

ARID WEST WATER QUALITY RESEARCH PROJECT

By **KAREN RAMAGE**, *Program Manager, Pima County Wastewater Management Department*,
ED CURLEY, *Environmental Planning Manager, Pima County Wastewater Management Department*;
and **RICHARD MEYERHOFF, PH.D.**, *AWWQRP Research Manager, CDM*

BACKGROUND

The Arid West Water Quality Research Project (AWWQRP or “Project”) began as an idea in the early 1990’s out of concerns regarding the applicability of national water quality criteria to western ephemeral and effluent-dependent waters. Two key issues were originally identified: (1) national water quality criteria were based on aquatic species and flow regimes not necessarily representative of ephemeral and effluent-dependent streams; and (2) the methods provided by the U.S. Environmental Protection Agency (EPA) to modify national water quality criteria for use in effluent-dependent and ephemeral streams were not readily applicable primarily because of the lack of basic data on organisms of importance in these arid West waters (note: throughout this article references to the arid West include both arid and semi-arid areas). With these concerns in mind, efforts were initiated to demonstrate the need for the establishment of a program for the development of standards and criteria applicable to the arid West, similar to regional programs established for the Great Lakes and coastal marine waters.

These efforts bore fruit with the establishment of the AWWQRP (Phase I) in 1995 as the result of a \$5,000,000 federal appropriation (Public Law 103-327) and the establishment of an Assistance Agreement between the EPA and Pima County Wastewater Management Department, Tucson, Arizona. The establishment of the Agreement provided a significant opportunity for Pima County, EPA Region IX and others throughout the arid West to work cooperatively to conduct the scientific research necessary to develop appropriate water quality criteria and standards for the region and improve the scientific basis for regulating wastewater and stormwater discharges in the arid and semi-arid West.

Since the establishment of the AWWQRP, a number of research projects have been funded. As these projects have been implemented and completed, the AWWQRP has shared Project results and their implications in a variety of forums. This outreach effort is leading to a broader understanding of water quality issues unique to the arid West and growing support for the establishment of a regional approach for the development and implementation of water quality standards. This growing support resulted in an additional federal appropriation of \$500,000 (Public Law 107-73) that is being administered separately as the “Phase II” AWWQRP grant. In addition, increased support of the AWWQRP also has been fueled by an increasing interest in recognizing the ecological benefit of effluent-supported riparian habitats in the West. Moreover, it is being recognized that as the cost of wastewater treatment climbs and the quality of effluent improves, the competition and value of treated wastewater will likewise increase to the extent that treated wastewater, which could be used to support riparian habitat and wildlife, will likely be diverted to other urban uses. This is especially a concern for areas of the arid West where riparian and wildlife

habitats are already limited. Thus, an ongoing purpose of the AWWQRP is to provide critical data to support efforts to address these unique western water quality concerns and provide innovative solutions.

PROJECT PURPOSE

The purpose of the AWWQRP is to conduct scientific research and disseminate scientific information on western ephemeral and effluent-dependent waters to help resolve issues of significance to both the regulated community and regulators at state, tribal and federal levels. To accomplish this purpose, research activities have focused on the following areas:

- Water quality criteria and standards for arid West habitats;
- Water quality criteria for chemicals of concern;
- Biological and ecological criteria and standards for arid West ecosystems;
- Whole effluent toxicity testing guidance for arid West waters; and
- Arid West water quality policy and implementation issues.

PROJECT ORGANIZATION

The AWWQRP is directed and managed by the AWWQRP Office established within Pima County Wastewater Management (PCWMD), Tucson, Arizona.

The EPA Region IX Project Officer serves as the primary point of contact with the EPA and participates to the extent possible in Project meetings, especially those involving the direction and management of the Project.

Scientific management of the AWWQRP is the responsibility of the Research Manager. A contractor recruited according to Pima County procurement procedures provides this service. CDM has provided scientific management services for the AWWQRP since 2001.

The grant awards specify that the Project will comply with Quality Assurance requirements that are consistent with the EPA. Consequently, the Project has developed a Quality Assurance Project Plan (QAPP) that specifies how this will be done and retains an experienced investigator in quality assurance to review individual project work plans for compliance with the QAPP. Aquatic Consulting & Testing, Inc. has provided this service for the Project.

The Regulatory Working Group (RWG) is comprised of a 15-member group of stakeholders representing both public and private interests. The RWG was established to ensure that the research undertaken by the AWWQRP has a sound regulatory basis, and that, to the extent practicable, the regulatory needs of arid West states are addressed by the Project.

The Scientific Advisory Group (SAG) is comprised of established scientists (e.g. aquatic toxicologists, terrestrial ecologists, etc.) from throughout the West with experience in water quality research and peer review of scientific and

technical literature. The function of the SAG is to recommend research topics for study, to ensure that studies undertaken are designed appropriately, and to assist in the technical review of research products.

COMPLETED PROJECTS – PHASES I AND II

Pre-Research Survey of Municipal NPDES Dischargers in the Arid and Semi-Arid West (Discharger Survey)

This research was implemented following an RWG recommendation that the Project survey as many arid West dischargers as possible to obtain information necessary to properly characterize arid West discharges and associated water quality concerns. A key finding of the resulting report, completed in March 2000, was that there was a general lack of data that effectively described effluent-dependent water habitats.

Habitat Characterization Study

Based on the findings of the Discharger Survey, the Habitat Characterization Study was commissioned for the purpose of characterizing the physical, chemical and biological characteristics of selected effluent-dependent waters (EDWs) across the arid West. It is believed that this effort represents the first attempt to focus data gathering efforts on this type of aquatic ecosystem. The final report was published in winter 2002.

Extant Criteria Evaluation

The primary focus of this project was to evaluate existing methods for generating federal ambient water quality criteria (AWQC), methods for site-specific modifications to criteria and, if appropriate, develop an approach for regional AWQC modification that takes into account the unique characteristics of ephemeral and effluent-dependent watercourses in the arid West. Four “model” AWQC, which represent different types of pollutants, were used as the basis for this evaluation: copper, selenium, diazinon and ammonia. The final report was completed with a limited publication in September 2003 and is expected to be published by the Society of Environmental Toxicology and Chemistry (SETAC) in 2007.

Evaluation of Whole Effluent Toxicity Testing as an Indicator of Aquatic Health

This project has been a collaborative research effort between the AWWQRP and the Water Environment Research Foundation (WERF, Project No. 03-ECO-2). WERF managed and directed the research project, and the AWWQRP, as a collaborative partner, contributed research funds and technical oversight. This pilot study evaluated the quality of data needed to determine relationships between chronic Whole Effluent Toxicity (WET) test results and instream biological condition. Benefits from this study included providing several data quality criteria for WET that should be considered along with test acceptance criteria to improve accuracy and defensibility of test results; demonstrated the importance of data quality factors and endpoint calculation methods in determining whether an effluent “passes” or “fails” its WET limit. The project was completed in 2006.

Evaluation of the Reliability of the Biotic Ligand Model (BLM) Predictions for Copper Toxicity in Waters Characteristic of the Arid West

The focus of this research project was a series of studies designed to further evaluate the reliability of the BLM to predict copper toxicity in arid West waters. Additionally, a series of tests to further evaluate the different roles of calcium vs. magnesium in controlling copper toxicity to invertebrates and fishes was also conducted.

Conclusions from this study further suggested that the BLM generates more appropriate and protective copper standards for waters with elevated hardness when compared to the hardness-based equation or Water-Effect Ratio (WER) approaches. Although the historical site-specific methods (hardness equation and WER) are useful for surface waters with low to moderate levels of hardness, the unique chemical conditions of arid West streams require site-specific methods that account for the influences of all water quality variables (i.e., pH, dissolved organic carbon, alkalinity, and major ions). Therefore, the BLM offers an improved alternative to the hardness-based and WER approach for modifying copper criteria, particularly for situations where the current methods would be under-protective of sensitive aquatic life. This project was completed in 2006.

Ammonia Water Effect Ratio

Although the 1999 AWQC is not expressed as a function of hardness, some toxicity studies have suggested that ammonia toxicity may vary with hardness for both invertebrates and fish. Therefore, a simple empirical study was conducted as a “proof of concept” to determine whether hardness exerts a significant enough effect on acute ammonia toxicity to be used as a basis for deriving site-specific ammonia standards in hard, effluent-dependent waters.

This study supported the limited toxicity literature available which suggests that hardness (and/or related cations) may influence acute ammonia toxicity. However, these effects have been shown to be species-specific, and only valid for invertebrates, not fish. This study has also shown that WERs >1 can be observed in effluent-dependent waters for both fish and invertebrates. The WERs found to be >1 may have been the result of a difference in ionic composition between the site and laboratory waters, but it is clear that the protective effect associated with these significant WERs was not due to hardness alone. Therefore, until these potential ion effects and/or mechanisms are better understood, it is difficult to predict whether a positive WER could be achieved for a given site without first conducting empirical tests. This project was completed in 2006.

Evaluation of EPA Recalculation Procedure and User's Guide for EPA Recalculation Procedure

The goals for this project were two-fold: 1) Evaluate the use of the EPA Recalculation Procedure to modify criteria in each selected arid West stream given the available data, and 2) develop a User's Guide for water quality standards practitioners to provide guidance on how to apply the Recalculation Procedure to arid West waters in general. To accomplish these goals, the evaluation focused on AWQC that represent different modes of toxicity, robustness of toxicological databases, and other recalculation issues.

In this study, AWQC were recalculated to better reflect the resident species observed in a number of effluent-dependent or dominant streams in the arid West.

Resident species lists were developed for each of the five selected waterbodies for comparison to the toxicity databases as a required step in the recalculation procedure. Additionally, each of the selected criteria (ammonia, copper, zinc, diazinon, and aluminum) were updated and subsequently used as the basis for evaluating the recalculation procedure at each of the study sites.

Based on the analyses conducted as part of this study, the recalculation procedure can be a useful tool, particularly when modified and applied to arid West streams. The results of recalculated site-specific criteria resulted in significant changes for some, but not all AWQC reviewed in this analysis. This project was completed in 2006.

Aquatic Communities of Ephemeral Stream Ecosystems

The focus of this research project was on aquatic biological communities that colonize ephemeral systems of the arid West in response to monsoonal thunderstorms. Fifteen study sites within three broad geographic regions (Hot Desert, Cool Desert/Great Basin, and High Plains) were sampled during runoff conditions when flows were expected to continue for several days. 86 distinct taxa of aquatic macroinvertebrates were collected. Most of the taxa had aerially dispersing life stages and were present either in that form or as immature larvae recently hatched from eggs deposited by the aerial life stage. Generally, taxa richness was highest the first few days after flows began to recede, and decreased as available habitat diminished.

Representative resident taxa lists from the arid West region, as compiled from previous AWWQRP projects, were supplemented by an additional 50 taxa collected in this study. It is expected that the lack of resident fish and elimination of key water quality indicator organisms such as cladocerans and isopods from the resident species lists will have a considerable effect on water quality criteria as applied to ephemeral streams. This project was completed in 2006.

User's Guide

This draft document is currently under review and includes a summary of findings of AWWQRP research, as well as other related research. These findings are discussed in the context of water quality standards program implementation as it is being carried out by the states and EPA. This document has been prepared with all water quality standards practitioners in mind, not just dischargers who must comply with the myriads of state and federal water quality standards regulations, but also state regulators, who are often searching for practical and innovative ways to develop and implement water quality standards within the bounds of Clean Water Act and its implementing regulations. This project will be completed in early 2007.

RESEARCH CONTINUATION

To date, research conducted under the AWWQRP has shown that the need for continued research in ephemeral and effluent-dependent waters is great. It is critical that we improve our understanding of these unique aquatic ecosystems so that appropriate beneficial uses and criteria are established for these watercourses.

As Phase II of the Project comes to an end, it is hoped that the legacy of the Arid West Water Quality Research Project will continue with the funding of other long-term research projects to enhance our understanding of arid West ecosystems.

ADDITIONAL PROJECT INFORMATION

Arid West Water Quality Research Project
Pima County Wastewater Management
201 N. Stone Avenue, 8th Floor, Tucson, Arizona 85701-1207
(520) 740-6977 E-mail: wqrp@wwm.pima.gov
Website: www.pima.gov/wwm/wqrp