial distribution of the solute be specified. The initial distribution of moisture can be assumed, inferred from matric potential measurements, obtained directly from gravimetric analysis of samples, or measured in situ by neutron attenuation or time domain reflectometry. Data regarding initial moisture distribution are generally sparse; however, the longer the period of simulation, the less sensitive the solution is to initial moisture distribution. The initial distribution of the contaminant is generally estimated from limited point measurements or, if the simulation begins at the release, is assumed to be zero.

Evapotranspiration, large fluxes in macropores, instabilities in the water flow fronts, diffusion into and out of immobile wetted pore space, rate-limited non-equilibrium partitioning, the presence and movement of nonaqueous phase liquids, temperature and hysteretic effects, and problems associated with the quantification of hydrodynamic dispersion at the field scale further complicate the mechanistic analysis of contaminant transport.

In seeking a standardized method of analysis, one that can be conducted (and reviewed) with a modest resource investment is needed. Given this constraint, the transport volume goes from an unknown to an unknowable. Obtaining sufficient information to accurately describe the transient flow of water and transport of solutes through a variably saturated, presumably heterogeneous porous medium without investing a great deal of time, money, and expertise is (arguably) not possible. Uncertainties in model input data propagate through the various computations in the model and will be reflected in the model outputs. The amount of site-specific information required to simulate an actual transport event, and the unquantifiable uncertainty associated with the process, contributes to the appeal of quicker, less complicated methods of analysis. In addition, the complexities of a mechanistic analysis of variably-saturated solute transport (conceptualizing the system, site characterization, and numerical solution) puts this approach beyond the capabilities of many (perhaps most) environmental professionals.

An alternative to simulating an actual contaminant release to a specific environment is to simulate the release of the chemical of interest into an idealized environment. The principal advantage here is that the properties of the system can be specified in such a way that analytical solutions can be employed. Whereas numerical analysis estimates the value of the dependent variable (e.g., hydraulic head or chemical concentration) at discrete points throughout the entire solution domain, an analytical solution can be written as a closed-form expression of the dependent variable at the point of interest. The main limitation of analytical methods of solution is that they are available only for relatively simple problems. Thus, simplifying assumptions regarding the dimensionality of flow and the temporal and spatial variability of the system will likely need to be made. Often these assumptions differ from the field conditions to such an extent that the analysis can no longer be considered an accurate simulation of the real event. However, the analysis can be used to improve understanding of the real system (e.g., through sensitivity analysis), or to determine how one chemical might behave relative to another in an idealized environment.

For an analytical solution to be derived, the system must be of simple geometry, uniform with respect to material properties and water distribution, and steady with respect to water flow. In this analysis, conditions in the vadose zone will differ markedly from those in the saturated zone. Flow in the vadose zone occurs at unsaturated conditions and is principally vertical. The saturated zone is a two-phase system where flow is principally horizontal. Thus, it is useful to consider transport in the two areas separately.

4 PROPOSED METHOD

4.1 INTRODUCTION

The method proposed here for development of GPLs couples an analytical solution for one-dimensional transport in the vadose zone with a simple mixing-cell model for one-dimensional transport in the saturated zone. Flow and transport are assumed to be two-dimensional in the x-z plane. Some site characteristics and many of the fate and transport processes discussed above can be included in the analysis. These include: depth to groundwater, depth of incorporation of the contaminant, the flux of water through the system (assumed steady), linear phase partitioning, first order decay, and several average characteristics of the medium (porosity, bulk density, organic carbon content, moisture content). Transient or nonuniform moisture movement, medium heterogeneities, and hydrodynamic dispersion are not considered in this analysis. Also, the ADEQ model does not account for partitioning to free phase (nonaqueous phase liquid) nor convective flow of the vapor phase. The method of analysis proposed for the saturated zone is discussed first.

4.2 MIXING CELL MODEL FOR THE SATURATED ZONE

A simple analytical method of solution for the saturated component of the simulation is not possible due to the non-uniform, time-varying concentration impinging on the upper boundary of the saturated system (the vadose zone-saturated zone interface). In the mixing cell approach, the flow domain is divided into a series of cells, the contents of which are uniformly mixed. These cells contain leachate from the vadose zone that is mixed with uncontaminated groundwater at the compliance point. At each time step, the following processes sequentially occur:

1) The fluid phase and its dissolved solute mass are convected to the down-gradient cell

2) The cells receive infiltration water and dissolved solute mass from adjacent up-gradient cells and boundaries.

3) The total chemical mass in each cell (dissolved + adsorbed) is computed.

4) The total chemical mass is reduced by first-order decay.

5) The remaining chemical mass is partitioned between the solid and liquid phases.

The time step size in the mixing-cell analysis is equal to the time it takes a particle of water to move the length of a cell:

$$\Delta t = \frac{\Delta x}{V_{gw}} \quad (1)$$

where Δx is the length of the mixing cell in the direction of flow, and V_{gw} is the velocity of the ground water.

The mixing cells are one meter in length (x-dimension), and of varying thickness (z-dimension). The thickness of the most hydraulically upgradient cell (i.e., the cell beneath the most upgradient portion of the release) is:

$$\frac{J_w \, \Delta t}{\phi} \quad (2)$$

where J_w is the flux of water through the vadose zone, and ϕ is the porosity.

This results in a cell pore-volume equal to the volume of water the cell receives from the vadose zone in one time step. Similarly, down gradient cell pore-volumes increase in size (relative to the adjacent up-gradient cell) by an amount equal to the volume of water that cell receives from the vadose zone in one time step (Figure 1). It should be noted that the flux of moisture through the waste cell is not necessarily the same as the flux outside the waste area; therefore, the increase in cell thickness may change at the point groundwater moves out from beneath the waste cell. The chemical mass that enters the mixing-cells from the vadose zone at each time step is calculated in the vadose zone model.

The mixing cell thickness at the compliance point, *AMCTCP*, is the most down-gradient thickness calculated by the model. For many combinations of flux and distance to the compliance point monitoring well, the mixing cell thickness is significantly smaller than the perforated interval of a typical monitoring well. Therefore, the monitoring well would intercept the layer of contaminated groundwater over only a part of the perforated interval. Since water pumped from a well is derived from the entire perforated interval (and compliance with groundwater standards is based on the chemical analysis of that mixed water), it is appropriate to calculate the *GPL* based on the ratio of the perforated interval to the last mixing cell thickness. This is how the model calculates the *GPL*. For reference, the printout also indicates a "cell *GPL*", which is a soil concentration calculated as if the contaminated groundwater in the last mixing cell had to meet the AWQS itself, not taking into account dilution over the entire perforated interval.

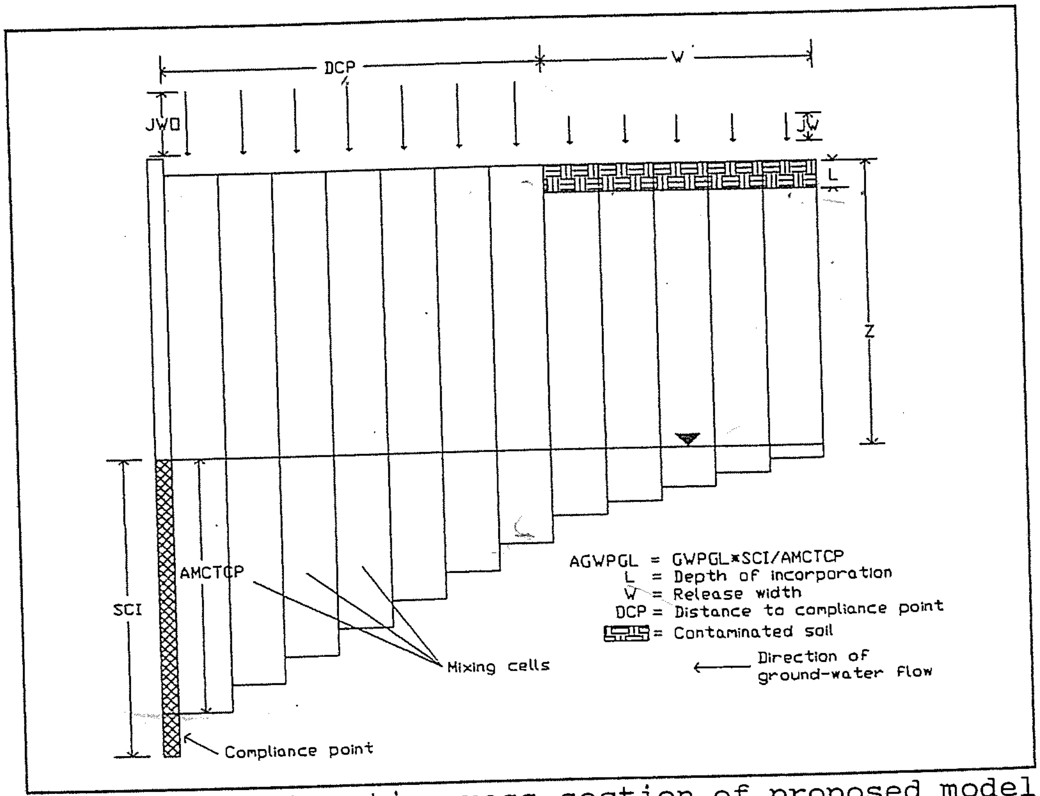


Figure 1 Schematic cross-section of proposed model

4.3 BEHAVIOR ASSESSMENT MODEL FOR THE UNSATURATED ZONE

ADEQ has adopted the Behavior Assessment Model (BAM) (Jury, et al., 1983) to determine the time varying mass flux of chemical into the saturated zone. ADEQ believes that BAM, when properly coupled with the mixing cell model, can be applied to develop a GPL. The BAM is an analytical solution to the transport equation written for the following conditions:

1) Uniform initial distribution of chemical mass between the surface and depth of incorporation, L,

2) No chemical mass between depth L and depth z (depth of observation) at time t = 0,

3) Uniform soil properties consisting of constant liquid water flux, moisture distribution, porosity, bulk density, and organic carbon content,

4) linear equilibrium phase partitioning,

5) first-order degradation,

6) transport by liquid-phase convection and diffusion, and by vapor-phase diffusion.

7) chemical diffusion through a stagnant air layer above the soil surface

The BAM can also be used to calculate volatilization losses through the soil surface.

The BAM parameters can be divided into two groups: soil and system properties, and physical-chemical properties of the contaminant. Soil and system properties consist of:

1) porosity, ϕ

2) bulk density, ρ_b

3) organic carbon fraction, f_{oc}

4) air diffusion coefficient, D_G^a

5) water diffusion coefficient, D_l^w

6) depth of incorporation of the chemical, L

7) water content, θ

8) water flux, J_w

9) stagnant air layer thickness above the soil surface, d .

Properties of the chemical consist of:

1) organic carbon partition coefficient, K_{oc}

2) Dimensionless Henry's constant, K_H (can be calculated as the ratio of saturated vapor density to solubility)

3) degradation coefficient, μ.

The BAM calculates total relative chemical concentration of all phases (in units of mass per unit volume) as a function of time and depth given the above soil, chemical, and system properties. From the assumption of linear partitioning, the liquid phase concentration can be obtained as:

$$C_l = \frac{C_T}{\rho_b\ f_{oc}\ K_{oc} + \theta + a\ K_H} \tag{3}$$

where a is the volumetric air content.

Knowing the liquid phase concentration (C_l) and the steady-state flux of moisture through the system (J_w), the mass flux of chemical past depth z (J_m) can be calculated as:

$$J_m(t) = C_l(t)\ J_w \tag{4}$$

Therefore, the chemical mass entering a mixing-cell (per unit depth) in time step k is:

$$M_k = J_m(t)\ \Delta t\ \Delta x \tag{5}$$

The most down-gradient mixing-cell in the saturated zone model represents the compliance point. Since the BAM generates relative concentrations (i.e., C/C_0) impinging on the saturated zone, concentrations calculated within the mixing cell at the compliance point can be compared to the groundwater standard allowing a GPL for the soil to be back-calculated.

4.4 MODEL ASSUMPTIONS

In both the vadose zone and saturated zone models, reversible, linear equilibrium phase partitioning is assumed. The relationship between the dissolved and adsorbed phases is expressed by:

$$C_s = K_d C_l = f_{oc} K_{oc} C_l \tag{6}$$

where C_s is the adsorbed phase concentration ($\mu g/g$ of soil), K_d is the distribution coefficient (cm^3/g), C_l is the liquid phase concentration ($\mu g/cm^3$ of soil solution), f_{oc} is the soil organic carbon fraction (may have different values in the vadose zone and saturated zone), and K_{oc} is the organic carbon partition coefficient (cm^3/g).

As mentioned above, adsorption is assumed to be reversible. Studies have shown that most organic chemicals show hysteresis in the adsorption-desorption isotherm, exhibiting a greater resistance to desorbing than to sorbing (Swanson and Dutt,1973; Sabatini, et al, 1990). Attempts have been made to model adsorption hysteresis using different equations to describe adsorption and desorption (van Genuchten, et al, 1974, Vaccari, D. A., et al, 1988). Another assumption is the linearity of the adsorption isotherm. Although this assumption allows considerable simplification in mathematical modeling, it can be a source of error particularly if a single linear isotherm is used to describe adsorption at both low and high concentrations.

At low flux rates, adsorption can approach an equilibrium condition; however, at high fluxes equilibrium adsorption models tend to overpredict adsorption. Additionally, preferential flow paths in the soil may bypass many adsorption sites and result in non-equilibrium adsorption. Many adsorption coefficients in the literature were derived from batch equilibrium measurements made on completely dispersed soil samples that were allowed to reach equilibrium. It is further assumed that all adsorption occurs on the surface of organic matter.. This is a reasonable assumption for non-polar organic chemicals; however, positively charged species adsorb primarily to mineral surfaces (principally clays).

The vapor and dissolved phases are assumed to be in equilibrium according to Henry's law:

$$C_g = K_H C_l \tag{7}$$

where C_g is the concentration of the gaseous phase ($\mu g/cm^3$ of soil air), and K_H is the dimensionless form of Henry's constant. Research suggests that, at least for some chemicals, this proportionality holds for the entire range of chemical concentrations. However, a standardized protocol for determining Henry's constant (i.e., for measuring vapor pressure and solubility) is not in use.

All chemical and biological degradation processes are lumped together and expressed by a single first-order rate equation:

$$\frac{M(t)}{M_o} = e^{-\mu t} \tag{8}$$

where M(t) is the mass of chemical remaining at time t, M_0 is the initial mass of chemical, μ is the rate constant, and t is time. Of the three input parameters associated with the chemical, the degradation rate is by far the most difficult to quantify. The rate and extent of chemical and biological transformations depend on the characteristics of the chemical, the physical and chemical conditions of the environment, and the number and nature of the soil microorganisms. Factors affecting the transformation of a chemical include:

1) chemical concentration
2) temperature
3) microbial population
4) oxygen and nutrient availability
5) water content
6) carbon content
7) pH

Many equations have been developed to describe individual transformation processes in the soil. Typically, these are functions of both the properties of the chemical, and the characteristics of the soil environment. Virtually all factors affecting these transformations can be expected to vary temporally and spatially.

The BAM does not account for hydrodynamic dispersion. As a result, the BAM can overestimate concentrations, particularly with conservative solutes. Jury compared field measured concentrations with concentrations predicted using the BAM and found that in some cases the BAM overestimated concentrations by as much as an order of magnitude (Jury, 1992).

The BAM considers chemical movement by convection in the dissolved phase, and by diffusion in the dissolved and vapor phases. The convective flux is simply the product of the liquid-phase concentration, C_l, and the steady-state flux of water, J_w. The diffusive fluxes are described by modified forms of Fick's law. The total chemical flux, J_s, is the sum of the dissolved solute flux, J_l, and the vapor flux, J_g:

$$J_g = -D_g \frac{\partial C_g}{\partial z} = \xi_g D_g^a \frac{\partial C_g}{\partial z} \qquad \textbf{(9)}$$

$$J_l = -D_l \frac{\partial C_l}{\partial z} + J_w C_l = \xi_l D_l^w \frac{\partial C_l}{\partial z} + J_w C_l \qquad \textbf{(10)}$$

where D_g and D_g^a (cm2/d) are the gaseous diffusion coefficients in soil and air, respectively; ξ_g and ξ_l are tortuosity factors to account for the reduced flow area and the increased path length of diffusing molecules in soil. The tortuosity factors are assumed to obey the model of Millington and Quirk (1961):

$$\xi_g = \frac{a^{10/3}}{\phi^2} \tag{11}$$

$$\xi_l = \frac{\theta^{10/3}}{\phi^2} \tag{12}$$

The mass conservation equation for the transport of a single chemical undergoing first-order decay in a one-dimensional, homogeneous porous medium may be written as:

$$\frac{\partial C_T}{\partial t} + \frac{\partial J_S}{\partial Z} + \mu C_T = 0 \tag{13}$$

where C_T is the total chemical concentration per unit volume of soil (g/m^3), and J_s is the total chemical mass flux ($g/d/m^2$).

Jury et al. (1983) combined the flux equations and the mass balance equation to write:

$$\frac{\partial C_T}{\partial t} + \mu C_T = D_E \frac{\partial^2 C_T}{\partial z^2} - V_E \frac{\partial C_T}{\partial z} \tag{14}$$

where

$$V_E = \frac{J_w}{\rho_b f_{oc} K_{oc} + \theta + a K_H} \tag{15}$$

is the effective solute velocity, and

$$D_E = \frac{(a^{10/3} D_g^a K_H + \theta^{10/3} D_l^w)/\phi^2}{\rho_b f_{oc} K_{oc} + \theta + a K_H} \tag{16}$$

4.5 MODEL LIMITATIONS

Most of the limitations of the ADEQ model have been described in the previous sections, and are summarized as follows:

1) Longitudinal and transverse dispersion is assumed negligible by the BAM. As a result, the BAM can overestimate concentrations, particularly with conservative solutes.
2) Free phase is not present
3) Convective flow of vapor phase is not considered
4) Biodegradation follows linear, first-order decay as a function of chemical concentration
5) Hysteresis of adsorption/desorption processes is negligible
6) The saturated zone flow domain mixes with fresh groundwater at the monitor well
7) The vadose and saturated zones are homogeneous
8) Only organic chemical transport can be simulated
9) Groundwater flow is horizontal
10) The aquifer is unconfined
11) Constant-head ponding is not simulated
12) Moisture flux and groundwater flow velocities are constant in time and space
13) Dimensionless Henry's Law constants, K_H, are based on a temperature of 20°C
14) Contaminant distribution is homogeneous throughout the depth of incorporation

5 MODEL REVIEW AND VERIFICATION

5.1 VADOSE ZONE MODEL

The ADEQ vadose zone model results were compared with published results from the Behavior Assessment Model (Jury, et al., 1983).

is the effective diffusion coefficient.

Jury et al. (1983) solved (14) with the initial conditions

$$C_T(z,0) = C_0 \quad 0<z<L \tag{17}$$

$$C_T(z,0) = 0 \quad z>L \tag{18}$$

to obtain:

$$\begin{aligned} C_t(z,t;L) = \frac{1}{2} C_0 \exp(-\mu t) \Bigg\{ & erfc\left[\frac{z - L - V_E t}{(4D_e t)^{1/2}}\right] - erfc\left[\frac{z - V_E t}{(4D_E t)^{1/2}}\right] + (1 + V_E/H_E) \exp(V_E z/D_E) \\ & \cdot \left[erfc\left(\frac{z + L + V_E t}{(4D_E t)^{1/2}}\right) - erfc\left(\frac{z + V_E t}{(4D_E t)^{1/2}}\right)\right] \\ & + (2 + V_E/H_E) \exp\{[H_E(H_E + V_E)t + (H_E + V_E)z]/D_E\} \\ & \cdot \left[erfc\left(\frac{z + (2H_E + V_E)t}{(4D_E t)^{1/2}}\right) - \exp(H_E L/D_E)\, erfc\left(\frac{z + L + (2H_E + V_E)t}{(4D_E t)^{1/2}}\right)\right]\Bigg\} \end{aligned} \tag{19}$$

where

$$H_E = \frac{D_g^a}{dK_H(\rho_b f_{oc} K_{oc} + \theta + aK_H)} \tag{20}$$

Equation 19 is used to determine the mass flux of contaminant to the saturated zone. The depth of observation (x) is held constant at the depth to the water table. The initial concentration of contaminant (C_o) is assumed to be unity. Values of total relative chemical concentration of all phases (in units of mass per unit volume) are then calculated at regular time intervals to establish the normalized chemical "break-through" at the water table. Assuming linear equilibrium partitioning, the liquid-phase chemical mass flux is calculated and input to the appropriate mixing-cells. This mass is then moved through the saturated-zone, mixing-cell model to the point of compliance, where a curve of groundwater concentration with respect to time is generated.

The ADEQ implementation is based on varying contaminant concentration with time rather than depth. Therefore, the model verification consisted of plotting results of ADEQ's model on a time-concentration axis compared with results of the Behavior Assessment Model plotted on a depth-concentration axis. These plots crossed at the appropriate points indicating identical results.

5.2 SATURATED ZONE MODEL

The author compared results of the mixing cell model used in this program with breakthrough curves generated by Hydrogeologic, Inc.'s computer model VAM2D (Huyakorn, et al, 1989). Identical breakthrough curves were generated when dispersion was simulated in the mixing-cell model by setting the aquifer mixing cell factor to 1.6.

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7 APPENDICES

7.1 PROGRAM OPERATION

Upon startup, the program asks for :

1. The name of a chemical file, or allows the user to generate a chemical file containing the following information:

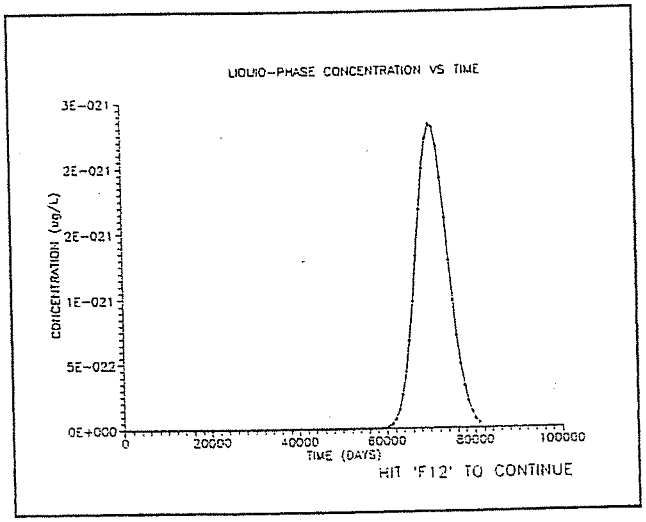
   - Chemical name
   - Organic Carbon Partition Coefficient, KOC (cm**3/g)
   - Dimensionless Henry's Law Constant, KH, (dimensionless)
   - Saturated Vapor Density, SVD (g/cm**3)
   - Chemical Solubility in Water, CS (g/cm**3)
   - Vadose Zone Half-Life, TV12 (days)
   - Saturated Zone Half-Life, TA12 (days)
   - Groundwater Standard, STD (μg/L)
   - Soil Health Based Guidance Level (mg/kg)

   The user may supply the dimensionless Henry's Law Constant, or may have the program calculate one if the saturated vapor density and chemical solubility in water are provided. If the user wishes to use the supplied value for Henry's Law Constant, the fields for vapor density and chemical solubility should be left blank to speed data input during successive runs.

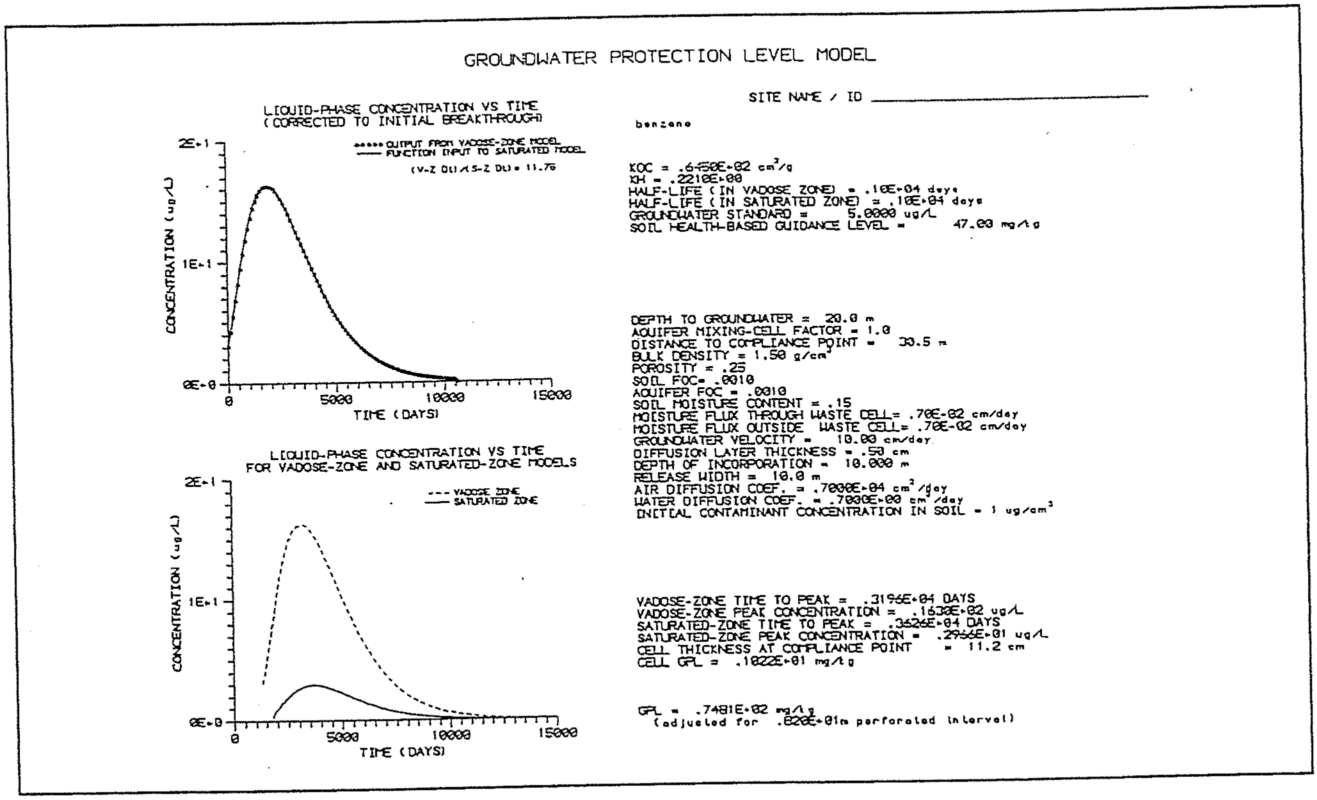
2. The name of a hydrogeologic parameters file, or allows the user to set up a file containing the parameters:

   - Bulk Density (g/cm**3), RB
   - Porosity, POR
   - Soil Fraction of Organic Carbon, SFOC
   - Aquifer Fraction of Organic Carbon, AFOC
   - Moisture Content, THET
   - Moisture flux in zone of incorporation (cm/day), JW
   - Moisture flux outside zone of incorporation (cm/day), JWO
   - Groundwater Velocity (cm/day), GWV
   - Diffusion Layer Thickness (cm), D
   - Depth of Incorporation (cm), L
   - Width of Release (INTEGER distance in m), W
   - Depth to Groundwater (m), Z
   - Aquifer Mixing-Cell Factor, AMCF
   - Distance to Compliance Point (m), DCP
   - Air Diffusion Coef. (cm**2/day), DGA
   - Water Diffusion Coef. (cm**2/day), DLW
   - Perforated Interval (m), SCI

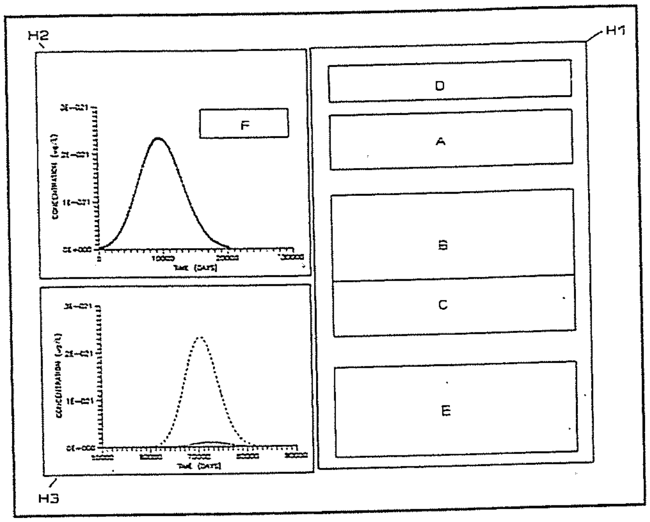
   All of the numerical input values must be entered with a decimal point, otherwise erratic results may be produced.



The program calculates intermediate results and can graphically display them as chemical breakthrough curves (concentration vs time) at the water table and at the well. The GPL model code utilizes the commercial program GRAPHER to generate graphical output. **Users of this model must have a licensed copy of GRAPHER on their computer to produce these figures.** Viewing these results on the fly allows the user to make sure the entire breakthrough curve has been captured (and captured with the desired resolution). If not, the user can change the simulation period and generate a new curve without starting the model over. After calculating a breakthrough curve, the model pauses and asks if a view of the curve is desired. If the user responds affirmatively, a plot similar to the one above appears on the screen. The final output for a simulation typically looks like the following plot:



```
SITE NAME / ID ____________________________

benzene

KOC = .6450E+02 cm³/g
KH = .2210E+00
HALF-LIFE (IN VADOSE ZONE) = .10E+04 days
HALF-LIFE (IN SATURATED ZONE) = .10E+04 days
GROUNDWATER STANDARD =     5.0000 ug/L
SOIL HEALTH-BASED GUIDANCE LEVEL =        47.00 mg/kg

DEPTH TO GROUNDWATER =  20.0 m
AQUIFER MIXING-CELL FACTOR = 1.0
DISTANCE TO COMPLIANCE POINT =   30.5 m
BULK DENSITY = 1.50 g/cm³
POROSITY = .25
SOIL FOC= .0010
AQUIFER FOC = .0010
SOIL MOISTURE CONTENT = .15
MOISTURE FLUX THROUGH WASTE CELL= .70E-02 cm/day
MOISTURE FLUX OUTSIDE  WASTE CELL= .70E-02 cm/day
GROUNDWATER VELOCITY =   10.00 cm/day
DIFFUSION LAYER THICKNESS = .50 cm
DEPTH OF INCORPORATION =  10.000 m
RELEASE WIDTH =  10.0 m
AIR DIFFUSION COEF. = .7000E+04 cm²/day
WATER DIFFUSION COEF. = .7000E+00 cm²/day
INITIAL CONTAMINANT CONCENTRATION IN SOIL = 1 ug/cm³

VADOSE-ZONE TIME TO PEAK =  .3196E+04 DAYS
VADOSE-ZONE PEAK CONCENTRATION =  .1630E+02 ug/L
SATURATED-ZONE TIME TO PEAK =  .3626E+04 DAYS
SATURATED-ZONE PEAK CONCENTRATION =  .2966E+01 ug/L
CELL THICKNESS AT COMPLIANCE POINT     =  11.2 cm
CELL GPL =  .1022E+01 mg/kg

GPL =  .7481E+02 mg/kg
  (adjusted for  .820E+01m perforated interval)
```



The final output consists of two graphs, each with two data sets, and six text blocks, A - F. Text block A gives chemical characteristics for the chemical named in text block D. Text block B lists the assumed aquifer characteristics. Text block C gives information about the spill and diffusion coefficients. Text block E is the output, the upper portion consisting of useful information about the model run, and the lower portion the raw GPL and adjusted GPL. The raw GPL is adjusted to account for the difference between calculated mixing cell thickness (depth) at the compliance point well and the perforated length of casing in the well (for further information see text of report.)

The ADEQ model is programmed in FORTRAN and creates data files in a format that can be imported directly into GRAPHER. Similarly, the FORTRAN program creates text files that can be imported into GRAPHER without modification. The final output is created with a series of nested batch files. These batch files use a utility called KEY-FAKE to send a series of key strokes to GRAPHER to load the graph and text files, and create and append the final output plot file. The entire process of creating and printing the final output is automated.

The following files are included with the program:

ONEKEY.COM	Redefines the F12 key to ESC, ESC, ENTER.
KEY-FAKE.COM	Supplies a series of keystrokes needed to initialize an application.
GWPGL.FOR	Program Source
GWPGL.EXE	Executable
RUN.BAT G1.BAT G3.BAT	Please look at these batch files and **modify pathnames** of each one as necessary to properly refer to Golden Software's GRAPHER. **RUN initiates execution of the program;** G1 and G3 produce on-screen plots during execution.

VPASS.GRF BOTH.GRF GWCON.GRF TIMVER.GRF	These files are created and passed to GRAPHER, either during the run on the fly, or for hardcopy plotting
BENZENE.	Test chemical data set for Benzene.
SOIL.	Test hydrologic and dimensional data set.
OPENRED.EXE	Opens the dummy-file READY. used to let the batch file RUN.BAT know that the space for GRAPHER has been reserved (see GRAPH.BAT below). This program is run by INIT.BAT.
INIT.BAT	Initializes system for first run, called by RUN.BAT if the dummy-file READY. is nonexistent.
F12.BAT	Calls ONEKEY to redefine F12 key. This file is called by INIT.BAT.
GRAPH.BAT	Calls GRAPHER. Called from INIT, this is done to reserve a block of memory. If 640k of memory is available, and no TSR’s other than ONEKEY and KEY-FAKE are loaded, this may not be necessary. Both GRAPHER and GWPGL seem to be able to run without invoking this batch file if 572K are available. If TSR’s use excessive low memory, the second and following executions of the program will result in the error message: Insufficient memory, unless INIT.BAT is run.

These files must be loaded into a directory on the hard disk, <path>. The AUTOEXEC.BAT file must contain the line: IF EXIST C:\<path>\READY ERASE C:\<path>\READY. Also, GRAPHER must be configured for C:\<path>, and DEVICE=C:\DOS\ANSI.SYS must be in CONFIG.SYS (or appropriate path). The program is initiated by RUN.BAT

The program was originally tested on 80386 clones that have 80387’s installed. The code has been successfully run on 80486 and Pentium processors. Use of a Pentium or fast 486 processor will greatly increase speed. All code was compiled with release 5.0 of the

Microsoft Fortran compiler. Release 1.77 of Grapher was used for graphing purposes. Release 4.14 of PLOT.EXE (also Golden Software, Inc.) was used to enable some new options. GRAPHER is necessary to produce hardcopy output from this version of the model. Those who do not wish to purchase GRAPHER can download the output ASCII files created by the model to their graphing program of choice; however, those users will not be able to graph results on the fly.

a. LIST OF PROGRAM VARIABLES

AGWPGL = Groundwater Protection Level (GPL). Calculated by scaling GWPGL to the screened interval length and calculated AMCTPCP. AGWPTL = GWPGL*SCI/AMCTPCP.

AMCF = Aquifer Mixing-Cell Factor. This factor simulates hydrodynamic dispersion when set greater than 1.0. When set to 1.0, no hydrodynamic dispersion is simulated.

AMCT = Aquifer Mixing-Cell Thickness. (m).

AMCTCP = Aquifer Mixing-Cell Thickness at the Compliance Point (m).

AFOC = Aquifer Fraction of Organic Carbon.

CELLPV = CELL Pore Volume, cm**3.

CMAX = The MAXimum Concentration (µg/L) reaching the water table (calculated in the vadose-zone model).

CON = Array containing CONcentration values (µg/L) in the saturated transport model (associated with times in array TB).

CONL = An array containing Liquid CONcentrations (µg/L) at time TIM in subroutines RELCON and FILTER.

CS = Chemical Solubility, g/cm**3. Used with the Saturated Vapor Density to calculate KH, if desired. KH = SVD/CS

D = Diffusion layer thickness (cm).

DCP = Distance to Compliance Point (m) from the edge of the zone of incorporation in soil.

DELTAB = Time step size in saturated transport model. DELTAB is the time it takes to cross one cell (1m) at the velocity of the groundwater.

DGA = Air Diffusion coef. (cm**2/day).

DLW = Water Diffusion coef.(cm**2/day).

DT = Initial Time-step size (days).

GTEST = 0 if no breakthrough occurred in the vadose-zone model.

GWCMAX = MAXimum Concentration at the compliance point.

GWPGL = Unadjusted soil level protective of groundwater, calculated as if the groundwater concentration in the last mixing cell comprised the entire groundwater output of the monitoring well. This is calculated by scaling GWCMAX to the groundwater STandarD, STD. GWPGL = (STD/GWCMAX)/(THET+RB).

GWST = New simulation time for Saturated Transport model (input interactively).

GWV = GroundWater Velocity (cm/day).

IC = Ith mixing Cell (meters from the first mixing cell).

ICOUNT = Number of time steps in the saturated transport model when the vertical input concentrations are nonzero.

IFLAG = 0 if the time derivative of concentration is positive and = 1 if the derivative is negative.

IW = Incorporation Width of contaminant in soil in the i^{th} cell (meters from initial cell).

JW = Soil moisture flux (cm/day) inside zone of incorporation.

JWO = Soil moisture flux (cm/day) Outside zone of incorporation.

KBT = Counter for arrays TA and ORD indicating the number of concentration values that are within two orders of magnitude of CMAX.

KBTPO = KBT + 1.

KH = Dimensionless Henry's constant of chemical.

KOC = Organic Carbon partition coefficient (cm**3/g) of chemical.

L = Depth of incorporation (cm) of contaminant in soil.

NCELLS = Number of mixing-CELLS in the saturated transport model.

NUMGWS = NUMber of time Steps in the saturated transport model.

NUMIT = NUMber of ITerations.

ORD = Array containing concentrations (µg/L) from the vadose-zone model that are within two ORDers of magnitude of CMAX. These concentrations are associated with the times in array TA and are passed to the saturated transport model as vertical inputs.

POR = PORosity of unsaturated and saturated zone.

RB = Bulk density (g/cm**3) of porous media in unsaturated and saturated zone.

RF = Retardation Factor.

SCI = SCreened Interval of well at compliance point (meters)

SFOC = Soil Fraction of Organic Carbon.

SHBGL = Soil Health-Based Guidance Level.

SIMTIME = SIMulation TIME (years) calculated from the time-step size and the number of iterations.

SIMTIML = SIMulation TIMe of most recent pass in the vadose-zone model.

STD = Groundwater STandarD. This is the concentration of contaminant that can not be exceeded in the compliance point well.

SVD = Saturated Vapor Density, g/cm**3. Used with Solubility to calculate KH, if desired. KH = SVD/CS.

TA = Array in subroutine FILTER containing Times (days) associated with concentrations in array ORD. TA and ORD are passed to the saturated transport model as vertical inputs.

TA12 = Half-life of contaminant in the saturated zone (days).

TB = Array containing Time values (days) of saturated transport model (associated with concentrations in array CON.)

TCB = Time (days) of arrival of first concentration value that is within two orders of magnitude of CMAX.

TCF = Time (days) of arrival of the last concentration value that is within two orders of magnitude of CMAX.

TESTA = 1 if the concentration is not decreasing (IFLAG = 1) in the last iteration of subroutine RELCON.

THET = Moisture Content in the unsaturated zone (fraction of pore space filled).

TIM = Array containing TIMe values (days) associated with the liquid concentrations in array CONL in subroutines RELCON and FILTER.

TMAX = Time (days) of MAXimum concentration in subroutine RELCON.

TV12 = Half-life of contaminant in the Vadose zone (days).

W = Width of soil zone of incorporation (INTEGER # m, equal to maximum IW).

YMAX = TMAX in years.

Z = Depth to groundwater from land surface (m).

APPENDIX C

SCREENING APPROACH FOR INORGANIC CONTAMINANTS

C-I. INORGANIC SCREENING METHOD SELECTION

The Working Group adopted a simplified and conservative approach for generating Minimum GPLs for metals-contaminated soil. This approach consists of two main components: 1) a very basic mixing cell for calculating contaminant concentration in the groundwater, and 2) an empirical relationship between soil leachate metals concentration and total metals content of the soil. Based on this approach, a method for determining Alternative GPLs is also provided.

In this approach, the mixing cell is simply taken as the volume of groundwater that would flow past a reference point (the perforated interval of the monitor well) during time, t. Also, during time t, leachate from the contaminated soil zone contributes mass, m, to the groundwater in the mixing cell, resulting in a groundwater contaminant concentration of C_w. Since the maximum allowable C_w for a metal is considered to be identical to its Aquifer Water Quality Standard (AWQS), the corresponding maximum allowable leachate concentration entering the mixing cell, C_i, can be easily calculated. To simplify the calculations, it is assumed that no vadose zone attenuation of metals occurs.

Consequently, the most difficult remaining problem is to relate the metals concentration of the fluid leaching from the contaminated soil to groundwater, C_i, to the total metals concentration in the contaminated soil. Such a relationship allows a Minimum GPL to be calculated for comparison to promulgated soil cleanup HBGLs or site-specific risk assessment levels.

The Working Group concluded that available models to determine the correlation between total metals in the soil and the potential impact to groundwater quality are too sophisticated for the level of characterization that can be practicably performed at a site. Therefore, a simpler approach was adopted. This approach relies on the relationship between total metals content for each metal under consideration and its corresponding concentration in leachate as determined by the Toxicity Characteristic Leaching Procedure (TCLP) test, the Synthetic Precipitation Leaching Procedure (SPLP) test or an alternative approved leaching procedure appropriate for site conditions.

Because of the way the leaching procedures are conducted, the theoretical correlation between the total metals test and leaching test can be no less than 20:1. This is the ratio at which 100% of the metal in the soil is leached by the TCLP or SPLP test. The actual ratio varies from site to site and metal to metal but is usually much greater than 20:1 because some fraction of the metals in soil is usually not readily leachable and remains in the soil. For the purpose of calculating the Minimum GPL, the default value of 20:1 was used for conservativeness. As described later, an Alternative GPL may be calculated if the party conducting the cleanup wishes to develop site-specific data on the relationship between the total and leachable fraction of metals for contaminated soil at the site.

C-II. DEFINITIONS

m = Mass of pollutant added during time, t
V = Volume of flow past a reference point during time, t
I = Infiltration rate through contaminated soil zone (cm/day)
L = Length of contaminant release parallel to direction of groundwater flow (m)
n = Effective porosity
z = Perforated length of monitor well (m)
v = Fluid velocity of groundwater (cm/day) (I think this is Darcy flow
Q = Flow rate of groundwater
A = Cross-sectional area of groundwater flow
b = Width of mixing cell perpendicular to direction of groundwater flow
C_w = Groundwater concentration in mixing cell (mg/l)
C_i = Leachate concentration infiltrating below contaminated soil zone (mg/l)
X_s = Maximum allowable metals concentration in soil to protect groundwater (mg/kg)
R = Ratio between total metals content in a soil and the TCLP or SPLP leachate result

C-III. DERIVATION

Over time, t, contaminant mass, m, from the soil will leach downward into volume, V, of groundwater flowing past the contaminated soil zone. If the volume of water infiltrating downward is negligible in comparison to the volume of groundwater then:

$$C_w = m/V$$

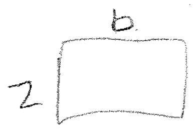
The mass of contaminant leaching to groundwater during time, t, is given by:

$$m = \text{Leachate Concentration} \times \text{Infiltration Rate} \times \text{Release Length} \times \text{Width} \times \text{Time}$$

$$m = C_i ILbt$$

The volume of groundwater into which mass, m, discharges is considered to be the volume flowing across the perforated interval of the monitor well during time, t:

$$V = Qt = Avt = bzn\vec{v}t$$



V= Darcy vel

The concentration of groundwater available across the perforated interval of the monitor well is therefore:

$$C_w = \frac{m}{V} = \frac{C_iILbt}{bznvt} = \frac{C_iIL}{znv}$$

If C_w is set equal to the maximum concentration allowable at the monitor well (i.e., the AWQS), then C_i is the maximum allowable leachate concentration from the contaminated soil zone:

$$C_i = \frac{C_wznv}{IL}$$

By substituting the same parameter values as used in our organic contaminant model, we obtain:

$$C_i = C_w \frac{(8.20\text{ m})(0.25)(10\text{ cm/day})}{(0.007\text{ cm/day})(10\text{ m})} = 292.9\ C_w$$

The remaining step is correlation of the total metals concentration in the soil, X_s, with the leachate concentration, C_i, which can be obtained through a TCLP or SPLP test. R is defined as the variable relating total metals concentration to leachate concentration. Therefore,

$$X_s = RC_i = (292.9)RC_w$$

As previously mentioned, the theoretical total metals concentration in a soil, expressed as mg/kg, can be no less than 20 times the leachate concentration from a TCLP or SPLP test, expressed as mg/l. In reality, the factor, R, is almost always greater than 20 and commonly greater than 100. However, for the theoretically worst-case when R=20, the following equation applies:

$$X_{20} = (292.9)(20)C_w = 5860C_w$$

X_s therefore represents the maximum allowable total metals concentration in soil which achieves protection of groundwater quality. X_s is dependent on determining the site-specific ratio, R, between results from total metals testing and TCLP or SPLP leachability testing. For the theoretically worst-case where R=20, X_{20} represents the total metals concentration in soil which is protective of groundwater. In other words, X_{20} represents the Minimum GPL as analogously used for organic chemicals. Table 6 lists these Minimum GPLs for metals having promulgated AWQS.

Table C-1. Worksheet for Developing Minimum GPLs for Metals

Metal	Maximum Ground-water Conc., C_w* (mg/l)	Leachate Conc., C_l (mg/l)	Ratio of Total Metals to TCLP or SPLP, R	**Minimum GPL, X_{20} (mg/kg)**	Resi-dential HBGL (mg/kg)	Non-Resident. ~~HBGL~~ SRL (mg/kg)	EPA Draft SSL (DAP=10) (mg/kg)
Antimony	0.006	3.51	20	**35**	47**	~~165**~~ 410	-
Arsenic	0.05	29.3	20	**290**	0.91	~~3.82~~ 10	15
Barium	2	1170	20	**12,000**	8200	~~28,700**~~ 170,000	32
Beryllium	0.004	2.34	20	**23**	0.32	~~1.34~~ 1900	180
Cadmium	0.005	2.93	20	**29**	58**	~~244**~~ 510	6
Chromium	0.1	58.6	20	**590**	580	2436**	19
Lead	0.05	29.3	20	**290**	400**	1400**	-
Mercury	0.002	1.17	20	**12**	35**	123**	3
Nickel	0.1	58.6	20	**590**	2300**	8050**	21
Selenium	0.05	29.3	20	**290**	580**	2030**	3
Thallium	0.002	1.17	20	**12**	8.2	28.7**	0.4

* Equivalent to the Aquifer Water Quality Standard
** HBGL is not sufficiently low to prevent groundwater contamination

NOTE: Minimum GPLs have been rounded to two significant digits.

C-IV. ALTERNATIVE GPLS FOR METALS

If sufficient site-specific data have been collected to determine the relationship, R, between the total metals concentration in contaminated soil and the leachable fraction of those metals, then an Alternative GPL may be calculated. For this calculation, the equation for X_s is used:

$$X_s = (292.9)RC_w$$

R may be calculated by dividing the total metals concentration in soil by the results from either TCLP or SPLP leaching tests. Because the SPLP test uses a mineral acid that is considered to be less aggressive than the organic acid used for the TCLP test, the SPLP test generally yields a lower leachate metals concentration than the TCLP test. This, in turn, would result in the calculation of a higher R and thus a higher Alternative GPL. For the purpose of developing a site-specific R, either TCLP or SPLP tests may be used.

C-V. ASSESSMENT OF METHOD

The Working Group believes the methodology for deriving Minimum GPLs is reasonable and conservative for the following reasons:

1. The aquifer mixing cell configuration represents a somewhat realistic condition from the standpoint of groundwater monitoring practices. However, it is not conservative as it includes no safety factor. As the equations show, the mixing cell calculations incorporate an almost 300-fold reduction of leachate contaminant concentration due to dilution. The equations operate such that any increase in contaminant flow to the mixing cell or any reduction in mixing cell efficiency below 300-fold would result in exceeding AWQS. On the other hand, the equations do not account for ion exchange or other ion-removal mechanisms. This provides some safety factor to counterbalance the lack of a safety factor connected with the mixing cell assumptions.

2. Leachate from the zone of contaminated soil is assumed not to attenuate in either volume or concentration, no matter how great the distance between the contamination and groundwater. This provides a significant safety factor over actual field conditions.

3. The theoretical worst-case leachable fraction from a TCLP or SPLP test is 20:1. This provides the Minimum GPL with a considerable safety factor because contaminated soil rarely leaches at the 20:1 ratio. Typically, the ratio is much larger because not all metals in soil are leachable.

4. The ratio, R, is based on results from TCLP or SPLP tests which use weak acids to leach the metals from disaggregated soil samples. Actual infiltration waters are generally not as agressive as these acids, thus the R would be even greater. This provides an additional safety factor.

When an Alternative GPL is determined on the basis of the field relationship between total and leachable metals, a safety factor is still maintained because the lowest R for the site is used in calculating the Alternative GPL.

C-VI. SUMMARY OF INORGANIC SCREENING METHOD

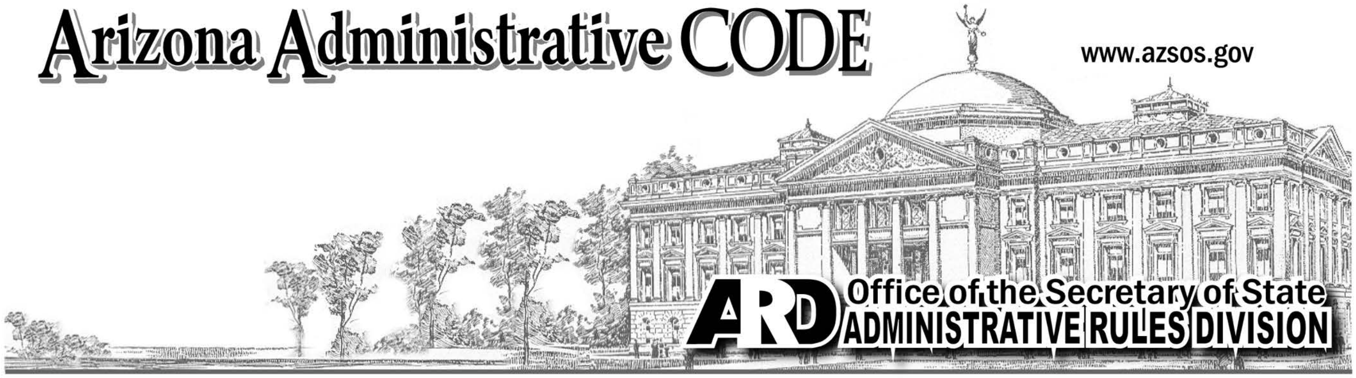
Based on the method assumptions and the safety factors described above, the Working Group believes the resulting Minimum GPL numbers are suitable for first-level screening of inorganic contaminants. As the table shows, the Residential HBGL is sufficient to protect groundwater for five of the eleven listed metals (arsenic, barium, beryllium, chromium and thallium). For non-residential cleanups, the Non-Residential HBGL is sufficiently protective only for arsenic and beryllium. In cases where the HBGL is insufficient to protect groundwater, the Minimum GPL should be used instead. However, it should be noted that the Minimum GPL is not appropriate in acid conditions (due to increased metals mobility). If site-specific data are available on the ratio between total and leachable metals for a contaminated soil, an Alternative GPL may be developed and used instead of the Minimum GPL. Finally, site-specific modeling may be used with the approval of ADEQ, but such modeling requires sufficient site characterization to adequately specify the input parameters to the model.

APPENDIX E

Arizona Aquifer Water Quality Standards

Arizona Administrative CODE

www.azsos.gov



Office of the Secretary of State
ADMINISTRATIVE RULES DIVISION

18 A.A.C. 11 **Supp. 22-4**

TITLE 18. ENVIRONMENTAL QUALITY

CHAPTER 11. DEPARTMENT OF ENVIRONMENTAL QUALITY - WATER QUALITY STANDARDS

The table of contents on page one contains links to the referenced page numbers in this Chapter.
Refer to the notes at the end of a Section to learn about the history of a rule as it was published in the *Arizona Administrative Register*.

This Chapter contains rules that were filed to be codified in the *Arizona Administrative Code* between the dates of
October 1, 2022 through December 31, 2022

Questions about these rules? Contact:

Department:	Department of Environmental Quality
Address:	1110 W. Washington St. Phoenix, AZ 85007
Website:	http://www.azdeq.gov/swpp
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Email:	Quinsey.Jonathan@azdeq.gov

The release of this Chapter in Supp. 22-4 replaces Supp. 19-3, 1-73 pages.

Please note that the Chapter you are about to replace may have rules still in effect after the publication date of this supplement. Therefore, all superseded material should be retained in a separate binder and archived for future reference.

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Scott Cancelosi, Director
ADMINISTRATIVE RULES DIVISION

RULES

The definition for a rule is provided for under A.R.S. § 41-1001. *"'Rule' means an agency statement of general applicability that implements, interprets, or prescribes law or policy, or describes the procedures or practice requirements of an agency."*

THE ADMINISTRATIVE CODE

The *Arizona Administrative Code* is where the official rules of the state of Arizona are published. The *Code* is the official codification of rules that govern state agencies, boards, and commissions.

The *Code* is separated by subject into Titles. Titles are divided into Chapters. A Chapter includes state agency rules. Rules in Chapters are divided into Articles, then Sections. The "R" stands for "rule" with a sequential numbering and lettering outline separated into subsections.

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First Quarter: January 1 - March 31
Second Quarter: April 1 - June 30
Third Quarter: July 1 - September 30
Fourth Quarter: October 1 - December 31

For example, the first supplement for the first quarter of 2022 is cited as Supp. 22-1. Supplements are traditionally released three to four weeks after the end of the quarter because filings are accepted until the last day of the quarter.

Please note: The Office publishes by Chapter, not by individual rule Section. Therefore there might be only a few Sections codified in each Chapter released in a supplement. This is why the Office lists only updated codified Sections on the previous page.

RULE HISTORY

Refer to the HISTORICAL NOTE at the end of each Section for the effective date of a rule. The note also includes the *Register* volume and page number in which the notice was published (A.A.R.) and beginning in supplement 21-4, the date the notice was published in the *Register*.

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The Office began to authenticate Chapters of the *Code* in Supp. 18-1 to comply with A.R.S. §§ 41-1012(B) and A.R.S. § 41-5505.

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An agency's exemption is written in law by the Arizona State Legislature or under a referendum or initiative passed into law by Arizona voters.

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Editor's notes at the beginning of a Chapter provide information about rulemaking Sections made by exempt rulemaking. Exempt rulemaking notes are also included in the historical note at the end of a rulemaking Section.

The Office makes a distinction to certain exemptions because some rules are made without receiving input from stakeholders or the public. Other exemptions may require an agency to propose exempt rules at a public hearing.

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Rhonda Paschal, rules managing editor, assisted with the editing of this Chapter.

Arizona Administrative Code
Publisher
Department of State
Office of the Secretary of State
Administrative Rules Division

Published electronically under the authority of A.R.S. § 41-1012.
Authentication authorized under Arizona Revised Statutes, Chapter 54, Uniform Electronic Legal Material Act.

Mailing Address:
Administrative Rules Division
Office of the Secretary of State
1700 W. Washington Street, Fl. 7
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Arizona Administrative Code **18 A.A.C. 11**

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TITLE 18. ENVIRONMENTAL QUALITY

CHAPTER 11. DEPARTMENT OF ENVIRONMENTAL QUALITY - WATER QUALITY STANDARDS

Authority: A.R.S. §§49-202(A), 49-203(A)(1)

Supp. 22-4

CHAPTER TABLE OF CONTENTS

ARTICLE 1. WATER QUALITY STANDARDS FOR SURFACE WATERS

Tables in Article 1, Appendix A have been updated and now include historical notes (Supp. 16-4).

Article 1, consisting of Appendices A through C, repealed April 24, 1996 (Supp. 96-2).

Article 1, consisting of Section R18-11-103, reserved effective April 24, 1996 (Supp. 96-2).

Article 1, consisting of Sections R18-11-105 and R18-11-106, and Appendices A and B, adopted April 24, 1996 (Supp. 96-2).

Article 1, consisting of Sections R18-11-101 and R18-11-102, R18-11-104, R18-11-107 through R18-11-109, R18-11-111 through R18-11-113, R18-11-115, R18-11-117 and R18-11-118, R18-11-120 and R18-11-121, amended effective April 24, 1996 (Supp. 96-2).

Article 1, consisting of Sections R18-11-101 through R18-11-121 and Appendices A through C, adopted effective February 18, 1992 (Supp. 92-1).

Article 1, consisting of Section R18-11-101, repealed effective February 18, 1992 (Supp. 92-1).

Article 1 consisting of Section R9-21-101 renumbered as Article 1, Section R18-11-101 (Supp. 87-3).

ARTICLE 2. WATER QUALITY STANDARDS FOR NON-WOTUS PROTECTED SURFACE WATERS

Article 2, consisting of Sections R18-11-201 through R18-11-205, adopted effective February 18, 1992 (Supp. 92-1).

Article 2, consisting of Sections R18-11-201 through R18-11-214 and Appendices A and B, repealed effective February 18, 1992 (Supp. 92-1).

Article 2 consisting of Sections R9-21-201 through R9-21-214 and Appendices A and B renumbered as Article 2, Sections R18-11-201 through R18-11-214 and Appendices A and B (Supp. 87-3).

ARTICLE 3. RECLAIMED WATER QUALITY STANDARDS

Article 3, consisting of Sections R18-11-301 through R18-11-309 and Table A, adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

Article 3 heading repealed effective April 24, 1996 (Supp. 96-2).

Article 3, consisting of Sections R18-11-301 through R18-11-304 repealed effective February 18, 1992 (Supp. 92-1).

Article 3 consisting of Sections R9-21-301 through R9-21-304 renumbered as Article 3, Sections R18-11-301 through R18-11-304 (Supp. 87-3).

ARTICLE 4. AQUIFER WATER QUALITY STANDARDS

ARTICLE 5. AQUIFER BOUNDARY AND PROTECTED USE CLASSIFICATION

New Article 5 consisting of Sections R18-11-501 through R18-11-504 and Section R18-11-506 adopted effective October 22, 1987.

Section

ARTICLE 6. IMPAIRED WATER IDENTIFICATION

Article 6, consisting of Sections R18-11-601 through R18-11-606, made by final rulemaking at 8 A.A.R. 3380, effective July 12, 2002 (Supp. 02-3).

Section

TITLE 18. ENVIRONMENTAL QUALITY

CHAPTER 11. DEPARTMENT OF ENVIRONMENTAL QUALITY - WATER QUALITY STANDARDS

ARTICLE 1. WATER QUALITY STANDARDS FOR SURFACE WATERS

R18-11-101. Definitions

The following terms apply to this Article:

1. "Acute toxicity" means toxicity involving a stimulus severe enough to induce a rapid response. In aquatic toxicity tests, an effect observed in 96 hours or less is considered acute.
2. "Agricultural irrigation (AgI)" means the use of a surface water for crop irrigation.
3. "Agricultural livestock watering (AgL)" means the use of a surface water as a water supply for consumption by livestock.
4. "Annual mean" is the arithmetic mean of monthly values determined over a consecutive 12-month period, provided that monthly values are determined for at least three months. A monthly value is the arithmetic mean of all values determined in a calendar month.
5. "Aquatic and wildlife (cold water) (A&Wc)" means the use of a surface water by animals, plants, or other cold-water organisms, generally occurring at an elevation greater than 5000 feet, for habitation, growth, or propagation.
6. "Aquatic and wildlife (effluent-dependent water) (A&Wedw)" means the use of an effluent-dependent water by animals, plants, or other organisms for habitation, growth, or propagation.
7. "Aquatic and wildlife (ephemeral) (A&We)" means the use of an ephemeral water by animals, plants, or other organisms, excluding fish, for habitation, growth, or propagation.
8. "Aquatic and wildlife (warm water) (A&Ww)" means the use of a surface water by animals, plants, or other warm-water organisms, generally occurring at an elevation less than 5000 feet, for habitation, growth, or propagation.
9. "Arizona Pollutant Discharge Elimination System (AZPDES)" means the point source discharge permitting program established under 18 A.A.C. 9, Article 9.
10. "Assimilative capacity" means the difference between the baseline water quality concentration for a pollutant and the most stringent applicable water quality criterion for that pollutant.
11. "Clean Water Act" means the Federal Water Pollution Control Act [33 U.S.C. 1251 to 1387].
12. "Complete Mixing" means the location at which concentration of a pollutant across a transect of a surface water differs by less than five percent.
13. "Criteria" means elements of water quality standards that are expressed as pollutant concentrations, levels, or narrative statements representing a water quality that supports a designated use.
14. "Critical flow conditions of the discharge" means the hydrologically based discharge flow averages that the director uses to calculate and implement applicable water quality criteria to a mixing zone's receiving water as follows:
    a. For acute aquatic water quality standard criteria, the discharge flow critical condition is represented by the maximum one-day average flow analyzed over a reasonably representative timeframe.
    b. For chronic aquatic water quality standard criteria, the discharge flow critical flow condition is represented by the maximum monthly average flow analyzed over a reasonably representative timeframe.
    c. For human health based water quality standard criteria, the discharge flow critical condition is the long-term arithmetic mean flow, averaged over several years so as to simulate long-term exposure.
15. "Critical flow conditions of the receiving water" means the hydrologically based receiving water low flow averages that the director uses to calculate and implement applicable water quality criteria:
    a. For acute aquatic water quality standard criteria, the receiving water critical condition is represented as the lowest one-day aver-age flow event expected to occur once every ten years, on average (1Q10).
    b. For chronic aquatic water quality standard criteria, the receiving water critical flow condition is represented as the lowest seven-consecutive-day average flow expected to occur once every 10 years, on average (7Q10), or
    c. For human health based water quality standard criteria, in order to simulate long-term exposure, the receiving water critical flow condition is the harmonic mean flow.
16. "Deep lake" means a lake or reservoir with an average depth of more than 6 meters.
17. "Designated use" means a use specified in Appendix B of this Article for a surface water.
18. "Domestic water source (DWS)" means the use of a surface water as a source of potable water. Treatment of a surface water may be necessary to yield a finished water suitable for human consumption.
19. "Effluent-dependent water (EDW)" means a surface water or portion of a surface water, that consists of a point source discharge without which the surface water would be ephemeral. An effluent-dependent water may be perennial or intermittent depending on the volume and frequency of the point source discharge of treated wastewater.
20. "Ephemeral water" means a surface water or portion of surface water that flows or pools only in direct response to precipitation.
21. "Existing use" means a use attained in the waterbody on or after November 28, 1975, whether or not it is included in the water quality standards.
22. "Fish consumption (FC)" means the use of a surface water by humans for harvesting aquatic organisms for consumption. Harvestable aquatic organisms include, but are not limited to, fish, clams, turtles, crayfish, and frogs.
23. "Full-body contact (FBC)" means the use of a surface water for swimming or other recreational activity that causes the human body to come into direct contact with the water to the point of complete submergence. The use is such that ingestion of the water is likely and sensitive body organs, such as the eyes, ears, or nose, may be exposed to direct contact with the water.
24. "Geometric mean" means the nth root of the product of n items or values. The geometric mean is calculated using the following formula:

$$GM_Y = \sqrt[n]{(Y_1)(Y_2)(Y_3)\ldots(Y_n)}$$

25. "Hardness" means the sum of the calcium and magnesium concentrations, expressed as calcium carbonate (CaCO3) in milligrams per liter.
26. "Igneous lake" means a lake located in volcanic, basaltic, or granite geology and soils.

27. "Intermittent water" means a surface water or portion of surface water that flows continuously during certain times of the year and more than in direct response to precipitation, such as when it receives water from a spring, elevated groundwater table or another surface source, such as melting snowpack.
28. "Mixing zone" means an area or volume of a surface water that is contiguous to a point source discharge where dilution of the discharge takes place.
29. "Oil" means petroleum in any form, including crude oil, gasoline, fuel oil, diesel oil, lubricating oil, or sludge.
30. "Outstanding Arizona water (OAW)" means a surface water that is classified as an outstanding state resource water by the Director under R18-11-112.
31. "Partial-body contact (PBC)" means the recreational use of a surface water that may cause the human body to come into direct contact with the water, but normally not to the point of complete submergence (for example, wading or boating). The use is such that ingestion of the water is not likely and sensitive body organs, such as the eyes, ears, or nose, will not normally be exposed to direct contact with the water.
32. "Perennial water" means a surface water or portion of surface water that flows continuously throughout the year.
33. "Pollutant" means fluids, contaminants, toxic wastes, toxic pollutants, dredged spoil, solid waste, substances and chemicals, pesticides, herbicides, fertilizers and other agricultural chemicals, incinerator residue, sewage, garbage, sewage sludge, munitions, petroleum products, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and mining, industrial, municipal, and agricultural wastes or any other liquid, solid, gaseous, or hazardous substance. A.R.S § 49-201(29)
34. "Pollutant Minimization Program" means a structured set of activities to improve processes and pollutant controls that will prevent and reduce pollutant loadings.
35. "Practical quantitation limit" means the lowest level of quantitative measurement that can be reliably achieved during a routine laboratory operation.
36. "Reference condition" means a set of abiotic physical stream habitat, water quality, and site selection criteria established by the Director that describe the typical characteristics of stream sites in a region that are least disturbed by environmental stressors. Reference biological assemblages of macroinvertebrates and algae are collected from these reference condition streams for calculating the Arizona Indexes of Biological Integrity thresholds.
37. "Regional Administrator" means the Regional Administrator of Region IX of the U.S. Environmental Protection Agency.
38. "Regulated discharge" means a point-source discharge regulated under an AZPDES permit, a discharge regulated by a § 404 permit, and any discharge authorized by a federal permit or license that is subject to state water quality certification under § 401 of the Clean Water Act.
39. "Riffle habitat" means a stream segment where moderate water velocity and substrate roughness produce moderately turbulent conditions that break the surface tension of the water and may produce breaking wavelets that turn the surface water into white water.
40. "Run habitat" means a stream segment where there is moderate water velocity that does not break the surface tension of the water and does not produce breaking wavelets that turn the surface water into white water.
41. "Sedimentary lake" means a lake or reservoir in sedimentary or karst geology and soils.
42. "Shallow lake" means a lake or reservoir, excluding an urban lake, with a smaller, flatter morphology and an average depth of less than 3 meters and a maximum depth of less than 4 meters.
43. "Significant degradation" means:
    a. The consumption of 20 percent or more of the available assimilative capacity for a pollutant of concern at critical flow conditions, or
    b. Any consumption of assimilative capacity beyond the cumulative cap of 50 percent of assimilative capacity.
44. "Surface water" means "WOTUS" as defined in A.R.S. § 49-201(53).
45. "Total nitrogen" means the sum of the concentrations of ammonia (NH3), ammonium ion (NH4+), nitrite (NO2), and nitrate (NO3), and dissolved and particulate organic nitrogen expressed as elemental nitrogen.
46. "Total phosphorus" means all of the phosphorus present in a sample, regardless of form, as measured by a persulfate digestion procedure.
47. "Toxic" means a pollutant or combination of pollutants, that after discharge and upon exposure, ingestion, inhalation, or assimilation into an organism, either directly from the environment or indirectly by ingestion through food chains, may cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations in the organism or its offspring.
48. "Urban lake" means a manmade lake within an urban landscape.
49. "Use attainability analysis" means a structured scientific assessment of the factors affecting the attainment of a designated use including physical, chemical, biological, and economic factors.
50. "Variance" means a time-limited designated use and criterion for a specific pollutant(s) or water quality parameter(s) that reflect the highest attainable condition during the term of the variance.
51. "Wadable" means a surface water can be safely crossed on foot and sampled without a boat.
52. "Wastewater" does not mean:
    a. Stormwater,
    b. Discharges authorized under the De Minimus General Permit,
    c. Other allowable non-stormwater discharges permitted under the Construction General Permit or the Multi-sector General Permit, or
    d. Stormwater discharges from a municipal storm sewer system (MS4) containing incidental amounts of non-stormwater that the MS4 is not required to prohibit.
53. "Wetland" means an area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. A wetland includes a swamp, marsh, bog, cienega, tinaja, and similar areas.

54. "Zone of initial dilution" means a small area in the immediate vicinity of an outfall structure in which turbulence is high and causes rapid mixing with the surrounding water.

Historical Note

Former Section R9-21-101 repealed, new Section R9-21-101 adopted effective January 29, 1980 (Supp. 80-1). Amended effective April 17, 1984 (Supp. 84-2). Amended effective January 7, 1985 (Supp. 85-1). Amended by adding subsection (C) effective August 12, 1986 (Supp. 86-4). Former Section R9-21-101 renumbered without change as Section R18-11-101 (Supp. 87-3). Former Section R18-11-101 repealed, new Section R18-11-101 adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Deleted first definition to R18-11-101(32) "Navigable Water", previously printed in error (Supp. 96-3). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3). Amended by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-102. Applicability

A. The water quality standards prescribed in this Article apply to surface waters.

B. The water quality standards prescribed in this Article do not apply to the following:
1. A waste treatment system, including an impoundment, pond, lagoon, or constructed wetland that is a part of the waste treatment system;
2. A man-made surface impoundment and any associated ditch and conveyance used in the extraction, beneficiation, or processing of metallic ores that is not a surface water or is located in an area that once was a surface water but is no longer a surface water because it has been and remains legally converted, including:
   a. A pit,
   b. Pregnant leach solution pond,
   c. Raffinate pond,
   d. Tailing impoundment,
   e. Decant pond,
   f. Pond or a sump in a mine pit associated with dewatering activity,
   g. Pond holding water that has come into contact with a process or product and that is being held for recycling,
   h. Spill or upset catchment pond, or
   i. A pond used for onsite remediation;
3. A man-made cooling pond that is neither created in a surface water nor results from the impoundment of a surface water; or
4. A surface water located on tribal lands.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-103. Repealed

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Repealed effective April 24, 1996 (Supp. 96-2).

R18-11-104. Designated Uses

A. The Director shall adopt or remove a designated use or subcategory of a designated use by rule.

B. Designated uses of a surface water may include full-body contact, partial-body contact, domestic water source, fish consumption, aquatic and wildlife (cold water), aquatic and wildlife (warm water), aquatic and wildlife (ephemeral), aquatic and wildlife (effluent-dependent water), agricultural irrigation, and agricultural livestock watering. The designated uses for specific surface waters are listed in Appendix B of this Article.

C. Numeric water quality criteria to maintain and protect water quality for the designated uses are prescribed in Appendix A, R18-11-109, R18-11-110, and R18-11-112. Narrative water quality standards to protect all surface waters are prescribed in R18-11-108.

D. If a surface water has more than one designated use listed in Appendix B, the most stringent water quality criterion applies.

E. The Director shall revise the designated uses of a surface water if water quality improvements result in a level of water quality that permits a use that is not currently listed as a designated use in Appendix B.

F. In designating uses of a surface water and in establishing water quality criteria to protect the designated uses, the Director shall take into consideration the applicable water quality standards for downstream surface waters and shall ensure that the water quality standards that are established for an upstream surface water also provide for the attainment and maintenance of the water quality standards of downstream surface waters.

G. A use attainability analysis shall be conducted prior to removal of a designated use or adoption of a subcategory of a designated use that requires less stringent water quality criteria.

H. The Director may remove a designated use or adopt a subcategory of a designated use that requires less stringent water quality criteria, provided the designated use is not an existing use and it is demonstrated through a use attainability analysis that attaining the designated use is not feasible for any of the following reasons:
1. A naturally-occurring pollutant concentration prevents the attainment of the use;
2. A natural, ephemeral, intermittent, or low-flow condition or water level prevents the attainment of the use;
3. A human-caused condition or source of pollution prevents the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;
4. A dam, diversion, or other type of hydrologic modification precludes the attainment of the use, and it is not feasible to restore the surface water to its original condition or to operate the modification in a way that would result in attainment of the use;
5. A physical condition related to the natural features of the surface water, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, precludes attainment of an aquatic life designated use; or

6. Controls more stringent than those required by § 301 (b) and § 306 of the Clean Water Act [33 U.S.C. § 1311 and § 1316] are necessary to attain the use and implementation of the controls would result in substantial and widespread economic and social impact.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1).

R18-11-105. Tributaries; Designated Uses

The following water quality standards apply to a surface water that is not listed in Appendix B but that is a tributary to a listed surface water.

1. The aquatic and wildlife (ephemeral) and partial-body contact standards apply to an unlisted tributary that is an ephemeral water.
2. The aquatic and wildlife (cold water), full-body contact, and fish consumption standards apply to an unlisted tributary that is a perennial or intermittent surface water and is above 5000 feet in elevation.
3. The aquatic and wildlife (warm water), full-body contact, and fish consumption standards apply to an unlisted tributary that is a perennial or intermittent surface water and is below 5000 feet in elevation.

Historical Note

Adopted effective April 24, 1996 (Supp. 96-2). Section heading amended per instructions of the Department of Environmental Quality, August 9, 1996 (Supp. 96-3). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1).

R18-11-106. Net Ecological Benefit

A. The Director may, by rule, modify a water quality standard on the ground that there is a net ecological benefit associated with the discharge of effluent to support or create a riparian and aquatic habitat in an area where water resources are limited. The Director may modify a water quality standard for a pollutant if it is demonstrated that:

1. The discharge of effluent creates or supports an ecologically valuable aquatic, wetland, or riparian ecosystem in an area where these resources are limited;
2. The ecological benefits associated with the discharge of effluent under a modified water quality standard exceed the environmental costs associated with the elimination of the discharge of effluent;
3. The cost of treatment to achieve compliance with a water quality standard is so high that it is more cost effective to eliminate the discharge of effluent to the surface water. The discharger shall demonstrate that it is feasible to eliminate the discharge of effluent that creates or supports the ecologically valuable aquatic, wetland, or riparian ecosystem;
4. The discharge of effluent to the surface water will not cause or contribute to a violation of a water quality standard that has been established for a downstream surface water;
5. All practicable point source discharge control programs, including local pretreatment, waste minimization, and source reduction programs are implemented; and
6. The discharge of effluent does not produce or contribute to the concentration of a pollutant in the tissues of aquatic organisms or wildlife that is likely to be harmful to humans or wildlife through food chain concentration.

B. The Director shall not modify a water quality criterion for a pollutant to be less stringent than a technology-based effluent limitation that applies to the discharge of that effluent. The discharge of effluent shall, at a minimum, comply with applicable technology-based effluent limitations.

Historical Note

Adopted effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

R18-11-107. Antidegradation

A. The Director shall, using R18-11-107.01 and this Section, determine whether there is degradation of water quality in a surface water on a pollutant-by-pollutant basis.

B. Tier 1: The level of water quality necessary to support an existing use shall be maintained and protected. No degradation of existing water quality is permitted in a surface water where the existing water quality does not meet the applicable water quality standards.

C. Tier 2: Where existing water quality in a surface water is better than the applicable water quality standard the existing water quality shall be maintained and protected. The Director may allow degradation of existing water quality in the surface water, if the Director makes all of the following findings:

1. The water quality necessary for existing uses is fully protected and water quality is not lowered to a level that does not comply with applicable water quality standards,
2. The highest statutory and regulatory requirements for new and existing point sources are achieved,
3. All cost-effective and reasonable best management practices for nonpoint source pollution control are implemented, and
4. Allowing lower water quality is necessary to accommodate important economic or social development in the area where the surface water is located.

D. Tier 3: Existing water quality shall be maintained and protected in a surface water that is classified as an OAW under R18-11-112. Degradation of an OAW under subsection (C) is prohibited.

E. The Director shall implement this Section in a manner consistent with § 316 of the Clean Water Act [33 U.S.C. 1326] if a potential water quality impairment associated with a thermal discharge is involved.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-107.01. Antidegradation Criteria

A. Tier 1 antidegradation protection.

1. Tier 1 antidegradation protection applies to the following surface waters:
   a. A surface water listed on the 303(d) list for the pollutant that resulted in the listing,
   b. An effluent dependent water,
   c. An ephemeral water,
   d. An intermittent water, and
   e. A canal listed in Appendix B.
2. A regulated discharge shall not cause a violation of a surface water quality standard or a wasteload allocation in a total maximum daily load approved by EPA.

3. Except as provided in subsections (E) and (F), Tier 1 antidegradation review requirements are satisfied for a point-source discharge regulated under an individual AZPDES permit to an ephemeral water, effluent dependent water, intermittent water, or a canal listed in Appendix B, if water quality-based effluent limitations designed to achieve compliance with applicable surface water quality standards are established in the permit and technology-based requirements of the Clean Water Act for the point source discharge are met.

B. Tier 2 antidegradation protection.

1. Tier 2 antidegradation protection applies to a perennial water with existing water quality that is better than applicable water quality standards. A perennial water that is not listed in subsection (A)(1) nor classified as an OAW under A.A.C. R18-9-112(G) has Tier 2 antidegradation protection for all pollutants of concern.
2. A regulated discharge that meets the following criteria, at critical flow conditions, does not cause significant degradation:
   a. The regulated discharge consumes less than 20 percent of the available assimilative capacity for each pollutant of concern, and
   b. At least 50 percent of the assimilative capacity for each pollutant of concern remains available in the surface water for each pollutant of concern.
3. Antidegradation review. Any person proposing a new or expanded regulated discharge under an individual AZPDES permit that may cause significant degradation shall provide ADEQ with the following information:
   a. Baseline characterization. A person seeking authorization to discharge under an individual AZPDES permit to a perennial water shall provide baseline water quality data on pollutants of concern where no data exists or there are insufficient data to characterize baseline water quality and to determine available assimilative capacity. A discharger shall characterize baseline water quality at a location upstream of the proposed discharge location;
   b. Alternative analysis.
      i. The person seeking authorization for the discharge shall prepare and submit a written analysis of alternatives to the discharge. The analysis shall provide information on all reasonable, cost-effective, less-degrading or nondegrading discharge alternatives. Alternatives may include wastewater treatment process changes or upgrades, pollution prevention measures, source reduction, water reclamation, alternative discharge locations, groundwater recharge, land application or treatment, local pretreatment programs, improved operation and maintenance of existing systems, seasonal or controlled discharge to avoid critical flow conditions, and zero discharge;
      ii. The alternatives analysis shall include cost information on base pollution control measures associated with the regulated discharge and cost information for each alternative;
      iii. The person shall implement the alternative that is cost-effective and reasonable, results in the least degradation, and is approved by the Director. An alternative is cost-effective and reasonable if treatment costs associated with the alternative are less than a 10 percent increase above the cost of base pollution control measures;
      iv. For purposes of this subsection, "base pollution control measures" are water pollution control measures required to meet technology-based requirements of the Clean Water Act and water quality-based effluent limits designed to achieve compliance with applicable water quality standards; and
   c. Social and economic justification. The person shall demonstrate to the Director that significant degradation is necessary to accommodate important economic or social development in the local area. The person seeking authorization for the discharge shall prepare a written social and economic justification that includes a description of the following:
      i. The geographic area where significant degradation of existing water quality will occur;
      ii. The current baseline social and economic conditions in the local area;
      iii. The net positive social and economic effects of development associated with the regulated discharge and allowing significant degradation;
      iv. The negative social, environmental, and economic effects of allowing significant degradation of existing water quality; and
      v. Alternatives to the regulated discharge that do not significantly degrade water quality yet may yield comparable social and economic benefits.
4. For purposes of this Section, the term "pollutant of concern" means a pollutant with either a numeric or narrative water quality standard.
5. Public participation. The Director shall provide public notice and an opportunity to comment on an antidegradation review under subsection (B)(3) and shall provide an opportunity for a public hearing under A.A.C. R18-9-A908(B).

C. Tier 3 antidegradation protection.

1. Tier 3 antidegradation protection applies only to an OAW listed in R18-11-112(G).
2. A new or expanded point-source discharge directly to an OAW is prohibited.
3. A person seeking authorization for a regulated discharge to a tributary to, or upstream of, an OAW shall demonstrate in a permit application or in other documentation submitted to ADEQ that the regulated discharge will not degrade existing water quality in the downstream OAW.
4. A discharge regulated under a § 404 permit that may affect existing water quality of an OAW requires a determination by the Director to ensure that existing water quality is maintained and protected and any water quality impacts are temporary. Temporary water quality impacts are those impacts that occur for a period of six months or less and are not regularly occurring. The form of such a determination shall be as follows:
   a. For Corps-issued § 404 permits, an individual § 401 water quality certification.
   b. For Director-issued § 404 permits, a § 404 permit action, wherein the Director shall conduct a water quality evaluation as a part of the state's requirements for issuing § 404 permits and in accordance with this Section.

D. Antidegradation review of a § 404 permit shall be conducted as follows:

1. For a Corps-issued § 404 permit. The Director shall conduct the antidegradation review of any discharge authorized under a nationwide or regional § 404 permit as part of the § 401 water quality certification prior to issuance of the nationwide or regional permit. The Director shall conduct the antidegradation review of an individual § 404 permit if the discharge may degrade existing water quality in an OAW or a water listed on the 303(d) List of impaired waters. For regulated discharges that may degrade water quality in an OAW or a water that is on the 303(d) List of impaired waters, the Director shall conduct the antidegradation review as part of the § 401 water quality certification process.
2. For a Director-issued § 404 permit. The Director shall conduct the antidegradation review of any discharge authorized under a general § 404 permit as a part of its determination whether to issue a general permit in accordance with state requirements for issuing a § 404 general permit and with this Section. The Director shall conduct the antidegradation review of an individual § 404 permit as part of the § 404 permit action in accordance with state requirements for issuing a § 404 permit and in accordance with this Section.

E. Antidegradation review of an AZPDES stormwater permit. An individual stormwater permit for a municipal separate storm sewer system (MS4) meets antidegradation requirements if the permittee complies with the permit, including developing a stormwater management plan containing controls that reduce the level of pollutants in stormwater discharges to the maximum extent practicable.

F. Antidegradation review of a general permit. The Director shall conduct the antidegradation review of a regulated discharge authorized by a general permit at the time the general permit is issued or renewed. A person seeking authorization to discharge under a general permit is not required to undergo an individual antidegradation review at the time the Notice of Intent is submitted unless the discharge may degrade existing water quality in an OAW or a water listed on the 303(d) List of impaired waters.

Historical Note

New Section made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

R18-11-108. Narrative Water Quality Standards

A. A surface water shall not contain pollutants in amounts or combinations that:

1. Settle to form bottom deposits that inhibit or prohibit the habitation, growth, or propagation of aquatic life;
2. Cause objectionable odor in the area in which the surface water is located;
3. Cause off-taste or odor in drinking water;
4. Cause off-flavor in aquatic organisms;
5. Are toxic to humans, animals, plants, or other organisms;
6. Cause the growth of algae or aquatic plants that inhibit or prohibit the habitation, growth, or propagation of other aquatic life or that impair recreational uses;
7. Cause or contribute to a violation of an aquifer water quality standard prescribed in R18-11-405 or R18-11-406; or
8. Change the color of the surface water from natural background levels of color.

B. A surface water shall not contain oil, grease, or any other pollutant that floats as debris, foam, or scum; or that causes a film or iridescent appearance on the surface of the water; or that causes a deposit on a shoreline, bank, or aquatic vegetation. The discharge of lubricating oil or gasoline associated with the normal operation of a recreational watercraft is not a violation of this narrative standard.

C. A surface water shall not contain a discharge of suspended solids in quantities or concentrations that interfere with the treatment processes at the nearest downstream potable water treatment plant or substantially increase the cost of handling solids produced at the nearest downstream potable water treatment plant.

D. A surface water shall not contain solid waste such as refuse, rubbish, demolition or construction debris, trash, garbage, motor vehicles, appliances, or tires.

E. A wadeable, perennial stream shall support and maintain a community of organisms having a taxa richness, species composition, tolerance, and functional organization comparable to that of a stream with reference conditions in Arizona.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-108.01. Narrative Biological Criteria for Wadeable, Perennial Streams

A. The narrative biological criteria in this Section apply to a wadeable, perennial stream with either an aquatic and wildlife (cold water) or an aquatic and wildlife (warm water) designated use.

B. The biological standard in R18-11-108(E) is met when a bioassessment result, as measured by the Arizona Index of Biological Integrity (IBI), for cold or warm water is:

1. Greater than or equal to the 25th percentile of reference condition, or
2. Greater than the 10th percentile of reference condition and less than the 25th percentile of reference condition and a verification bioassessment result is greater than or equal to the 25th percentile of reference condition.

C. Arizona Index of Biological Integrity (IBI) scores:

Bioassessment Result	Index of Biological Integrity Scores	
	A&Wc	A&Ww
Greater than or equal to the 25th percentile of reference condition	≥52	≥50
Greater than the 10th and less than the 25th percentile of reference condition	46 - 51	40 - 49

Historical Note

New Section made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-108.02. Narrative Bottom Deposit Criteria for Wadeable, Perennial Streams

A. The narrative bottom deposit criteria in this Section apply to wadeable, perennial streams with an aquatic and wildlife (cold water) or an aquatic and wildlife (warm water) designated use.

B. The narrative water quality standard for bottom deposits at R18-11-108(A)(1) is met when:

1. The percentage of fine sediments in the riffle habitats of a wadeable, perennial stream with an A&Wc designated use, as determined by a riffle pebble count, is less than or equal to 30 percent.
2. The percentage of fine sediments in all stream habitats of a wadeable, perennial stream with an A&Ww designated use, as determined by a reach level pebble count, is equal to or less than 50 percent.

Historical Note

New Section made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-108.03. Narrative Nutrient Criteria for Lakes and Reservoirs

A. The narrative nutrient criteria in this Section apply to those lakes and reservoirs categorized in Appendix B.

B. The narrative water quality standard for nutrients at R18-11-108(A)(6) is met when, based on a minimum of two lake sample events conducted during the peak season based on lake productivity, the results show an average chlorophyll-*a* value below the applicable threshold for designated use and lake and reservoir category in subsection (D).

1. The mean chlorophyll-*a* concentration is less than the lower value in the target range chlorophyll-*a* for the lake and reservoir category, or
2. The mean chlorophyll-*a* concentration is within the target range for the lake and reservoir category and:
   a. The mean blue green algae count is at or below 20,000 per milliliter, and
   b. The blue green algae count is less than 50 percent of the total algae count, and
   c. There is no evidence of nutrient-related impairments such as:
      i. An exceedance of dissolved oxygen or pH standards;
      ii. A fish kill coincident with a dissolved oxygen or pH exceedance;
      iii. A fish kill or other aquatic organism mortality coincident with algal toxicity;
      iv. Secchi depth is less than the lower value prescribed for the lake and reservoir category;
      v. A nuisance algal bloom is present in the limnetic portion of the lake or reservoir; or
      vi. The concentration of total phosphorous, total nitrogen, or total Kjehldal nitrogen (TKN) is greater than the upper value in the range prescribed for the lake and reservoir category; or
3. For a shallow lake. In addition to meeting the mean chlorophyll-*a* concentrations in subsections (B)(1) or (2), submerged aquatic vegetation covers 50 percent or less of the lake bottom and there is less than a 5 mg/L swing in diel-dissolved oxygen concentration measured within the photic zone.

C. The following threshold ranges apply during the peak season for lake productivity:

1. Warm water lakes peak season, April – October;
2. Cold water lakes peak season, May – September.

D. The following table lists the numeric targets for lakes and reservoirs.

NUMERIC TARGETS FOR LAKES AND RESERVOIRS

Designated Use	Lake Category	Chl-*a* (µg/L)	Secchi Depth (m)	Total Phosphorus (µg/L)	Total Nitrogen (mg/L)	Total Kjehldal Nitrogen (TKN) (mg/L)	Blue-Green Algae (per ml)	Blue-Green Algae (% of total count)	Dissolved Oxygen (mg/L)	pH (SU)
FBC and PBC	Deep	10-15	1.5-2.5	70-90	1.2-1.4	1.0-1.1	20,000			6.5-9.0
	Shallow	10-15	1.5-2.0	70-90	1.2-1.4	1.0-1.1				
	Igneous	20-30	0.5-1.0	100-125	1.5-1.7	1.2-1.4				
	Sedimentary	20-30	1.5-2.0	100-125	1.5-1.7	1.2-1.4				
	Urban	20-30	0.5-1.0	100-125	1.5-1.7	1.2-1.4				
A&Wc	All	5-15	1.5-2.0	50-90	1.0-1.4	0.7-1.1		<50	7 (top m)	6.5-9.0
A&Ww	All (except urban lakes)	25-40	0.8-1.0	115-140	1.6-1.8	1.3-1.6			6 (top m)	
	Urban	30-50	0.7-1.0	125-160	1.7-1.9	1.4-1.7				
A&Wedw	All	30-50	0.7-1.0	125-160	1.7-1.9	1.4-1.7				6.5-9.0
DWS	All	10-20	0.5-1.5	70-100	1.2-1.5	1.0-1.2	20,000			5.0-9.0

Historical Note

New Section made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-109. Numeric Water Quality Standards

A. *E. coli* bacteria. The following water quality standards for *Escherichia coli* (*E. coli*) are expressed in colony forming units per 100 milliliters of water (cfu / 100 ml) or as a Most Probable Number (MPN):

E. coli	**FBC**	**PBC**
Geometric mean (minimum of four samples in 30 days)	126	126
Statistical threshold value	410	576

B. pH. The following water quality standards for pH are expressed in standard units:

pH	**DWS**	**FBC, PBC, A&W[1]**	**AgI**	**AgL**
Maximum	9.0	9.0	9.0	9.0
Minimum	5.0	6.5	4.5	6.5

Footnotes:

1. "1" Includes A&Wc, A&Ww, A&Wedw, and A&We.

C. The maximum allowable increase in ambient water temperature, due to a thermal discharge is as follows:

A&Ww	A&Wedw	A&Wc
3.0° C	3.0° C	1.0° C

D. Suspended sediment concentration.

1. The following water quality standards for suspended sediment concentration, expressed in milligrams per liter (mg/L), are expressed as a median value determined from a minimum of four samples collected at least seven days apart:

A&Wc	A&Ww
25	80

2. The Director shall not use the results of a suspended sediment concentration sample collected during or within 48 hours after a local storm event to determine the median value.

E. Dissolved oxygen. A surface water meets the water quality standard for dissolved oxygen when either:

1. The percent saturation of dissolved oxygen is equal to or greater than 90 percent, or
2. The single sample minimum concentration for the designated use, as expressed in milligrams per liter (mg/L) is as follows:

Designated Use	Single sample minimum concentration in mg/L
A&Ww	6.0
A&Wc	7.0
A&W edw for a sample taken from three hours after sunrise to sunset	3.0
A&W edw for a sample taken from sunset to three hours after sunrise	1.0

The single sample minimum concentration is the same for the designated use in a lake, but the sample must be taken from a depth no greater than one meter.

F. Nutrient criteria. The following are water quality standards for total phosphorus and total nitrogen (expressed in milligrams per liter (mg/L)) that apply to the surface waters listed below. A minimum of 10 samples, each taken at least 10 days apart in a consecutive 12-month period, are required to determine a 90th percentile. Not more than 10 percent of the samples may exceed the 90th percentile value listed below. The Director will apply these water quality standards for total phosphorus and total nitrogen to the surface waters listed below, and to their perennial tributaries, if listed. The Director may also apply these total phosphorus and total nitrogen standards to any source discharging to any tributary (ephemeral, intermittent, effluent dependent water, or perennial) of the surface waters listed below, if necessary to protect nutrient water quality in the listed surface water, based on the volume, frequency, magnitude and duration of the discharge, and distance to the downstream surface water listed below:

1. Verde River and its perennial tributaries from the Verde headwaters to Bartlett Lake:

Surface Water	Annual Mean	90th Percentile	Single Sample Maximum
Total phosphorus	0.10	0.30	1.00
Total nitrogen	1.00	1.50	3.00

2. Black River, Tonto Creek and their perennial tributaries for any segments that are not located on tribal lands:

Surface Water	Annual Mean	90th Percentile	Single Sample Maximum
Total phosphorus	0.10	0.20	0.80
Total nitrogen	0.50	1.00	2.00

3. Salt River and its perennial tributaries above Roosevelt Lake for any segments that are not located on tribal lands:

Surface Water	Annual Mean	90th Percentile	Single Sample Maximum
Total phosphorus	0.12	0.30	1.00
Total nitrogen	0.60	1.20	2.00

4. Salt River below Stewart Mountain Dam to its confluence with the Verde River:

Surface Water	Annual Mean	90th Percentile	Single Sample Maximum
Total phosphorus	0.05	–	0.20
Total nitrogen	0.60	–	3.00

5. Little Colorado River and its perennial tributaries upstream from:
   a. The headwaters to River Reservoir,
   b. South Fork of Little Colorado River at 34°00’49”/109°24’18” to above South Fork Campground at 34°04’49”/109°24’18”, and
   c. The headwaters of Water Canyon Creek to the Apache-Sitgreaves National Forest boundary:

Surface Water	Annual Mean	90th Percentile	Single Sample Maximum
Total phosphorus	0.08	0.10	0.75
Total nitrogen	0.60	0.75	1.10

6. From the Little Colorado River and State Route 260 at 34°06’39”/109°18’55” to Lyman Lake:

Surface Water	Annual Mean	90th Percentile	Single Sample Maximum
Total phosphorus	0.20	0.30	0.75
Total nitrogen	0.70	1.20	1.50

7. Colorado River at the Northern International Boundary near Morelos Dam:

Surface Water	Annual Mean	90th Percentile	Single Sample Maximum
Total phosphorus	–	0.33	–
Total nitrogen	–	2.50	–

8. Oak Creek from its headwaters at 35°01'30"/111°44'12" to its confluence with the Verde River and the West Fork of Oak Creek from its headwaters at 35°02'44"/111°54'48" to its confluence with Oak Creek.

Surface Water	Annual Mean	90th Percentile	Single Sample Maximum
Total phosphorus	0.1	0.25	0.30

Total nitrogen	1.00	1.50	2.50

9. No discharge of wastewater to Show Low Creek or its perennial tributaries upstream of and including Fools Hollow Lake shall exceed 0.16 mg/L total phosphates as P.
10. No discharge of wastewater to the San Francisco River or its perennial tributaries upstream of Luna Lake Dam shall exceed 1.0 mg/L total phosphates as P.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

R18-11-110. Salinity Standards for the Colorado River

A. The flow-weighted average annual salinity in the lower main stem of the Colorado River shall not exceed the following criteria:

Location	**Total Dissolved Solids**
Below Hoover Dam	723 mg/L
Below Parker Dam	747 mg/L
At Imperial Dam	879 mg/L

B. The plan of implementation contained in the "2014 Review, Water Quality Standards for Salinity, Colorado River System," approved October 2014, is incorporated by reference to preserve the basin-wide approach to salinity control developed by the Colorado River Basin Salinity Control Forum and to ensure compliance with the numeric criteria for salinity in subsection (A). This material does not include any later amendments or editions of the incorporated material. Copies of the incorporated material are available for inspection at the Arizona Department of Environmental Quality, 1110 West Washington Street, Phoenix, Arizona 85007 or may be obtained from the Colorado River Basin Salinity Control Forum, 106 West 500 South, Suite 101, Bountiful, Utah 84010-6232 or at http://www.coloradoriversalinity.org/.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

R18-11-111. Analytical Methods

A. A person conducting an analysis of a sample taken to determine compliance with a water quality standard shall use an analytical method prescribed in A.A.C. R9-14-610, 40 CFR 136.3, or an alternative analytical method approved under A.A.C. R9-14-610(C).

B. A test result from a sample taken to determine compliance with a water quality standard is valid only if the sample is analyzed by a laboratory that is licensed by the Arizona Department of Health Services, an out-of-state laboratory licensed under A.R.S. § 36-495.14, or a laboratory exempted under A.R.S. § 36-495.02, for the analysis performed.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-112. Outstanding Arizona Waters

A. The Director shall classify a surface water as an outstanding Arizona water (OAW) by rule.

B. The Director may adopt, under R18-11-115, a site-specific standard to maintain and protect existing water quality in an OAW.

C. Any person may nominate a surface water for classification as an OAW by filing a nomination with the Director. The nomination shall include:

1. A map and a description of the surface water;
2. A written statement in support of the nomination, including specific reference to the applicable criteria for an OAW classification prescribed in subsection (D);
3. Supporting evidence demonstrating that the criteria prescribed in subsection (D) are met; and
4. Available water quality data relevant to establishing the baseline water quality of the proposed OAW.

D. The Director may classify a surface water as an OAW based upon the following criteria:

1. The surface water is a perennial or intermittent water;
2. The surface water is in a free-flowing condition. For purposes of this subsection, "in a free-flowing condition" means that a surface water does not have an impoundment, diversion, channelization, rip-rapping or other bank armor, or another hydrological modification within the reach nominated for an OAW classification;
3. The surface water has good water quality. For purposes of this subsection, "good water quality" means that the surface water has water quality that meets or is better than applicable surface water quality standards. A surface water that is listed as impaired under R18-11-604(E) is ineligible for OAW classification; and
4. The surface water meets one or both of the following conditions:
    a. The surface water is of exceptional recreational or ecological significance because of its unique attributes, such as the geology, flora and fauna, water quality, aesthetic value, or the wilderness characteristic of the surface water;
    b. An endangered or threatened species is associated with the surface water and the existing water quality is essential to the species' maintenance and propagation or the surface water provides critical habitat for the threatened or endangered species. An endangered or threatened species is identified in "Endangered and Threatened Wildlife," 50 CFR 17.11 (revised 2005), and "Endangered and Threatened Plants," 50 CFR 17.12 (revised 2005). This material is incorporated by reference and does not include any later amendments or editions of the incorporated material. Copies of the incorporated material are available for inspection at the Arizona Department of Environmental Quality, 1110 West Washington Street, Phoenix, Arizona 85007 or may be obtained from the National Archives and Records Administration at http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1.

E. The Director shall hold at least one public meeting in the local area of a surface water that is nominated for classification as an OAW to solicit public comment on the nomination.

F. The Director shall consider the following factors when deciding whether to classify a surface water as an OAW:
   1. Whether there is the ability to manage the surface water and its watershed to maintain and protect existing water quality;
   2. The social and economic impact of Tier 3 antidegradation protection;
   3. The public comments in support of, or in opposition to, an OAW classification;
   4. The timing of the nomination relative to the triennial review of surface water quality standards;
   5. The consistency of an OAW classification with applicable water quality management plans; and
   6. Whether the nominated surface water is located within a national or state park, national monument, national recreation area, wilderness area, riparian conservation area, area of critical environmental concern, or it has another special use designation (for example, Wild and Scenic River).

G. The following surface waters are classified as OAWs:
   1. The West Fork of the Little Colorado River, from its headwaters to Government Springs (approximately 9.1 river miles);
   2. Oak Creek, from its headwaters to its confluence with the Verde River (approximately 50.3 river miles);
   3. West Fork of Oak Creek, from its headwaters to its confluence with Oak Creek (approximately 15.8 river miles);
   4. Peeples Canyon Creek, from its headwaters to its confluence with the Santa Maria River (approximately 8.1 river miles);
   5. Burro Creek, from its headwaters to its confluence with Boulder Creek (approximately 29.5 miles);
   6. Francis Creek, from its headwaters to its confluence with Burro Creek (approximately 22.9 river miles);
   7. Bonita Creek, from its boundary of the San Carlos Indian Reservation to its confluence with the Gila River (approximately 14.7 river miles);
   8. Cienega Creek, from its confluence with Gardner Canyon to the USGS gaging station (#09484600) (approximately 28.3 river miles);
   9. Aravaipa Creek, from its confluence with Stowe Gulch to the downstream boundary of the Aravaipa Canyon Wilderness Area (approximately 15.5 river miles);
   10. Cave Creek, from its headwaters to the Coronado National Forest boundary (approximately 10.4 river miles);
   11. South Fork of Cave Creek, from its headwaters to its confluence with Cave Creek (approximately 8.6 river miles);
   12. Buehman Canyon Creek, from its headwaters to its confluence with unnamed tributary at 32°24'31"/110°32'08" (approximately 9.8 river miles);
   13. Lee Valley Creek, from its headwaters to Lee Valley Reservoir (approximately 1.6 river miles);
   14. Bear Wallow Creek, from its headwaters to the boundary of the San Carlos Indian Reservation (approximately 4.25 river miles);
   15. North Fork of Bear Wallow Creek, from its headwaters to its confluence with Bear Wallow Creek (approximately 3.8 river miles);
   16. South Fork of Bear Wallow Creek, from its headwaters to its confluence with Bear Wallow Creek (approximately 3.8 river miles);
   17. Snake Creek, from its headwaters to its confluence with the Black River (approximately 6.2 river miles);
   18. Hay Creek, from its headwaters to its confluence with the West Fork of the Black River (approximately 5.5 river miles);
   19. Stinky Creek, from the White Mountain Apache Indian Reservation boundary to its confluence with the West Fork of the Black River (approximately 3.0 river miles);
   20. KP Creek, from its headwaters to its confluence with the Blue River (approximately 12.7 river miles);
   21. Davidson Canyon, from the unnamed spring at 31°59'00"/110°38'49" to its confluence with Cienega Creek; and
   22. Fossil Creek, from its headwaters at the confluence of Sandrock and Calf Pen Canyons above Fossil Springs to its confluence with the Verde River (approximately 17.2 river miles).

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Added "water quality standards" to R18-11-112, previously omitted in error (Supp. 96-3). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

R18-11-113. Effluent-Dependent Waters

A. The Director shall classify a surface water as an effluent-dependent water by rule.

B. The Director may adopt, under R18-11-115, a site-specific water quality standard for an effluent-dependent water.

C. Any person may submit a petition for rule adoption requesting that the Director classify a surface water as an effluent-dependent water. The petition shall include:
   1. A map and a description of the surface water;
   2. Information that demonstrates that the surface water consists of a point source discharge of wastewater; and
   3. Information that demonstrates that, without a point source discharge of a wastewater, the receiving water is an ephemeral water.

D. The Director shall use the water quality standards that apply to an effluent-dependent water to derive water quality-based effluent limits for a point source discharge of wastewater to an ephemeral water.

E. The Director may use aquatic and wildlife (edw) acute standards only to derive water quality based effluent limits for a sporadic, infrequent, or emergency point source discharge to an ephemeral water or to an effluent-dependent water. The Director shall consider the following factors when deciding whether to apply A&Wedw (acute) standards:
   1. The amount, frequency, and duration of the discharge;
   2. The length of time water may be present in the receiving water;
   3. The distance to a downstream water with aquatic and wildlife chronic standards; and
   4. The likelihood of chronic exposure to pollutants.

F. The Director may establish alternative water quality-based effluent limits in an AZPDES permit based on seasonal differences in the discharge.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective December 18, 1992 (Supp. 92-4). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-114. Mixing Zones

A. The Director may establish a mixing zone for a point source discharge to a surface water as a condition of an individual AZPDES permit on a pollutant-by-pollutant basis. A mixing zone is prohibited in an ephemeral water or where there is no water for dilution, or as prohibited pursuant to subsection (H).

B. The owner or operator of a point source seeking the establishment of a mixing zone shall submit a request to the Director for a mixing zone as part of an application for an AZPDES permit. The request shall include:

1. An identification of the pollutant for which the mixing zone is requested;
2. A proposed outfall design;
3. A definition of the boundary of the proposed mixing zone. For purposes of this subsection, the boundary of a mixing zone is where complete mixing occurs; and
4. A complete and detailed description of the existing physical, biological, and chemical conditions of the receiving water and the predicted impact of the proposed mixing zone on those conditions. The description shall also address the factors listed in subsection (D) that the Director must consider when deciding to grant or deny a request and shall address the mixing zone requirements in subsection (H).

C. The Director shall consider the following factors when deciding whether to grant or deny a request for a mixing zone:

1. The assimilative capacity of the receiving water;
2. The likelihood of adverse human health effects;
3. The location of drinking water plant intakes and public swimming areas;
4. The predicted exposure of biota and the likelihood that resident biota will be adversely affected;
5. Bioaccumulation;
6. Whether there will be acute toxicity in the mixing zone, and, if so, the size of the zone of initial dilution;
7. The known or predicted safe exposure levels for the pollutant for which the mixing zone is requested;
8. The size of the mixing zone;
9. The location of the mixing zone relative to biologically sensitive areas in the surface water;
10. The concentration gradient of the pollutant within the mixing zone;
11. Sediment deposition;
12. The potential for attracting aquatic life to the mixing zone; and
13. The cumulative impacts of other mixing zones and other discharges to the surface water.

D. Director determination.

1. The Director shall deny a request to establish a mixing zone if a water quality standard will be violated outside the boundaries of the proposed mixing zone.
2. If the Director approves the request to establish a mixing zone, the Director shall establish the mixing zone as a condition of an AZPDES permit. The Director shall include any mixing zone condition in the AZPDES permit that is necessary to protect human health and the designated uses of the surface water.

E. Any person who is adversely affected by the Director's decision to grant or deny a request for a mixing zone may appeal the decision under A.R.S. § 49-321 et seq. and A.R.S. § 41-1092 et seq.

F. The Director shall reevaluate a mixing zone upon issuance, reissuance, or modification of the AZPDES permit for the point source or a modification of the outfall structure.

G. Mixing zone requirements.

1. A mixing zone shall be as small as practicable in that it shall not extend beyond the point in the waterbody at which complete mixing occurs under the critical flow conditions of the discharge and of the receiving water.
2. The total horizontal area allocated to all mixing zones on a lake shall not exceed 10 percent of the surface area of the lake.
3. Adjacent mixing zones in a lake shall not overlap or be located closer together than the greatest horizontal dimension of the largest mixing zone.
4. The design of any discharge outfall shall maximize initial dilution of the wastewater in a surface water.
5. The size of the zone of initial dilution in a mixing zone shall prevent lethality to organisms passing through the zone of initial dilution. The mixing zone shall prevent acute toxicity and lethality to organisms passing through the mixing zone.

H. The Director shall not establish a mixing zone in an AZPDES permit for the following persistent, bioaccumulative pollutants:

1. Chlordane,
2. DDT and its metabolites (DDD and DDE),
3. Dieldrin,
4. Dioxin,
5. Endrin,
6. Endrin aldehyde,
7. Heptachlor,
8. Heptachlor epoxide,
9. Lindane,
10. Mercury,
11. Polychlorinated biphenyls (PCBs), and
12. Toxaphene.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

R18-11-115. Site-Specific Standards

A. The Director shall adopt a site-specific standard by rule.

B. The Director may adopt a site-specific standard based upon a request or upon the Director's initiative for any of the following reasons:

1. Local physical, chemical, or hydrological conditions of a surface water such as pH, hardness, fate and transport, or temperature alters the biological availability or toxicity of a pollutant;
2. The sensitivity of resident aquatic organisms that occur in a surface water to a pollutant differs from the sensitivity of the species used to derive the numeric water quality standards to protect aquatic life in Appendix A;
3. Resident aquatic organisms that occur in a surface water represent a narrower mix of species than those in the dataset used by ADEQ to derive numeric water quality standards to protect aquatic life in Appendix A;
4. The natural background concentration of a pollutant is greater than the numeric water quality standard to protect aquatic life prescribed in Appendix A. "Natural background" means the concentration of a pollutant in a surface water due only to non-anthropogenic sources; or

5. Other factors or combination of factors that upon review by the Director warrant changing a numeric water quality standard for a surface water.

C. Site-specific standard by request. To request that the Director adopt a site-specific standard, a person must conduct a study to support the development of a site-specific standard using a scientifically-defensible procedure.

1. Before conducting the study, a person shall submit a study outline to the Director for approval that contains the following elements:
    a. Identifies the pollutant;
    b. Describes the reach's boundaries;
    c. Uses one of the following procedures, as defined by the most recent EPA guidance documents:
        i. The recalculation procedure,
        ii. The water effects ratio for metals,
        iii. The streamlined water effects ratio, or
        iv. The Biotic ligand model.
    d. Demonstrates that all designated uses are protected.
2. Alternatively, a study outline submitted for the Director's approval must contain the following elements:
    a. Identifies the pollutant;
    b. Describes the reach's boundaries;
    c. Describes the hydrologic regime of the waterbody;
    d. Describes the scientifically-defensible procedure, which can include relevant aquatic life studies, ecological studies, laboratory tests, biological translators, fate and transport models, and risk analyses;
    e. Describes and compares the taxonomic composition, distribution and density of the aquatic biota within the reach to a reference reach and describes the basis of any major taxonomic differences;
    f. Describes the pollutant's effect on the affected species or appropriate surrogate species and on the other designated uses listed for the reach;
    g. Demonstrates that all designated uses are protected; and
    h. A person seeking to develop a site-specific standard based on natural background may use statistical or modeling approaches to determine natural background concentration. Modeling approaches include Better Assessment Science Integrating Source and Nonpoint Sources (Basins), Hydrologic Simulation Program-Fortran (HSPF), and Hydrologic Engineering Center (HEC) programs developed by the U.S. Army Corps of Engineers.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Section repealed by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). New Section made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

R18-11-116. Resource Management Agencies

Nothing in this Article prohibits fisheries management activities by the Arizona Game and Fish Department or the U.S. Fish and Wildlife Service. This Article does not exempt fish hatcheries from AZPDES permit requirements.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-117. Canals and Urban Park Lakes

A. Nothing in this Article prevents the routine physical or mechanical maintenance of canals, drains, and the urban lakes identified in Appendix B. Physical or mechanical maintenance includes dewatering, lining, dredging, and the physical, biological, or chemical control of weeds and algae. Increases in turbidity that result from physical or mechanical maintenance activities are permitted in canals, drains, and the urban lakes identified in Appendix B.

B. The discharge of lubricating oil associated with the start-up of well pumps that discharge to canals is not a violation of R18-11-108(B).

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-118. Dams and Flood Control Structures

Increases in turbidity that result from the routine physical or mechanical maintenance of a dam or flood control structure are not violations of this Article. Nothing in this Article requires the release of water from a dam or a flood control structure.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

R18-11-119. Natural background

Where the concentration of a pollutant exceeds a water quality standard and the exceedance is not caused by human activity but is due solely to naturally-occurring conditions, the exceedance shall not be considered a violation of the water quality standard.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1).

R18-11-120. Enforcement of Non-permitted Discharges

A. The Department may establish a numeric water quality standard at a concentration that is below the practical quantitation limit. Therefore, in enforcement actions pursuant to subsection (B), the water quality standard is enforceable at the practical quantitation limit.

B. Except for chronic aquatic and wildlife criteria, for non-permitted discharge violations, the Department shall determine compliance with numeric water quality standard criteria from the analytical result of a single sample, unless additional samples are required under this article. For chronic aquatic and wildlife criteria, compliance for non-permitted discharge violations shall be determined from the geometric mean of the analytical results of the last four samples taken at least 24 hours apart. For the purposes of this Section, a "non-permitted discharge violation" does not include a discharge regulated under an AZPDES permit.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

R18-11-121. Schedules of Compliance

A compliance schedule in an AZPDES permit shall require the permittee to comply with a discharge limitation based upon a new or revised water quality standard as soon as possible to achieve compliance. The permittee shall demonstrate that all requirements under § 301(b) and § 306 of the Clean Water Act [33 U.S.C. 1311(b) and 1316] are achieved and that the point source cannot comply with a discharge limitation based upon the new or revised water quality standard through the application of existing water pollution control technology, operational changes, or source reduction. In establishing a compliance schedule, the Director shall consider:

1. How much time the permittee has already had to meet any effluent limitations under a prior permit;
2. The extent to which the permittee has made good faith efforts to comply with the effluent limitations and other requirements in a prior permit;
3. Whether treatment facilities, operations, or measures must be modified to meet the effluent limitations;
4. How long any necessary modifications would take to implement; and
5. Whether the permittee would be expected to use the same treatment facilities, operations or other measures to meet the effluent limitations as it would have used to meet the effluent limitations in a prior permit.

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Amended effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

R18-11-122. Variances

A. Upon request, the Director may establish, by rule, a discharger-specific or water segment(s)-specific variance from a water quality standard if requirements pursuant to this Section are met.

B. A person who requests a variance must demonstrate all of the following information:

1. Identification of the specific pollutant and water quality standard for which a variance is sought.
2. Identification of the receiving surface water segment or segments to which the variance would apply.
3. A detailed discussion of the need for the variance, including the reasons why compliance with the water quality standard cannot be achieved over the term of the proposed variance, and any other useful information or analysis to evaluate attainability.
4. A detailed discussion of the discharge control technologies that are available for achieving compliance with the water quality standard for which a variance is sought.
5. Documentation that more advanced treatment technology than applicable technology-based effluent limitations is necessary to achieve compliance with the water quality standard for which a variance is sought.
6. A detailed description of proposed interim discharge limitations and pollutant control activities that represent the highest level of treatment achievable by a point source discharger or dischargers during the term of the variance.
7. Documentation that the proposed term is only as long as necessary to achieve the highest attainable condition.
8. Documentation that is appropriate to the type of use to which the variance would apply as follows:
    a. For a water quality standard variance to a use specified in Clean Water Act § 101(a)(2), documentation must include demonstration of at least one of the following factors that preclude attainment of the use during the term of the variance:
        i. Naturally occurring pollutant concentrations prevent attainment of the use;
        ii. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met;
        iii. That human-caused conditions or sources of pollution prevent the attainment of the water quality standard for which the variance is sought and either (1) it is not possible to remedy the conditions or sources of pollution or (2) remedying the human-caused conditions would cause more environmental damage to correct than to leave in place;
        iv. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification n a way that would result in the attainment of the use;
        v. Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses;
        vi. That installation and operation of each of the available discharge technologies more advanced than those required to comply with technology-based effluent limitations to achieve compliance with the water quality standard would result in substantial and widespread economic and social impact; or
        vii. Actions necessary to facilitate lake, wetland, or stream restoration through dam removal or other significant reconfiguration activities preclude attainment of the designated use and criterion while the actions are being implemented.
    b. For a water quality standard variance to a use other than those uses specified in Clean Water Act § 101(a)(2), documentation must justify how consideration and value of the water subject to the use appropriately supports the variance and term. A demonstration consistent with (B)(8)(a) of this Section may be used to satisfy this requirement.
9. For a waterbody segment(s)-specific variance, the following information is required before the Director may issue a variance, in addition to all other required documentation pursuant to this Section:
    a. Identification and documentation of any cost-effective and reasonable best management practices for nonpoint source controls related to the pollutant(s) or water quality parameter(s) and water body or waterbody segment(s) specified in the variance that

could be implemented to make progress towards attaining the underlying designated use and criterion; and

b. If any variance pursuant to subsection (B)(9)(a) previously applied to the water body or waterbody segment(s), documentation must also demonstrate whether and to what extent best management practices for nonpoint source controls were implemented to address the pollutant(s) or water quality parameter(s) subject to the water quality variance and the water quality progress achieved.

10. For a discharger-specific variance, the following information is required before the Director may issue a variance, in addition to all other required documentation pursuant to this Section:
    a. Identification of the permittee subject to the variance;
    b. For an existing point source discharge, a detailed description of the existing discharge control technologies that are used to achieve compliance with applicable water quality standards. For a new point source discharge, a detailed description of the proposed discharge control technologies that will be used to achieve compliance with applicable water quality standards; and
    c. Documentation that the existing or proposed discharge control technologies will comply with applicable technology-based effluent limitations.

C. The Director shall consider the following factors when deciding whether to grant or deny a variance request:
1. Bioaccumulation,
2. The predicted exposure of biota and the likelihood that resident biota will be adversely affected,
3. The known or predicted safe exposure levels for the pollutant for which the variance is requested, and
4. The likelihood of adverse human health effects.

D. The variance shall represent the highest attainable condition of the water body or water body segment applicable throughout the term of the variance.

E. A variance shall not result in any lowering of the currently attained ambient water quality, unless the variance is necessary for restoration activities, consistent with subsection (B)(8)(a)(vii). The Director must specify the highest attainable condition of the water body or waterbody segment as a quantifiable expression of one of the following:
1. The highest attainable interim criterion,
2. The interim effluent condition that reflects the greatest pollutant reduction achievable; or
3. If no additional feasible pollutant control technology can be identified, the interim criterion or interim effluent condition that reflects the greatest pollutant reduction achievable with the pollutant control technologies installed at the time of the issuance of the variance, and the adoption and implementation of a Pollutant Minimization Program.

F. A variance shall not modify the underlying designated use and criterion. A variance is only a time limited exception to the underlying standard. For discharge-specific variances, other point source dischargers to the surface water that are not granted a variance shall still meet all applicable water quality standards.

G. Point source discharges shall meet all other applicable water quality standards for which a variance is not granted.

H. The Director may not grant a variance for a point source discharge to an OAW listed in R18-11-112(G).

I. Each variance established by the Director is subject to review and approval by the Regional Administrator.

J. The term of the water quality variance may only be as long as necessary to achieve the highest attainable condition and must be consistent with the supporting documentation in subsection (E). The variance term runs from the approval of the variance by the Regional Administrator.

K. The Director shall reevaluate, in its triennial review, whether each variance continues to represent the highest attainable condition. Comment on the variance shall be considered regarding whether the variance continues to represent the highest attainable condition. If the Director determines that the requirements of the variance do not represent the highest attainable condition, then the Director shall modify or repeal the variance in its triennial review rulemaking.

L. If the variance is modified by rulemaking, the requirements of the variance shall represent the highest attainable condition at the time of initial adoption of the variance, or the highest attainable condition identified during the current reevaluation, whichever is more stringent.

M. Upon expiration of a variance, point source dischargers shall comply with the water quality standard.

N. The following are discharger-specific variances adopted by the Director:

O. The following are water body and waterbody segment-specific variances adopted by the Director:

Historical Note

Adopted effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

R18-11-123. Discharge Prohibitions

A. The discharge of wastewater to the following surface waters is prohibited:
1. Sabino Canyon Creek;
2. Vekol Wash, upstream of the Ak-Chin Indian Reservation; and
3. Smith Wash, upstream of the Ak-Chin Indian Reservation.

B. The discharge to Lake Powell of human body wastes and the wastes from toilets and other receptacles intended to receive or retain wastes from a vessel is prohibited.

Historical Note

Adopted effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4).

Appendix A. Numeric Water Quality Standards

Table 1. Water Quality Criteria By Designated Use (see f)Footnotes

Parameter	CAS NUMBER	DWS (µg/L)	FC (µg/L)	FBC (µg/L)	PBC (µg/L)	A&Wc Acute (µg/L)	A&Wc Chronic (µg/L)	A&Ww Acute (µg/L)	A&Ww Chronic (µg/L)	A&Wedw Acute| (µg/L)	A&Wedw Chronic (µg/L)	A&We Acute (µg/L)	AgI (µg/L)	AgL (µg/L)
Acenaphthene	83329	420	198	56,000	56,000	850	550	850	550	850	550			
Acrolein	107028	3.5	1.9	467	467	3	3	3	3	3	3			
Acrylonitrile	107131	0.06	0.2	3	37,333	3,800	250	3,800	250	3,800	250			
Alachlor	15972608	2		9,333	9,333	2,500	170	2,500	170	2,500	170			
Aldrin	309002	0.002	0.00005	0.08	28	3		3		3		4.5	0.003	See (b)
Alpha Particles (Gross) Radioactivity		15 pCi/L See (h)												
Ammonia	7664417					See (e) & Tables 11 (present) & 14 (absent)	See (e) & Tables 13 (present) & 17 (absent)	See (e) & Tables 12 (present) & 15 (absent)	See (e) & Tables 13 (present) & 16 (absent)	See (e) & Table 15 (absent)	See (e) & Table 16 (absent)			
Anthracene	120127	2,100	74	280,000	280,000									
Antimony	7440360	6 T	640 T	747 T	747 T	88 D	30 D	88 D	30 D	1,000 D	600 D			
Arsenic	7440382	10 T	80 T	30 T	280 T	340 D	150 D	340 D	150 D	340 D	150 D	440 D	2,000 T	200 T
Asbestos	1332214	See (a)												
Atrazine	1912249	3		32,667	32,667									
Barium	7440393	2,000 T		98,000 T	98,000 T									
Benz(a)anthracene	56553	0.005	0.02	0.2	0.2									
Benzene	71432	5	140	93	3,733	2,700	180	2,700	180	8,800	560			
Benzo[b]fluoranthene	205992	0.005	0.02	1.9	1.9									
Benzidine	92875	0.0002	0.0002	0.01	2,800	1,300	89	1,300	89	1,300	89	10,000	0.01	0.01
Benzo(a)pyrene	50328	0.2	0.02	0.2	0.2									
Benzo(k)fluoranthene	207089	0.005	0.02	1.9	1.9									
Beryllium	7440417	4 T	84 T	1,867 T	1,867 T	65 D	5.3 D	65 D	5.3 D	65 D	5.3 D			
Beta particles and photon emitters		4 millirems / year See (i)												
Bis(2-chloroethyl) ether	111444	0.03	0.5	1	1	120,000	6,700	120,000	6,700	120,000	6,700			
Bis(2-chloroisopropyl) ether	108601	280	3,441	37,333	37,333									
Boron	7440428	1,400 T		186,667 T	186,667 T								1,000 T	
Bromodichloromethane	75274	TTHM See (g)	17	TTHM	18,667									
4-Bromophenyl phenyl ether	101553					180	14	180	14	180	14			
Bromoform	75252	TTHM See (g)	133	180	18,667	15,000	10,000	15,000	10,000	15,000	10,000			
Bromomethane	74839	9.8	299	1,307	1,307	5,500	360	5,500	360	5,500	360			
Butyl benzyl phthalate	85687	1,400	386	186,667	186,667	1,700	130	1,700	130	1,700	130			
Cadmium	7440439	5 T	84 T	700 T	700 T	See (d) & Table 2	See (d) & Table 3	See (d) & Table 2	See (d) & Table 3	See (d) & Table 2	See (d) & Table 3	See (d) & Table 2	50	50
Carbaryl	63252					2.1	2.1	2.1	2.1	2.1	2.1	2.1		
Carbofuran	1563662	40		4,667	4,667	650	50	650	50	650	50			
Carbon tetrachloride	56235	5	2	11	980	18,000	1,100	18,000	1,100	18,000	1,100			
Chlordane	57749	2	0.0008	4	467	2.4	0.004	2.4	0.2	2.4	0.2	3.2		
Chlorine (total residual)	7782505	4,000		4,000	4,000	19	11	19	11	19	11			
Chlorobenzene	108907	100	1,553	18,667	18,667	3,800	260	3,800	260	3,800	260			
2-Chloroethyl vinyl ether	110758					180,000	9,800	180,000	9,800	180,000	9,800			
Chloroform	67663	TTHM See (g)	470	230	9,333	14,000	900	14,000	900	14,000	900			
p-Chloro-m-cresol	59507					15	4.7	15	4.7	15	4.7	48,000		
Chloromethane	74873					270,000	15,000	270,000	15,000	270,000	15,000			
beta-Chloronaphthalene	91587	560	1267 317	74,667	74,667									
2-Chlorophenol	95578	35	30	4,667	4,667	2,200	150	2,200	150	2,200	150			
Chloropyrifos	2921882	21		2,800	2,800	0.08	0.04	0.08	0.04	0.08	0.04			
Chromium III	16065831		75,000 T	1,400,000 T	1,400,000 T	See (d) & Table 4	See (d) & Table 4	See (d) & Table 4	See (d) & Table 4	See (d) & Table 4	See (d) & Table 4	See (d) & Table 4		
Chromium VI	18540299	21 T	150 T	2,800 T	2,800 T	16 D	11 D	16 D	11 D	16 D	11 D	34 D		
Chromium (Total)	7440473	100 T											1,000	1,000
Chrysene	218019	0.005	0.02	19	19									
Copper	7440508	1,300 T		1,300 T	1,300 T	See (d) & Table 5	See (d) & Table 5	See (d) & Table 5	See (d) & Table 5	See (d) & Table 5	See (d) & Table 5	See (d) & Table 5	5,000 T	500 T
Cyanide (as free cyanide)	57125	200 T	16,000 T	18,667 T	18,667 T	22 T	5.2 T	41 T	9.7 T	41 T	9.7 T	84 T		200 T
Dalapon	75990	200	8,000	28,000	28,000									
DDT and its breakdown products	50293	0.1	0.0002	4	467	1.1	0.001	1.1	0.001	1.1	0.001	1.1	0.001	0.001
Demeton	8065483						0.1		0.1		0.1			
Diazinon	333415					0.17	0.17	0.17	0.17	0.17	0.17	0.17		
Dibenz (ah) anthracene	53703	0.005	0.02	1.9	1.9									
Dibromochloromethane	124481	TTHM See (g)	13	TTHM	18,667									
1,2-Dibromo-3-chloropropane	96128	0.2		2,800	2,800									
1,2-Dibromoethane	106934	0.05		8,400	8,400									
Dibutyl phthalate	84742	700	899	93,333	93,333	470	35	470	35	470	35	1,100		
1,2-Dichlorobenzene	95501	600	205	84,000	84,000	790	300	1,200	470	1,200	470	5,900		
1,3-Dichlorobenzene	541731					2,500	970	2,500	970	2,500	970			
1,4-Dichlorobenzene	106467	75	5755	373,333	373,333	560	210	2,000	780	2,000	780	6,500		
3,3'-Dichlorobenzidine	91941	0.08	0.03	3	3									
1,2-Dichloroethane	107062	5	37	15	186,667	59,000	41,000	59,000	41,000	59,000	41,000			
1,1-Dichloroethylene	75354	7	7,143	46,667	46,667	15,000	950	15,000	950	15,000	950			

1,2-cis-Dichloroethylene	156592	70		70	70									
1,2-trans-Dichloroethylene	156605	100	10,127	18,667	18,667	68,000	3,900	68,000	3,900	68,000	3,900			
Dichloromethane	75092	5	593	190	56,000	97,000	5,500	97,000	5,500	97,000	5,500			
2,4-Dichlorophenol	120832	21	59	2,800	2,800	1,000	88	1,000	88	1,000	88			
2,4-Dichlorophenoxyacetic acid (2,4-D)	94757	70		9,333	9,333									
1,2-Dichloropropane	78875	5	17,518	84,000	84,000	26,000	9,200	26,000	9,200	26,000	9,200			
1,3-Dichloropropene	542756	0.7	42	420	28,000	3,000	1,100	3,000	1,100	3,000	1,100			
Dieldrin	60571	0.002	0.00005	0.09	47	0.2	0.06	0.2	0.06	0.2	0.06	4	0.003	See (b)
Diethyl phthalate	84662	5,600	8,767	746,667	746,667	26,000	1,600	26,000	1,600	26,000	1,600			
Di (2-ethylhexyl) adipate	103231	400		560,000	560,000									
Di (2-ethylhexyl) phthalate	117817	6	3	100	18,667	400	360	400	360	400	360	3,100		
2,4-Dimethylphenol	105679	140	171	18,667	18,667	1,000	310	1,000	310	1,000	310	150,000		
Dimethyl phthalate	131113					17,000	1,000	17,000	1,000	17,000	1,000			
4,6-Dinitro-o-cresol	534521	28	582	3,733	3,733	310	24	310	24	310	24			
2,4-Dinitrophenol	51285	14	1,067	1,867	1,867	110	9.2	110	9.2	110	9.2			
2,4-Dinitrotoluene	121142	14	421	1,867	1,867	14,000	860	14,000	860	14,000	860			
2,6-Dinitrotoluene	606202	0.05		2	3,733									
Di-n-octyl phthalate	117840	2,800		373,333	373,333									
Dinoseb	88857	7		933	933									
1,2-Diphenylhydrazine	122667	0.04	0.2	1.8	1.8	130	11	130	11	130	11			
Diquat	85007	20		2,053	2,053									
Endosulfan sulfate	1031078	42	18	5,600	5,600	0.2	0.06	0.2	0.06	0.2	0.06	3		
Endosulfan (Total)	115297	42	18	5,600	5,600	0.2	0.06	0.2	0.06	0.2	0.06	3		
Endothall	145733	100		18,667	18,667									
Endrin	72208	2	0.06	280	280	0.09	0.04	0.09	0.04	0.09	0.04	0.7	0.004	0.004
Endrin aldehyde	7421934					0.09	0.04	0.09	0.04	0.09	0.04	0.7		
Ethylbenzene	100414	700	2,133	93,333	93,333	23,000	1,400	23,000	1,400	23,000	1,400			
Fluoranthene	206440	280	28	37,333	37,333	2,000	1,600	2,000	1,600	2,000	1,600			
Fluorene	86737	280	1,067	37,333	37,333									
Fluoride	7782414	4,000		140,000	140,000									
Glyphosate	1071836	700	266,667	93,333	93,333									
Guthion	86500						0.01		0.01		0.01			
Heptachlor	76448	0.4	0.00008	0.4	467	0.5	0.004	0.5	0.004	0.6	0.01	0.9		
Heptachlor epoxide	1024573	0.2	0.00004	0.2	12	0.5	0.004	0.5	0.004	0.6	0.01	0.9		
Hexachlorobenzene	118741	1	0.0003	1	747	6	3.7	6	3.7	6	3.7			
Hexachlorobutadiene	87683	0.4	18	18	187	45	8.2	45	8.2	45	8.2			
Hexachlorocyclohexane alpha	319846	0.006	0.005	0.22	7,467	1,600	130	1,600	130	1,600	130	1,600		
Hexachlorocyclohexane beta	319857	0.02	0.02	0.78	560	1,600	130	1,600	130	1,600	130	1,600		
Hexachlorocyclohexane delta	319868					1,600	130	1,600	130	1,600	130	1,600		
Hexachlorocyclohexane gamma (lindane)	58899	0.2	1.8	280	280	1	0.08	1	0.28	1	0.61	11		
Hexachlorocyclopentadiene	77474	50	580	9,800	9,800	3.5	0.3	3.5	0.3	3.5	0.3			
Hexachloroethane	67721	2.5	3.3	100	933	490	350	490	350	490	350	850		
Hydrogen sulfide	7783064						2 See (c)		2 See (c)		2 See (c)			
Indeno (1,2,3-cd) pyrene	193395	0.05	0.49	1.9	1.9									
Iron	7439896						1,000 D		1,000 D		1,000 D			
Isophorone	78591	37	961	1,500	186,667	59,000	43,000	59,000	43,000	59,000	43,000			
Lead	7439921	15 T		15 T	15 T	See (d) & Table 6	See (d) & Table 6	See (d) & Table 6	See (d) & Table 6	See (d) & Table 6	See (d) & Table 6	See (d) & Table 6	10,000 T	100 T
Malathion	121755	140		18,667	18,667		0.1		0.1		0.1			
Manganese	7439965	980		130,667	130,667								10,000	
Mercury	7439976	2 T		280 T	280 T	2.4 D	0.01 D	2.4 D	0.01 D	2.4 D	0.01 D	5 D		10 T
Methoxychlor	72435	40		4,667	4,667		0.03		0.03		0.03			
Methylmercury	22967926		0.3 mg/ kg											
Mirex	2385855	1		187	187		0.001		0.001		0.001			
Naphthalene	91203	140	1,524	18,667	18,667	1,100	210	3,200	580	3,200	580			
Nickel	7440020	140 T	4,600 T	28,000 T	28,000 T	See (d) & Table 7	See (d) & Table 7	See (d) & Table 7	See (d) & Table 7	See (d) & Table 7	See (d) & Table 7	See (d) & Table 7		
Nitrate	14797558	10,000		3,733,333	3,733,333									
Nitrite	14797650	1,000		233,333	233,333									
Nitrate + Nitrite		10,000												
Nitrobenzene	98953	3.5	138	467	467	1,300	850	1,300	850	1,300	850			
p-Nitrophenol	100027					4,100	3,000	4,100	3,000	4,100	3,000			
N-nitrosodimethylamine	62759	0.001	3	0.03	0.03									
N-Nitrosodiphenylamine	86306	7.1	6	290	290	2,900	200	2,900	200	2,900	200			
N-nitrosodi-n-propylamine	621647	0.005	0.5	0.2	88,667									
Nonylphenol	104405					28	6.6	28	6.6	28	6.6	28		
Oxamyl	23135220	200		23,333	23,333									
Parathion	56382					0.07	0.01	0.07	0.01	0.07	0.01			
Paraquat	1910425	32		4,200	4,200	100	54	100	54	100	54			
Pentachlorophenol	87865	1	1,000	12	28,000	See (e), (j) & Table 10	See (e), (j) & Table 10	See (e), (j) & Table 10	See (e), (j) & Table 10	See (e), (j) & Table 10	See (e), (j) & Table 10	See (e), (j) & Table 10		
Permethrin	52645531	350		46,667	46,667	0.3	0.2	0.3	0.2	0.3	0.2			
Phenanthrene	85018					30	6.3	30	6.3	30	6.3			
Phenol	108952	2,100	37	280,000	280,000	5,100	730	7,000	1,000	7,000	1,000	180,000		
Picloram	1918021	500	2,710	65,333	65,333									
Polychlorinatedbiphenyls (PCBs)	1336363	0.5	0.00006	19	19	2	0.01	2	0.02	2	0.02	11	0.001	0.001

Pyrene	129000	210	800	28,000	28,000									
Radium 226 + Radium 228		5 pCi/L												
Selenium	7782492	50 T	667 T	4,667 T	4,667 T		2 T		2 T		2 T	33 T	20 T	50 T
Silver	7440224	35 T	8,000 T	4,667 T	4,667 T	See (d) & Table 8		See (d) & Table 8		See (d) & Table 8		See (d) & Table 8		
Simazine	112349	4		4,667	4,667									
Strontium	7440246	8 pCi/L												
Styrene	100425	100		186,667	186,667	5,600	370	5,600	370	5,600	370			
Sulfides												100		
2,3,7,8-Tetrachlorod- ibenzo-p-dioxin (2,3,7,8-TCDD)	1746016	0.00003	5x10-9	0.00003	0.0009	0.01	0.005	0.01	0.005	0.01	0.005	0.1		
1,1,2,2-Tetrachloroethane	79345	0.2	4	7	56,000	4,700	3,200	4,700	3,200	4,700	3,200			
Tetrachloroethylene	127184	5	261	9,333	9,333	2,600	280	6,500	680	6,500	680	15,000		
Thallium	7440280	2 T	7.2 T	75 T	75 T	700 D	150 D	700 D	150 D	700 D	150 D			
Toluene	108883	1,000	201,000	280,000	280,000	8,700	180	8,700	180	8,700	180			
Toxaphene	8001352	3	0.0003	1.3	933	0.7	0.0002	0.7	0.0002	0.7	0.0002	11	0.005	0.005
Tributyltin						0.5	0.07	0.5	0.07	0.5	0.07			
1,2,4-Trichlorobenzene	120821	70	70	9,333	9,333	750	130	1,700	300	1,700	300			
1,1,1-Trichloroethane	71556	200	428,571	1,866,667	1,866,667	2,600	1,600	2,600	1,600	2,600	1,600		1,000	
1,1,2-Trichloroethane	79005	5	16	25	3,733	18,000	12,000	18,000	12,000	18,000	12,000			
Trichloroethylene	79016	5	29	280,000	280	20,000	1,300	20,000	1,300	20,000	1,300			
2,4,6-Trichlorophenol	88062	3.2	2	130	130	160	25	160	25	160	25	3,000		
2,4,5-Trichlorophenoxy propionic acid (2,4,5-TP)	93721	50		7,467	7,467									
Trihalomethanes (T)		80												
Tritium	10028178	20,000 pCi/L												
Uranium	7440611	30 D		2,800	2,800									
Vinyl chloride	75014	2	5	2	2,800									
Xylenes (T)	1330207	10,000		186,667	186,667									
Zinc	7440666	2,100 T	5,106 T	280,000 T	280,000 T	See (d) & Table 9	See (d) & Table 9	See (d) & Table 9	See (d) & Table 9	See (d) & Table 9	See (d) & Table 9	See (d) & Table 9	10,000 T	25,000 T

Footnotes

a. The asbestos standard is 7 million fibers (longer than 10 micrometers) per liter.

b. The aldrin/dieldrin standard is exceeded when the sum of the two compounds exceeds 0.003 µg/L.

c. In lakes, the acute criteria for hydrogen sulfide apply only to water samples taken from the epilimnion, or the upper layer of a lake or reservoir.

d. Hardness, expressed as mg/L $CaCO_3$, is determined according to the following criteria:
   i. If the receiving water body has an A&Wc or A&Ww designated use, then hardness is based on the hardness of the receiving water body from a sample taken at the same time that the sample for the metal is taken, except that the hardness may not exceed 400 mg/L $CaCO_3$.
   ii. If the receiving water has an A&Wedw or A&We designated use, then the hardness is based on the hardness of the effluent from a sample taken at the same time that the sample for the metal is taken, except that the hardness may not exceed 400 mg/L $CaCO_3$.
   iii. The mathematical equations for the hardness-dependent parameter represent the water quality standards. Examples of criteria for the hardness-dependent parameters have been calculated and are presented in separate tables at the end of Appendix A for the convenience of the user.

e. pH is determined according to the following criteria:
   i. If the receiving water has an A&Wc or A&Ww designated use, then pH is based on the pH of the receiving water body from a sample taken at the same time that the sample for pentachlorophenol or ammonia is taken.
   ii. If the receiving water body has an A&Wedw or A&We designated use, then the pH is based on the pH of the effluent from a sample taken at the same time that the sample for pentachlorophenol or ammonia is taken.
   iii. The mathematical equations for ammonia represent the water quality standards. Examples of criteria for ammonia have been calculated and are presented in separate tables at the end of Appendix A for the convenience of the user.

f. Table 1 abbreviations.
   i. µg/L = micrograms per liter,
   ii. mg/kg = milligrams per kilogram,
   iii. pCi/L = picocuries per liter,
   iv. D = dissolved,
   v. T = total recoverable,
   vi. TTHM indicates that the chemical is a trihalomethane.

g. The total trihalomethane (TTHM) standard is exceeded when the sum of these four compounds exceeds 80 µg/L, as a rolling annual average.

h. The concentration of gross alpha particle activity includes radium-226, but excludes radon and uranium.

i. The average annual concentration of beta particle activity and photon emitters from manmade radionuclides shall not produce an annual dose equivalent to the total body or any internal organ greater than four millirems per year.

j. The mathematical equations for the pH-dependent parameters represent the water quality standards. Examples of criteria for the pH-dependent parameters have been calculated and are presented in separate tables at the end of Appendix A for the convenience of the user.

k. Abbreviations for the mathematical equations are as follows:
   e = the base of the natural logarithm and is a mathematical constant equal to 2.71828
   LN = is the natural logarithm
   CMC = Criterion Maximum Concentration (acute)
   CCC= Criterion Continuous Concentration (chronic)

Historical Note

Appendix A repealed; new Appendix A, Table 1 adopted effective April 24, 1996 (Supp. 96-2). Appendix A, Table 1 amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 1 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 1 repealed; new Appendix A, Table 1 made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 1 amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3). Amended by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 2. Acute Water Quality Standards for Dissolved Cadmium

Aquatic and Wildlife coldwater		Aquatic and Wildlife warm water, and edw		Aquatic and Wildlife ephemeral	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L.**
20	0.40	20	2.1	20	4.9
100	1.8	100	9.4	100	22
400	6.5	400	34	400	80
$_{e}$(0.9789*LN(Hardness)-3.866)*(1.136672-LN(Hardness)*0.041838)		$_{e}$(0.9789*LN(Hardness)-2.208)*(1.136672-LN(Hardness)*0.041838)		$_{e}$(0.9789*LN(Hardness)-1.363)(1.136672-LN(Hardness)*0.041838)	

Historical Note

Appendix A repealed; new Appendix A, Table 2 adopted effective April 24, 1996 (Supp. 96-2). Appendix A, Table 2 amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 2 amended to correct references to footnotes (Supp. 02-4). Appendix A, Table 2 footnotes amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 2 repealed; new Appendix A, Table 2 made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 2 repealed; new Table 2 made by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 3. Chronic Water Quality Standards for Dissolved Cadmium

Aquatic and Wildlife coldwater, warmwater, and edw	
Hard. mg/L	**Std. µg/L**
20	0.21
100	0.72
400	2.0
$_{e}$(0.7977*LN(Hardness)-3.909)*(1.101672-LN(Hardness)*0.041838)	

Historical Note

Appendix A, Table 3 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 3 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 3 amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 3 repealed; new Table 3 made by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 4. Water Quality Standards for Dissolved Chromium III

Acute Aquatic and Wildlife coldwater, warmwater and edw		Chronic Aquatic and Wildlife coldwater, warmwater and edw		Acute Aquatic and Wildlife ephemeral	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	152	20	19.8	20	512
100	570	100	74.1	100	1,912
400	1,773	400	231	400	5,950
$_{e}$(0.819*LN(Hardness)+3.7256)*(0.316)		$_{e}$(0.819*LN(Hardness)+0.6848)*(0.86)		$_{e}$(0.819*LN(Hardness)+4.9361) * (0.316)	

Historical Note

Appendix A, Table 4 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 4 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 4 amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 4 repealed; new Table 4 made by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 5. Water Quality Standards for Dissolved Copper

Acute Aquatic and Wildlife coldwater, warmwater and edw		Chronic Aquatic and Wildlife coldwater, warmwater and edw		Acute Aquatic and Wildlife ephemeral	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	2.9	20	2.3	20	5.1
100	13	100	9.0	100	23
400	50	400	29	400	86
$_{e}$(0.9422*LN(Hardness)-1.702)*(0.96)		$_{e}$(0.8545*LN(Hardness)-1.702)*(0.96)		$_{e}$(0.9422*LN(Hardness)-1.1514)*(0.96)	

Historical Note

Appendix A, Table 5 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 5 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 5 amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 5 repealed; new Table 5 made by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 6. Water Quality Standards for Dissolved Lead

Acute Aquatic and Wildlife coldwater, warmwater and edw		**Chronic Aquatic and Wildlife coldwater, warmwater and edw**		**Acute Aquatic and Wildlife ephemeral**	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	10.8	20	0.42	20	22.8
100	64.6	100	2.5	100	136.3
400	281	400	10.9	400	592.7
e(1.273*LN(Hardness)-1.46)*(1.46203-(LN(Hardness))*(0.145712))		e(1.273*LN(Hardness)-4.705) * (1.46203-(LN(Hardness))*(0.145712))		e(1.273*(LN(Hardness))-0.7131) * (1.46203-(LN(Hardness))*(0.145712))	

Historical Note

Appendix A, Table 6 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 6 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 6 renumbered to Table 9; new Table 6 made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 6 repealed; new Table 6 made by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 7. Water Quality Standards for Dissolved Nickel

Acute Aquatic and Wildlife coldwater, warmwater and edw		**Chronic Aquatic and Wildlife coldwater, warmwater and edw**		**Acute Aquatic and Wildlife ephemeral**	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	120.0	20	13.3	20	1066
100	468	100	52.0	100	4158
400	1513	400	168	400	13436
e(0.846*LN(Hardness)+2.255)*(0.998)		e(0.846*LN(Hardness)+0.0584)*(0.997)		e(0.846*LN(Hardness)+4.4389)*(0.998)	

Historical Note

Appendix A, Table 7 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 7 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 7 amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 7 repealed; new Table 7 made by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 8. Water Quality Standards for Dissolved Silver

Acute Aquatic and Wildlife coldwater, warmwater, edw, and ephemeral	
Hard. mg/L	**Std. µg/L**
20	0.20
100	3.2
400	34.9
e(1.72*LN(Hardness)-6.59)*(0.85)	

Historical Note

Appendix A, Table 8 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 8 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 8 amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 8 repealed; new Table 8 made by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 9. Water Quality Standards for Dissolved Zinc

Acute and Chronic Aquatic and Wildlife coldwater, warmwater and edw		**Acute Aquatic and Wildlife ephemeral**	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	30.0	20	284
100	117	100	1112
400	379	400	3599
e(0.8473*LN(Hardness)+0.884)*(0.978)		e(0.8473*LN(Hardness)+3.1342)*(0.978)	

Historical Note

Appendix A, Table 9 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 9 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 9 renumbered to Table 11; new Table 9 renumbered from Table 6 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-

4). Appendix A, Table 9 repealed; new Table 9 made by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 10. Water Quality Standards for Pentachlorophenol

Acute Aquatic and Wildlife coldwater, warmwater and edw			Chronic Aquatic and Wildlife coldwater, warmwater and edw			Acute Aquatic and Wildlife ephemeral	
pH	**µg/L**		**pH**	**µg/L**		**pH**	**µg/L**
3	0.16		3	0.1		3	0.66
6	3.3		6	2.1		6	13.5
9	67.7		9	42.7		9	274
$_{e}(1.005*(pH)-4.83)$			$_{e}(1.005*(pH)-5.29)$			$_{e}(1.005*(pH)-3.4306)$	

Historical Note

Appendix A, Table 10 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 10 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 10 renumbered to Table 12; new Table 10 renumbered from Table 11 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 10 repealed; new Table 10 made by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 11. Acute Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Coldwater, Unionid Mussels Present

For the aquatic and wildlife coldwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

	Temperature (°C)																
pH	**0-14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	33	33	32	29	27	25	23	21	19	18	16	15	14	13	12	11	9.9
6.6	31	31	30	28	26	24	22	20	18	17	16	14	13	12	11	10	9.5
6.7	30	30	29	27	24	22	21	19	18	16	15	14	13	12	11	9.8	9
6.8	28	28	27	25	23	21	20	18	17	15	14	13	12	11	10	9.2	8.5
6.9	26	26	25	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	7.9
7	24	24	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	8	7.3
7.1	22	22	21	20	18	17	15	14	13	12	11	10	9.3	8.5	7.9	7.2	6.7
7.2	20	20	19	18	16	15	14	13	12	11	9.8	9.1	8.3	7.7	7.1	6.5	6
7.3	18	18	17	16	14	13	12	11	10	9.5	8.7	8	7.4	6.8	6.3	5.8	5.3
7.4	15	15	15	14	13	12	11	9.8	9	8.3	7.7	7	6.5	6	5.5	5.1	4.7
7.5	13	13	13	12	11	10	9.2	8.5	7.8	7.2	6.6	6.1	5.6	5.2	4.8	4.4	4
7.6	11	11	11	10	9.3	8.6	7.9	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.1	3.8	3.5
7.7	9.6	9.6	9.3	8.6	7.9	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.1	3.8	3.5	3.2	3
7.8	8.1	8.1	7.9	7.2	6.7	6.1	5.6	5.2	4.8	4.4	4	3.7	3.4	3.2	2.9	2.7	2.5
7.9	6.8	6.8	6.6	6	5.6	5.1	4.7	4.3	4	3.7	3.4	3.1	2.9	2.6	2.4	2.2	2.1
8	5.6	5.6	5.4	5	4.6	4.2	3.9	3.6	3.3	3	2.8	2.6	2.4	2.2	2	1.9	1.7
8.1	4.6	4.6	4.5	4.1	3.8	3.5	3.2	3	2.7	2.5	2.3	2.1	2	1.8	1.7	1.5	1.4
8.2	3.8	3.8	3.7	3.5	3.1	2.9	2.7	2.4	2.3	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.2
8.3	3.1	3.1	3.1	2.8	2.6	2.4	2.2	2	1.9	1.7	1.6	1.4	1.3	1.2	1.1	1	0.96
8.4	2.6	2.6	2.5	2.3	2.1	2	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1	0.93	0.86	0.79
8.5	2.1	2.1	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.2	1.1	0.98	0.9	0.83	0.77	0.71	0.65
8.6	1.8	1.8	1.7	1.6	1.5	1.3	1.2	1.1	1	0.96	0.88	0.81	0.75	0.69	0.63	0.59	0.54
8.7	1.5	1.5	1.4	1.3	1.2	1.1	1	0.94	0.87	0.8	0.74	0.68	0.62	0.57	0.53	0.49	0.45
8.8	1.2	1.2	1.2	1.1	1	0.93	0.86	0.79	0.73	0.67	0.62	0.57	0.52	0.48	0.44	0.41	0.37
8.9	1	1	1	0.93	0.85	0.79	0.72	0.67	0.61	0.56	0.52	0.48	0.44	0.4	0.37	0.34	0.32
9	0.88	0.88	0.86	0.79	0.73	0.67	0.62	0.57	0.52	0.48	0.44	0.41	0.37	0.34	0.32	0.29	0.27
$MIN\left(\left(\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}\right),\left(0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times\left(23.12\times 10^{0.036\times(20-T)}\right)\right)\right.$																	

Historical Note

Appendix A, Table 11 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 11 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 11 renumbered to Table 10; new Table 11 renumbered from Table 9 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 11 repealed; new Table 11 renumbered from Table 25 and amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Appendix A, Table 11 repealed; new Appendix A, Table 11 made by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 12. Acute Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Warmwater, Unionid Mussels Present

For the aquatic and wildlife warmwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

	Temperature (°C)																				
pH	**0-10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	51	48	44	41	37	34	32	29	27	25	23	21	19	18	16	15	14	13	12	11	9.9
6.6	49	46	42	39	36	33	30	28	26	24	22	20	18	17	16	14	13	12	11	10	9.5
6.7	46	44	40	37	34	31	29	27	24	22	21	19	18	16	15	14	13	12	11	9.8	9
6.8	44	41	38	35	32	30	27	25	23	21	20	18	17	15	14	13	12	11	10	9.2	8.5
6.9	41	38	35	32	30	28	25	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	7.9
7	38	35	33	30	28	25	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	7.9	7.3
7.1	34	32	30	27	25	23	21	20	18	17	15	14	13	12	11	10	9.3	8.5	7.9	7.2	6.7
7.2	31	29	27	25	23	21	19	18	16	15	14	13	12	11	9.8	9.1	8.3	7.7	7.1	6.5	6
7.3	27	26	24	22	20	18	17	16	14	13	12	11	10	9.5	8.7	8	7.4	6.8	6.3	5.8	5.3
7.4	24	22	21	19	18	16	15	14	13	12	11	9.8	9	8.3	7.7	7	6.5	6	5.5	5.1	4.7
7.5	21	19	18	17	15	14	13	12	11	10	9.2	8.5	7.8	7.2	6.6	6.1	5.6	5.2	4.8	4.4	4
7.6	18	17	15	14	13	12	11	10	9.3	8.6	7.9	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.1	3.8	3.5
7.7	15	14	13	12	11	10	9.3	8.6	7.9	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.1	3.8	3.5	3.2	2.9
7.8	13	12	11	10	9.3	8.5	7.9	7.2	6.7	6.1	5.6	5.2	4.8	4.4	4	3.7	3.4	3.2	2.9	2.7	2.5
7.9	11	9.9	9.1	8.4	7.7	7.1	6.6	3	5.6	5.1	4.7	4.3	4	3.7	3.4	3.1	2.9	2.6	2.4	2.2	2.1
8	8.8	8.2	7.6	7	6.4	5.9	5.4	5	4.6	4.2	3.9	3.6	3.3	3	2.8	2.6	2.4	2.2	2	1.9	1.7
8.1	7.2	6.8	6.3	5.8	5.3	4.9	4.5	4.1	3.8	3.5	3.2	3	2.7	2.5	2.3	2.1	2	1.8	1.7	1.5	1.4
8.2	6	5.6	5.2	4.8	4.4	4	3.7	3.4	3.1	2.9	2.7	2.4	2.3	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.2
8.3	4.9	4.6	4.3	3.9	3.6	3.3	3.1	2.8	2.6	2.4	2.2	2	1.9	1.7	1.6	1.4	1.3	1.2	1.1	1	0.96
8.4	4.1	3.8	3.5	3.2	3	2.7	2.5	2.3	2.1	2	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1	0.93	0.86	0.79
8.5	3.3	3.1	2.9	2.7	2.4	2.3	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.2	1.1	0.98	0.9	0.83	0.77	0.71	0.65
8.6	2.8	2.6	2.4	2.2	2	1.9	1.7	1.6	1.5	1.3	1.2	1.1	1	0.96	0.88	0.81	0.75	0.69	0.63	0.58	0.54
8.7	2.3	2.2	2	1.8	1.7	1.6	1.4	1.3	1.2	1.1	1	0.94	0.87	0.8	0.74	0.68	0.62	0.57	0.53	0.49	0.45
8.8	1.9	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1	0.93	0.86	0.79	0.73	0.67	0.62	0.57	0.52	0.48	0.44	0.41	0.37
8.9	1.6	1.5	1.4	1.3	1.2	1.1	1	0.93	0.85	0.79	0.72	0.67	0.61	0.56	0.52	0.48	0.44	0.4	0.37	0.34	0.32
9	1.4	1.3	1.2	1.1	1	0.93	0.86	0.79	0.73	0.67	0.62	0.57	0.52	0.48	0.44	0.41	0.37	0.34	0.32	0.29	0.27

$$0.7249 \times \left(\frac{0.0114}{1 + 10^{7.204-pH}} + \frac{1.6181}{1 + 10^{pH-7.204}}\right) \times MIN(51.93, 23.12 \times 10^{0.036 \times (20-T)})$$

Historical Note

Appendix A, Table 12 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 12 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 12 renumbered to Table 18; new Table 12 renumbered from Table 10 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 12 repealed; new Table 12 renumbered from Table 26 and amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Appendix A, Table 11 repealed; new Appendix A, Table 11 made by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3). Appendix A, Table 12 repealed; new Appendix A, Table 12 made by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 13. Chronic Criteria for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife coldwater and warmwater, Unionid Mussels Present

For the aquatic and wildlife cold and warm water uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

	Temperature (°C)																						
pH	**0-7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	4.9	4.6	4.3	4.1	3.8	3.6	3.3	3.1	2.9	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8	1.6	1.5	1.5	1.4	1.3	1.2	1.1
6.6	4.8	4.5	4.3	4	3.8	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1
6.7	4.8	4.5	4.2	3.9	3.7	3.5	3.2	3	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1
6.8	4.6	4.4	4.1	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1
6.9	4.5	4.2	4	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1
7	4.4	4.1	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	0.99
7.1	4.2	3.9	3.7	3.5	3.2	3	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95
7.2	4	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.96	0.9
7.3	3.8	3.5	3.3	3.1	2.9	2.7	2.6	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.97	0.91	0.85
7.4	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.96	0.9	0.85	0.79
7.5	3.2	3	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95	0.89	0.83	0.78	0.73
7.6	2.9	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	0.98	0.92	0.86	0.81	0.76	0.71	0.67
7.7	2.6	2.4	2.3	2.2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1	0.94	0.88	0.83	0.78	0.73	0.68	0.64	0.6
7.8	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95	0.89	0.84	0.79	0.74	0.69	0.65	0.61	0.57	0.53
7.9	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95	0.89	0.84	0.79	0.74	0.69	0.65	0.61	0.57	0.53	0.5	0.47
8	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1	0.94	0.88	0.83	0.78	0.73	0.68	0.64	0.6	0.56	0.53	0.5	0.44	0.44	0.41
8.1	1.5	1.5	1.4	1.3	1.2	1.1	1.1	0.99	0.92	0.87	0.81	0.76	0.71	0.67	0.63	0.59	0.55	0.52	0.49	0.46	0.43	0.4	0.38	0.35
8.2	1.3	1.2	1.2	1.1	1	0.96	0.9	0.84	0.79	0.74	0.7	0.65	0.61	0.57	0.54	0.5	0.47	0.44	0.42	0.39	0.37	0.34	0.32	0.3
8.3	1.1	1.1	0.99	0.93	0.87	0.82	0.76	0.72	0.67	0.63	0.59	0.55	0.52	0.49	0.46	0.43	0.4	0.38	0.35	0.33	0.31	0.29	0.27	0.26
8.4	0.95	0.89	0.84	0.79	0.74	0.69	0.65	0.61	0.57	0.53	0.5	0.47	0.44	0.41	0.39	0.36	0.34	0.32	0.3	0.28	0.26	0.25	0.23	0.22
8.5	0.8	0.75	0.71	0.67	0.62	0.58	0.55	0.51	0.48	0.45	0.42	0.4	0.37	0.35	0.33	0.31	0.29	0.27	0.25	0.24	0.22	0.21	0.2	0.18
8.6	0.68	0.64	0.6	0.56	0.53	0.49	0.46	0.43	0.41	0.38	0.36	0.33	0.31	0.29	0.28	0.26	0.24	0.23	0.21	0.2	0.19	0.18	0.16	0.15
8.7	0.57	0.54	0.51	0.47	0.44	0.42	0.39	0.37	0.34	0.32	0.3	0.28	0.27	0.25	0.23	0.22	0.21	0.19	0.18	0.17	0.16	0.15	0.14	0.13
8.8	0.49	0.46	0.43	0.4	0.38	0.35	0.33	0.31	0.29	0.27	0.26	0.24	0.23	0.21	0.2	0.19	0.17	0.16	0.15	0.14	0.13	0.13	0.12	0.11
8.9	0.42	0.39	0.37	0.34	0.32	0.3	0.28	0.27	0.25	0.23	0.22	0.21	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.1	0.09
9	0.36	0.34	0.32	0.3	0.28	0.26	0.24	0.23	0.21	0.2	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.1	0.09	0.09	0.08

$$0.8876 \times \left(\frac{0.0278}{1 + 10^{7.688 - pH}} + \frac{1.1994}{1 + 10^{pH - 7.688}}\right) \times \left(2.126 \times 10^{0.028 \times (20 - MAX(T,7))}\right)$$

Historical Note

Appendix A, Table 13 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 13 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 13 renumbered to Table 15; new Table 13 renumbered from Table 14 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 13 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). New Appendix A, Table 13 made by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 14. Acute Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Coldwater, Unionid Mussels Absent

For the aquatic and wildlife coldwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

	Temperature (°C)																
pH	**0-14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	33	33	33	33	33	33	33	33	33	33	33	33	33	33	31	29	27
6.6	31	31	31	31	31	31	31	31	31	31	31	31	31	31	30	28	26
6.7	30	30	30	30	30	30	30	30	30	30	30	30	30	30	29	26	24
6.8	28	28	28	28	28	28	28	28	28	28	28	28	28	28	27	25	23
6.9	26	26	26	26	26	26	26	26	26	26	26	26	26	26	25	23	21
7	24	24	24	24	24	24	24	24	24	24	24	24	24	24	23	21	20
7.1	22	22	22	22	22	22	22	22	22	22	22	22	22	22	21	19	18
7.2	20	20	20	20	20	20	20	20	20	20	20	20	20	20	19	17	16
7.3	18	18	18	18	18	18	18	18	18	18	18	18	18	18	17	16	14
7.4	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	14	13
7.5	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	11
7.6	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	10	9.3
7.7	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.3	8.6	7.9
7.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	7.8	7.2	6.6
7.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.5	6	5.5
8	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.4	5	4.6
8.1	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.5	4.1	3.8
8.2	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.7	3.4	3.1
8.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3	2.8	2.6
8.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.3	2.1
8.5	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	1.9	1.8
8.6	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6	1.4
8.7	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.3	1.2
8.8	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1
8.9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.92	0.85
9	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.85	0.78	0.72

$$MIN\left(\left(\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}\right),\left(0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times\left(62.15\times 10^{0.036\times(20-T)}\right)\right)\right)$$

Historical Note

Appendix A, Table 14 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 14 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 14 renumbered to Table 13; new Table 14 renumbered from Table 15 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 14 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). New Appendix A, Table 14 made by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 15. Acute Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Warmwater and Effluent Dependent, Unionid Mussels Absent

For the aquatic and wildlife warmwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment. For the aquatic and wildlife effluent dependent uses, unionids will be assumed to be absent.

	Temperature (°C)																
pH	**0-14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	51	51	51	51	51	51	51	51	51	48	44	40	37	34	31	29	27
6.6	49	49	49	49	49	49	49	49	49	46	42	39	36	33	30	28	26
6.7	46	46	46	46	46	46	46	46	46	43	40	37	34	31	29	26	24
6.8	44	44	44	44	44	44	44	44	44	41	38	35	32	29	27	25	23
6.9	41	41	41	41	41	41	41	41	41	38	35	32	30	27	25	23	21
7	38	38	38	38	38	38	38	38	38	35	32	30	27	25	23	21	20
7.1	34	34	34	34	34	34	34	34	34	32	29	27	25	23	21	19	18
7.2	31	31	31	31	31	31	31	31	31	29	26	24	22	21	19	17	16
7.3	27	27	27	27	27	27	27	27	27	26	23	22	20	18	17	16	14
7.4	24	24	24	24	24	24	24	24	24	22	21	19	17	16	15	14	13
7.5	21	21	21	21	21	21	21	21	21	19	18	16	15	14	13	12	11
7.6	18	18	18	18	18	18	18	18	18	17	15	14	13	12	11	10	9.3
7.7	15	15	15	15	15	15	15	15	15	14	13	12	11	10	9.3	8.6	7.9
7.8	13	13	13	13	13	13	13	13	13	12	11	10	9.2	8.5	7.8	7.2	6.6
7.9	11	11	11	11	11	11	11	11	11	9.9	9.1	8.4	7.7	7.1	6.5	6	5.5
8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.2	7.5	6.9	6.4	5.9	5.4	5	4.6
8.1	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	6.8	6.2	5.7	5.3	4.9	4.5	4.1	3.8
8.2	6	6	6	6	6	6	6	6	6	5.6	5.1	4.7	4.4	4	3.7	3.4	3.1
8.3	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.6	4.2	3.9	3.6	3.3	3	2.8	2.6
8.4	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	3.8	3.4	3.2	3	2.7	2.5	2.3	2.1
8.5	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.1	2.9	2.6	2.4	2.2	2.1	1.9	1.8
8.6	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.6	2.4	2.2	2	1.9	1.7	1.6	1.4
8.7	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2	1.8	1.7	1.5	1.4	1.3	1.2
8.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1
8.9	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.3	1.2	1.1	1	0.92	0.85
9	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.2	1.1	1	0.93	0.85	0.78	0.72

$$0.7249 \times \left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right) \times MIN\left(51.93, \left(62.15 \times 10^{0.036\times(20-T)}\right)\right)$$

Historical Note

Appendix A, Table 15 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 15 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 15 renumbered to Table 14; new Table 15 renumbered from Table 13 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 15 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). New Appendix A, Table 14 made by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 16. Chronic Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Warmwater and Effluent Dependent, Unionid Mussels Absent

For the aquatic and wildlife warmwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment. For the aquatic and wildlife effluent dependent uses, unionids will be assumed to be absent.

pH	Temperature (°C)																							
	0-7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
6.5	19	17	16	15	14	13	13	12	11	10	9.7	9.1	8.5	8	7.5	7	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.2
6.6	18	17	16	15	14	13	12	12	11	10	9.6	9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.4	5	4.7	4.4	4.1
6.7	18	17	16	15	14	13	12	11	11	10	9.4	8.8	8.3	7.7	7.3	6.8	6.4	6	5.6	5.3	4.9	4.6	4.3	4.1
6.8	17	16	15	14	14	13	12	11	10	9.8	9.2	8.6	8.1	7.6	7.1	6.7	6.2	5.8	5.5	5.1	4.8	4.5	4.2	4
6.9	17	16	15	14	13	12	12	11	10	9.5	8.9	8.4	7.8	7.4	6.9	6.5	6.1	5.7	5.3	5	4.7	4.4	4.1	3.9
7	16	15	14	14	13	12	11	10	9.8	9.2	8.6	8.1	7.6	7.1	6.7	6.2	5.9	5.5	5.1	4.8	4.5	4.2	4	3.7
7.1	16	15	14	13	12	11	11	10	9.4	8.8	8.3	7.7	7.3	6.8	6.4	6	5.6	5.3	4.9	4.6	4.3	4.1	3.8	3.6
7.2	15	14	13	12	12	11	10	9.5	9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.3	5	4.7	4.4	4.1	3.9	3.6	3.4
7.3	14	13	12	12	11	10	9.6	9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.4	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2
7.4	13	12	12	11	10	9.5	9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.3	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2	3
7.5	12	11	11	10	9.4	8.8	8.2	7.7	7.2	6.8	6.4	6	5.6	5.2	4.9	4.6	4.3	4.1	3.8	3.6	3.3	3.1	2.9	2.8
7.6	11	10	10	9.1	8.5	8	7.5	7	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.2	3.9	3.7	3.5	3.2	3	2.9	2.7	2.5
7.7	9.9	9.3	8.7	8.1	7.7	7.2	6.8	6.3	5.9	5.6	5.2	4.9	4.6	4.3	4	3.8	3.5	3.3	3.1	2.9	2.7	2.6	2.4	2.3
7.8	8.8	8.3	7.8	7.3	6.8	6.4	6	5.6	5.3	5	4.6	4.4	4.1	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2
7.9	7.8	7.3	6.8	6.4	6	5.6	5.3	5	4.6	4.4	4.1	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8
8	6.8	6.3	6	5.6	5.2	4.9	4.6	4.3	4	3.8	3.6	3.3	3.1	2.9	2.7	2.6	2.4	2.3	2.1	2	1.9	1.7	1.6	1.5
8.1	5.8	5.5	5.1	4.8	4.5	4.2	4	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3
8.2	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2	3	2.8	2.6	2.5	2.3	2.2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1
8.3	4.2	4	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.96
8.4	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	0.99	0.92	0.87	0.81
8.5	3	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95	0.89	0.83	0.78	0.73	0.69
8.6	2.6	2.4	2.2	2.1	2	1.9	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.97	0.91	0.85	0.8	0.75	0.7	0.66	0.62	0.58
8.7	2.2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1	0.93	0.88	0.82	0.77	0.72	0.68	0.63	0.6	0.56	0.52	0.49
8.8	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.96	0.9	0.85	0.79	0.74	0.7	0.65	0.61	0.58	0.54	0.51	0.47	0.44	0.42
8.9	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1	0.94	0.88	0.82	0.77	0.72	0.68	0.64	0.6	0.56	0.52	0.49	0.46	0.43	0.4	0.38	0.36
9	1.4	1.3	1.2	1.1	1	0.98	0.92	0.86	0.81	0.76	0.71	0.66	0.62	0.58	0.55	0.51	0.48	0.45	0.42	0.4	0.37	0.35	0.33	0.31

$$0.9405 \times \left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right)\times\left(7.547\times 10^{0.028\times(20-MAX(T,7))}\right)$$

Historical Note

Appendix A, Table 16 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 16 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 16 amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 16 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Appendix A, Table 16 made by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 17. Chronic Criteria for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife coldwater, Unionid Mussels Absent

For the aquatic and wildlife coldwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

	Temperature (°C)																
pH	**0-14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.2
6.6	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	6.9	6.5	6.1	5.7	5.4	5	4.7	4.4	4.1
6.7	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	6.8	6.4	6	5.6	5.3	4.9	4.6	4.3	4.1
6.8	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.6	6.2	5.8	5.5	5.1	4.8	4.5	4.2	4
6.9	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.5	6.1	5.7	5.3	5	4.7	4.4	4.1	3.9
7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.2	5.8	5.5	5.1	4.8	4.5	4.2	4	3.7
7.1	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6	5.6	5.3	4.9	4.6	4.3	4.1	3.8	3.6
7.2	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.7	5.3	5	4.7	4.4	4.1	3.9	3.6	3.4
7.3	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.4	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2
7.4	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2	3
7.5	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.6	4.3	4.1	3.8	3.6	3.3	3.1	2.9	2.8
7.6	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.2	3.9	3.7	3.5	3.2	3	2.9	2.7	2.5
7.7	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.8	3.5	3.3	3.1	2.9	2.7	2.6	2.4	2.3
7.8	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2
7.9	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8
8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.4	2.3	2.1	2	1.9	1.7	1.6	1.5
8.1	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3
8.2	2	2	2	2	2	2	2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1
8.3	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.96
8.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.2	1.1	1.1	0.99	0.93	0.87	0.81
8.5	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1	0.95	0.89	0.83	0.78	0.73	0.69
8.6	1	1	1	1	1	1	1	1	0.97	0.91	0.85	0.8	0.75	0.7	0.66	0.62	0.58
8.7	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.82	0.77	0.72	0.68	0.64	0.6	0.56	0.52	0.49
8.8	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.7	0.65	0.61	0.58	0.54	0.51	0.47	0.44	0.42
8.9	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.6	0.56	0.52	0.49	0.46	0.43	0.41	0.38	0.36
9	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.51	0.48	0.45	0.42	0.4	0.37	0.35	0.33	0.31

$$0.9405 \times \left(\frac{0.0278}{1+10^{7.688-pH}} + \frac{1.1994}{1+10^{pH-7.688}}\right) \times MIN\left(6.920, \left(7.547 \times 10^{0.028 \times (20-T)}\right)\right)$$

Historical Note

Appendix A, Table 17 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 17 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 17 amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 17 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Appendix A, Table 16 made by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

Table 18. Repealed

Historical Note

Appendix A, Table 18 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 18 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 18 repealed; new Table 18 renumbered from Table 12 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 18 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 19. Repealed

Historical Note

Appendix A, Table 19 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1).

Appendix A, Table 19 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 19 renumbered to Table 21; new Table 19 made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 19 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 20. Repealed

Historical Note

Appendix A, Table 20 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 20 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 20 amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 20 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 21. Repealed

Historical Note

Appendix A, Table 21 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 21 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 21 renumbered to Table 22; new Table 21 renumbered from Table 19 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 21 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 22. Repealed

Historical Note

Appendix A, Table 22 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 22 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 22 renumbered to Table 23; new Table 22 renumbered from Table 21 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 22 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 23. Repealed

Historical Note

Appendix A, Table 23 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 23 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 23 renumbered to Table 24; new Table 23 renumbered from Table 22 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 23 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 24. Repealed

Historical Note

Appendix A, Table 24 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 24 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 24 renumbered to Table 25; new Table 24 renumbered from Table 23 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 24 repealed by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 25. Renumbered

Historical Note

Appendix A, Table 25 adopted by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Appendix A, Table 25 amended by final rulemaking at 9 A.A.R. 716, effective April 8, 2003 (Supp. 03-1). Appendix A, Table 25 renumbered to Table 26; new Table 25 renumbered from Table 24 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 25 renumbered to Table 11 by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Table 26. Renumbered

Historical Note

Appendix A, Table 26 renumbered from Table 25 and amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Appendix A, Table 26 renumbered to Table 12 by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4).

Appendix B. Surface Waters and Designated Uses

(Coordinates are from the North American Datum of 1983 (NAD83). All latitudes in Arizona are north and all longitudes are west, but the negative signs are not included in the Appendix B table. Some web-based mapping systems require a negative sign before the longitude values to indicate it is a west longitude.)

Watersheds:

BW = Bill Williams
CG = Colorado – Grand Canyon
CL = Colorado – Lower Gila
LC = Little Colorado
MG = Middle Gila
SC = Santa Cruz – Rio Magdelena – Rio Sonoyta
SP = San Pedro – Willcox Playa – Rio Yaqui
SR = Salt River
UG = Upper Gila
VR = Verde River

Other Abbreviations:

WWTP = Wastewater Treatment Plant
Km = kilometers

	Surface	Segment Description and Location	Lake	Aquatic and Wildlife				Human Health				Agricultural	
Watershed	**Waters**	**(Latitude and Longitudes are in NAD 83)**	**Category**	**A&Wc**	**A&Ww**	**A&We**	**A&Wedw**	**FBC**	**PBC**	**DWS**	**FC**	**AgI**	**AgL**
BW	Alamo Lake	34°14'06"/113°35'00"	Deep		A&Ww			FBC			FC		AgL
BW	Big Sandy River	Headwaters to Alamo Lake			A&Ww			FBC			FC		AgL
BW	Bill Williams River	Alamo Lake to confluence with Colorado River			A&Ww			FBC			FC		AgL
BW	Blue Tank	34°40'14"/112°58'17"			A&Ww			FBC			FC		AgL
BW	Boulder Creek	Headwaters to confluence with unnamed tributary at 34°41'13"/113°03'37"		A&Wc				FBC			FC		AgL
BW	Boulder Creek	Below confluence with unnamed tributary to confluence with Burro Creek			A&Ww			FBC			FC		AgL
BW	Burro Creek (OAW)	Headwaters to confluence with Boulder Creek			A&Ww			FBC			FC		AgL
BW	Burro Creek	Below confluence with Boulder Creek to confluence with Big Sandy River			A&Ww			FBC			FC		AgL
BW	Carter Tank	34°52'27"/112°57'31"			A&Ww			FBC			FC		AgL
BW	Conger Creek	Headwaters to confluence with unnamed tributary at 34°45'15"/113°05'46"		A&Wc				FBC			FC		AgL
BW	Conger Creek	Below confluence with unnamed tributary to confluence with Burro Creek			A&Ww			FBC			FC		AgL
BW	Copper Basin Wash	Headwaters to confluence with unnamed tributary at 34°28'12"/112°35'33"		A&Wc				FBC			FC		AgL
BW	Copper Basin Wash	Below confluence with unnamed tributary to confluence with Skull Valley Wash				A&We			PBC				AgL
BW	Cottonwood Canyon	Headwaters to Bear Trap Spring		A&Wc				FBC			FC		AgL
BW	Cottonwood Canyon	Below Bear Trap Spring to confluence at Sycamore Creek			A&Ww			FBC			FC		AgL
BW	Date Creek	Headwaters to confluence with Santa Maria River			A&Ww			FBC			FC		AgL
BW	Francis Creek (OAW)	Headwaters to confluence with Burro Creek			A&Ww			FBC		DWS	FC	AgI	AgL
BW	Kirkland Creek	Headwaters to confluence with Santa Maria River			A&Ww			FBC			FC	AgI	AgL
BW	Knight Creek	Headwaters to confluence with Big Sandy River			A&Ww			FBC			FC		AgL
BW	Peeples Canyon (OAW)	Headwaters to confluence with Santa Maria River			A&Ww			FBC			FC		AgL
BW	Red Lake	35°12'18"/113°03'57"	Sedimentary		A&Ww			FBC			FC		AgL
BW	Santa Maria River	Headwaters to Alamo Lake			A&Ww			FBC			FC	AgI	AgL
BW	Trout Creek	Headwaters to confluence with unnamed tributary at 35°06'47"/113°13'01"		A&Wc				FBC			FC		AgL
BW	Trout Creek	Below confluence with unnamed tributary to confluence with Knight Creek			A&Ww			FBC			FC		AgL
CG	Agate Canyon	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Beaver Dam Wash	Headwaters to confluence with the Virgin River			A&Ww			FBC			FC		AgL
CG	Big Springs Tank	36°36'08"/112°21'01"		A&Wc				FBC			FC		AgL
CG	Boucher Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Bright Angel Creek	Headwaters to confluence with Roaring Springs Creek		A&Wc				FBC			FC		
CG	Bright Angel Creek	Below Roaring Spring Springs Creek to confluence with Colorado River			A&Ww			FBC			FC		
CG	Bright Angel Wash	Headwaters to Grand Canyon National Park South Rim WWTP outfall at 36°02'59"/112°09'02"				A&We			PBC				
CG	Bright Angel Wash (EDW)	Grand Canyon National Park South Rim WWTP outfall to Coconino Wash					A&Wedw		PBC				AgL
CG	Bulrush Canyon Wash	Headwaters to confluence with Kanab Creek				A&We			PBC				
CG	Cataract Creek	Headwaters to Santa Fe Reservoir		A&Wc				FBC		DWS	FC	AgI	AgL

CG	Cataract Creek	Santa Fe Reservoir to City of Williams WWTP outfall at 35°14'40"/112°11'18"		A&Wc				FBC			FC	AgI	AgL
CG	Cataract Creek (EDW)	City of Williams WWTP outfall to 1 km downstream					A&Wedw		PBC				
CG	Cataract Creek	Red Lake Wash to Havasupai Indian Reservation boundary				A&We			PBC				AgL
CG	Cataract Lake	35°15'04"/112°12'58"	Igneous	A&Wc				FBC		DWS	FC		AgL
CG	Chuar Creek	Headwaters to confluence with unnamed tributary at 36°11'35"/111°52'20"		A&Wc				FBC			FC		
CG	Chuar Creek	Below unnamed tributary to confluence with the Colorado River			A&Ww			FBC			FC		
CG	City Reservoir	35°13'57"/112°11'25"	Igneous	A&Wc				FBC		DWS	FC		
CG	Clear Creek	Headwaters to confluence with unnamed tributary at 36°07'33"/112°00'03"		A&Wc				FBC			FC		
CG	Clear Creek	Below confluence with unnamed tributary to confluence with Colorado River			A&Ww			FBC			FC		
CG	Coconino Wash (EDW)	South Grand Canyon Sanitary District Tusayan WRF outfall at 35°58'39"/112°08'25" to 1 km downstream					A&Wedw		PBC				
CG	Colorado River	Lake Powell to Lake Mead		A&Wc				FBC		DWS	FC	AgI	AgL
CG	Crystal Creek	Headwaters to confluence with unnamed tributary at 36°13'41"/112°11'49"		A&Wc				FBC			FC		
CG	Crystal Creek	Below confluence with unnamed tributary to confluence with Colorado River			A&Ww			FBC			FC		
CG	Deer Creek	Headwaters to confluence with unnamed tributary at 36°26'15"/112°28'20"		A&Wc				FBC			FC		
CG	Deer Creek	Below confluence with unnamed tributary to confluence with Colorado River			A&Ww			FBC			FC		
CG	Detrital Wash	Headwaters to Lake Mead				A&We			PBC				
CG	Dogtown Reservoir	35°12'40"/112°07'54"	Igneous	A&Wc				FBC		DWS	FC	AgI	AgL
CG	Dragon Creek	Headwaters to confluence with Milk Creek		A&Wc				FBC			FC		
CG	Dragon Creek	Below confluence with Milk Creek to confluence with Crystal Creek			A&Ww			FBC			FC		
CG	Garden Creek	Headwaters to confluence with Pipe Creek			A&Ww			FBC			FC		
CG	Gonzalez Lake	35°15'26"/112°12'09"	Shallow		A&Ww			FBC			FC	AgI	AgL
CG	Grand Wash	Headwaters to Colorado River				A&We			PBC				
CG	Grapevine Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Grapevine Wash	Headwaters to Colorado River				A&We			PBC				
CG	Hakatai Canyon	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Hance Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Havasu Creek	From the Havasupai Indian Reservation boundary to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Hermit Creek	Headwaters to Hermit Pack Trail crossing at 36°03'38"/112°14'00"		A&Wc				FBC			FC		
CG	Hermit Creek	Below Hermit Pack Trail crossing to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Horn Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Hualapai Wash	Headwaters to Lake Mead				A&We			PBC				
CG	Jacob Lake	36°42'27"/112°13'50"	Sedimentary	A&Wc				FBC			FC		
CG	Kaibab Lake	35°17'04"/112°09'32"	Igneous	A&Wc				FBC		DWS	FC	AgI	AgL
CG	Kanab Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC		DWS	FC		AgL
CG	Kwagunt Creek	Headwaters to confluence with unnamed tributary at 36°13'37"/111°54'50"		A&Wc				FBC			FC		
CG	Kwagunt Creek	Below confluence with unnamed tributary to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Lake Mead	36°06'18"/114°26'33"	Deep	A&Wc				FBC		DWS	FC	AgI	AgL
CG	Lake Powell	36°59'53"/111°08'17"	Deep	A&Wc				FBC		DWS	FC	AgI	AgL
CG	Lonetree Canyon Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Matkatamiba Creek	Below Havasupai Indian Reservation boundary to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Monument Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Nankoweap Creek	Headwaters to confluence with unnamed tributary at 36°15'29"/111°57'26"		A&Wc				FBC			FC		
CG	Nankoweap Creek	Below confluence with unnamed tributary to confluence with Colorado River			A&Ww			FBC			FC		
CG	National Canyon Creek	Headwaters to Hualapai Indian Reservation boundary at 36°15'15"/112°52'34"			A&Ww			FBC			FC		
CG	North Canyon Creek	Headwaters to confluence with unnamed tributary at 36°33'58"/111°55'41"		A&Wc				FBC			FC		
CG	North Canyon Creek	Below confluence with unnamed tributary to confluence with Colorado River			A&Ww			FBC			FC		
CG	Olo Canyon	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Parashant Canyon	Headwaters to confluence with unnamed tributary at 36°21'02"/113°27'56"		A&Wc				FBC			FC		
CG	Parashant Canyon	Below confluence with unnamed tributary to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Paria River	Utah border to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Phantom Creek	Headwaters to confluence with unnamed tributary at 36°09'29"/112°08'13"		A&Wc				FBC			FC		
CG	Phantom Creek	Below confluence with unnamed tributary to confluence with Bright Angel Creek			A&Ww			FBC			FC		
CG	Pipe Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		

CG	Red Canyon Creek	Headwaters to confluence with the Colorado River '			A&Ww			FBC			FC		
CG	Roaring Springs	36°11'45"/112°02'06"		A&Wc				FBC		DWS	FC		
CG	Roaring Springs Creek	Headwaters to confluence with Bright Angel Creek		A&Wc				FBC			FC		
CG	Royal Arch Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Ruby Canyon	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Russell Tank	35°52'21"/111°52'45"		A&Wc				FBC			FC		AgL
CG	Saddle Canyon Creek	Headwaters to confluence with unnamed tributary at 36°21'36"/112°22'43"		A&Wc				FBC			FC		
CG	Saddle Canyon Creek	Below confluence with unnamed tributary to confluence with Colorado River			A&Ww			FBC			FC		
CG	Santa Fe Reservoir	35°14'31"/112°11'10"	Igneous	A&Wc				FBC		DWS	FC		
CG	Sapphire Canyon	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Serpentine Canyon	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Shinumo Creek	Headwaters to confluence with unnamed tributary at 36°18'18"/112°18'07"		A&Wc				FBC			FC		
CG	Shinumo Creek	Below confluence with unnamed tributary to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Short Creek	Headwaters to confluence with Fort Pearce Wash				A&We			PBC				
CG	Slate Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Spring Canyon Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Stone Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Tapeats Creek	Headwaters to confluence with the Colorado River		A&Wc				FBC			FC		
CG	Thunder River	Headwaters to confluence with Tapeats Creek		A&Wc				FBC			FC		
CG	Trail Canyon Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Transept Canyon	Headwaters to Grand Canyon National Park North Rim WWTP outfall at 36°12'20"/112°03'35"				A&We			PBC				
CG	Transept Canyon (EDW)	Grand Canyon National Park North Rim WWTP outfall to 1 km downstream					A&Wedw		PBC				
CG	Transept Canyon	From 1 km downstream of the Grand Canyon National Park North Rim WWTP outfall to confluence with Bright Angel Creek				A&We			PBC				
CG	Travertine Canyon Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Turquoise Canyon	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Unkar Creek	Below confluence with unnamed tributary at 36°07'54"/111°54'06" to confluence with Colorado River			A&Ww			FBC			FC		
CG	Unnamed Wash (EDW)	Grand Canyon National Park Desert View WWTP outfall at 36°02'06"/111°49'13" to confluence with Cedar Canyon					A&Wedw		PBC				
CG	Unnamed Wash (EDW)	Valle Airpark WRF outfall at 35°38'34"/112°09'22" to confluence with Spring Valley Wash					A&Wedw		PBC				
CG	Vasey's Paradise	A spring at 36°29'52"/111°51'26"		A&Wc				FBC			FC		
CG	Virgin River	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC	AgI	AgL
CG	Vishnu Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	Warm Springs Creek	Headwaters to confluence with the Colorado River			A&Ww			FBC			FC		
CG	West Cataract Creek	Headwaters to confluence with Cataract Creek		A&Wc				FBC			FC		AgL
CG	White Creek	Headwaters to confluence with unnamed tributary at 36°18'45"/112°21'03"		A&Wc				FBC			FC		
CG	White Creek	Below confluence with unnamed tributary to confluence with the Colorado River			A&Ww			FBC			FC		
CL	A10 Backwater	33°31'45"/114°33'19"	Shallow		A&Ww			FBC			FC		
CL	A7 Backwater	33°34'27"/114°32'04"	Shallow		A&Ww			FBC			FC		
CL	Adobe Lake	33°02'36"/114°39'26"	Shallow		A&Ww			FBC			FC		
CL	Cibola Lake	33°14'01"/114°40'31"	Shallow		A&Ww			FBC			FC		
CL	Clear Lake	33°01'59"/114°31'19"	Shallow		A&Ww			FBC			FC		
CL	Columbus Wash	Headwaters to confluence with the Gila River				A&We			PBC				
CL	Colorado River	Lake Mead to Topock Marsh		A&Wc				FBC		DWS	FC	AgI	AgL
CL	Colorado River	Topock Marsh to Morelos Dam			A&Ww			FBC		DWS	FC	AgI	AgL
CL	Gila River	Painted Rock Dam to confluence with the Colorado River			A&Ww			FBC			FC	AgI	AgL
CL	Holy Moses Wash	Headwaters to City of Kingman Downtown WWTP outfall at 35°10'33"/114°03'46"				A&We			PBC				
CL	Holy Moses Wash (EDW)	City of Kingman Downtown WWTP outfall to 3 km downstream					A&Wedw		PBC				
CL	Holy Moses Wash	From 3 km downstream of City of Kingman Downtown WWTP outfall to confluence with Sawmill Wash				A&We			PBC				
CL	Hunter's Hole Backwater	32°31'13"/114°48'07"	Shallow		A&Ww			FBC			FC		AgL
CL	Imperial Reservoir	32°53'02"/114°27'54"	Shallow		A&Ww			FBC		DWS	FC	AgI	AgL
CL	Island Lake	33°01'44"/114°36'42"	Shallow		A&Ww			FBC			FC		
CL	Laguna Reservoir	32°51'35"/114°28'29"	Shallow		A&Ww			FBC		DWS	FC	AgI	AgL
CL	Lake Havasu	34°35'18"/114°25'47"	Deep		A&Ww			FBC		DWS	FC	AgI	AgL
CL	Lake Mohave	35°26'58"/114°38'30"	Deep	A&Wc				FBC		DWS	FC	AgI	AgL

CL	Martinez Lake	32°58'49"/114°28'09"	Shallow		A&Ww			FBC			FC	AgI	AgL
CL	Mittry Lake	32°49'17"/114°27'54"	Shallow		A&Ww			FBC			FC		
CL	Mohave Wash	Headwaters to Lower Colorado River				A&We			PBC				
CL	Nortons Lake	33°02'30"/114°37'59"	Shallow		A&Ww			FBC			FC		
CL	Painted Rock (Borrow Pit) Lake	33°04'55"/113°01'17"	Sedimentary		A&Ww			FBC			FC	AgI	AgL
CL	Pretty Water Lake	33°19'51"/114°42'19"	Shallow		A&Ww			FBC			FC		
CL	Quigley Pond	32°43'40"/113°57'44"	Shallow		A&Ww			FBC			FC		
CL	Redondo Lake	32°44'32"/114°29'03"	Shallow		A&Ww			FBC			FC		
CL	Sacramento Wash	Headwaters to Topock Marsh				A&We			PBC				
CL	Sawmill Canyon	Headwaters to abandoned gaging station at 35°09'45"/ 113°57'56"			A&Ww			FBC			FC		AgL
CL	Sawmill Canyon	Below abandoned gaging station to confluence with Holy Moses Wash				A&We			PBC				AgL
CL	Topock Marsh	34°43'27"/114°28'59"	Shallow		A&Ww			FBC		DWS	FC	AgI	AgL
CL	Tyson Wash (EDW)	Town of Quartzsite WWTP outfall at 33°42'39"/ 114°13'10" to 1 km downstream					A&Wedw		PBC				
CL	Wellton Canal	Wellton-Mohawk Irrigation District								DWS		AgI	AgL
CL	Yuma Area Canals	Above municipal water treatment plant intakes								DWS		AgI	AgL
CL	Yuma Area Canals	Below municipal water treatment plant intakes and all drains										AgI	AgL
LC	Als Lake	35°02'10"/111°25'17"	Igneous		A&Ww			FBC			FC		AgL
LC	Ashurst Lake	35°01'06"/111°24'18"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Atcheson Reservoir	33°59'59"/109°20'43"	Igneous		A&Ww			FBC			FC	AgI	AgL
LC	Auger Creek	Headwaters to confluence with Nutrioso Creek		A&Wc				FBC			FC		AgL
LC	Barbershop Canyon Creek	Headwaters to confluence with East Clear Creek		A&Wc				FBC			FC		AgL
LC	Bear Canyon Creek	Headwaters to confluence with General Springs Canyon		A&Wc				FBC			FC		AgL
LC	Bear Canyon Creek	Headwaters to confluence with Willow Creek		A&Wc				FBC			FC		AgL
LC	Bear Canyon Lake	34°24'00"/111°00'06"	Sedimentary	A&Wc				FBC			FC	AgI	AgL
LC	Becker Lake	34°09'11"/109°18'23"	Shallow	A&Wc				FBC			FC		AgL
LC	Billy Creek	Headwaters to confluence with Show Low Creek		A&Wc				FBC			FC		AgL
LC	Black Canyon	Headwaters to confluence with Chevelon Creek		A&Wc				FBC			FC	AgI	AgL
LC	Black Canyon Lake	34°20'32"/110°40'13"	Sedimentary	A&Wc				FBC		DWS	FC	AgI	AgL
LC	Bow and Arrow Wash	Headwaters to confluence with Rio de Flag				A&We			PBC				
LC	Buck Springs Canyon Creek	Headwaters to confluence with Leonard Canyon Creek		A&Wc				FBC			FC		AgL
LC	Bunch Reservoir	34°02'20"/109°26'48"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Carnero Lake	34°06'57"/109°31'42"	Shallow	A&Wc				FBC			FC		AgL
LC	Chevelon Canyon Lake	34°29'18"/110°49'30"	Sedimentary	A&Wc				FBC			FC	AgI	AgL
LC	Chevelon Creek	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC	AgI	AgL
LC	Chevelon Creek, West Fork	Headwaters to confluence with Chevelon Creek		A&Wc				FBC			FC		AgL
LC	Chilson Tank	34°51'43"/111°22'54"	Igneous		A&Ww			FBC			FC		AgL
LC	Clear Creek	Headwaters to confluence with the Little Colorado River		A&Wc				FBC		DWS	FC		AgL
LC	Clear Creek Reservoir	34°57'09"/110°39'14"	Shallow	A&Wc				FBC		DWS	FC	AgI	AgL
LC	Coconino Reservoir	35°00'05"/111°24'10"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Colter Creek	Headwaters to confluence with Nutrioso Creek		A&Wc				FBC			FC		AgL
LC	Colter Reservoir	33°56'39"/109°28'53"	Shallow	A&Wc				FBC			FC		AgL
LC	Concho Creek	Headwaters to confluence with Carrizo Wash		A&Wc				FBC			FC		AgL
LC	Concho Lake	34°26'37"/109°37'40"	Shallow	A&Wc				FBC			FC	AgI	AgL
LC	Cow Lake	34°53'14"/111°18'51"	Igneous		A&Ww			FBC			FC		AgL
LC	Coyote Creek	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC	AgI	AgL
LC	Cragin Reservoir (formerly Blue Ridge Reservoir)	34°32'40"/111°11'33"	Deep	A&Wc				FBC			FC	AgI	AgL
LC	Crisis Lake (Snake Tank #2)	34°47'51"/111°17'32"			A&Ww			FBC			FC		AgL
LC	Dane Canyon Creek	Headwaters to confluence with Barbershop Canyon Creek		A&Wc				FBC			FC		AgL
LC	Daves Tank	34°44'22"/111°17'15"			A&Ww			FBC			FC		AgL
LC	Deep Lake	35°03'34"/111°25'00"	Igneous		A&Ww			FBC			FC		AgL
LC	Ducksnest Lake	34°59'14"/111°23'57"			A&Ww			FBC			FC		AgL
LC	East Clear Creek	Headwaters to confluence with Clear Creek		A&Wc				FBC			FC	AgI	AgL
LC	Ellis Wiltbank Reservoir	34°05'25"/109°28'25"	Igneous		A&Ww			FBC			FC	AgI	AgL
LC	Estates at Pine Canyon lakes (EDW)	35°09'32"/111°38'26"	EDW				A&Wedw		PBC				
LC	Fish Creek	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC		AgL
LC	Fool's Hollow Lake	34°16'30"/110°03'43"	Igneous	A&Wc				FBC			FC		AgL

LC	General Springs Canyon Creek	Headwaters to confluence with East Clear Creek		A&Wc				FBC			FC		AgL
LC	Geneva Reservoir	34°01'45"/109°31'46"	Igneous		A&Ww			FBC			FC		AgL
LC	Hall Creek	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC	AgI	AgL
LC	Hart Canyon Creek	Headwaters to confluence with Willow Creek		A&Wc				FBC			FC		AgL
LC	Hay Lake	34°00'11"/109°25'57"	Igneous	A&Wc				FBC			FC		AgL
LC	Hog Wallow Lake	33°58'57"/109°25'39"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Horse Lake	35°03'55"/111°27'50"			A&Ww			FBC			FC		AgL
LC	Hulsey Creek	Headwaters to confluence with Nutrioso Creek		A&Wc				FBC			FC		AgL
LC	Hulsey Lake	33°55'58"/109°09'40"	Sedimentary	A&Wc				FBC			FC		AgL
LC	Indian Lake	35°00'39"/111°22'41"			A&Ww			FBC			FC		AgL
LC	Jacks Canyon Creek	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC	AgI	AgL
LC	Jarvis Lake	33°58'59"/109°12'36"	Sedimentary		A&Ww			FBC			FC		AgL
LC	Kinnikinick Lake	34°53'53"/111°18'18"	Igneous	A&Wc				FBC			FC		AgL
LC	Knoll Lake	34°25'38"/111°05'13"	Sedimentary	A&Wc				FBC			FC		AgL
LC	Lake Humphreys (EDW)	35°11'51"/111°35'19"	EDW				A&Wedw		PBC				
LC	Lake Mary, Lower	35°06'21"/111°34'38"	Igneous	A&Wc				FBC		DWS	FC		AgL
LC	Lake Mary, Upper	35°03'23"/111°28'34"	Igneous	A&Wc				FBC		DWS	FC		AgL
LC	Lake of the Woods	34°09'40"/109°58'47"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Lee Valley Creek (OAW)	Headwaters to Lee Valley Reservoir		A&Wc				FBC			FC		
LC	Lee Valley Creek	From Lee Valley Reservoir to confluence with the East Fork of the Little Colorado River		A&Wc				FBC			FC		AgL
LC	Lee Valley Reservoir	33°56'29"/109°30'04"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Leonard Canyon Creek	Headwaters to confluence with Clear Creek		A&Wc				FBC			FC		AgL
LC	Leonard Canyon Creek, East Fork	Headwaters to confluence with Leonard Canyon Creek		A&Wc				FBC			FC		AgL
LC	Leonard Canyon Creek, Middle Fork	Headwaters to confluence with Leonard Canyon, West Fork		A&Wc				FBC			FC		AgL
LC	Leonard Canyon Creek, West Fork	Headwaters to confluence with Leonard Canyon, East Fork		A&Wc				FBC			FC		AgL
LC	Lily Creek	Headwaters to confluence with Coyote Creek		A&Wc				FBC			FC		AgL
LC	Little Colorado River	Headwaters to Lyman Reservoir		A&Wc				FBC			FC	AgI	AgL
LC	Little Colorado River	Below Lyman Reservoir to confluence with the Puerco River		A&Wc				FBC		DWS	FC	AgI	AgL
LC	Little Colorado River	Below Puerco River confluence to the Colorado River, excluding segments on Native American Lands			A&Ww			FBC		DWS	FC	AgI	AgL
LC	Little Colorado River, East Fork	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC		AgL
LC	Little Colorado River, South Fork	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC		AgL
LC	Little Colorado River, West Fork (OAW)	Headwaters to Government Springs		A&Wc				FBC			FC		
LC	Little Colorado River, West Fork	Below Government Springs to confluence with the Little Colorado River		A&Wc				FBC			FC		AgL
LC	Little George Reservoir	34°00'37"/109°19'15"	Igneous		A&Ww			FBC			FC	AgI	
LC	Little Mormon Lake	34°17'00"/109°58'06"	Igneous		A&Ww			FBC			FC	AgI	AgL
LC	Long Lake, Lower	34°47'16"/111°12'40"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Long Lake, Upper	35°00'08"/111°21'23"	Igneous	A&Wc				FBC			FC		AgL
LC	Long Tom Tank	34°20'35"/110°49'22"		A&Wc				FBC			FC		AgL
LC	Lower Walnut Canyon Lake (EDW)	35°12'04"/111°34'07"	EDW				A&Wedw		PBC				
LC	Lyman Reservoir	34°21'21"/109°21'35"	Deep	A&Wc				FBC			FC	AgI	AgL
LC	Mamie Creek	Headwaters to confluence with Coyote Creek		A&Wc				FBC			FC		AgL
LC	Marshall Lake	35°07'18"/111°32'07"	Igneous	A&Wc				FBC			FC		AgL
LC	McKay Reservoir	34°01'27"/109°13'48"		A&Wc				FBC			FC	AgI	AgL
LC	Merritt Draw Creek	Headwaters to confluence with Barbershop Canyon Creek		A&Wc				FBC			FC		AgL
LC	Mexican Hay Lake	34°01'58"/109°21'25"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Milk Creek	Headwaters to confluence with Hulsey Creek		A&Wc				FBC			FC		AgL
LC	Miller Canyon Creek	Headwaters to confluence with East Clear Creek		A&Wc				FBC			FC		AgL
LC	Miller Canyon Creek, East Fork	Headwaters to confluence with Miller Canyon Creek		A&Wc				FBC			FC		AgL
LC	Morton Lake	34°53'37"/111°17'41"	Igneous	A&Wc				FBC			FC		AgL
LC	Mud Lake	34°55'19"/111°21'29"	Shallow		A&Ww			FBC			FC		AgL
LC	Ned Lake (EDW)	34°17'17"/110°03'22"	EDW				A&Wedw		PBC				

LC	Nelson Reservoir	34°02'52"/109°11'19"	Sedimentary	A&Wc				FBC			FC	AgI	AgL
LC	Norton Reservoir	34°03'57"/109°31'27"	Igneous		A&Ww			FBC			FC		AgL
LC	Nutrioso Creek	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC	AgI	AgL
LC	Paddy Creek	Headwaters to confluence with Nutrioso Creek		A&Wc				FBC			FC		AgL
LC	Pierce Seep	34°23'39"/110°31'17"		A&Wc					PBC				
LC	Pine Tank	34°46'49"/111°17'21"	Igneous		A&Ww			FBC			FC		AgL
LC	Pintail Lake (EDW)	34°18'05"/110°01'21"	EDW				A&Wedw		PBC				
LC	Porter Creek	Headwaters to confluence with Show Low Creek		A&Wc				FBC			FC		AgL
LC	Puerco River	Headwaters to confluence with the Little Colorado River			A&Ww			FBC		DWS	FC	AgI	AgL
LC	Puerco River (EDW)	Sanders Unified School District WWTP outfall at 35°12'52"/109°19'40" to 0.5 km downstream					A&Wedw		PBC				
LC	Rainbow Lake	34°09'00"/109°59'09"	Shallow Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Reagan Reservoir	34°02'09"/109°08'41"	Igneous		A&Ww			FBC			FC		AgL
LC	Rio de Flag	Headwaters to City of Flagstaff WWTP outfall at 35°12'21"/111°39'17"				A&We			PBC				
LC	Rio de Flag (EDW)	From City of Flagstaff WWTP outfall to the confluence with San Francisco Wash					A&Wedw		PBC				
LC	River Reservoir	34°02'01"/109°26'07"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Rogers Reservoir	33°56'30"/109°16'20"	Igneous		A&Ww			FBC			FC		AgL
LC	Rudd Creek	Headwaters to confluence with Nutrioso Creek		A&Wc				FBC			FC		AgL
LC	Russel Reservoir	33°59'29"/109°20'01"	Igneous		A&Ww			FBC			FC	AgI	AgL
LC	San Salvador Reservoir	33°58'51"/109°19'55"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Scott Reservoir	34°10'31"/109°57'31"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Show Low Creek	Headwaters to confluence with Silver Creek		A&Wc				FBC			FC	AgI	AgL
LC	Show Low Lake	34°11'36"/110°00'12"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Silver Creek	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC	AgI	AgL
LC	Slade Reservoir	33°59'41"/109°20'26"	Igneous		A&Ww			FBC			FC	AgI	AgL
LC	Soldiers Annex Lake	34°47'15"/111°13'51"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Soldiers Lake	34°47'47"/111°14'04"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Spaulding Tank	34°30'17"/111°02'06"			A&Ww			FBC			FC		AgL
LC	St Johns Reservoir (Little Reservoir)	34°29'10"/109°22'06"	Igneous		A&Ww			FBC			FC	AgI	AgL
LC	Telephone Lake (EDW)	34°17'35"/110°02'42"	EDW				A&Wedw		PBC				
LC	Tremaine Lake	34°46'02"/111°13'51"	Igneous	A&Wc				FBC			FC		AgL
LC	Tunnel Reservoir	34°01'53"/109°26'34"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Turkey Draw (EDW)	High Country Pines II WWTP outfall at 33°25'35"/ 110°38'13" to confluence with Black Canyon Creek					A&Wedw		PBC				
LC	Unnamed Wash (EDW)	Bison Ranch WWTP outfall at 34°23'31"/110°31'29" to Pierce Seep					A&Wedw		PBC				
LC	Walnut Creek	Headwaters to confluence with Billy Creek		A&Wc				FBC			FC		AgL
LC	Water Canyon Creek	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC		AgL
LC	Whale Lake (EDW)	35°11'13"/111°35'21"	EDW				A&Wedw		PBC				
LC	Whipple Lake	'34°16'49"/109°58'29"	Igneous		A&Ww			FBC			FC		AgL
LC	White Mountain Lake	34°21'57"/109°59'21"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	White Mountain Reservoir	34°00'12"/109°30'39"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Willow Creek	Headwaters to confluence with Clear Creek		A&Wc				FBC			FC		AgL
LC	Willow Springs Canyon Creek	Headwaters to confluence with Chevelon Creek		A&Wc				FBC			FC		AgL
LC	Willow Springs Lake	34°18'13"/110°52'16"	Sedimentary	A&Wc				FBC			FC	AgI	AgL
LC	Woodland Reservoir	34°07'35"/109°57'01"	Igneous	A&Wc				FBC			FC	AgI	AgL
LC	Woods Canyon Creek	Headwaters to confluence with Chevelon Creek		A&Wc				FBC			FC		AgL
LC	Woods Canyon Lake	34°20'09"/110°56'45"	Sedimentary	A&Wc				FBC			FC	AgI	AgL
LC	Zuni River	Headwaters to confluence with the Little Colorado River		A&Wc				FBC			FC	AgI	AgL
MG	Agua Fria River	Headwaters to confluence with unnamed tributary at 34°35'14"/112°16'18"				A&We			PBC				AgL
MG	Agua Fria River (EDW)	Below confluence with unnamed tributary to State Route 169					A&Wedw		PBC				AgL
MG	Agua Fria River	From State Route 169 to Lake Pleasant			A&Ww			FBC		DWS	FC	AgI	AgL
MG	Agua Fria River	Below Lake Pleasant to the City of El Mirage WWTP at ' 33°34'20"/112°18'32"				A&We			PBC				AgL
MG	Agua Fria River (EDW)	From City of El Mirage WWTP outfall to 2 km downstream					A&Wedw		PBC				
MG	Agua Fria River	Below 2 km downstream of the City of El Mirage WWTP to City of Avondale WWTP outfall at 33°23'55"/ 112°21'16"				A&We			PBC				
MG	Agua Fria River	From City of Avondale WWTP outfall to confluence with Gila River					A&Wedw		PBC				
MG	Andorra Wash	Headwaters to confluence with Cave Creek Wash				A&We			PBC				
MG	Antelope Creek	Headwaters to confluence with Martinez Creek			A&Ww			FBC			FC		AgL

MG	Arlington Canal	From Gila River at 33°20'54"/112°35'39" to Gila River at 33°13'44"/112°46'15"											AgL
MG	Ash Creek	Headwaters to confluence with Tex Canyon		A&Wc				FBC			FC	AgI	AgL
MG	Ash Creek	Below confluence with Tex Canyon to confluence with Agua Fria River			A&Ww			FBC			FC	AgI	AgL
MG	Beehive Tank	32°52'37"/111°02'20"			A&Ww			FBC			FC		AgL
MG	Big Bug Creek	Headwaters to confluence with Eugene Gulch		A&Wc				FBC			FC	AgI	AgL
MG	Big Bug Creek	Below confluence with Eugene Gulch to confluence with Agua Fria River			A&Ww			FBC			FC	AgI	AgL
MG	Black Canyon Creek	Headwaters to confluence with the Agua Fria River			A&Ww			FBC			FC		AgL
MG	Blind Indian Creek	Headwaters to confluence with the Hassayampa River			A&Ww			FBC			FC		AgL
MG	Cave Creek	Headwaters to the Cave Creek Dam			A&Ww			FBC			FC		AgL
MG	Cave Creek	Cave Creek Dam to the Arizona Canal				A&We			PBC				
MG	Centennial Wash	Headwaters to confluence with the Gila River at 33°16'32"/112°48'08"				A&We			PBC				AgL
MG	Centennial Wash Ponds	33°54'52"/113°23'47"			A&Ww			FBC			FC		AgL
MG	Chaparral Park Lake	Hayden Road & Chaparral Road, Scottsdale at 33°30'40"/111°54'27"	Urban		A&Ww				PBC		FC	AgI	
MG	Devils Canyon	Headwaters to confluence with Mineral Creek			A&Ww				FBC		FC		AgL
MG	East Maricopa Floodway	From Brown and Greenfield Rds to the Gila River Indian Reservation Boundary			A&We				PBS				AgL
MG	Eldorado Park Lake	Miller Road & Oak Street, Tempe at 33°28'25"/ 111°54'53"	Urban		A&Ww				PBC		FC		
MG	Fain Lake	Town of Prescott Valley Park Lake 34°34'29"/ 112°21'06"	Urban		A&Ww				PBC		FC		
MG	French Gulch	Headwaters to confluence with Hassayampa River			A&Ww				PBC				AgL
MG	Galena Gulch	Headwaters to confluence with the Agua Fria River				A&We			PBC				AgL
MG	Galloway Wash (EDW)	Town of Cave Creek WWTP outfall at 33°50'15"/ 111°57'35" to confluence with Cave Creek					A&Wedw		PBC				
MG	Gila River	San Carlos Indian Reservation boundary to the Ashurst-Hayden Dam			A&Ww			FBC			FC	AgI	AgL
MG	Gila River	Ashurst-Hayden Dam to the Town of Florence WWTP outfall at 33°02'20"/111°24'19"				A&We			PBC				AgL
MG	Gila River (EDW)	Town of Florence WWTP outfall to Felix Road					A&Wedw		PBC				
MG	Gila River	Felix Road to the Gila River Indian Reservation boundary				A&We			PBC				AgL
MG	Gila River (EDW)	From the confluence with the Salt River to Gillespie Dam					A&Wedw		PBC		FC	AgI	AgL
MG	Gila River	Gillespie Dam to confluence with Painted Rock Dam			A&Ww			FBC			FC	AgI	AgL
MG	Groom Creek	Headwaters to confluence with the Hassayampa River		A&Wc				FBC		DWS	FC		AgL
MG	Hassayampa Lake	34°25'45"/112°25'33"	Igneous	A&Wc				FBC		DWS	FC		
MG	Hassayampa River	Headwaters to confluence with unnamed tributary at 34°26'09"/112°30'32"		A&Wc				FBC			FC	AgI	AgL
MG	Hassayampa River	Below confluence with unnamed tributary to confluence with unnamed tributary at 33°51"52"/112°39'56"			A&Ww			FBC			FC	AgI	AgL
MG	Hassayampa River	Below unnamed tributary to the Buckeye Irrigation Company Canal				A&We			PBC				AgL
MG	Hassayampa River	Below Buckeye Irrigation Company canal to the Gila River			A&Ww			FBC			FC		AgL
MG	Horsethief Lake	34°09'42"/112°17'57"	Igneous	A&Wc				FBC		DWS	FC		AgL
MG	Indian Bend Wash	Headwaters to confluence with the Salt River				A&We			PBC				
MG	Indian Bend Wash Lakes	Scottsdale at 33°30'32"/111°54'24"	Urban		A&Ww				PBC		FC		
MG	Indian School Park Lake	Indian School Road & Hayden Road, Scottsdale at 33°29'39"/111°54'37"	Urban		A&Ww				PBC		FC		
MG	Kiwanis Park Lake	6000 South Mill Avenue, Tempe at 33°22'27"/ 111°56'22"	Urban		A&Ww				PBC		FC	AgI	
MG	Lake Pleasant	33°53'46"/112°16'29"	Deep		A&Ww			FBC		DWS	FC	AgI	AgL
MG	Lake Pleasant, Lower	33°50'32"/112°16'03"			A&Ww			FBC			FC	AgI	AgL
MG	Lion Canyon	Headwaters to confluence with Weaver Creek			A&Ww			FBC			FC		AgL
MG	Little Ash Creek	Headwaters to confluence with Ash Creek at			A&Ww			FBC			FC		AgL
MG	Lynx Creek	Headwaters to confluence with unnamed tributary at 34°34'29"/112°21'07"		A&Wc				FBC			FC		AgL
MG	Lynx Creek	Below confluence with unnamed tributary at 34°34'29"/ 112°21'07" to confluence with Agua Fria River			A&Ww			FBC			FC		AgL
MG	Lynx Lake	34°31'07"/112°23'07"	Deep	A&Wc				FBC		DWS	FC	AgI	AgL
MG	Martinez Canyon	Headwaters to confluence with Box Canyon			A&Ww			FBC			FC		AgL
MG	Martinez Creek	Headwaters to confluence with the Hassayampa River			A&Ww			FBC			FC	AgI	AgL
MG	McKellips Park Lake	Miller Road & McKellips Road, Scottsdale at 33°27'14"/ 111°54'49"	Urban		A&Ww				PBC		FC	AgI	
MG	McMicken Wash (EDW)	City of Peoria Jomax WWTP outfall at 33°43'31"/ 112°20'15" to confluence with Agua Fria River					A&Wedw		PBC				
MG	Mineral Creek	Headwaters to 33°12'34"/110°59'58"			A&Ww			FBC			FC		AgL
MG	Mineral Creek (diversion tunnel and lined channel)	33°12'24"/110°59'58" to 33°07'56"/110°58'34"						PBC					
MG	Mineral Creek	End of diversion channel to confluence with Gila River			A&Ww			FBC			FC		AgL
MG	Minnehaha Creek	Headwaters to confluence with the Hassayampa River			A&Ww			FBC			FC		AgL
MG	New River	Headwaters to Interstate 17 at 33°54'19.5"/112°08'46"			A&Ww			FBC			FC	AgI	AgL

MG	New River	Below Interstate 17 to confluence with Agua Fria River				A&We			PBC				AgL
MG	Painted Rock Reservoir	33°04'23"/113°00'38"	Sedimentary		A&Ww			FBC			FC	AgI	AgL
MG	Papago Park Ponds	Galvin Parkway, Phoenix at 33°27'15"/111°56'45"	Urban		A&Ww				PBC		FC		
MG	Papago Park South Pond	Curry Road, Tempe 33°26'22"/111°55'55"	Urban		A&Ww				PBC		FC		
MG	Perry Mesa Tank	34°11'03"/112°02'01"			A&Ww			FBC			FC		AgL
MG	Phoenix Area Canals	Granite Reef Dam to all municipal WTP intakes								DWS		AgI	AgL
MG	Phoenix Area Canals	Below municipal WTP intakes and all other locations										AgI	AgL
MG	Picacho Reservoir	32°51'10"/111°28'25"	Shallow		A&Ww			FBC			FC	AgI	AgL
MG	Poland Creek	Headwaters to confluence with Lorena Gulch		A&Wc				FBC			FC		AgL
MG	Poland Creek	Below confluence with Lorena Gulch to confluence with Black Canyon Creek			A&Ww			FBC			FC		AgL
MG	Queen Creek	Headwaters to the Town of Superior WWTP outfall at 33°16'33"/111°07'44"			A&Ww				PBC		FC		AgL
MG	Queen Creek (EDW)	Below Town of Superior WWTP outfall to confluence with Potts Canyon					A&Wedw		PBC				
MG	Queen Creek	Below Potts Canyon to ' Whitlow Dam			A&Ww			FBC			FC		AgL
MG	Queen Creek	Below Whitlow Dam to confluence with Gila River				A&We			PBC				
MG	Salt River	Verde River to 2 km below Granite Reef Dam			A&Ww			FBC		DWS	FC	AgI	AgL
MG	Salt River	2 km below Granite Reef Dam to City of Mesa NW WRF outfall at 33°26'22"/111°53'14"				A&We			PBC				
MG	Salt River (EDW)	City of Mesa NW WRF outfall to Tempe Town Lake					A&Wedw		PBC				
MG	Salt River	Below Tempe Town Lake to Interstate 10 bridge				A&We			PBC				
MG	Salt River	Below Interstate 10 bridge to the City of Phoenix 23rd Avenue WWTP outfall at 33°24'44"/ 112°07'59"			A&Ww				PBC		FC		
MG	Salt River (EDW)	From City of Phoenix 23rd Avenue WWTP outfall to confluence with Gila River					A&Wedw		PBC		FC	AgI	AgL
MG	Siphon Draw (EDW)	Superstition Mountains CFD WWTP outfall at 33°21'40"/ 111°33'30" to 6 km downstream					A&Wedw		PBC				
MG	Sycamore Creek	Headwaters to confluence with Tank Canyon		A&Wc				FBC			FC		AgL
MG	Sycamore Creek	Below confluence with Tank Canyon to confluence with Agua Fria River			A&Ww			FBC			FC		AgL
MG	Tempe Town Lake	At Mill Avenue Bridge at 33°26'00"/111°56'26"	Urban		A&Ww			FBC			FC		
MG	The Lake Tank	32°54'14"/111°04'15"			A&Ww			FBC			FC		AgL
MG	Tule Creek	Headwaters to confluence with the Agua Fria River			A&Ww			FBC			FC		AgL
MG	Turkey Creek	Headwaters to confluence with unnamed tributary at 34°19'28"/112°21'33"		A&Wc				FBC			FC	AgI	AgL
MG	Turkey Creek	Below confluence with unnamed tributary to confluence with Poland Creek			A&Ww			FBC			FC	AgI	AgL
MG	Unnamed Wash (EDW)	Gila Bend WWTP outfall to confluence with the Gila River					A&Wedw		PBC				
MG	Unnamed Wash (EDW)	Luke Air Force Base WWTP outfall at 33°32'21"/ 112°19'15" to confluence with the Agua Fria River					A&Wedw		PBC				
MG	Unnamed Wash (EDW)	North Florence WWTP outfall at 33°03'50"/ 111°23'13" to confluence with Gila River					A&Wedw		PBC				
MG	Unnamed Wash (EDW)	Town of Prescott Valley WWTP outfall at34°35'16"/ 112°16'18" to confluence with the Agua Fria River					A&Wedw		PBC				
MG	Unnamed Wash (EDW)	Town of Cave Creek WRF outfall at 33°48'02"/ 111°59'22" to confluence with Cave Creek					A&Wedw		PBC				
MG	Wagner Wash (EDW)	City of Buckeye Festival Ranch WRF outfall at 33°39'14"/ 112°40'18" to 2 km downstream					A&Wedw		PBC				
MG	Walnut Canyon Creek	Headwaters to confluence with the Gila River			A&Ww			FBC			FC		AgL
MG	Weaver Creek	Headwaters to confluence with Antelope Creek, tributary to Martinez Creek			A&Ww			FBC			FC		AgL
MG	White Canyon Creek	Headwaters to confluence with Walnut Canyon Creek			A&Ww			FBC			FC		AgL
MG	Yavapai Lake (EDW)	Town of Prescott Valley WWTP outfall 002 at 34°36'07"/ 112°18'48" to Navajo Wash	EDW				A&Wedw		PBC				
SC	Agua Caliente Lake	12325 East Roger Road, Tucson 32°16'51"/ 110°43'52"	Urban		A&Ww				PBC		FC		
SC	Agua Caliente Wash	Headwaters to confluence with Soldier Trail			A&Ww			FBC			FC		AgL
SC	Agua Caliente Wash	Below Soldier Trail to confluence with Tanque Verde Creek				A&We			PBC				AgL
SC	Aguirre Wash	From the Tohono O'odham Indian Reservation boundary to 32°28'38"/111°46'51"				A&We			PBC				
SC	Alambre Wash	Headwaters to confluence with Brawley Wash				A&We			PBC				
SC	Alamo Wash	Headwaters to confluence with Rillito Creek				A&We			PBC				
SC	Altar Wash	Headwaters to confluence with Brawley Wash				A&We			PBC				
SC	Alum Gulch	Headwaters to 31°28'20"/110°43'51"				A&We			PBC				AgL
SC	Alum Gulch	From 31°28'20"/110°43'51" to 31°29'17"/110°44'25"			A&Ww			FBC			FC		AgL
SC	Alum Gulch	Below 31°29'17"/110°44'25" to confluence with Sonoita Creek				A&We			PBC				AgL
SC	Arivaca Creek	Headwaters to confluence with Altar Wash			A&Ww			FBC			FC		AgL
SC	Arivaca Lake	31°31'52"/111°15'06"	Igneous		A&Ww			FBC			FC	AgI	AgL
SC	Atterbury Wash	Headwaters to confluence with Pantano Wash				A&We			PBC				AgL
SC	Bear Grass Tank	31°33'01"/111°11'03"			A&Ww			FBC			FC		AgL

SC	Big Wash	Headwaters to confluence with Cañada del Oro				A&We			PBC				
SC	Black Wash (EDW)	Pima County WWMD Avra Valley WWTP outfall at 32°09'58"/111°11'17" to confluence with Brawley Wash					A&Wedw		PBC				
SC	Bog Hole Tank	31°28'36"/110°37'09"			A&Ww			FBC			FC		AgL
SC	Brawley Wash	Headwaters to confluence with Los Robles Wash				A&We			PBC				
SC	California Gulch	Headwaters To U.S./Mexico border			A&Ww			FBC			FC		AgL
SC	Cañada del Oro	Headwaters to State Route 77			A&Ww			FBC			FC	AgI	AgL
SC	Cañada del Oro	Below State Route 77 to confluence with the Santa Cruz River				A&We			PBC				AgL
SC	Cienega Creek	Headwaters to confluence with Gardner Canyon			A&Ww			FBC			FC		AgL
SC	Cienega Creek (OAW)	From confluence with Gardner Canyon to USGS gaging station (#09484600)			A&Ww			FBC			FC		AgL
SC	Davidson Canyon	Headwaters to unnamed spring at 31°59'00"/ 110°38'49"				A&We			PBC				AgL
SC	Davidson Canyon (OAW)	From unnamed Spring to confluence with unnamed tributary at 31°59'09"/110°38'44"			A&Ww			FBC			FC		AgL
SC	Davidson Canyon (OAW)	Below confluence with unnamed tributary to unnamed spring at 32°00'40"/110°38'36"				A&We			PBC				AgL
SC	Davidson Canyon (OAW)	From unnamed spring to confluence with Cienega Creek			A&Ww			FBC			FC		AgL
SC	Empire Gulch	Headwaters to unnamed spring at 31°47'18"/ 110°38'17"				A&We			PBC				
SC	Empire Gulch	From 31°47'18"/110°38'17" to 31°47'03"/110°37'35"			A&Ww			FBC			FC		
SC	Empire Gulch	From 31°47'03"/110°37'35" to 31°47'05"/ 110°36'58"				A&We			PBC				AgL
SC	Empire Gulch	From 31°47'05"/110°36'58" to confluence with Cienega Creek			A&Ww			FBC			FC		
SC	Flux Canyon	Headwaters to confluence with Alum Gulch				A&We			PBC				AgL
SC	Gardner Canyon Creek	Headwaters to confluence with Sawmill Canyon		A&Wc				FBC			FC		
SC	Gardner Canyon Creek	Below Sawmill Canyon to confluence with Cienega Creek			A&Ww			FBC			FC		
SC	Greene Wash	Santa Cruz River to the Tohono O'odham Indian Reservation boundary				A&We			PBC				
SC	Greene Wash	Tohono O'odham Indian Reservation boundary to confluence with Santa Rosa Wash at 32°53'52"/ 111°56'48"				A&We			PBC				
SC	Harshaw Creek	Headwaters to confluence with Sonoita Creek at				A&We			PBC				AgL
SC	Hit Tank	32°43'57"/111°03'18"			A&Ww			FBC			FC		AgL
SC	Holden Canyon Creek	Headwaters to U.S./Mexico border			A&Ww			FBC			FC		
SC	Huachuca Tank	31°21'11"/110°30'18"			A&Ww			FBC			FC		AgL
SC	Julian Wash	Headwaters to confluence with the Santa Cruz River				A&We			PBC				
SC	Kennedy Lake	Mission Road & Ajo Road, Tucson at 32°10'49"/ 111°00'27"	Urban		A&Ww				PBC		FC		
SC	Lakeside Lake	8300 East Stella Road, Tucson at 32°11'11"/ 110°49'00"	Urban		A&Ww				PBC		FC		
SC	Lemmon Canyon Creek	Headwaters to confluence with unnamed tributary at 32°23'48"/110°47'49"		A&Wc				FBC			FC		
SC	Lemmon Canyon Creek	Below unnamed tributary at 32°23'48"/110°47'49" to confluence with Sabino Canyon Creek			A&Ww			FBC			FC		
SC	Los Robles Wash	Headwaters to confluence with the Santa Cruz River				A&We			PBC				
SC	Madera Canyon Creek	Headwaters to confluence with unnamed tributary at 31°43'42"/110°52'51"		A&Wc				FBC			FC		AgL
SC	Madera Canyon Creek	Below unnamed tributary at 31°43'42"/110°52'51 to confluence with the Santa Cruz River			A&Ww			FBC			FC		AgL
SC	Mattie Canyon	Headwaters to confluence with Cienega Creek			A&Ww			FBC			FC		AgL
SC	Nogales Wash	Headwaters to confluence with Potrero Creek			A&Ww				PBC		FC		
SC	Oak Tree Canyon	Headwaters to confluence with Cienega Creek				A&We			PBC				
SC	Palisade Canyon	Headwaters to confluence with unnamed tributary at 32°22'33"/110°45'31"		A&Wc				FBC			FC		
SC	Palisade Canyon	Below 32°22'33"/110°45'31" to unnamed tributary of Sabino Canyon			A&Ww			FBC			FC		
SC	Pantano Wash	Headwaters to confluence with Tanque Verde Creek				A&We			PBC				
SC	Parker Canyon Creek	Headwaters to confluence with unnamed tributary at 31°24'17"/110°28'47"	A&Wc					FBC			FC		
SC	Parker Canyon Creek	Below unnamed tributary to U.S./Mexico border			A&Ww			FBC			FC		
SC	Parker Canyon Lake	31°25'35"/110°27'15"	Deep	A&Wc				FBC			FC	AgI	AgL
SC	Patagonia Lake	31°29'56"/110°50'49"	Deep		A&Ww			FBC			FC	AgI	AgL
SC	Peña Blanca Lake	31°24'15"/111°05'12"	Igneous		A&Ww			FBC			FC	AgI	AgL
SC	Potrero Creek	Headwaters to Interstate 19				A&We			PBC				AgL
SC	Potrero Creek	Below Interstate 19 to confluence with Santa Cruz River			A&Ww			FBC			FC		AgL
SC	Puertocito Wash	Headwaters to confluence with Altar Wash				A&We			PBC				
SC	Quitobaquito Spring	(Pond and Springs) 31°56'39"/113°01'06"			A&Ww			FBC			FC		AgL
SC	Redrock Canyon Creek	Headwaters to confluence with Harshaw Creek			A&Ww			FBC			FC		
SC	Rillito Creek	Headwaters to confluence with the Santa Cruz River				A&We			PBC				AgL
SC	Romero Canyon Creek	Headwaters to confluence with unnamed tributary at 32°24'29"/110°50'39"		A&Wc				FBC			FC		
SC	Romero Canyon Creek	Below unnamed tributary to confluence with Sutherland Wash			A&Ww			FBC			FC		
SC	Rose Canyon Creek	Headwaters to confluence with Sycamore Canyon		A&Wc				FBC			FC		

SC	Rose Canyon Lake	32°23'13"/110°42'38"	Igneous	A&Wc				FBC			FC		AgL
SC	Ruby Lakes	31°26'29"/111°14'22"	Igneous		A&Ww			FBC			FC		AgL
SC	Sabino Canyon	Headwaters to 32°23'20"/110°47'06"		A&Wc				FBC		DWS	FC	AgI	
SC	Sabino Canyon	Below 32°23'20"/110°47'06" to confluence with Tanque Verde River			A&Ww			FBC		DWS	FC	AgI	
SC	Salero Ranch Tank	31°35'43"/110°53'25"			A&Ww			FBC			FC		AgL
SC	Santa Cruz River	Headwaters to the at U.S./Mexico border			A&Ww			FBC			FC	AgI	AgL
SC	Santa Cruz River	U.S./Mexico border to the Nogales International WWTP outfall at 31°27'25"/110°58'04"			A&Ww			FBC		DWS	FC	AgI	AgL
SC	Santa Cruz River (EDW)	Nogales International WWTP outfall to the Tubac Bridge					A&Wedw		PBC				AgL
SC	Santa Cruz River	Tubac Bridge to Agua Nueva WRF outfall at 32°17'04"/ 111°01'45"				A&We			PBC				AgL
SC	Santa Cruz River (EDW)	Agua Nueva WRF outfall to Baumgartner Road					A&Wedw		PBC				
SC	Santa Cruz River, West Branch	Headwaters to the confluence with Santa Cruz River				A&We			PBC				AgL
SC	Santa Cruz River	Baumgartner Road to the Ak Chin Indian Reservation boundary				A&We			PBC				AgL
SC	Santa Cruz Wash, North Branch	Headwaters to City of Casa Grande WRF outfall at 32°54'57"/111°47'13"				A&We			PBC				
SC	Santa Cruz Wash, North Branch (EDW)	City of Casa Grande WRF outfall to 1 km downstream					A&Wedw		PBC				
SC	Santa Rosa Wash	Below Tohono O'odham Indian Reservation to the Ak Chin Indian Reservation				A&We			PBC				
SC	Santa Rosa Wash (EDW)	Palo Verde Utilities CO-WRF outfall at 33°04'20"/ 112°01'47" to the Chin Indian Reservation					A&Wedw		PBC				
SC	Soldier Tank	32°25'34"/110°44'43"		A&Wc				FBC			FC		AgL
SC	Sonoita Creek	Headwaters to the Town of Patagonia WWTP outfall at 31°32'25"/110°45'31"				A&We			PBC				AgL
SC	Sonoita Creek (EDW)	Town of Patagonia WWTP outfall to permanent groundwater upwelling point approximately 1600 feet downstream of outfall					A&Wedw		PBC				AgL
SC	Sonoita Creek	Below 1600 feet downstream of Town of Patagonia WWTP outfall groundwater upwelling point to confluence with the Santa Cruz River			A&Ww			FBC			FC	AgI	AgL
SC	Split Tank	31°28'11"/111°05'12"			A&Ww			FBC			FC		AgL
SC	Sutherland Wash	Headwaters to confluence with Cañada del Oro			A&Ww			FBC			FC		
SC	Sycamore Canyon	Headwaters to 32°21'60" / 110°44'48"		A&Wc				FBC			FC		
SC	Sycamore Canyon	From 32°21'60" / 110°44'48" to Sycamore Reservoir			A&Ww			FBC			FC		
SC	Sycamore Canyon	Headwaters to the U.S./Mexico border			A&Ww			FBC			FC		AgL
SC	Sycamore Reservoir	32°20'57'/110°47'38"		A&Wc				FBC			FC		AgL
SC	Tanque Verde Creek	Headwaters to Houghton Road			A&Ww			FBC			FC		AgL
SC	Tanque Verde Creek	Below Houghton Road to confluence with Rillito Creek				A&We			PBC				AgL
SC	Three R Canyon	Headwaters to Unnamed Trib to Three R Canyon at 31°28'26"/110°46'04"				A&We			PBC				AgL
SC	Three R Canyon	From 31°28'26"/110°46'04" to 31°28'28"/110°47'15" (Cox Gulch)			A&Ww			FBC			FC		AgL
SC	Three R Canyon	From (Cox Gulch) 31°28'28"/110°47'15" to confluence with Sonoita Creek				A&We			PBC				AgL
SC	Tinaja Wash	Headwaters to confluence with the Santa Cruz River				A&We			PBC				AgL
SC	Unnamed Wash (EDW)	Oracle Sanitary District WWTP outfall at 32°36'54"/ 110°48'02" to 5 km downstream					A&Wedw		PBC				
SC	Unnamed Wash (EDW)	Arizona City Sanitary District WWTP outfall at 32°45'43"/ 111°44'24" to confluence with Santa Cruz Wash					A&Wedw		PBC				
SC	Unnamed Wash (EDW)	Saddlebrook WWTP outfall at 32°32'00"/110°53'01" to confluence with Cañada del Oro					A&Wedw		PBC				
SC	Vekol Wash	Headwater to Santa Cruz Wash: Those reaches not located on the Ak-Chin, Tohono O'odham and Gila River Indian Reservations				A&We			PBC				
SC	Wakefield Canyon	Headwaters to confluence with unnamed tributary at 31°52'48"/110°26'27"		A&Wc				FBC			FC		AgL
SC	Wakefield Canyon	Below confluence with unnamed tributary to confluence with Cienega Creek			A&Ww			FBC			FC		AgL
SC	Wild Burro Canyon	Headwaters to confluence with unnamed tributary at 32°27'43"/111°05'47"			A&Ww			FBC			FC		AgL
SC	Wild Burro Canyon	Below confluence with unnamed tributary to confluence with Santa Cruz River				A&We			PBC				AgL
SP	Abbot Canyon	Headwaters to confluence with Whitewater Draw			A&Ww			FBC			FC		AgL
SP	Aravaipa Creek	Headwaters to confluence with Stowe Gulch			A&Ww			FBC			FC		AgL
SP	Aravaipa Creek (OAW)	Stowe Gulch to downstream boundary of Aravaipa Canyon Wilderness Area			A&Ww			FBC			FC		AgL
SP	Aravaipa Creek	Below downstream boundary of Aravaipa Canyon Wilderness Area to confluence with the San Pedro River			A&Ww			FBC			FC		AgL
SP	Ash Creek	Headwaters to 31°50'28"/109°40'04"			A&Ww			FBC			FC	AgI	AgL

SP	Babocomari River	Headwaters to confluence with the San Pedro River			A&Ww			FBC			FC		AgL
SP	Bass Canyon Creek	Headwaters to confluence with unnamed tributary at 32°26'06"/110°13'22"		A&Wc				FBC			FC		AgL
SP	Bass Canyon Creek	Below confluence with unnamed tributary to confluence with Hot Springs Canyon Creek			A&Ww			FBC			FC		AgL
SP	Bass Canyon Tank	32°24'00"/110°13'00"			A&Ww			FBC			FC		AgL
SP	Bear Creek	Headwaters to U.S./Mexico border			A&Ww			FBC			FC		AgL
SP	Blacktail Pond	Fort Huachuca Military Reservation at 31°31'04"/ 110°24'47", headwater lake in Blacktail Canyon			A&Ww			FBC			FC		
SP	Black Draw	Headwaters to the U.S./Mexico border			A&Ww			FBC			FC		AgL
SP	Booger Canyon	Headwaters to confluence with Aravaipa Creek			A&Ww			FBC			FC		AgL
SP	Buck Canyon	Headwaters to confluence with Buck Creek Tank			A&Ww			FBC			FC		AgL
SP	Buck Canyon	Below Buck Creek Tank to confluence with Dry Creek				A&We			PBC				AgL
SP	Buehman Canyon Creek (OAW)	Headwaters to confluence with unnamed tributary at 32°24'54"/110°32'10"			A&Ww			FBC			FC		AgL
SP	Buehman Canyon Creek	Below confluence with unnamed tributary to confluence with San Pedro River			A&Ww			FBC			FC		AgL
SP	Bullock Canyon	Headwaters to confluence with Buehman Canyon			A&Ww			FBC			FC		AgL
SP	Carr Canyon Creek	Headwaters to confluence with unnamed tributary at 31°27'01"/110°15'48"		A&Wc				FBC			FC		AgL
SP	Carr Canyon Creek	Below confluence with unnamed tributary to confluence with the San Pedro River			A&Ww			FBC			FC		AgL
SP	Copper Creek	Headwaters to confluence with Prospect Canyon			A&Ww			FBC			FC		AgL
SP	Copper Creek	Below confluence with Prospect Canyon to confluence with the San Pedro River				A&We			PBC				AgL
SP	Deer Creek	Headwaters to confluence with unnamed tributary at 32°59'57"/110°20'11"		A&Wc				FBC			FC		AgL
SP	Deer Creek	Below confluence with unnamed tributary to confluence with Aravaipa Creek			A&Ww			FBC			FC		AgL
SP	Dixie Canyon	Headwaters to confluence with Mexican Canyon			A&Ww			FBC			FC		AgL
SP	Double R Canyon Creek	Headwaters to confluence with Bass Canyon			A&Ww			FBC			FC		
SP	Dry Canyon	Headwaters to confluence with Whitewater draw			A&Ww			FBC			FC		AgL
SP	East Gravel Pit Pond	Fort Huachuca Military Reservation at 31°30'54"/ 110°19'44"	Sedimentary		A&Ww			FBC			FC		
SP	Espiritu Canyon Creek	Headwaters to confluence with Soza Wash			A&Ww			FBC			FC		AgL
SP	Fourmile Creek	Headwaters to confluence with Aravaipa Creek			A&Ww			FBC			FC		AgL
SP	Fourmile Canyon, Left Prong	Headwaters to confluence with unnamed tributary at 32°43'15"/110°23'46"		A&Wc				FBC			FC		AgL
SP	Fourmile Canyon, Left Prong	Below confluence with unnamed tributary to confluence with Fourmile Canyon Creek			A&Ww			FBC			FC		AgL
SP	Fourmile Canyon, Right Prong	Headwaters to confluence with Fourmile Canyon			A&Ww			FBC			FC		AgL
SP	Gadwell Canyon	Headwaters to confluence with Whitewater Draw			A&Ww			FBC			FC		AgL
SP	Garden Canyon Creek	Headwaters to confluence with unnamed tributary at 31°29'01"/110°19'44"		A&Wc				FBC		DWS	FC	Agl	
SP	Garden Canyon Creek	Below confluence with unnamed tributary to confluence with the San Pedro River			A&Ww			FBC		DWS	FC	Agl	
SP	Glance Creek	Headwaters to confluence with Whitewater Draw			A&Ww			FBC			FC		AgL
SP	Gold Gulch	Headwaters to U.S./Mexico border			A&Ww			FBC			FC		AgL
SP	Gravel Pit Pond	Fort Huachuca Military Reservation at 31°30'52"/ 110°19'49"	Sedimentary		A&Ww			FBC			FC		
SP	Greenbush Draw	From U.S./Mexico border to confluence with San Pedro River				A&We			PBC				
SP	Hidden Pond	Fort Huachuca Military Reservation at 32°30'30"/ 109°22'17"			A&Ww			FBC			FC		
SP	Horse Camp Canyon	Headwaters to confluence with Aravaipa Creek			A&Ww			FBC			FC		AgL
SP	Hot Springs Canyon Creek	Headwaters to confluence with the San Pedro River			A&Ww			FBC			FC		AgL
SP	Johnson Canyon	Headwaters to Whitewater Draw at 31°32'46"/ 109°43'32"			A&Ww			FBC			FC		AgL
SP	Leslie Canyon Creek	Headwaters to confluence with Whitewater Draw			A&Ww			FBC			FC		AgL
SP	Lower Garden Canyon Pond	Fort Huachuca Military Reservation at 31°29'39"/ 110°18'34"			A&Ww			FBC			FC		
SP	Mexican Canyon	Headwaters to confluence with Dixie Canyon			A&Ww			FBC			FC		AgL
SP	Miller Canyon	Headwaters to Broken Arrow Ranch Road at 31°25'35"/ 110°15'04"		A&Wc				FBC		DWS	FC		AgL
SP	Miller Canyon	Below Broken Arrow Ranch Road to confluence with the San Pedro River			A&Ww			FBC		DWS	FC		AgL
SP	Mountain View Golf Course Pond	Fort Huachuca Military Reservation at 31°32'14"/ 110°18'52"	Sedimentary		A&Ww				PBC		FC		
SP	Mule Gulch	Headwaters to the Lavender Pit at 31°26'11"/ 109°54'02"			A&Ww				PBC		FC		
SP	Mule Gulch	The Lavender Pit to the' Highway 80 bridge at 31°26'30"/ 109°49'28"				A&We			PBC				
SP	Mule Gulch	Below the Highway 80 bridge to confluence with Whitewater Draw				A&We			PBC				AgL
SP	Oak Grove Canyon	Headwaters to confluence with Turkey Creek			A&Ww			FBC			FC		AgL

SP	Officers Club Pond	Fort Huachuca Military Reservation at 31°32'51"/ 110°21'37"	Sedimentary		A&Ww				PBC		FC		
SP	Paige Canyon Creek	Headwaters to confluence with the San Pedro River			A&Ww			FBC			FC		AgL
SP	Parsons Canyon Creek	Headwaters to confluence with Aravaipa Creek			A&Ww			FBC			FC		AgL
SP	Ramsey Canyon Creek	Headwaters to Forest Service Road #110 at 31°27'44"/ 110°17'30"		A&Wc				FBC			FC	AgI	AgL
SP	Ramsey Canyon Creek	Below Forest Service Road #110 to confluence with Carr Wash			A&Ww			FBC			FC	AgI	AgL
SP	Rattlesnake Creek	Headwaters to confluence with Brush Canyon		A&Wc				FBC			FC		AgL
SP	Rattlesnake Creek	Below confluence with Brush Canyon to confluence with Aravaipa Creek			A&Ww			FBC			FC		AgL
SP	Redfield Canyon	Headwaters to confluence with unnamed tributary at 32°33'40"/110°18'42"		A&Wc				FBC			FC		AgL
SP	Redfield Canyon	Below confluence with unnamed tributary to confluence with the San Pedro River			A&Ww			FBC			FC		AgL
SP	Rucker Canyon	Headwaters to confluence with Whitewater Draw		A&Wc				FBC			FC		AgL
SP	Rucker Canyon Lake	31°46'46"/109°18'30"	Shallow	A&Wc				FBC			FC		AgL
SP	San Pedro River	U.S./ Mexico Border to Buehman Canyon			A&Ww			FBC			FC	AgI	AgL
SP	San Pedro River	From Buehman canyon to confluence with the Gila River			A&Ww			FBC			FC		AgL
SP	Soto Canyon	Headwaters to confluence with Dixie Canyon			A&Ww			FBC			FC		AgL
SP	Swamp Springs Canyon	Headwaters to confluence with Redfield Canyon			A&Ww			FBC			FC		AgL
SP	Sycamore Pond I	Fort Huachuca Military Reservation at 31°35'12"/ 110°26'11"	Sedimentary		A&Ww			FBC			FC		
SP	Sycamore Pond II	Fort Huachuca Military Reservation at 31°34'39"/ 110°26'10"	Sedimentary		A&Ww			FBC			FC		
SP	Turkey Creek	Headwaters to confluence with Aravaipa Creek			A&Ww			FBC			FC		AgL
SP	Unnamed Wash (EDW)	Mt. Lemmon WWTP outfall at 32°26'51"/110°45'08" to 0.25 km downstream					A&Wedw		PBC				
SP	Virgus Canyon	Headwaters to confluence with Aravaipa Creek			A&Ww			FBC			FC		AgL
SP	Walnut Gulch	Headwaters to Tombstone WWTP outfall at 31°43'47"/ 110°04'06"				A&We			PBC				
SP	Walnut Gulch (EDW)	Tombstone WWTP outfall to the confluence with Tombstone Wash					A&Wedw		PBC				
SP	Walnut Gulch	Tombstone Wash to confluence with San Pedro River				A&We			PBC				
SP	Whitewater Draw	Headwaters to confluence with unnamed tributary at 31°20'36"/109°43'48"				A&We			PBC				AgL
SP	Whitewater Draw	Below confluence with unnamed tributary to U.S./ Mexico border			A&Ww			FBC			FC		AgL
SP	Woodcutters Pond	Fort Huachuca Military Reservation at 31°30'09"/ 110°20'12"	Igneous		A&Ww			FBC			FC		
SR	Ackre Lake	33°37'01"/109°20'40"		A&Wc				FBC			FC	AgI	AgL
SR	Apache Lake	33°37'23"/111°12'26"	Deep		A&Ww			FBC		DWS	FC	AgI	AgL
SR	Barnhard Creek	Headwaters to confluence with unnamed tributary at 34°05'37/111°26'40"		A&Wc				FBC			FC		AgL
SR	Barnhardt Creek	Below confluence with unnamed tributary to confluence with Rye Creek			A&Ww			FBC			FC		AgL
SR	Basin Lake	33°55'00"/109°26'09"	Igneous		A&Ww			FBC			FC		AgL
SR	Bear Creek	Headwaters to confluence with the Black River		A&Wc				FBC			FC	AgI	AgL
SR	Bear Wallow Creek (OAW)	Headwaters to confluence with the Black River		A&Wc				FBC			FC		AgL
SR	Bear Wallow Creek, North Fork (OAW)	Headwaters to confluence with Bear Wallow Creek		A&Wc				FBC			FC		AgL
SR	Bear Wallow Creek, South Fork (OAW)	Headwaters to confluence with Bear Wallow Creek		A&Wc				FBC			FC		AgL
SR	Beaver Creek	Headwaters to confluence with Black River		A&Wc				FBC			FC	AgI	AgL
SR	Big Lake	33°52'36"/109°25'33"	Igneous	A&Wc				FBC		DWS	FC	AgI	AgL
SR	Black River	Headwaters to confluence with Salt River		A&Wc				FBC		DWS	FC	AgI	AgL
SR	Black River, East Fork	From 33°51'19"/109°18'54" to confluence with the Black River		A&Wc				FBC		DWS	FC	AgI	AgL
SR	Black River, North Fork of East Fork	Headwaters to confluence with Boneyard Creek		A&Wc				FBC		DWS	FC	AgI	AgL
SR	Black River, West Fork	Headwaters to confluence with the Black River		A&Wc				FBC		DWS	FC	AgI	AgL
SR	Bloody Tanks Wash	Headwaters to Schultze Ranch Road				A&We			PBC				AgL
SR	Bloody Tanks Wash	Schultze Ranch Road to confluence with Miami Wash				A&We			PBC				
SR	Boggy Creek	Headwaters to confluence with Centerfire Creek		A&Wc				FBC			FC	AgI	AgL
SR	Boneyard Creek	Headwaters to confluence with Black River, East Fork		A&Wc				FBC			FC	AgI	AgL
SR	Boulder Creek	Headwaters to confluence with LaBarge Creek			A&Ww			FBC			FC		
SR	Campaign Creek	Headwaters to Roosevelt Lake			A&Ww			FBC			FC		AgL
SR	Canyon Creek	Headwaters to the White Mountain Apache Reservation boundary		A&Wc				FBC		DWS	FC	AgI	AgL
SR	Canyon Lake	33°32'44"/111°26'19"	Deep		A&Ww			FBC		DWS	FC	AgI	AgL
SR	Centerfire Creek	Headwaters to confluence with the Black River		A&Wc				FBC			FC	AgI	AgL
SR	Chambers Draw Creek	Headwaters to confluence with the North Fork of the East Fork of Black River		A&Wc				FBC			FC		AgL

SR	Cherry Creek	Headwaters to confluence with unnamed tributary at 34°05'09"/110°56'07"		A&Wc				FBC			FC	AgI	AgL
SR	Cherry Creek	Below unnamed tributary to confluence with the Salt River			A&Ww			FBC			FC	AgI	AgL
SR	Christopher Creek	Headwaters to confluence with Tonto Creek		A&Wc				FBC			FC	AgI	AgL
SR	Cold Spring Canyon Creek	Headwaters to confluence with unnamed tributary at 33°49'50"/110°52'58"		A&Wc				FBC			FC		AgL
SR	Cold Spring Canyon Creek	Below confluence with unnamed tributary to confluence with Cherry Creek			A&Ww			FBC			FC		AgL
SR	Conklin Creek	Headwaters to confluence with the Black River		A&Wc				FBC			FC	AgI	AgL
SR	Coon Creek	Headwaters to confluence with unnamed tributary at 33°46'41"/110°54'26"		A&Wc				FBC			FC		AgL
SR	Coon Creek	Below confluence with unnamed tributary to confluence with Salt River			A&Ww			FBC			FC		AgL
SR	Corduroy Creek	Headwaters to confluence with Fish Creek		A&Wc				FBC			FC	AgI	AgL
SR	Coyote Creek	Headwaters to confluence with the Black River, East Fork		A&Wc				FBC			FC	AgI	AgL
SR	Crescent Lake	33°54'38"/109°25'18"	Shallow	A&Wc				FBC			FC	AgI	AgL
SR	Deer Creek	Headwaters to confluence with the Black River, East Fork		A&Wc				FBC			FC		AgL
SR	Del Shay Creek	Headwaters to confluence with Gun Creek			A&Ww			FBC			FC		AgL
SR	Devils Chasm Creek	Headwaters to confluence with unnamed tributary at 33°48'46" /110°52'35"		A&Wc				FBC			FC		AgL
SR	Devils Chasm Creek	Below confluence with unnamed tributary to confluence with Cherry Creek			A&Ww			FBC			FC		AgL
SR	Dipping Vat Reservoir	33°55'47"/109°25'31"	Igneous		A&Ww			FBC			FC		AgL
SR	Double Cienega Creek	Headwaters to confluence with Fish Creek		A&Wc				FBC			FC		AgL
SR	Fish Creek	Headwaters to confluence with the Black River		A&Wc				FBC			FC	AgI	AgL
SR	Fish Creek	Headwaters to confluence with the Salt River			A&Ww			FBC			FC		
SR	Gold Creek	Headwaters to confluence with unnamed tributary at 33°59'47"/111°25'10"		A&Wc				FBC			FC		AgL
SR	Gold Creek	Below confluence with unnamed tributary to confluence with Tonto Creek			A&Ww			FBC			FC		AgL
SR	Gordon Canyon Creek	Headwaters to confluence with Hog Canyon		A&Wc				FBC			FC		AgL
SR	Gordon Canyon Creek	Below confluence with Hog Canyon to confluence with Haigler Creek			A&Ww			FBC			FC		AgL
SR	Greenback Creek	Headwaters to confluence with Tonto Creek			A&Ww			FBC			FC		AgL
SR	Haigler Creek	Headwaters to confluence with unnamed tributary at 34°12'23"/111°00'15"		A&Wc				FBC			FC	AgI	AgL
SR	Haigler Creek	Below confluence with unnamed tributary to confluence with Tonto Creek			A&Ww			FBC			FC	AgI	AgL
SR	Hannagan Creek	Headwaters to confluence with Beaver Creek		A&Wc				FBC			FC		AgL
SR	Hay Creek (OAW)	Headwaters to confluence with the Black River, West Fork		A&Wc				FBC			FC		AgL
SR	Home Creek	Headwaters to confluence with the Black River, West Fork		A&Wc				FBC			FC		AgL
SR	Horse Creek	Headwaters to confluence with the Black River, West Fork		A&Wc				FBC			FC		AgL
SR	Horse Camp Creek	Headwaters to confluence with unnamed tributary at 33°54'00"/110°50'07"		A&Wc				FBC			FC		AgL
SR	Horse Camp Creek	Below confluence with unnamed tributary to confluence with Cherry Creek			A&Ww			FBC			FC		AgL
SR	Horton Creek	Headwaters to confluence with Tonto Creek		A&Wc				FBC			FC	AgI	AgL
SR	Houston Creek	Headwaters to confluence with Tonto Creek			A&Ww			FBC			FC		AgL
SR	Hunter Creek	Headwaters to confluence with Christopher Creek		A&Wc				FBC			FC		AgL
SR	LaBarge Creek	Headwaters to Canyon Lake			A&Ww			FBC			FC		
SR	Lake Sierra Blanca	33°52'25"/109°16'05"		A&Wc				FBC			FC	AgI	AgL
SR	Miami Wash	Headwaters to confluence with Pinal Creek				A&We			PBC				
SR	Mule Creek	Headwaters to confluence with Canyon Creek		A&Wc				FBC		DWS	FC	AgI	AgL
SR	Open Draw Creek	Headwaters to confluence with the East Fork of Black River		A&Wc				FBC			FC		AgL
SR	P B Creek	Headwaters to Forest Service Road #203 at 33°57'08"/ 110°56'12"		A&Wc				FBC			FC		AgL
SR	P B Creek	Below Forest Service Road #203 to Cherry Creek			A&Ww			FBC			FC		AgL
SR	Pinal Creek	Headwaters to confluence with unnamed EDW wash (Globe WWTP) at 33°25'29"/110°48'20"				A&We			PBC				AgL
SR	Pinal Creek (EDW)	Confluence with unnamed EDW wash (Globe WWTP) to 33°26'55"/110°49' 25"					A&Wedw		PBC				
SR	Pinal Creek	From 33°26'55"/110°49'25" to Lower Pinal Creek water treatment plant outfall #001 at 33°31'04"/ 110°51'55"				A&We			PBC				AgL
SR	Pinal Creek	From Lower Pinal Creek WTP outfall # to See Ranch Crossing at 33°32'25"/110°52'28"					A&Wedw		PBC				
SR	Pinal Creek	From See Ranch Crossing to confluence with unnamed tributary at 33°35'28"/110°54'31"			A&Ww			FBC					
SR	Pinal Creek	From unnamed tributary to confluence with Salt River			A&Ww			FBC			FC		
SR	Pine Creek	Headwaters to confluence with the Salt River			A&Ww			FBC			FC		
SR	Pinto Creek	Headwaters to confluence with unnamed tributary at 33°19'27"/110°54'58"		A&Wc				FBC			FC	AgI	AgL
SR	Pinto Creek	Below confluence with unnamed tributary to Roosevelt Lake			A&Ww			FBC			FC	AgI	AgL
SR	Pole Corral Lake	33°30'38"/110°00'15"	Igneous		A&Ww			FBC			FC	AgI	AgL

SR	Pueblo Canyon Creek	Headwaters to confluence with unnamed tributary at 33°50'23"/110°51'37"		A&Wc				FBC			FC		AgL
SR	Pueblo Canyon Creek	Below confluence with unnamed tributary to confluence with Cherry Creek			A&Ww			FBC			FC		AgL
SR	Reevis Creek	Headwaters to confluence with Pine Creek			A&Ww			FBC			FC		
SR	Reservation Creek	Headwaters to confluence with the Black River		A&Wc				FBC			FC		AgL
SR	Reynolds Creek	Headwaters to confluence with Workman Creek		A&Wc				FBC			FC		AgL
SR	Roosevelt Lake	33°52'17"/111°00'17"	Deep		A&Ww			FBC		DWS	FC	AgI	AgL
SR	Russell Gulch	From Headwaters to confluence with Miami Wash				A&We			PBC				
SR	Rye Creek	Headwaters to confluence with Tonto Creek			A&Ww			FBC			FC		AgL
SR	Saguaro Lake	33°33'44"/111°30'55"	Deep		A&Ww			FBC		DWS	FC	AgI	AgL
SR	Salome Creek	Headwaters to confluence with the Salt River			A&Ww			FBC			FC	AgI	AgL
SR	Salt House Lake	33°57'04"/109°20'11"	Igneous		A&Ww			FBC			FC		AgL
SR	Salt River	White Mountain Apache Reservation Boundary at 33°48'52"/110°31'33" to Roosevelt Lake			A&Ww			FBC			FC		AgL
SR	Salt River	Theodore Roosevelt Dam to 2 km below Granite Reef Dam			A&Ww			FBC		DWS	FC	AgI	AgL
SR	Slate Creek	Headwaters to confluence with Tonto Creek			A&Ww			FBC			FC		AgL
SR	Snake Creek (OAW)	Headwaters to confluence with the Black River		A&Wc				FBC			FC		AgL
SR	Spring Creek	Headwaters to confluence with Tonto Creek			A&Ww			FBC			FC		AgL
SR	Stinky Creek (OAW)	Headwaters to confluence with the Black River, West Fork		A&Wc				FBC			FC		AgL
SR	Thomas Creek	Headwaters to confluence with Beaver Creek		A&Wc				FBC			FC		AgL
SR	Thompson Creek	Headwaters to confluence with the West Fork of the Black River		A&Wc				FBC			FC		AgL
SR	Tonto Creek	Headwaters to confluence with unnamed tributary at 34°18'11"/111°04'18"		A&Wc				FBC			FC	AgI	AgL
SR	Tonto Creek	Below confluence with unnamed tributary to Roosevelt Lake			A&Ww			FBC			FC	AgI	AgL
SR	Turkey Creek	Headwaters to confluence with Rock Creek		A&Wc				FBC			FC		
SR	Wildcat Creek	Headwaters to confluence with Centerfire Creek		A&Wc				FBC			FC		AgL
SR	Willow Creek	Headwaters to confluence with Beaver Creek		A&Wc				FBC			FC		AgL
SR	Workman Creek	Headwaters to confluence with Reynolds Creek		A&Wc				FBC			FC	AgI	AgL
SR	Workman Creek	Below confluence with Reynolds Creek to confluence with Salome Creek			A&Ww			FBC			FC	AgI	AgL
UG	Apache Creek	Headwaters to confluence with the Gila River			A&Ww			FBC			FC		AgL
UG	Ash Creek	Headwaters to confluence with unnamed tributary at 32°46'15"/109°51'45"		A&Wc				FBC			FC		AgL
UG	Ash Creek	Below confluence with unnamed tributary to confluence with the Gila River			A&Ww			FBC			FC		AgL
UG	Bennett Wash	Headwaters to the Gila River				A&We			PBC				
UG	Bitter Creek	Headwaters to confluence with the Gila River			A&Ww			FBC			FC		
UG	Blue River	Headwaters to confluence with Strayhorse Creek at 33°29'02"/109°12'14"		A&Wc				FBC			FC	AgI	AgL
UG	Blue River	Below confluence with Strayhorse Creek to confluence with San Francisco River			A&Ww			FBC			FC	AgI	AgL
UG	Bonita Creek (OAW)	San Carlos Indian Reservation boundary to confluence with the Gila River			A&Ww			FBC		DWS	FC		AgL
UG	Buckelew Creek	Headwaters to confluence with Castle Creek		A&Wc				FBC			FC		AgL
UG	Campbell Blue Creek	Headwaters to confluence with the Blue River		A&Wc				FBC			FC		AgL
UG	Castle Creek	Headwaters to confluence with Campbell Blue Creek		A&Wc				FBC			FC		AgL
UG	Cave Creek (OAW)	Headwaters to confluence with South Fork Cave Creek		A&Wc				FBC			FC	AgI	AgL
UG	Cave Creek (OAW)	Below confluence with South Fork Cave Creek to Coronado National Forest boundary			A&Ww			FBC			FC	AgI	AgL
UG	Cave Creek	Below Coronado National Forest boundary to New Mexico border			A&Ww			FBC			FC	AgI	AgL
UG	Cave Creek, South Fork	Headwaters to confluence with Cave Creek		A&Wc				FBC			FC	AgI	AgL
UG	Chase Creek	Headwaters to the Phelps-Dodge Morenci Mine			A&Ww			FBC			FC		AgL
UG	Chase Creek	Below the Phelps-Dodge Morenci Mine to confluence with San Francisco River				A&We			PBC		FC		
UG	Chitty Canyon Creek	Headwaters to confluence with Salt House Creek		A&Wc				FBC			FC		AgL
UG	Cima Creek	Headwaters to confluence with Cave Creek		A&Wc				FBC			FC		AgL
UG	Cluff Reservoir #1	32°48'55"/109°50'46"	Sedimentary		A&Ww			FBC			FC	AgI	AgL
UG	Cluff Reservoir #3	32°48'21"/109°51'46"	Sedimentary		A&Ww			FBC			FC	AgI	AgL
UG	Coleman Creek	Headwaters to confluence with Campbell Blue Creek		A&Wc				FBC			FC		AgL
UG	Dankworth Lake	32°43'13"/109°42'17"	Sedimentary	A&Wc				FBC			FC		
UG	Deadman Canyon Creek	Headwaters to confluence with unnamed tributary at 32°43'50"/109°49'03"		A&Wc				FBC		DWS	FC		AgL
UG	Deadman Canyon Creek	Below confluence with unnamed tributary to confluence with Graveyard Wash			A&Ww			FBC		DWS	FC		AgL
UG	Eagle Creek	Headwaters to confluence with unnamed tributary at 33°22'32"/109°29'43"		A&Wc				FBC		DWS	FC	AgI	AgL
UG	Eagle Creek	Below confluence with unnamed tributary to confluence with the Gila River			A&Ww			FBC		DWS	FC	AgI	AgL
UG	East Eagle Creek	Headwaters to confluence with Eagle Creek		A&Wc				FBC			FC		AgL

UG	East Turkey Creek	Headwaters to confluence with unnamed tributary at 31°58'22"/109°12'20"		A&Wc				FBC			FC		AgL
UG	East Turkey Creek	Below confluence with unnamed tributary to terminus near San Simon River			A&Ww			FBC			FC		AgL
UG	East Whitetail	Headwaters to terminus near San Simon River			A&Ww			FBC			FC		AgL
UG	Emigrant Canyon	Headwaters to terminus near San Simon River			A&Ww			FBC			FC		AgL
UG	Evans Pond #1	32°49'19"/109°51'12"	Sedimentary		A&Ww			FBC			FC	AgI	AgL
UG	Evans Pond #2	32°49'14"/109°51'09"	Sedimentary		A&Ww			FBC			FC	AgI	AgL
UG	Fishhook Creek	Headwaters to confluence with the Blue River		A&Wc				FBC			FC		AgL
UG	Foote Creek	Headwaters to confluence with the Blue River		A&Wc				FBC			FC		AgL
UG	Frye Canyon Creek	Headwaters to Frye Mesa Reservoir		A&Wc				FBC		DWS	FC		AgL
UG	Frye Canyon Creek	Frye Mesa reservoir to terminus at Highline Canal.			A&Ww			FBC			FC		AgL
UG	Frye Mesa Reservoir	32°45'14"/109°50'02"	Igneous	A&Wc				FBC		DWS	FC		
UG	Gibson Creek	Headwaters to confluence with Marijilda Creek		A&Wc				FBC			FC		AgL
UG	Gila River	New Mexico border to the San Carlos Indian Reservation boundary			A&Ww			FBC			FC	AgI	AgL
UG	Grant Creek	Headwaters to confluence with the Blue River		A&Wc				FBC			FC		AgL
UG	Judd Lake	33°51'15"/109°09'35"	Sedimentary	A&Wc				FBC			FC		
UG	K P Creek (OAW)	Headwaters to confluence with the Blue River		A&Wc				FBC			FC		AgL
UG	Lanphier Canyon Creek	Headwaters to confluence with the Blue River		A&Wc				FBC			FC		AgL
UG	Little Blue Creek	Headwaters to confluence with Dutch Blue Creek		A&Wc				FBC			FC		AgL
UG	Little Blue Creek	Below confluence with Dutch Blue Creek to confluence with Blue Creek			A&Ww			FBC			FC		AgL
UG	Little Creek	Headwaters to confluence with the San Francisco River		A&Wc				FBC			FC		
UG	Georges Tank	33°51'24"/109°08'30"	Sedimentary	A&Wc				FBC			FC		AgL
UG	Luna Lake	33°49'50"/109°05'06"	Sedimentary	A&Wc				FBC			FC		AgL
UG	Marijilda Creek	Headwaters to confluence with Gibson Creek		A&Wc				FBC			FC		AgL
UG	Marijilda Creek	Below confluence with Gibson Creek to confluence with Stockton Wash			A&Ww			FBC			FC	AgI	AgL
UG	Markham Creek	Headwaters to confluence with the Gila River			A&Ww			FBC			FC		AgL
UG	Pigeon Creek	Headwaters to confluence with the Blue River			A&Ww			FBC			FC		AgL
UG	Raspberry Creek	Headwaters to confluence with the Blue River		A&Wc				FBC			FC		
UG	Roper Lake	32°45'23"/109°42'14"	Sedimentary		A&Ww			FBC			FC		
UG	San Francisco River	Headwaters to the New Mexico border		A&Wc				FBC			FC	AgI	AgL
UG	San Francisco River	New Mexico border to confluence with the Gila River			A&Ww			FBC			FC	AgI	AgL
UG	San Simon River	Headwaters to confluence with the Gila River				A&We			PBC				AgL
UG	Sheep Tank	32°46'14"/109°48'09"	Sedimentary		A&Ww			FBC			FC		AgL
UG	Smith Pond	32°49'15"/109°50'36"	Sedimentary		A&Ww			FBC			FC		
UG	Squaw Creek	Headwaters to confluence with Thomas Creek		A&Wc				FBC			FC		AgL
UG	Stone Creek	Headwaters to confluence with the San Francisco River		A&Wc				FBC			FC	AgI	AgL
UG	Strayhorse Creek	Headwaters to confluence with the Blue River		A&Wc				FBC			FC		
UG	Thomas Creek	Headwaters to confluence with Rousensock Creek		A&Wc				FBC			FC		AgL
UG	Thomas Creek	Below confluence with Rousensock Creek to confluence with Blue River			A&Ww			FBC			FC		AgL
UG	Tinny Pond	33°47'49"/109°04'27"	Sedimentary		A&Ww			FBC			FC		AgL
UG	Turkey Creek	Headwaters to confluence with Campbell Blue Creek		A&Wc				FBC			FC		AgL
VR	American Gulch	Headwaters to the Northern Gila County Sanitary District WWTP outfall at 34°14'02"/111°22'14"			A&Ww			FBC			FC	AgI	AgL
VR	American Gulch (EDW)	Below Northern Gila County Sanitary District WWTP outfall to confluence with the East Verde River					A&Wedw		PBC				
VR	Apache Creek	Headwaters to confluence with Walnut Creek			A&Ww			FBC			FC		AgL
VR	Ashbrook Wash	Headwaters to the Fort McDowell Indian Reservation boundary				A&We			PBC				
VR	Aspen Creek	Headwaters to confluence with Granite Creek			A&Ww			FBC			FC		
VR	Bar Cross Tank	35°00'41"/112°05'39"			A&Ww			FBC			FC		AgL
VR	Barrata Tank	35°02'43"/112°24'21"			A&Ww			FBC			FC		AgL
VR	Bartlett Lake	33°49'52"/111°37'44"	Deep		A&Ww			FBC		DWS	FC	AgI	AgL
VR	Beaver Creek	Headwaters to confluence with the Verde River			A&Ww			FBC			FC		AgL
VR	Big Chino Wash	Headwaters to confluence with Sullivan Lake				A&We			PBC				AgL
VR	Bitter Creek	Headwaters to the Jerome WWTP outfall at 34°45'12"/112°06'24"				A&We			PBC				AgL
VR	Bitter Creek (EDW)	Jerome WWTP outfall to the Yavapai Apache Indian Reservation boundary					A&Wedw		PBC				AgL
VR	Bitter Creek	Below the Yavapai Apache Indian Reservation boundary to confluence with the Verde River			A&Ww			FBC			FC	AgI	AgL
VR	Black Canyon Creek	Headwaters to confluence with unnamed tributary at 34°39'20"/112°05'06"		A&Wc				FBC			FC		AgL
VR	Black Canyon Creek	Below confluence with unnamed tributary to confluence with the Verde River			A&Ww			FBC			FC		AgL
VR	Bonita Creek	Headwaters to confluence with Ellison Creek		A&Wc				FBC		DWS	FC		
VR	Bray Creek	Headwaters to confluence with Webber Creek		A&Wc				FBC			FC		AgL
VR	Camp Creek	Headwaters to confluence with the Verde River			A&Ww			FBC			FC		AgL
VR	Cereus Wash	Headwaters to the Fort McDowell Indian Reservation boundary				A&We			PBC				
VR	Chase Creek	Headwaters to confluence with the East Verde River		A&Wc				FBC		DWS	FC		
VR	Clover Creek	Headwaters to confluence with Headwaters of West Clear Creek		A&Wc				FBC			FC		AgL

VR	Coffee Creek	Headwaters to confluence with Spring Creek			A&Ww			FBC			FC		AgL
VR	Colony Wash	Headwaters to the Fort McDowell Indian Reservation boundary				A&We			PBC				
VR	Dead Horse Lake	34°45'08"/112°00'42"	Shallow		A&Ww			FBC			FC		
VR	Deadman Creek	Headwaters to Horseshoe Reservoir			A&Ww			FBC			FC		AgL
VR	Del Monte Gulch	Headwaters to confluence with City of Cottonwood WWTP outfall 002 at 34°43'57"/112°02'46"				A&We			PBC				
VR	Del Monte Gulch (EDW)	City of Cottonwood WWTP outfall 002 at 34°43'57"/ 112°02'46" to confluence with Verde River					A&Wedw		PBC				
VR	Del Rio Dam Lake	34°48'55"/112°28'03"	Sedimentary		A&Ww			FBC			FC		AgL
VR	Dry Beaver Creek	Headwaters to confluence with Beaver Creek			A&Ww			FBC			FC	AgI	AgL
VR	Dry Creek (EDW)	Sedona Ventures WWTP outfall at 34°50'02"/ 111°52'17" to 34°48'12"/111°52'48"					A&Wedw		PBC				
VR	Dude Creek	Headwaters to confluence with the East Verde River		A&Wc				FBC			FC	AgI	AgL
VR	East Verde River	Headwaters to confluence with Ellison Creek		A&Wc				FBC		DWS	FC	AgI	AgL
VR	East Verde River	Below confluence with Ellison Creek to confluence with the Verde River			A&Ww			FBC		DWS	FC	AgI	AgL
VR	Ellison Creek	Headwaters to confluence with the East Verde River		A&Wc				FBC			FC		AgL
VR	Fossil Creek (OAW)	Headwaters to confluence with the Verde River			A&Ww			FBC			FC		AgL
VR	Fossil Springs (OAW)	34°25'24"/111°34'27"			A&Ww			FBC		DWS	FC		
VR	Foxboro Lake	34°53'42"/111°39'55"			A&Ww			FBC			FC		AgL
VR	Fry Lake	35°03'45"/111°48'04"			A&Ww			FBC			FC		AgL
VR	Gap Creek	Headwaters to confluence with Government Spring		A&Wc				FBC			FC		AgL
VR	Gap Creek	Below Government Spring to confluence with the Verde River			A&Ww			FBC			FC		AgL
VR	Garrett Tank	35°18'57"/112°42'20"			A&Ww			FBC			FC		AgL
VR	Goldwater Lake, Lower	34°29'56"/112°27'17"	Sedimentary	A&Wc				FBC		DWS	FC		
VR	Goldwater Lake, Upper	34°29'52"/112°26'59"	Igneous	A&Wc				FBC		DWS	FC		
VR	Granite Basin Lake	34°37'01"/112°32'58"	Igneous	A&Wc				FBC			FC	AgI	AgL
VR	Granite Creek	Headwaters to Watson Lake		A&Wc				FBC			FC	AgI	AgL
VR	Granite Creek	Below Watson Lake to confluence with the Verde River			A&Ww			FBC			FC	AgI	AgL
VR	Green Valley Lake (EDW)	34°13'54"/111°20'45"	Urban				A&Wedw		PBC		FC		
VR	Heifer Tank	35°20'27"/112°32'59"			A&Ww			FBC			FC		AgL
VR	Hells Canyon Tank	35°04'59"/112°24'07"	Igneous		A&Ww			FBC			FC		AgL
VR	Homestead Tank	35°21'24"/112°41'36"	Igneous		A&Ww			FBC			FC		AgL
VR	Horse Park Tank	34°58'15"/111°36'32"			A&Ww			FBC			FC		AgL
VR	Horseshoe Reservoir	34°00'25"/111°43'36"	Sedimentary		A&Ww			FBC			FC	AgI	AgL
VR	Houston Creek	Headwaters to confluence with the Verde River			A&Ww			FBC			FC		AgL
VR	Huffer Tank	34°27'46"/111°23'11"			A&Ww			FBC			FC		AgL
VR	J.D. Dam Lake	35°04'02"/112°01'48"	Shallow	A&Wc				FBC			FC	AgI	AgL
VR	Jacks Canyon	Headwaters to Big Park WWTP outfall at 34°45'46"/ 111°45'51"				A&We			PBC				
VR	Jacks Canyon (EDW)	Below Big Park WWTP outfall to confluence with Dry Beaver Creek					A&Wedw		PBC				
VR	Lime Creek	Headwaters to Horseshoe Reservoir			A&Ww			FBC			FC		AgL
VR	Masonry Number 2 Reservoir	35°13'32"/112°24'10"		A&Wc				FBC			FC	AgI	AgL
VR	McLellan Reservoir	35°13'09"/112°17'06"	Igneous		A&Ww			FBC			FC	AgI	AgL
VR	Meath Dam Tank	35°07'52"/112°27'35"			A&Ww			FBC			FC		AgL
VR	Mullican Place Tank	34°44'16"/111°36'10"	Igneous		A&Ww			FBC			FC		AgL
VR	Oak Creek (OAW)	Headwaters to confluence with unnamed tributary at 34°59'15"/111°44'47"		A&Wc				FBC		DWS	FC	AgI	AgL
VR	Oak Creek (OAW)	Below confluence with unnamed tributary to confluence with Verde River			A&Ww			FBC		DWS	FC	AgI	AgL
VR	Oak Creek, West Fork (OAW)	Headwaters to confluence with Oak Creek		A&Wc				FBC			FC		AgL
VR	Odell Lake	34°56'5"/111°37'53"	Igneous	A&Wc				FBC			FC		
VR	Peck’s Lake	34°46'51"/112°02'01"	Shallow		A&Ww			FBC			FC	AgI	AgL
VR	Perkins Tank	35°06'42"/112°04'12"	Shallow	A&Wc				FBC			FC		AgL
VR	Pine Creek	Headwaters to confluence with unnamed tributary at 34°21'51"/111°26'49"		A&Wc				FBC		DWS	FC	AgI	AgL
VR	Pine Creek	Below confluence with unnamed tributary to confluence with East Verde River			A&Ww			FBC		DWS	FC	AgI	AgL
VR	Red Creek	Headwaters to confluence with the Verde River			A&Ww			FBC			FC		AgL
VR	Reservoir #1	35°13'5"/111°50'09"	Igneous		A&Ww			FBC			FC		
VR	Reservoir #2	35°13'17"/111°50'39"	Igneous		A&Ww			FBC			FC		
VR	Roundtree Canyon Creek	Headwaters to confluence with Tangle Creek			A&Ww			FBC			FC		AgL
VR	Scholze Lake	35°11'53"/112°00'37"	Igneous	A&Wc				FBC			FC		AgL
VR	Spring Creek	Headwaters to confluence with unnamed tributary at 34°57'23"/111°57'21"		A&Wc				FBC			FC	AgI	AgL

VR	Spring Creek	Below confluence with unnamed tributary to confluence with Oak Creek			A&Ww			FBC			FC	AgI	AgL
VR	Steel Dam Lake	35°13'36"/112°24'54"	Igneous	A&Wc				FBC			FC		AgL
VR	Stehr Lake	34°22'01"/111°40'02"	Sedimentary		A&Ww			FBC			FC		AgL
VR	Stoneman Lake	34°46'47"/111°31'14"	Shallow	A&Wc				FBC			FC	AgI	AgL
VR	Sullivan Lake	34°51'42"/112°27'51"			A&Ww			FBC			FC	AgI	AgL
VR	Sycamore Creek	Headwaters to confluence with unnamed tributary at 35°03'41"/111°57'31"		A&Wc				FBC			FC	AgI	AgL
VR	Sycamore Creek	Below confluence with unnamed tributary to confluence with Verde River			A&Ww			FBC			FC	AgI	AgL
VR	Sycamore Creek	Headwaters to confluence with Verde River at 33°37'55"/111°39'58"			A&Ww			FBC			FC	AgI	AgL
VR	Sycamore Creek	Headwaters to confluence with Fort McDowell Indian Reservation boundary at 33°39'19.8"/-111°37'42.7"			A&Ww			FBC			FC		AgL
VR	Tangle Creek	Headwaters to confluence with Verde River			A&Ww			FBC			FC	AgI	AgL
VR	Trinity Tank	35°27'44"/112°48'01"			A&Ww			FBC			FC		AgL
VR	Unnamed Wash	Flagstaff Meadows WWTP outfall at '35°13'59"/111°48'35" to Volunteer Wash					A&Wedw		PBC				
VR	Verde River	From headwaters at confluence of Chino Wash and Granite Creek to Bartlett Lake Dam			A&Ww			FBC			FC	AgI	AgL
VR	Verde River	Below Bartlett Lake Dam to Salt River			A&Ww			FBC		DWS	FC	AgI	AgL
VR	Walnut Creek	Headwaters to confluence with Big Chino Wash			A&Ww			FBC			FC		AgL
VR	Watson Lake	34°34'58"/112°25'26"	Igneous		A&Ww			FBC			FC	AgI	AgL
VR	Webber Creek	Headwaters to confluence with the East Verde River		A&Wc				FBC			FC		AgL
VR	West Clear Creek	Headwaters to confluence with Meadow Canyon		A&Wc				FBC			FC		AgL
VR	West Clear Creek	Below confluence with Meadow Canyon to confluence with the Verde River			A&Ww			FBC			FC	AgI	AgL
VR	Wet Beaver Creek	Headwaters to unnamed springs at 34°41'17"/111°34'34"		A&Wc				FBC			FC	AgI	AgL
VR	Wet Beaver Creek	Below unnamed springs to confluence with Dry Beaver Creek			A&Ww			FBC			FC	AgI	AgL
VR	Whitehorse Lake	35°06'59"/112°00'48"	Igneous	A&Wc				FBC		DWS	FC	AgI	AgL
VR	Williamson Valley Wash	Headwaters to confluence with Mint Wash				A&We			PBC				AgL
VR	Williamson Valley Wash	From confluence of Mint Wash to 10.5 km downstream			A&Ww			FBC			FC		AgL
VR	Williamson Valley Wash	From 10.5 km downstream of Mint Wash confluence to confluence with Big Chino Wash				A&We			PBC				AgL
VR	Williscraft Tank	35°11'22"/112°35'40"			A&Ww			FBC			FC		AgL
VR	Willow Creek	Above Willow Creek Reservoir		A&Wc				FBC			FC		AgL
VR	Willow Creek	Below Willow Creek Reservoir to confluence with Granite Creek			A&Ww			FBC			FC		AgL
VR	Willow Creek Reservoir	34°36'17"/112°26'19"	Shallow		A&Ww			FBC			FC	AgI	AgL
VR	Willow Valley Lake	34°41'08"/111°20'02"	Sedimentary		A&Ww			FBC			FC		AgL

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Appendix B repealed, new Appendix B adopted effective April 24, 1996 (Supp. 96-2). Amended by final rulemaking at 8 A.A.R. 1264, effective March 8, 2002 (Supp. 02-1). Amended by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Appendix B amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3). Appendix B amended by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Appendix C. Site-Specific Standards

Watershed	Surface Water	Surface Water Description & Location	Parameter	Site-Specific Criterion
LC	Rio de Flag (EDW)	Flagstaff WWTP outfall to the confluence with San Francisco Wash	Copper (D)	36 µg/L (A&Wedw)
CL	Yuma East Wetlands	From inlet culvert from Colorado River into restored channel to Ocean Bridge	Selenium (T)	2.2 µg/L (A&Ww chronic)
			Total residual chlorine	33 µg/L (A&Ww acute)
				20 µg/L (A&Ww chronic)
SR	Pinto Creek	From confluence of Ellis Ranch tributary at 33°19'26.7"/110°54'57.5" to the confluence of West Fork of Pinto Creek at 33°27'32.3"/111°00'19.7"	Copper (D)	34 µg/L (A&Ww acute for hardness values below 268 mg/L)
				34 µg/L (A&Ww chronic)

Historical Note

Adopted effective February 18, 1992 (Supp. 92-1). Appendix C repealed effective April 24, 1996 (Supp. 96-2). New Appendix C made by final rulemaking at 14 A.A.R. 4708, effective January 31, 2009 (Supp. 08-4). Amended by final rulemaking at 22 A.A.R. 2328, effective August 2, 2016 (Supp. 16-4). Appendix C amended by final rulemaking at 25 A.A.R. 2515, effective November 9, 2019 (Supp. 19-3).

ARTICLE 2. WATER QUALITY STANDARDS FOR NON-WOTUS PROTECTED SURFACE WATERS

R18-11-201. Definitions

The following terms apply to this Article:

1. "Acute toxicity" means toxicity involving a stimulus severe enough to induce a rapid response. In aquatic toxicity tests, an effect observed in 96 hours or less is considered acute.
2. "Agricultural irrigation AZ (AgI AZ)" means the use of a non-WOTUS protected surface water for crop irrigation.
3. "Agricultural livestock watering AZ (AgL AZ)" means the use of a non-WOTUS protected surface water as a water supply for consumption by livestock.
4. "Aquatic and wildlife AZ (cold water) (A&Wc AZ)" means the use of a non-WOTUS protected surface water by animals, plants, or other cold-water organisms, generally occurring at an elevation greater than 5000 feet, for habitation, growth, or propagation.
5. "Aquatic and wildlife AZ (warm water) (A&Ww AZ)" means the use of a non-WOTUS protected surface water by animals, plants, or other warm-water organisms, generally occurring at an elevation less than 5000 feet, for habitation, growth, or propagation.
6. "Assimilative capacity" means the difference between the baseline water quality concentration for a pollutant and the most stringent applicable water quality criterion for that pollutant.
7. "Complete Mixing" means the location at which concentration of a pollutant across a transect of a surface water differs by less than five percent.
8. "Criteria" means elements of water quality standards expressed as pollutant concentrations, levels, or narrative statements representing a water quality that supports a designated use.
9. "Critical flow conditions of the discharge" means the hydrologically based discharge flow averages that the director uses to calculate and implement applicable water quality criteria to a mixing zone's receiving water as follows:
    a. For acute aquatic water quality standard criteria, the discharge flow critical condition is represented by the maximum one-day average flow analyzed over a reasonably representative timeframe.
    b. For chronic aquatic water quality standard criteria, the discharge flow critical flow condition is represented by the maximum monthly average flow analyzed over a reasonably representative timeframe.
    c. For human health-based water quality standard criteria, the discharge flow critical condition is the long-term arithmetic mean flow, averaged over several years so as to simulate long-term exposure.
10. "Critical flow conditions of the receiving water" means the hydrologically based receiving water low flow averages that the director uses to calculate and implement applicable water quality criteria:
    a. For acute aquatic water quality standard criteria, the receiving water critical condition is represented as the lowest one-day average flow event expected to occur once every ten years, on average (1Q10).
    b. For chronic aquatic water quality standard criteria, the receiving water critical flow condition is represented as the lowest seven-consecutive-day average flow expected to occur once every 10 years, on average (7Q10), or
    c. For human health-based water quality standard criteria, in order to simulate long-term exposure, the receiving water critical flow condition is the harmonic mean flow.
11. "Designated use" means a use specified on the Protected Surface Waters List for a non-WOTUS protected surface water.
12. "Domestic water source AZ (DWS AZ)" means the use of a non-WOTUS protected surface water as a source of potable water. Treatment of a surface water may be necessary to yield a finished water suitable for human consumption.
13. "Fish consumption AZ (FC AZ)" means the use of a non-WOTUS protected surface water by humans for harvesting aquatic organisms for consumption. Harvestable aquatic organisms include, but are not limited to, fish, clams, turtles, crayfish, and frogs.
14. "Full-body contact AZ (FBC AZ)" means the use of a non-WOTUS protected surface water for swimming or other recreational activity that causes the human body to come into direct contact with the water to the point of complete submergence. The use is such that ingestion of the water is likely, and sensitive body organs, such as the eyes, ears, or nose, may be exposed to direct contact with the water.
15. "Geometric mean" means the nth root of the product of n items or values. The geometric mean is calculated using the following formula:

$$GM_y = \sqrt[n]{(Y_1)(Y_2)(Y_3)(Y_n)}$$

16. "Hardness" means the sum of the calcium and magnesium concentrations, expressed as calcium carbonate (CaCO3) in milligrams per liter.
17. "Mixing zone" means an area or volume of a surface water that is contiguous to a point source discharge where dilution of the discharge takes place.
18. "Non-WOTUS protected surface water" means a protected surface water designated in Table A of R18-11-216 or added to the PSWL by an emergency action authorized by A.R.S. § 49-221(G)(7) that is not a WOTUS.
19. "Oil" means petroleum in any form, including crude oil, gasoline, fuel oil, diesel oil, lubricating oil, or sludge.
20. "Partial-body contact AZ (PBC AZ)" means the recreational use of a non-WOTUS protected surface water that may cause the human body to come into direct contact with the water, but normally not to the point of complete submergence (for example, wading or boating). The use is such that ingestion of the water is not likely and, sensitive body organs, such as the eyes, ears, or nose, will not normally be exposed to direct contact with the water.
21. "Pollutant" means fluids, contaminants, toxic wastes, toxic pollutants, dredged spoil, solid waste, substances and chemicals, pesticides, herbicides, fertilizers and other

agricultural chemicals, incinerator residue, sewage, garbage, sewage sludge, munitions, petroleum products, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and mining, industrial, municipal, and agricultural wastes or any other liquid, solid, gaseous, or hazardous substance.

22. "Practical quantitation limit" means the lowest level of quantitative measurement that can be reliably achieved during a routine laboratory operation.
23. "Recharge Project" means a facility necessary or convenient to obtain, divert, withdraw, transport, exchange, deliver, treat, or store water to infiltrate or reintroduce that water into the ground.
24. "Toxic" means a pollutant or combination of pollutants, that after discharge and upon exposure, ingestion, inhalation, or assimilation into an organism, either directly from the environment or indirectly by ingestion through food chains, may cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations in the organism or its offspring.
25. "Urban lake" means a manmade lake within an urban landscape.
26. "Wastewater" does not mean:
    a. Stormwater,
    b. Discharges authorized under the De Minimus General Permit,
    c. Other allowable non-stormwater discharges permitted under the Construction General Permit or the Multi-sector General Permit, or
    d. Stormwater discharges from a municipal storm sewer system (MS4) containing incidental amounts of non-stormwater that the MS4 is not required to prohibit.
27. "Wetland" means, for the purposes of non-WOTUS protected surface waters, an area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions.
28. "WOTUS" means waters of the state that are also navigable waters as defined by Section 502(7) of the Clean Water Act.
29. "WOTUS protected surface water" means a protected surface water that is a WOTUS.
30. "Zone of initial dilution" means a small area in the immediate vicinity of an outfall structure in which turbulence is high and causes rapid mixing with the surrounding water.

Historical Note

Amended effective January 29, 1980 (Supp. 80-1). Amended subsection A. effective April 17, 1984 (Supp. 84-2). Former Section R9-21-201 repealed, former Section R9-21-203 renumbered as Section R9-21-201 and amended effective January 7, 1985 (Supp. 85-1). Amended effective August 12, 1986 (Supp. 86-4). Former Section R9-21-201 renumbered without change as Section R18-11-201 (Supp. 87-3). Amended effective December 1, 1988 (Supp. 88-4). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-202. Applicability

A. The water quality standards prescribed in this Article apply to non-WOTUS protected surface waters.

B. The water quality standards prescribed in this Article do not apply to the following:
1. A waste treatment system, including an impoundment, pond, lagoon, or constructed wetland that is part of the waste treatment system;
2. A man-made surface impoundment and any associated ditch and conveyance used in the extraction, beneficiation, or processing of metallic ores including:
    a. A pit,
    b. Pregnant leach solution pond
    c. Raffinate pond,
    d. Tailing impoundment,
    e. Decant pond,
    f. Pond of sump in a mine put associated with dewatering activity,
    g. Pond holding water that has come into contact with a process or product that is being held for recycling,
    h. Spill or catchment pond, or
    i. A pond used for onsite remediation
3. A man-made cooling pond that is neither created in a surface water nor results from the impoundment of a surface water; or
4. A surface water located on tribal lands.
5. WOTUS Protected Surface Waters.

Historical Note

Former Section R9-21-202 repealed, former Section R9-21-102 renumbered as Section R9-21-202 and amended effective January 7, 1985 (Supp. 85-1). Amended subsections (B), (D), and (E) effective August 12, 1986 (Supp. 86-4). Former Section R9-21-202 renumbered without change as Section R18-11-202 (Supp. 87-3). Section repealed, new Section adopted effective February 18, 1992 (Supp. 92-1). Section repealed effective April 24, 1996 (Supp. 96-2). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-203. Designated Uses for Non-WOTUS Protected Surface Waters

A. The designated uses for specific non-WOTUS protected surface waters are listed in the Protected Surface Waters List in this article. The designated uses that may be assigned to a non-WOTUS protected surface water are:
1. Full-body contact AZ,
2. Partial-body contact AZ,
3. Domestic water source AZ,
4. Fish consumption AZ,
5. Aquatic and wildlife AZ (cold water),
6. Aquatic and wildlife AZ (warm water),
7. Agricultural irrigation AZ, and
8. Agricultural livestock watering AZ.

B. Numeric water quality criteria to maintain and protect water quality for the designated uses assigned to non-WOTUS protected surface waters are prescribed in R18-11-215. Narrative water quality standards to protect non-WOTUS protected surface waters are prescribed in R18-11-214.

C. If a non-WOTUS protected surface water has more than one designated use listed in the Protected Surface Waters List, the most stringent water quality criterion applies.

D. The Director shall revise the designated uses of a non-WOTUS protected surface water if water quality improvements result in a level of water quality that permits a use that is not currently listed as a designated use in the Protected Surface Waters List.

E. The Director may remove a designated use or adopt a subcategory of a designated use that requires less stringent water quality criteria through a rulemaking action for any of the following reasons:
1. A naturally-occurring pollutant concentration prevents the attainment of the use;
2. A human-caused condition or source of pollution prevents the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;
3. A dam, diversion, or other type of hydrologic modification precludes the attainment of the use, and it is not feasible to restore the non-WOTUS protected surface water to its original condition or to operate the modification in a way that would result in attainment of the use;
4. A physical condition related to the natural features of the surface water, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, precludes attainment of an aquatic life designated use.

Historical Note

Amended effective January 29, 1980 (Supp. 80-1). Amended subsection (B) by adding paragraphs (27) and (28) effective October 14, 1981 (Supp. 81-5). Former Section R9-21-203 renumbered as Section R9-21-201, former Section R9-21-204 renumbered as Section R9-21-203 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-203 renumbered and amended as Section R9-21-204, new Section R9-21-203 adopted effective August 12, 1986 (Supp. 86-4). Former Section R9-21-203 renumbered without change as Section R18-11-203 (Supp. 87-3). Amended subsection (B) effective December 1, 1988 (Supp. 88-4). Section repealed, new Section adopted effective February 18, 1992 (Supp. 92-1). Section repealed effective April 24, 1996 (Supp. 96-2). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-204. Interim, Presumptive Designated Uses

The following water quality standards apply to a non-WOTUS protected surface water that is not listed on the Protected Surface Waters List but is added on an emergency basis pursuant to A.R.S. § 49-221(G)(7):
1. The aquatic and wildlife AZ (cold water use applies to a non-WOTUS protected surface water above 5000 feet in elevation;
2. The aquatic and wildlife AZ (warm water) applies to a non-WOTUS protected surface water below 5000 feet in elevation;
3. The full-body contact AZ use applies to a non-WOTUS protected surface water if the Director makes a determination that the non-WOTUS protected surface water is used by humans for swimming or other recreational activity that causes the human body to come into direct contact with the water to the point of complete submergence. The use is such that ingestion of the water is likely and sensitive body organs, such as the eyes, ears, or nose, may be exposed to direct contact with the water.
4. The partial-body contact AZ use applies to a non-WOTUS protected surface water if the Director makes a determination that the non-WOTUS protected surface water is used by humans in a way that may cause the human body to come into direct contact with the water, but normally not to the point of complete submergence (for example, wading or boating). The use is such that ingestion of the water is not likely and sensitive body organs, such as the eyes, ears, or nose, will not normally be exposed to direct contact with the water.
5. The fish consumption AZ use applies to a non-WOTUS protected surface water if the Director makes a determination that the non-WOTUS protected surface water is used by humans for harvesting aquatic organisms for consumption. Harvestable aquatic organisms include, but are not limited to, fish, clams, turtles, crayfish, and frogs.
6. The domestic water source AZ use applies to a non-WOTUS protected surface water if the Director makes a determination that the non-WOTUS protected surface water is used by humans as a source of potable water.
7. The agricultural irrigation AZ use applies to a non-WOTUS protected surface water if the Director makes a determination that the non-WOTUS protected surface water is used for crop irrigation.
8. The agricultural livestock watering AZ use applies to any non-WOTUS protected surface water if the Director makes a determination that the non-WOTUS protected surface water is used as a water supply for consumption by livestock.

Historical Note

Former Section R9-21-204 renumbered and amended as Section R9-21-207, former Section R9-21-206 renumbered and amended as Section R9-21-204 effective January 29, 1980 (Supp. 80-1). Former Section R9-21-204 renumbered as Section R9-21-203, former Section R9-21-205 renumbered as Section R9-21-204 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-204 renumbered and amended as Section R9-21-205, former Section R9-21-203 renumbered and amended as Section R9-21-204 effective August 12, 1986 (Supp. 86-4). Former Section R9-21-204 renumbered without change as Section R18-11-204 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-205. Analytical Methods

A. A person conducting an analysis of a sample taken to determine compliance with a water quality standard shall use an analytical method prescribed in A.A.C. R9-14-610 or an alternative method approved under A.A.C. R9-14-610(C).

B. A test result from a sample taken to determine compliance with a water quality standard is valid only if the sample is analyzed by a laboratory that is licensed by the Arizona Department of Health Services, an out-of-state laboratory licensed under A.R.S. § 36-495.14, or a laboratory exempted under A.R.S. § 36-495.02, for the analysis performed.

Historical Note

Former Section R9-21-205 repealed, new Section R9-21-205 adopted effective January 29, 1980 (Supp. 80-1). Former Section R9-21-205 renumbered as Section R9-21-204, former Section R9-21-206 renumbered as Section R9-21-205 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-205 renumbered and amended as Section R9-21-206, former Section R9-21-204 renumbered and amended as Section

R9-21-205 effective August 12, 1986 (Supp. 86-4).
Former Section R9-21-205 renumbered without change
as Section R18-11-205 (Supp. 87-3). Section repealed,
new Section adopted effective February 18, 1992
(Supp. 92-1). Section repealed April 24, 1996
(Supp. 96-2). New Section made by final rulemaking at
29 A.A.R. 302 (January 27, 2023), effective February 20,
2023 (Supp. 22-4).

R18-11-206. Mixing Zones

A. The Director may establish a mixing zone for a point source discharge to a non-WOTUS protected surface water as a condition of an individual AZPDES permit on a pollutant-by-pollutant basis. A mixing zone is prohibited where there is no water for dilution, or as prohibited pursuant to subsection (H).

B. The owner or operator of a point source seeking the establishment of a mixing zone shall submit a request to the Director for a mixing zone as part of an application for an AZPDES permit. The request shall include:

1. An identification of the pollutant for which the mixing zone is requested;
2. A proposed outfall design;
3. A definition of the boundary of the proposed mixing zone. For purposes of this subsection, the boundary of a mixing zone is where complete mixing occurs; and
4. A complete and detailed description of the existing physical, biological, and chemical conditions of the receiving water and the predicted impact of the proposed mixing zone on those conditions. The description shall also address the factors listed in subsection (D) that the Director must consider when deciding to grant or deny a request and shall address the mixing zone requirements in subsection (H).

C. The Director shall consider the following factors when deciding whether to grant or deny a request for a mixing zone:

1. The assimilative capacity of the receiving water;
2. The likelihood of adverse human health effects;
3. The location of drinking water plant intakes and public swimming areas;
4. The predicted exposure of biota and the likelihood that resident biota will be adversely affected;
5. Bioaccumulation;
6. Whether there will be acute toxicity in the mixing zone, and, if so, the size of the zone of initial dilution;
7. The known or predicted safe exposure levels for the pollutant for which the mixing zone is requested;
8. The size of the mixing zone;
9. The location of the mixing zone relative to biologically sensitive areas in the surface water;
10. The concentration gradient of the pollutant within the mixing zone;
11. Sediment deposition;
12. The potential for attracting aquatic life to the mixing zone; and
13. The cumulative impacts of other mixing zones and other discharges to the surface water.

D. Director determination.

1. The Director shall deny a request to establish a mixing zone if an applicable water quality standard will be violated outside the boundaries of the proposed mixing zone.
2. If the Director approves the request to establish a mixing zone, the Director shall establish the mixing zone as a condition of an AZPDES permit. The Director shall include any mixing zone condition in the AZPDES permit that is necessary to protect human health and the designated uses of the surface water.

E. Any person who is adversely affected by the Director's decision to grant or deny a request for a mixing zone may appeal the decision under A.R.S. § 49-321 et seq. and A.R.S. § 41-1092 et seq.

F. The Director shall reevaluate a mixing zone upon issuance, reissuance, or modification of the AZPDES permit for the point source or a modification of the outfall structure.

G. Mixing zone requirements.

1. A mixing zone shall be as small as practicable in that it shall not extend beyond the point in the waterbody at which complete mixing occurs under the critical flow conditions of the discharge and of the receiving water.
2. The total horizontal area allocated to all mixing zones on a lake shall not exceed 10 percent of the surface area of the lake.
3. Adjacent mixing zones in a lake shall not overlap or be located closer together than the greatest horizontal dimension of the largest mixing zone.
4. The design of any discharge outfall shall maximize initial dilution of the wastewater in a surface water.
5. The size of the zone of initial dilution in a mixing zone shall prevent lethality to organisms passing through the zone of initial dilution. The mixing zone shall prevent acute toxicity and lethality to organisms passing through the mixing zone.

H. The Director shall not establish a mixing zone in an AZPDES permit for the following persistent, bioaccumulative pollutants:

1. Chlordane,
2. DDT and its metabolites (DDD and DDE),
3. Dieldrin,
4. Dioxin,
5. Endrin,
6. Endrin aldehyde,
7. Heptachlor,
8. Heptachlor epoxide,
9. Lindane,
10. Mercury,
11. Polychlorinated biphenyls (PCBs), and
12. Toxaphene.

Historical Note

Former Section R9-21-206 renumbered and amended as
Section R9-21-204, new Section R9-21-206 adopted
effective January 29, 1980 (Supp. 80-1). Amended by
adding subsection (B) effective October 14, 1981 (Supp.
81-5). Amended subsection (B) and Table 1 effective
January 29, 1982 (Supp. 82-1). Amended subsection (B)
and Table 1 effective August 13, 1982 (Supp. 82-4).
Former Section R9-21-206 renumbered as Section
R9-21-205, former Section R9-21-207 renumbered as
Section R9-21-206 and amended effective January 7,
1985 (Supp. 85-1). Former Section R9-21-206
renumbered and amended as Section R9-21-207, former
Section R9-21-205 renumbered and amended as
R9-21-206 effective August 12, 1986 (Supp. 86-4).
Former Section R9-21-206 renumbered without change
as Section R18-11-206 (Supp. 87-3). New Section made
by final rulemaking at 29 A.A.R. 302 (January 27, 2023),
effective February 20, 2023 (Supp. 22-4).

R18-11-207. Natural Background

Where the concentration of a pollutant exceeds a water quality standard and the exceedance is caused solely by naturally occurring conditions, the exceedance shall not be considered a violation of the water quality standard.

Historical Note

Former Section R9-21-207 repealed, former Section R9-21-204 renumbered and amended as Section R9-21-207 effective January 29, 1980 (Supp. 80-1). Former Section R9-21-207 renumbered as Section R9-21-206, former Section R9-21-208 renumbered as Section R9-21-207 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-207 renumbered without change as Section R9-21-208, former Section R9-21-206 renumbered and amended as Section R9-21-207 effective August 12, 1986 (Supp. 86-4). Former Section R9-21-207 renumbered without change as Section R18-11-207 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-208. Schedules of Compliance

A compliance schedule in an AZPDES permit shall require the permittee to comply with a discharge limitation based upon a new or revised water quality standard as soon as possible to achieve compliance. The permittee shall demonstrate that the point source cannot comply with a discharge limitation based upon the new or revised water quality standard through the application of existing water pollution control technology, operational changes, or source reduction. In establishing a compliance schedule, the Director shall consider:

1. How much time the permittee has already had to meet any effluent limitations under a prior permit;
2. The extent to which the permittee has made good faith efforts to comply with the effluent limitations and other requirements in a prior permit;
3. Whether treatment facilities, operations, or measures must be modified to meet the effluent limitations;
4. How long any necessary modifications would take to implement; and
5. Whether the permittee would be expected to use the same treatment facilities, operations or other measures to meet the effluent limitations as it would have used to meet the effluent limitations in a prior permit.

Historical Note

Former Section R9-21-208 repealed, new Section R9-21-208 adopted effective January 29, 1980 (Supp. 80-1). Former Section R9-21-208 renumbered as Section R9-21-207, Appendices 1 through 9 amended as Appendix A (now shown following R9-21-213), former Section R9-21-209 renumbered as R9-21-208 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-208 renumbered and amended as Section R9-21-209, former Section R9-21-207 renumbered without change as Section R9-21-208 effective August 12, 1986 (Supp. 86-4). Former Section R9-21-208 renumbered without change as Section R18-11-208 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-209. Variances

A. Upon request, the Director may establish, by rule, a discharger-specific or water segment-specific or water segments-specific variance from a water quality standard if requirements pursuant to this Section are met.

B. A person who requests a variance must demonstrate all of the following information:

1. Identification of the specific pollutant and water quality standard for which a variance is sought.
2. Identification of the receiving surface water segment or segments to which the variance would apply.
3. A detailed discussion of the need for the variance, including the reasons why compliance with the water quality standard cannot be achieved over the term of the proposed variance, and any other useful information or analysis to evaluate attainability.
4. A detailed description of proposed interim discharge limitations and pollutant control activities that represent the highest level of treatment achievable by a point source discharger or dischargers during the term of the variance.
5. Documentation that the proposed term is only as long as necessary to achieve compliance with applicable water quality standards.
6. Documentation that is appropriate to the type of designated use to which the variance would apply as follows. For a water quality standard variance documentation must include a demonstration of at least one of the following factors that preclude attainment of the use during the term of the variance:
    a. Naturally occurring pollutant concentrations prevent attainment of the use;
    b. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met;
    c. That human-caused conditions or sources of pollution prevent the attainment of the water quality standard for which the variance is sought and either (1) it is not possible to remedy the conditions or sources of pollution or (2) remedying the human-caused conditions would cause more environmental damage to correct than to leave in place;
    d. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification n a way that would result in the attainment of the use;
    e. Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses;
    f. Actions necessary to facilitate lake, wetland, or stream restoration through dam removal or other significant reconfiguration activities preclude attainment of the designated use and criterion while the actions are being implemented.
7. For a waterbody segment-specific or segments-specific variance, the following information is required before the Director may issue a variance, in addition to all other required documentation pursuant to this Section:
    a. Identification and documentation of any cost-effective and reasonable best management practices for

nonpoint source controls related to the pollutant or pollutants or water quality parameter or parameters and water body or waterbody segment or segments specified in the variance that could be implemented to make progress towards attaining the underlying designated use and criterion; and

b. If any variance pursuant to subsection (B)(7)(a) previously applied to the water body or waterbody segment or segments, documentation must also demonstrate whether and to what extent best management practices for nonpoint source controls were implemented to address the pollutant or pollutants or water quality parameter or parameters subject to the water quality variance and the water quality progress achieved.

8. For a discharger-specific variance, the following information is required before the Director may issue a variance, in addition to all other required documentation pursuant to this Section: Identification of the permittee subject to the variance.

C. The Director shall consider the following factors when deciding whether to grant or deny a variance request:
1. Bioaccumulation,
2. The predicted exposure of biota and the likelihood that resident biota will be adversely affected,
3. The known or predicted safe exposure levels for the pollutant for which the variance is requested, and
4. The likelihood of adverse human health effects.

D. The variance shall represent the highest attainable condition of the water body or water body segment applicable throughout the term of the variance.

E. A variance shall not result in any lowering of the currently attained ambient water quality, unless the variance is necessary for restoration activities, consistent with subsection (B)(6)(a)(vi). The Director must specify the highest attainable condition of the water body or waterbody segment as a quantifiable expression of one of the following:
1. The highest attainable interim criterion,
2. The interim effluent condition that reflects the greatest pollutant reduction achievable.

F. A variance shall not modify the underlying designated use and criterion. A variance is only a time limited exception to the underlying standard. For discharge-specific variances, other point source dischargers to the surface water that are not granted a variance shall still meet all applicable water quality standards.

G. Point source discharges shall meet all other applicable water quality standards for which a variance is not granted.

H. The term of the water quality variance may only be as long as necessary to achieve the highest attainable condition and must be consistent with the supporting documentation in subsection (E).

I. The Director shall periodically, but not more than every five years, reevaluate whether each variance continues to represent the highest attainable condition. Comment on the variance shall be considered regarding whether the variance continues to represent the highest attainable condition during each rulemaking for this Article. If the Director determines that the requirements of the variance do not represent the highest attainable condition, then the Director shall modify or repeal the variance during the rulemaking.

J. If the variance is modified by rulemaking, the requirements of the variance shall represent the highest attainable condition at the time of initial adoption of the variance, or the highest attainable condition identified during the current reevaluation, whichever is more stringent.

K. Upon expiration of a variance, point source dischargers shall comply with the water quality standard.

Historical Note

Former Section R9-21-209 renumbered and amended as Section R9-21-210, new Section R9-21-209 adopted effective January 29, 1980 (Supp. 80-1). Former Section R9-21-209 renumbered as Section R9-21-208, Tables I and II amended as Appendix B (now shown following R9-21-213 and Appendix A), former Section R9-21-210 renumbered as Section R9-21-209 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-209 renumbered and amended as Section R9-21-210, former Section R9-21-208 renumbered and amended as Section R9-21-209 effective August 12, 1986 (Supp. 86-4). Former Section R9-21-209 renumbered without change as Section R18-11-209 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-210. Site Specific Standards

A. The Director shall adopt a site-specific standard by rule.

B. The Director may adopt a site-specific standard based upon a request or upon the Director's initiative for any of the following reasons:
1. Local physical, chemical, or hydrological conditions of a non-WOTUS protected surface water such as pH, hardness, fate and transport, or temperature alters the biological availability or toxicity of a pollutant;
2. The sensitivity of resident aquatic organisms that occur in a non-WOTUS protected surface water to a pollutant differs from the sensitivity of the species used to derive the numeric water quality standards to protect aquatic life in R18-11-215;
3. Resident aquatic organisms that occur in a non-WOTUS protected surface water represent a narrower mix of species than those in the dataset used by ADEQ to derive numeric water quality standards to protect aquatic life in R18-11-215;
4. The natural background concentration of a pollutant is greater than the numeric water quality standard to protect aquatic life prescribed in R18-11-215. "Natural background" means the concentration of a pollutant in a non-WOTUS protected surface water due only to non-anthropogenic sources; or
5. Other factors or combination of factors that upon review by the Director warrant changing a numeric water quality standard for a non-WOTUS protected surface water.

C. Site-specific standard by request. To request that the Director adopt a site-specific standard, a person must conduct a study to support the development of a site-specific standard using a scientifically defensible procedure. Before conducting the study, a person shall submit a study outline to the Director for approval that contains the following elements:
1. Identifies the pollutant;
2. Describes the reach's boundaries;
3. Describes the hydrologic regime of the waterbody;
4. Describes the scientifically defensible procedure, which can include relevant aquatic life studies, ecological studies, laboratory tests, biological translators, fate and transport models, and risk analyses;

5. Describes and compares the taxonomic composition, distribution and density of the aquatic biota within the reach to a reference reach and describes the basis of any major taxonomic differences;
6. Describes the pollutant's effect on the affected species or appropriate surrogate species and on the other designated uses listed for the reach;
7. Demonstrates that all designated uses are protected; and
8. A person seeking to develop a site-specific standard based on natural background may use statistical or modeling approaches to determine natural background concentration.

Historical Note

Former Section R9-21-210 renumbered and amended as Section R9-21-211, former Section R9-21-209 renumbered and amended as Section R9-21-210 effective January 29, 1980 (Supp. 80-1). Amended subsection (A) effective April 17, 1984 (Supp. 84-2). Former Section R9-21-210 renumbered as Section R9-21-209, former Section R9-21-211 renumbered as Section R9-21-210 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-210 renumbered and amended as Section R9-21-211, former Section R9-21-209 renumbered and amended as Section R9-21-210 effective August 12, 1986 (Supp. 86-4). Former Section R9-21-210 renumbered without change as Section R18-11-210 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-211. Enforcement of Non-permitted Discharges to Non-WOTUS Protected Surface Waters

A. The Department may establish a numeric water quality standard at a concentration that is below the practical quantitation limit. Therefore, in enforcement actions pursuant to subsection (B), the water quality standard is enforceable at the practical quantitation limit.

B. Except for chronic aquatic and wildlife criteria, for non-permitted discharge violations, the Department shall determine compliance with numeric water quality standard criteria from the analytical result of a single sample, unless additional samples are required under this article. For chronic aquatic and wildlife criteria, compliance for non-permitted discharge violations shall be determined from the geometric mean of the analytical results of the last four samples taken at least 24 hours apart. For the purposes of this Section, a "non-permitted discharge violation" does not include a discharge regulated under an AZPDES permit.

Historical Note

Former Section R9-21-210 renumbered and amended as Section R9-21-211 effective January 29, 1980 (Supp. 80-1). Amended subsections (D), (G) three (I), and added (J) effective October 14, 1981 (Supp. 81-5). Former Section R9-21-211 renumbered as Section R9-21-210, former Section R9-21-212 renumbered as Section R9-21-211 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-211 renumbered and amended as Section R9-21-212, former Section R9-21-210 renumbered and amended as Section R9-21-211 effective August 12, 1986 (Supp. 86-4). Former Section R9-21-211 renumbered without change as Section R18-11-211 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-212. Statements of Intent and Limitations on the Reach of Article 2

A. Nothing in this Article prohibits fisheries management activities by the Arizona Game and Fish Department or the U.S. Fish and Wildlife Service. This Article does not exempt fish hatcheries from AZPDES permit requirements.

B. Nothing in this Article prevents the routine physical or mechanical maintenance of canals, drains, and the urban lakes identified as non-WOTUS protected surface waters on the Protected Surface Waters List. Physical or mechanical maintenance includes dewatering, lining, dredging, and the physical, biological, or chemical control of weeds and algae. Increases in turbidity that result from physical or mechanical maintenance activities are permitted in canals, drains, and the urban lakes identified on the Protected Surface Waters List.

C. Increases in turbidity that result from the routine physical or mechanical maintenance of a dam or flood control structure are not violations of this Article.

D. Nothing in this Article requires the release of water from a dam or a flood control structure.

Historical Note

Adopted effective January 29, 1980 (Supp. 80-1). Former Section R9-21-212 renumbered as Section R9-21-211, former Section R9-21-213 renumbered as Section R9-21-212 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-212 repealed, former Section R9-21-211 renumbered and amended as Section R9-21-212 effective August 12, 1986 (Supp. 86-4). Former Section R9-21-212 renumbered without change as Section R18-11-212 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-213. Procedures for Determining Economic, Social, and Environmental Cost and Benefits

A. The Director shall perform an economic, social, and environmental cost and benefits analysis that shows the benefits outweigh the costs before conducting any of the following rulemaking actions:
  1. Adopting a water quality standard that applies to non-WOTUS protected surface waters at a particular level or for a particular water category of non-WOTUS protected surface waters;
  2. Adding a non-WOTUS protected surface water to the Protected Surface Waters List when the conditions of A.R.S. § 49-221(G)(4) apply; or
  3. Removing a non-WOTUS protected surface water from the Protected Surface Waters List when the conditions of A.R.S. § 49-221(G)(6) apply.

B. The economic, social, and environmental cost and benefit analysis must include:
  1. A justification of the valuation methodology used to quantify the costs or benefits of the rulemaking action;
  2. A reference to any study relevant to the economic, social, and environmental cost and benefit analysis that the agency reviewed and proposes either to rely on or not to rely on in its evaluation of the costs and benefits of the rulemaking action;
  3. A description of any data on which an economic, social, and environmental cost and benefits analysis is based and

an explanation of how the data was obtained and why the data is acceptable data.

4. A description of the probable impact of the rulemaking on any existing AZPDES permits that are impacted by the rulemaking action;
5. A description of the probable amount of additional AZPDES permits that will be required for known and ongoing point-source discharges after the rulemaking is completed that otherwise would not have been required if the Director did not undertake the rulemaking action; and
6. The administrative and other costs to ADEQ associated with the proposed rulemaking.

C. The Director shall publish a copy of the economic, social, and environmental cost and benefits analysis to the agency website prior to filing any rulemaking materials during any of the rulemaking actions listed in subsection (A) of this rule.

D. If for any reason enough data is not reasonably available to comply with the requirements of subsection (B) of this section, the agency shall explain the limitations of the data and the methods that were employed in the attempt to obtain the data and shall characterize the probable impacts in qualitative terms.

E. The Director is not required to prepare the economic, social, and environmental cost and benefits analysis required by this rule when:

1. Adding or removing a WOTUS-protected surface water from the Protected Surface Waters List; or
2. Adding a water to the Protected Surface Waters List on an emergency basis pursuant to A.R.S. § 49-221(G)(7).

Historical Note

Adopted effective January 29, 1980 (Supp. 80-1). Amended effective April 17, 1984 (Supp. 84-2). Former Section R9-21-213 renumbered as Section R9-21-212, former Section R9-21-103 renumbered as Section R9-21-213 and amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-213 renumbered without change as Section R9-21-214, new Section R9-21-213 adopted effective August 12, 1986 (Supp. 86-4). Former Section R9-21-213 renumbered without change as Section R18-11-213 (Supp. 87-3). Amended effective December 1, 1988 (Supp. 88-4). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-214. Narrative Water Quality Standards for Non-WOTUS Protected Surface Waters

A. A non-WOTUS protected surface water shall not contain pollutants in amounts or combinations that:

1. Settle to form bottom deposits that inhibit or prohibit the habitation, growth, or propagation of aquatic life;
2. Cause objectionable odor in the area in which the non-WOTUS protected surface water is located;
3. Cause off-taste or odor in drinking water;
4. Cause off-flavor in aquatic organisms;
5. Are toxic to humans, animals, plants, or other organisms;
6. Cause the growth of algae or aquatic plants that inhibit or prohibit the habitation, growth, or propagation of other aquatic life or that impair recreational uses;
7. Cause or contribute to a violation of an aquifer water quality standard prescribed in R18-11-405 or R18-11-406; or
8. Change the color of the non-WOTUS protected surface water from natural background levels of color.

B. A non-WOTUS protected surface water shall not contain oil, grease, or any other pollutant that floats as debris, foam, or scum; or that causes a film or iridescent appearance on the surface of the water; or that causes a deposit on a shoreline, bank, or aquatic vegetation. The discharge of lubricating oil or gasoline associated with the normal operation of a recreational watercraft is not a violation of this narrative standard

C. A non-WOTUS protected surface water shall not contain a discharge of suspended solids in quantities or concentrations that interfere with the treatment processes at the nearest downstream potable water treatment plant or substantially increase the cost of handling solids produced at the nearest downstream potable water treatment plant.

Historical Note

Former Section R9-21-213 renumbered without change as Section R9-21-214 effective August 12, 1986 (Supp. 86-4). Former Section R9-21-214 renumbered without change as Section R18-11-214 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-215. Numeric Water Quality Standards for Non-WOTUS Protected Surface Waters

A. *E. coli* bacteria. The following water quality standards for *Escherichia coli (E. coli)* are expressed in colony-forming units per 100 milliliters of water (cfu / 100 ml) or as a Most Probable Number (MPN):

E. coli	FBC AZ	PBC AZ
Geometric mean (minimum of four samples in 30 days)	126	126
Statistical threshold value	410	576

B. pH. The following water quality standards for non-WOTUS protected surface waters pH are expressed in standard units:

pH	DWS AZ	FBC AZ, PBC AZ, A&Ww AZ, A&Wc AZ	AgI AZ	AgL AZ
Maximum	9.0	9.0	9.0	9.0
Minimum	5.0	6.5	4.5	6.5

C. The maximum allowable increase in ambient water temperature, due to a thermal discharge is as follows:

A&Ww AZ	A&Wc AZ
3.0° C	1.0° C

D. Suspended sediment concentration.

1. The following water quality standards for suspended sediment concentration, expressed in milligrams per liter (mg/L), are expressed as a median value determined from a minimum of four samples collected at least seven days apart:
2. The Director shall not use the results of a suspended sediment concentration sample collected during or within 48 hours after a local storm event to determine the median value.

A&Wc AZ	A&Ww AZ
25	80

E. Dissolved oxygen. A non-WOTUS protected surface water meets the water quality standard for dissolved oxygen when either:

1. The percent saturation of dissolved oxygen is equal to or greater than 90 percent, or

2. The single sample minimum concentration for the designated use, as expressed in milligrams per liter (mg/L) is as follows:

Designated Use	**Single sample minimum concentration in mg/L**
A&Ww AZ	6.0
A&Wc AZ	7.0

The single sample minimum concentration is the same for the designated use in a lake, but the sample must be taken from a depth no greater than one meter.

F. Tables 1 through 17 prescribe water quality criteria for individual pollutants by designated use.

Historical Note

New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 1. Water Quality Criteria by Designated Use (see footnote)

Parameter	CAS NUMBER	DWS AZ (µg/L)	FC AZ (µg/L)	FBC AZ (µg/L)	PBC AZ (µg/L)	A&Wc AZ Acute (µg/L)	A&Wc AZ Chronic (µg/L)	A&Ww AZ Acute (µg/L)	A&Ww AZ Chronic (µg/L)	AgI AZ (µg/L)	AgL AZ (µg/L)
Acenaphthene	83329	420	198	56,000	56,000	850	550	850	550		
Acrolein	107028	3.5	1.9	467	467	3	3	3	3		
Acrylonitrile	107131	0.06	0.2	3	37,333	3,800	250	3,800	250		
Alachlor	15972608	2		9,333	9,333	2,500	170	2,500	170		
Aldrin	309002	0.002	0.00005	0.08	28	3		3		0.003	See (b)
Alpha Particles (Gross) Radioactivity		15 pCi/L See (h)									
Ammonia	7664417					See (e) & Tables 11 (present) & 14 (absent)	See (e) & Tables 13 (present) & 17 (absent)	See (e) & Tables 12 (present) & 15 (absent)	See (e) & Tables 13 (present) & 16 (absent)		
Anthracene	120127	2,100	74	280,000	280,000						
Antimony	7440360	6 T	640 T	747 T	747 T	88 D	30 D	88 D	30 D		
Arsenic	7440382	10 T	80 T	30 T	280 T	340 D	150 D	340 D	150 D	2,000 T	200 T
Asbestos	1332214	See (a)									
Atrazine	1912249	3		32,667	32,667						
Barium	7440393	2,000 T		98,000 T	98,000 T						
Benz(a)anthracene	56553	0.005	0.02	0.2	0.2						
Benzene	71432	5	140	93	3,733	2,700	180	2,700	180		
Benzo[b]fluoranthene Benzfluoranthene	205992	0.005	0.02	1.9	1.9						
Benzidine	92875	0.0002	0.0002	0.01	2,800	1,300	89	1,300	89	0.01	0.01
Benzo(a)pyrene	50328	0.2	0.02	0.2	0.2						
Benzo(k)fluoranthene	207089	0.005	0.02	1.9	1.9						
Beryllium	7440417	4 T	84 T	1,867 T	1,867 T	65 D	5.3 D	65 D	5.3 D		
Beta particles and photon emitters		4 millirems / year See (i)									
Bis(2-chloroethyl) ether	111444	0.03	0.5	1	1	120,000	6,700	120,000	6,700		
Bis(2-chloroisopropyl) ether	108601	280	3,441	37,333	37,333						
Boron	7440428	1,400 T		186,667 T	186,667 T					1,000 T	
Bromodichloromethane	75274	TTHM See (g)	17	TTHM	18,667						
4-Bromophenyl phenyl ether	101553					180	14	180	14		
Bromoform	75252	TTHM See (g)	133	180	18,667	15,000	10,000	15,000	10,000		
Bromomethane	74839	9.8	299	1,307	1,307	5,500	360	5,500	360		
Butyl benzyl phthalate	85687	1,400	386	186,667	186,667	1,700	130	1,700	130		
Cadmium	7440439	5 T	84 T	700 T	700 T	See (d) & Table 2	See (d) & Table 3	See (d) & Table 2	See (d) & Table 3	50	50
Carbaryl	63252					2.1	2.1	2.1	2.1		
Carbofuran	1563662	40		4,667	4,667	650	50	650	50		
Carbon tetrachloride	56235	5	2	11	980	18,000	1,100	18,000	1,100		
Chlordane	57749	2	0.0008	4	467	2.4	0.004	2.4	0.2		
Chlorine (total residual)	7782505	4,000		4000	4000	19	11	19	11		
Chlorobenzene	108907	100	1,553	18,667	18,667	3,800	260	3,800	260		
2-Chloroethyl vinyl ether	110758					180,000	9,800	180,000	9,800		
Chloroform	67663	TTHM See (g)	470	230	9,333	14,000	900	14,000	900		
p-Chloro-m-cresol	59507					15	4.7	15	4.7		
Chloromethane	74873					270,000	15,000	270,000	15,000		
beta-Chloronaphthalene	91587	560	317	74,667	74,667						
2-Chlorophenol	95578	35	30	4,667	4,667	2,200	150	2,200	150		
Chloropyrifos	2921882	21		2,800	2,800	0.08	0.04	0.08	0.04		
Chromium III	16065831		75,000 T	1,400,000 T	1,400,000 T	See (d) & Table 4	See (d) & Table 4	See (d) & Table 4	See (d) & Table 4		
Chromium VI	18540299	21 T	150 T	2,800 T	2,800 T	16 D	11 D	16 D	11 D		
Chromium (Total)	7440473	100 T								1,000	1,000
Chrysene	218019	0.005	0.02	19	19						
Copper	7440508	1,300 T		1,300 T	1,300 T	See (d) & Table 5	See (d) & Table 5	See (d) & Table 5	See (d) & Table 5	5,000 T	500 T
Cyanide (as free cyanide)	57125	200 T	16,000 T	18,667 T	18,667 T	22 T	5.2 T	41 T	9.7 T		200 T
Dalapon	75990	200	8,000	28,000	28,000						
DDT and its breakdown products	50293	0.1	0.0002	14	467	1.1	0.001	1.1	0.001	0.001	0.001
Demeton	8065483						0.1		0.1		
Diazinon	333415					0.17	0.17	0.17	0.17		
Dibenz (ah) anthracene	53703	0.005	0.02	1.9	1.9						

Dibromochloromethane	124481	TTHM See (g)	13	TTHM	18,667						
1,2-Dibromo-3-chloropro- pane	96128	0.2		2,800	2,800						
1,2-Dibromoethane	106934	0.05		8,400	8,400						
Dibutyl phthalate	84742	700	899	93,333	93,333	470	35	470	35		
1,2-Dichlorobenzene	95501	600	205	84,000	84,000	790	300	1,200	470		
1,3-Dichlorobenzene	541731					2,500	970	2,500	970		
1,4-Dichlorobenzene	106467	75	5755	373,333	373,333	560	210	2,000	780		
3,3'-Dichlorobenzidine	91941	0.08	0.03	3	3						
1,2-Dichloroethane	107062	5	37	15	186,667	59,000	41,000	59,000	41,000		
1,1-Dichloroethylene	75354	7	7,143	46,667	46,667	15,000	950	15,000	950		
1,2-cis-Dichloroethylene	156592	70		70	70						
1,2-trans-Dichloroethylene	156605	100	10,127	18,667	18,667	68,000	3,900	68,000	3,900		
Dichloromethane	75092	5	593	190	56,000	97,000	5,500	97,000	5,500		
2,4-Dichlorophenol	120832	21	59	2,800	2,800	1,000	88	1,000	88		
2,4-Dichlorophenoxyacetic acid (2,4-D)	94757	70		9,333	9,333						
1,2-Dichloropropane	78875	5	17,518	84,000	84,000	26,000	9,200	26,000	9,200		
1,3-Dichloropropene	542756	0.7	42	420	28,000	3,000	1,100	3,000	1,100		
Dieldrin	60571	0.002	0.00005	0.09	47	0.2	0.06	0.2	0.06	0.003	See (b)
Diethyl phthalate	84662	5,600	8,767	746,667	746,667	26,000	1,600	26,000	1,600		
Di (2-ethylhexyl) adipate	103231	400		560,000	560,000						
Di (2-ethylhexyl) phthalate	117817	6	3	100	18,667	400	360	400	360		
2,4-Dimethylphenol	105679	140	171	18,667	18,667	1,000	310	1,000	310		
Dimethyl phthalate	131113					17,000	1,000	17,000	1,000		
4,6-Dinitro-o-cresol	534521	28	582	3,733	3,733	310	24	310	24		
2,4-Dinitrophenol	51285	14	1,067	1,867	1,867	110	9.2	110	9.2		
2,4-Dinitrotoluene	121142	14	421	1,867	1,867	14,000	860	14,000	860		
2,6-Dinitrotoluene	606202	0.05		2	3,733						
Di-n-octyl phthalate	117840	2,800		373,333	373,333						
Dinoseb	88857	7		933	933						
1,2-Diphenylhydrazine	122667	0.04	0.2	1.8	1.8	130	11	130	11		
Diquat	85007	20		2,053	2,053						
Endosulfan sulfate	1031078	42	18	5,600	5,600	0.2	0.06	0.2	0.06		
Endosulfan (Total)	115297	42	18	5,600	5,600	0.2	0.06	0.2	0.06		
Endothall	145733	100		18,667	18,667						
Endrin	72208	2	0.06	280	280	0.09	0.04	0.09	0.04	0.004	0.004
Endrin aldehyde	7421934	2				0.09	0.04	0.09	0.04		
Ethylbenzene	100414	700	2,133	93,333	93,333	23,000	1,400	23,000	1,400		
Fluoranthene	206440	280	28	37,333	37,333	2,000	1,600	2,000	1,600		
Fluorene	86737	280	1,067	37,333	37,333						
Fluoride	7782414	4,000		140,000	140,000						
Glyphosate	1071836	700	266,667	93,333	93,333						
Guthion	86500						0.01		0.01		
Heptachlor	76448	0.4	0.00008	0.4	467	0.5	0.004	0.5	0.004		
Heptachlor epoxide	1024573	0.2	0.00004	0.2	12	0.5	0.004	0.5	0.004		
Hexachlorobenzene	118741	1	0.0003	1	747	6	3.7	6	3.7		
Hexachlorobutadiene	87683	0.4	18	18	187	45	8.2	45	8.2		
Hexachlorocyclohexane alpha	319846	0.006	0.005	0.22	7,467	1,600	130	1,600	130		
Hexachlorocyclohexane beta	319857	0.02	0.02	0.78	560	1,600	130	1,600	130		
Hexachlorocyclohexane delta	319868					1,600	130	1,600	130		
Hexachlorocyclohexane gamma (lindane)	58899	0.2	1.8	280	280	1	0.08	1	0.28		
Hexachlorocyclopentadiene	77474	50	580	9,800	9,800	3.5	0.3	3.5	0.3		
Hexachloroethane	67721	2.5	3.3	100	933	490	350	490	350		
Hydrogen sulfide	7783064						2 See (c)		2 See (c)		
Indeno (1,2,3-cd) pyrene	193395	0.05	0.49	1.9	1.9						
Iron	7439896						1,000 D		1,000 D		
Isophorone	78591	37	961	1,500	186,667	59,000	43,000	59,000	43,000		
Lead	7439921	15 T		15 T	15 T	See (d) & Table 6	See (d) & Table 6	See (d) & Table 6	See (d) & Table 6	10,000 T	100 T
Malathion	121755	140		18,667	18,667		0.1		0.1		
Manganese	7439965	980		130,667	130,667					10,000	
Mercury	7439976	2 T		280 T	280 T	2.4 D	0.01 D	2.4 D	0.01 D		10 T
Methoxychlor	72435	40		4,667	4,667		0.03		0.03		
Methylmercury	22967926		0.3 mg/ kg								
Mirex	2385855	1		187	187		0.001		0.001		
Naphthalene	91203	140	1,524	18,667	18,667	1,100	210	3,200	580		
Nickel	7440020	140 T	4,600 T	28,000 T	28,000 T	See (d) & Table 7	See (d) & Table 7	See (d) & Table 7	See (d) & Table 7		
Nitrate	14797558	10,000		3,733,333	3,733,333						
Nitrite	14797650	1,000		233,333	233,333						
Nitrate + Nitrite		10,000									
Nitrobenzene	98953	3.5	138	467	467	1,300	850	1,300	850		
p-Nitrophenol	100027					4,100	3,000	4,100	3,000		
N-nitrosodimethylamine	62759	0.001	3	0.03	0.03						
N-Nitrosodiphenylamine	86306	7.1	6	290	290	2,900	200	2,900	200		
N-nitrosodi-n-propylamine	621647	0.005	0.5	0.2	88,667						
Nonylphenol	104405					28	6.6	28	6.6		
Oxamyl	23135220	200		23,333	23,333						
Parathion	56382					0.07	0.01	0.07	0.01		
Paraquat	1910425	32		4,200	4,200	100	54	100	54		

Pentachlorophenol	87865	1	1,000	12	28,000	See (e), (j) & Table 10	See (e), (j) & Table 10	See (e), (j) & Table 10	See (e), (j) & Table 10		
Permethrin	52645531	350		46,667	46,667	0.3	0.2	0.3	0.2		
Phenanthrene	85018					30	6.3	30	6.3		
Phenol	108952	2,100	37	280,000	280,000	5,100	730	7,000	1,000		
Picloram	1918021	500	2,710	65,333	65,333						
Polychlorinatedbiphenyls (PCBs)	1336363	0.5	0.00006	2 19	19	2	0.01	2	0.02	0.001	0.001
Pyrene	129000	210	800	28,000	28,000						
Radium 226 + Radium 228		5 pCi/L									
Selenium	7782492	50 T	667 T	4,667 T	4,667 T		2 T		2 T	20 T	50 T
Silver	7440224	35 T	8,000 T	4,667 T	4,667 T	See (d) & Table 8		See (d) & Table 8			
Simazine	112349	4		4,667	4,667						
Strontium	7440246	8 pCi/L									
Styrene	100425	100		186,667	186,667	5,600	370	5,600	370		
Sulfides											
2,3,7,8-Tetrachlorod- ibenzo-p-dioxin (2,3,7,8-TCDD)	1746016	0.00003	5x10-9	0.00003	0.0009	0.01	0.005	0.01	0.005		
1,1,2,2-Tetrachloroethane	79345	0.2	4	7	56,000	4,700	3,200	4,700	3,200		
Tetrachloroethylene	127184	5	261	9,333	9,333	2,600	280	6,500	680		
Thallium	7440280	2 T	7.2 T	75 T	75 T	700 D	150 D	700 D	150 D		
Toluene	108883	1,000	201.000	280,000	280,000	8,700	180	8,700	180		
Toxaphene	8001352	3	0.0003	1.3	933	0.7	0.0002	0.7	0.0002	0.005	0.005
Tributyltin						0.5	0.07	0.5	0.07		
1,2,4-Trichlorobenzene	120821	70	70	9,333	9,333	750	130	1,700	300		
1,1,1-Trichloroethane	71556	200	428,571	1,866,667	1,866,667	2,600	1,600	2,600	1,600	1,000	
1,1,2-Trichloroethane	79005	5	16	25	3,733	18,000	12,000	18,000	12,000		
Trichloroethylene	79016	5	29	280,000	280	20,000	1,300	20,000	1,300		
2,4,6-Trichlorophenol	88062	3.2	2	130	130	160	25	160	25		
2,4,5-Trichlorophenoxy proprionic acid (2,4,5-TP)	93721	50		7,467	7,467						
Trihalomethanes (T)		80									
Tritium	10028178	20,000 pCi/L									
Uranium	7440611	30 D		2,800	2,800						
Vinyl chloride	75014	2	5	2	2,800						
Xylenes (T)	1330207	10,000		186,667	186,667						
Zinc	7440666	2,100 T	5,106 T	280,000 T	280,000 T	See (d) & Table 9	See (d) & Table 9	See (d) & Table 9	See (d) & Table 9	10,000 T	25,000 T

Historical Note

Table 1 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 2. Acute Water Quality Standards for Dissolved Cadmium

Aquatic and Wildlife Coldwater AZ		Aquatic and Wildlife Warm Water AZ	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	0.40	20	2.1
100	1.8	100	9.4
400	6.5	400	34
e(0.9789*LN(Hardness)-3.866)*(1.136672-LN(Hardness)*0.041838)		e(0.9789*LN(Hardness)-2.208)*(1.136672-LN(Hardness)*0.041838)	

Historical Note

Table 2 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 3. Chronic Water Quality Standards for Dissolved Cadmium

Aquatic and Wildlife Coldwater AZ and Warmwater AZ	
Hard. mg/L	**Std. µg/L**
20	0.21
100	0.72
400	2.0
e(0.7977*LN(Hardness)-3.909)*(1.101672-LN(Hardness)*0.041838)	

Historical Note

Table 3 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 4. Water Quality Standards for Dissolved Chromium III

Acute Aquatic and Wildlife Coldwater AZ and Warmwater AZ		Chronic Aquatic and Wildlife Coldwater AZ and Warmwater AZ	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	152	20	19.8
100	570	100	74.1
400	1,773	400	231
e(0.819*LN(Hardness)+3.7256)*(0.316)		e(0.819*LN(Hardness)+0.6848)*(0.86)	

Historical Note

Table 4 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 5. Water Quality Standards for Dissolved Copper

Acute Aquatic and Wildlife Coldwater AZ and Warmwater AZ		Chronic Aquatic and Wildlife Coldwater AZ and Warmwater AZ	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	2.9	20	2.3
100	13	100	9.0
400	50	400	29
e(0.9422*LN(Hardness)-1.702)*(0.96)		e(0.8545*LN(Hardness)-1.702)*(0.96)	

Historical Note

Table 5 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 6. Water Quality Standards for Dissolved Lead

Acute Aquatic and Wildlife Coldwater AZ and Warmwater AZ		Chronic Aquatic and Wildlife Coldwater AZ and Warmwater AZ	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	10.8	20	0.42
100	64.6	100	2.5
400	281	400	10.9
e(1.273*LN(Hardness)-1.46)*(1.46203-(LN(Hardness))*(0.145712))		e(1.273*LN(Hardness)-4.705) * (1.46203-(LN(Hardness))*(0.145712))	

Historical Note

Table 6 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 7. Water Quality Standards for Dissolved Nickel

Acute Aquatic and Wildlife Coldwater AZ and Warmwater AZ		Chronic Aquatic and Wildlife Coldwater AZ and Warmwater AZ	
Hard. mg/L	**Std. µg/L**	**Hard. mg/L**	**Std. µg/L**
20	120.0	20	13.3
100	468	100	52.0
400	1513	400	168
e(0.846*LN(Hardness)+2.255)*(0.998)		e(0.846*LN(Hardness)+0.0584)*(0.997)	

Historical Note

Table 7 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 8. Water Quality Standards for Dissolved Silver

Acute Aquatic and Wildlife Coldwater AZ and Warmwater AZ	
Hard. mg/L	**Std. µg/L**
20	0.20
100	3.2
400	34.9
e(1.72*LN(Hardness)-6.59)*(0.85)	

Historical Note

Table 8 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 9. Water Quality Standards for Dissolved Zinc

Acute and Chronic Aquatic and Wildlife Coldwater AZ and Warmwater AZ	
Hard. mg/L	**Std. µg/L**
20	30.0
100	117
400	379
e(0.8473*LN(Hardness)+0.884)*(0.978)	

Historical Note

Table 9 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 10. Water Quality Standards for Pentachlorophenol

Acute Aquatic and Wildlife Coldwater AZ and Warmwater AZ		Chronic Aquatic and Wildlife Coldwater AZ and Warmwater AZ	
pH	**µg/L**	**pH**	**µg/L**
3	0.16	3	0.1
6	3.3	6	2.1
9	67.7	9	42.7
e(1.005*(pH)-4.83)		e(1.005*(pH)-5.29)	

Historical Note

Table 10 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 11. Acute Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Coldwater AZ, Unionid Mussels Present

For the Aquatic and Wildlife Coldwater AZ uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

	Temperature (°C)																
pH	**0-14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	33	33	32	29	27	25	23	21	19	18	16	15	14	13	12	11	9.9
6.6	31	31	30	28	26	24	22	20	18	17	16	14	13	12	11	10	9.5
6.7	30	30	29	27	24	22	21	19	18	16	15	14	13	12	11	9.8	9
6.8	28	28	27	25	23	21	20	18	17	15	14	13	12	11	10	9.2	8.5
6.9	26	26	25	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	7.9
7	24	24	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	8	7.3
7.1	22	22	21	20	18	17	15	14	13	12	11	10	9.3	8.5	7.9	7.2	6.7
7.2	20	20	19	18	16	15	14	13	12	11	9.8	9.1	8.3	7.7	7.1	6.5	6
7.3	18	18	17	16	14	13	12	11	10	9.5	8.7	8	7.4	6.8	6.3	5.8	5.3
7.4	15	15	15	14	13	12	11	9.8	9	8.3	7.7	7	6.5	6	5.5	5.1	4.7
7.5	13	13	13	12	11	10	9.2	8.5	7.8	7.2	6.6	6.1	5.6	5.2	4.8	4.4	4
7.6	11	11	11	10	9.3	8.6	7.9	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.1	3.8	3.5
7.7	9.6	9.6	9.3	8.6	7.9	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.1	3.8	3.5	3.2	3
7.8	8.1	8.1	7.9	7.2	6.7	6.1	5.6	5.2	4.8	4.4	4	3.7	3.4	3.2	2.9	2.7	2.5
7.9	6.8	6.8	6.6	6	5.6	5.1	4.7	4.3	4	3.7	3.4	3.1	2.9	2.6	2.4	2.2	2.1
8	5.6	5.6	5.4	5	4.6	4.2	3.9	3.6	3.3	3	2.8	2.6	2.4	2.2	2	1.9	1.7
8.1	4.6	4.6	4.5	4.1	3.8	3.5	3.2	3	2.7	2.5	2.3	2.1	2	1.8	1.7	1.5	1.4
8.2	3.8	3.8	3.7	3.5	3.1	2.9	2.7	2.4	2.3	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.2
8.3	3.1	3.1	3.1	2.8	2.6	2.4	2.2	2	1.9	1.7	1.6	1.4	1.3	1.2	1.1	1	0.96
8.4	2.6	2.6	2.5	2.3	2.1	2	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1	0.93	0.86	0.79
8.5	2.1	2.1	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.2	1.1	0.98	0.9	0.83	0.77	0.71	0.65
8.6	1.8	1.8	1.7	1.6	1.5	1.3	1.2	1.1	1	0.96	0.88	0.81	0.75	0.69	0.63	0.59	0.54
8.7	1.5	1.5	1.4	1.3	1.2	1.1	1	0.94	0.87	0.8	0.74	0.68	0.62	0.57	0.53	0.49	0.45
8.8	1.2	1.2	1.2	1.1	1	0.93	0.86	0.79	0.73	0.67	0.62	0.57	0.52	0.48	0.44	0.41	0.37
8.9	1	1	1	0.93	0.85	0.79	0.72	0.67	0.61	0.56	0.52	0.48	0.44	0.4	0.37	0.34	0.32
9	0.88	0.88	0.86	0.79	0.73	0.67	0.62	0.57	0.52	0.48	0.44	0.41	0.37	0.34	0.32	0.29	0.27

$$MIN\left(\left(\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}\right),\left(0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times\left(23.12\times 10^{0.036\times(20-T)}\right)\right)\right)$$

Historical Note

Table 11 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 12. Acute Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Warmwater AZ, Unionid Mussels Present

For the Aquatic and Wildlife Warmwater AZ uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

pH	Temperature (°C)																				
	0-10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	51	48	44	41	37	34	32	29	27	25	23	21	19	18	16	15	14	13	12	11	9.9
6.6	49	46	42	39	36	33	30	28	26	24	22	20	18	17	16	14	13	12	11	10	9.5
6.7	46	44	40	37	34	31	29	27	24	22	21	19	18	16	15	14	13	12	11	9.8	9
6.8	44	41	38	35	32	30	27	25	23	21	20	18	17	15	14	13	12	11	10	9.2	8.5
6.9	41	38	35	32	30	28	25	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	7.9
7	38	35	33	30	28	25	23	21	20	18	17	15	14	13	12	11	10	9.4	8.6	7.9	7.3
7.1	34	32	30	27	25	23	21	20	18	17	15	14	13	12	11	10	9.3	8.5	7.9	7.2	6.7
7.2	31	29	27	25	23	21	19	18	16	15	14	13	12	11	9.8	9.1	8.3	7.7	7.1	6.5	6
7.3	27	26	24	22	20	18	17	16	14	13	12	11	10	9.5	8.7	8	7.4	6.8	6.3	5.8	5.3
7.4	24	22	21	19	18	16	15	14	13	12	11	9.8	9	8.3	7.7	7	6.5	6	5.5	5.1	4.7
7.5	21	19	18	17	15	14	13	12	11	10	9.2	8.5	7.8	7.2	6.6	6.1	5.6	5.2	4.8	4.4	4
7.6	18	17	15	14	13	12	11	10	9.3	8.6	7.9	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.1	3.8	3.5
7.7	15	14	13	12	11	10	9.3	8.6	7.9	7.3	6.7	6.2	5.7	5.2	4.8	4.4	4.1	3.8	3.5	3.2	2.9
7.8	13	12	11	10	9.3	8.5	7.9	7.2	6.7	6.1	5.6	5.2	4.8	4.4	4	3.7	3.4	3.2	2.9	2.7	2.5
7.9	11	9.9	9.1	8.4	7.7	7.1	6.6	3	5.6	5.1	4.7	4.3	4	3.7	3.4	3.1	2.9	2.6	2.4	2.2	2.1
8	8.8	8.2	7.6	7	6.4	5.9	5.4	5	4.6	4.2	3.9	3.6	3.3	3	2.8	2.6	2.4	2.2	2	1.9	1.7
8.1	7.2	6.8	6.3	5.8	5.3	4.9	4.5	4.1	3.8	3.5	3.2	3	2.7	2.5	2.3	2.1	2	1.8	1.7	1.5	1.4
8.2	6	5.6	5.2	4.8	4.4	4	3.7	3.4	3.1	2.9	2.7	2.4	2.3	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.2
8.3	4.9	4.6	4.3	3.9	3.6	3.3	3.1	2.8	2.6	2.4	2.2	2	1.9	1.7	1.6	1.4	1.3	1.2	1.1	1	0.96
8.4	4.1	3.8	3.5	3.2	3	2.7	2.5	2.3	2.1	2	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1	0.93	0.86	0.79
8.5	3.3	3.1	2.9	2.7	2.4	2.3	2.1	1.9	1.8	1.6	1.5	1.4	1.3	1.2	1.1	0.98	0.9	0.83	0.77	0.71	0.65
8.6	2.8	2.6	2.4	2.2	2	1.9	1.7	1.6	1.5	1.3	1.2	1.1	1	0.96	0.88	0.81	0.75	0.69	0.63	0.58	0.54
8.7	2.3	2.2	2	1.8	1.7	1.6	1.4	1.3	1.2	1.1	1	0.94	0.87	0.8	0.74	0.68	0.62	0.57	0.53	0.49	0.45
8.8	1.9	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1	0.93	0.86	0.79	0.73	0.67	0.62	0.57	0.52	0.48	0.44	0.41	0.37
8.9	1.6	1.5	1.4	1.3	1.2	1.1	1	0.93	0.85	0.79	0.72	0.67	0.61	0.56	0.52	0.48	0.44	0.4	0.37	0.34	0.32
9	1.4	1.3	1.2	1.1	1	0.93	0.86	0.79	0.73	0.67	0.62	0.57	0.52	0.48	0.44	0.41	0.37	0.34	0.32	0.29	0.27

$$0.7249 \times \left(\frac{0.0114}{1 + 10^{7.204-pH}} + \frac{1.6181}{1 + 10^{pH-7.204}}\right) \times MIN(51.93, 23.12 \times 10^{0.036\times(20-T)})$$

Historical Note

Table 12 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 13. Chronic Criteria for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Coldwater AZ and Warmwater AZ, Unionid Mussels Present

For the Aquatic and Wildlife Coldwater and Warmwater AZ uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

	Temperature (°C)																							
pH	**0-7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	4.9	4.6	4.3	4.1	3.8	3.6	3.3	3.1	2.9	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8	1.6	1.5	1.5	1.4	1.3	1.2	1.1
6.6	4.8	4.5	4.3	4	3.8	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1
6.7	4.8	4.5	4.2	3.9	3.7	3.5	3.2	3	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1
6.8	4.6	4.4	4.1	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1
6.9	4.5	4.2	4	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1
7	4.4	4.1	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	0.99
7.1	4.2	3.9	3.7	3.5	3.2	3	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95
7.2	4	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.96	0.9
7.3	3.8	3.5	3.3	3.1	2.9	2.7	2.6	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.97	0.91	0.85
7.4	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.96	0.9	0.85	0.79
7.5	3.2	3	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95	0.89	0.83	0.78	0.73
7.6	2.9	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	0.98	0.92	0.86	0.81	0.76	0.71	0.67
7.7	2.6	2.4	2.3	2.2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1	0.94	0.88	0.83	0.78	0.73	0.68	0.64	0.6
7.8	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95	0.89	0.84	0.79	0.74	0.69	0.65	0.61	0.57	0.53
7.9	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95	0.89	0.84	0.79	0.74	0.69	0.65	0.61	0.57	0.53	0.5	0.47
8	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1	0.94	0.88	0.83	0.78	0.73	0.68	0.64	0.6	0.56	0.53	0.5	0.44	0.44	0.41
8.1	1.5	1.5	1.4	1.3	1.2	1.1	1.1	0.99	0.92	0.87	0.81	0.76	0.71	0.67	0.63	0.59	0.55	0.52	0.49	0.46	0.43	0.4	0.38	0.35
8.2	1.3	1.2	1.2	1.1	1	0.96	0.9	0.84	0.79	0.74	0.7	0.65	0.61	0.57	0.54	0.5	0.47	0.44	0.42	0.39	0.37	0.34	0.32	0.3
8.3	1.1	1.1	0.99	0.93	0.87	0.82	0.76	0.72	0.67	0.63	0.59	0.55	0.52	0.49	0.46	0.43	0.4	0.38	0.35	0.33	0.31	0.29	0.27	0.26
8.4	0.95	0.89	0.84	0.79	0.74	0.69	0.65	0.61	0.57	0.53	0.5	0.47	0.44	0.41	0.39	0.36	0.34	0.32	0.3	0.28	0.26	0.25	0.23	0.22
8.5	0.8	0.75	0.71	0.67	0.62	0.58	0.55	0.51	0.48	0.45	0.42	0.4	0.37	0.35	0.33	0.31	0.29	0.27	0.25	0.24	0.22	0.21	0.2	0.18
8.6	0.68	0.64	0.6	0.56	0.53	0.49	0.46	0.43	0.41	0.38	0.36	0.33	0.31	0.29	0.28	0.26	0.24	0.23	0.21	0.2	0.19	0.18	0.16	0.15
8.7	0.57	0.54	0.51	0.47	0.44	0.42	0.39	0.37	0.34	0.32	0.3	0.28	0.27	0.25	0.23	0.22	0.21	0.19	0.18	0.17	0.16	0.15	0.14	0.13
8.8	0.49	0.46	0.43	0.4	0.38	0.35	0.33	0.31	0.29	0.27	0.26	0.24	0.23	0.21	0.2	0.19	0.17	0.16	0.15	0.14	0.13	0.13	0.12	0.11
8.9	0.42	0.39	0.37	0.34	0.32	0.3	0.28	0.27	0.25	0.23	0.22	0.21	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.1	0.09
9	0.36	0.34	0.32	0.3	0.28	0.26	0.24	0.23	0.21	0.2	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.1	0.09	0.09	0.08

$$0.8876 \times \left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right) \times \left(2.126 \times 10^{0.028 \times (20-MAX(T,7))}\right)$$

Historical Note

Table 13 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 14. Acute Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Coldwater AZ, Unionid Mussels Absent

For the Aquatic and Wildlife Coldwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

	Temperature (°C)																
pH	**0-14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	33	33	33	33	33	33	33	33	33	33	33	33	33	33	31	29	27
6.6	31	31	31	31	31	31	31	31	31	31	31	31	31	31	30	28	26
6.7	30	30	30	30	30	30	30	30	30	30	30	30	30	30	29	26	24
6.8	28	28	28	28	28	28	28	28	28	28	28	28	28	28	27	25	23
6.9	26	26	26	26	26	26	26	26	26	26	26	26	26	26	25	23	21
7	24	24	24	24	24	24	24	24	24	24	24	24	24	24	23	21	20
7.1	22	22	22	22	22	22	22	22	22	22	22	22	22	22	21	19	18
7.2	20	20	20	20	20	20	20	20	20	20	20	20	20	20	19	17	16
7.3	18	18	18	18	18	18	18	18	18	18	18	18	18	18	17	16	14
7.4	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	14	13
7.5	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	11
7.6	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	10	9.3
7.7	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.3	8.6	7.9
7.8	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	7.8	7.2	6.6
7.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.5	6	5.5
8	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.4	5	4.6
8.1	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.5	4.1	3.8
8.2	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.7	3.4	3.1
8.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3	2.8	2.6
8.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.3	2.1
8.5	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	1.9	1.8
8.6	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6	1.4
8.7	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.3	1.2
8.8	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1
8.9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.92	0.85
9	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.85	0.78	0.72

$$MIN\left(\left(\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}\right),\left(0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times\left(62.15\times 10^{0.036\times(20-T)}\right)\right)$$

Historical Note

Table 14 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 15. Acute Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Warmwater AZ Uses, Unionid Mussels Absent

For the Aquatic and Wildlife Warmwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment. For the aquatic and wildlife effluent dependent uses, unionids will be assumed to be absent.

	Temperature (°C)																
pH	**0-14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
6.5	51	51	51	51	51	51	51	51	51	48	44	40	37	34	31	29	27
6.6	49	49	49	49	49	49	49	49	49	46	42	39	36	33	30	28	26
6.7	46	46	46	46	46	46	46	46	46	43	40	37	34	31	29	26	24
6.8	44	44	44	44	44	44	44	44	44	41	38	35	32	29	27	25	23
6.9	41	41	41	41	41	41	41	41	41	38	35	32	30	27	25	23	21
7	38	38	38	38	38	38	38	38	38	35	32	30	27	25	23	21	20
7.1	34	34	34	34	34	34	34	34	34	32	29	27	25	23	21	19	18
7.2	31	31	31	31	31	31	31	31	31	29	26	24	22	21	19	17	16
7.3	27	27	27	27	27	27	27	27	27	26	23	22	20	18	17	16	14
7.4	24	24	24	24	24	24	24	24	24	22	21	19	17	16	15	14	13
7.5	21	21	21	21	21	21	21	21	21	19	18	16	15	14	13	12	11
7.6	18	18	18	18	18	18	18	18	18	17	15	14	13	12	11	10	9.3
7.7	15	15	15	15	15	15	15	15	15	14	13	12	11	10	9.3	8.6	7.9
7.8	13	13	13	13	13	13	13	13	13	12	11	10	9.2	8.5	7.8	7.2	6.6
7.9	11	11	11	11	11	11	11	11	11	9.9	9.1	8.4	7.7	7.1	6.5	6	5.5
8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.2	7.5	6.9	6.4	5.9	5.4	5	4.6
8.1	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	6.8	6.2	5.7	5.3	4.9	4.5	4.1	3.8
8.2	6	6	6	6	6	6	6	6	6	5.6	5.1	4.7	4.4	4	3.7	3.4	3.1
8.3	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.6	4.2	3.9	3.6	3.3	3	2.8	2.6
8.4	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	3.8	3.4	3.2	3	2.7	2.5	2.3	2.1
8.5	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.1	2.9	2.6	2.4	2.2	2.1	1.9	1.8
8.6	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.6	2.4	2.2	2	1.9	1.7	1.6	1.4
8.7	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2	1.8	1.7	1.5	1.4	1.3	1.2
8.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.7	1.5	1.4	1.3	1.2	1.1	1
8.9	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.3	1.2	1.1	1	0.92	0.85
9	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.2	1.1	1	0.93	0.85	0.78	0.72

$$0.7249 \times \left(\frac{0.0114}{1 + 10^{7.204-pH}} + \frac{1.6181}{1 + 10^{pH-7.204}}\right) \times MIN\left(51.93, \left(62.15 \times 10^{0.036\times(20-T)}\right)\right)$$

Historical Note

Table 15 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 16. Chronic Standards for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Warmwater AZ, Unionid Mussels Absent

For the Aquatic and Wildlife Warmwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment. For the aquatic and wildlife effluent dependent uses, unionids will be assumed to be absent.

pH	Temperature (°C)																						
	0-7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
6.5	19	17	16	15	14	13	13	12	11	10	9.7	9.1	8.5	8	7.5	7	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.2
6.6	18	17	16	15	14	13	12	12	11	10	9.6	9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.4	5	4.7	4.4	4.1
6.7	18	17	16	15	14	13	12	11	11	10	9.4	8.8	8.3	7.7	7.3	6.8	6.4	6	5.6	5.3	4.9	4.6	4.3	4.1
6.8	17	16	15	14	14	13	12	11	10	9.8	9.2	8.6	8.1	7.6	7.1	6.7	6.2	5.8	5.5	5.1	4.8	4.5	4.2	4
6.9	17	16	15	14	13	12	12	11	10	9.5	8.9	8.4	7.8	7.4	6.9	6.5	6.1	5.7	5.3	5	4.7	4.4	4.1	3.9
7	16	15	14	14	13	12	11	10	9.8	9.2	8.6	8.1	7.6	7.1	6.7	6.2	5.9	5.5	5.1	4.8	4.5	4.2	4	3.7
7.1	16	15	14	13	12	11	11	10	9.4	8.8	8.3	7.7	7.3	6.8	6.4	6	5.6	5.3	4.9	4.6	4.3	4.1	3.8	3.6
7.2	15	14	13	12	12	11	10	9.5	9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.3	5	4.7	4.4	4.1	3.9	3.6	3.4
7.3	14	13	12	12	11	10	9.6	9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.4	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2
7.4	13	12	12	11	10	9.5	9	8.4	7.9	7.4	6.9	6.5	6.1	5.7	5.3	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2	3
7.5	12	11	11	10	9.4	8.8	8.2	7.7	7.2	6.8	6.4	6	5.6	5.2	4.9	4.6	4.3	4.1	3.8	3.6	3.3	3.1	2.9	2.8
7.6	11	10	10	9.1	8.5	8	7.5	7	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.2	3.9	3.7	3.5	3.2	3	2.9	2.7	2.5
7.7	9.9	9.3	8.7	8.1	7.7	7.2	6.8	6.3	5.9	5.6	5.2	4.9	4.6	4.3	4	3.8	3.5	3.3	3.1	2.9	2.7	2.6	2.4	2.3
7.8	8.8	8.3	7.8	7.3	6.8	6.4	6	5.6	5.3	5	4.6	4.4	4.1	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2
7.9	7.8	7.3	6.8	6.4	6	5.6	5.3	5	4.6	4.4	4.1	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8
8	6.8	6.3	6	5.6	5.2	4.9	4.6	4.3	4	3.8	3.6	3.3	3.1	2.9	2.7	2.6	2.4	2.3	2.1	2	1.9	1.7	1.6	1.5
8.1	5.8	5.5	5.1	4.8	4.5	4.2	4	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3
8.2	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2	3	2.8	2.6	2.5	2.3	2.2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1
8.3	4.2	4	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.1	2	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.96
8.4	3.6	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	0.99	0.92	0.87	0.81
8.5	3	2.8	2.7	2.5	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.95	0.89	0.83	0.78	0.73	0.69
8.6	2.6	2.4	2.2	2.1	2	1.9	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.97	0.91	0.85	0.8	0.75	0.7	0.66	0.62	0.58
8.7	2.2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1	0.93	0.88	0.82	0.77	0.72	0.68	0.63	0.6	0.56	0.52	0.49
8.8	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.2	1.1	1	0.96	0.9	0.85	0.79	0.74	0.7	0.65	0.61	0.58	0.54	0.51	0.47	0.44	0.42
8.9	1.6	1.5	1.4	1.3	1.2	1.1	1.1	1	0.94	0.88	0.82	0.77	0.72	0.68	0.64	0.6	0.56	0.52	0.49	0.46	0.43	0.4	0.38	0.36
9	1.4	1.3	1.2	1.1	1	0.98	0.92	0.86	0.81	0.76	0.71	0.66	0.62	0.58	0.55	0.51	0.48	0.45	0.42	0.4	0.37	0.35	0.33	0.31

$$0.9405 \times \left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right) \times \left(7.547 \times 10^{0.028 \times (20-MAX(T,7))}\right)$$

Historical Note

Table 16 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table 17. Chronic Criteria for Total Ammonia (in mg/L, as N) for Aquatic and Wildlife Coldwater AZ, Unionid Mussels Absent

For the Aquatic and Wildlife Coldwater uses, unionids will be assumed to be present unless a study is performed demonstrating that they are absent and there is no historic evidence of their presence, or hydrologic modification has altered the flow regime in a way that would prevent their reestablishment.

pH	Temperature (°C)																
	0-14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
6.5	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7	6.6	6.2	5.8	5.4	5.1	4.8	4.5	4.2
6.6	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	6.9	6.5	6.1	5.7	5.4	5	4.7	4.4	4.1
6.7	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	6.8	6.4	6	5.6	5.3	4.9	4.6	4.3	4.1
6.8	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.6	6.2	5.8	5.5	5.1	4.8	4.5	4.2	4
6.9	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.5	6.1	5.7	5.3	5	4.7	4.4	4.1	3.9
7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.2	5.8	5.5	5.1	4.8	4.5	4.2	4	3.7
7.1	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6	5.6	5.3	4.9	4.6	4.3	4.1	3.8	3.6
7.2	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.7	5.3	5	4.7	4.4	4.1	3.9	3.6	3.4
7.3	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.4	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2
7.4	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5	4.7	4.4	4.1	3.9	3.6	3.4	3.2	3
7.5	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.6	4.3	4.1	3.8	3.6	3.3	3.1	2.9	2.8
7.6	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.2	3.9	3.7	3.5	3.2	3	2.9	2.7	2.5
7.7	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.8	3.5	3.3	3.1	2.9	2.7	2.6	2.4	2.3
7.8	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.4	3.2	3	2.8	2.6	2.4	2.3	2.1	2
7.9	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3	2.8	2.6	2.4	2.3	2.1	2	1.9	1.8
8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.4	2.3	2.1	2	1.9	1.7	1.6	1.5
8.1	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.7	1.6	1.5	1.4	1.3
8.2	2	2	2	2	2	2	2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1
8.3	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.5	1.4	1.3	1.2	1.2	1.1	1	0.96
8.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.2	1.1	1.1	0.99	0.93	0.87	0.81
8.5	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1	0.95	0.89	0.83	0.78	0.73	0.69
8.6	1	1	1	1	1	1	1	1	0.97	0.91	0.85	0.8	0.75	0.7	0.66	0.62	0.58
8.7	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.82	0.77	0.72	0.68	0.64	0.6	0.56	0.52	0.49
8.8	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.7	0.65	0.61	0.58	0.54	0.51	0.47	0.44	0.42
8.9	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.6	0.56	0.52	0.49	0.46	0.43	0.41	0.38	0.36
9	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.51	0.48	0.45	0.42	0.4	0.37	0.35	0.33	0.31

$$0.9405 \times \left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right) \times MIN\left(6.920,\left(7.547 \times 10^{0.028\times(20-T)}\right)\right)$$

Historical Note

Table 17 made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-216. The Protected Surface Waters List

Tables A through C prescribe the protected surface waters list.

Historical Note

Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table A. Non-WOTUS Protected Surface Waters and Designated Uses

Watershed	Surface Waters	Segment Description and Location (Latitude and Longitudes are in NAD 83)	Aquatic and Wildlife		Human Health				Agricultural	
			A&Wc AZ	A&Ww AZ	FBC AZ	PBC AZ	DWS AZ	FC AZ	AgI AZ	AgL AZ
CG	Cottonwood Creek	Headwaters to confluence with unnamed tributary at 35°20'46"/113°35'31"	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
CG	Cottonwood Creek	Below confluence with unnamed tributary to confluence with Truxton Wash		A&Ww AZ	FBC AZ			FC AZ		AgL AZ
CG	Wright Canyon Creek	Headwaters to confluence with unnamed tributary at 35°20'48"/113°30'40"	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
CG	Wright Canyon Creek	Below confluence with unnamed tributary to confluence with Truxton Wash		A&Ww AZ	FBC AZ			FC AZ		AgL AZ
LC	Boot Lake	34°58'54"/111°20'11"	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
LC	Little Ortega Lake	34°22'47"/109°40'06"	A&Wc AZ		FBC AZ			FC AZ		
LC	Mormon Lake	34°56'38"/111°27'25"	A&Wc AZ		FBC AZ		DWS AZ	FC AZ	AgI AZ	AgL AZ
LC	Potato Lake	35°03'15"/111°24'13"	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
LC	Pratt Lake	34°01'32"/109°04'18"	A&Wc AZ		FBC AZ			FC AZ		
LC	Sponseller Lake	34°14'09"/109°50'45"	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
LC	Vail Lake	35°05'23"/111°30'46"	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
LC	Water Canyon Reservoir	34°03'38"/109°26'20		A&Ww AZ	FBC AZ			FC AZ	AgI AZ	AgL AZ
MG	Bonsall Park Lake	59th Avenue & Bethany Home Road at 33°31'24"/ 112°11'08"		A&Ww AZ		PBC AZ		FC AZ		
MG	Canal Park Lake	College Avenue & Curry Road, Tempe at 33°26'54"/ 111°56'19"		A&Ww AZ		PBC AZ		FC AZ		
SP	Big Creek	Headwaters to confluence with Pitchfork Canyon Wash	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
SP	Goudy Canyon Wash	Headwaters to confluence with Grant Creek	A&Wc AZ		FBC AZ			FC AZ		
SP	Grant Creek	Headwaters to confluence with unnamed tributary at 32°38'10"/109°56'37"		A&Ww AZ	FBC AZ		DWS AZ	FC AZ		
SP	Grant Creek	Below confluence with unnamed tributary to terminus near Willcox Playa		A&Ww AZ	FBC AZ			FC AZ		
SP	High Creek	Headwaters to confluence with unnamed tributary at 32°33'08"/110°14'42"	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
SP	High Creek	Below confluence with unnamed tributary to terminus near Willcox Playa	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
SP	Pinery Creek	Headwaters to State Highway 181	A&Wc AZ		FBC AZ		DWS AZ	FC AZ		AgL AZ
SP	Pinery Creek	Below State Highway 181 to terminus near Willcox Playa		A&Ww AZ	FBC AZ		DWS AZ	FC AZ		AgL AZ
SP	Post Creek	Headwaters to confluence with Grant Creek	A&Wc AZ		FBC AZ			FC AZ	AgI AZ	AgL AZ
SP	Riggs Flat Lake	32°42'28"/109°57'53"	A&Wc AZ		FBC AZ			FC AZ	AgI AZ	AgL AZ
SP	Rock Creek	Headwaters to confluence with Turkey Creek			FBC AZ			FC AZ		AgL AZ
SP	Soldier Creek	Headwaters to confluence with Post Creek at 32°40'50"/ 109°54'41"	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
SP	Snow Flat Lake	32°39'10"/109°51'54"	A&Wc AZ		FBC AZ			FC AZ	AgI AZ	AgL AZ
SP	Stronghold Canyon East	Headwaters to 31°55'9.28"/109°57'53.24"	A&Wc AZ			PBC AZ				
SP	Stronghold Canyon East	31°55'9.28"/109°57'53.24" to confluence with Carlink Canyon		A&Ww AZ		PBC AZ				
SP	Turkey Creek	Headwaters to confluence with Rock Creek	A&Wc AZ		FBC AZ			FC AZ	AgI AZ	AgL AZ
SP	Turkey Creek	Below confluence with Rock Creek to terminus near Willcox Playa		A&Ww AZ	FBC AZ			FC AZ	AgI AZ	AgL AZ
UG	Ward Canyon	Headwaters to confluence with Turkey Creek	A&Wc AZ		FBC AZ			FC AZ		AgL AZ
VR	Moonshine Creek	Headwaters to confluence with Post Creek	A&Wc AZ		FBC AZ			FC AZ		AgL AZ

Historical Note

Table A made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table B. WOTUS Protected Surface Waters

The waters listed in this table have been tentatively identified by ADEQ as WOTUS, under the law governing on 8/26/2022. Notwithstanding its inclusion on the list below, the status of a particular water in this table can be contested by a person in an enforcement or permit proceeding, a challenge to an identification as an impaired water, or a challenge to a proposed TMDL for an impaired water. Any changes to Table B will be made through formal rulemaking.

The waters on this list have their designated uses assigned by Title 18, Chapter 11, Article 1. Coordinates are from the North American Datum of 1983 (NAD83). All latitudes in Arizona are north and all longitudes are west, but the negative signs are not included in the WOTUS Protected Surface Waters Table. Some web-based mapping systems require a negative sign before the longitude values to indicate it is a west longitude.

Watersheds:

BW = Bill Williams
CG = Colorado – Grand Canyon
CL = Colorado – Lower Gila
LC = Little Colorado
MG = Middle Gila
SC = Santa Cruz – Rio Magdelena – Rio Sonoyta
SP = San Pedro – Willcox Playa – Rio Yaqui
SR = Salt River
UG = Upper Gila
VR = Verde River

Other Abbreviations:

WWTP = Wastewater Treatment Plant
Km = kilometers

Watershed	Surface Water	Segment Description and Location (Latitude and Longitudes are in NAD 83)
BW	Big Sandy River	Headwaters to Alamo Lake
BW	Boulder Creek	Below confluence with unnamed tributary to confluence with Burro Creek
BW	Burro Creek	Below confluence with Boulder Creek to confluence with Big Sandy River
BW	Burro Creek (OAW)	Headwaters to confluence with Boulder Creek
BW	Francis Creek (OAW)	Headwaters to confluence with Burro Creek
BW	Kirkland Creek	Headwaters to confluence with Santa Maria River
BW	Trout Creek	Below confluence with unnamed tributary to confluence with Knight Creek
CG	Beaver Dam Wash	Headwaters to confluence with the Virgin River
CG	Bright Angel Creek	Headwaters to confluence with Roaring Springs Creek
CG	Bright Angel Creek	Below Roaring Spring Springs Creek to confluence with Colorado River
CG	Colorado River	Lake Powell to Lake Mead
CG	Crystal Creek	Below confluence with unnamed tributary to confluence with Colorado River
CG	Deer Creek	Below confluence with unnamed tributary to confluence with Colorado River
CG	Garden Creek	Headwaters to confluence with Pipe Creek
CG	Havasu Creek	From the Havasupai Indian Reservation boundary to confluence with the Colorado River
CG	Hermit Creek	Below Hermit Pack Trail crossing to confluence with the Colorado River
CG	Kanab Creek	Headwaters to confluence with the Colorado River
CG	Lake Mead	36°06'18"/114°26'33"
CG	Lake Powell	36°59'53"/111°08'17"
CG	Nankoweap Creek	Below confluence with unnamed tributary to confluence with Colorado River
CG	Paria River	Utah border to confluence with the Colorado River
CG	Phantom Creek	Below confluence with unnamed tributary to confluence with Bright Angel Creek
CG	Pipe Creek	Headwaters to confluence with the Colorado River
CG	Shinumo Creek	Below confluence with unnamed tributary to confluence with the Colorado River
CG	Short Creek	Headwaters to confluence with Fort Pearce Wash
CG	Tapeats Creek	Headwaters to confluence with the Colorado River
CG	Thunder River	Headwaters to confluence with Tapeats Creek
CG	Vasey's Paradise	A spring at 36°29'52"/111°51'26"
CG	Virgin River	Headwaters to confluence with the Colorado River
CG	White Creek	Headwaters to confluence with unnamed tributary at 36°18'45"/112°21'03"
CG	White Creek	Below confluence with unnamed tributary to confluence with the Colorado River
CL	A10 Backwater	33°31'45"/114°33'19"
CL	A7 Backwater	33°34'27"/114°32'04"
CL	Adobe Lake	33°02'36"/114°39'26"
CL	Cibola Lake	33°14'01"/114°40'31"
CL	Clear Lake	33°01'59"/114°31'19"
CL	Colorado River	Lake Mead to Topock Marsh
CL	Colorado River	Topock Marsh to Morelos Dam
CL	Gila River	Painted Rock Dam to confluence with the Colorado River
CL	Hunter's Hole Backwater	32°31'13"/114°48'07"
CL	Imperial Reservoir	32°53'02"/114°27'54"
CL	Island Lake	33°01'44"/114°36'42"
CL	Laguna Reservoir	32°51'35"/114°28'29"
CL	Lake Havasu	34°35'18"/114°25'47"
CL	Lake Mohave	35°26'58"/114°38'30"
CL	Martinez Lake	32°58'49"/114°28'09"
CL	Mittry Lake	32°49'17"/114°27'54"
CL	Nortons Lake	33°02'30"/114°37'59"
CL	Pretty Water Lake	33°19'51"/114°42'19"

CL	Topock Marsh	34°43'27"/114°28'59"
LC	Auger Creek	Headwaters to confluence with Nutrioso Creek
LC	Chevelon Canyon	Headwaters to confluence with the Little Colorado River
LC	Chevelon Canyon Lake	34°29'18"/110°49'30"
LC	Clear Creek	Headwaters to confluence with the Little Colorado River
LC	Clear Creek Reservoir	34°57'09"/110°39'14"
LC	Colter Creek	Headwaters to confluence with Nutrioso Creek
LC	Colter Reservoir	33°56'39"/109°28'53"
LC	Coyote Creek	Headwaters to confluence with the Little Colorado River
LC	Cragin Reservoir (formerly Blue Ridge Reservoir)	34°32'40"/111°11'33"
LC	East Clear Creek	Headwaters to confluence with Clear Creek
LC	Ellis Wiltbank Reservoir	34°05'25"/109°28'25"
LC	Fool's Hollow Lake	34°16'30"/110°03'43"
LC	Lee Valley Creek	From Lee Valley Reservoir to confluence with the East Fork of the Little Colorado River
LC	Lily Creek	Headwaters to confluence with Coyote Creek
LC	Little Colorado River	Headwaters to Lyman Reservoir
LC	Little Colorado River	Below Lyman Reservoir to confluence with the Puerco River
LC	Little Colorado River	Below Puerco River confluence to the Colorado River, excluding segments on Native American Lands
LC	Little Colorado River, East Fork	Headwaters to confluence with the Little Colorado River
LC	Little Colorado River, South Fork	Headwaters to confluence with the Little Colorado River
LC	Little Colorado River, West Fork	Below Government Springs to confluence with the Little Colorado River
LC	Lyman Reservoir	34°21'21"/109°21'35"
LC	Mamie Creek	Headwaters to confluence with Coyote Creek
LC	Morrison Creek	Headwaters to Mamie Creek @ 33°59'24.45"/109°03'51.94
LC	Nutrioso Creek	Headwaters to confluence with the Little Colorado River
LC	Porter Creek	Headwaters to confluence with Show Low Creek
LC	Riggs Creek	Headwaters to Nutrioso Creek
LC	Rio de Flag	Headwaters to City of Flagstaff WWTP outfall at 35°12'21"/111°39'17"
LC	Rudd Creek	Headwaters to confluence with Nutrioso Creek
LC	Rosey Creek	Headwaters to 34°02'28.72"/109°27'24.3"
LC	Scott Reservoir	34°10'31"/109°57'31"
LC	Show Low Creek	Headwaters to confluence with Silver Creek
LC	Show Low Lake	34°11'36"/110°00'12"
LC	Silver Creek	Headwaters to confluence with the Little Colorado River
LC	White Mountain Lake	34°21'57"/109°59'21"
LC	Willow Creek	Headwaters to confluence with Clear Creek
LC	Zuni River	Headwaters to confluence with the Little Colorado River
MG	Agua Fria River	From State Route 169 to Lake Pleasant
MG	Ash Creek	Headwaters to confluence with Tex Canyon
MG	East Maricopa Floodway	From Brown and Greenfield Rds to the Gila River Indian Reservation Boundary
MG	Fain Lake	Town of Prescott Valley Park Lake 34°34'29"/ 112°21'06"
MG	Gila River	San Carlos Indian Reservation boundary to the Ashurst-Hayden Dam
MG	Gila River (EDW)	From the confluence with the Salt River to Gillespie Dam
MG	Hassayampa Lake	34°25'45"/112°25'33"
MG	Hassayampa River	Below unnamed tributary to the Buckeye Irrigation Company Canal
MG	Hassayampa River	Headwaters to confluence with unnamed tributary at 34°26'09"/112°30'32"
MG	Lake Pleasant	33°53'46"/112°16'29"
MG	Little Ash Creek	Headwaters to confluence with Ash Creek at 34°20'45.74"/112°4'17.26"
MG	Little Sycamore Creek	Headwaters to Sycamore Creek @ 34°21'39.13"/111°58'49.98”
MG	Mineral Creek (diversion tunnel and lined channel)	33°12'24"/110°59'58" to 33°07'56"/110°58'34"
MG	Papago Park South Pond	Curry Road, Tempe 33°26'22"/111°55'55"
MG	Salt River	Verde River to 2 km below Granite Reef Dam
MG	Seven Springs Wash	Headwaters to Unnamed trib @ 33°57'58.66"/111°51'52.07"
MG	Tempe Town Lake	At Mill Avenue Bridge at 33°26'00"/111°56'26"
MG	Turkey Creek	Headwaters to confluence with unnamed tributary at 34°19'28"/112°21'33"
SC	Alum Gulch	Below 31°29'17"/110°44'25" to confluence with Sonoita Creek
SC	California Gulch	Headwaters To U.S./Mexico border
SC	Cienega Creek (OAW)	From confluence with Gardner Canyon to USGS gaging station (#09484600)
SC	Cox Gulch	Headwaters to Three R Canyon @ 31°28'28.03"/110°47'14.65"
SC	Holden Canyon Creek	Headwaters to U.S./Mexico border
SC	Julian Wash	Headwaters to confluence with the Santa Cruz River
SC	Nogales Wash	Headwaters to confluence with Potrero Creek
SC	Parker Canyon Creek	Below unnamed tributary to U.S./Mexico border
SC	Rillito Creek	Headwaters to confluence with the Santa Cruz River
SC	Romero Canyon Creek	Below unnamed tributary to confluence with Sutherland Wash
SC	Santa Cruz River	Headwaters to the at U.S./Mexico border
SC	Santa Cruz River	U.S./Mexico border to the Nogales International WWTP outfall at 31°27'25"/110°58'04"
SC	Santa Cruz River	Tubac Bridge to Agua Nueva WRF outfall at 32°17'04"/111°01'45"
SC	Santa Cruz River (EDW)	Agua Nueva WRF outfall to Baumgartner Road
SC	Sonoita Creek	Headwaters to the Town of Patagonia WWTP outfall at 31°32'25"/110°45'31"
SC	Sonoita Creek (EDW)	Town of Patagonia WWTP outfall to permanent groundwater upwelling point approximately 1600 feet downstream of outfall
SC	Sycamore Canyon	Headwaters to the U.S./Mexico border
SP	Aravaipa Creek	Below downstream boundary of Aravaipa Canyon Wilderness Area to confluence with the San Pedro River
SP	Aravaipa Creek (OAW)	Stowe Gulch to downstream boundary of Aravaipa Canyon Wilderness Area
SP	Bass Canyon Creek	Below confluence with unnamed tributary to confluence with Hot Springs Canyon Creek
SP	Bear Creek	Headwaters to U.S./Mexico border
SP	Black Draw	Headwaters to the U.S./Mexico border
SP	Carr Canyon Creek	Headwaters to confluence with unnamed tributary at 31°27'01"/110°15'48"
SP	Gold Gulch	Headwaters to U.S./Mexico border
SP	Ramsey Canyon Creek	Below Forest Service Road #110 to confluence with Carr Wash

SP	San Pedro River	U.S./ Mexico Border to Buehman Canyon
SP	San Pedro River	From Buehman canyon to confluence with the Gila River
SP	Whitewater Draw	Headwaters to confluence with unnamed tributary at 31°20'36"/109°43'48"
SP	Whitewater Draw	Below confluence with unnamed tributary to U.S./ Mexico border
SR	Ackre Lake	33°37'01"/109°20'40"
SR	Apache Lake	33°37'23"/111°12'26"
SR	Bear Wallow Creek (OAW)	Headwaters to confluence with the Black River
SR	Beaver Creek	Headwaters to confluence with Black River
SR	Black River	Headwaters to confluence with Salt River
SR	Black River, East Fork	From 33°51'19"/109°18'54" to confluence with the Black River
SR	Black River, North Fork of East Fork	Headwaters to confluence with Boneyard Creek
SR	Black River, West Fork	Headwaters to confluence with the Black River
SR	Boggy Creek	Headwaters to confluence with Centerfire Creek
SR	Boneyard Creek	Headwaters to confluence with Black River, East Fork
SR	Canyon Lake	33°32'44"/111°26'19"
SR	Cherry Creek	Below unnamed tributary to confluence with the Salt River
SR	Conklin Creek	Headwaters to confluence with the Black River
SR	Corduroy Creek	Headwaters to confluence with Fish Creek
SR	Devils Chasm Creek	Below confluence with unnamed tributary to confluence with Cherry Creek
SR	Dipping Vat Reservoir	33°55'47"/109°25'31"
SR	Fish Creek	Headwaters to confluence with the Black River
SR	Haigler Creek	Headwaters to confluence with unnamed tributary at 34°12'23"/111°00'15"
SR	Haigler Creek	Below confluence with unnamed tributary to confluence with Tonto Creek
SR	Hannagan Creek	Headwaters to confluence with Beaver Creek
SR	Hay Creek (OAW)	Headwaters to confluence with the Black River, West Fork
SR	Horton Creek	Headwaters to confluence with Tonto Creek
SR	P B Creek	Below Forest Service Road #203 to Cherry Creek
SR	Pinal Creek	From Lower Pinal Creek WTP outfall # to See Ranch Crossing at 33°32'25"/110°52'28"
SR	Pinal Creek	From unnamed tributary to confluence with Salt River
SR	Pinto Creek	Headwaters to confluence with unnamed tributary at 33°19'27"/110°54'58"
SR	Roosevelt Lake	33°52'17"/111°00'17"
SR	Rye Creek	Headwaters to confluence with Tonto Creek
SR	Saguaro Lake	33°33'44"/111°30'55"
SR	Salt River	White Mountain Apache Reservation Boundary at 33°48'52"/110°31'33" to Roosevelt Lake
SR	Salt River	Theodore Roosevelt Dam to 2 km below Granite Reef Dam
SR	Thompson Creek	Headwaters to confluence with the West Fork of the Black River
SR	Tonto Creek	Headwaters to confluence with unnamed tributary at 34°18'11"/111°04'18"
SR	Tonto Creek	Below confluence with unnamed tributary to Roosevelt Lake
SR	Willow Creek	Headwaters to confluence with Beaver Creek
SR	Workman Creek	Below confluence with Reynolds Creek to confluence with Salome Creek
UG	Apache Creek	Headwaters to confluence with the Gila River
UG	Bitter Creek	Headwaters to confluence with the Gila River
UG	Blue River	Headwaters to confluence with Strayhorse Creek at 33°29'02"/109°12'14"
UG	Blue River	Below confluence with Strayhorse Creek to confluence with San Francisco River
UG	Bob Thomas Creek	Headwaters to Stone Creek 33°51'93"/109°42'52"
UG	Bonita Creek (OAW)	San Carlos Indian Reservation boundary to confluence with the Gila River
UG	Campbell Blue Creek	Headwaters to confluence with the Blue River
UG	Cave Creek (OAW)	Headwaters to confluence with South Fork Cave Creek
UG	Cave Creek (OAW)	Below confluence with South Fork Cave Creek to Coronado National Forest boundary
UG	Cave Creek, South Fork	Headwaters to confluence with Cave Creek
UG	Deadman Canyon Creek	Headwaters to confluence with unnamed tributary at 32°43'50"/109°49'03"
UG	Eagle Creek	Below confluence with unnamed tributary to confluence with the Gila River
UG	Gila River	New Mexico border to the San Carlos Indian Reservation boundary
UG	Grant Creek	Headwaters to confluence with the Blue River
UG	Judd Lake	33°51'15"/109°09'35"
UG	K P Creek (OAW)	Headwaters to confluence with the Blue River
UG	Little Blue Creek	Below confluence with Dutch Blue Creek to confluence with Blue Creek
UG	Luna Lake	33°49'50"/109°05'06"
UG	North Fork Cave Creek	Headwaters to Cave Creek @ 31°52'56.63"/109°12'19.75"
UG	Raspberry Creek	Headwaters to confluence with the Blue River
UG	San Francisco River	Headwaters to the New Mexico border
UG	San Francisco River	New Mexico border to confluence with the Gila River
UG	San Simon River	Headwaters to confluence with the Gila River
UG	Stone Creek	Headwaters to confluence with the San Francisco River
UG	Thomas Creek	Below confluence with Rousensock Creek to confluence with Blue River
UG	Turkey Creek	Headwaters to confluence with Campbell Blue Creek
VR	Bartlett Lake	33°49'52"/111°37'44"
VR	Beaver Creek	Headwaters to confluence with the Verde River
VR	Bitter Creek	Headwaters to the Jerome WWTP outfall at 34°45'12"/112°06'24"
VR	Bitter Creek	Below the Yavapai Apache Indian Reservation boundary to confluence with the Verde River
VR	Dead Horse Lake	34°45'08"/112°00'42"
VR	East Verde River	Headwaters to confluence with Ellison Creek
VR	East Verde River	Below confluence with Ellison Creek to confluence with the Verde River
VR	Fossil Creek (OAW)	Headwaters to confluence with the Verde River
VR	Fossil Springs (OAW)	34°25'24"/111°34'27"
VR	Horseshoe Reservoir	34°00'25"/111°43'36"
VR	Oak Creek (OAW)	Headwaters to confluence with unnamed tributary at 34°59'15"/111°44'47"
VR	Oak Creek (OAW)	Below confluence with unnamed tributary to confluence with Verde River
VR	Spring Creek	Below confluence with unnamed tributary to confluence with Oak Creek
VR	Sullivan Lake	34°51'42"/112°27'51"

VR	Sycamore Creek	Headwaters to confluence with unnamed tributary at 35°03'41"/111°57'31"
VR	Sycamore Creek	Headwaters to confluence with Verde River at 33°37'55"/111°39'58"
VR	Verde River	From headwaters at confluence of Chino Wash and Granite Creek to Bartlett Lake Dam
VR	Verde River	Below Bartlett Lake Dam to Salt River
VR	West Clear Creek	Headwaters to confluence with Meadow Canyon
VR	West Clear Creek	Below confluence with Meadow Canyon to confluence with the Verde River
VR	Wet Beaver Creek	Below unnamed springs to confluence with Dry Beaver Creek
VR	Willow Creek Reservoir	34°36'17"/112°26'19"

Historical Note

Table B made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Table C. Historically Regulated as WOTUS and in Need of Confirmation

The waters listed in this table have historically been and will continue to be regulated as WOTUS unless ADEQ makes a determination that they are non-WOTUS. Notwithstanding its inclusion on the list below, the status of a particular water in this table can be contested by a person in an enforcement or permit proceeding, a challenge to an identification as an impaired water, or a challenge to a proposed TMDL for an impaired water. Any changes to Table C will be made through formal rulemaking.

The waters on this list have their designated uses assigned by Title 18, Chapter 11, Article 1. Coordinates are from the North American Datum of 1983 (NAD83). All latitudes in Arizona are north and all longitudes are west, but the negative signs are not included in the Historically Regulated as WOTUS and in Need of Confirmation Table. Some web-based mapping systems require a negative sign before the longitude values to indicate it is a west longitude.

Watersheds:

BW = Bill Williams
CG = Colorado – Grand Canyon
CL = Colorado – Lower Gila
LC = Little Colorado
MG = Middle Gila
SC = Santa Cruz – Rio Magdelena – Rio Sonoyta
SP = San Pedro – Willcox Playa – Rio Yaqui
SR = Salt River
UG = Upper Gila
VR = Verde River

Other Abbreviations:

WWTP = Wastewater Treatment Plant
Km = kilometers

Watershed	Surface Water	Segment Description and Location (Latitude and Longitudes are in NAD 83)
BW	Alamo Lake	34°14'06"/113°35'00"
BW	Bill Williams River	Alamo Lake to confluence with Colorado River
BW	Blue Tank	34°40'14"/112°58'17"
BW	Boulder Creek	Headwaters to confluence with unnamed tributary at 34°41'13"/113°03'37"
BW	Burro Creek	Below confluence with Boulder Creek to confluence with Big Sandy River
BW	Burro Creek (OAW)	Headwaters to confluence with Boulder Creek
BW	Carter Tank	34°52'27"/112°57'31"
BW	Conger Creek	Headwaters to confluence with unnamed tributary at 34°45'15"/113°05'46"
BW	Conger Creek	Below confluence with unnamed tributary to confluence with Burro Creek
BW	Copper Basin Wash	Headwaters to confluence with unnamed tributary at 34°28'12"/112°35'33"
BW	Copper Basin Wash	Below confluence with unnamed tributary to confluence with Skull Valley Wash
BW	Cottonwood Canyon	Headwaters to Bear Trap Spring
BW	Cottonwood Canyon	Below Bear Trap Spring to confluence at Sycamore Creek
BW	Date Creek	Headwaters to confluence with Santa Maria River
BW	Knight Creek	Headwaters to confluence with Big Sandy River
BW	Peoples Canyon (OAW)	Headwaters to confluence with Santa Maria River
BW	Red Lake	35°12'18"/113°03'57"
BW	Santa Maria River	Headwaters to Alamo Lake
BW	Trout Creek	Headwaters to confluence with unnamed tributary at 35°06'47"/113°13'01"
CG	Agate Canyon	Headwaters to confluence with the Colorado River
CG	Big Springs Tank	36°36'08"/112°21'01"
CG	Boucher Creek	Headwaters to confluence with the Colorado River
CG	Bright Angel Wash	Headwaters to Grand Canyon National Park South Rim WWTP outfall at 36°02'59"/112°09'02"
CG	Bright Angel Wash (EDW)	Grand Canyon National Park South Rim WWTP outfall to Coconino Wash
CG	Bulrush Canyon Wash	Headwaters to confluence with Kanab Creek
CG	Cataract Creek	Headwaters to Santa Fe Reservoir
CG	Cataract Creek	Santa Fe Reservoir to City of Williams WWTP outfall at 35°14'40"/112°11'18"
CG	Cataract Creek	Red Lake Wash to Havasupai Indian Reservation boundary
CG	Cataract Creek (EDW)	City of Williams WWTP outfall to 1 km downstream
CG	Cataract Lake	35°15'04"/112°12'58"
CG	Chuar Creek	Headwaters to confluence with unnamed tributary at 36°11'35"/111°52'20"
CG	Chuar Creek	Below unnamed tributary to confluence with the Colorado River
CG	City Reservoir	35°13'57"/112°11'25"
CG	Clear Creek	Headwaters to confluence with unnamed tributary at 36°07'33"/112°00'03"
CG	Clear Creek	Below confluence with unnamed tributary to confluence with Colorado River
CG	Coconino Wash (EDW)	South Grand Canyon Sanitary District Tusayan WRF outfall at 35°58'39"/112°08'25" to 1 km downstream
CG	Crystal Creek	Headwaters to confluence with unnamed tributary at 36°13'41"/112°11'49"
CG	Deer Creek	Headwaters to confluence with unnamed tributary at 36°26'15"/112°28'20"
CG	Detrital Wash	Headwaters to Lake Mead
CG	Dogtown Reservoir	35°12'40"/112°07'54"
CG	Dragon Creek	Headwaters to confluence with Milk Creek
CG	Dragon Creek	Below confluence with Milk Creek to confluence with Crystal Creek
CG	Gonzalez Lake	35°15'26"/112°12'09"
CG	Grand Wash	Headwaters to Colorado River
CG	Grapevine Creek	Headwaters to confluence with the Colorado River
CG	Grapevine Wash	Headwaters to Colorado River
CG	Hakatai Canyon	Headwaters to confluence with the Colorado River
CG	Hance Creek	Headwaters to confluence with the Colorado River
CG	Hermit Creek	Headwaters to Hermit Pack Trail crossing at 36°03'38"/112°14'00"
CG	Horn Creek	Headwaters to confluence with the Colorado River

CG	Hualapai Wash	Headwaters to Lake Mead
CG	Jacob Lake	36°42'27"/112°13'50"
CG	Kaibab Lake	35°17'04"/112°09'32"
CG	Kwagunt Creek	Headwaters to confluence with unnamed tributary at 36°13'37"/111°54'50"
CG	Kwagunt Creek	Below confluence with unnamed tributary to confluence with the Colorado River
CG	Lonetree Canyon Creek	Headwaters to confluence with the Colorado River
CG	Matkatamiba Creek	Below Havasupai Indian Reservation boundary to confluence with the Colorado River
CG	Monument Creek	Headwaters to confluence with the Colorado River
CG	Nankoweap Creek	Below confluence with unnamed tributary to confluence with Colorado River
CG	National Canyon Creek	Headwaters to Hualapai Indian Reservation boundary at 36°15'15"/112°52'34"
CG	North Canyon Creek	Headwaters to confluence with unnamed tributary at 36°33'58"/111°55'41"
CG	North Canyon Creek	Below confluence with unnamed tributary to confluence with Colorado River
CG	Olo Canyon	Headwaters to confluence with the Colorado River
CG	Parashant Canyon	Headwaters to confluence with unnamed tributary at 36°21'02"/113°27'56"
CG	Parashant Canyon	Below confluence with unnamed tributary to confluence with the Colorado River
CG	Phantom Creek	Headwaters to confluence with unnamed tributary at 36°09'29"/112°08'13"
CG	Red Canyon Creek	Headwaters to confluence with the Colorado River '
CG	Roaring Springs	36°11'45"/112°02'06"
CG	Roaring Springs Creek	Headwaters to confluence with Bright Angel Creek
CG	Royal Arch Creek	Headwaters to confluence with the Colorado River
CG	Ruby Canyon	Headwaters to confluence with the Colorado River
CG	Russell Tank	35°52'21"/111°52'45"
CG	Saddle Canyon Creek	Headwaters to confluence with unnamed tributary at 36°21'36"/112°22'43"
CG	Saddle Canyon Creek	Below confluence with unnamed tributary to confluence with Colorado River
CG	Santa Fe Reservoir	35°14'31"/112°11'10"
CG	Sapphire Canyon	Headwaters to confluence with the Colorado River
CG	Serpentine Canyon	Headwaters to confluence with the Colorado River
CG	Shinumo Creek	Headwaters to confluence with unnamed tributary at 36°18'18"/112°18'07"
CG	Slate Creek	Headwaters to confluence with the Colorado River
CG	Spring Canyon Creek	Headwaters to confluence with the Colorado River
CG	Trail Canyon Creek	Headwaters to confluence with the Colorado River
CG	Transept Canyon	Headwaters to Grand Canyon National Park North Rim WWTP outfall at 36°12'20"/112°03'35"
CG	Transept Canyon	From 1 km downstream of the Grand Canyon National Park North Rim WWTP outfall to confluence with Bright Angel Creek
CG	Transept Canyon (EDW)	Grand Canyon National Park North Rim WWTP outfall to 1 km downstream
CG	Travertine Canyon Creek	Headwaters to confluence with the Colorado River
CG	Turquoise Canyon	Headwaters to confluence with the Colorado River
CG	Unkar Creek	Below confluence with unnamed tributary at 36°07'54"/111°54'06" to confluence with Colorado River
CG	Unnamed Wash to Cedar Canyon (EDW)	Grand Canyon National Park Desert View WWTP outfall at 36°02'06"/111°49'13" to confluence with Cedar Canyon
CG	Unnamed Wash to Spring Valley Wash (EDW)	Valle Airpark WRF outfall at 35°38'34"/112°09'22" to confluence with Spring Valley Wash
CG	Vishnu Creek	Headwaters to confluence with the Colorado River
CG	Warm Springs Creek	Headwaters to confluence with the Colorado River
CG	West Cataract Creek	Headwaters to confluence with Cataract Creek
CL	Columbus Wash	Headwaters to confluence with the Gila River
CL	Holy Moses Wash	Headwaters to City of Kingman Downtown WWTP outfall at 35°10'33"/114°03'46"
CL	Holy Moses Wash	From 3 km downstream of City of Kingman Downtown WWTP outfall to confluence with Sawmill Wash
CL	Holy Moses Wash (EDW)	City of Kingman Downtown WWTP outfall to 3 km downstream
CL	Mohave Wash	Headwaters to Lower Colorado River
CL	Painted Rock (Borrow Pit) Lake	33°04'55"/113°01'17"
CL	Quigley Pond	32°43'40"/113°57'44"
CL	Redondo Lake	32°44'32"/114°29'03"
CL	Sacramento Wash	Headwaters to Topock Marsh
CL	Sawmill Canyon	Headwaters to abandoned gaging station at 35°09'45"/113°57'56"
CL	Sawmill Canyon	Below abandoned gaging station to confluence with Holy Moses Wash
CL	Tyson Wash (EDW)	Town of Quartzsite WWTP outfall at 33°42'39"/ 114°13'10" to 1 km downstream
CL	Wellton Canal	Wellton-Mohawk Irrigation District
CL	Yuma Area Canals	Above municipal water treatment plant intakes
CL	Yuma Area Canals	Below municipal water treatment plant intakes and all drains
LC	Als Lake	35°02'10"/111°25'17"
LC	Ashurst Lake	35°01'06"/111°24'18"
LC	Atcheson Reservoir	33°59'59"/109°20'43"
LC	Barbershop Canyon Creek	Headwaters to confluence with East Clear Creek
LC	Bear Canyon Creek	Headwaters to confluence with General Springs Canyon
LC	Bear Canyon Creek	Headwaters to confluence with Willow Creek
LC	Bear Canyon Lake	34°24'00"/111°00'06"
LC	Becker Lake	34°09'11"/109°18'23"
LC	Billy Creek	Headwaters to confluence with Show Low Creek
LC	Black Canyon	Headwaters to confluence with Chevelon Creek
LC	Bow and Arrow Wash	Headwaters to confluence with Rio de Flag
LC	Buck Springs Canyon Creek	Headwaters to confluence with Leonard Canyon Creek
LC	Bunch Reservoir	34°02'20"/109°26'48"
LC	Carnero Lake	34°06'57"/109°31'42"
LC	Chevelon Creek, West Fork	Headwaters to confluence with Chevelon Creek
LC	Chilson Tank	34°51'43"/111°22'54"
LC	Coconino Reservoir	35°00'05"/111°24'10"
LC	Colter Creek	Headwaters to confluence with Nutrioso Creek
LC	Concho Creek	Headwaters to confluence with Carrizo Wash
LC	Concho Lake	34°26'37"/109°37'40"
LC	Cow Lake	34°53'14"/111°18'51"
LC	Crisis Lake (Snake Tank #2)	34°47'51"/111°17'32"
LC	Dane Canyon Creek	Headwaters to confluence with Barbershop Canyon Creek

LC	Daves Tank	34°44'22"/111°17'15"
LC	Deep Lake	35°03'34"/111°25'00"
LC	Ducksnest Lake	34°59'14"/111°23'57"
LC	Estates at Pine Canyon lakes (EDW)	35°09'32"/111°38'26"
LC	Fish Creek	Headwaters to confluence with the Little Colorado River
LC	General Springs Canyon Creek	Headwaters to confluence with East Clear Creek
LC	Geneva Reservoir	34°01'45"/109°31'46"
LC	Hall Creek	Headwaters to confluence with the Little Colorado River
LC	Hart Canyon Creek	Headwaters to confluence with Willow Creek
LC	Hay Lake	34°00'11"/109°25'57"
LC	Hog Wallow Lake	33°58'57"/109°25'39"
LC	Horse Lake	35°03'55"/111°27'50"
LC	Hulsey Creek	Headwaters to confluence with Nutrioso Creek
LC	Hulsey Lake	33°55'58"/109°09'40"
LC	Humphrey Lake (EDW)	35°11'51"/111°35'19"
LC	Indian Lake	35°00'39"/111°22'41"
LC	Jacks Canyon	Headwaters to confluence with the Little Colorado River
LC	Jarvis Lake	33°58'59"/109°12'36"
LC	Kinnikinick Lake	34°53'53"/111°18'18"
LC	Knoll Lake	34°25'38"/111°05'13"
LC	Lake Mary, Lower	35°06'21"/111°34'38"
LC	Lake Mary, Upper	35°03'23"/111°28'34"
LC	Lake of the Woods	34°09'40"/109°58'47"
LC	Lee Valley Creek (OAW)	Headwaters to Lee Valley Reservoir
LC	Lee Valley Reservoir	33°56'29"/109°30'04"
LC	Leonard Canyon Creek	Headwaters to confluence with Clear Creek
LC	Leonard Canyon Creek, East Fork	Headwaters to confluence with Leonard Canyon Creek
LC	Leonard Canyon Creek, Middle Fork	Headwaters to confluence with Leonard Canyon, West Fork
LC	Leonard Canyon Creek, West Fork	Headwaters to confluence with Leonard Canyon, East Fork
LC	Leroux Wash, tributary to Little Colorado River	From City of Holbrook-Painted Mesa WRF outfall at 34° 54' 30", -110° 11' 36" to Little Colorado River. The outfall discharges into Leroux Wash. All reaches of the Little Colorado River between the outfall to the Colorado River are perennial or intermittent.
LC	Little Colorado River, West Fork (OAW)	Headwaters to Government Springs
LC	Little George Reservoir	34°00'37"/109°19'15"
LC	Little Mormon Lake	34°17'00"/109°58'06"
LC	Long Lake, Lower	34°47'16"/111°12'40"
LC	Long Lake, Upper	35°00'08"/111°21'23"
LC	Long Tom Tank	34°20'35"/110°49'22"
LC	Lower Walnut Canyon Lake (EDW)	35°12'04"/111°34'07"
LC	Marshall Lake	35°07'18"/111°32'07"
LC	McKay Reservoir	34°01'27"/109°13'48"
LC	Merritt Draw Creek	Headwaters to confluence with Barbershop Canyon Creek
LC	Mexican Hay Lake	34°01'58"/109°21'25"
LC	Milk Creek	Headwaters to confluence with Hulsey Creek
LC	Miller Canyon Creek	Headwaters to confluence with East Clear Creek
LC	Miller Canyon Creek, East Fork	Headwaters to confluence with Miller Canyon Creek
LC	Morton Lake	34°53'37"/111°17'41"
LC	Mud Lake	34°55'19"/111°21'29"
LC	Ned Lake (EDW)	34°17'17"/110°03'22"
LC	Norton Reservoir	34°03'57"/109°31'27"
LC	Paddy Creek	Headwaters to confluence with Nutrioso Creek
LC	Pierce Seep	34°23'39"/110°31'17"
LC	Pine Tank	34°46'49"/111°17'21"
LC	Pintail Lake (EDW)	34°18'05"/110°01'21"
LC	Puerco River	Headwaters to confluence with the Little Colorado River
LC	Puerco River (EDW)	Sanders Unified School District WWTP outfall at 35°12'52"/109°19'40" to 0.5 km downstream
LC	Rainbow Lake	34°09'00"/109°59'09"
LC	Reagan Reservoir	34°02'09"/109°08'41"
LC	Rio de Flag (EDW)	From City of Flagstaff WWTP outfall to the confluence with San Francisco Wash
LC	River Reservoir	34°02'01"/109°26'07"
LC	Rogers Reservoir	33°56'30"/109°16'20"
LC	Russel Reservoir	33°59'29"/109°20'01"
LC	San Salvador Reservoir	33°58'51"/109°19'55"
LC	Slade Reservoir	33°59'41"/109°20'26"
LC	Soldiers Annex Lake	34°47'15"/111°13'51"
LC	Soldiers Lake	34°47'47"/111°14'04"
LC	Spaulding Tank	34°30'17"/111°02'06"
LC	St Johns Reservoir (Little Reservoir)	34°29'10"/109°22'06"
LC	Telephone Lake (EDW)	34°17'35"/110°02'42"
LC	Tremaine Lake	34°46'02"/111°13'51"
LC	Tunnel Reservoir	34°01'53"/109°26'34"
LC	Turkey Draw (EDW)	High Country Pines II WWTP outfall at 33°25'35"/ 110°38'13" to confluence with Black Canyon Creek
LC	Unnamed Wash to Pierce Wash (EDW)	Bison Ranch WWTP outfall at 34°23'31"/110°31'29" to Pierce Seep
LC	Unnamed wash, tributary to Rio de Flag River (Bow and Arrow Wash)	Treated municipal wastewater is piped from the Rio de Flag WWTP through a city-wide reuse system to the main effluent storage pond that is in an unnamed wash.
LC	Walnut Creek	Headwaters to confluence with Billy Creek
LC	Water Canyon Creek	Headwaters to confluence with the Little Colorado River
LC	Whale Lake (EDW)	35°11'13"/111°35'21"
LC	Whipple Lake	34°16'49"/109°58'29"
LC	White Mountain Reservoir	34°00'12"/109°30'39"
LC	Willow Creek	Headwaters to confluence with Clear Creek
LC	Willow Springs Canyon Creek	Headwaters to confluence with Chevelon Creek

LC	Willow Springs Lake	34°18'13"/110°52'16"
LC	Woodland Reservoir	34°07'35"/109°57'01"
LC	Woods Canyon Creek	Headwaters to confluence with Chevelon Creek
LC	Woods Canyon Lake	34°20'09"/110°56'45"
MG	Agua Fria River	Headwaters to confluence with unnamed tributary at 34°35'14"/112°16'18"
MG	Agua Fria River	Below Lake Pleasant to the City of El Mirage WWTP at ' 33°34'20"/112°18'32"
MG	Agua Fria River	Below 2 km downstream of the City of El Mirage WWTP to City of Avondale WWTP outfall at 33°23'55"/112°21'16"
MG	Agua Fria River	From City of Avondale WWTP outfall to confluence with Gila River
MG	Agua Fria River (EDW)	Below confluence with unnamed tributary to State Route 169
MG	Agua Fria River (EDW)	From City of El Mirage WWTP outfall to 2 km downstream
MG	Andorra Wash	Headwaters to confluence with Cave Creek Wash
MG	Antelope Creek	Headwaters to confluence with Martinez Creek
MG	Arlington Canal	From Gila River at 33°20'54"/112°35'39" to Gila River at 33°13'44"/112°46'15"
MG	Arnett Creek	Headwaters to Queen Creek @ 33°16'43.24"/111°10'12.49"
MG	Ash Creek	Headwaters to confluence with Tex Canyon
MG	Beehive Tank	32°52'37"/111°02'20"
MG	Big Bug Creek	Headwaters to confluence with Eugene Gulch
MG	Big Bug Creek	Below confluence with Eugene Gulch to confluence with Agua Fria River
MG	Black Canyon Creek	Headwaters to confluence with the Agua Fria River
MG	Blind Indian Creek	Headwaters to confluence with the Hassayampa River
MG	Cash Gulch	Headwaters to Jersey Gulch @ 34°25'31.39"/112°25'30.96"
MG	Cave Creek	Headwaters to the Cave Creek Dam
MG	Cave Creek	Cave Creek Dam to the Arizona Canal
MG	Centennial Wash	Headwaters to confluence with the Gila River at 33°16'32"/112°48'08"
MG	Centennial Wash Ponds	33°54'52"/113°23'47"
MG	Chaparral Park Lake	Hayden Road & Chaparral Road, Scottsdale at 33°30'40"/111°54'27"
MG	Corgett Wash	From Corgett Wash WRF outfall at 33°21’42”, -112°27’05” to Gila River. The discharge point is 0.5 miles from the ephemeral conveyance Corgett Wash. The Gila River is then 1.5 miles downstream from Corgett Wash.
MG	Devils Canyon	Headwaters to confluence with Mineral Creek
MG	Eldorado Park Lake	Miller Road & Oak Street, Tempe at 33°28'25"/ 111°54'53"
MG	Eugene Gulch	Headwaters to Big Bug Creek @ 34°27'11.51"/112°18'30.95"
MG	French Gulch	Headwaters to confluence with Hassayampa River
MG	Galena Gulch	Headwaters to confluence with the Agua Fria River
MG	Galloway Wash (EDW)	Town of Cave Creek WWTP outfall at 33°50'15"/ 111°57'35" to confluence with Cave Creek
MG	Gila River	Ashurst-Hayden Dam to the Town of Florence WWTP outfall at 33°02'20"/111°24'19"
MG	Gila River	Felix Road to the Gila River Indian Reservation boundary
MG	Gila River	Gillespie Dam to confluence with Painted Rock Dam
MG	Gila River (EDW)	Town of Florence WWTP outfall to Felix Road
MG	Groom Creek	Headwaters to confluence with the Hassayampa River
MG	Hassayampa River	Below confluence with unnamed tributary to confluence with unnamed tributary at 33°51"52"/112°39'56".
MG	Hassayampa River	Below Buckeye Irrigation Company canal to the Gila River
MG	Hassayampa River	From City of Buckeye-Palo Verde Road WWTP outfall at 33° 23’ 54.3”, -112° 40’ 33.7” to Buckeye Canal
MG	Horsethief Lake	34°09'42"/112°17'57"
MG	Indian Bend Wash	Headwaters to confluence with the Salt River
MG	Indian Bend Wash Lakes	Scottsdale at 33°30'32"/111°54'24"
MG	Indian School Park Lake	Indian School Road & Hayden Road, Scottsdale at 33°29'39"/111°54'37"
MG	Jersey Gulch	Headwaters to Hassayampa River @ 34°25'40.16"/112°25'45.64"
MG	Kiwanis Park Lake	6000 South Mill Avenue, Tempe at 33°22'27"/111°56'22"
MG	Lake Pleasant, Lower	33°50'32"/112°16'03"
MG	Lion Canyon	Headwaters to confluence with Weaver Creek
MG	Lynx Creek	Headwaters to confluence with unnamed tributary at 34°34'29"/112°21'07"
MG	Lynx Creek	Below confluence with unnamed tributary at 34°34'29"/112°21'07" to confluence with Agua Fria River
MG	Lynx Lake	34°31'07"/112°23'07"
MG	Martinez Canyon	Headwaters to confluence with Box Canyon
MG	Martinez Creek	Headwaters to confluence with the Hassayampa River
MG	McKellips Park Lake	Miller Road & McKellips Road, Scottsdale at 33°27'14"/111°54'49"
MG	McMicken Wash (EDW)	City of Peoria Jomax WWTP outfall at 33°43'31"/ 112°20'15" to confluence with Agua Fria River
MG	Mineral Creek	Headwaters to 33°12'34"/110°59'58"
MG	Mineral Creek	End of diversion channel to confluence with Gila River
MG	Minnehaha Creek	Headwaters to confluence with the Hassayampa River
MG	Money Metals Trib	Headwaters to Unnamed Trib (UB1)
MG	New River	Headwaters to Interstate 17 at 33°54'19.5"/112°08'46"
MG	New River	Below Interstate 17 to confluence with Agua Fria River
MG	Painted Rock Reservoir	33°04'23"/113°00'38"
MG	Papago Park Ponds	Galvin Parkway, Phoenix at 33°27'15"/111°56'45"
MG	Perry Mesa Tank	34°11'03"/112°02'01"
MG	Phoenix Area Canals	Granite Reef Dam to all municipal WTP intakes
MG	Phoenix Area Canals	Below municipal WTP intakes and all other locations
MG	Picacho Reservoir	32°51'10"/111°28'25"
MG	Poland Creek	Headwaters to confluence with Lorena Gulch
MG	Poland Creek	Below confluence with Lorena Gulch to confluence with Black Canyon Creek
MG	Queen Creek	Headwaters to the Town of Superior WWTP outfall at 33°16’33”/111°07’44”
MG	Queen Creek	Below Potts Canyon to ' Whitlow Dam
MG	Queen Creek	Below Whitlow Dam to confluence with Gila River
MG	Queen Creek (EDW)	Below Town of Superior WWTP outfall to confluence with Potts Canyon
MG	Salt River	2 km below Granite Reef Dam to City of Mesa NW WRF outfall at 33°26'22"/111°53'14"
MG	Salt River	Below Tempe Town Lake to Interstate 10 bridge
MG	Salt River	Below Interstate 10 bridge to the City of Phoenix 23rd Avenue WWTP outfall at 33°24'44"/ 112°07'59"
MG	Salt River (EDW)	City of Mesa NW WRF outfall to Tempe Town Lake
MG	Salt River (EDW)	From City of Phoenix 23rd Avenue WWTP outfall to confluence with Gila River
MG	Siphon Draw (EDW)	Superstition Mountains CFD WWTP outfall at 33°21'40"/111°33'30" to 6 km downstream

MG	Sycamore Creek	Headwaters to confluence with Tank Canyon
MG	Sycamore Creek	Below confluence with Tank Canyon to confluence with Agua Fria River
MG	The Lake Tank	32°54'14"/111°04'15"
MG	Tule Creek	Headwaters to confluence with the Agua Fria River
MG	Turkey Creek	Below confluence with unnamed tributary to confluence with Poland Creek
MG	Unnamed Trib (UQ2) to Queen Creek	Headwaters to Queen Creek @ 33°18'26.15"/111°04'19.3"
MG	Unnamed Trib (UQ3) to Queen Creek	Headwaters to Queen Creek @ 33°18'33.75"/111°04'02.61"
MG	Unnamed Trib to Big Bug Creek (UB1)	Headwaters to Big Bug Creek @ 34°25'38.86"/112°22'29.32"
MG	Unnamed Trib to Eugene Gulch	Headwaters to Eugene Gulch @ 34°27'34.6"/112°20'24.53"
MG	Unnamed Trib to Lynx Creek	Headwaters to Superior Mining Div. Outfall @ Lynx Creek @ 34°27'10.57"/112°23'14.22"
MG	Unnamed tributary to Deadman's Wash	From EPCOR Water Anthem Water Campus WWTP outfall at 33° 50' 47.9", -112° 08' 25.6" to Deadman's Wash
MG	Unnamed tributary to Gila River (EDW)	Gila Bend WWTP outfall to confluence with the Gila River
MG	Unnamed tributary to Gila River (EDW)	North Florence WWTP outfall at 33°03'50"/ 111°23'13" to confluence with Gila River
MG	Unnamed tributary to the Agua Fria River	From Softwinds WWTP outfall at 34˚ 32’ 43”, -112˚ 14’ 21” to the Agua Fria River. Discharges to Agua Fria which is a jurisdictional tributary to Lake Pleasant (TNW)
MG	Unnamed tributary to Winters Wash	From Balterra WWTP outfall at 33? 29' 45", -112? 55' 10" to Winters Wash
MG	Unnamed Wash (EDW)	Luke Air Force Base WWTP outfall at 33°32'21"/112°19'15" to confluence with the Agua Fria River
MG	Unnamed Wash (EDW)	Town of Prescott Valley WWTP outfall at 34°35'16"/ 112°16'18" to confluence with the Agua Fria River
MG	Unnamed Wash (EDW)	Town of Cave Creek WRF outfall at 33°48'02"/ 111°59'22" to confluence with Cave Creek
MG	Unnamed wash, tributary to Black Canyon Creek	From Black Canyon Ranch RV Resort WWTP outfall to Agua Fria River.
MG	Unnamed wash, tributary to Queen Creek	Queen Creek, AZ15050100-013B is closest WBID to outfall coordinates
MG	Unnamed wash, tributary to Waterman Wash	The Rainbow Valley outfall discharges to an unnamed wash to Waterman wash to the Gila River.
MG	Wagner Wash (EDW)	City of Buckeye Festival Ranch WRF outfall at 33°39'14"/112°40'18" to 2 km downstream
MG	Walnut Canyon Creek	Headwaters to confluence with the Gila River
MG	Weaver Creek	Headwaters to confluence with Antelope Creek, tributary to Martinez Creek
MG	White Canyon	Headwaters to confluence with Walnut Canyon Creek
MG	Yavapai Lake (EDW)	Town of Prescott Valley WWTP outfall 002 at 34°36'07"/112°18'48" to Navajo Wash
SC	Agua Caliente Lake	12325 East Roger Road, Tucson 32°16'51"/ 110°43'52"
SC	Agua Caliente Wash	Headwaters to confluence with Soldier Trail
SC	Agua Caliente Wash	Below Soldier Trail to confluence with Tanque Verde Creek
SC	Aguirre Wash	From the Tohono O'odham Indian Reservation boundary to 32°28'38"/111°46'51"
SC	Alambre Wash	Headwaters to confluence with Brawley Wash
SC	Alamo Wash	Headwaters to confluence with Rillito Creek
SC	Altar Wash	Headwaters to confluence with Brawley Wash
SC	Alum Gulch	Headwaters to 31°28'20"/110°43'51"
SC	Alum Gulch	From 31°28'20"/110°43'51" to 31°29'17"/110°44'25"
SC	Arivaca Creek	Headwaters to confluence with Altar Wash
SC	Arivaca Lake	31°31'52"/111°15'06"
SC	Atterbury Wash	Headwaters to confluence with Pantano Wash
SC	Bear Grass Tank	31°33'01"/111°11'03"
SC	Big Wash	Headwaters to confluence with Cañada del Oro
SC	Black Wash (EDW)	Pima County WWMD Avra Valley WWTP outfall at 32°09'58"/111°11'17" to confluence with Brawley Wash
SC	Bog Hole Tank	31°28'36"/110°37'09"
SC	Brawley Wash	Headwaters to confluence with Los Robles Wash
SC	Cañada del Oro	Headwaters to State Route 77
SC	Cañada del Oro	Below State Route 77 to confluence with the Santa Cruz River
SC	Cienega Creek	Headwaters to confluence with Gardner Canyon
SC	Davidson Canyon	Headwaters to unnamed spring at 31°59'00"/ 110°38'49"
SC	Davidson Canyon (OAW)	From unnamed Spring to confluence with unnamed tributary at 31°59'09"/110°38'44"
SC	Davidson Canyon (OAW)	Below confluence with unnamed tributary to unnamed spring at 32°00'40"/110°38'36"
SC	Davidson Canyon (OAW)	From unnamed spring to confluence with Cienega Creek
SC	Empire Gulch	Headwaters to unnamed spring at 31°47'18"/ 110°38'17"
SC	Empire Gulch	From 31°47'18"/110°38'17" to 31°47'03"/110°37'35"
SC	Empire Gulch	From 31°47'03"/110°37'35" to 31°47'05"/ 110°36'58"
SC	Empire Gulch	From 31°47'05"/110°36'58" to confluence with Cienega Creek
SC	Flux Canyon	Headwaters to confluence with Alum Gulch
SC	Gardner Canyon Creek	Headwaters to confluence with Sawmill Canyon
SC	Gardner Canyon Creek	Below Sawmill Canyon to confluence with Cienega Creek
SC	Greene Wash	Santa Cruz River to the Tohono O'odham Indian Reservation boundary
SC	Greene Wash	Tohono O'odham Indian Reservation boundary to confluence with Santa Rosa Wash at 32°53'52"/ 111°56'48"
SC	Harshaw Creek	Headwaters to confluence with Sonoita Creek at
SC	Hit Tank	32°43'57"/111°03'18"
SC	Holden Canyon Creek	Headwaters to U.S./Mexico border
SC	Huachuca Tank	31°21'11"/110°30'18"
SC	Humboldt Canyon	Headwaters to Alum Gulch @ 31°28'25.84"/110°44'01.57"
SC	Julian Wash	Headwaters to confluence with the Santa Cruz River
SC	Kennedy Lake	Mission Road & Ajo Road, Tucson at 32°10'49"/ 111°00'27"
SC	Lakeside Lake	8300 East Stella Road, Tucson at 32°11'11"/ 110°49'00"
SC	Lemmon Canyon Creek	Headwaters to confluence with unnamed tributary at 32°23'48"/110°47'49"
SC	Lemmon Canyon Creek	Below unnamed tributary at 32°23'48"/110°47'49" to confluence with Sabino Canyon Creek
SC	Los Robles Wash	Headwaters to confluence with the Santa Cruz River
SC	Madera Canyon Creek	Headwaters to confluence with unnamed tributary at 31°43'42"/110°52'51"
SC	Madera Canyon Creek	Below unnamed tributary at 31°43'42"/110°52'51 to confluence with the Santa Cruz River
SC	Mattie Canyon	Headwaters to confluence with Cienega Creek
SC	Oak Tree Canyon	Headwaters to confluence with Cienega Creek
SC	Palisade Canyon	Headwaters to confluence with unnamed tributary at 32°22'33"/110°45'31"
SC	Palisade Canyon	Below 32°22'33"/110°45'31" to unnamed tributary of Sabino Canyon
SC	Pantano Wash	Headwaters to confluence with Tanque Verde Creek
SC	Parker Canyon Creek	Headwaters to confluence with unnamed tributary at 31°24'17"/110°28'47"
SC	Parker Canyon Lake	31°25'35"/110°27'15"
SC	Patagonia Lake	31°29'56"/110°50'49"

SC	Peña Blanca Lake	31°24'15"/111°05'12"
SC	Potrero Creek	Headwaters to Interstate 19
SC	Potrero Creek	Below Interstate 19 to confluence with Santa Cruz River
SC	Puertocito Wash	Headwaters to confluence with Altar Wash
SC	Quitobaquito Spring	(Pond and Springs) 31°56'39"/113°01'06"
SC	Redrock Canyon Creek	Headwaters to confluence with Harshaw Creek
SC	Rillito Creek	Headwaters to confluence with the Santa Cruz River
SC	Romero Canyon Creek	Headwaters to confluence with unnamed tributary at 32°24'29"/110°50'39"
SC	Rose Canyon Creek	Headwaters to confluence with Sycamore Canyon
SC	Rose Canyon Lake	32°23'13"/110°42'38"
SC	Ruby Lakes	31°26'29"/111°14'22"
SC	Sabino Creek	Headwaters to 32°23'20"/110°47'06"
SC	Sabino Creek	Below 32°23'20"/110°47'06" to confluence with Tanque Verde River
SC	Salero Ranch Tank	31°35'43"/110°53'25"
SC	Santa Cruz River	Headwaters to the at U.S./Mexico border
SC	Santa Cruz River	Baumgartner Road to the Ak Chin Indian Reservation boundary
SC	Santa Cruz River (EDW)	Nogales International WWTP outfall to the Tubac Bridge
SC	Santa Cruz River, West Branch	Headwaters to the confluence with Santa Cruz River
SC	Santa Cruz Wash, North Branch	Headwaters to City of Casa Grande WRF outfall at 32°54'57"/111°47'13"
SC	Santa Cruz Wash, North Branch (EDW)	City of Casa Grande WRF outfall to 1 km downstream
SC	Santa Rosa Wash	Below Tohono O'odham Indian Reservation to the Ak Chin Indian Reservation
SC	Santa Rosa Wash (EDW)	Palo Verde Utilities CO-WRF outfall at 33°04'20"/ 112°01'47" to the Chin Indian Reservation
SC	Soldier Tank	32°25'34"/110°44'43"
SC	Sonoita Creek	Headwaters to the Town of Patagonia WWTP outfall at 31°32'25"/110°45'31"
SC	Sonoita Creek	Below 1600 feet downstream of Town of Patagonia WWTP outfall groundwater upwelling point to confluence with the Santa Cruz River
SC	Split Tank	31°28'11"/111°05'12"
SC	Sutherland Wash	Headwaters to confluence with Cañada del Oro
SC	Sycamore Canyon	Headwaters to 32°21'60" / 110°44'48"
SC	Sycamore Canyon	From 32°21'60" / 110°44'48" to Sycamore Reservoir
SC	Sycamore Reservoir	32°20'57'/110°47'38"
SC	Tanque Verde Creek	Headwaters to Houghton Road
SC	Tanque Verde Creek	Below Houghton Road to confluence with Rillito Creek
SC	Three R Canyon	Headwaters to Unnamed Trib to Three R Canyon at 31°28'26"/110°46'04"
SC	Three R Canyon	From 31°28'26"/110°46'04" to 31°28'28"/110°47'15" (Cox Gulch)
SC	Three R Canyon	From (Cox Gulch) 31°28'28"/110°47'15" to confluence with Sonoita Creek
SC	Tinaja Wash	Headwaters to confluence with the Santa Cruz River
SC	Unnamed Trib (Endless Mine Tributary) to Harshaw Creek	Headwaters to Harshaw Creek @ 31°26'12.3"/110°43'27.26"
SC	Unnamed Trib (UA2) to Alum Gulch	Headwaters to Alum Gulch @ 31°28'49.67"/110°44'12.86"
SC	Unnamed Trib to Cox Gulch	Headwaters to Cox Gulch @ 31°27'53.86"/110°46'51.29"
SC	Unnamed Trib to Three R Canyon	Headwaters to Three R Canyon @ 31°28'25.82"/110°46'04.11"
SC	Unnamed Wash to Canada Del Oro (EDW)	Oracle Sanitary District WWTP outfall at 32°36'54"/ 110°48'02" to 5 km downstream
SC	Unnamed Wash to Canada del Oro (EDW)	Saddlebrook WWTP outfall at 32°32'00"/110°53'01" to confluence with Cañada del Oro
SC	Unnamed Wash to Santa Cruz Wash (EDW)	Arizona City Sanitary District WWTP outfall at 32°45'43"/111°44'24" to confluence with Santa Cruz Wash
SC	Vekol Wash	Headwater to Santa Cruz Wash: Those reaches not located on the Ak-Chin, Tohono O'odham and Gila River Indian Reservations
SC	Wakefield Canyon	Headwaters to confluence with unnamed tributary at 31°52'48"/110°26'27"
SC	Wakefield Canyon	Below confluence with unnamed tributary to confluence with Cienega Creek
SC	Wild Burro Canyon	Headwaters to confluence with unnamed tributary at 32°27'43"/111°05'47"
SC	Wild Burro Canyon	Below confluence with unnamed tributary to confluence with Santa Cruz River
SP	Abbot Canyon	Headwaters to confluence with Whitewater Draw
SP	Aravaipa Creek	Headwaters to confluence with Stowe Gulch
SP	Ash Creek	Headwaters to 31°50'28"/109°40'04"
SP	Babocomari River	Headwaters to confluence with the San Pedro River
SP	Bass Canyon Creek	Headwaters to confluence with unnamed tributary at 32°26'06"/110°13'22"
SP	Bass Canyon Tank	32°24'00"/110°13'00"
SP	Blacktail Pond	Fort Huachuca Military Reservation at 31°31'04"/110°24'47", headwater lake in Blacktail Canyon
SP	Booger Canyon	Headwaters to confluence with Aravaipa Creek
SP	Brewery Gulch	Headwaters to Mule Gulch @ 31°26'27.88"/109°54'48.1"
SP	Buck Canyon	Headwaters to confluence with Buck Creek Tank
SP	Buck Canyon	Below Buck Creek Tank to confluence with Dry Creek
SP	Buehman Canyon Creek	Below confluence with unnamed tributary to confluence with San Pedro River
SP	Buehman Canyon Creek (OAW)	Headwaters to confluence with unnamed tributary at 32°24'54"/110°32'10"
SP	Bullock Canyon	Headwaters to confluence with Buehman Canyon
SP	Carr Canyon Creek	Below confluence with unnamed tributary to confluence with the San Pedro River
SP	Copper Creek	Headwaters to confluence with Prospect Canyon
SP	Copper Creek	Below confluence with Prospect Canyon to confluence with the San Pedro River
SP	Curry Draw	Headwaters to San Pedro River
SP	Deer Creek	Headwaters to confluence with unnamed tributary at 32°59'57"/110°20'11"
SP	Deer Creek	Below confluence with unnamed tributary to confluence with Aravaipa Creek
SP	Dixie Canyon	Headwaters to confluence with Mexican Canyon
SP	Double R Canyon Creek	Headwaters to confluence with Bass Canyon
SP	Dry Canyon	Headwaters to confluence with Whitewater draw
SP	East Gravel Pit Pond	Fort Huachuca Military Reservation at 31°30'54"/ 110°19'44"
SP	Espiritu Canyon Creek	Headwaters to confluence with Soza Wash
SP	Fourmile Canyon Creek	Headwaters to confluence with Aravaipa Creek
SP	Fourmile Canyon, Left Prong	Headwaters to confluence with unnamed tributary at 32°43'15"/110°23'46"
SP	Fourmile Canyon, Left Prong	Below confluence with unnamed tributary to confluence with Fourmile Canyon Creek
SP	Fourmile Canyon, Right Prong	Headwaters to confluence with Fourmile Canyon
SP	Gadwell Canyon	Headwaters to confluence with Whitewater Draw
SP	Garden Canyon Creek	Headwaters to confluence with unnamed tributary at 31°29'01"/110°19'44"
SP	Garden Canyon Creek	Below confluence with unnamed tributary to confluence with the San Pedro River

SP	Glance Creek	Headwaters to confluence with Whitewater Draw
SP	Gravel Pit Pond	Fort Huachuca Military Reservation at 31°30'52"/ 110°19'49"
SP	Greenbush Draw	From U.S./Mexico border to confluence with San Pedro River
SP	Greenbush Draw	From City of Bisbee San Jose WWTP outfall at 31˚ 20' 35.4", -109˚ 56' 10.2" to San Pedro River. The City of Bisbee San Jose WWTP outfall discharges to Greenbush Draw.
SP	Hidden Pond	Fort Huachuca Military Reservation at 32°30'30"/ 109°22'17"
SP	Horse Camp Canyon	Headwaters to confluence with Aravaipa Creek
SP	Hot Springs Canyon	Headwaters to confluence with the San Pedro River
SP	Johnson Canyon	Headwaters to Whitewater Draw at 31°32'46"/ 109°43'32"
SP	Leslie Creek	Headwaters to confluence with Whitewater Draw
SP	Lower Garden Canyon Pond	Fort Huachuca Military Reservation at 31°29'39"/ 110°18'34"
SP	Mexican Canyon	Headwaters to confluence with Dixie Canyon
SP	Miller Canyon	Headwaters to Broken Arrow Ranch Road at 31°25'35"/110°15'04"
SP	Miller Canyon	Below Broken Arrow Ranch Road to confluence with the San Pedro River
SP	Montezuma Creek	Headwaters to Mexico Border @ 31°20'01.87"/110°13'40.97"
SP	Mountain View Golf Course Pond	Fort Huachuca Military Reservation at 31°32'14"/ 110°18'52"
SP	Mule Gulch	Headwaters to the Lavender Pit at 31°26'11"/ 109°54'02"
SP	Mule Gulch	The Lavender Pit to the' Highway 80 bridge at 31°26'30"/109°49'28"
SP	Mule Gulch	Below the Highway 80 bridge to confluence with Whitewater Draw
SP	Oak Grove Canyon	Headwaters to confluence with Turkey Creek
SP	Officers Club Pond	Fort Huachuca Military Reservation at 31°32'51"/ 110°21'37"
SP	Paige Canyon Creek	Headwaters to confluence with the San Pedro River
SP	Parsons Canyon	Headwaters to confluence with Aravaipa Creek
SP	Ramsey Canyon Creek	Headwaters to Forest Service Road #110 at 31°27'44"/110°17'30"
SP	Rattlesnake Creek	Headwaters to confluence with Brush Canyon
SP	Rattlesnake Creek	Below confluence with Brush Canyon to confluence with Aravaipa Creek
SP	Redfield Canyon	Headwaters to confluence with unnamed tributary at 32°33'40"/110°18'42"
SP	Redfield Canyon	Below confluence with unnamed tributary to confluence with the San Pedro River
SP	Rucker Canyon	Headwaters to confluence with Whitewater Draw
SP	Rucker Canyon Lake	31°46'46"/109°18'30"
SP	Soto Canyon	Headwaters to confluence with Dixie Canyon
SP	Swamp Springs Canyon Creek	Headwaters to confluence with Redfield Canyon
SP	Sycamore Pond I	Fort Huachuca Military Reservation at 31°35'12"/ 110°26'11"
SP	Sycamore Pond II	Fort Huachuca Military Reservation at 31°34'39"/ 110°26'10"
SP	Turkey Creek	Headwaters to confluence with Aravaipa Creek
SP	Unnamed Wash Mt. Lemmon (EDW)	Mt. Lemmon WWTP outfall at 32°26'51"/110°45'08" to 0.25 km downstream
SP	Virgus Canyon	Headwaters to confluence with Aravaipa Creek
SP	Walnut Gulch	Headwaters to Tombstone WWTP outfall at 31°43'47"/110°04'06"
SP	Walnut Gulch	Tombstone Wash to confluence with San Pedro River
SP	Walnut Gulch (EDW)	Tombstone WWTP outfall to the confluence with Tombstone Wash
SP	Woodcutters Pond	Fort Huachuca Military Reservation at 31°30'09"/ 110°20'12"
SR	Barnhard Creek	Headwaters to confluence with unnamed tributary at 34°05'37/111°26'40"
SR	Barnhardt Creek	Below confluence with unnamed tributary to confluence with Rye Creek
SR	Basin Lake	33°55'00"/109°26'09"
SR	Bear Creek	Headwaters to confluence with the Black River
SR	Bear Wallow Creek, North Fork (OAW)	Headwaters to confluence with the Bear Wallow Creek
SR	Bear Wallow Creek, South Fork (OAW)	Headwaters to confluence with the Bear Wallow Creek
SR	Big Lake	33°52'36"/109°25'33"
SR	Bloody Tanks Wash	Headwaters to Schultze Ranch Road
SR	Bloody Tanks Wash	Schultze Ranch Road to confluence with Miami Wash
SR	Boulder Creek	Headwaters to confluence with LaBarge Creek
SR	Campaign Creek	Headwaters to Roosevelt Lake
SR	Canyon Creek	Headwaters to the White Mountain Apache Reservation boundary
SR	Centerfire Creek	Headwaters to confluence with the Black River
SR	Chambers Draw Creek	Headwaters to confluence with the North Fork of the East Fork of Black River
SR	Cherry Creek	Headwaters to confluence with unnamed tributary at 34°05'09"/110°56'07"
SR	Christopher Creek	Headwaters to confluence with Tonto Creek
SR	Cold Spring Canyon Creek	Headwaters to confluence with unnamed tributary at 33°49'50"/110°52'58"
SR	Cold Spring Canyon Creek	Below confluence with unnamed tributary to confluence with Cherry Creek
SR	Coon Creek	Headwaters to confluence with unnamed tributary at 33°46'41"/110°54'26"
SR	Coon Creek	Below confluence with unnamed tributary to confluence with Salt River
SR	Coyote Creek	Headwaters to confluence with the Black River, East Fork
SR	Deer Creek (D2E)	Headwaters to confluence with the Black River, East Fork
SR	Del Shay Creek	Headwaters to confluence with Gun Creek
SR	Devils Chasm Creek	Headwaters to confluence with unnamed tributary at 33°48'46" /110°52'35"
SR	Dipping Vat Reservoir	33°55'47"/109°25'31"
SR	Double Cienega Creek	Headwaters to confluence with Fish Creek
SR	Fish Creek	Headwaters to confluence with the Salt River
SR	Five Point Mountain Tributary	Headwaters to Pinto Creek @ 33°22'25.93"/110°58'14"
SR	Gibson Mine Tributary	Headwaters to Pinto Creek @ 33°20'48.99"/110°56'42.31"
SR	Gold Creek	Headwaters to confluence with unnamed tributary at 33°59'47"/111°25'10"
SR	Gold Creek	Below confluence with unnamed tributary to confluence with Tonto Creek
SR	Gordon Canyon Creek	Headwaters to confluence with Hog Canyon
SR	Gordon Canyon Creek	Below confluence with Hog Canyon to confluence with Haigler Creek
SR	Greenback Creek	Headwaters to confluence with Tonto Creek
SR	Home Creek	Headwaters to confluence with the Black River, West Fork
SR	Horse Camp Creek	Headwaters to confluence with unnamed tributary at 33°54'00"/110°50'07"
SR	Horse Camp Creek	Below confluence with unnamed tributary to confluence with Cherry Creek
SR	Houston Creek	Headwaters to confluence with Tonto Creek
SR	Hunter Creek	Headwaters to confluence with Christopher Creek
SR	LaBarge Creek	Headwaters to Canyon Lake

SR	Lake Sierra Blanca	33°52'25"/109°16'05"
SR	Miami Wash	Headwaters to confluence with Pinal Creek
SR	Mule Creek	Headwaters to confluence with Canyon Creek
SR	Open Draw Creek	Headwaters to confluence with the East Fork of Black River
SR	P B Creek	Headwaters to Forest Service Road #203 at 33°57'08"/110°56'12"
SR	Pinal Creek	Headwaters to confluence with unnamed EDW wash (Globe WWTP) at 33°25'29"/110°48'20"
SR	Pinal Creek	From 33°26'55"/110°49'25" to Lower Pinal Creek water treatment plant outfall #001 at 33°31'04"/ 110°51'55"
SR	Pinal Creek	From See Ranch Crossing to confluence with unnamed tributary at 33°35'28"/110°54'31"
SR	Pinal Creek (EDW)	Confluence with unnamed EDW wash (Globe WWTP) to 33°25'29"/110°48'20"
SR	Pine Creek	Headwaters to confluence with the Salt River
SR	Pinto Creek	Below confluence with unnamed tributary to Roosevelt Lake
SR	Pole Corral Lake	33°30'38"/110°00'15"
SR	Pueblo Canyon Creek	Headwaters to confluence with unnamed tributary at 33°50'23"/110°51'37"
SR	Pueblo Canyon Creek	Below confluence with unnamed tributary to confluence with Cherry Creek
SR	Reevis Creek	Headwaters to confluence with Pine Creek
SR	Reservation Creek	Headwaters to confluence with the Black River
SR	Reynolds Creek	Headwaters to confluence with Workman Creek
SR	Russell Gulch	From Headwaters to confluence with Miami Wash
SR	Salome Creek	Headwaters to confluence with the Salt River
SR	Salt House Lake	33°57'04"/109°20'11"
SR	Slate Creek	Headwaters to confluence with Tonto Creek
SR	Snake Creek (OAW)	Headwaters to confluence with the Black River
SR	Spring Creek	Headwaters to confluence with Tonto Creek
SR	Stinky Creek (OAW)	Headwaters to confluence with the Black River, West Fork
SR	Thomas Creek	Headwaters to confluence with Beaver Creek
SR	Thompson Creek	Headwaters to confluence with the West Fork of the Black River
SR	Turkey Creek	Headwaters to confluence with Rock Creek
SR	Unnamed trib to Black River North Fork East Fork	Headwaters to Black River NF of EF
SR	Wildcat Creek	Headwaters to confluence with Centerfire Creek
SR	Workman Creek	Below confluence with Reynolds Creek to confluence with Salome Creek
UG	Ash Creek	Headwaters to confluence with unnamed tributary at 32°46'15"/109°51'45"
UG	Ash Creek	Below confluence with unnamed tributary to confluence with the Gila River
UG	Bennett Wash	Headwaters to the Gila River
UG	Buckelew Creek	Headwaters to confluence with Castle Creek
UG	Castle Creek	Headwaters to confluence with Campbell Blue Creek
UG	Cave Creek	Below Coronado National Forest boundary to New Mexico border
UG	Chase Creek	Headwaters to the Phelps-Dodge Morenci Mine
UG	Chase Creek	Below the Phelps-Dodge Morenci Mine to confluence with San Francisco River
UG	Chitty Canyon Creek	Headwaters to confluence with Salt House Creek
UG	Cima Creek	Headwaters to confluence with Cave Creek
UG	Cluff Reservoir #1	32°48'55"/109°50'46"
UG	Cluff Reservoir #3	32°48'21"/109°51'46"
UG	Coleman Creek	Headwaters to confluence with Campbell Blue Creek
UG	Dankworth Lake	32°43'13"/109°42'17"
UG	Deadman Canyon Creek	Below confluence with unnamed tributary to confluence with Graveyard Wash
UG	Eagle Creek	Headwaters to confluence with unnamed tributary at 33°22'32"/109°29'43"
UG	East Eagle Creek	Headwaters to confluence with Eagle Creek
UG	East Turkey Creek	Headwaters to confluence with unnamed tributary at 31°58'22"/109°12'20"
UG	East Turkey Creek	Below confluence with unnamed tributary to terminus near San Simon River
UG	East Whitetail	Headwaters to terminus near San Simon River
UG	Emigrant Canyon	Headwaters to terminus near San Simon River
UG	Evans Pond #1	32°49'19"/109°51'12"
UG	Evans Pond #2	32°49'14"/109°51'09"
UG	Fishhook Creek	Headwaters to confluence with the Blue River
UG	Foote Creek	Headwaters to confluence with the Blue River
UG	Frye Canyon Creek	Headwaters to Frye Mesa Reservoir
UG	Frye Canyon Creek	Frye Mesa reservoir to terminus at Highline Canal.
UG	Frye Mesa Reservoir	32°45'14"/109°50'02"
UG	Georges Tank	33°51'24"/109°08'30"
UG	Gibson Creek	Headwaters to confluence with Marijilda Creek
UG	Lanphier Canyon	Headwaters to confluence with the Blue River
UG	Little Blue Creek	Headwaters to confluence with Dutch Blue Creek
UG	Little Creek	Headwaters to confluence with the San Francisco River
UG	Marijilda Creek	Headwaters to confluence with Gibson Creek
UG	Marijilda Creek	Below confluence with Gibson Creek to confluence with Stockton Wash
UG	Markham Creek	Headwaters to confluence with the Gila River
UG	Pigeon Creek	Headwaters to confluence with the Blue River
UG	Roper Lake	32°45'23"/109°42'14"
UG	Sheep Tank	32°46'14"/109°48'09"
UG	Smith Pond	32°49'15"/109°50'36"
UG	Squaw Creek	Headwaters to confluence with Thomas Creek
UG	Stone Creek	Headwaters to confluence with the San Francisco River
UG	Strayhorse Creek	Headwaters to confluence with the Blue River
UG	Thomas Creek	Headwaters to confluence with Rousensock Creek
UG	Tinny Pond	33°47'49"/109°04'27"
VR	American Gulch	Headwaters to the Northern Gila County Sanitary District WWTP outfall at 34°14'02"/111°22'14"
VR	American Gulch (EDW)	Below Northern Gila County Sanitary District WWTP outfall to confluence with the East Verde River
VR	Apache Creek	Headwaters to confluence with Walnut Creek
VR	Ashbrook Wash	Headwaters to the Fort McDowell Indian Reservation boundary
VR	Aspen Creek	Headwaters to confluence with Granite Creek

VR	Banning Creek	Headwaters to Granite Creek @ 34°31'01.02"/112°28'37.63"
VR	Bar Cross Tank	35°00'41"/112°05'39"
VR	Barrata Tank	35°02'43"/112°24'21"
VR	Big Chino Wash	Headwaters to confluence with Sullivan Lake
VR	Bitter Creek	Headwaters to the Jerome WWTP outfall at 34°45'12"/112°06'24"
VR	Bitter Creek (EDW)	Jerome WWTP outfall to the Yavapai Apache Indian Reservation boundary
VR	Black Canyon Creek	Headwaters to confluence with unnamed tributary at 34°39'20"/112°05'06"
VR	Black Canyon Creek	Below confluence with unnamed tributary to confluence with the Verde River
VR	Bonita Creek	Headwaters to confluence with Ellison Creek
VR	Bray Creek	Headwaters to confluence with Webber Creek
VR	Butte Creek	Headwaters to Miller Creek @ 34°32'49.03"/112°28'29.3"
VR	Camp Creek	Headwaters to confluence with Verde River
VR	Cereus Wash	Headwaters to the Fort McDowell Indian Reservation boundary
VR	Chase Creek	Headwaters to confluence with the East Verde River
VR	Clover Creek	Headwaters to confluence with Headwaters of West Clear Creek
VR	Coffee Creek	Headwaters to confluence with Spring Creek
VR	Colony Wash	Headwaters to the Fort McDowell Indian Reservation boundary
VR	Deadman Creek	Headwaters to Horseshoe Reservoir
VR	Del Monte Gulch	Headwaters to confluence with City of Cottonwood WWTP outfall 002 at 34°43'57"/112°02'46"
VR	Del Monte Gulch (EDW)	City of Cottonwood WWTP outfall 002 at 34°43'57"/ 112°02'46" to confluence with Verde River
VR	Del Rio Dam Lake	34°48'55"/112°28'03"
VR	Dry Beaver Creek	Headwaters to confluence with Beaver Creek
VR	Dry Creek (EDW)	Sedona Ventures WWTP outfall at 34°50'42"/ 111°52'26" to 34°50'02"/ 111°52'17"
VR	Dude Creek	Headwaters to confluence with the East Verde River
VR	Ellison Creek	Headwaters to confluence with the East Verde River
VR	Foxboro Lake	34°53'42"/111°39'55"
VR	Fry Lake	35°03'45"/111°48'04"
VR	Gap Creek	Headwaters to confluence with Government Spring
VR	Gap Creek	Below Government Spring to confluence with the Verde River
VR	Garrett Tank	35°18'57"/112°42'20"
VR	Goldwater Lake, Lower	34°29'56"/112°27'17"
VR	Goldwater Lake, Upper	34°29'52"/112°26'59"
VR	Government Canyon	Headwaters to Granite Creek @ 34°33'29.49"/112°26'53.18"
VR	Granite Basin Lake	34°37'01"/112°32'58"
VR	Granite Creek	Headwaters to Watson Lake
VR	Granite Creek	Below Watson Lake to confluence with the Verde River
VR	Green Valley Lake (EDW)	34°13'54"/111°20'45"
VR	Heifer Tank	35°20'27"/112°32'59"
VR	Hells Canyon Tank	35°04'59"/112°24'07"
VR	Homestead Tank	35°21'24"/112°41'36"
VR	Horse Park Tank	34°58'15"/111°36'32"
VR	Houston Creek	Headwaters to confluence with the Verde River
VR	Huffer Tank	34°27'46"/111°23'11"
VR	J.D. Dam Lake	35°04'02"/112°01'48"
VR	Jacks Canyon	Headwaters to Big Park WWTP outfall at 34°45'46"/ 111°45'51"
VR	Jacks Canyon (EDW)	Below Big Park WWTP outfall to confluence with Dry Beaver Creek
VR	Lime Creek	Headwaters to Horseshoe Reservoir
VR	Mail Creek	Headwaters to East Verde River @ 34°25'03.88"/111°15'49.6"
VR	Manzanita Creek	Headwaters to Granite Creek @ 34°31'31.19"/112°28'44.34"
VR	Masonry Number 2 Reservoir	35°13'32"/112°24'10"
VR	McLellan Reservoir	35°13'09"/112°17'06"
VR	Meath Dam Tank	35°07'52"/112°27'35"
VR	Miller Creek	Headwaters to Granite Creek @ 34°32'48.55"/112°28'12.96"
VR	Mullican Place Tank	34°44'16"/111°36'10"
VR	Munds Creek (EDW), Tributary to Oak Creek	From Pinewood Sanitary District Kay S. Blackman WWTP outfall at 34? 56' 09", -111? 38' 35" to Oak Creek.
VR	North Fork Miller	Headwaters to Miller Creek
VR	North Granite Creek	Headwaters to Granite Creek @ 34°33'04.33"/112°27'50.45"
VR	Oak Creek, West Fork (OAW)	Headwaters to confluence with Oak Creek
VR	Odell Lake	34°56'5"/111°37'53"
VR	Peck's Lake	34°46'51"/112°02'01"
VR	Perkins Tank	35°06'42"/112°04'12"
VR	Pine Creek	Headwaters to confluence with unnamed tributary at 34°21'51"/111°26'49"
VR	Pine Creek	Below confluence with unnamed tributary to confluence with East Verde River
VR	Red Creek	Headwaters to confluence with the Verde River
VR	Reservoir #1	35°13'5"/111°50'09"
VR	Reservoir #2	35°13'17"/111°50'39"
VR	Roundtree Canyon Creek	Headwaters to confluence with Tangle Creek
VR	Scholze Lake	35°11'53"/112°00'37"
VR	Slaugterhouse Gulch	Headwaters to Yavapai Res. Boundary
VR	Spring Creek	Headwaters to confluence with unnamed tributary at 34°57'23"/111°57'21"
VR	Steel Dam Lake	35°13'36"/112°24'54"
VR	Stehr Lake	34°22'01"/111°40'02"
VR	Stoneman Lake	34°46'47"/111°31'14"
VR	Sycamore Creek	Below confluence with unnamed tributary to confluence with Verde River
VR	Sycamore Creek	Headwaters to confluence with Verde River at 34°04'42"/111°42'14"
VR	Tangle Creek	Headwaters to confluence with Verde River
VR	Trinity Tank	35°27'44"/112°48'01"
VR	Unnamed Trib to Granite Creek (UGC)	Headwaters to Yavapai Prescott Reservation Boundary
VR	Unnamed Trib to UGC (UUG)	Headwaters to Unnamed Trib to Granite Creek (UGC)
VR	Unnamed Wash	Flagstaff Meadows WWTP outfall at 35°13'53.54"/ 111°48'40.32'"to Volunteer Wash

VR	Walnut Creek	Headwaters to confluence with Big Chino Wash
VR	Watson Lake	34°34'58"/112°25'26"
VR	Webber Creek	Headwaters to confluence with the East Verde River
VR	Wet Beaver Creek	Headwaters to unnamed springs at 34°41'17"/ 111°34'34"
VR	Whitehorse Lake	35°06'59"/112°00'48"
VR	Williamson Valley Wash	Headwaters to confluence with Mint Wash
VR	Williamson Valley Wash	From confluence of Mint Wash to 10.5 km downstream
VR	Williamson Valley Wash	From 10.5 km downstream of Mint Wash confluence to confluence with Big Chino Wash
VR	Williscraft Tank	35°11'22"/112°35'40"
VR	Willow Creek	Above Willow Creek Reservoir
VR	Willow Valley Lake	34°41'08"/111°20'02"

Historical Note

Table C made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

R18-11-217. Best Management Practices for non-WOTUS Protected Surface Waters

A. The BMPs described in this rule are intended to ensure that activities within the ordinary high-water mark of perennial or intermittent non-WOTUS protected surface waters, or within the bed and bank of other waters that materially impact (i.e., are within 1/4 mile upstream of) non-WOTUS protected surface waters, do not violate applicable surface water quality standards in the non-WOTUS protected surface waters. For purposes of this Section, the activities described in the prior sentence will be referred to as "regulated activities." Depending on the regulated activities conducted, not all of the BMPs described below may be applicable to a particular project. The owner or operator is responsible to consider the BMPs outlined below and to implement those necessary to ensure that the regulated activities will not violate applicable surface water quality standards in the non-WOTUS protected surface water.

B. The BMPs described below are not applicable to any activities that are addressed under an individual or general AZPDES permit that are otherwise regulated under A.R.S. Title 49.

C. Erosion and sedimentation control BMPs:

1. When flow is present in any non-WOTUS protected surface waters within a project area, flow shall not be altered except to prevent erosion or pollution of any non-WOTUS protected surface waters.
2. Any disturbance within the ordinary high-water mark of non-WOTUS protected surface waters or within the bed and banks of other waters, that is not intended to be permanently altered, shall be stabilized as soon as practicable to prevent erosion and sedimentation.
3. When flow in any non-WOTUS protected surface water is sufficient to erode, carry, or deposit material, regulated activities shall cease until:
   a. The flow decreases below the point where sediment movement ceases; or
   b. Control measures have been undertaken, i.e., equipment and material easily transported by flow are protected within non-erodible barriers or moved outside the flow area.
4. Silt laden or turbid water resulting from regulated activities should be managed in a manner to reduce sediment load prior to discharging.
5. No washing or dewatering of fill material should occur within the ordinary high-water mark of any perennial or intermittent non-WOTUS protected surface waters. Other than the replacement of native fill or material used to support vegetation rooting or growth, fill placed within the ordinary high-water mark of any perennial or intermittent non-WOTUS protected surface water must resist washout whether such resistance is derived via particle size limits, presence of a binder, vegetation, or other armoring.

D. Pollutant management BMPs:

1. If regulated activities are likely to violate applicable surface water quality standards in a perennial or intermittent non-WOTUS protected surface water, operations shall cease until the problem is resolved or until control measures have been implemented.
2. Construction material and/or fill (other than native fill or that necessary to support revegetation) placed within surface waters as a result of regulated activities shall not include pollutants in concentrations that will violate applicable surface water quality standards in a perennial or intermittent non-WOTUS protected surface water.

E. Construction phase BMPs:

1. Equipment staging and storage areas or fuel, oil, and other petroleum products storage and solid waste containment should not be located within the ordinary high-water mark of any perennial or intermittent non-WOTUS protected surface water.
2. Any equipment maintenance, washing, or fueling shall not be done within the ordinary high-water mark of any perennial or intermittent non-WOTUS protected surface waters with the following exception: Equipment too large or unwieldy to be readily moved, such as large cranes, may be fueled and serviced in non-WOTUS protected surface waters (but outside of standing or flowing water) provided material specifically manufactured and sold as spill containment is in place during fueling/servicing.
3. All equipment shall be inspected for leaks, all leaks shall be repaired, and all repaired equipment shall be cleaned to remove any fuel or other fluid residue prior to use within the ordinary high-water mark of any perennial or intermittent non-WOTUS protected surface waters.
4. Washout of concrete handling equipment shall not take place within the ordinary high-water mark of any perennial or intermittent non-WOTUS protected surface waters.

F. Post-construction BMPs:

1. Upon completion of regulated activities, areas within the ordinary high-water mark of any perennial or intermittent non-WOTUS protected surface waters shall be promptly cleared of all forms, piling, construction residues, equipment, debris, or other obstructions.
2. If fully, partially, or occasionally submerged structures are constructed of cast-in-place concrete instead of precast concrete, steps will be taken using sheet piling or temporary dams to prevent contact between water (instream and runoff) and the concrete until it cures and until any curing agents have evaporated or are no longer a pollutant threat.
3. Any permanent water crossings within the ordinary high-water mark of any perennial or intermittent in a non-WOTUS protected surface water (other than fords) shall

not be equipped with gutters, drains, scuppers, or other conveyances that allow untreated runoff (due to events equal to or lesser in magnitude than the design event for the crossing structure) to directly enter a non-WOTUS protected surface water if such runoff can be directed to a local stormwater drainage, containment, and/or treatment system.

4. Debris shall be cleared as needed from culverts, ditches, dips, and other drainage structures within the ordinary high-water mark of any perennial or intermittent non-WOTUS protected surface water to prevent clogging or conditions that may lead to a washout.
5. Temporary structures constructed or imported materials shall be removed no later than upon completion of the regulated activities.
6. Temporary structures constructed of native materials, if they provide an obstacle to flow or can contribute to or cause erosion, or cause changes in sediment load, shall be removed no later than upon completion of the regulated activities.

G. Design consideration BMPs:

1. All temporary structures constructed of imported materials and all permanent structures, including but not limited to, access roadways, culvert crossings, staging areas, material stockpiles, berms, dikes, and pads, shall be constructed so as to accommodate overtopping and resist washout by streamflow.
2. Any temporary crossing, other than fords on native material, shall be constructed in such a manner so as to provide armoring of the stream channel. Materials used to provide this armoring shall not include anything easily transportable by flow. Examples of acceptable materials include steel plates, untreated wooden planks, pre-cast concrete planks or blocks. Examples of unacceptable materials include clay, silt, sand, and gravel finer than cobble (roughly fist-sized). The armoring shall, via mass, anchoring systems, or a combination of the two, resist washout.

H. Notification. The owner or operator of any regulated activities shall, five days prior to initiation of the regulated activities, submit a notice to ADEQ on a form that includes basic information including the GPS location, the waterbody ID of the nearest non-WOTUS protected surface water, general description of planned activities, types of BMPs to be employed during the project, and phone number and email for a contact person. Work may proceed after five calendar days have passed since the owner/operator provided notification to ADEQ unless ADEQ responds in writing to the contact person for the owner/operator.

I. Exclusions: The BMPS and notification requirements in this Section shall not apply to:

1. Activities that are already regulated under A.R.S. Title 49.
2. Discharges to a non-WOTUS protected surface water incidental to a recharge project.
3. Established or ongoing farming, ranching and silviculture activities such as plowing, seeding, cultivating, minor drainage or harvesting for the production of food, fiber or forest products or upland soil and water conservation practices.
4. Maintenance but not construction of drainage ditches.
5. Construction and maintenance of irrigation ditches.
6. Maintenance of structures as dams, dikes, and levees.

Historical Note

New Section made by final rulemaking at 29 A.A.R. 302 (January 27, 2023), effective February 20, 2023 (Supp. 22-4).

Appendix A. Repealed

Historical Note

Former Section R9-21-208, Appendices 1 through 9 renumbered and amended as new Appendix A adopted effective January 7, 1985 (Supp. 85-1). Amended effective August 12, 1986 (Supp. 86-4). Appendix repealed effective February 18, 1992 (Supp. 92-1).

Appendix B. Repealed

Historical Note

Former R9-21-209, Table 1 and Table 2 renumbered and amended as Appendix B adopted effective January 7, 1985 (Supp.85-1). Amended effective August 12, 1986 (Supp. 86-4). Appendix repealed effective February 18, 1992 (Supp. 92-1).

ARTICLE 3. RECLAIMED WATER QUALITY STANDARDS

R18-11-301. Definitions

The terms in this Article have the following meanings:

"Direct reuse" has the meaning prescribed in R18-9-701(1).

"Disinfection" means a treatment process that uses oxidants, ultraviolet light, or other agents to kill or inactivate pathogenic organisms in wastewater.

"Filtration" means a treatment process that removes particulate matter from wastewater by passage through porous media.

"Gray water" means wastewater, collected separately from a sewage flow, that originates from a clothes washer, bathtub, shower, or sink, but it does not include wastewater from a kitchen sink, dishwasher, or a toilet.

"Industrial wastewater" means wastewater generated from an industrial process.

"Landscape impoundment" means a manmade lake, pond, or impoundment of reclaimed water where swimming, wading, boating, fishing, and other water-based recreational activities are prohibited. A landscape impoundment is created for storage, landscaping, or for aesthetic purposes only.

"NTU" means nepholometric turbidity unit.

"On-site wastewater treatment facility" has the meaning prescribed in A.R.S. § 49-201(24).

"Open access" means that access to reclaimed water by the general public is uncontrolled.

"Reclaimed water" has the meaning prescribed in A.R.S. § 49-201(31).

"Recreational impoundment" means a manmade lake, pond, or impoundment of reclaimed water where boating or fishing is an intended use of the impoundment. Swimming and other full-body recreation activities (for example, water-skiing) are prohibited in a recreational impoundment.

"Restricted access" means that access to reclaimed water by the general public is controlled.

"Secondary treatment" means a biological treatment process that achieves the minimum level of effluent quality defined by the federal secondary treatment regulation at 40 CFR § 133.102.

"Sewage" means untreated wastes from toilets, baths, sinks, lavatories, laundries, and other plumbing fixtures in places of human habitation, employment, or recreation.

Historical Note

Adopted effective July 9, 1981 (Supp. 81-4). Former Section R9-21-301 renumbered without change as Section R18-11-301 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

R18-11-302. Applicability

This Article applies to the direct reuse of reclaimed water, except for:

1. The direct reuse of gray water, or
2. The direct reuse of reclaimed water from an onsite wastewater treatment facility regulated by a general Aquifer Protection Permit under 18 A.A.C. 9, Article 3.

Historical Note

Adopted effective June 8, 1981 (Supp. 81-3). Amended effective January 7, 1985 (Supp. 85-1). Former Section R9-21-302 renumbered without change as Section R18-11-302 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

R18-11-303. Class A+ Reclaimed Water

A. Class A+ reclaimed water is wastewater that has undergone secondary treatment, filtration, nitrogen removal treatment, and disinfection. Chemical feed facilities to add coagulants or polymers are required to ensure that filtered effluent before disinfection complies with the 24-hour average turbidity criterion prescribed in subsection (B)(1). Chemical feed facilities may remain idle if the 24-hour average turbidity criterion in (B)(1) is achieved without chemical addition.

B. An owner of a facility shall ensure that:

1. The turbidity of Class A+ reclaimed water at a point in the wastewater treatment process after filtration and immediately before disinfection complies with the following:
   a. The 24-hour average turbidity of filtered effluent is two NTUs or less, and
   b. The turbidity of filtered effluent does not exceed five NTUs at any time.
2. Class A+ reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. There are no detectable fecal coliform organisms in four of the last seven daily reclaimed water samples taken, and
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 23 / 100 ml.
   c. If alternative treatment processes or alternative turbidity criteria are used, or reclaimed water is blended with other water to produce Class A+ reclaimed water under subsection (C), there are no detectable enteric virus in four of the last seven monthly reclaimed water samples taken.
3. The 5-sample geometric mean concentration of total nitrogen in a reclaimed water sample is less than 10 mg / L.

C. An owner of a facility may use alternative treatment methods other than those required by subsection (A), or comply with alternative turbidity criteria other than those required by subsection (B)(1), or blend reclaimed water with other water to produce Class A+ reclaimed water provided the owner demonstrates through pilot plant testing, existing water quality data, or other means that the alternative treatment methods, alternative turbidity criteria, or blending reliably produces a reclaimed water that meets the disinfection criteria in subsection (B)(2) and the total nitrogen criteria in subsection (B)(3) before discharge to a reclaimed water distribution system.

D. Class A+ reclaimed water is not required for any type of direct reuse. A person may use Class A+ reclaimed water for any type of direct reuse listed in Table A.

Historical Note

Adopted effective January 7, 1985 (Supp. 85-1). Amended effective August 12, 1986 (Supp. 86-4). Former Section R9-21-303 renumbered without change as Section R18-11-303 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

R18-11-304. Class A Reclaimed Water

A. Class A reclaimed water is wastewater that has undergone secondary treatment, filtration, and disinfection. Chemical feed facilities to add coagulants or polymers are required to ensure that filtered effluent before disinfection complies with the 24-hour average turbidity criterion prescribed in subsection (B)(1). Chemical feed facilities may remain idle if the 24-hour average turbidity criterion in subsection (B)(1) is achieved without chemical addition.

B. An owner of a facility shall ensure that:

1. The turbidity of Class A reclaimed water at a point in the wastewater treatment process after filtration and immediately before disinfection complies with the following:
   a. The 24-hour average turbidity of filtered effluent is two NTUs or less, and
   b. The turbidity of filtered effluent does not exceed five NTUs at any time.
2. Class A reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. There are no detectable fecal coliform organisms in four of the last seven daily reclaimed water samples taken, and
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 23 / 100 ml.
   c. If alternative treatment processes or alternative turbidity criteria are used, or reclaimed water is blended with other water to produce Class A reclaimed water under subsection (C), there are no detectable enteric virus in four of the last seven monthly reclaimed water samples taken.

C. An owner of a facility may use alternative treatment methods other than those required by subsection (A), or comply with alternative turbidity criteria other than those required by subsection (B)(1), or blend reclaimed water with other water to produce Class A reclaimed water provided the owner demonstrates through pilot plant testing, existing water quality data, or other means that the alternative treatment methods, alternative turbidity criteria, or blending reliably produces a reclaimed water that meets the disinfection criteria in subsection (B)(2) before discharge to a reclaimed water distribution system.

D. A person shall use Class A reclaimed water for a type of direct reuse listed as Class A in Table A. A person may use Class A reclaimed water for a type of direct reuse listed as Class B or Class C in Table A.

Historical Note

Adopted effective January 7, 1985 (Supp. 85-1). Amended effective August 12, 1986 (Supp. 86-4). Former Section R9-21-304 renumbered without change as Section R18-11-304 (Supp. 87-3). Section repealed effective February 18, 1992 (Supp. 92-1). New Section adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

R18-11-305. Class B+ Reclaimed Water

A. Class B+ reclaimed water is wastewater that has undergone secondary treatment, nitrogen removal treatment, and disinfection.

B. An owner of a facility shall ensure that:

1. Class B+ reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:
   a. The concentration of fecal coliform organisms in four of the last seven daily reclaimed water samples is less than 200 / 100 ml.
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 800 / 100 ml.
2. The 5-sample geometric mean concentration of total nitrogen in a reclaimed water sample is less than 10 mg / L.

C. Class B+ reclaimed water is not required for a type of direct reuse. A person may use Class B+ reclaimed water for a type of direct reuse listed as Class B or Class C in Table A. A person shall not use Class B+ reclaimed water for a type of direct reuse listed as Class A in Table A.

Historical Note

New Section adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

R18-11-306. Class B Reclaimed Water

A. Class B reclaimed water is wastewater that has undergone secondary treatment and disinfection.

B. An owner of a facility shall ensure that Class B reclaimed water meets the following criteria after disinfection treatment and before discharge to a reclaimed water distribution system:

1. The concentration of fecal coliform organisms in four of the last seven daily reclaimed water samples is less than 200 / 100 ml.
2. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 800 / 100 ml.

C. A person shall use a minimum of Class B reclaimed water for a type of direct reuse listed as Class B in Table A. A person may use Class B reclaimed water for a type of direct reuse listed as Class C in Table A. A person shall not use Class B reclaimed water for a type of direct reuse listed as Class A in Table A.

Historical Note

New Section adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

R18-11-307. Class C Reclaimed Water

A. Class C reclaimed water is wastewater that has undergone secondary treatment in a series of wastewater stabilization ponds, including aeration, with or without disinfection.

B. The owner of a facility shall ensure that:

1. The total retention time of Class C reclaimed water in wastewater stabilization ponds is at least 20 days.
2. Class C reclaimed water meets the following criteria after treatment and before discharge to a reclaimed water distribution system:
   a. The concentration of fecal coliform organisms in four of the last seven reclaimed water samples taken is less than 1000 / 100 ml.
   b. The single sample maximum concentration of fecal coliform organisms in a reclaimed water sample is less than 4000 / 100 ml.

C. A person shall use a minimum of Class C reclaimed water for a type of direct reuse listed as Class C in Table A. A person shall not use Class C reclaimed water for a type of direct reuse listed as Class A or Class B in Table A.

Historical Note

New Section adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

R18-11-308. Industrial Reuse

A. The reclaimed water quality requirements for the following direct reuse applications are industry-specific and shall be determined by the Department on a case-by-case basis in a reclaimed water permit issued by the Department under 18 A.A.C. 9, Article 7:

1. Direct reuse of industrial wastewater containing sewage.
2. Direct reuse of industrial wastewater for the production or processing of any crop used as human or animal food.

B. The Department shall use best professional judgment to determine the reclaimed water quality requirements needed to protect public health and the environment for a type of direct reuse specified in subsection (A).

Historical Note

New Section adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

R18-11-309. Reclaimed Water Quality Standards for an Unlisted Type of Direct Reuse

A. The Department may prescribe in an individual reclaimed water permit issued under 18 A.A.C. 9, Article 7, reclaimed water quality requirements for a type of direct reuse not listed in Table A. Before permitting a direct reuse of reclaimed water not listed in Table A, the Department shall, using its best professional judgment, determine and require compliance with reclaimed water quality requirements needed to protect public health and the environment.

B. Department may determine that Class A+, A, B+, B, or C reclaimed water is appropriate for a new type of direct reuse.

C. The Department shall consider the following factors when prescribing reclaimed water quality requirements for a new type of direct reuse:

1. The risk to public health;
2. The degree of public access to the site where the reclaimed water is reused and human exposure to the reclaimed water;
3. The level of treatment necessary to ensure that the reclaimed water is aesthetically acceptable;
4. The level of treatment necessary to prevent nuisance conditions;

5. Specific water quality requirements for the intended type of direct reuse;
6. The means of application of the reclaimed water;
7. The degree of treatment necessary to avoid a violation of surface water quality standards or aquifer water quality standards;
8. The potential for improper or unintended use of the reclaimed water;
9. The reuse guidelines, criteria, or standards adopted or recommended by the U.S. Environmental Protection Agency or other federal or state agencies that apply to the new type of direct reuse; and
10. Similar wastewater reclamation experience of reclaimed water providers in the United States.

Historical Note

New Section adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

Table A. Minimum Reclaimed Water Quality Requirements for Direct Reuse

Type of Direct Reuse	Minimum Class of Reclaimed Water Required
Irrigation of food crops	A
Recreational impoundments	A
Residential landscape irrigation	A
Schoolground landscape irrigation	A
Open access landscape irrigation	A
Toilet and urinal flushing	A
Fire protection systems	A
Spray irrigation of an orchard or vineyard	A
Commercial closed loop air conditioning systems	A
Vehicle and equipment washing (does not include self-service vehicle washes)	A
Snowmaking	A
Surface irrigation of an orchard or vineyard	B
Golf course irrigation	B
Restricted access landscape irrigation	B
Landscape impoundment	B
Dust control	B
Soil compaction and similar construction activities	B
Pasture for milking animals	B
Livestock watering (dairy animals)	B
Concrete and cement mixing	B
Materials washing and sieving	B
Street cleaning	B
Pasture for non-dairy animals	C
Livestock watering (non-dairy animals)	C
Irrigation of sod farms	C
Irrigation of fiber, seed, forage, and similar crops	C
Silviculture	C

Note: Nothing in this Article prevents a wastewater treatment plant from using a higher quality reclaimed water for a type of direct reuse than the minimum class of reclaimed water listed in Table A. For example, a wastewater treatment plant may provide Class A reclaimed water for a type of direct reuse where Class B or Class C reclaimed water is acceptable.

Historical Note

New Table adopted by final rulemaking at 7 A.A.R. 870, effective January 22, 2001 (Supp. 01-1).

ARTICLE 4. AQUIFER WATER QUALITY STANDARDS

R18-11-401. Definitions

In addition to the definitions contained in A.R.S. §§ 49-101 and 49-201, the terms of this Article shall have the following meanings:

1. "Beta particle and photon radioactivity from man-made radionuclides" means all radionuclides emitting beta particles or photons, except Thorium-232, Uranium-235, Uranium-238 and their progeny.
2. "Dose equivalent" means the product of the absorbed dose from ionizing radiation and such factors as account for differences in biological effectiveness due to the type of radiation and its distribution in the body as specified by the International Commission on Radiological Units and Measurements.
3. "Drinking water protected use" means the protection and maintenance of aquifer water quality for human consumption.
4. "Gross alpha particle activity" means the total radioactivity due to alpha particle emission as inferred from measurements on a dry sample.
5. "Mg/l" means milligrams per liter.
6. "Millirem" means 1/1000 of a rem. A rem means the unit of dose equivalent from ionizing radiation to the total body or any internal organ or organ system.
7. "Non-drinking water protected use" means the protection and maintenance of aquifer water quality for a use other than for human consumption.
8. "pCi" means picocurie, or the quantity of radioactive material producing 2.22 nuclear transformations per minute.
9. "Total trihalomethanes" means the sum of the concentrations of the following trihalomethane compounds: trichloromethane (chloroform), dibromo-chloromethane, bromodichloromethane and tribromo-methane (bromoform).

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Amended effective August 14, 1992 (Supp. 92-3).

R18-11-402. Repealed

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Repealed effective August 14, 1992 (Supp. 92-3).

R18-11-403. Analytical Methods

Analysis of a sample to determine compliance with an aquifer water quality standard shall be in accordance with an analytical method specified in A.A.C. Title 9, Chapter 14, Article 6 or an alternative analytical method that is approved by the Director of the Arizona Department of Health Services pursuant to A.A.C. R9-14-607(B).

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Amended effective August 14, 1992 (Supp. 92-3).

R18-11-404. Laboratories

A test result from a sample taken to determine compliance with an aquifer water quality standard shall be valid only if the sample has been analyzed by a laboratory that is licensed by the Arizona Department of Health Services for the analysis performed.

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Amended effective August 14, 1992 (Supp. 92-3).

R18-11-405. Narrative Aquifer Water Quality Standards

A. A discharge shall not cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration which endangers human health.

B. A discharge shall not cause or contribute to a violation of a water quality standard established for a navigable water of the state.

C. A discharge shall not cause a pollutant to be present in an aquifer which impairs existing or reasonably foreseeable uses of water in an aquifer.

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Amended effective August 14, 1992 (Supp. 92-3).

R18-11-406. Numeric Aquifer Water Quality Standards: Drinking Water Protected Use

A. The aquifer water quality standards in this Section apply to aquifers that are classified for drinking water protected use.

B. The following are the aquifer water quality standards for inorganic chemicals:

Pollutant	mg/L)
Antimony	0.006
Arsenic	0.05
Asbestos	7 million fibers/liter (longer than 10 mm)
Barium	2
Beryllium	0.004
Cadmium	0.005
Chromium	0.1
Cyanide (As Free Cyanide)	0.2
Fluoride	4.0
Lead	0.05
Mercury	0.002
Nickel	0.1
Nitrate (as N)	10
Nitrite (as N)	1
Nitrate and nitrite (as N)	10
Selenium	0.05
Thallium	0.002

C. The following are the aquifer water quality standards for organic chemicals:

Pollutant	(mg/L)
Benzene	0.005
Benzo (a) pyrene	0.0002
Carbon Tetrachloride	0.005
o-Dichlorobenzene	0.6
para-Dichlorobenzene	0.075
1,2-Dichloroethane	0.005
1,1-Dichloroethylene	0.007
cis-1,2-Dichloroethylene	0.07
trans-1,2-Dichloroethylene	0.1
1,2-Dichloropropane	0.005
Dichloromethane	0.005
Di (2-ethylhexyl) adipate	0.4
Di (2-ethylhexyl) pthalate	0.006
Ethylbenzene	0.7
Hexachlorobenzene	0.001
Hexachlorocyclopentadiene	0.05
Monochlorobenzene	0.1
Pentachlorophenol	0.001
Styrene	0.1
2,3,7,8-TCDD (Dioxin)	0.00000003
Tetrachloroethylene	0.005
Toluene	1
Trihalomethanes (Total)	0.10
1,2,4-Trichlorobenzene	0.07
1,1,1-Trichloroethane	0.20
1,1,2-Trichloroethane	0.005
Trichloroethylene	0.005
Vinyl Chloride	0.002
Xylenes (Total)	10

D. The following are the aquifer water quality standards for pesticides and polychlorinated biphenyls (PCBs):

Pollutant	(mg/L)
Alachlor	0.002
Atrazine	0.003
Carbofuran	0.04
Chlordane	0.002
Dalapon	0.2
1,2-Dibromo-3-Chloropropane (DBCP)	0.0002
2,4,-Dichlorophenoxyacetic Acid(2,4-D)	0.07
Dinoseb	0.007
Diquat	0.02
Endothall	0.1
Endrin	0.002
Ethylene Dibromide (EDB)	0.00005
Glyphosate	0.7
Heptachlor	0.0004
Heptachlor Epoxide	0.0002
Lindane	0.0002
Methoxychlor	0.04
Oxamyl	0.2
Picloram	0.5
Polychlorinated Biphenols (PCBs)	0.0005
Simazine	0.004
Toxaphene	0.003
2,4,5-Trichlorophenoxypropionic Acid (2,4,5-TP or Silvex)	0.05

E. The following are the aquifer water quality standards for radionuclides:

1. The maximum concentration for gross alpha particle activity, including Radium-226 but excluding radon and uranium, shall not exceed 15 pCi/l.
2. The maximum concentration for combined Radium-226 and Radium-228 shall not exceed 5 pCi/l.
3. The average annual concentration of beta particle and photon radioactivity from man-made radionuclides shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year.
4. Except for the radionuclides listed in this subsection, the concentration of man-made radionuclides causing 4 millirem total body or organ dose equivalents shall be calculated on the basis of a 2-liter-per-day drinking water intake using the 168-hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Con-

centration of Radionuclides in Air or Water for Occupational Exposure," National Bureau of Standards Handbook 69, National Bureau of Commerce, as amended August 1963 (and no future editions), incorporated herein by reference and on file with the Office of the Secretary of State and with the Department. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year. The following average annual concentrations are assumed to produce a total body or organ dose of 4 millirem/year:

Radionuclide	Critical Organ	pCi/l
Tritium	Total body	20,000
Strontium-90	Bone Marrow	8

F. The aquifer water quality standard for microbiological contaminants is based upon the presence or absence of total coliforms in a 100-milliliter sample. If a sample is total coliform-positive, a 100-milliliter repeat sample shall be taken within two weeks of the time the sample results are reported. Any total coliform-positive repeat sample following a total coliform-positive sample constitutes a violation of the aquifer water quality standard for microbiological contaminants.

G. The following are the aquifer water quality standards for turbidity:
1. One nephelometric turbidity unit as determined by a monthly average except that five or fewer nephelometric turbidity units may be allowed if it can be determined that the higher turbidity does not interfere with disinfection, prevent maintenance of effective disinfectant agents in water supply distribution systems, or interfere with microbiological determinations.
2. Five nephelometric turbidity units based on an average of two consecutive days.

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Amended effective August 14, 1992 (Supp. 92-3).
Amended effective May 26, 1994 (Supp. 94-2).

R18-11-407. Aquifer Water Quality Standards in Reclassified Aquifers

A. All aquifers in the state are classified for drinking water protected use except for aquifers which are reclassified to a nondrinking water protected use pursuant to A.R.S. § 49-224 and A.A.C. R18-11-503.

B. Aquifer water quality standards for drinking water protected use apply to reclassified aquifers except where expressly superseded by aquifer water quality standards adopted pursuant to subsection (C) of this Section.

C. The Director shall adopt, by rule, aquifer water quality standards for reclassified aquifers within one year of the date of the order reclassifying the aquifer to a nondrinking water protected use. The Director shall adopt aquifer water quality standards for reclassified aquifers only for pollutants that are specifically identified in a petition for reclassification as prescribed by A.R.S. § 49-223(D) and A.A.C. R18-11-503(B). Aquifer water quality standards for reclassified aquifers shall be sufficient to protect the use of the reclassified aquifer.

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Amended effective August 14, 1992 (Supp. 92-3).

R18-11-408. Petition for Adoption of a Numeric Aquifer Water Quality Standard

A. Any person may petition the Director to adopt, by rule, a numeric aquifer water quality standard for a pollutant for which no numeric aquifer water quality standard exists.

B. Petitions for adoption of a numeric aquifer water quality standard shall be filed with the Department and shall comply with the requirements applicable to petitions for rule adoption as provided by A.R.S. § 41-1033 and A.A.C. R18-1-302, except as otherwise provided by A.R.S. § 49-223 or this Section.

C. In addition to the requirements of A.A.C. R18-1-302, a petition for rule adoption to establish a numeric aquifer water quality standard shall include specific reference to:
1. Technical information that the pollutant is a toxic pollutant.
2. Technical information upon which the Director reasonably may base the establishment of a numeric aquifer water quality standard.
3. Evidence that the pollutant that is the subject of the petition is or may in the future be present in an aquifer or part of an aquifer that is classified for drinking water protected use. Evidence may include, but is not limited to, any of the following:
   a. A laboratory analysis of a water sample by a laboratory licensed by the Arizona Department of Health Services which indicates the presence of the pollutant in the aquifer.
   b. A hydrogeological study which demonstrates that the pollutant that is the subject of the petition may be present in an aquifer in the future. The hydrogeological study shall include the following:
      i. A description of the use that results in a discharge of the pollutant that is the subject of the petition.
      ii. A description of the mobility of the pollutant in the vadose zone and in the aquifer.
      iii. A description of the persistence of the pollutant in the vadose zone and in the aquifer.

D. Within 180 calendar days of the receipt of a complete petition for rule adoption to establish a numeric aquifer water quality standard, the Director shall make a written determination of whether the petition should be granted or denied. The Director shall give written notice by regular mail of the determination to the petitioner.

E. If the petition for rule adoption is granted, the Director shall initiate rulemaking proceedings to adopt a numeric aquifer water quality standard. The Director shall, within one year of the date that the petition for adoption of a numeric aquifer water quality standard is granted, either adopt a rule establishing a numeric aquifer water quality standard or publish a notice of termination of rulemaking in the Arizona Administrative Register.

F. If the petition for rule adoption is denied, the Director shall issue a denial letter to the petitioner which explains the reasons for the denial. The denial of a petition for rule adoption to establish a numeric aquifer water quality standard is not subject to judicial review.

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).

Appendix 1. Repealed

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Repealed effective August 14, 1992 (Supp. 92-3).

Appendix 2. Repealed

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Repealed effective August 14, 1992 (Supp. 92-3).

Appendix 3. Repealed

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Repealed effective August 14, 1992 (Supp. 92-3).

Appendix 4. Repealed

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Repealed effective August 14, 1992 (Supp. 92-3).

Appendix 5. Repealed

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Repealed effective August 14, 1992 (Supp. 92-3).

Appendix 6. Repealed

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Repealed effective August 14, 1992 (Supp. 92-3).

Appendix 7. Repealed

Historical Note

Adopted effective January 4, 1990 (Supp. 90-1).
Repealed effective August 14, 1992 (Supp. 92-3).

ARTICLE 5. AQUIFER BOUNDARY AND PROTECTED USE CLASSIFICATION

R18-11-501. Definitions

In addition to the definitions contained in A.R.S. § 49-201, the words and phrases of this Article shall have the following meaning:

1. "Drinking water protected use" means the protection and maintenance of aquifer water quality for human consumption.
2. "Hardrock areas containing little or no water" means areas of igneous or metamorphic rock which do not yield usable quantities of water.
3. "Nondrinking water protected use" means the protection and maintenance of aquifer water quality for a use other than human consumption.
4. "Usable quantities" means five gallons of water per day.

Historical Note

Adopted effective October 22, 1987 (Supp. 87-4).

R18-11-502. Aquifer boundaries

A. Except as provided in subsection (B) of this rule, aquifer boundaries for the aquifers in this state are identified and defined as being identical to the hydrologic basin and subbasin boundaries, as found by the Director of the Department of Water Resources, Findings and Order In the Matter of The Designation of Groundwater Basins and Subbasins In The State of Arizona (dated June 21, 1984), pursuant to A.R.S. §§ 45-403 and 45-404, which is incorporated herein by reference and on file with the Department of Environmental Quality and the Office of the Secretary of State.

B. Excluded from the boundaries of the aquifers are hard rock areas which contain little or no water, as identified in Plate 1 of the Department of Water Resources, Water Resource Hydrologic Map Series Report Number 2 (dated January 1981) and as further identified in the Bureau of Mines, University of Arizona County Geologic Map Series (individual county maps dated 1957 through 1960), which are incorporated herein by reference and on file with the Department of Environmental Quality and the Office of the Secretary of State.

C. The Director may, by rule, modify or add an aquifer boundary provided that one or more of the following applies:

1. The Department of Water Resources modifies the boundaries of its basins or subbasins.
2. The Director is made aware of new technical information or data which supports refinement of an aquifer boundary.

D. Facilities located outside of the boundaries defined in these rules shall be subject to A.R.S. § 49-241 except as provided therein.

Historical Note

Adopted effective October 22, 1987 (Supp. 87-4).

R18-11-503. Petition for reclassification

A. Any person may petition the Director to reclassify an aquifer from a drinking water protected use to a nondrinking water protected use pursuant to A.R.S. § 49-224(C).

B. A written petition for reclassification pursuant to A.R.S. § 49-224(C) or A.R.S. § 49-224(D) shall be filed with the Department and shall include the following categories of information:

1. The proposed protected use for which the reclassification is being requested.
2. The pollutant and affected aquifer water quality standards for which the reclassification is being requested.
3. A hydrogeologic report which demonstrates that the aquifer proposed for reclassification is or will be hydrologically isolated, to the extent described in A.R.S. § 49-224(C)(1). This report and demonstration of hydrologic isolation for the area containing such aquifer, and immediate adjacent geologic units, shall include at least the following:
    a. Hydrogeologic area maps and cross sections.
    b. An analysis of subsurface geology, including geologic and hydrologic separation.
    c. Water level elevation or piezometric level contour maps.
    d. Analysis of hydrologic characteristics of the aquifer and the immediate adjacent geologic units.
    e. Description of existing water quality and analysis of water chemistry.
    f. Projected annual quantity of water to be withdrawn.
    g. Identification of pumping centers, cones of depression and areas of recharge.
    h. A water balance.
    i. Existing flow direction and evaluation of the effects of seasonal and future pumping on flow.
    j. An evaluation as to whether the reclassification will contribute to or cause a violation of aquifer water quality standards in other aquifers, or in parts of the aquifer not being proposed for reclassification.
4. Documentation demonstrating that water from the aquifer or part of the aquifer for which reclassification is proposed is not being used as drinking water. This documentation shall include at least the following:
    a. A list of all wells or springs including their location, ownership and use within the aquifer or part of the aquifer being proposed for reclassification.

  - b. Identification of groundwater withdrawal rights, on file with the Department of Water Resources, within the aquifer or part of the aquifer being proposed for reclassification.
  - c. A comprehensive list of agencies, persons and other information sources consulted for aquifer use documentation.
5. A cost-benefit analysis developed pursuant to the requirements of A.R.S. § 49-224(C)(3), except for petitions submitted pursuant to A.R.S. § 49-224(D). This analysis shall identify potential future uses of the aquifer being proposed for reclassification, as well as other opportunity costs associated with reclassification, and shall contain a description of the cost-benefit methodology used, including all assumptions, data, data sources and criteria considered and all supporting statistical analyses.

Historical Note

Adopted effective October 22, 1987 (Supp. 87-4).

R18-11-504. Agency action on petition

A. Upon receipt of a petition for reclassification, the Director shall review the petition for compliance with the requirements of R18-11-503. If additional information is necessary, the petitioner shall be notified of specific deficiencies in writing within 30 calendar days of receipt of the petition.

B. Within 120 calendar days after receipt of a complete petition, and after consultation with the appropriate advisory council pursuant to A.R.S. §§ 49-224(C) and 49-204, the Director shall make a final decision to grant or deny the petition and shall notify the petitioner of such decision and the reason for such determination in writing.

C. Upon a decision to grant a petition for aquifer reclassification, the Director shall initiate proceedings for promulgation of aquifer water quality standards and, if applicable, for aquifer boundary designation for the reclassified aquifers.

Historical Note

Adopted effective October 22, 1987 (Supp. 87-4).

R18-11-505. Public participation

A. Within 30 days of receipt of a complete petition for reclassification filed pursuant to A.R.S. § 49-224(D), or if the Director deems it necessary to consider a reclassification under A.R.S. § 49-224(C), the Director shall give public notice of the proposed reclassification pursuant to A.A.C. R18-1-401.

B. The Director shall hold at least one public hearing at a location as near as practicable to the aquifer proposed for reclassification. The Director shall give notice of each public hearing and conduct the public hearing in accordance with the provisions of A.A.C. R18-1-402.

Historical Note

Adopted effective June 29, 1989 (Supp. 89-2).

R18-11-506. Rescission of reclassification

The Director may, by rule, rescind an aquifer reclassification and return an aquifer to a drinking water protected use if he determines that any of the conditions under which the reclassification was granted are no longer valid. If the Director initiates a change under this Section, he shall consult with the appropriate advisory council pursuant to A.R.S. §§ 49-224(C) and 49-204.

Historical Note

Adopted effective October 22, 1987 (Supp. 87-4).

ARTICLE 6. IMPAIRED WATER IDENTIFICATION

Article 6, consisting of Sections R18-11-601 through R18-11-606, made by final rulemaking at 8 A.A.R. 3380, effective July 12, 2002 (Supp. 02-3).

R18-11-601. Definitions

In addition to the definitions established in A.R.S. §§ 49-201 and 49-231, and A.A.C. R18-11-101, the following terms apply to this Article:

1. "303(d) List" means the list of surface waters or segments required under section 303(d) of the Clean Water Act and A.R.S. Title 49, Chapter 2, Article 2.1, for which TMDLs are developed and submitted to EPA for approval.
2. "Attaining" means there is sufficient, credible, and scientifically defensible data to assess a surface water or segment and the surface water or segment does not meet the definition of impaired or not attaining.
3. "AZPDES" means the Arizona Pollutant Elimination Discharge System.
4. "Credible and scientifically defensible data" means data submitted, collected, or analyzed using:
   - a. Quality assurance and quality control procedures under A.A.C. R18-11-602;
   - b. Samples or analyses representative of water quality conditions at the time the data were collected;
   - c. Data consisting of an adequate number of samples based on the nature of the water in question and the parameters being analyzed; and
   - d. Methods of sampling and analysis, including analytical, statistical, and modeling methods that are generally accepted and validated by the scientific community as appropriate for use in assessing the condition of the water.
5. "Designated use" means those uses specified in 18 A.A.C. 11, Article 1 for each surface water or segment whether or not they are attaining.
6. "EPA" means the U.S. Environmental Protection Agency.
7. "Impaired water" means a Navigable water for which credible scientific data exists that satisfies the requirements of A.R.S. § 49-232 and that demonstrates that the water should be identified pursuant to 33 United States Code § 1313(d) and the regulations implementing that statute. A.R.S. § 49-231(1).
8. "Laboratory detection limit" means a "Method Reporting Limit" (MRL) or "Reporting Limit" (RL). These analogous terms describe the laboratory reported value, which is the lowest concentration level included on the calibration curve from the analysis of a pollutant that can be quantified in terms of precision and accuracy.
9. "Monitoring entity" means the Department or any person who collects physical, chemical, or biological data used for an impaired water identification or a TMDL decision.
10. "Naturally occurring condition" means the condition of a surface water or segment that would have occurred in the absence of pollutant loadings as a result of human activity.
11. "Not attaining" means a surface water is assessed as impaired, but is not placed on the 303(d) List because:
    - a. A TMDL is prepared and implemented for the surface water;
    - b. An action, which meets the requirements of R18-11-604(D)(2)(h), is occurring and is expected to bring the surface water to attaining before the next 303(d) List submission; or

   c. The impairment of the surface water is due to pollution but not a pollutant, for which a TMDL load allocation cannot be developed.

12. "NPDES" means National Pollutant Discharge Elimination System.
13. "Planning List" means a list of surface waters and segments that the Department will review and evaluate to determine if the surface water or segment is impaired and whether a TMDL is necessary.
14. "Pollutant" means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water. 33 U.S.C. 1362(6). Characteristics of water, such as dissolved oxygen, pH, temperature, turbidity, and suspended sediment are considered pollutants if they result or may result in the non-attainment of a water quality standard.
15. "Pollution" means "the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water." 33 U.S.C. 1362(19).
16. "QAP" means a quality assurance plan detailing how environmental data operations are planned, implemented, and assessed for quality during the duration of a project.
17. "Sampling event" means one or more samples taken under consistent conditions on one or more days at a distinct station or location.
18. "SAP" means a site specific sampling and analysis plan that describes the specifics of sample collection to ensure that data quality objectives are met and that samples collected and analyzed are representative of surface water conditions at the time of sampling.
19. "Spatially independent sample" means a sample that is collected at a distinct station or location. The sample is independent if the sample was collected:
    a. More than 200 meters apart from other samples, or
    b. Less than 200 meters apart, and collected to characterize the effect of an intervening tributary, outfall or other pollution source, or significant hydrographic or hydrologic change.
20. "Temporally independent sample" means a sample that is collected at the same station or location more than seven days apart from other samples.
21. "Threatened" means that a surface water or segment is currently attaining its designated use, however, trend analysis, based on credible and scientifically defensible data, indicates that the surface water or segment is likely to be impaired before the next listing cycle.
22. "TMDL" means total maximum daily load.
23. "TMDL decision" means a decision by the Department to:
    a. Prioritize an impaired water for TMDL development,
    b. Develop a TMDL for an impaired water, or
    c. Develop a TMDL implementation plan.
24. *"Total maximum daily load" means an estimation of the total amount of a pollutant from all sources that may be added to a water while still allowing the water to achieve and maintain applicable surface water quality standards. Each total maximum daily load shall include allocations for sources that contribute the pollutant to the water, as required by section 303(d) of the clean water act (33 United States Code section 1313(d)) and regulations implementing that statute to achieve applicable surface water quality standards.* A.R.S. § 49-231(4).
25. "Water quality standard" means a standard composed of designated uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, the antidegradation policy, and moderating provisions, for example, mixing zones, site-specific alternative criteria, and exemptions, in A.A.C. Title 18, Chapter 11, Article 1.
26. "WQARF" means the water quality assurance revolving fund established under A.R.S. § 49-282.

Historical Note

New Section made by final rulemaking at 8 A.A.R. 3380, effective July 12, 2002 (Supp. 02-3).

R18-11-602. Credible Data

A. Data are credible and relevant to an impaired water identification or a TMDL decision when:

1. Quality Assurance Plan. A monitoring entity, which contribute data for an impaired water identification or a TMDL decision, provides the Department with a QAP that contains, at a minimum, the elements listed in subsections (A)(1)(a) through (A)(1)(f). The Department may accept a QAP containing less than the required elements if the Department determines that an element is not relevant to the sampling activity and that its omission will not impact the quality of the results based upon the type of pollutants to be sampled, the type of surface water, and the purpose of the sampling.
    a. An approval page that includes the date of approval and the signatures of the approving officials, including the project manager and project quality assurance manager;
    b. A project organization outline that identifies all key personnel, organizations, and laboratories involved in monitoring, including the specific roles and responsibilities of key personnel in carrying out the procedures identified in the QAP and SAP, if applicable;
    c. Sampling design and monitoring data quality objectives or a SAP that meets the requirements of subsection (A)(2) to ensure that:
        i. Samples are spatially and temporally representative of the surface water,
        ii. Samples are representative of water quality conditions at the time of sampling, and
        iii. The monitoring is reproducible;
    d. The following field sampling information to assure that samples meet data quality objectives:
        i. Sampling and field protocols for each parameter or parametric group, including the sampling methods, equipment and containers, sample preservation, holding times, and any analysis proposed for completion in the field or outside of a laboratory;
        ii. Field and laboratory methods approved under subsection (A)(5);
        iii. Handling procedures to identify samples and custody protocols used when samples are brought from the field to the laboratory for analysis;
        iv. Quality control protocols that describe the number and type of field quality control samples for the project that includes, if appropriate

        for the type of sampling being conducted, field blanks, travel blanks, equipment blanks, method blanks, split samples, and duplicate samples;
    v. Procedures for testing, inspecting, and maintaining field equipment;
    vi. Field instrument calibration procedures that describe how and when field sampling and analytical instruments will be calibrated;
    vii. Field notes and records that describe the conditions that require documentation in the field, such as weather, stream flow, transect information, distance from water edge, water and sample depth, equipment calibration measurements, field observations of watershed activities, and bank conditions. Indicate the procedures implemented for maintaining field notes and records and the process used for attaching pertinent information to monitoring results to assist in data interpretation;
    viii. Minimum training and any specialized training necessary to do the monitoring, that includes the proper use and calibration of field equipment used to collect data, sampling protocols, quality assurance/quality control procedures, and how training will be achieved;
  e. Laboratory analysis methods and quality assurance/ quality control procedures that assure that samples meet data quality objectives, including:
    i. Analytical methods and equipment necessary for analysis of each parameter, including identification of approved laboratory methods described in subsection (A)(5), and laboratory detection limits for each parameter;
    ii. The name of the designated laboratory, its license number, if licensed by the Arizona Department of Health Services, and the name of a laboratory contact person to assist the Department with quality assurance questions;
    iii. Quality controls that describe the number and type of laboratory quality control samples for the project, including, if appropriate for the type of sampling being conducted, field blanks, travel blanks, equipment blanks, method blanks, split samples, and duplicate samples;
    iv. Procedures for testing, inspecting, and maintaining laboratory equipment and facilities;
    v. A schedule for calibrating laboratory instruments, a description of calibration methods, and a description of how calibration records are maintained; and
    vi. Sample equipment decontamination procedures that outline specific methods for sample collection and preparation of equipment, identify the frequency of decontamination, and describe the procedures used to verify decontamination;
  f. Data review, management, and use that includes the following:
    i. A description of the data handling process from field to laboratory, from laboratory to data review and validation, and from validation to data storage and use. Include the role and responsibility of each person for each step of the process, type of database or other storage used, and how laboratory and field data qualifiers are related to the laboratory result;
    ii. Reports that describe the intended frequency, content, and distribution of final analysis reports and project status reports;
    iii. Data review, validation, and verification that describes the procedure used to validate and verify data, the procedures used if errors are detected, and how data are accepted, rejected, or qualified; and
    iv. Reconciliation with data quality objectives that describes the process used to determine whether the data collected meets the project objectives, which may include discarding data, setting limits on data use, or revising data quality objectives.
2. Sampling and analysis plan.
  a. A monitoring entity shall develop a SAP that contains, at a minimum, the following elements:
    i. The experimental design of the project, the project goals and objectives, and evaluation criteria for data results;
    ii. The background or historical perspective of the project;
    iii. Identification of target conditions, including a discussion of whether any weather, seasonal variations, stream flow, lake level, or site access may affect the project and the consideration of these factors;
    iv. The data quality objectives for measurement of data that describe in quantitative and qualitative terms how the data meet the project objectives of precision, accuracy, completeness, comparability, and representativeness;
    v. The types of samples scheduled for collection;
    vi. The sampling frequency;
    vii. The sampling periods;
    viii. The sampling locations and rationale for the site selection, how site locations are benchmarked, including scaled maps indicating approximate location of sites; and
    ix. A list of the field equipment, including tolerance range and any other manufacturer's specifications relating to accuracy and precision.
  b. The Department may accept a SAP containing less than the required elements if the Department determines that an element is not relevant to the sampling activity and that its omission will not impact the quality of the results based upon the type of pollutants to be samples, the type of surface water, and the purpose of the sampling.
3. The monitoring entity may include any of the following in the QAP or SAP:
  a. The name, title, and role of each person and organization involved in the project, identifying specific roles and responsibilities for carrying out the procedures identified in the QAP and SAP;
  b. A distribution list of each individual and organization receiving a copy of the approved QAP and SAP;
  c. A table of contents;
  d. A health and safety plan;
  e. The inspection and acceptance requirements for supplies;

  - f. The data acquisition that describes types of data not obtained through this monitoring activity, but used in the project;
  - g. The audits and response actions that describe how field, laboratory, and data management activities and sampling personnel are evaluated to ensure data quality, including a description of how the project will correct any problems identified during these assessments; and
  - h. The waste disposal methods that identify wastes generated in sampling and methods for disposal of those wastes.
- 4. Exceptions. The Department may determine that the following data are also credible and relevant to an impaired water identification or TMDL decision when data were collected, provided the conditions in subsections (A)(5), (A)(6), and (B) are met, and where the data were collected in the surface water or segment being evaluated for impairment:
  - a. The data were collected before July 12, 2002 and the Department determines that the data yield results of comparable reliability to the data collected under subsections (A)(1) and (A)(2);
  - b. The data were collected after July 12, 2002 as part of an ongoing monitoring effort by a governmental agency and the Department determines that the data yield results of comparable reliability to the data collected under subsections (A)(1) and (A)(2); or
  - c. The instream water quality data were or are collected under the terms of a NPDES or AZPDES permit or a compliance order issued by the Department or EPA, a consent decree signed by the Department or EPA, or a sampling program approved by the Department or EPA under WQARF or CERCLA, and the Department determines that the data yield results of comparable reliability to data collected under subsections (A)(1) and (A)(2).
- 5. Data collection, preservation, and analytical procedures. The monitoring entity shall collect, preserve, and analyze data using methods of sample collection, preservation, and analysis established under A.A.C. R9-14-610.
- 6. Laboratory. The monitoring entity shall ensure that chemical and toxicological samples are analyzed in a state-licensed laboratory, a laboratory exempted by the Arizona Department of Health Services for specific analyses, or a federal or academic laboratory that can demonstrate proper quality assurance/quality control procedures substantially equal to those required by the Arizona Department of Health Services, and shall ensure that the laboratory uses approved methods identified in A.A.C. R9-14-610.

B. Documentation for data submission. The monitoring entity shall provide the Department with the following information either before or with data submission:

- 1. A copy of the QAP or SAP, or both, revisions to a previously submitted QAP or SAP, and any other information necessary for the Department to evaluate the data under subsection (A)(4);
- 2. The applicable dates of the QAP and SAP, including any revisions;
- 3. Written assurance that the methods and procedures specified in the QAP and SAP were followed;
- 4. The name of the laboratory used for sample analyses and its certification number, if the laboratory is licensed by the Arizona Department of Health Services;
- 5. The quality assurance/quality control documentation, including the analytical methods used by the laboratory, method number, detection limits, and any blank, duplicate, and spike sample information necessary to properly interpret the data, if different from that stated in the QAP or SAP;
- 6. The data reporting unit of measure;
- 7. Any field notes, laboratory comments, or laboratory notations concerning a deviation from standard procedures, quality control, or quality assurance that affects data reliability, data interpretation, or data validity; and
- 8. Any other information, such as complete field notes, photographs, climate, or other information related to flow, field conditions, or documented sources of pollutants in the watershed, if requested by the Department for interpreting or validating data.

C. Recordkeeping. The monitoring entity shall maintain all records, including sample results, for the duration of the listing cycle. If a surface water or segment is added to the Planning List or to the 303(d) List, the Department shall coordinate with the monitoring entity to ensure that records are kept for the duration of the listing.

Historical Note

New Section made by final rulemaking at 8 A.A.R. 3380, effective July 12, 2002 (Supp. 02-3).

R18-11-603. General Data Interpretation Requirements

A. The Department shall use the following data conventions to interpret data for impaired water identifications and TMDL decisions:

- 1. Data reported below laboratory detection limits.
  - a. When the analytical result is reported as <X, where X is the laboratory detection limit for the analyte and the laboratory detection limit is less than or equal to the surface water quality standard, consider the result as meeting the water quality standard:
    - i. Use these statistically derived values in trend analysis, descriptive statistics or modeling if there is sufficient data to support the statistical estimation of values reported as less than the laboratory detection limit; or
    - ii. Use one-half of the value of the laboratory detection limit in trend analysis, descriptive statistics, or modeling, if there is insufficient data to support the statistical estimation of values reported as less than the laboratory detection limit.
  - b. When the sample value is less than or equal to the laboratory detection limit but the laboratory detection limit is greater than the surface water quality standard, shall not use the result for impaired water identifications or TMDL decisions;
- 2. Identify the field equipment specifications used for each listing cycle or TMDL developed. A field sample measurement within the manufacturer's specification for accuracy meets surface water quality standards;
- 3. Resolve a data conflict by considering the factors identified under the weight-of-evidence determination in R18-11-605(B);
- 4. When multiple samples from a surface water or segment are not spatially or temporally independent, or when lake

samples are from multiple depths, use the following resultant value to represent the specific dataset:

a. The appropriate measure of central tendency for the dataset for:
    i. A pollutant listed in the surface water quality standards 18 A.A.C. 11, Article 1, Appendix A, Table 1, except for nitrate or nitrate/nitrite;
    ii. A chronic water quality standard for a pollutant listed in 18 A.A.C. 11, Article 1, Appendix A, Table 2;
    iii. A surface water quality standard for a pollutant that is expressed as an annual or geometric mean;
    iv. The surface water quality standard for temperature or the single sample maximum water quality standard for suspended sediment concentration, nitrogen, and phosphorus in R18-11-109;
    v. The surface water quality standard for radiochemicals in R18-11-109(G); or
    vi. Except for chromium, all single sample maximum water quality standards in R18-11-112.
b. The maximum value of the dataset for:
    i. The acute water quality standard for a pollutant listed in 18 A.A.C. 11, Article 1, Appendix A, Table 2 and acute water quality standard in R18-11-112;
    ii. The surface water quality standard for nitrate or nitrate/nitrite in 18 A.A.C. 11, Article 1, Appendix A, Table 1;
    iii. The single sample maximum water quality standard for bacteria in subsections R18-11-109(A); or
    iv. The 90th percentile water quality standard for nitrogen and phosphorus in R18-11-109(F) and R18-11-112.
c. The worst case measurement of the dataset for:
    i. Surface water quality standard for dissolved oxygen under R18-11-109(E). For purposes of this subsection, worst case measurement means the minimum value for dissolved oxygen;
    ii. Surface water quality standard for pH under R18-11-109(B). For purposes of this subsection, “worst case measurement” means both the minimum and maximum value for pH.

B. The Department shall not use the following data for placing a surface water or segment on the Planning List, the 303(d) List, or in making a TMDL decision.
1. Any measurement outside the range of possible physical or chemical measurements for the pollutant or measurement equipment,
2. Uncorrected data transcription errors or laboratory errors, and
3. An outlier identified through statistical procedures, where further evaluation determines that the outlier represents a valid measure of water quality but should be excluded from the dataset.

C. The Department may employ fundamental statistical tests if appropriate for the collected data and type of surface water when evaluating a surface water or segment for impairment or in making a TMDL decision. The statistical tests include descriptive statistics, frequency distribution, analysis of variance, correlation analysis, regression analysis, significance testing, and time series analysis.

D. The Department may employ modeling when evaluating a surface water or segment for impairment or in making a TMDL decision, if the method is appropriate for the type of waterbody and the quantity and quality of available data meet the requirements of R18-11-602. Modeling methods include:
1. Better Assessment Science Integrating Source and Nonpoint Sources (BASINS),
2. Fundamental statistics, including regression analysis,
3. Hydrologic Simulation Program-Fortran (HSPF),
4. Spreadsheet modeling, and
5. Hydrologic Engineering Center (HEC) programs developed by the Army Corps of Engineers.

Historical Note

New Section made by final rulemaking at 8 A.A.R. 3380, effective July 12, 2002 (Supp. 02-3).

R18-11-604. Types of Surface Waters Placed on the Planning List and 303(d) List

A. The Department shall evaluate, at least every five years, Arizona’s surface waters by considering all readily available data.
1. The Department shall place a surface water or segment on:
    a. The Planning List if it meets any of the criteria described in subsection (D), or
    b. The 303(d) List if it meets the criteria for listing described in subsection (E).
2. The Department shall remove a surface water or segment from the Planning List based on the requirements in R18-11-605(E)(1) or from the 303(d) List, based on the requirements in R18-11-605(E)(2).
3. The Department may move surface waters or segments between the Planning List and the 303(d) List based on the criteria established in R18-11-604 and R18-11-605.

B. When placing a surface water or segment on the Planning List or the 303(d) List, the Department shall list the stream reach, derived from EPA’s Reach File System or National Hydrography Dataset, or the entire lake, unless the data indicate that only a segment of the stream reach or lake is impaired or not attaining its designated use, in which case, the Department shall describe only that segment for listing.

C. Exceptions. The Department shall not place a surface water or segment on either the Planning List or the 303(d) List if the non-attainment of a surface water quality standard is due to one of the following:
1. Pollutant loadings from naturally occurring conditions alone are sufficient to cause a violation of applicable water quality standards;
2. The data were collected within a mixing zone or under a variance or nutrient waiver established in a NPDES or AZPDES permit for the specific parameter and the result does not exceed the alternate discharge limitation established in the permit. The Department may use data collected within these areas for modeling or allocating loads in a TMDL decision; or
3. An activity exempted under R18-11-117, R18-11-118, or a condition exempted under R18-11-119.

D. Planning List.
1. The Department shall:
    a. Use the Planning List to prioritize surface waters for monitoring and evaluation as part of the Department’s watershed management approach;
    b. Provide the Planning List to EPA; and
    c. Evaluate each surface water and segment on the Planning List for impairment based on the criteria in

R18-11-605(D) to determine the source of the impairment.

2. The Department shall place a surface water or segment on the Planning List based the criteria in R18-11-605(C). The Department may also include a surface water or segment on the Planning List when:
   a. A TMDL is completed for the pollutant and approved by EPA;
   b. The surface water or segment is on the 1998 303(d) List but the dataset used for the listing:
      i. Does not meet the credible data requirements of R18-11-602, or
      ii. Contains insufficient samples to meet the data requirements under R18-11-605(D);
   c. Some monitoring data exist but there are insufficient data to determine whether the surface water or segment is impaired or not attaining, including:
      i. A numeric surface water quality standard is exceeded, but there are not enough samples or sampling events to fulfill the requirements of R18-11-605(D);
      ii. Evidence exists of a narrative standard violation, but the amount of evidence is insufficient, based on narrative implementation procedures and the requirements of R18-11-605(D)(3);
      iii. Existing monitoring data do not meet credible data requirements in R18-11-602; or
      iv. A numeric surface water quality standard is exceeded, but there are not enough sample results above the laboratory detection limit to support statistical analysis as established in R18-11-603(A)(1).
   d. The surface water or segment no longer meets the criteria for impairment based on a change in the applicable surface water quality standard or a designated use approved by EPA under section 303(c)(1) of the Clean Water Act, but insufficient current or original monitoring data exist to determine whether the surface water or segment will meet current surface water quality standards;
   e. Trend analysis using credible and scientifically defensible data indicate that surface water quality standards may be exceeded by the next assessment cycle;
   f. The exceedance of surface water quality standards is due to pollution, but not a pollutant;
   g. Existing data were analyzed using methods with laboratory detection limits above the numeric surface water quality standard but analytical methods with lower laboratory detection limits are available;
   h. The surface water or segment is expected to attain its designated use by the next assessment as a result of existing or proposed technology-based effluent limitations or other pollution control requirements under local, state, or federal authority. The appropriate entity shall provide the Department with the following documentation to support placement on the Planning List:
      i. Verification that discharge controls are required and enforceable;
      ii. Controls are specific to the surface water or segment, and pollutant of concern;
      iii. Controls are in place or scheduled for implementation; and
      iv. There are assurances that the controls are sufficient to bring about attainment of water quality standards by the next 303(d) List submission; or
   i. The surface water or segment is threatened due to a pollutant and, at the time the Department submits a final 303(d) List to EPA, there are no federal regulations implementing section 303(d) of the Clean Water Act that require threatened waters be included on the list.

E. 303(d) List. The Department shall:
1. Place a surface water or segment on the 303(d) List if the Department determines:
   a. Based on R18-11-605(D), that the surface water or segment is impaired due to a pollutant and that a TMDL decision is necessary; or
   b. That the surface water or segment is threatened due to a pollutant and, at the time the Department submits a final 303(d) List to EPA, there are federal regulations implementing section 303(d) of the Clean Water Act that require threatened waters be included on the list.
2. Provide public notice of the 303(d) List according to the requirements of A.R.S. § 49-232 and submit the 303(d) List according to section 303(d) of the Clean Water Act.

Historical Note

New Section made by final rulemaking at 8 A.A.R. 3380, effective July 12, 2002 (Supp. 02-3).

R18-11-605. Evaluating A Surface Water or Segment For Listing and Delisting

A. The Department shall compile and evaluate all reasonably current, credible, and scientifically defensible data to determine whether a surface water or segment is impaired or not attaining.

B. Weight-of-evidence approach.
1. The Department shall consider the following concepts when evaluating data:
   a. Data or information collected during critical conditions may be considered separately from the complete dataset, when the data show that the surface water or segment is impaired or not attaining its designated use during those critical conditions, but attaining its uses during other periods. Critical conditions may include stream flow, seasonal periods, weather conditions, or anthropogenic activities;
   b. Whether the data indicate that the impairment is due to persistent, seasonal, or recurring conditions. If the data do not represent persistent, recurring, or seasonal conditions, the Department may place the surface water or segment on the Planning List;
   c. Higher quality data over lower quality data when making a listing decision. Data quality is established by the reliability, precision, accuracy, and representativeness of the data, based on factors identified in R18-11-602(A) and (B), including monitoring methods, analytical methods, quality control procedures, and the documented field and laboratory quality control information submitted with the data. The Department shall consider the following factors when determining higher quality data:
      i. The age of the measurements. Newer measurements are weighted heavier than older measure-

ments, unless the older measurements are more representative of critical flow conditions;

    - ii. Whether the data provide a direct measure of an impact on a designated use. Direct measurements are weighted heavier than measurements of an indicator or surrogate parameter; or
    - iii. The amount or frequency of the measurements. More frequent data collection are weighted heavier than nominal datasets.

2. The Department shall evaluate the following factors to determine if the water quality evidence supports a finding that the surface water or segment is impaired or not attaining:
    - a. An exceedance of a numeric surface water quality standard based on the criteria in subsections (C)(1), (C)(2), (D)(1), and (D)(2);
    - b. An exceedance of a narrative surface water quality standard based on the criteria in subsections (C)(3) and (D)(3);
    - c. Additional information that determines whether a water quality standard is exceeded due to a pollutant, suspected pollutant, or naturally occurring condition:
        - i. Soil type, geology, hydrology, flow regime, biological community, geomorphology, climate, natural process, and anthropogenic influence in the watershed;
        - ii. The characteristics of the pollutant, such as its solubility in water, bioaccumulation potential, sediment sorption potential, or degradation characteristics, to assist in determining which data more accurately indicate the pollutant's presence and potential for causing impairment; and
        - iii. Available evidence of direct or toxic impacts on aquatic life, wildlife, or human health, such as fish kills and beach closures, where there is sufficient evidence that these impacts occurred due to water quality conditions in the surface water.
    - d. Other available water quality information, such as NPDES or AZPDES water quality discharge data, as applicable.
    - e. If the Department determines that a surface water or segment does not merit listing under numeric water quality standards based on criteria in subsections (C)(1), (C)(2), (D)(1), or (D)(2) for a pollutant, but there is evidence of a narrative standard exceedance in that surface water or segment under subsection (D)(3) as a result of the presence of the same pollutant, the Department shall list the surface water or segment as impaired only when the evidence indicates that the numeric water quality standard is insufficient to protect the designated use of the surface water or segment and the Department justifies the listing based on any of the following:
        - i. The narrative standard data provide a more direct indication of impairment as supported by professionally prepared and peer-reviewed publications;
        - ii. Sufficient evidence of impairment exists due to synergistic effects of pollutant combinations or site-specific environmental factors; or
        - iii. The pollutant is bioaccumulative, relatively insoluble in water, or has other characteristics that indicate it is occurring in the specific surface water or segment at levels below the laboratory detection limits, but at levels sufficient to result in an impairment.

3. The Department may consider a single line of water quality evidence when the evidence is sufficient to demonstrate that the surface water or segment is impaired or not attaining.

C. Planning List.

1. When evaluating a surface water or segment for placement on the Planning List.
    - a. Consider at least ten spatially or temporally independent samples collected over three or more temporally independent sampling events; and
    - b. Determine numeric water quality standards exceedances. The Department shall:
        - i. Place a surface water or segment on the Planning List following subsection (B), if the number of exceedances of a surface water quality standard is greater than or equal to the number listed in Table 1, which provides the number of exceedances that indicate a minimum of a 10 percent exceedance frequency with a minimum of a 80 percent confidence level using a binomial distribution for a given sample size; or
        - ii. For sample datasets exceeding those shown in Table 1, calculate the number of exceedances using the following equation: $(X \geq x|\ n, p)$ where n = number of samples; p = exceedance probability of 0.1; x = smallest number of exceedances required for listing with "n" samples; and confidence level $\geq$ 80 percent.

Table 1. Minimum Number of Samples Exceeding the Numeric Standard

MINIMUM NUMBER OF SAMPLES EXCEEDING THE NUMERIC STANDARD								
Number of Samples		Number of Samples Exceeding Standard	Number of Samples		Number of Samples Exceeding Standard	Number of Samples		Number of Samples Exceeding Standard
From	To		From	To		From	To	
10	15	3	173	181	22	349	357	41
16	23	4	182	190	23	358	367	42
24	31	5	191	199	24	368	376	43
32	39	6	200	208	25	377	385	44
40	47	7	209	218	26	386	395	45
48	56	8	219	227	27	396	404	46
57	65	9	228	236	28	405	414	47

66	73	10	237	245	29	415	423	48
74	82	11	246	255	30	424	432	49
83	91	12	256	264	31	433	442	50
92	100	13	265	273	32	443	451	51
101	109	14	274	282	33	452	461	52
110	118	15	283	292	34	462	470	53
119	126	16	293	301	35	471	480	54
127	136	17	302	310	36	481	489	55
137	145	18	311	320	37	490	499	56
146	154	19	321	329	38	500		57
155	163	20	330	338	39			
164	172	21	339	348	40			

2. When there are less than ten samples, the Department shall place a surface water or segment on the Planning List following subsection (B), if three or more temporally independent samples exceed the following surface water quality standards:
    a. The surface water quality standard for a pollutant listed in 18 A.A.C. 11, Article 1, Appendix A, Table 1, except for nitrate or nitrate/nitrite;
    b. The surface water quality standard for temperature or the single sample maximum water quality standard for suspended sediment concentration, nitrogen, and phosphorus in R18-11-109;
    c. The surface water quality standard for radiochemicals in R18-11-109(G);
    d. The surface water quality standard for dissolved oxygen under R18-11-109(E);
    e. The surface water quality standard for pH under R18-11-109(B); or
    f. The following surface water quality standards in R18-11-112:
        i. Single sample maximum standards for nitrogen and phosphorus,
        ii. All metals except chromium, or
        iii. Turbidity.
3. The Department shall place a surface water or segment on the Planning List if information in subsections (B)(2)(c), (B)(2)(d), and (B)(2)(e) indicates that a narrative water quality standard violation exists, but no narrative implementation procedure required under A.R.S. § 49-232(F) exists to support use of the information for listing.

D. 303(d) List.

1. When evaluating a surface water or segment for placement on the 303(d) List.
    a. Consider at least 20 spatially or temporally independent samples collected over three or more temporally independent sampling events; and
    b. Determine numeric water quality standards exceedances. The Department shall:
        i. Place a surface water or segment on the 303(d) List, following subsection (B), if the number of exceedances of a surface water quality standard is greater than or equal to the number listed in Table 2, which provides the number of exceedances that indicate a minimum of a 10 percent exceedance frequency with a minimum of a 90 percent confidence level using a binomial distribution, for a given sample size; or
        ii. For sample datasets exceeding those shown in Table 2, calculate the number of exceedances using the following equation: $(X \geq x | n, p)$ where n = number of samples; p = exceedance probability of 0.1; x = smallest number of exceedances required for listing with "n" samples; and confidence level ≥ 90 percent.

Table 2. Minimum Number of Samples Exceeding the Numeric Standard

MINIMUM NUMBER OF SAMPLES EXCEEDING THE NUMERIC STANDARD								
Number of Samples		Number of Samples Exceeding Standard	Number of Samples		Number of Samples Exceeding Standard	Number of Samples		Number of Samples Exceeding Standard
From	To		From	To		From	To	
20	25	5	174	182	24	344	352	43
26	32	6	183	191	25	353	361	44
33	40	7	192	199	26	362	370	45
41	47	8	200	208	27	371	379	46
48	55	9	209	217	28	380	388	47
56	63	10	218	226	29	389	397	48
64	71	11	227	235	30	398	406	49
72	79	12	236	244	31	407	415	50
80	88	13	245	253	32	416	424	51
89	96	14	254	262	33	425	434	52
97	104	15	263	270	34	435	443	53
105	113	16	271	279	35	444	452	54

114	121	17	280	288	36	453	461	55
122	130	18	289	297	37	462	470	56
131	138	19	298	306	38	471	479	57
139	147	20	307	315	39	480	489	58
148	156	21	316	324	40	490	498	59
157	164	22	325	333	41	499	500	60
165	173	23	334	343	42			

2. The Department shall place a surface water or segment on the 303(d) List, following subsection (B) without the required number of samples or numeric water quality standard exceedances under subsection (D)(1), if either the following conditions occur:
   a. More than one temporally independent sample in any consecutive three-year period exceeds the surface water quality standard in:
      i. The acute water quality standard for a pollutant listed in 18 A.A.C. 11, Article 1, Appendix A, Table 2 and the acute water quality standards in R18-11-112;
      ii. The surface water quality standard for nitrate or nitrate/nitrite in 18 A.A.C. 11, Article 1, Appendix A, Table 1; or
      iii. The single sample maximum water quality standard for bacteria in subsections R18-11-109(A).
   b. More than one exceedance of an annual mean, 90th percentile, aquatic and wildlife chronic water quality standard, or a bacteria 30-day geometric mean water quality standard occurs, as specified in R18-11-109, R18-11-110, R18-11-112, or 18 A.A.C. 11, Article 1, Appendix A, Table 2.
3. Narrative water quality standards exceedances. The Department shall place a surface water or segment on the Planning List if the listing requirements are met under A.R.S. § 49-232(F).

E. Removing a surface water, segment, or pollutant from the Planning List or the 303(d) List.
1. Planning List. The Department shall remove a surface water, segment, or pollutant from the Planning List when:
   a. Monitoring activities indicate that:
      i. There is sufficient credible data to determine that the surface water or segment is impaired under subsection (D), in which case the Department shall place the surface water or segment on the 303(d) List. This includes surface waters with an EPA approved TMDL when the Department determines that the TMDL strategy is insufficient for the surface water or segment to attain water quality standards; or
      ii. There is sufficient credible data to determine that the surface water or segment is attaining all designated uses and standards.
   b. All pollutants for the surface water or segment are delisted.
2. 303(d) List. The Department shall:
   a. Remove a pollutant from a surface water or segment from the 303(d) List based on one or more of the following criteria:
      i. The Department developed, and EPA approved, a TMDL for the pollutant;
      ii. The data used for previously listing the surface water or segment under R18-11-605(D) is superseded by more recent credible and scientifically defensible data meeting the requirements of R18-11-602, showing that the surface water or segment meets the applicable numeric or narrative surface water quality standard. When evaluating data to remove a pollutant from the 303(d) List, the monitoring entity shall collect the more recent data under similar hydrologic or climatic conditions as occurred when the samples were taken that indicated impairment, if those conditions still exist;
      iii. The surface water or segment no longer meets the criteria for impairment based on a change in the applicable surface water quality standard or a designated use approved by EPA under section 303(c)(1) of the Clean Water Act;
      iv. The surface water or segment no longer meets the criteria for impairment for the specific narrative water quality standard based on a change in narrative water quality standard implementation procedures;
      v. A re-evaluation of the data indicate that the surface water or segment does not meet the criteria for impairment because of a deficiency in the original analysis; or
      vi. Pollutant loadings from naturally occurring conditions alone are sufficient to cause a violation of applicable water quality standards;
   b. Remove a surface water, segment, or pollutant from the 303(d) List, based on criteria that are no more stringent than the listing criteria under subsection (D);
   c. Remove a surface water or segment from the 303(d) List if all pollutants for the surface water or segment are removed from the list;
   d. Remove a surface water, segment, or pollutant, from the 303(d) List and place it on the Planning List, if:
      i. The surface water, segment or pollutant was on the 1998 303(d) List and the dataset used in the original listing does not meet the credible data requirements under R18-11-602, or contains insufficient samples to meet the data requirements under subsection (D); or
      ii. The monitoring data indicate that the impairment is due to pollution, but not a pollutant.

Historical Note

New Section made by final rulemaking at 8 A.A.R. 3380, effective July 12, 2002 (Supp. 02-3).

R18-11-606. TMDL Priority Criteria for 303(d) Listed Surface Waters or Segments

A. In addition to the factors specified in A.R.S. § 49-233(C), the Department shall consider the following when prioritizing an impaired water for development of TMDLs:
1. A change in a water quality standard;

2. The date the surface water or segment was added to the 303(d) List;
3. The presence in a surface water or segment of species listed as threatened or endangered under section 4 of the Endangered Species Act;
4. The complexity of the TMDL;
5. State, federal, and tribal policies and priorities; and
6. The efficiencies of coordinating TMDL development with the Department's surface water monitoring program, the watershed monitoring rotation, or with remedial programs.

B. The Department shall prioritize an impaired surface water or segment for TMDL development based on the factors specified in A.R.S. § 49-233(C) and subsection (A) as follows:
1. Consider an impaired surface water or segment a high priority if:
   a. The listed pollutant poses a substantial threat to the health and safety of humans, aquatic life, or wildlife based on:
      i. The number and type of designated uses impaired;
      ii. The type and extent of risk from the impairment to human health, aquatic life, or wildlife;
      iii. The pollutant causing the impairment, or
      iv. The severity, magnitude, and duration the surface water quality standard was exceeded;
   b. A new or modified individual NPDES or AZPDES permit is sought for a new or modified discharge to the impaired water;
   c. The listed surface water or segment is listed as a unique water in A.A.C. R18-11-112 or is part of an area classified as a "wilderness area," "wild and scenic river," or other federal or state special protection of the water resource;
   d. The listed surface water or segment contains a species listed as threatened or endangered under the federal Endangered Species Act and the presence of the pollutant in the surface water or segment is likely to jeopardize the listed species;
   e. A delay in conducting the TMDL could jeopardize the Department's ability to gather sufficient credible data necessary to develop the TMDL;
   f. There is significant public interest and support for the development of a TMDL;
   g. The surface water or segment has important recreational and economic significance to the public; or
   h. The pollutant is listed for eight years or more.
2. Consider an impaired surface water or segment a medium priority if:
   a. The surface water or segment fails to meet more than one designated use;
   b. The pollutant exceeds more than one surface water quality standard;
   c. A surface water quality standard exceedance is correlated to seasonal conditions caused by natural events, such as storms, weather patterns, or lake turnover;
   d. It will take more than two years for proposed actions in the watershed to result in the surface water attaining applicable water quality standards;
   e. The type of pollutant and other factors relating to the surface water or segment make the TMDL complex; or
   f. The administrative needs of the Department, including TMDL schedule commitments with EPA, permitting requirements, or basin priorities that require completion of the TMDL.
3. Consider an impaired surface water or segment a low priority if:
   a. The Department has formally submitted a proposal to delist the surface water, segment, or pollutant to EPA based on R18-11-605(E)(2). If the Department makes the submission outside the listing process cycle, the change in priority ranking will not be effective until EPA approves the submittal;
   b. The Department has modified, or formally proposed for modification, the designated use or applicable surface water quality standard, resulting in an impaired water no longer being impaired, but the modification has not been approved by EPA;
   c. The surface water or segment is expected to attain surface water quality standards due to any of the following:
      i. Recently instituted treatment levels or best management practices in the drainage area,
      ii. Discharges or activities related to the impairment have ceased, or
      iii. Actions have been taken and controls are in place or scheduled for implementation that will likely to bring the surface water back into compliance;
   d. The surface water or segment is ephemeral or intermittent. The Department shall re-prioritize the surface water or segment if the presence of the pollutant in the listed water poses a threat to the health and safety of humans, aquatic life, or wildlife using the water, or the pollutant is contributing to the impairment of a downstream perennial surface water or segment;
   e. The pollutant poses a low ecological and human health risk;
   f. Insufficient data exist to determine the source of the pollutant load;
   g. The uncertainty of timely coordination with national and international entities concerning international waters;
   h. Naturally occurring conditions are a major contributor to the impairment; and
   i. No documentation or effective analytical tools exist to develop a TMDL for the surface water or segment with reasonable accuracy.

C. The Department will target surface waters with high priority factors in subsections (B)(1)(a) through (B)(1)(d) for initiation of TMDLs within two years following EPA approval of the 303(d) List.

D. The Department may shift priority ranking of a surface water or segment for any of the following reasons:
1. A change in federal, state, or tribal policies or priorities that affect resources to complete a TMDL;
2. Resource efficiencies for coordinating TMDL development with other monitoring activities, including the Department's ambient monitoring program that monitors watersheds on a five-year rotational basis;
3. Resource efficiencies for coordinating TMDL development with Department remedial or compliance programs;

4. New information is obtained that will revise whether the surface water or segment is a high priority based on factors in subsection (B); and
5. Reduction or increase in staff or budget involved in the TMDL development.

E. The Department may complete a TMDL initiated before July 12, 2002 for a surface water or segment that was listed as impaired on the 1998 303(d) List but does not qualify for listing under the criteria in R18-11-605, if:

1. The TMDL investigation establishes that the water quality standard is not being met and the allocation of loads is expected to bring the surface water into compliance with standards,
2. The Department estimates that more than 50 percent of the cost of completing the TMDL has been spent,
3. There is community involvement and interest in completing the TMDL, or
4. The TMDL is included within an EPA-approved state workplan initiated before July 12, 2002.

Historical Note

New Section made by final rulemaking at 8 A.A.R. 3380, effective July 12, 2002 (Supp. 02-3).

APPENDIX F

ADEQ Soil Vapor Sampling Guidance

Notice Required by ARS § 41-1091(B):
"This substantive policy statement is advisory only. A substantive policy statement does not include internal procedural documents that only affect the internal procedures of the agency and does not impose additional requirements or penalties on regulated parties or include confidential information or rules made in accordance with the Arizona Administrative Procedure Act. If you believe that this substantive policy statement does impose additional requirements or penalties on regulated parties you may petition the agency under A.R.S. § 41-1033 for a review of the statement."

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

SOIL VAPOR SAMPLING GUIDANCE

July 10, 2008
(Revised May 19, 2011)
(Revised April 21, 2017)

Soil Vapor Sampling Guidance

1. Scope and Application

1.1 This guidance describes procedures for collection of active soil vapor samples and does not address procedures for collection of passive soil vapor samples.

1.2 This guidance details sampling procedures to ensure delivery of soil vapor samples to the laboratory that will yield reliable and consistent results that are representative of actual conditions.

1.3 This guidance provides a methodology to estimate the total contaminant concentration in soil using soil vapor samples.

2. Definitions

2.1 Dead Volume – volume of the sampling probe and the connected sampling tubing and equipment. The boring volume is not included in the calculation of dead volume, because the probe tip sand-pack space is assumed to have been allowed to equilibrate with surrounding soil formation before soil vapor sampling occurs.

2.2 Internal Volume – dead volume plus probe tip sand-pack volume.

2.3 Probe Driving System – hydraulic or hammer system used for installation of soil vapor sampling probes.

2.4 Soil Vapor Monitoring Well – a well constructed specifically to sample soil vapor from the vadose zone.

2.5 Soil Vapor Sample – a sample of soil vapor representative of the vadose zone at the sampled location.

2.6 Soil Vapor Sampling Port – any mechanical device (usually a ball valve with a hose barb) that allows a representative soil vapor sample to be collected from a soil vapor monitoring well.

2.7 Soil Vapor Sampling Probe – any mechanical device that allows collection of a representative soil vapor sample from a specified sampling depth.

2.8 Vapor Equilibration – the condition where vapor concentration entering a sampling probe is 95% or greater of vapor concentration in surrounding soil.

3. Considerations when Planning for Soil Vapor Sampling

The collection and analysis of soil vapor samples, along with any existing soil and groundwater data or any reasonably obtainable data (e.g., soil solids and groundwater data), is useful for the objectives of site characterization, determination of potential pathways of exposure for health risk, optimization of remedial or mitigation systems design, and confirmation of compliance with remedial goals.

3.1 Temporal Variations in Soil Vapor Concentrations

Variations in soil vapor concentrations due to temporal effects are principally due to temperature changes, precipitation, and activities within any overlying structure. Variations are greater for samples close to the surface and vary less with increasing depth. There are a number of available studies on the temporal variation in soil vapor concentrations and more are currently underway or planned in 2007 by the EPA and independent groups. The results of these studies have shown that short-term variations in soil vapor concentrations at depths four feet or deeper are less than a factor of two and seasonal variations in colder climates less that a factor of five.

Descriptions of expected variations in soil vapor concentrations due to temperature variation and periods of heavy precipitation follows:

3.1.1 Temperature: Effects on soil vapor concentrations due to actual changes in the vadose zone temperature will be minimal.

3.1.2 Precipitation: Infiltration from rainfall can potentially impact soil vapor concentrations by displacing the soil vapor, dissolving volatile organic compounds, and by creating a “cap” above the soil vapor. In most settings, infiltration from large storms only penetrates into the uppermost vadose zone. Soil vapor samples collected at depths greater than 3 to 5 feet below ground surface (bgs) under foundations or areas with surface cover are unlikely to be significantly affected. However, soil vapor samples collected closer to the surface (<3 feet) with no surface cover may be affected. It is preferred that sample collection not occur if any precipitation is falling or has fallen within 24 hours. Difficult collection of soil vapor samples is typical when the moisture has penetrated to the sampling zone. Consider measured values as minimum values when encountering high vacuum readings when collecting a sample or when drops of moisture are evident in the sampling system or sample. Measurement of percent moisture of the soil may also be useful if shallow sampling is performed during or shortly after significant rainfall (>1.0 inch).

3.1.3 Pressure: Barometric pressure variations are unlikely to have a significant effect on soil vapor concentrations at depths exceeding three to five feet bgs and only a minor effect (less than a factor of 2) at shallower depths unless a major storm front is passing through the area. A recent study in Wyoming (Luo et al., 2006) has shown little to no relationship between barometric pressure and soil vapor oxygen concentrations.

Human induced influences to pressure are likely to have a bigger effect upon soil vapor concentrations. For example, pressure changes resulting from the on-off cycling of an overlying building's heating or HVAC system and the ventilation of the structure due to open doors and windows can greatly influence soil vapor concentrations at locations near the building. In colder climates, greater impacts are most likely in the winter season. Literature suggests that temporal variations in the radon concentrations are typically less than a factor of two and seasonal effects less than a factor of five. (Vapor Intrusion Pathway: A Practical Guideline, January 2007 Interstate Technology and Regulatory Council)

3.2 Conditions Unsuitable for Collection of Soil Vapor Samples

3.2.1 Collection of soil vapor samples is not desirable if:

a. Groundwater is very close to the ground surface (i.e., < 3 feet);

b. Chemical(s) of concern is/are not volatile; and

c. Moisture or unknown material is in the sample stream or sample container. This is a field sampling quality concern, not a laboratory concern.

Please note that due to increased diffusivity, advective flow, and temperature fluctuations at near surface boundaries, the collection of a soil vapor sample in near surface soils is not useful for the purpose of calculating total soil solid VOC concentrations.

3.3 Tests to Determine if Soil Vapor Sampling is Practicable

Some soil types (i.e., clay or silty clays) may not be conducive for soil vapor collection. Tests to ascertain if soil vapor collection is possible from the soils are below.

3.3.1 Qualitative – connect a gas-tight syringe to the soil vapor sampling tubing to determine if a sample can be withdrawn. Please note that the soil vapor sampling tubing must have a volume of less than the gas-tight syringe for a meaningful result.

3.3.2 Qualitative – follow the instructions below:

a. Install a T-connection at the end of the soil-vapor-sampling tubing;

b. Connect a vacuum gauge to one branch of the T-connection;

c. Connect a syringe fitting and a 60-mL or larger syringe to the remaining branch of the T-connector;

d. With the syringe connected, pull the plunger back to the full-scale reading and hold in that position; and then

e. Monitor the vacuum created at the full draw position and during relaxation

If the vacuum does not relax (i.e. less pressure over time) within a few minutes to an hour, it is unlikely that soil vapor sampling is practicable at that particular location and other locations in the subsurface with similar soil characteristics.

- A vacuum conversion table is provided in Attachment 1 for convenience.

3.4 Confirmation Sampling

Soil vapor samples used to verify completion of remedial actions must verify that residual contaminant concentrations are at or below the corrective action standard for each chemical of concern in the contaminated soil as determined under A.A.C. R18-7-201 *et seq* (please refer to Section 6). Collection of soil vapor samples must occur throughout all areas previously reporting soil solid concentrations for chemicals of concern above applicable corrective action standards.

Utilization of soil vapor data collected for the UST Program as part of assessing vapor intrusion issues for LUST case closure purposes occurs by demonstrating that soil contaminant concentrations above an applicable residential soil remediation level (rSRL), as determined by soil solids analysis, does not pose an unacceptable vapor intrusion risk.

4. Installation Methods

This section provides useful construction information and details for installation methods.

4.1 Sample Through Rods (also known as temporary probes)

This method is advantageous if only one sampling round is required. Also, minimal disturbance of the in-situ vapor occurs due to less material placed in the ground, which decreases the need for collection of blanks.

Consider the following construction details for the collection of a sample through rods:

4.1.1 Seal probes at the surface with bentonite before sampling;

4.1.2 Utilize small diameter tubing (e.g. nylon - preferred tubing when conducting risk assessments - polyethylene, copper or stainless steel) which will not react, absorb or interact with site contaminants. It is suggested to use new tubing for new field events or demonstrate that the tubing you are using is contaminant free; and

4.1.3 When using direct-push borings for the installation of soil-vapor-sampling probes, avoid lateral movement of the probes once they are in the ground to prevent atmospheric air from entering the sampling system.

4.2 Permanent Probes

4.2.1 Consider the following construction details for the installation of permanent probes:

a. Use short discreet sampling intervals (e.g., 6 to 12 inches);

b. Color code or tag tubing of probes at the surface to be sure that the sampling depth is easily identifiable for future sampling events;

c. Complete and seal permanent probes at the ground surface (e.g., road boxes, locked caps, vapor-tight valves).

4.3 Types of Drilling

When using auger, air rotary, air knife, or rotosonic drilling methods for the installation of soil-vapor sampling probes, consider the following:

4.3.1 Install sampling probes with sand-pack intervals of approximately 1 foot;

4.3.2 Seal each sampling interval with bentonite or grout above and below the sand pack in the annulus of the boring. Take care to ensure that the seal material does not intrude into the sand pack;

4.3.3 If the boring contains dry bentonite, take care to fully hydrate the bentonite. Placing the bentonite in small increments (e.g., < 6 inches) followed by water is helpful. Alternatively, the bentonite can be added using a combination of dry and hydrated bentonite, or in slurry form if the boring is of sufficient diameter; and

4.3.4 For deeper probes, down-hole support rods may be necessary during probe installation, especially for tubing sized greater than 1/8-inch outside diameter (OD).

4.4 Equilibration Time

During probe installation, subsurface conditions are disturbed. For probes installed with auger, air rotary, air knife, or rotosonic drilling methods, purge volume test, leak test and soil vapor sampling should not be conducted for at least 48 hours (depending on site lithologic conditions and stage of investigation) following probe installation. When utilizing sample through rods, the recommended equilibration time is 20 to 30 minutes.

5. Sampling and Analysis

5.1 Sampling Containers

The sample containers chosen for a specific site will depend on the sampling equipment and analytical requirements. Select the final storage container prior to the initial sampling.

5.1.1 Examples of different sample containers include:

a. Tedlar™ bags;

b. 1.0 Liter (L) stainless steel canisters (e.g., Summa™ canisters). The lab is responsible for certifying the cleanliness of the canister and evacuating the canister before leaving the lab. It is strongly suggested that the lab be responsible for providing a record of the canister vacuum/pressure before and after sampling; and

c. Gas-tight syringes

All of the above listed sample containers are relatively simple to fill. Tedlar™ bags have a 72 hour holding time. Stainless steel canisters have a 30 day holding time. On-site analysis by a mobile lab typically utilize syringes for which the holding time should be as short as possible (less than 5 minutes for plastic syringes and less than 15 minutes for glass syringes). ADEQ does not recommend extending holding times by transferring samples to different container types.

ADEQ's UST Program recommends Tedlar™ bags for their soil vapor extraction (SVE) system influent or effluent sampling. Summa™ canisters certified as clean are the preferred sample container for soil vapor data used in risk assessments.

5.2 Shallow Samples

Observe care when collecting shallow soil gas samples to minimize atmospheric influence from the surface. If possible, avoid extensive purging or use of large volume sample containers (e.g. 6.0 L Summa™ canisters) for collection of near-surface samples.

5.3 Storage and Shipping Considerations

5.3.1 Do not put sample on ice;

5.3.2 Do not store sample exposed to light (keep sample in dark place);

5.3.3 Keep sample at standard temperature and pressure as much as practicable;

5.3.4 Do not ship Tedlar™ samples by airplane.

5.4 Sample Collection

ADEQ recommends use of the ADEQ QA/QC checklist for Soil Vapor Sampling when sampling (see Attachment 2).

5.4.1 Purging

Utilize purging to obtain a sample that represents equilibrated vapor concentrations of soil surrounding the sampling probe. Conduct the initial purge testing in an area where positive detections are most likely to occur.

The purged volume selected should be consistent for all sample locations across the site. Please consider the following procedure with respect to purging:

a. Remove three to five internal volumes of a sample system. This should ensure that vapor concentration entering a sampling container is 95% or greater representation of vapor concentration in surrounding soil; or

b. If vapor equilibration has occurred, remove one to five dead volumes;

Base the number of dead volumes requiring removal on procedures such as:

c. Analyzing the purged vapor with a field vapor analyzer (photoionization detector (PID) or flame ionization detector (FID)) until the concentrations stabilize and assess consistency across sequential purged volume samples; or

d. Conducting a purged volume test to determine the number of dead volumes to remove that corresponds to the highest recovered vapor concentrations.

5.4.2 Purging Equipment

a. A vacuum pump with a flow controller and flow meter can be used when sampling large (> than 200 milliliters (mL) probe volume) or middle size probe. Use another device (e.g. syringe) for small size probes (less than 3 mL probe volume).

b. To evaluate lithologic conditions adjacent to the soil gas probe (such as no flow conditions due to clayey lithology), a vacuum gauge or similar device should be used between the soil gas sample tubing and the soil gas extraction devices (e.g. vacuum pump).

The whole purging device should be used at the end of the sampling train (after the T-valve and canister) to avoid field cross contamination from the device.

5.4.3 Purging flow rate

a. 200 mL/min is the recommended default rate, unless a non-permeable cover is present.

b. Modify the purge rate based on conditions encountered in individual soil gas probes, such as:

- The probe vacuum reading > 5 inches Hg (full vacuum reading is 29.9 inch Hg
- Condensation is present in the sampling train, or
- The internal volume of the sampling train is very large (i.e., the purging time would be over one hour at 200 mL/min flow rate). If the purge time is longer than 30 minutes, re-evaluate sampling conditions.

c. Document any modified rates.

5.4.4 Purging time

a. Determine the dead volume - the internal volume of the probe plus the internal volume of the tubing used to connect the probe and the sampling train.

b. The dead volume divided by 200 mL/min or the appropriate purging flow rate is the purging time.

Please take care to not collect a sample under non-equilibrium conditions generated by high purge rates. Overpurging is a common mistake of soil vapor sampling.

5.5. Leak Testing

Consider conducting a leak test where leakage may be a concern (i.e. at fitting junctures and anywhere leakage may occur).

The following are examples of procedures for checking below ground sampling equipment for leaks:

5.5.1 Use oxygen as a qualitative test for a high-end indicator of short circuiting. Elevated oxygen measurements in soil vapor analytical results may indicate significant short-circuiting. This, though, may not be true for shallow depths or in areas where there is only halogenated VOC contamination); and

5.5.2 Use tracer compounds (e.g., difluoroethane) to conduct leak tests. For example, apply the tracer at the surface where air could enter the soil vapor probes. When using helium as a tracer gas, use a shroud to keep the tracer gas in contact with the probe during the testing. Please note that helium is a common carrier gas during sample analysis, so it is not recommended for use as a tracer compound. If using difluoroethane, use it sparingly on a rag and do not use a shroud. Alternatively, use a shut in test to test for system leaks.

NOTE – Contact the lab with any specific questions regarding any further information on tracer compound and techniques.

5.5.3 Gently apply the tracer compound at the surface where air could enter the soil vapor probes (i.e. at the top of the probe) and at all the connections of the sampling train when the sampling starts. Never over apply. Over application of the tracer compound may cause cross contamination and failure to obtain usable results.

The Detection Limit for leak check compounds should be 10 parts per billion by volume (ppbv) or less in an undiluted sample. Analyze the soil vapor sample for the tracer compound using a method that can detect it as a calibrated analyte or as a Tentatively Identified Compound (TIC).

Take care that the tracer compound of interest and other co-existing volatile compounds in the tracer media are not target compounds of interest in soil vapors investigated at the site. Appendix D (pages D-9 and 10) of the January 2007 ITRC ***Vapor Intrusion Pathway: A Practical Guideline*** contains a discussion of advantages and disadvantages regarding different tracers.

5.6 Sample Collection Flow Rates

Maintain flow rates should not exceed approximately 200 mL/min and vacuums to below 10 inch Hg if practical. Also, consider the following:

5.6.1 Minimize the sample collection flow rate for near groundwater situations to prevent groundwater from entering the sample container;

5.6.2 Measure and record the vacuum for each sampling probe at sample collection;

5.6.3 Use a calibrated flow controller supplied by the lab to provide a consistent flow rate for each sample collected. Use one flow controller for each sample collected.

5.7 Sample Collection Procedure

The following are examples of sample collection procedures utilizing different types of sample containers:

5.7.1 Collection using Tedlar™ bags:

a. Use a "T-coupling" to place the Tedlar™ bag in the sampling system ahead of the purging equipment used to purge vapor from the system. Appropriate compatible connecting threads will be required in order to use the Tedlar™ bag;

b. Attach sample tubing to a vacuum box and pump;

c. Open the valve on a clean dry Tedlar™ bag and attach it to the inside of the vacuum box;

d. Close the vacuum box, close stopcock (3-way valve) between vacuum box and pump, then turn the pump on;

e. Allow Tedlar™ bag to fill to 50 – 70% of capacity (do not overfill), shut off the pump, close the toggle switch (to prevent loss of sample), open the stopcock, and remove Tedlar™ bag from the vacuum box; and

f. Label the bag accordingly and keep it in a dark area with the temperature as near as possible to the soil temperature at the time sampled (to avoid condensation) until analysis occurs. Analyze the sample collected in a Tedlar™ bag as soon as possible after collection.

5.7.2 Collection using stainless steel canisters (e.g., Summa™canisters):

a. The lab should provide a pre-cleaned, certified for cleanliness Flow Controller with every canister to control the sampling flow rate equivalent to 200 mL/min or appropriate rate.

b. Use a "T-coupling" to place the stainless steel canister in the sampling system ahead of the purging equipment used to purge vapor from the system. Appropriate compatible connecting threads will be required in order to use the stainless steel canisters;

c. If necessary, use a vacuum gauge to verify the pressure inside the stainless steel canister prior to sampling to ensure the canister has arrived from the laboratory with the proper vacuum. Please note, any kind of vacuum gauge may have potential field cross contamination risk if not used properly. ADEQ recommends to check the clean canister with vacuum gauge just prior to sampling in the field. Due to cross-contamination possibilities, do not use the same vacuum gauge while collecting samples at multiple locations.

d. Empty stainless steel canisters may not be stored for more than 30 days prior to sample collection. Once filled, properly label and package the stainless steel canisters for transport to the off-site laboratory. (Note: Only stainless steel canisters can be shipped by air freight to an analytical laboratory for analysis and should be analyzed within 30 days after sample collection.);

e. Connect all parts of the sampling train in the following order:

- top of the probe
- tubing

- "T-coupling"
- purging pump

Place the Flow controller on the site of "T-coupling".

For permanently installed probes, check the tightness of the probe, the valve on the top of the probe, and the presence of glue applied at the probe junctures. Fix any problems if possible before purging, and record on the Soil Vapor QA/QC form which is included as an appendix.

5.7.3 Open all the valves; turn on the pump at the appropriate flow rate for the calculated purging time. During the purge, take action if any of the following conditions are noted:

a. The probe vacuum is > 5 inches Hg, or
b. Condensate is present in the sampling train

To address condition "a", close the T-coupling valve, turn off the pump, and extend the sampling time (e.g. from 5 minutes to 10 or 15 minutes). To address condition "b", raise the canister as high as possible until the water evacuates the line. Record all observations and actions.

If the probe vacuum is < 5 inches Hg, finish within the purging time, close the T-coupling valve, and turn off the pump.

Connect the canister to the Flow Controller, open the canister valve. If a canister with a bayonet style quick connector is used, simply push the canister fitting into the flow controller until it securely seats. Apply the leak test tracer compound (as described in 5.5) immediately after the canister is connected or opened.

Allow the canister to fill for the appropriate time.

5.7.4 Disconnect the canister from the sampling train, replace the canister valve cap and complete the sample label (Note: Label the tag attached to the canister), do not write on the outside of the stainless steel canister itself.

5.7.5 Use the **equipment blank** to monitor any cross contamination from the sampling train. Use the same setup as outlined above, using clean cylinder air or nitrogen (preferred) as source gas.

5.7.6 A **background blank** will monitor any cross contamination from the surrounding ambient air. To collect a background sample, place the canister upwind and as close as possible to the probe location.

5.7.7 A duplicate or split sample should be collected every 20 samples or field sampling event. Please note that it is very difficult to have reasonable precision for sample duplicates if a T-manifold splitter is not used, especially for medium or shallow depth probes.

5.8 Analysis

Analysis of vapor samples can occur in the field (mobile laboratory) or at a fixed laboratory setting. Use of a mobile laboratory for vapor analyses can be practical in terms of data collection when making field decisions, especially during the investigative process. The intention of analyses in the field is to ensure a good data set that provides results in real time that adequately represents conditions at the site. A good field data set should result in less time spent during the site investigation process.

The following analytical methods are acceptable for soil vapor analysis. Analytical methodology will depend on the project's objective(s), reporting limits needed, and sample container type:

For VOCs:

5.8.1 8260BAZ (Modified for Vapor)

5.8.2 8021B (Modified for Vapor)

5.8.3 TO-15 (Preferred method for risk assessments)

5.8.4 TO-14A

NOTE: Please contact the regulating program for the appropriate analytical method. All COCs may not be included in the method target compound list.

5.9 Data Quality Objectives (DQOs)

Data quality objectives (DQOs) will vary with both the stage of investigation and the intended use of the data collected from soil vapor sampling. During screening or the initial stages of investigation, DQOs will be less stringent than those for confirmation of remediation or risk assessment for indoor air vapor intrusion. DQOs will determine the sampling method, the type of sample collected, the frequency of sample collection, sampling location, the number of samples to be collected, and the specific quality assurance (QA) and quality control (QC) necessary, both in the field as well as in the laboratory. Following DQOs will ensure that the data is useable for the intended purpose.

The most important QA/QC activities and parameters include:

5.9.1 Sampling method

5.9.2. Sampling equipment maintenance and calibration

5.9.3 Control samples, i.e., trip blanks, field blanks, method blanks

5.9.4 Standard Operation Procedures (SOPs)

5.9.5 Analyses method appropriate for target compounds

5.9.6 Sample holding times and transportation conditions

5.9.7 Analyses method with required practical quantitation level

5.9.8 Laboratory QC samples

5.10 Quality Assurance/Quality Control

5.10.1 Sampling QA/QC

Solid quality assurance and quality control procedures start with organized planning. A well thought out work plan will help to ensure collection of soil vapor samples in a manner resulting in data of known quality. Stated data objectives and quality control techniques are essential to the work plan. There are several quality control procedures to ensure collection of representative samples. Listed are some of those quality control procedures to consider:

a. Purging (see Section 5.4.1)

b. Leak Testing (see Section 5.5)

5.10.2 Analysis QA/QC

All soil vapor samples require analysis by an Arizona Department of Health Services (ADHS) certified laboratory and maintains a Quality Assurance Plan. Quality Control Procedures for analysis performed with soil vapor sampling should follow good laboratory practices and criteria within the specified methods and at a minimum include the following quality control criteria:

a. Detection Limit Study

b. Method Blank

c. Calibration

d. Calibration Verification

e. Surrogates

f. Duplicate (1 per 20 sample/field sampling event)

g. Proficiency Test (PT) Samples

When QC criteria fall outside specified control limits, the analysis should be qualified using Arizona data qualifiers. The final report includes a case narrative for any event not describable by data qualifiers. Using the Arizona data qualifiers does not automatically qualify the data as acceptable to ADEQ. ADEQ expects that data reported utilizing these qualifiers, unless stated otherwise, is useable, scientifically valid and defensible.

5.10.3 Other Soil Vapor Analytes

Chemicals of interest for soil vapor sampling are specific for the type of contaminant release and breakdown products. They include both volatile organic and inorganic compounds, as well as some semi-volatile organic compounds. The method selected for laboratory analysis should be consistent with the stage of investigation and remediation, the volume of sample that is practical to collect, and the DQO's. Analysis of all samples collected to demonstrate compliance with regulatory requirements requires a laboratory licensed by the ADHS using an ADHS approved method.

The following table lists the types of compounds, methods, and ADHS approval status. Consult the laboratory for specific target list compounds, as well as detection limits. If using a particular laboratory analytical method not currently approved by ADHS for compliance samples, please contact ADEQ to begin an approval process through A.A.C. R9-14-610(C).

Table 5.1 Analytical Methods

Compounds	Method	ADHS Certified
Chlorinated VOCs and Petroleum VOCs BTEX/MTBE	TO-14A	Yes
Chlorinated VOCs and Petroleum VOCs	TO-15	Yes
VOCs	8260BAZ	Yes
VOCs	8021B	Yes

6. Relating Soil Vapor Concentration to Total Soil Concentration

Calculation of total soil concentrations using the method outlined below will vary depending on the input choice of chemical and physical values, such as soil adsorption coefficients (K_{oc}) and soil organic carbon fractions (f_{oc}). In this section, ADEQ provides a list of default values and methods to derive alternative values to be utilized in the three-phase partitioning equation outlined in Section 6.1. The listed default values are appropriate for use throughout much of Arizona and are conservative values so as to be protective of public health and the environment.

6.1 Three-phase Partitioning Equation

ADEQ accepts the following three-phase partitioning equation for the calculation of total soil concentrations which may occur in situ for a chemical. The basis of this equation is a standard soil partitioning equilibrium model that assumes non-aqueous phase liquid (NAPL) is not present. Therefore, at soil concentrations exceeding the 3-phase saturation limit, measured soil vapor concentrations are inapplicable for calculating total soil concentrations using this equation. For a better understanding of when the 3-phase partitioning equation is not applicable, please see Section 6.5 of this document. The equations used that govern the equilibrium partitioning between phases are the linear sorption partitioning equation normalized with respect to organic carbon (Karichoff et al., 1979) and Henry's Law:

$$C_t = \frac{C_g[K_{oc}f_{oc}\rho_b/H_o + \theta_w/H_o + (\theta_t - \theta_w)]}{\rho_b}$$

where:

C_t – Total concentration in soil (micrograms per kilogram (µg/kg))

C_g – Concentration in soil vapor (micrograms per liter (µg/L))

f_{oc} – Mass fraction of natural soil organic carbon content (grams (g)-organic carbon/g-soil)

K_{oc} – Soil organic carbon-water partitioning coefficient (milliliters per gram (ml/g))

ρ_b – Dry Bulk Density (kilograms per liter (kg/L))

H_o – Henry's Law Constant (dimensionless)

θ_t – Total soil porosity (volume of voids/volume total)

θ_w – Volumetric Water Content (volume of water/volume of soil)

6.2 List of Default Values for the Soil Matrix

6.2.1. **Fraction of Organic Carbon in Soil (f_{oc})**. 0.006 (0.6%) is the default value for fraction of organic carbon in soil for use in the equation.

6.2.2 **Soil Dry Bulk Density (ρ_b).** -1.5 kg/L is the default value for dry bulk soil density of 1.5 kg/L for use in the equation. Dry bulk-densities for basin-fill deposits typically range from 1.3 to 1.8 kg/L. The 1.5 kg/L value is within this range.

6.2.3 **Total Soil Porosity (θ_t). 0.43 (43%) is the default value for** total soil porosity selected for use in the equation. Its' basis is the default soil particle density (ρ_s) of 2.65 kg/L [$\theta_t = 1 - \rho_b/\rho_s = 0.43$].

6.2.4 **Soil Volumetric Water Content (θ_w).** 15% (0.15) is the default value selected for use in the equation. Volumetric water content in basin-fill deposits typically range from 5 to 25 percent. The 15% value is within this range.

6.3 Test Methods Required to Change Soil Matrix Default Values

This section specifies procedures and requirements to derive site-specific input parameters for use in the three-phase partitioning equation. Site-specific value substitutions for one or more of the following four input parameters are acceptable: soil dry bulk density, soil organic carbon content, total soil porosity, and soil volumetric water content.

6.3.1 **Deriving soil organic carbon fraction (f_{oc}).** ASTM Method D2974 or other methods approved by ADEQ to derive site-specific soil organic carbon fraction values are acceptable. Using uncontaminated soil samples from lithologic zones that are representative of where the soil-vapor contamination is present is necessary to measure site-specific soil organic carbon content. Laboratory methods cannot include inorganic carbon in laboratory measurements.

6.3.2 **Deriving soil dry bulk density (ρ_b).** ASTM Method D2049 or D2937 or other methods approved by ADEQ to derive site-specific soil bulk density values are acceptable.

6.3.3 **Deriving total soil porosity (θ_t).** ASTM Method D4404 or other methods approved by ADEQ to derive site-specific total soil porosity values are acceptable.

6.3.4 **Deriving soil volumetric water content (θ_w).** ASTM Method D2216 or other methods approved by ADEQ to derive soil volumetric water content values are acceptable.

6.4 List of Chemical Default Values (K_{oc} and H_o) for Selected VOCs

The VOCs listed in the following table provide soil organic carbon-water partitioning coefficients (K_{oc}) and dimensionless Henry's Law constants (H_o). ADEQ accepts these values, taken from *Soil Screening Guidance* (US EPA, 1996), for use in the three-phase partitioning equation. The chemicals shown are not a complete list of all potential VOCs encountered in contaminant releases, but represent those commonly encountered, those with greater potential to exist in the vapor phase, or those with greater toxicity relative to other VOCs.

Alternative K_{oc} and H_o values listed on the following table are substitutions for the values listed in the table on the next page when those alternative values more accurately represent conditions encountered at a site. Sources for these values may be obtained from the *Superfund Chemical Data Matrix* (US EPA, most current editions) and the EPA's most recent version of Estimation Programs Interface Suite™ available at http://www.epa.gov/opptintr/exposure/pubs/episuite.htm.

Alternative K_{oc} and H_o values based on scientific literature are subject to ADEQ approval.

Table 6.1. List of Chemical Default Values for Selected VOCs

Compound	K_{oc} (L/kg)[1]	H_c (dimensionless)[2]
Benzene	5.89E+01	2.28E-01
Bromodichloromethane	5.50E+01	6.56E-02
Bromoform	8.71E+01	2.19E-02
Carbon disulfide	4.57E+01	1.24E+00
Carbon tetrachloride	1.74E+02	1.25E+00
Chlorobenzene	2.19E+02	1.52E-01
Chloroform	3.98E+01	1.50E-01
1,2-Dibromoethane (EDB)	2.81E+01	2.90E-02
1,1-Dichloroethane	3.16E+01	2.30E-01
1,2-Dichloroethane (DCA)	1.74E+01	4.01E-02
1,1-Dichloroethene	5.89E+01	1.07E+00
cis-1,2Dichloroethene	3.55E+01	1.67E-01
Trans-1,2=Dichloroethene	5.25E+01	3.85E-01
1,2-Dichloropropane	4.37E+01	1.15E-01
1,3-Dichloropropene	4.57E+01	7.26E-01
Ethyl benzene	3.63E+02	3.23E-01
Methyl bromide	1.05E+01	2.56E-01
Methylene chloride	1.17E+01	8.98E-02
Styrene	7.76E+02	1.13E-01
1,1,2,2-Tetrachloroethane	9.33E+01	1.41E-02
Tetrachloroethene (PCE)	1.55E+02	7.54E-01
Toluene	1.82E+02	2.72E-01
1,1,1-Trichloroethane	1.10E+02	7.05E-01
1,1,2-Trichlorethane	5.01E+01	3.74E-02
Trichloroethene (TCE)	1.66E+02	4.22E-01
1,2,4-Trimethylbenzene	3.72E+03	2.30E-01
1,3,5-Trimethylbenzene	8.19E+02	3.20E-01
Vinyl acetate	5.25E+00	2.10E-02
Vinyl chloride	1.86E+01	1.11E+00
Xylenes (total)[3]	3.86E+02	2.76E-01

Ref: U.S. EPA Soil Screening Guidance: User's Guide, 2nd Edition (July 1996)

[1] - K_{oc} = organic carbon partition coefficient

[2] - H_c = Dimensionless Henry's Law Constant (HLC[atm-m]*41(25°C))

[3] – K_{oc} and F_{oc} values for total Xylenes represent average of values for *ortho*-, *meta*-, and *para*-Xylenes.

Supplied below are formula air unit conversions:

ug/m³ = ppbv x (Molecular Weight) /24.45

ppbv = ug/m³ x 24.45(MolecularWeight)

For example: 2.5 ppbv Benzene x 78.11 / 24.45 = 7.99 ug/m³

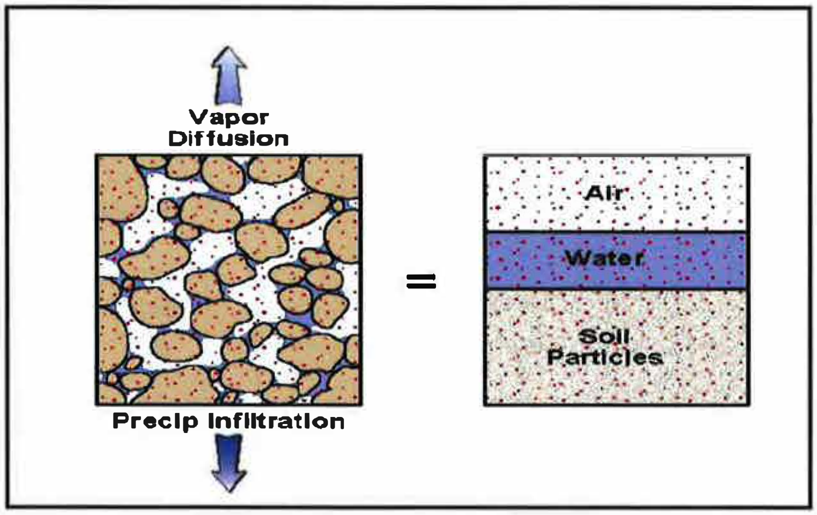
(Standard Condition: 1 atm, 25°C)

ppbv = parts per billion by volume
ppmv = parts per million by volume
1 ppmv = 1,000 ppbv
1 m³ = 1,000 Liters
1 mg = 1,000 ug
1 mg/m³ = 1,000 ug/m³ = 1 ug/Liter

6.5 Inappropriate Situations in which to apply the Three-Phase Partitioning Equation to calculate total contaminant concentrations in soil

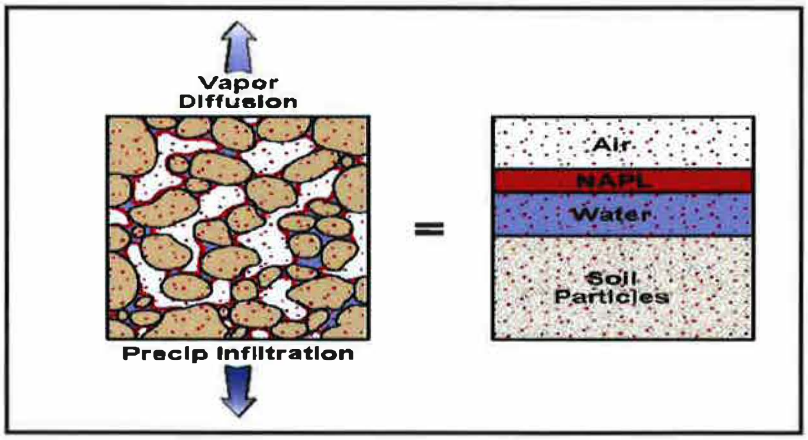
6.5.1 The Presence of NAPL

Section 6.1 indicates that the three-phase partitioning equation is not applicable when NAPL is present. The following diagrams illustrate this inapplicability:

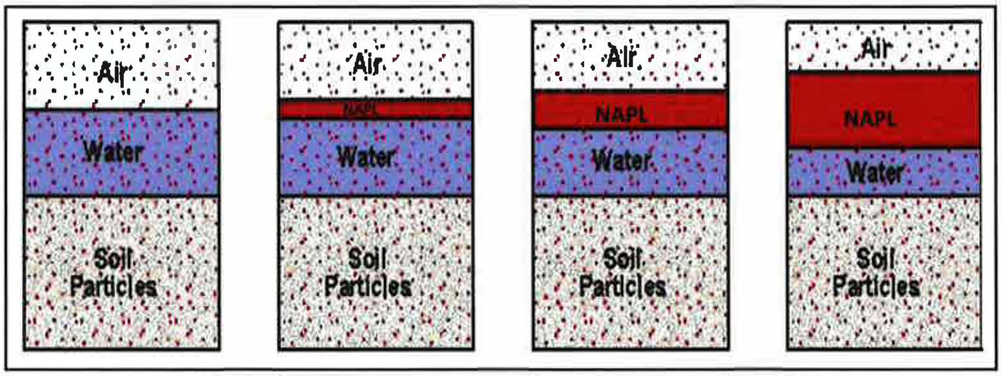


The red dots represent contamination. The red dots placed on the soil grains represent the sorbed phase contamination. The red dots placed on the soil moisture represent the dissolved phase contamination. The red dots placed in the open spaces represent the vapor phase contamination.

If a vapor sample was collected in this type of situation, where there are only 3 phases present, the 3-phase partitioning equation could be used to calculate a total contaminant concentration in the soil. The next diagram is the same as the previous with NAPL added.



The 3-phase partitioning equation is not applicable in this type of situation. This next diagram helps explains why this is so.



Vapor Conc 1 = Vapor Conc 2 = Vapor Conc 3 = Vapor Conc 4
Dissolved Conc 1 = Dissolved Conc 2 = Dissolved Conc 3 = Dissolved Conc 4
Adsorbed Conc 1 = Adsorbed Conc 2 = Adsorbed Conc 3 = Adsorbed Conc 4
Total Conc.1 < Total Conc 2 < Total Conc 3 < Total Conc 4

The key to understanding the above diagram is first understanding the concept of saturation with respect to contamination in a given volume of soil. Saturation is a comparison between the degree to which something is dissolved, absorbed, or volatilized and the maximum dissolution, adsorption, or volatilization, respectively, possible.

When adding a contaminant to a given volume of soil, that contaminant, over time, will separate and equilibrate into the vapor, dissolved and sorbed phases. Each phase, though, can only accept so much contamination. Once these three phases accepts the maximum possible amount of contamination, they will not accept additional contamination and is in a state of saturation. When adding a contaminant to a given volume of soil already saturated with that contaminant, the additional contaminant will remain as Non-aqueous phase liquid contamination.

Example:

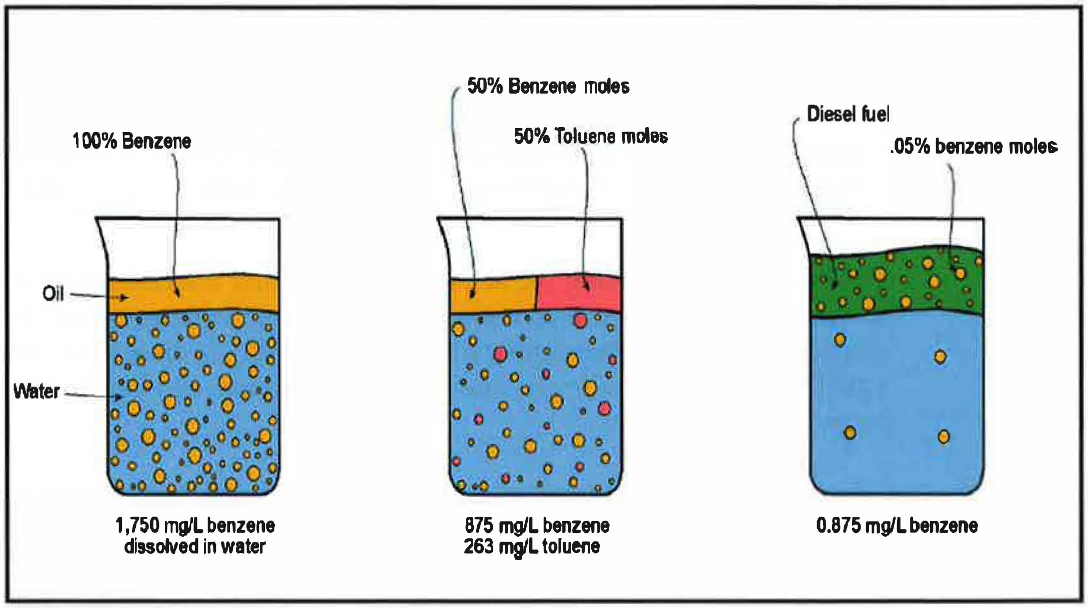
Please consider the four situations depicted in the diagram above. The saturation value for PCE in a typical Arizona soil is about 61 mg/kg. A PCE vapor concentration from the 1st volume of soil plugged into the 3-phase partitioning equation would result in a total contaminant concentration of 61 mg/kg – which is a true value for that volume of soil.

Now consider a vapor sample collected from soil volume #3. A PCE vapor concentration from the 3rd volume of soil plugged into the 3-phase partitioning equation would still result in a total contaminant concentration of 61 mg/kg - which is not a true value for that soil volume #3.

Vapor samples collected from each of the volumes of soil depicted here have the same concentrations because the volumes of soil are at or over their saturation limit of 61 mg/kg PCE. The sorbed, dissolved and vapor phases in all of the volumes of soil cannot accept any more contamination. Calculating a total contaminant concentration for soil volumes 2, 3 and 4 using only vapor data will not yield an accurate result.

6.5.2 Single vs Multiple Chemical Contaminant Mix

The presence of NAPL is not the only factor to be aware of when using soil vapor data to calculate total contaminant values. Multiple chemical mixes are also a consideration. Saturation values for chemicals change when a contaminant mix has additional chemicals added.



Adding additional chemicals to the contaminant mix changes individual chemical saturation values.

To illustrate how saturation values change when multiple chemicals are in the contaminant mix, consider these three beakers with different combinations of chemicals in them.

The first beaker contains only one chemical in the contaminant mix - benzene. The water can only dissolve so much contamination before a state of saturation occurs. Since this beaker contains benzene as the sole contaminant, 1,750 mg/L of benzene dissolves into the water – this represents the benzene saturation value when no other chemical is present in the contaminant mix.

The second beaker contains two chemicals in the contaminant mix – benzene and toluene in equal molar amounts. No matter how many chemicals are in the contaminant mix, the water can still only dissolve the same amount of contamination as the first beaker before a state of saturation occurs. Since there are equal molar amounts of benzene and toluene in the contaminant mix, an equal amount of benzene and toluene moles dissolve in the water. This effectively cuts the amount of dissolved benzene in half compared to the first beaker. The saturation value for benzene has changed compared to the first beaker.

The third beaker contains diesel fuel for the contaminant mix. Diesel fuel is composed of several dozen chemicals. In this example, the diesel fuel contains .05% benzene moles. This means that the water in this beaker will only contain a dissolved benzene concentration of 0.875 mg/L (1,750 mg/L x .05% = 0.875 mg/L). 0.875 mg/L represents its saturation value for this contaminant mix.

Although this illustration focuses on the dissolved phase, the same concept holds true for the vapor phase. This is an important concept with respect to using the 3-phase partitioning equation. One needs to know the contaminant mix concentration in order to derive saturation values for individual chemicals. If only vapor sample collection occurs in places of saturation value exceedances, calculated total contaminant concentrations will be inaccurate.

7. Procedure References

7.1 Karichoff, S.W., D.S. Brown, and T.A. Scott. 1979. Sorption of hydrophobic pollutants on natural sediments. Water Resources Research 13, no. 3: 241–248.

7.2 Luo, H., P. Dahlen, P. Johnson, T. Creamer, T. Peargin, P. Lundegard, B. Hartman, L. Abreau, and T. McAlary. 2006. "Spatial and Temporal Variability in Hydrocarbon and Oxygen Concentrations Beneath a Building Above a Shallow NAPL Source." Presented at Remediation of Chlorinated and Recalcitrant Compounds, Monterey, Calif.

7.3 U.S. EPA Soil Screening Guidance: User's Guide, 2nd Edition (July 1996)

7.4 Vapor Intrusion Pathway: A Practical Guideline, January 2007, Interstate Technology and Regulatory Council.

Other useful references

Atlantic RBCA Version 2.0 for Petroleum Impacted Sites in Atlantic Canada, User Guidance, Appendix 9 – Guidance for Soil Vapor and Indoor Air Monitoring Assessments

California Regional Water Quality Control Board, California Department of Toxic Substances Control. Advisory – Active Soil Gas Investigations January 28, 2003. Hartman, Blayne (2006). Part 4 – "How to Collect Reliable Soil-Gas Data for Risk-Based Applications, Specifically Vapor Intrusion: Updates on Soil-Gas Collection and Analytical Procedures." LUSTLine Bulletin 53 September 2006

Wilson, L. H., P. C. Johnson, and J.R. Rocco (2005). Collecting and Interpreting Soil Gas Samples form the Vadose Zone: A Practical Strategy for Assessing the Subsurface-

Vapor-to-Indoor-Air Migration Pathway at Petroleum Hydrocarbon Sites. API Soil Gas Sampling May 2005 Pre-Publication Version.

Attachment 1

Vacuum Conversion Table

Vacuum	In Hg (rel)	ft H_2O (rel)	Torr (abs) mm Hg (abs)	mbar (abs)	psia (abs)
0%	0.00	0.00	760.0	1013.3	14.70
10%	2.99	3.39	684.0	911.7	13.23
20%	5.98	6.78	608.0	810.4	11.76
30%	8.98	10.17	532.0	709.1	10.29
40%	11.97	13.56	456.0	607.8	8.82
50%	14.96	16.95	380.0	506.5	7.35
60%	17.95	20.34	304.0	405.2	5.88
70%	20.94	23.73	228.0	303.9	4.41
80%	23.94	27.12	152.0	202.6	2.94
90%	26.93	30.51	76.0	101.3	1.47
91%	27.23	30.85	68.4	91.2	1.32
92%	27.53	31.19	60.8	81.0	1.18
93%	27.83	31.53	53.2	70.9	1.03
94%	28.13	31.87	45.6	60.8	0.88
95%	28.42	32.21	38.0	50.6	0.73
96%	28.72	32.54	30.4	40.5	0.59
97%	29.02	32.88	22.8	30.4	0.44
98%	29.32	33.22	15.2	20.3	0.29
99%	29.62	33.56	7.6	10.1	0.15
99.10%	29.65	33.59	6.8	9.1	0.13
99.20%	29.68	33.63	6.1	8.1	0.12
99.30%	29.71	33.66	5.3	7.1	0.10
99.40%	29.74	33.70	4.6	6.1	0.09
99.50%	29.77	33.73	3.8	5.1	0.07
99.60%	29.80	33.76	3.0	4.1	0.06
99.70%	29.83	33.80	2.3	3.0	0.04
99.80%	29.86	33.83	1.5	2.0	0.03
99.90%	29.89	33.87	0.8	1.0	0.01
<100%	29.92	33.90	0.0	0.0	0.00

Pressure measurement units:

In Hg - inches of mercury
ft H_2O – feet of water
mm Hg – millimeters of mercury
mbar – millibars
psia – pounds per square inch absolute

Attachment 2

Arizona Department of Environmental Quality QA/QC checklist for Soil Vapor Sampling

Sampling Company

1 Date: ____________ Start time: ____________ ____________ ☐ ☐

2 Company Name: ____________ Sampler's Name: ____________

Consulting Firm:

3 Company Name: ____________ Project Name: ____________

4 Project Manager: ____________ Project Number: ____________

Well's Information

5 Location: ____________ Client ID: ____________ Permanent ☐ Temporary ☐

6 Address: ____________

7 ADEQ File Identification #(s) ____________

8 Describe the probe location: ____________

9 Probe Depth: ______ inch Probe ID: ______ inch **Probe volume: 0 inch^3 (0) mls**

10 Probe type: Tygon ☐ Teflon ☐ Vinyl ☐ PVC ☐ Metal ☐ Other: ____________

11 Is probe tested in the lab before installed? Y ☐ N ☐ NA ☐ Don't know ☐

12 Comments: ____________

Weather Conditions

13 Temperature: ________ C^0 ☐ F^0 ☐

14 Has there been significant rain or snow recent to the sampling event? Y ☐ N ☐

15 If Yes to Question 14 Date ____________ Amount of Precipitate ________ inches

Soil Conditions Information

16 Was a soil sample collected and analyzed for volumetric moisture content? Y ☐ N ☐ attach results if yes

If yes, attach results

If no, is the apparent moisture content dry ☐ moist ☐ saturated ☐

17 What is soil type encountered at sample location? ____________

18 Was sample collected beneath a surface cover (e.g. parking lot, sidewalk, road, building, other)? Y ☐ N ☐

19 Describe the surface cover, if any ____________

20 Was the sample collected near a subsurface conduit? Y ☐ N ☐

Describe subsurface conduit, if any ____________

Sampling Train

21 Sample container: Canister : 1.0 L ☐ 6.0 L ☐ Silanized: Y ☐ N ☐

Other: ____________

Tedlar bag: Y ☐ N ☐ Gas tight syringe Y ☐ N ☐

22 Flow restrictor: On: 1000 mL/min ☐ 500 mL/min ☐ 200 mL/min ☐ Other: ________

One min = Taking one minute to fill one liter canister.

23 Tubing type: Tygon ☐ Teflon ☐ Vinyl ☐ PVC ☐ Other: ____________

24 Tubing used from probe top to canister: Length: ______ inch ID ______ inch

25 **Tubing volume: 0 inch^3 (0) mls**

26 Are all parts of Sampling Train tested in the lab before sampling? Y ☐ N ☐

Probe Purging Before Sampling

27 Total volume: probe(v) + tubing(v) = Probe volume 0 + Tubing volume 0 = 0 mls

28 Total volume to be purged (mls): 1x 0 ☐ 1.5x 0 ☐ 2x 0 ☐ 3x 0 ☐

29 Purging pump #: ________ Purging flow rate: ml/min Purging time: mins seconds

30 Gauge reading: < 5 inHg ☐ Other: ____________ Comments: ____________

31 Syringe Purging: NA ☐ Dedicated Syringe ☐ Re-used Suringe ☐ Volume ________

32 Is there condensation evident in the sampling train? Y ☐ N ☐

33 Post sample collection - Is there condensation evident in the sampling container? Y ☐ N ☐

34 **Leak Test** Y ☐ N ☐ If Yes, fill in the blanks blow:

35 Tracer compound:____________ Trade name: ____________ Tested before use: Y ☐ N ☐

36 Locations applied: Probe top ☐ Sampling train: ☐ Other: ____________

37 **Field Duplicate** Y ☐ N ☐ If Yes, fill in the blanks blow:

38 Used the Duplicate Splitter? Y ☐ N ☐ If no, describe the procedure: ____________

Other Information

39 Identify the equipment and method used to install probe and collect sample ____________

40 What was the equilibration time between probe installation and withdrawal of any soil vapor? ________

41 Sample storage /shipping temperature ____________

42 Sample storage /shipping container ____________

43 Sample transportation mode(s) ____________

44 Was an equipment blank taken? Y ☐ N ☐ Was Tank air or Nitrogen used? ____________

Note: Ambient air should not be used

45 Was a field blank taken? Y ☐ N ☐

46 Was a background (upwind ambient) sar Y ☐ N ☐

47 Are there any potential VOC sources other than the identified release nearby?

Groundwater/active fueling station/ dry cleaners/ dry wells/ other - please describe ____________

48 **Well (Probe) Inspection Note:** ____________

Attachment 3

1.0 Directive Owner (Person Responsible for Implementing & Maintaining the Directive – Title/Unit/Section/Division)

WPD Environmental Associate Hydrogeologist

2.0 Audience

Stakeholders conducting Hazardous Waste, WQARF, UST and other remediation or corrective action

3.0 Communication & Training

The Waste Programs Division Environmental Associate Hydrogeologist will conduct a class within 45 days of the policy effective date and annually thereafter insure that employees that deal with soil vapor issues are familiar with the policy's content, including any procedures for internal compliance, audit and review. Concurrent with the 2nd class and annually thereafter, the Environmental Associate Hydrogeologist will review the policy for any needed changes or updates.

4.0 Compliance & Audit Plan

Prior to each annual review, the Environmental Associate Hydrogeologist will arrange for a records review or similar inquiry to estimate the number of corrective actions that have involved issues with soil vapor contained in the current policy. Each annual review shall evaluate whether applicable WPD personnel and external stakeholders are aware of the policy and explore methods to increase awareness if needed.

5.0 Review & Revision

This directive will be reviewed after the first year on an annual basis.

6.0 Additional Documentation

This policy complements the Site Investigation Guidance Manual.

7.0 Approved by:

Title	Name	Signature	Date
WPD Division Director	Laura Malone	Laura Malone	3/31/17
Administrative Counsel (as to form)	Sherri Zendri		4/21/17

11.0 Historical Note

[*Describes the changes or updates to a directive, which serves as a reference for the reader to understand any past changes*.]

Date	Change	Ref. Section
July 10, 2008	Issued	
May 19, 2011	Revised	Grammatical changes and procedure clarifications
April 21, 2017	Revised	Grammatical changes and added Section 6.5

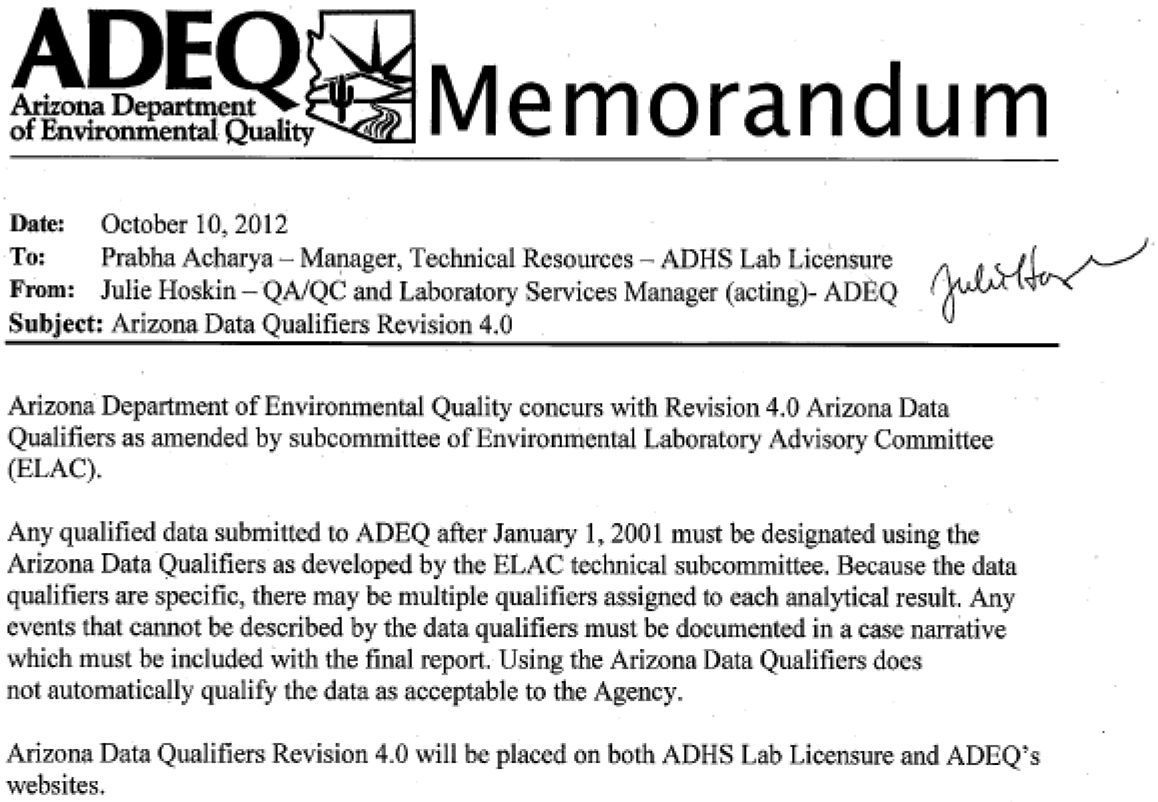
APPENDIX G

Arizona Data Qualifiers

Arizona Data Qualifiers

Revision 4.0

9/5/12



ADEQ Arizona Department of Environmental Quality **Memorandum**

Date: October 10, 2012

To: Prabha Acharya – Manager, Technical Resources – ADHS Lab Licensure

From: Julie Hoskin – QA/QC and Laboratory Services Manager (acting)- ADEQ

Subject: Arizona Data Qualifiers Revision 4.0

Arizona Department of Environmental Quality concurs with Revision 4.0 Arizona Data Qualifiers as amended by subcommittee of Environmental Laboratory Advisory Committee (ELAC).

Any qualified data submitted to ADEQ after January 1, 2001 must be designated using the Arizona Data Qualifiers as developed by the ELAC technical subcommittee. Because the data qualifiers are specific, there may be multiple qualifiers assigned to each analytical result. Any events that cannot be described by the data qualifiers must be documented in a case narrative which must be included with the final report. Using the Arizona Data Qualifiers does not automatically qualify the data as acceptable to the Agency.

Arizona Data Qualifiers Revision 4.0 will be placed on both ADHS Lab Licensure and ADEQ's websites.

Arizona Data Qualifiers
Revision 4.0
9/5/12

Developed by the Sub-committee of the Arizona Environmental Laboratory Advisory Committee
This is an updated list of the Rev. 3.0 Arizona Data Qualifiers dated 9/20/2007, with some new qualifiers added, some obsolete ones deleted and some modified. The new qualifiers are designated in red font. If there was a minor modification to the existing qualifier, it has been highlighted in blue.

Using the following Arizona Data Qualifiers does not automatically denote acceptability to the Regulatory Agency. Arizona Department of Environmental Quality expects that data reported utilizing the following qualifiers, unless stated otherwise, is useable, scientifically valid and defensible. In the laboratory's judgment if the data should not be used for compliance, the T6 qualifier must be used. Other general guidelines for use and application of the following data qualifiers can be found as an attachment to this document (ATTACHMENT A).

Note: Please note that as of 10/28/08, AZ Drinking Water Data Qualifiers have been discontinued, please use Arizona Data Qualifiers Revision 4.0 dated 9/5/12.

Microbiology:

A1 = Too numerous to count.
A2 = Sample incubation period exceeded method requirement.
A3 = Sample incubation period was shorter than method requirement.
A4 = Target organism detected in associated method blank.
A5 = Incubator/water bath temperature was outside method requirements.
A6 = Target organism not detected in associated positive control.
A7 = Micro sample received without adequate headspace.
A8 = Plate count was outside the method's reporting range. Reported value is estimated.

Method/calibration/Trip blank:

B1 = Target analyte detected in method blank at or above the method reporting limit.
B2 = Non-target analyte detected in method blank and sample, producing interference.
B3 = Target analyte detected in calibration blank at or above the method reporting limit.
B4 = Target analyte detected in blank at or above method acceptance criteria.
B5 = Target analyte detected in method blank at or above the method reporting limit, but below trigger level or MCL.
B6 = Target analyte detected in calibration blank at or above the method reporting limit, but below trigger level or MCL.
B7 = Target analyte detected in method blank at or above method reporting limit.

Concentration found in the sample was 10 times above the concentration found in the method blank.
B8 = Analyte found in both the travel blank and sample.

Confirmation:

C1 = Confirmatory analysis not performed as required by the method.
C2 = deleted
C3 = Qualitative confirmation performed.
C4 = Confirmatory analysis was past holding time.
C5 = Confirmatory analysis was past holding time. Original result not confirmed.
C6 = deleted
C7 = deleted
C8 = Sample RPD between the primary and confirmatory analysis exceeded 40%. Per EPA Method 8000C, the lower value was reported as there was no evidence of chromatographic problems.

Dilution:

D1 = Sample required dilution due to matrix.
D2 = Sample required dilution due to high concentration of target analyte.
D3 = deleted.
D4 = Minimum Reporting Limit (MRL) adjusted to reflect sample amount received and analyzed.
D5 = Minimum Reporting Limit (MRL) adjusted due to sample dilution; analyte was nondetect in the sample.
D6 = Minimum Reporting Limit (MRL) adjusted due to an automatic 10X dilution performed on this sample for the purpose of reporting traditional drinking water analytes for wastewater requirements.
D7= Minimum Reporting Limit adjusted to reflect sample dilution.

Estimated concentration:

E1 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not possible due to insufficient sample.
E2 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to sample matrix.
E3 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to holding time requirements.
E4 = Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL) but above MDL.
E5 = Concentration estimated. Analyte was detected below laboratory minimum reporting limit (MRL), but not confirmed by alternate analysis.
E6 = Concentration estimated. Internal standard recoveries did not meet method acceptance criteria.

E7 = Concentration estimated. Internal standard recoveries did not meet laboratory acceptance criteria.
E8 = Analyte reported to MDL per project specification. Target analyte was not detected in the sample.

Hold time:

H1 = Sample analysis performed past holding time.
H2 = Initial analysis within holding time. Reanalysis for the required dilution was past holding time.
H3 = Sample was received and/ or analysis requested past holding time.
H4 = Sample was extracted past required extraction holding time, but analyzed within analysis holding time.
H5 = This test is specified to be performed in the field within 15 minutes of sampling; sample was received and analyzed past the regulatory holding time.
H6 = The filtration was not done within the required 15 minutes of sampling, the sample was filtered in the laboratory.

BOD/CBOD:

K1 = The sample dilutions set-up for the BOD/CBOD analysis did not meet the oxygen depletion criteria of at least 2 mg/L. Any reported result is an estimated value.
K2 = The sample dilutions set up for the BOD/CBOD analysis did not meet the criteria of a residual dissolved oxygen of at least 1 mg/L. Any reported result is an estimated value.
K3 = deleted.
K4 = deleted.
K5 = The dilution water D.O. depletion was > 0.2 mg/L.
K6 = Glucose/glutamic acid BOD/CBOD was below method acceptance criteria.
K7 = A discrepancy between the BOD and COD results has been verified by reanalysis of the sample for COD.
K8 = Glucose/glutamic acid BOD/CBOD was above method acceptance levels.
K9=Test replicates show more than 30% difference between high and low values.
K10=Seed control samples do not deplete at least 2.0 mg/L, with a retention of at least 1.0 mg/L DO criteria in all samples.
K11=Minimum DO is less than 1.0 mg/L in all dilutions.

Laboratory fortified blank/blank spike:

L1 = The associated blank spike recovery was above laboratory acceptance limits
L2 = The associated blank spike recovery was below laboratory acceptance limits.
L3 = The associated blank spike recovery was above method acceptance limits.
L4 = The associated blank spike recovery was below method acceptance limits.
L5 = The associated blank spike recovery was above laboratory/method acceptance limits. This analyte was not detected in the sample.

Matrix spike:

M1 = Matrix spike recovery was high; the associated blank spike recovery was acceptable.
M2 = Matrix spike recovery was low; the associated blank spike recovery was acceptable.
M3 = The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The associated blank spike recovery was acceptable.
M4 = The analysis of the spiked sample required a dilution such that the spike recovery calculation does not provide useful information. The associated blank spike recovery was acceptable.
M5 = Analyte concentration was determined by the method of standard addition (MSA).
M6 = Matrix spike recovery was high. Data reported per ADEQ policy 0154.000. Matrix Interference was confirmed.
M7 = Matrix spike recovery was low. Data reported per ADEQ policy 0154.000. Matrix Interference was confirmed.

General:

N1 = See case narrative.
N2 = See corrective action report.
N3 = deleted.
N4 = The Minimum Reporting Limit (MRL) verification check did not meet the laboratory acceptance limit.
N5 = The Minimum Reporting Limit (MRL) verification check did not meet the method acceptance limit.
N6 = Data suspect due to quality control failure, reported per data user’s request.
N7= Additional analysis was not performed based on the “Total” result which was below the requested analyte’s MCL/Action level/Trigger level.

Sample quality:

Q1 = Sample integrity was not maintained. See case narrative.
Q2 = Sample received with head space.
Q3 = Sample received with improper chemical preservation.
Q4 = Sample received and analyzed without chemical preservation.
Q5 = Sample received with inadequate chemical preservation, but preserved by the laboratory.
Q6 = Sample was received above recommended temperature.
Q7 = Sample inadequately dechlorinated.
Q8 = Insufficient sample received to meet method QC requirements. Batch QC requirements satisfy ADEQ policy 0154.000.
Q9 = Insufficient sample received to meet method QC requirements.
Q10 = Sample received in inappropriate sample container.
Q11 = Sample is heterogeneous. Sample homogeneity could not be readily achieved using routine laboratory practices.

Duplicates:

R1 = RPD/RSD exceeded the method acceptance limit. See case narrative.
R2 = RPD/RSD exceeded the laboratory acceptance limit. See case narrative.
R3 = deleted.
R4 = MS/MSD RPD exceeded the method acceptance limit. Recovery met acceptance criteria.
R5 = MS/MSD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.
R6 = LFB/LFBD RPD exceeded the method acceptance limit. Recovery met acceptance criteria.
R7 = LFB/LFBD RPD exceeded the laboratory acceptance limit. Recovery met acceptance criteria.
R8 = Sample RPD exceeded the method acceptance limit.
R9 = Sample RPD exceeded the laboratory acceptance limit.
R10 = deleted.
R11 = The RPD calculation for MS/MSD does not provide useful information due to the varying sample weights when Encore samplers/methanol field preserved samples are used.
R12 - RPD/RSD exceeded the method acceptance limit. Result less than 5 times the PQL.
R13 = MS/MSD RPD exceeded method acceptance limit. Matrix spike recovery was outside acceptance criteria. Batch precision and accuracy were demonstrated.

Surrogate:

S1 = Surrogate recovery was above laboratory acceptance limits, but within method acceptance limits.
S2 = deleted.
S3 = Surrogate recovery was above laboratory acceptance limits, but within method acceptance limits. No target analytes were detected in the sample.
S4 = Surrogate recovery was above laboratory and method acceptance limits. No target analytes were detected in the sample.
S5 = Surrogate recovery was below laboratory acceptance limits, but within method acceptance limits.
S6 = Surrogate recovery was below laboratory and method acceptance limits. Reextraction and/or reanalysis confirms low recovery caused by matrix effect.
S7 = Surrogate recovery was below laboratory and method acceptance limits. Unable to confirm matrix effect.
S8 = The analysis of the sample required a dilution such that the surrogate recovery calculation does not provide useful information. The associated blank spike recovery was acceptable.
S9 = deleted.
S10 = Surrogate recovery was above laboratory and method acceptance limits. See case narrative.
S11 = Surrogate recovery was high. Data reported per ADEQ policy 0154.000.
S12 = Surrogate recovery was low. Data reported per ADEQ policy 0154.000.

Method/analyte discrepancies:

T1 = Method approved by EPA, but not yet licensed by ADHS.
T2 = Cited ADHS licensed method does not contain this analyte as part of method compound list.
T3 = Method not promulgated either by EPA or ADHS.
T4 = Tentatively identified compound. Concentration is estimated and based on the closest internal standard.
T5 = Laboratory not licensed for this parameter.
T6 = The reported result cannot be used for compliance purposes.
T7 = Incubator/Oven temperatures were not monitored as required during all days of use.
T8= Method used not listed in 40 CFR 136; alternate method chosen as acceptable per permit.
T9 = Less than the prescribed sample amount was available to perform the leachate extraction. The volume of extraction fluid was adjusted proportionately based on the method prescribed ratio of extraction fluid to sample weight.

Calibration verification:

V1 = CCV recovery was above method acceptance limits. This target analyte was not detected in the sample.
V2 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample. The sample could not be reanalyzed due to insufficient sample.
V3 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample, but the sample was not reanalyzed. See case narrative.
V4 = deleted.
V5 = CCV recovery after a group of samples was above acceptance limits. This target analyte was not detected in the sample; acceptable per EPA Method 8000C.
V6 = Data reported from one-point calibration criteria.
V7 = deleted.
V8 = deleted.
V9 = CCV recovery was below method acceptance limits.

Calibration:

W1= deleted.
W2= deleted.

ATTACHMENT A
“Guidance on the Usage of Data Qualifiers”

These standardized data qualifiers are for use in qualifying analytical results for compliance samples in Arizona to represent events that occurred during analysis.
The technical subcommittee has endeavored to develop qualifiers that are succinct and narrow in scope to eliminate broad or multiple interpretations when assessing the impact on data. It must also be noted that due to the specialized nature of the individual qualifiers, it is likely that more than one qualifier may be needed in order to accurately represent the data.

Note: 1. Using the Arizona Data Qualifiers does not automatically denote acceptability to the Regulatory Agency.

2. As specified in the Arizona Adopted Rules, R9-14-615.C.9, *for each parameter tested at the laboratory for which quality control acceptance criteria are not specified in the approved method or by EPA or ADEQ,:*
a. Use default limits provided in Exhibit II; or
b. Statistically develop limits from historical data

The laboratory has an option of using ADHS Default Limits which can be accessed at http://www.azdhs.gov/lab/license/tech/altdefaultlimit.pdf

Microbiology:

None.

Method/calibration blank:

Apply appropriate qualifier to affected analyte in the blank if target analyte is not detected at ≥ RL in the samples. If analytes are detected, then all corresponding analytes for the associated samples should also be qualified.

Confirmation:

For methods that require qualitative confirmation. C3 applies to methods that require quantitative confirmation.

Dilution:

If all analytes are reported from the diluted sample, apply qualifier to the entire sample. Otherwise apply qualifier to each analyte that required dilution.

Estimated concentration:

Appropriate qualifier must be used for any analyte result reported outside the calibration range. Affects data reported outside the calibration range or down to the MDL. E8 is only required if additional clarification is necessary.

Hold time:

Qualify samples appropriately when method extraction and/ or analysis holding time have been exceeded.

BOD/CBOD:

Qualifiers K5, K6, & K8 indicate situations that may impact all results in an analytical run and should be used to qualify all affected samples as well as any affected quality control samples when reported. K3 was deleted because if the seed depletion was out, then the situation must be explained in the case narrative. Criteria for qualifiers K9, K10, K11 taken from Standard Methods 5210 B, 2001 Revision.

Laboratory fortified blank/blank spike:

Appropriate qualifier must be applied to the affected analytes in the Laboratory fortified blank/blank spike and to all corresponding analytes in the associated samples.

Matrix spike:

Appropriate qualifier must be applied to the affected analytes in the matrix spike and should also be added to all corresponding analytes in the associated spiked sample. If a batch spike recovery is outside of the acceptable range, it is permissible to only flag the sample that was spiked and not the other samples in the batch. As required in the Arizona Adopted Rules A.A.C. R9-14-617.8.d, clients must always be informed if the batch QC result is unacceptable whether one of their samples was spiked or not. The laboratory can choose how the unacceptable QC is reported to the client (e.g., cover letter or flag).

The ADEQ policy 0154.000 can be accessed at http://www.azdeq.gov/function/programs/download/spike8.pdf

General:

For example, qualifier N7 refers to total cyanide vs. free or amendable cyanide, total nitrate/nitrite vs. nitrite, total metals vs. TCLP metals, total PCB’s vs. individual aroclors, and total chromium vs. hexavalent chromium.

Sample quality:

Flag samples with appropriate qualifier when sample quality may be potentially impacted or when method requirements were not met.
The ADEQ policy 0154.000 can be accessed at http://www.azdeq.gov/function/programs/download/spike8.pdf

Duplicates:

For use with sample, matrix spike, LFB and LFB/blank spike duplicates. Qualify all affected analytes. For MS/MSD or sample duplicates qualify only the original source sample.

Surrogate:

Qualify surrogates appropriately when they do not meet criteria. Surrogate failures in quality control samples will most likely require additional narration. S11 & S12 are used to qualify sample surrogates and only in cases where the Laboratory Fortified Blank/ blank spike has acceptable surrogate recoveries.

Method/analyte discrepancies:

For use with methods or analytes that are not currently approved under the Environmental Laboratory Licensure Rules or for which the lab is not licensed.

Calibration verification:

Appropriate qualifier must be applied to all affected analytes in any samples associated with the calibration verification.

Calibration:

None.