

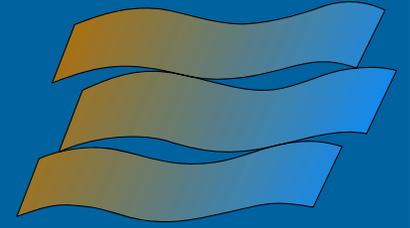


Research Update: The Arid West Water Quality Research Project



Arizona Water &
Pollution Control
Association

Mesa, Arizona
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Edward F. Curley, Project Director
Karen J. Ramage, Project Manager

Richard D. Meyerhoff, Ph.D., Research Manager,
Camp Dresser & McKee, Inc.

Pima County Wastewater Management Department
Michael Gritzuk, P.E., Director



Arid West Water Quality Research Project (AWWQRP)

- Project Purpose: Improve scientific basis for regulation of water quality and protection of species, habitats and uses of effluent-dependent and ephemeral waters in the arid West.
- Funded by the U.S. Environmental Protection Agency
- Initiated in 1995
- Phase I Grant (P.L. 103-327): \$5,000,000 (1995 – 2006)
- Phase II Grant (P.L. 107-73): \$500,000 (2003 – 2006)



Upstream of discharge



5 miles downstream of discharge



Below discharge

**An Effluent-dependent
Stream:
Santa Fe River
Santa Fe, New Mexico**



AWWQRP: Stakeholders Working Together

- Pima County Wastewater Management Department
- U.S. Environmental Protection Agency – Region IX / Headquarters
- Regulatory Working Group – Identify regulatory issues that should be addressed by research and develop the Research Agenda
- Scientific Advisory Group – Review proposals received, rank and recommend worthy proposals based on scientific merit and review research products





Regulatory Working Group

- Michael Gritzuk, RWG Chair, Pima County Wastewater, AZ
- Ed Anton, California State Water Resources Control Board, CA
- Rod Cruze, Riverside Regional Water Quality Control, CA
- Steve Davis, Malcom Pirnie, AZ
- Paul Frohardt, Colorado Water Quality Control Commission, CO
- Gary Ullinskey, City of Phoenix Water Services, AZ
- Robyn Stuber, U.S. EPA, Region IX
- Andy Laurenzi, Sonoran Institute, AZ
- Lynn Wellman, U.S. Fish & Wildlife Service, Albuquerque, NM
- Pat Maley, Strategic Environmental Management, Boise, ID
- Jim Pendergast, U.S. EPA, Headquarters
- Sam Rector, Arizona Department of Environmental Quality, AZ
- Eric Rich, Navajo Environmental Protection Agency, AZ
- Dan Santantonio, City of Las Cruces, Utilities Division, NM



Scientific Advisory Group – Expertise

- Paul Adamus, Ph.D., Oregon State University, Corvallis, OR – terrestrial ecology, wetland-riparian systems, ornithology and aquatic invertebrates
- Gary Chapman, Ph.D., Paladin Water Quality Consulting, Corvallis, OR – water quality criteria development, aquatic and sediment toxicology
- Karmen King, Colorado Mountain College, Leadville, CO – aquatic toxicology, fisheries biology and aquatic chemistry
- Robert McFarlane, Ph.D., McFarlane & Associates, Houston, TX – aquatic and terrestrial ecology, threatened and endangered species, environmental impact assessments, habitat evaluation and wetlands
- Benjamin Parkhurst, Ph.D., HAF, Inc. Laramie, WY – ecological risk assessment, aquatic toxicology, fisheries biology and aquatic ecology

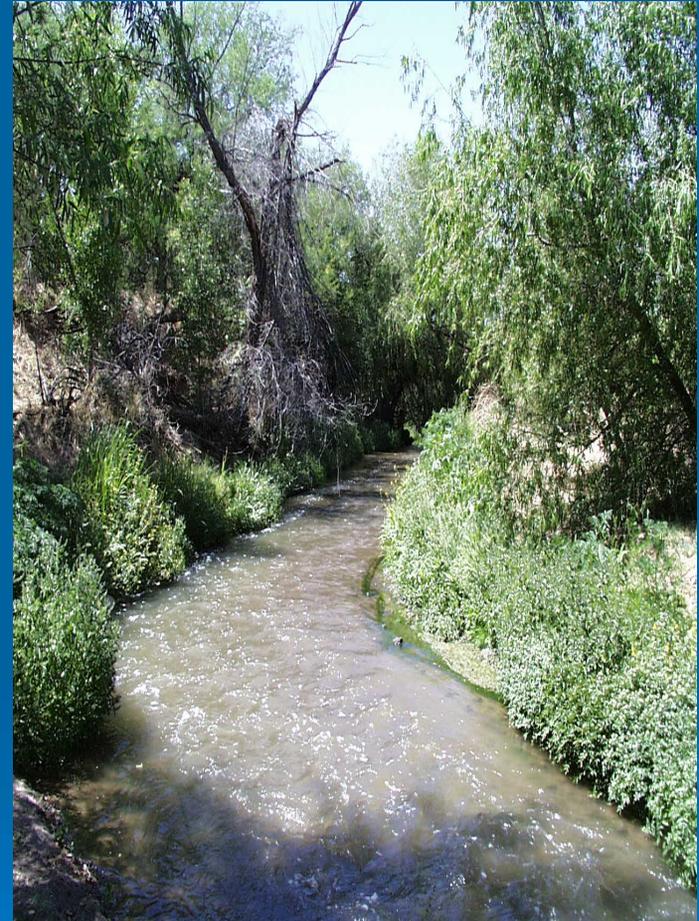
Research Activities





Discharger Survey, Spring 2000

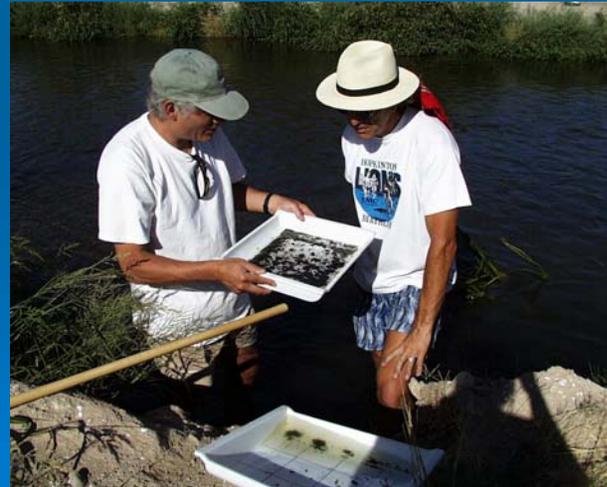
- Survey of Municipal Dischargers in the Arid and Semi-arid West
 - Basic data included:
 - Effluent discharge rates, characteristics of receiving waters and issues of concern.





Habitat Characterization Study, Summer 2002

- Purpose: Objectively describe and characterize effluent-dependent ecosystems in the arid West.
- 10 case studies: Documented the physical, chemical, and biological characteristics of ten effluent-dependent waters in the arid West.





Habitat Characterization Study Results

- Effluent-dependent waters are sufficiently different from other waterbody types to represent a distinct waterbody class;





Habitat Characterization Study Results

- Physical habitat of an effluent-dependent water is a combination of several factors, most significant – physical dynamics associated with the discharge itself and channel modifications associated with development of urban areas;





Habitat Characterization Study Results

- Differences exist between the chemical composition of waters at the study sites and laboratory water used for WET testing and pollutant-specific laboratory toxicity studies;





Habitat Characterization Study Results

- Aquatic and terrestrial biological communities are a reflection of the physical and chemical template resulting from instream flow characteristics (natural and effluent-driven); and





Habitat Characterization Study Results

- Increased levels of wastewater treatment may not be the most cost-effective approach for improving the aquatic communities of waters receiving discharges of treated effluent.





Extant Criteria Evaluation, Fall 2003

➤ Objectives:

- Examine the appropriateness of AWQC for arid Western ecosystems,
- Identify potential weaknesses in the AWQC (or their derivation methods) for these systems, and
- Recommend future research to address any identified potential weaknesses.





Extant Criteria Evaluation Results

- *AWQC Magnitudes* – Changes in default national AWQC magnitudes are probably warranted to maximize the accuracy by which they represent chemical concentrations which are protective of aquatic life in these systems.





Extant Criteria Evaluation Results

- Existing *site-specific criteria modification methods* (i.e., recalculation procedure, water-effect ratio procedure, and resident species procedure) may adequately address these changes, and so a “regional” approach may not be necessary in many cases.





Extant Criteria Evaluation Results

- *AWQC Duration and Frequency* – the Criteria implementation also depends upon the duration (i.e., averaging period) and frequency (i.e., period between criteria excursions that still allows for recovery of aquatic communities) components of an AWQC. Because default duration values are based entirely on laboratory toxicology and toxicokinetics data, it is not possible to suggest modifications on the basis of conditions unique to the arid West.



Extant Criteria Evaluation Results

- Recent laboratory evidence suggests that these default duration values may be overly conservative (i.e., too short) in some cases. Increasing duration values would significantly increase design flows for NPDES permit calculations, and so is an important avenue of future study.





Extant Criteria Evaluation Results

- The relevance of the default 3-yr recovery period to arid West biotic assemblages was evaluated not only as a function of community recovery from disturbance, but also as a function of hydrologic disturbance frequency.





Extant Criteria Evaluation Results

- The analysis suggests that the frequency and duration of hydrologic events in ephemeral streams of the arid West have the potential to be of similar importance to biotic communities as is exposure to toxics.





Extant Criteria Evaluation Results

- The frequency of hydrologic disturbance to ephemeral and effluent-dependent streams certainly is high enough to suggest that these ecosystems could be disturbed more frequently than once every three years.





Extant Criteria Evaluation Results

- In contrast, the biotic assemblages of ephemeral and effluent-dependent streams may still require longer time periods (e.g., 3 yrs) to recover from disturbance even if a substantial number of endemic species still remain. This suggests that it may be environmentally conservative to retain the default 3-yr frequency of allowed excursions except, perhaps, for relatively unmodified ephemeral streams. Frequency values also can have a significant impact on derivation of NPDES permit design flows, and so a closer examination of the 3-yr default frequency—at least in the case of ephemeral streams—deserves closer attention.



Extant Criteria Evaluation Results: Copper Hardness – the Toxicity Study

- Waters in the arid West frequently exceed 400 mg/L hardness (above the levels identified in EPA's AWQC), and the applicability of hardness-toxicity relationships in these waters are unknown.





Extant Criteria Evaluation Results: Copper Hardness – Toxicity Study

- Although copper toxicity still decreased with increasing hardness at levels > 400 mg/L, the hardness-toxicity relationships differed with ion composition. In particular, increasing alkalinity, magnesium, or sodium concentrations explained decreases in copper toxicity better than did either hardness or calcium concentrations.



Extant Criteria Evaluation Results: Copper Hardness – Toxicity Study

- Therefore, further study is needed to determine whether simple hardness-based metals criteria are appropriate for use in the arid West, or whether more complex approaches are warranted.





Biotic Ligand Model – Copper Toxicity Study, Summer 2006

Principal Investigator: Bob Gensemer, Parametrix

Technical Leads: Eric Van Genderen, Parametrix; Bob Santore, HydroQual

- Purpose – to further evaluate the reliability of the Biotic Ligand Model to predict copper toxicity in arid West waters.

Note: The Biotic Ligand Model is a computational model that represents complex chemical factors that influence how metal chemically binds to biological surfaces (i.e. fish gill).



Biotic Ligand Model – Copper Toxicity Study, Summer 2006

➤ Tasks included:

- Conduct acute copper toxicity tests with three different aquatic test species under a range of water quality conditions
- Conduct a statistical evaluation of the predictive capabilities of the BLM for these waters





Biotic Ligand Model – Copper Toxicity Study Results

- Hardness and related inorganic WQ characteristics do not have the same magnitude of effect on copper toxicity at higher hardness levels as they do at lower hardness levels.





Biotic Ligand Model – Copper Toxicity Study Results

- Related WQ characteristics do not correlate as well in high hardness water as they do in waters of relatively low hardness.





Biotic Ligand Model – Copper Toxicity Study Results

- Results suggest that the BLM offers an improved alternative to the site specific methods for modifying copper criteria.





Biotic Ligand Model – Copper Toxicity Study Results

- The BLM represents a greatly improved method for site-specific derivation of copper criteria in effluent-dependent and effluent-dominated waters of the arid West.





EPA Recalculation Procedure Study & User's Guide, Summer 2006

Principal Investigator: Mark Murphy, URS

Technical Lead: Steve Canton, Chadwick Ecological

User's Guide Principal Investigator: Bob Gensemer,
Parametrix

- Purpose – to evaluate the effectiveness of the EPA Recalculation Procedure to establish site-specific water quality criteria in arid West effluent-dependent waters.





EPA Recalculation Procedure Study & User's Guide Results

- Based on our analysis, the recalculation procedure can be a useful tool, particularly when modified and applied to arid West streams as recommended in this report. The results of recalculated site-specific criteria were successful for some, but not all AWQC reviewed in this analysis.
- Success was measured by a change in values of at least 10% from the updated national criteria (any change less than this may or may not be worth the effort) and the biological relevance of the site-specific values.
- Successful recalculations conducted in this effort include copper, diazinon and zinc.



EPA Recalculation Procedure Study & User's Guide Results

- Regardless of the outcome of the recalculation values, we believe our analysis shows that the investment will be worth the effort.
- Specifically, the findings assure that any resulting criteria are more relevant for a particular stream than a generalized, often out-dated national value.
- In fact, simply updating the national criteria, without proceeding with the recalculation procedure, can be worth the effort by establishing more confidence in the calculated values.
- Alternatively, regional-specific recalculated criteria, such as those presented here for the Southwest and High Plains, would be a cost-effective and protective solution for smaller dischargers in these regions.



EPA Recalculation Procedure Study & User's Guide Results

- Completion of this analysis of the recalculation procedure in arid West streams has generated the following recommendations:
- Adopt the arid West modifications to the recalculation procedure outlined in Chapter 8. These modifications include:
 - Use of a revised arid West eight family rule, which was specifically designed to better represent aquatic communities expected to occur in arid West stream segments relative to the default eight family rule.
 - Use of the refined step-wise process for deriving site-specific toxicity databases.
 - Conducting the recalculation procedure on the species level rather than at the genus level that is presently used in AWQC derivation. Use of the species level maximizes the size of the toxicity database, which is particularly important in effluent-dependent waters that may possess limited numbers of resident species.



EPA Recalculation Procedure Study & User's Guide Results

- Develop a resident species list for each river segment of interest for development of a site-specific water quality standard.
 - Based the species list on existing monitoring program, if this effort has already been established.
 - Establish a monitoring program if none exists.
 - Data collected should include both fish and invertebrate communities.
 - Efforts can be shared with other dischargers in the basin and potentially coordinated with State and Federal agencies.



EPA Recalculation Procedure Study & User's Guide Results

- Support continued updates of existing EPA AWQC.
 - Recommend that the EPA update their older criteria.
 - Permits would then be based on AWQC using most up-to-date toxicity data and information.
 - Alternatively, updates can be completed by other entities.
 - AWWQRP special project
 - WESTCAS
 - WERF
 - Other consortium?
 - However, any update must be approved by the EPA, as well as State and local authorities. This should be done as an open, multi-stakeholder process to ensure any approach would be acceptable at all levels of regulatory authority.



EPA Recalculation Procedure Study & User's Guide Results

- It is imperative that more toxicity testing for all AWQC be conducted with species resident to arid West streams.
 - Concentrate on criteria of interest to arid West rivers and criteria with more limited databases (e.g., aluminum, diazinon).
 - Funding for these tests could come from interested parties,
 - USEPA
 - AWWQRP
 - WESTCAS
 - WERF
 - others?



Ammonia Water Effect Ratio Study, Summer 2006

Principal Investigator: Bob Gensemer, Parametrix

➤ Technical Leads: Eric Van Genderen, Parametrix; Steve Canton, Chadwick Ecological

- Purpose – to establish the basis for developing a water-effect ratio for ammonia to take into account local or regional water quality characteristics in arid West effluent-dependent waters
- Tasks included:
 - A brief literature review
 - A series of acute toxicity tests that independently varied hardness and pH to further evaluate the significance of hardness-ammonia toxicity relationships
 - A limited set of confirmatory WER studies in effluent-dependent waters of varying hardness with two standard lab test species and an aquatic insect species



Ammonia Water Effect Ratio Study Recommendations

- Issues that would benefit from future research:
 - To more fully understand the effects of ionic composition on acute ammonia toxicity, a series of additional experiments are needed. Major ions, such as sodium and potassium, would be independently manipulated and the effects of these ions on ammonia toxicity compared with the effects of hardness on ammonia toxicity.
 - To more fully understand the role of sodium on the hardness/ammonia toxicity relationship, a more robust experimental design with additional species is required.
 - Evaluating the major ion composition of the lab and site waters tested, especially sodium and potassium versus calcium and magnesium, may help us to better interpret WER results



WERF – AWWQRP Research Activity

Evaluation of WET Testing as an Indicator of Aquatic Health, Summer 2006

➤ Principal Investigator: Jerry Diamond, Tetra Tech, Inc.

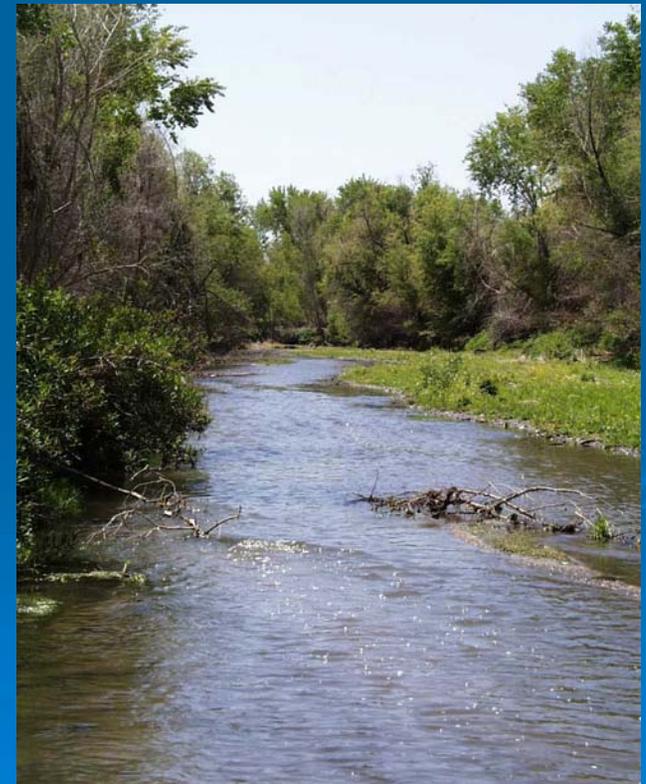
- Goal – Determine the design for a comprehensive study to address relationships between WET and instream biological conditions.
- Objectives:
 - Evaluate ability of biological assessments and WET tests to meet Data Quality Objectives (DQO) and Measurement Quality Objectives
 - Determine appropriate biological assemblages and evaluate sampling protocols
 - Determine minimum amount of WET and biological assessment data needed to address project DQOs
- Draft report issued for review
- Final report – Summer 2006



Ongoing AWWQRP Research Activity

Research Implementation Document, Fall 2006

- Similar in style to the EPA CALM Document
- Potential elements to be included:
 - Use Designation and Protection
 - Establishment of Water Quality Criteria
 - NPDES Permit Guidance
 - Case Studies
- Final report – Fall 2006





Recently Initiated AWWQRP Research Activity

Aquatic Communities of Ephemeral Stream Ecosystems,
Fall 2006

- Principal Investigator: Mark Murphy, URS
 - Purpose – to evaluate the applicability of chronic aquatic life criteria or chronic toxicity test to ephemeral stream ecosystems in the arid West.





Aquatic Communities of Ephemeral Stream Ecosystems

➤ Tasks include:

- Literature review
- Field studies – collect data on aquatic species that colonize ephemeral streams following precipitation or snowmelt events
- Field studies – evaluate aquatic communities in ephemeral streams as a function of duration of water present in the ephemeral streams
- Data evaluation in context of federal WQ standards program, provide recommendations

Moving Forward





Completion of Arid West Water Quality Research Project

- Complete current research projects – Fall 2006
- Conduct RWG meeting – October 2006
- Continue outreach activities – Dissemination of research information
 - WESTCAS – June 2006
 - AWPCA – May 2007
- Continue to submit abstracts for national and regional conferences

AWWQRP – Stakeholders Working Together





AWWQRP Has Played An Important Role

- Brought similar interests together
- Focused scientific efforts
- Created databases for use by both regulators and those regulated
- Provided opportunity to discuss critical water supply and quality issues in common forum



Arid West Water Quality Research Project



**Contact:
Ed Curley or Karen Ramage
(520) 740-6500
www.pima.gov/wwm/wqrp**

Thank you