STATE OF NEW MEXICO
BEFORE THE WATER QUALITY CONTROL COMMISSION

In the Matter of:	
PROPOSED AMENDMENTS TO STANDARDS FOR INTERSTATE AND INTRASTATE SURFACE WATERS, 20.6.4 NMAC	**No. 14-05 (R)**

FREEPORT-MCMORAN CHINO MINES COMPANY'S NOTICE OF INTENT TO , PRESENT TECHNICAL TESTIMONY AND EXHIBITS

Freeport-McMoRan Chino Mines Company ("Chino Mines Company" or "Chino") files this, its Notice of Intent to Present Technical Testimony ("NOI") pursuant to the Water Quality Act and the Water Quality Control Commission's ("the Commission") Guidelines for Water Quality Control Commission Regulation Hearings and the Procedural Order dated July 10th, 2014. This testimony will be in support of Chino's petition that requests addition of site-specific aquatic life criteria for copper to NMAC 20.6.4 for certain surface waters located within the area known as the Chino Mines Smelter Tailings and Soil Investigation Unit ("STSIU") near the towns of Bayard and Hurley in Grants County, New Mexico.

1. Entity for whom the witnesses will testify: Chino.

2. Technical Witnesses:

Joseph S. Meyer, Ph.D.

The CV and qualifications of the witness are attached in Exhibit D.

Barry Fulton

The CV and qualifications of the witness are attached in Exhibit F.

3. Testimony: The written direct testimony of Joseph S. Meyer, Ph.D. is attached as Exhibit E. Dr. Meyer is also expected to provide oral testimony lasting approximately 30 minutes. The written direct testimony of Barry Fulton is attached in Exhibit G. Mr. Fulton is also expected to provide oral testimony lasting approximately 15 minutes.

4. Recommended Amendments: Recommended changes to NMAC 20.6.4 are attached here as Exhibit H, First Amended Proposed Rule, and Exhibit I, Conditional Alternative Proposed Rule.

Chino's First Amended Proposed Rule removes portions of waters designated by the U.S. Fish and Wildlife Service as critical habitat for the Chiricahua Leopard Frog, or "CLF," from the waters to be covered by the proposed site-specific standard for copper in the Chino Mines STSIU. Although Chino's technical testimony supports the inclusion of the CLF critical habitat in the site specific standard, to allow for a proposal that can be approved by the Commission and EPA without raising questions about the need for additional interagency consultation, Chino is amending its proposal so that the site-specific copper criteria, if adopted by the Commission, would not apply to the designated Chiricahua Leopard Frog habitat.

Chino's Conditional Alternative Proposed Rule provides the Commission with alternative rule language to consider. The Conditional Alternative Proposed Rule language is intended to consolidate in one location, for ease of reference, the elements of the surface water quality standards for the waters proposed to be covered by the site-specific standard for copper, including the designated uses of the waters. This format is more consistent with other portions of 20.6.4 that apply to specific waters, and is not intended to be any different, in substance, than if the Commission adopted the language in Chino's First Amended Proposed Rule. The Conditional Alternative Proposed Rule, however, incorporates the separate proposal offered by

the Environment Department to classify portions of the waters as ephemeral (proposed section 20.6.4.809). Consequently, adoption of the Conditional Alternative Proposed Rule language is offered only if the Commission adopts NMED's proposal regarding the ephemeral waters. While Chino prefers its initial proposal, the alternative language also is acceptable, so long as waters proposed to be designated as ephemeral by the New Mexico Environment Department, based on the Use Attainability Analysis conducted using New Mexico Environment Department's Hydrology Protocol, is also approved by the Commission.

5. Exhibits: Chino will provide the following exhibits:

Exhibit Designation	**Description**
Exhibit A (replaces map attached to petition)	STSIU Surface Waters Map
Exhibit B (attached to petition)	2013 Revised Site-Specific Copper Toxicity Model Report for Smelter Tailings Soils IU Drainages – Chino Administrative Order on Consent
Exhibit C (attached to petition)	*B.A. Fulton and J.S. Meyer,* "Development of a Regression Model to Predict Copper Toxicity to *Daphnia magna* and Site-Specific Copper Criteria Across Multiple Surface-Water Drainages in an Arid Landscape," Vol. 33, No. 8 pp. 1865-1873 (2014).6.
Exhibit D	Resume/CV of Joseph S. Meyer, Ph.D.
Exhibit E	Direct written testimony of Joseph S. Meyer, Ph.D.
Exhibit F	Resume/CV of Barry Fulton.
Exhibit G	Direct written testimony of Barry Fulton.
Exhibit H	Chino's First Amended Rule Proposal
Exhibit I	Chino's Conditional Alternative Rule Proposal

Please note that Exhibits B and C have already been filed with Chino's petition and are available online at http://www.nmenv.state.nm.us/swqb/TriennialReview/2013/Freeport-

McMoRanChinoMinesCompanyPetition.pdf. For this reason, Chino will not re-submit Exhibits B and C with this NOI. If any party would like a physical copy of these Exhibits, please contact Gallagher & Kennedy, P.A. at the contact information provided below.

6. Statements of Position:

Chino takes the following positions in regard to the proposals submitted in these proceedings.

a. Amigos Bravos

i. Ephemeral and Intermittent Water Use Designations for Los Alamos National Laboratory

Chino does not support Amigos Bravos' proposal to change one of the designated uses for ephemeral and intermittent waters on Los Alamos National Laboratory's (LANLs) property from limited to marginal aquatic life.

ii. Aquatic Life Criteria for Aluminum

Chino does not support Amigos Bravos' proposal to replace the current hardness-based criteria for aluminum, which was approved by the Commission in 2010 and the U.S. Environmental Protection agency (USEPA) in 2012, with the aquatic life criteria that were in place prior to the 2009 Triennial Review. Chino supports the current hardness-based aquatic life criteria for aluminum as currently stated in NMAC §20.6.4.900.

b. New Mexico Environment Department (NMED)

Chino supports NMED's proposal to add a new provision under 20.6.4.10.F NMAC to adopt temporary standards for surface waters in the state. Chino agrees with statements made by NMED that a provision for temporary standards would be a useful regulatory tool in many instances. Further, Chino is confident that NMED's proposal is consistent with the Clean Water Act ("CWA") as well as similar regulatory tools used by other states.

c. Peabody Energy

Chino supports Peabody Energy's proposal in this proceeding. The proposal appears to be based on sound scientific and policy principles.

7. Reservation of Rights: Chino reserves the right to call additional witnesses or introduce additional exhibits in response to the testimony and witnesses presented at hearing.

RESPECTFULLY SUBMITTED this 12th day of December, 2014.

GALLAGHER & KENNEDY, P.A.

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CERTIFICATE OF SERVICE

I hereby certify that a copy of this, Freeport-Chino's Notice of Intent to Present Technical Testimony has been served electronically and/or via hand delivery to the following parties on December 12, 2014:

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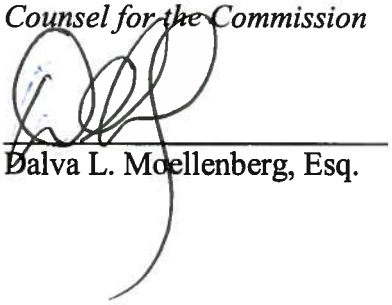
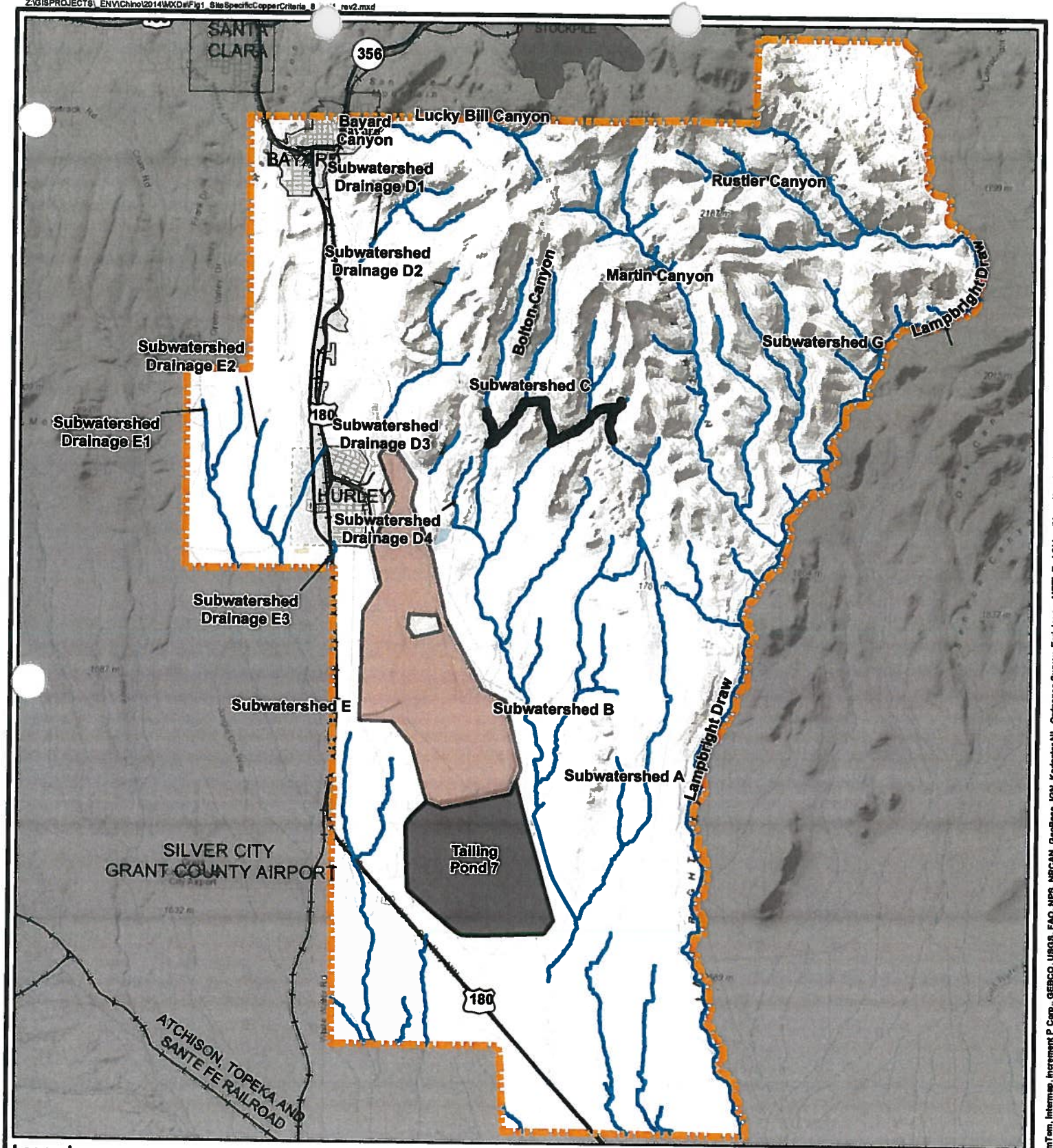


Dalva L. Moellenberg, Esq.



Legend

- STSIU Study Boundary
- Reclaimed Older Tailing Impoundments
- Stockpiles
- STSIU Drainages Subject to Site-Specific Copper Criteria
- USFWS Critical Habitat Transect
- Drainages excluded from site-specific criteria
- Highway
- Railroad
- Town Roads

0 1.25 2.5 Miles

GRAPHIC SCALE

FREEPORT-MCMORAN CHINO MINES COMPANY
VANADIUM, NEW MEXICO

CHINO MINES SITE-SPECIFIC COPPER CRITERIA MAP

ARCADIS

EXHIBIT A

NOI EXHIBIT B – PLEASE REFER TO CHINO'S PETITION

NOI EXHIBIT C – PLEASE REFER TO CHINO'S PETITION

NOTICE EXHIBIT D: RESUME/CV OF JOSEPH S. MEYER, PH.D.

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EDUCATION

1986 Ph.D. Zoology, University of Wyoming, Laramie, WY
1973 B.S. Chemical Engineering, Lehigh University, Bethlehem, PA

ACADEMIC POSITIONS

2005-2007 Professor, Department of Zoology and Physiology, University of Wyoming
1999-2005 Associate Professor, Department of Zoology and Physiology, University of Wyoming
1999-2004 Director, Red Buttes Environmental Biology Laboratory, University of Wyoming
1994-1999 Assistant Professor, Department of Zoology and Physiology, University of Wyoming
1991-1993 Coordinator, Wastewater Utilization Graduate Program, Humboldt State University, Arcata, CA
1990-1993 Lecturer, Department of Fisheries, Humboldt State University, Arcata, CA

OTHER POSITIONS

2007-Present Technical Expert and Principal Scientist, ARCADIS U.S., Inc., Lakewood, Colorado
1989-1990 Postdoctoral Researcher, University of Wyoming-National Park Service Research Center, University of Wyoming
1988-1989 Postdoctoral Researcher, Lake Research Laboratory, Swiss Federal Institute for Water Resources and Water Pollution Control (EAWAG/ETH), Kastanienbaum, Switzerland
1987-1988 NATO Postdoctoral Research Fellow, Lake Research Laboratory, Swiss Federal Institute for Water Resources and Water Pollution Control (EAWAG/ETH), Kastanienbaum, Switzerland
1987 Research Scientist, Department of Zoology and Physiology, University of Wyoming
1986 Graduate Research and Teaching Assistant, Department of Zoology and Physiology, University of Wyoming
1980-1983 Associate Scientist, Western Aquatics, Inc., Laramie, WY [part-time]
1976-1985 Research Scientist, Department of Zoology and Physiology, University of Wyoming
1972-1973 Undergraduate Research Assistant, Department of Chemical Engineering, Lehigh University, Bethlehem, PA
1972 Student Participant, NASA Summer Institute for Biomedical Engineering, Howard University and Goddard Space Flight Center, Greenbelt, MD

TEACHING

Year	Semester	Course No./Title	Cr. Hrs.	Enroll-ment
2007	Spring	ZOO 5780 – Aquatic Toxicology	3	3
2006	Fall	ENR 4500/5500 - Risk Analysis	3	14
2006	Fall	ZOO 4100 - Writing in Zoology (discussion)	1	2
2006	Spring	ZOO 4100 - Writing in Zoology (lecture)	2	23
2006	Spring	ZOO 4100 - Writing in Zoology (discussion)	1	4
2006	Spring	ZOO 5780 - Advanced Limnology	3	3
2005	Fall	ENR 4500/5500 - Risk Analysis	1	14
2005	Summer	BIOL 2400 - General Ecology	3	11
2005	Spring	ZOO 4100 - Writing in Zoology	1	5
2004	Fall	ENR 4990 - Topics: Risk Analysis	3	5
2004	Fall	ENR 5990 - Topics: Risk Analysis	3	4
2004	Fall	ZOO 4970 - Internship in Wildlife Management	1	3
2004	Fall	ZOO 4971 - Internship in Zoology & Physiology	1	1
2004	Spring	ENR 4990 - Topics: Risk Analysis	3	12
2004	Spring	ENR 5990 - Topics: Risk Analysis	3	10
2003	Fall	ZOO 4900 - Problems	3	1
2003	Fall	ZOO 4970 - Internship in Wildlife Management	1	1
2003	Spring	ZOO 5780 - Advanced Limnology	3	6
2002	Fall	ZOO 4970 - Internship in Wildlife Management	1	1
2002	Fall	ZOO 4971 - Internship in Zoology & Physiology	1	1
2002	Spring	BIOL 1000 - Principles of Biology	3	125
2002	Spring	ZOO 5890 - Seminar: Biocomplexity (co-taught with Drs. Colberg and Hall)	1	9
2001	Fall	BIOL 1000 - Principles of Biology (taught first half of one section)	3	125
2001	Fall	ZOO 1000 - Introduction to University Life	1	13
2001	Fall	ZOO 4970 - Internship in Wildlife Management	1	2
2001	Spring	BIOL 1000 - Principles of Biology	3	118
2001	Spring	ZOO 5790 - Ecotoxicology	3	2
2000	Spring	BIOL 1000 - Principles of Biology	3	126
2000	Spring	ZOO 5780 - Advanced Limnology	3	6
1999	Fall	BIOL 1000 - Principles of Biology (taught second half of 2 sections)	3	145 & 120
1999	Spring	BIOL 1000 - Principles of Biology	3	129
1998	Fall	BIOL 1000 - Principles of Biology (taught second half of one section)	3	88
1998	Fall	BIOL 2400 - General Ecology	3	73
1998	Fall	ZOO 1000 - Introduction to University Life	1	16
1998	Spring	ZOO 5780 - Advanced Limnology	3	5
1997	Fall	ZOO 1000 - Introduction to University Life (team-taught with Dr. Ken Gerow)	1	21

TEACHING (cont.)

Year	Semester	Course No./Title	Cr. Hrs.	Enrollment
1996	Fall	BIOL 1000 - Principles of Biology (taught second half of one section)	3	100
1996	Fall	ENR 3000 - ENR Approaches (team-taught with Dr. Tom Crocker)	3	15
1996	Fall	ZOO 1000 - Introduction to University Life (team-taught with Dr. Ken Gerow)	1	20
1996	Spring	BIOL 2400 - General Ecology	3	58
1996	Spring	ZOO 5890 - Groundwater Remediation	2	16
1995	Fall	ENR 3000 - ENR Approaches (team-taught with Dr. Tom Crocker)	3	20
1995	Fall	ZOO 1000 - Introduction to University Life (team-taught with Dr. Ken Gerow)	1	19
1995	Spring	ZOO 4400 - Population Ecology	3	45
1995	Spring	ZOO 5780 - Advanced Limnology	3	14
1994	Fall	BIOL 1000 - Principles of Biology (taught second half of 2 sections)	3	180 & 152
1994	Fall	ENR 3000 - ENR Approaches (team-taught with Dr. Tom Crocker)	3	19
1994	Spring	ZOO 5890 - Groundwater Remediation	1	13

PUBLISHED WORKS

Peer-reviewed Journal Articles:

Farley, K.J. and **J.S. Meyer**. 201_. Metal mixtures modeling evaluation: 3. Lessons learned and steps forward. *Environmental Toxicology and Chemistry*: in review.

Farley, K.J., **J.S. Meyer**, L.S. Balistrieri, Y. Iwasaki, M. Kamo, S. Lofts, C.A. Mebane, W. Naito, A.C. Ryan, R.C. Santore and E. Tipping. 2015. Metal mixtures modeling evaluation: 2. Comparison of four modeling approaches. *Environmental Toxicology and Chemistry*: in press.

DeForest, D.K. and **J.S. Meyer**. 2015. Critical review: Toxicity of dietborne metals to aquatic organisms. *Critical Reviews in Environmental Science and Technology*: in press.

Meyer, J.S., K.J. Farley and E.R. Garman. 2015. Metal mixtures modeling evaluation: 1. Technical background. *Environmental Toxicology and Chemistry*: in press.

Meyer, J.S., J.F. Ranville, M. Pontasch, J.W. Gorsuch and W.J. Adams. 2015. Acute toxicity of binary and ternary mixtures of Cd, Cu, and Zn to *Daphnia magna*. *Environmental Toxicology and Chemistry*: in press.

Fulton, B.A. and **J.S. Meyer**. 2014. Development of a regression model to predict copper toxicity to *Daphnia magna* and site-specific copper criteria across multiple surface-water drainages in an arid landscape. *Environmental Toxicology and Chemistry* 33:1865-1873.

Adams, W.J., R. Blust, U. Borgmann, K.V. Brix, D.K. DeForest, A.S. Green, **J.S. Meyer**, J.C. McGeer, P.R. Paquin, P.S. Rainbow and C.M. Wood. 2011. Utility of tissue residues for predicting effects of metals on aquatic organisms. *Integrated Environmental Assessment and Management* 7:75-98.

DeForest, D.K., **J.S. Meyer**, R.W. Gensemer, B.K. Shephard, W.J. Adams, R.L. Dwyer, J.W. Gorsuch and E.J. Van Genderen. 2011. Are ambient water quality criteria for copper protective of olfactory impairment in fish? *Integrated Environmental Assessment and Management* 7:145-146.

Dyer, S., M.St.J. Warne, **J.S. Meyer**, H.A. Leslie and B.I. Escher. 2011. Tissue residue approach for chemical mixtures. *Integrated Environmental Assessment and Management* 7:99-115.

Meyer, J.S. and W.J. Adams. 2010. Relationship between biotic ligand model-based water quality criteria and avoidance and olfactory responses to copper by fish. *Environmental Toxicology and Chemistry* 29:2096-2103.

Kolts, J.M., C.J. Boese and **J.S. Meyer**. 2009. Effects of dietborne copper and silver on reproduction by *Ceriodaphnia dubia*. *Environmental Toxicology and Chemistry* 28:71-85.

Kolts, J.M., M.L. Brooks, B.D. Cantrell, C.J. Boese, R.A. Bell and **J.S. Meyer**. 2008. Dissolved fraction of standard laboratory cladoceran food alters toxicity of waterborne silver to *Ceriodaphnia dubia*. *Environmental Toxicology and Chemistry* 27:1426-1434.

Brooks, M.L., **J.S. Meyer** and C.J. Boese. 2007. Toxicity of copper to larval *Pimephales promelas* in the presence of photodegraded natural dissolved organic matter. *Canadian Journal of Fisheries and Aquatic Sciences* 64:391-401.

Peer-reviewed Journal Articles (cont.):

Brooks, M.L., **J.S. Meyer** and D.M. McKnight. 2007. Photooxidation of wetland and riverine dissolved organic matter: Altered copper complexation and organic composition. *Hydrobiologia* 579:95-113.

Meyer, J.S., C.J. Boese and J.M. Morris. 2007. Use of the biotic ligand model to predict pulse-exposure toxicity of copper to fathead minnows (*Pimephales promelas*). *Aquatic Toxicology* 84:268-278.

Morris, J.M. and **J.S. Meyer**. 2007. Photosynthetically mediated Zn removal from the water column in High Ore Creek, Montana. *Water, Air, and Soil Pollution* 179:391-395.

Bringolf, R.B., B.A. Morris, C.J. Boese, R.C. Santore, H.E. Allen and **J.S. Meyer**. 2006. Influence of dissolved organic matter on acute toxicity of zinc to larval fathead minnows (*Pimephales promelas*). *Archives of Environmental Contamination and Toxicology* 51:438-444.

Brooks, M.L., C.J. Boese and **J.S. Meyer**. 2006. Complexation and time-dependent accumulation of copper by larval fathead minnows (*Pimephales promelas*): Implications for modeling toxicity. *Aquatic Toxicology* 78:42-49.

Kolts, J.M., C.J. Boese and **J.S. Meyer**. 2006. Acute toxicity of copper and silver to *Ceriodaphnia dubia* in the presence of food. *Environmental Toxicology and Chemistry* 25:1831-1835.

Meyer, J.S., M.J. Suedkamp, A.M. Farag and J.M. Morris. 2006. Leachability of protein and metals incorporated into aquatic invertebrates: Are species and metals-exposure history important? *Archives of Environmental Contamination and Toxicology* 50:79-87.

Morris, J.M., A.M. Farag, D.A. Nimick and **J.S. Meyer**. 2006. Light-mediated Zn uptake in photosynthetic biofilm. *Hydrobiologia* 571:361-371.

Morris, J.M. and **J.S. Meyer**. 2006. Extracellular and intracellular uptake of Zn in a photosynthetic biofilm matrix. *Bulletin of Environmental Contamination and Toxicology* 77:30-35.

Morris, J.M., E. Snyder-Conn, J.S. Foott, R.A. Holt, M.J. Suedkamp, H.M. Lease, S.J. Clearwater and **J.S. Meyer**. 2006. Survival of Lost River suckers (*Deltistes luxatus*) challenged with *Flavobacterium columnare* during exposure to sublethal ammonia concentrations at pH 9.5. *Archives of Environmental Contamination and Toxicology* 50:256-263.

Morris, J.M., A.M. Farag, D.M. Nimick and **J.S. Meyer**. 2005. Does biofilm contribute to diel cycling of Zn in High Ore Creek, Montana? *Biogeochemistry* 76:233-259.

Lease, H.M., J.A. Hansen, H.L. Bergman and **J.S. Meyer**. 2003. Structural changes in gills of Lost River suckers exposed to elevated pH and ammonia concentrations. *Comparative Biochemistry and Physiology Part C* 134:491-500.

Morris, J.M., S.A. Collyard and **J.S. Meyer**. 2003. Effects of chronic copper exposure on the nutritional composition of *Hyalella azteca*. *Aquatic Toxicology* 63:197-206.

Clearwater, S.J., A.M. Farag and **J.S. Meyer**. 2002. Bioavailability and toxicity of dietborne copper and zinc to fish. *Comparative Biochemistry and Physiology Part C* 132:269-313.

Meyer, J.S. 2002. The utility of the terms "bioavailability" and "bioavailable fraction" for metals. *Marine Environmental Research* 53:417-423.

Peer-reviewed Journal Articles (cont.):

Meyer, J.S., C.J. Boese and S.A. Collyard. 2002. Whole-body accumulation of copper predicts acute toxicity to an aquatic oligochaete (*Lumbriculus variegatus*) as pH and calcium are varied. *Comparative Biochemistry and Physiology Part C* 133:99-109.

Meyer, J.S. and J.A. Hansen. 2002. Subchronic toxicity of low dissolved oxygen concentrations, elevated pH, and elevated ammonia concentrations to Lost River suckers. *Transactions of the American Fisheries Society* 131:656-666.

Dare, M.R., W.A. Hubert and **J.S. Meyer**. 2001. Influence of stream flow on hydrogen sulfide concentrations and distributions of two trout species in a Rocky Mountains tailwater. *North American Journal of Fisheries Management* 21:971-975.

Di Toro, D.M., H.E. Allen, H.L. Bergman, **J.S. Meyer**, P.R. Paquin and R.C. Santore. 2001. Biotic ligand model of the acute toxicity of metals. 1. Technical basis. *Environmental Toxicology and Chemistry* 20:2383-2396.

Goldstein, J.N., W.A. Hubert, D.F. Woodward, A.M. Farag and **J.S. Meyer**. 2001. Naturalized salmonid populations occur in the presence of elevated trace element concentrations and temperatures in the Firehole River, Yellowstone National Park, Wyoming. *Environmental Toxicology and Chemistry* 20:2342-2352.

Santore, R.C., D.M. Di Toro, P.R. Paquin, H.E. Allen and **J.S. Meyer**. 2001. Biotic ligand model of the acute toxicity of metals. 2. Application to acute copper toxicity in freshwater fish and *Daphnia*. *Environmental Toxicology and Chemistry* 20:2397-2402.

Farag, A.M., M.J. Suedkamp, **J.S. Meyer**, R. Barrows and D.F. Woodward. 2000. Distribution of metals during digestion by cutthroat trout fed invertebrates contaminated in the Clark Fork River, Montana and the Coeur d'Alene River, Idaho, U.S.A., and fed artificially contaminated *Artemia*. *Journal of Fish Biology* 56:173-190.

Frankenbach, R. and **J.S. Meyer**. 1999. Nitrogen removal in a surface-flow wastewater treatment wetland. *Wetlands* 19:403-412.

MacRae, R.K., A.S. Maest and **J.S. Meyer**. 1999. Selection of an organic acid analogue of dissolved organic matter for use in toxicity testing. *Canadian Journal of Fisheries and Aquatic Sciences* 56:1484-1493.

MacRae, R.K., D.E. Smith, N. Swoboda-Colberg, **J.S. Meyer** and H.L. Bergman. 1999. Copper binding affinity of rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*) gills: implications for assessing bioavailable metal. *Environmental Toxicology and Chemistry* 18:1180-1189.

Marr, J.C.A., J. Lipton, D. Cacela, J.A. Hansen, **J.S. Meyer** and H.L. Bergman. 1999. Bioavailability and acute toxicity of copper to rainbow trout in the presence of organic acids simulating natural dissolved organic carbon. *Canadian Journal of Fisheries and Aquatic Sciences* 56:1471-1483.

Meyer, J.S. 1999. A mechanistic explanation for the ln(LC50) vs. ln(hardness) adjustment equation for metals. *Environmental Science and Technology* 33:908-912.

Meyer, J.S., R.C. Santore, J.P. Bobbitt, L.D. DeBrey, C.J. Boese, P.R. Paquin, H.E. Allen, H.L. Bergman and D.M. Di Toro. 1999. Binding of nickel and copper to fish gills predicts toxicity when water hardness varies, but free-ion activity does not. *Environmental Science and Technology* 33:913-916.

Peer-reviewed Journal Articles (cont.):

Farag, A.M., D.F. Woodward, J.N. Goldstein, W. Brumbaugh and **J.S. Meyer**. 1998. Concentrations of metals associated with mining waste in sediments, biofilm, benthic macroinvertebrates, and fish from the Coeur d'Alene River Basin, Idaho. *Archives of Environmental Contamination and Toxicology* 34:119-127.

Markwiese, J.T., **J.S. Meyer** and P.J.S. Colberg. 1998. Copper tolerance in iron-reducing bacteria: implications for copper mobilization in sediments. *Environmental Toxicology and Chemistry* 17:675-678.

Marr, J.C.A., J.A. Hansen, **J.S. Meyer**, D. Cacela, T. Podrabsky, J. Lipton and H.L. Bergman. 1998. Toxicity of cobalt and copper to rainbow trout: application of a mechanistic model for predicting survival. *Aquatic Toxicology* 43:225-238.

Meyer, J.S., A. Boelter, D.F. Woodward, J.N. Goldstein, A.M. Farag and W.A. Hubert. 1998. Relationships between boron concentrations and trout in the Firehole River, Wyoming, USA: historical information and preliminary results of a field study. *Biological Trace Element Research* 66:167-184.

Marr, J.C.A., J. Lipton, D. Cacela, J.A. Hansen, H.L. Bergman, **J.S. Meyer** and C. Hogstrand. 1996. Relationship between copper exposure duration, tissue copper concentration, and rainbow trout growth. *Aquatic Toxicology* 36:17-30.

Meyer, J.S., D.D. Gulley, M.S. Goodrich, D.C. Szmania and A.S. Brooks. 1995. Modeling toxicity due to intermittent exposure of rainbow trout and common shiners to monochloramine. *Environmental Toxicology and Chemistry* 14:165-175.

Gächter, R. and **J.S. Meyer**. 1993. The role of microorganisms in mobilization and fixation of phosphorus in sediments. *Hydrobiologia* 253:103-121.

Ingersoll, C.G., D.A. Sanchez, **J.S. Meyer**, D.D. Gulley and J.E. Tietge. 1990. Epidermal response to pH, aluminum, and calcium exposure in brook trout (*Salvelinus fontinalis*) fry. *Canadian Journal of Fisheries and Aquatic Sciences* 47:1616-1622.

Gächter, R., **J.S. Meyer** and A. Marés. 1988. Contribution of bacteria to release and fixation of phosphorus in lake sediments. *Limnology and Oceanography* 33:1542-1558.

Meyer, J.S., C.G. Ingersoll and L.L. McDonald. 1987. Sensitivity analysis of population growth rates estimated from cladoceran chronic toxicity tests. *Environmental Toxicology and Chemistry* 6:115-126.

Meyer, J.S., C.G. Ingersoll, L.L. McDonald and M.S. Boyce. 1986. Estimating uncertainty in population growth rates: Jackknife vs. Bootstrap techniques. *Ecology* 67:1156-1166.

Meyer, J.S. and G. Linder. 1986. Exhaustive steam distillation extraction of aromatic organics from rainbow trout and water. *Environmental Toxicology and Chemistry* 5:155-159.

Linder, G., H.L. Bergman and **J.S. Meyer**. 1985. Anthracene bioconcentration in rainbow trout during single-compound and complex-mixture exposures. *Environmental Toxicology and Chemistry* 4:549-558.

Meyer, J.S., D.A. Sanchez, J.A. Brookman, D.B. McWhorter and H.L. Bergman. 1985. Chemistry and aquatic toxicity of raw oil shale leachates from Piceance Basin, Colorado. *Environmental Toxicology and Chemistry* 4:559-572.

Woodward, D.F., R.G. Riley, M.G. Henry, **J.S. Meyer** and T.R. Garland. 1985. Leaching of retorted oil shale: Assessing the toxicity to Colorado squawfish, fathead minnows, and two food-chain organisms. *Transactions of the American Fisheries Society* 114:887-894.

Peer-reviewed Journal Articles (cont.):

Meyer, J.S., M.D. Marcus and H.L. Bergman. 1984. Inhibitory interactions of aromatic organics during microbial degradation. *Environmental Toxicology and Chemistry* 3:583-587.

Parkhurst, B.R., R.G. Elder, **J.S. Meyer**, D.A. Sanchez, R.W. Pennak and W.T. Waller. 1984. An environmental hazard evaluation of uranium in a Rocky Mountain stream. *Environmental Toxicology and Chemistry* 3:113-124.

DeGraeve, G.M., D.L. Geiger, **J.S. Meyer** and H.L. Bergman. 1980. Acute and embryo-larval toxicity of phenolic compounds to aquatic biota. *Archives of Environmental Contamination and Toxicology* 9:557-568.

Non-peer-reviewed Journal Articles:

Meyer, J.S. and GG. Pyle. 2013. Effects of anthropogenic chemicals on chemosensation and behavior in fish: Organismal, ecological, and regulatory implications. *Fisheries* 38:283-284.

Linder, G., H.L. Bergman and **J.S. Meyer**. 1984. Constituent bioconcentration in rainbow trout exposed to a complex chemical mixture. *Bulletin of Environmental Contamination and Toxicology* 33:330-338.

Parkhurst, B.R., **J.S. Meyer**, G.M. DeGraeve and H.L. Bergman. 1981. A reevaluation of the toxicity of coal conversion process waters. *Bulletin of Environmental Contamination and Toxicology* 26:9-15.

Peer-reviewed Monographs:

Meyer, J.S., L.L. Irwin and M.S. Boyce. 1998. Influence of habitat fragmentation on spotted owls in western Oregon. *Wildlife Monographs* 139:1-51.

Book Reviews:

Meyer, J.S. 1986. Book review: *Multispecies Toxicity Testing*. *Journal of the North American Benthological Society* 5:249-250.

Peer-reviewed Books:

Meyer, J.S., S.J. Clearwater, T.A. Doser, M.J. Rogaczewski and J.A. Hansen. 2007. *Effects of Water Chemistry on the Bioavailability and Toxicity of Waterborne Cadmium, Copper, Nickel, Lead, and Zinc to Freshwater Organisms.* SETAC Press, Pensacola, Florida, USA.

Meyer, J.S., W.J. Adams, K.V. Brix, S.N. Luoma, D.R. Mount, W.A. Stubblefield and C.M. Wood (eds.). 2005. *Toxicity of Dietborne Metals to Aquatic Organisms*. SETAC Press, Pensacola, Florida, USA.

Peer-reviewed Chapters in Books:

Campbell, P.G.C., S.J. Clearwater, P.B. Brown, N.S. Fisher, C. Hogstrand, G.R. Lopez, L.M. Mayer and **J.S. Meyer**. 2005. Digestive physiology, chemistry, and nutrition. p. 13-57 in: J.S. Meyer, W.J. Adams, K.V. Brix, S.N. Luoma, D.R. Mount, W.A. Stubblefield and C.M. Wood (eds.), *Toxicity of Dietborne Metals to Aquatic Organisms*, SETAC Press, Pensacola, Florida, USA.

Meyer, J.S., W.J. Adams, K.V. Brix, S.N. Luoma, D.R. Mount, W.A. Stubblefield and C.M. Wood. 2005. Workshop summary and conclusions. p. 191-201 in: J.S. Meyer, W.J. Adams, K.V. Brix, S.N. Luoma, D.R. Mount, W.A. Stubblefield and C.M. Wood (eds.), *Toxicity of Dietborne Metals to Aquatic Organisms*, SETAC Press, Pensacola, Florida, USA.

Benson, W.H., H.E. Allen, J.P. Connolly, C.G. Delos, L.W. Hall, Jr., S.N. Luoma, D. Maschwitz, **J.S. Meyer**, J.W. Nichols and W.A. Stubblefield. 2003. Exposure analysis. p. 15-51 in: M.C. Reiley, W.A. Stubblefield, W.J. Adams, D.M. Di Toro, P.V. Hodson, R.J. Erickson and F.J. Keating, Jr. (eds.). *Reevaluation of the State of the Science for Water-quality Criteria Development*. SETAC Press, Pensacola, Florida, USA.

Boyce, M.S., **J.S. Meyer** and L. Irwin. 1994. Habitat-based PVA for the northern spotted owl. p. 63-85 in: D.J. Fletcher and B.F.J. Manly (eds.). *Statistics in Ecology and Environmental Monitoring*. University of Otago Press, Dunedin, New Zealand.

Meyer, J.S. and M.S. Boyce. 1994. Life historical consequences of pesticides and other insults to vital rates. p. 349-363 in: R.J. Kendall and T.E. Lacher, Jr. (eds.). *Wildlife Toxicology and Population Modeling: Integrated Studies of Agroecosystems*. Lewis Publishers, Boca Raton, Florida, USA.

Meyer, J.S., W. Davison, B. Sundby, J.T. Oris, D.J. Laurén, U. Förstner, J. Hong and D.G. Crosby. 1994. Synopsis of discussion session: The effects of variable redox potentials, pH, and light on bioavailability in dynamic water-sediment environments. p. 155-170 in: J.L. Hamelink, P.F. Landrum, H.L. Bergman and W.H. Benson (eds.). *Bioavailability: Physical, Chemical and Biological Interactions*. Lewis Publishers, Boca Raton, Florida, USA.

Gächter, R. and **J.S. Meyer**. 1990. Mechanisms controlling fluxes of nutrients across the sediment/water interface in a eutrophic lake. p. 131-162 in: R. Baudo, J.P. Geisy and H. Muntau (eds.). *Sediments: Chemistry and Toxicity of In-place Pollutants*. Lewis Publishers, Inc., Ann Arbor, Michigan, USA.

Loewengart, G.V., W.A. Brungs, R.A. Conway, **J.S. Meyer**, D.I. Mount and D. Willis. 1986. Workshop summary and conclusions: Hazard assessment of effluents. p. 339-356 in: H.L. Bergman, R.A. Kimerle and A.W. Maki (eds.). *Environmental Hazard Assessment of Effluents*. Pergamon Press, Elmsford, New York, USA.

Bergman, H.L. and **J.S. Meyer**. 1982. Complex effluent fate modeling. p. 247-267 in: K.L. Dickson, A.W. Maki and J. Cairns, Jr. (eds.). *Modeling the Fate of Chemicals in the Aquatic Environment*. Ann Arbor Science, Ann Arbor, Michigan, USA.

Non-peer-reviewed Chapters in Books:

Kramer, J.R., H.E. Allen, W. Davison, K.L. Godtfredsen, **J.S. Meyer**, E.M. Perdue, E. Tipping, D. van de Meent and J.C. Westall. 1997. Chemical speciation and metal toxicity in surface freshwaters. p. 57-70 in: H.L. Bergman and E.J. Dorward-King (eds.). *Reassessment of Metals Criteria for Aquatic Life Protection*. SETAC Press, Pensacola, Florida, USA.

Zeyer, J. and **J. Meyer**. 1989. Ecotoxicological criteria for final storage quality: possibilities and limits. p. 341-352 in: P. Baccini (ed.). *The Landfill: Reactor and Final Storage*. Springer-Verlag, Berlin, Germany.

Meyer, J.S., G.L. Linder, M.D. Marcus and H.L. Bergman. 1984. Identifying problem compounds in complex organic mixtures: oil shale retort water examples. p. 343-371 in: K.E. Cowser (ed.). *Synthetic Fossil Fuel Technologies: Results of Health and Environmental Studies*. Butterworth Publishers, Boston, Massachusetts, USA.

Non-peer-reviewed Proceedings/Transactions:

DeForest, D.K., J.S. Meyer, R.W. Gensemer, J.W. Gorsuch and W.J. Adams. 2014. Protectiveness of copper aquatic life criteria/guidelines against olfactory impairment in fish: An international comparison. Society for Mining, Metallurgy, and Exploration (SME) Annual Meeting, Salt Lake City, UT. February 23-26. [Received 2014 Outstanding Paper Award in the SME Environmental Division]

Meyer J.S., D.K. DeForest, R.W. Gensemer, J.W. Gorsuch and W.J Adams. 2013. Aquatic life criteria are protective against copper-caused impairment of olfaction in salmonid fishes. Society for Mining, Metallurgy, and Exploration (SME) Annual Meeting, Denver, CO. February 24-27. [Received 2013 Outstanding Paper Award in the SME Environmental Division]

Williamson, J., M.R. Pastorinho, J.F. Ranville, **J.S. Meyer**, R.C. Santore, A.C. Ryan, J.W. Gorsuch, E. Rogevich-Garman, C.E. Schlekat and R.L. Dwyer. 2013. Toxicity of metal mixtures to *Daphnia magna*: Comparison of laboratory and field investigations. pp. 499-505 in: A. Brown, L. Figueroa and C. Wolkersdorfer. Reliable Mine Water Technology (Vol. I). Publication Printers, Denver, Colorado, USA.

Bergman, H.L., **J.S. Meyer** and D.A. Sanchez. 1983. Assessing the effects of oil shale facilities on waste water quality: critique and alternatives. p. 110-117 in: K.K. Peterson (ed.). *Oil Shale: The Environmental Challenges III*. Colorado School of Mines Press, Golden, Colorado, USA.

Bergman, H.L., G.M. DeGraeve, **J.S. Meyer**, M.D. Marcus and D.L. Geiger. 1981. Aquatic ecosystem hazard assessment of underground coal gasification process waters. p. 270-293 in: D.D. Mahlum, R.H. Gray and W.D. Felix (eds.). *Coal Conversion and the Environment: Chemical, Biomedical, and Ecological Considerations*. U.S. Department of Energy, CONF-801039.

Other Non-peer-reviewed Publications:

Meyer, J.S., W.J. Adams, D.K. DeForest, R.L. Dwyer, R.W. Gensemer, J.W. Gorsuch, R.K. Johnston, R.C. Santore and E. Van Genderen. 2012. Letter to the editor: Water chemistry matters in metal-toxicity papers. *Environmental Toxicology and Chemistry* 31:689-690.

DeForest, D., **J. Meyer**, B. Adams, B. Dwyer, B. Gensemer, J. Gorsuch and E. Van Genderen. 2011. Importance of water chemistry in evaluating the olfactory effects of copper in salmonids. *SETAC Globe* 12 (9): http://www.setac.org/globe/2011/september/water.html.

Clearwater, S.J., B.A. Morris and **J.S. Meyer**. 2005. Potential effects of coalbed natural gas product waters on surface waters in the Powder River Basin, Wyoming. *Wyoming State Geological Survey Public Information Circular* 43:18-19.

Forbes, M.B., S.J. Clearwater, B.A. Morris and **J.S. Meyer**. 2005. Toxicity of coalbed natural gas product waters and receiving waters from the Powder River Basin, Wyoming. *Wyoming State Geological Survey Public Information Circular* 43:115-116.

Meyer, J.S., M.B. Forbes and S.J. Clearwater. 2005. Policy decisions and management tools needed for an aquatic risk assessment of coalbed natural gas product waters. *Wyoming State Geological Survey Public Information Circular* 43:108-109.

Doctoral Dissertation:

Meyer, J.S. 1986. Variability and bias in estimating cladoceran population growth rates. Ph.D. Dissertation. University of Wyoming, Laramie, Wyoming, USA.

Popular Articles:

Luoma, S.N., P.V. Hodson and **J.S. Meyer**. 2004. Beyond Adam's rib. *SETAC Globe* 5(1):38.

Cardwell, R., **J. Meyer** and M. Reiley. 2012. Commemorating the accomplishments of Bill Adams and Kevin Brix. *SETAC Globe* 13(12): http://ww2.setac.org/globe/2012/december/commemoration-accomplishments.html.

Technical Reports:

DiToro, D.M., H.E. Allen, H.L. Bergman, **J.S. Meyer**, P.R. Paquin and R.C. Santore. 2000. The biotic ligand model: a computational approach for assessing the ecological effects of copper and other metals in aquatic systems. International Copper Association, Ltd., New York, New York, USA.

Cors, C., D. Beltman, J. Lipton, D. Cacela, A. Maest, J. Marr, **J. Meyer** and R. MacRae. 1995. Use of geochemical modeling to evaluate acute toxicity injuries to salmonids: Panther Creek Basin, Blackbird Mine Site, Idaho. RCG/Hagler Bailly, Boulder, Colorado, USA (prepared for State of Idaho and National Oceanic and Atmospheric Administration).

MacRae, R., **J.S. Meyer**, A. Maest, D. Beltman and C. Cors. 1995. Geochemical complexation studies: Blackbird Mine Natural Resource Damage Assessment, Idaho. RCG/Hagler Bailly, Boulder, Colorado, USA (prepared for National Oceanic and Atmospheric Administration).

Marr, J., J. Lipton, D. Cacela, M. Barron, D. Beltman, C. Cors, K. LeJeune, A. Maest, T. Podrabsky, H. Bergman, J. Hansen, **J.S. Meyer** and R. MacRae. 1995. Fisheries toxicity injury studies: Blackbird Mine Site, Idaho. RCG/Hagler Bailly, Boulder, Colorado, USA (prepared for State of Idaho and National Oceanic and Atmospheric Administration).

Meyer, J.S., D.D. Gulley and H.L. Bergman. 1993. Modeling the effect of fluctuating monochloramine concentrations on survival of freshwater fish. Technical Report No. EPRI TR-102057. Electric Power Research Institute, Palo Alto, California, USA.

Meyer, J.S., A. Boelter and M. Crossey. 1988. Evaluation of ambient toxicity tests for detecting groundwater pollution entering streams and rivers: Final report. Wyoming Water Research Center, University of Wyoming, Laramie, Wyoming, USA.

Crossey, M.J., **J.S. Meyer** and A. Boelter. 1986. Evaluation of ambient toxicity tests for detecting groundwater pollution entering streams and rivers: Year 1 progress report. Wyoming Water Research Center, University of Wyoming, Laramie, Wyoming, USA. 75 pp.

Bub, K., M.D. Marcus, **J.S. Meyer**, M.K. Rothwell, M. Parker and L.B. Zeveloff. 1983. An assessment of the relationship among acidifying depositions, surface water acidification, and fish populations in North America. Volume 2: Bibliography. Research Report No. EPRI EA-3127. Electric Power Research Institute, Palo Alto, California, USA. 302 pp.

CONTRACTS AND GRANTS

Funded Projects as PI:

2006-2007 "Longitudinal Changes in Toxicity of Coal Bed Natural Gas Produced Water along Beaver Creek in the Powder River Basin, Wyoming", funded by U.S. Department of Energy, $129,444.

2005-2006 "THE POTENTIAL FOR SODIUM BICARBONATE TO ADVERSELY AFFECT AQUATIC LIFE UNDER EXPOSURE CONDITIONS SIMULATING THE TONGUE RIVER, MONTANA, USA", FUNDED BY U.S. GEOLOGICAL SURVEY, $15,000.

2005 "ACUTE TOXICITY OF SALINE WETLAND WATERS TO *CERIODAPHNIA DUBIA*", FUNDED BY U.S. FISH AND WILDLIFE SERVICE, $10,000.

2004-2005 "CHEMICAL ANALYSIS OF WATERFOWL STUDY SAMPLES", FUNDED BY U.S. FISH AND WILDLIFE SERVICE, $29,543.

2004-2005 "CHEMICAL ANALYSIS OF FECAL SAMPLES", FUNDED BY U.S. GEOLOGICAL SURVEY, $12,348.

2004-2005 "LEAD BIOACCUMULATION AND PATHWAY INTO RIPARIAN SONGBIRDS", FUNDED BY U.S. FISH AND WILDLIFE SERVICE, $26,455.

2004 "COMPLETION OF AQUATIC METAL BIOAVAILABILITY BOOK", FUNDED BY INTERNATIONAL LEAD ZINC RESEARCH ORGANIZATION, $7,500.

2003-2006 "A TEST OF THE BIOTIC LIGAND MODEL: FISH EXPOSED TO TIME-VARIABLE CONCENTRATIONS OF COPPER AND ZINC - YEARS 1, 2 AND 3", FUNDED BY U.S. ENVIRONMENTAL PROTECTION AGENCY (THROUGH CENTER FOR THE STUDY OF METALS IN THE ENVIRONMENT, UNIVERSITY OF DELAWARE), $113,148.

2002-2005 "Bioavailability and Effects of Ingested Metals on Aquatic Organisms", funded by Water Environment Research Foundation (through HydroQual Inc.), $135,000.

2002-2003 "BIOACCUMULATION AND TOXICITY OF DIETBORNE PARTICULATE METALS TO BENTHIC INVERTEBRATES",

FUNDED BY U.S. ENVIRONMENTAL PROTECTION AGENCY (THROUGH CENTER FOR THE STUDY OF METALS IN THE ENVIRONMENT, UNIVERSITY OF DELAWARE), $46,560.

2002 "Acute and Chronic Toxicity of Waterborne and Dietborne Copper to Aquatic Invertebrates", funded by International Copper Association (through HydroQual, Inc.), $50,000.

2001-2003 "Diel Cycling of Trace Metals in Biofilm", funded by U.S. Geological Survey, $50,000.

2001-2002 "Accumulation of Metals in Aquatic Resources in Pritchard Creek, Idaho and Prickly Pear Creek, Montana: Two Watersheds with Abandoned Mine Lands", funded by U.S. Geological Survey, $63,340.

2001 "Analytical Chemistry Support for Diet Studies", funded by Stratus Consulting Inc., $27,787.

2000-2002 "Development of a Biotic Ligand Model for Zinc", funded by International Lead Zinc Research Organization (through HydroQual, Inc.), $105,000.

2000 "Analytical Chemistry Support for Field Studies -- Fall 2000", funded by Stratus Consulting Inc., $972.

2000 "Pheromonal Response in Brook Trout", funded by U.S. Forest Service, $10,340.

Funded Projects as PI (cont.):

1999 "Bacterial Challenge to Lost River Suckers During Exposure to Elevated Ammonia and pH", funded by U.S. Fish and Wildlife Service (through U.S. Geological Survey), $23,000.

1999 "Toxicity of Copper to Bull Trout", funded by State of Montana (through Stratus Consulting Inc.), $23,853.

1998 "Analytical Chemistry Support for Toxicity Studies", funded by State of Montana (through Hagler Bailly Services, Inc.), $1,833.

1997-1999 "Literature Review of the Bioavailability and Toxicity of Selected Metals in the Aquatic Environment Relative to Natural Water Chemistry", funded by International Copper Association, International Lead Zinc Research Organization, and Nickel Producers Environmental Research Association, $77,821.

1997 "Analytical Chemistry Support for Toxicity Studies", funded by State of California (through Hagler Bailly Services, Inc.), $27,100.

1996 "Geochemical Characterization and Modeling of Copper Availability in Surface Waters Draining the Iron Mountain Mine Site in Northern California", funded by U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, California Department of Fish and Game, and State of California (through Hagler Bailly Consulting, Inc.), $50,876.

1996 "Evaluation of the Relationship between Boron Concentrations and the Rainbow Trout Population in the Firehole River, Wyoming, USA: Historical Phase", funded by Borax Europe Limited and U.S. Borax Inc., $14,871.

1996 "Analysis of Diets and Feces from Clark Fork River and Coeur d'Alene River Digestive Studies", funded by National Biological Service, $5,000.

1995-1997 "Mechanisms of Toxicity in Fish Caused by Dietary Exposure to Metals" (Carlos Martínez del Rio, CoPI; Theodore Kerstetter, CoI), funded by Electric Power Research Institute, $54,962.

1995-1996 "Organic Complexes of Metals in Invertebrates Consumed by Fish in the Clark Fork River" (Aïda Farag, CoI), funded by State of Montana Department of Justice, $23,060.

1995-1996 "Organic Complexes of Metals in Invertebrates Consumed by Fish in the Coeur d'Alene River, Idaho", funded by National Biological Service, $6,300.

1995 "Purchase of Liquid Chromatography Column to Quantify Chitin in Dietary Assimilation Efficiency Studies with Fish", funded by University of Wyoming, College of Arts and Sciences Basic Research Grants Program, $2,000.

1993-1994 "Wastewater Utilization Program", funded by The City of Arcata, California, $53,000 (at Humboldt State University).

1992-1993 "Wastewater Utilization Program", funded by The City of Arcata, California, $42,000 (at Humboldt State University).

1987-1988 "Microbial Control of Phosphorus Release from Sediments", NATO Postdoctoral Fellowship, funded by U.S. National Science Foundation, $20,400.

Funded Projects as CoPI:

2005-2006 "BIOACCUMULATION OF SELENIUM BY BRINE SHRIMP IN THE GREAT SALT LAKE: IMPLICATIONS FOR TOXICITY TO WATERFOWL AND SHOREBIRDS" (MARJORIE BROOKS, COPI), FUNDED BY KENNECOTT UTAH COPPER CORPORATION, $94,650.

2002-2005 "INFLUENCE OF CLIMATE-INDUCED ALTERATIONS IN DOC ON METAL TOXICITY AND UV RADIATION IN ROCKY MOUNTAIN STREAMS", FUNDED BY U.S. ENVIRONMENTAL PROTECTION AGENCY (THROUGH COLORADO STATE UNIVERSITY), $29,073 (UW PORTION ONLY).

1998-2002 "Application of Sediment Quality Criteria for Metals to a Montane Lotic Ecosystem: Field Validation during Reclamation of a Copper Mine Causing Acid Mine Drainage" (Jeffrey A. Lockwood and Richard W. Rockwell, CoPIs), funded by U.S. Environmental Protection Agency, $449,558.

1998-2001 "Copper Bioavailability to Aquatic Invertebrates" (Harold L. Bergman, CoPI), funded by International Copper Association (through HydroQual, Inc.), $184,000.

1998-1999 "Toxicity Testing with Bull Trout" (Harold L. Bergman, CoPI), funded by U.S. Environmental Protection Agency (through URS Greiner Woodward Clyde), $109,842.

1997-1999 "Effects of Low and High Dissolved Oxygen and Elevated pH on Lost River Suckers" (Harold L. Bergman, CoPI), funded by U.S. Bureau of Reclamation (through U.S. Geological Survey), $199,064.

1996-2000 "Bioavailability of Cadmium and Nickel to Fathead Minnows in the Presence of Dissolved Organic Matter" (Harold L. Bergman, CoPI), funded by U.S. Environmental Protection Agency (through the University of Delaware), $165,000.

1996-1998 "Metal Bioavailability to Aquatic Biota" (Harold L. Bergman, CoPI), funded by International Copper Association (through HydroQual, Inc.), $62,000.

1995-1996 "Evaluation of the Performance, Potential Loading Rates and Mechanisms of Removal of Petroleum Hydrocarbons and Antifreeze in Land Farming Plots at

Jacobs Ranch Mine, Wyoming" (Patricia J.S. Colberg and Norbert Swoboda-Colberg, CoPIs), funded by Kerr-McGee Corporation, $9,375.

1994-1995 "Fish Injury Assessment Studies, Blackbird Mine, Idaho" (Harold Bergman, CoPI), funded by National Oceanic and Atmospheric Administration, U.S. Department of Justice, U.S. Forest Service, and State of Idaho, $323,985.

1994-1995 "Metal Residues in Fish from the Coeur d'Alene River, Idaho" (Stanley Anderson, CoPI), funded by National Biological Service, $31,500.

1994-1995 "Evaluation of the Performance, Potential Loading Rates and Mechanisms of Removal of Petroleum Hydrocarbons and Antifreeze in Land Farming Plots at Jacobs Ranch Mine, Wyoming" (Patricia J.S. Colberg, CoPI), funded by University of Wyoming Office of Research, $20,000.

1985-1987 "Evaluation of Ambient Toxicity Tests for Detecting Groundwater Pollution Entering Streams and Rivers" (Harold Bergman, PI), funded by U.S. Geological Survey, $60,169.

Funded Projects as CoI:

2001 "Coal Bed Methane Product Water Acute Toxicity Testing" (Susan Clearwater, PI), funded by Wyoming Department of Environmental Quality, $20,160.

1995-1998 "Biogeochemistry of Trace Elements in Aquatic Systems" (Steven Gloss, PI; Daniel Buttry, Patricia Colberg and Patrick Sullivan, CoPIs; Scott Bohle, Keith Carron, James Drever and Norbert Swoboda-Colberg, CoIs), funded by National Science Foundation EPSCoR Program and Wyoming Science, Technology and Energy Authority, $2,400,000.

Pending Projects as PI:

Pending Projects as CoPI:

Proposals Not Accepted as PI:

2001-2003 "Incubator-activity Proposal: Biocomplexity at Multiple Levels of Biological Organization Along a Gradient of Extreme Water Quality in the Lakes of the Great Rift Valley of Africa" (Patrick J. Walsh and Chris M. Wood, Co-PIs), submitted to U.S. National Science Foundation, $99,972.

1997-2000 "Effects of Ingestion of Metals-Contaminated Invertebrates on Digestive Physiology and Ultrastructure of Key Organs in Early-Life-Stage Brown Trout" (Carlos Martinez del Rio, CoPI; Aïda Farag and Daniel F. Woodward, CoIs), submitted to U.S. Environmental Protection Agency, $365,444.

1996-1999 "Bioavailability of Metals Leaching from Mine Sites: Effects of Binding Affinities of Dissolved Organic Matter and Suspended Particles, Microbial Processing, and Sunlight", submitted to U.S. Environmental Protection Agency, $448,343.

1996 "Biogeochemistry of Metal Availability to Fish" (Steven Gloss, CoPI; Scott Bohle, Daniel Buttry, Keith Carron, Patricia Colberg, James Drever, Carrick Eggleston, Patrick Sullivan and Norbert Swoboda-Colberg, CoI's), submitted to Electric Power Research Institute, $225,000.

1994 "Proposal to Purchase a Multi-element Atomic Absorption Spectrophotometer", submitted to University of Wyoming Major Equipment Committee, $85,000.

Proposals Not Accepted as CoPI or CoI:

2001-2002 "Aquatic Toxicity of Coal Bed Methane Product Water: Determination of Suitability for Discharge to Surface Waters" (Kattah J. Reddy, PI; Susan J. Clearwater, Co-PI), submitted to University of Wyoming Water Research Program, $94,738.

2000-2002 "Water, Ecosystems, and People: An Integrative, Science-based Approach and Tools for Citizen Decision-making in Urbanizing Mountain Watersheds" (Kenneth Kolm, John Emerick, Robert Hall, William Reiners, Phillipe Ross, Jason Shogren, CoPIs), submitted to U.S. Environmental Protection Agency, $899,904 (UW share = $599,999).

2000-2002 "Rapid and Selective Detection of Bioavailable Copper", (Robert Corcoran, PI; Keith Carron, CoPI), submitted to U.S. Environmental Protection Agency, $227,848.

1996-1999 "Cellular Mechanisms of Metal Toxicity in Aquatic Organisms" (Donald DiBona, PI; Harold Bergman, CoI), submitted to U.S. Environmental Protection Agency, $356,073.

1996-1998 "Phytoremediation of Toxic Metals" (John Nishio, PI; Harvey Doner, Maria Ghirardi, Akali Igbene, Michael Seibert, Peter Stahl, George Vance and Stephen Williams, CoIs), preproposal submitted to U.S. Department of Energy.

1995 "The Interaction of Aquatic Ecosystems and Economies in the Rocky Mountain West" (John Tschirhart, PI; Thomas Crocker and Jason Shogren, CoPIs), submitted to U.S. Environmental Protection Agency and National Science Foundation, $345,965.

1995 "The Interaction of Aquatic Ecosystems and Economics in the Rocky Mountain West" (Thomas Crocker, PI; Jason Shogren and John Tschirhart, CoPIs), submitted to Wyoming Agricultural Experiment Station Competitive Grants Program, $40,716.

1995 "Phytoremediation of Copper and Uranium Mines in the Rocky Mountain Region" (John Nishio, PI; Peter Stahl, George Vance and Steven Williams, CoIs), submitted to Wyoming EPSCoR Program, $416,759.

PROFESSIONAL AFFILIATIONS AND ACTIVITIES

Scientific Organization Membership:

Society of Environmental Toxicology and Chemistry

Professional Society Offices:

Rocky Mountain Association of Environmental Professionals:

- Member, Board of Directors: September 1983 - September 1984.

Society of Environmental Toxicology and Chemistry:

- President, Rocky Mountain Chapter: 2004-2005.
- Vice President, Rocky Mountain Chapter: 2003-2004.
- Member, Board of Directors, Rocky Mountain Chapter: 2002-2006.

- Member, Steering Committee of the Metals Interest Group: 2000-present.
- Member, Editorial Board for *Environmental Toxicology and Chemistry*: January 1997 - 2000.
- Member, Technical Committee: January 1983 - December 1986.

Professional Society Service:

Rocky Mountain Association of Environmental Professionals:

- Organizer, Effluent Toxicity Testing Seminar. Denver, CO. August 10, 1984. (Cosponsored by the Society of Environmental Toxicology and Chemistry)

Society of Environmental Toxicology and Chemistry:

- Program Committee Co-chair for Special Symposia, Annual Meeting. Salt Lake City, UT. November 16-20, 2002.
- Steering Committee Member, Workshop on Toxicity of Dietborne Metals. Fairmont Hot Springs, BC, Canada. July 28 - 31, 2002.
- Session Co-chairperson, "Speciation and Bioavailability of Trace Elements." Third World Congress. Brighton, England. May 21-25, 2000.
- Co-organizer, Thirteenth Annual Meeting of the Rocky Mountain Chapter. Laramie, WY. April 6-7, 2000.
- Program Committee Co-chair for Platform Sessions, Fifteenth Annual Meeting. Denver, CO. October 30 - November 3, 1994.
- Session Chairperson, "Contaminant Effects on Populations and Communities." Fifth Annual Meeting. Arlington, VA. November 7, 1984.

External Tenure and Promotion Reviews:

University of North Texas: Tenure for Dr. Barney Venables, Department of Biological Sciences -- November 2005.

University of Miami: Change from research to tenure track for Dr. Martin Grosell, Rosenstiel School of Marine and Atmospheric Science, University of Miami -- July 2005.

Humboldt State University: Tenure and promotion for Dr. Timothy Mulligan, Department of Fisheries -- August 1994.

Manuscript Refereeing for Scientific Journals:

Aquatic Sciences: 2003 - 1 (reviewed twice); 1995 - 1; 1989 - 1; 1988 - 1.

Aquatic Toxicology: 2006 - 1; 2003 - 3; 2002 - 4.

Archives of Environmental Contamination and Toxicology: 2012 - 1; 2011 - 1; 2008 - 1; 2007 - 1; 2006 - 1; 2005 - 2; 2004 - 2.

Bulletin of Environmental Contamination and Toxicology: 2011 - 2 (incl. 1 twice-revised MS); 2008 - 1.

Bulletin of the Geological Society of America: 1996 - 1.

Canadian Journal of Fisheries and Aquatic Sciences: 2005 - 1; 1999 - 1; 1998 - 1.

Canadian Journal of Zoology: 2011 - 1.

Chemosphere: 2001 - 1; 2000 - 1; 1998 - 1.

Comparative Biochemistry and Physiology: 2014 - 1; 2009 - 1; 2005 - 1; 2003 - 1 (revised MS); 2002 - 1; 2001 - 1; 1997 - 1 (revised MS); 1996 - 1.

Ecotoxicology and Environmental Safety: 2014 - 1; 2012 - 1; 2010 - 1; 2007 - 1; 2006 - 1; 2005 - 1; 2004 - 1 (reviewed twice).

Environmental Health Perspectives: 1998 - 1.
Environmental Monitoring and Assessment: 2005 - 1.
Environmental Science and Technology: 2014 - 1; 2013 - 1; 2011 - 1 (incl. revised MS); 2010 - 2 (incl. 1 revised MS); 2009 - 1; 2007 - 1; 2003 - 2; 2002 - 1; 2001 - 3; 2000 - 3; 1999 -1.
Environmental Toxicology and Chemistry: 2014 - 2; 2013 - 1; 2012 - 1; 2011 - 2; 2010 - 3; 2009 - 3; 2008 - 2; 2007 - 2; 2005 - 1; 2002 - 1; 2001 - 2; 2000 - 6; 1999 - 5; 1998 - 6; 1997 - 6; 1995 - 6; 1994 - 3; 1993 - 2; 1992 - 1; 1982 - 1.
Journal of Environmental Quality: 1998 - 1.
Journal of Experimental Biology: 2003 - 1.
Journal of the North American Benthological Society: 1986 - 1.
Journal of Wildlife Management: 1996 - 2; 1995 - 1.
Limnology and Oceanography: 2005 - 1 (reviewed twice); 1995 - 1.
Marine Geology: 1995 - 1 (reviewed twice).
Science of the Total Environment: 2013 - 1; 2011 - 1.
Wetlands: 1999 - 2.

Manuscript Refereeing for Scientific Books:

Coastal and Estuarine Risk Assessment (SETAC Press): reviewed one chapter (Oct. 2000)
Environmental Contaminants in Biota: Interpreting Tissue Concentrations (CRC Press): reviewed one chapter (Dec. 2008)
Homeostasis and Toxicology of Essential Metals (Fish Physiology Volume 31a): reviewed ne chapter (Aug. 2010)

Grant Review Panels:

Natural Environment Research Council (UK): May 2006 (1 proposal)
DEPSCoR Program, University of Wyoming: Research Proposal Peer Reviews -- September 2004 (1 proposal)
National Environment Research Council (UK): Freshwater Program -- September 2000 (1 proposal)
National Science Foundation (USA): Life in Extreme Environments Program -- June 2000 (1 proposal)
Board of Regents, State of Louisiana: Research Competitiveness Subprogram -- January 2000 (1 proposal)
Water Resources Center, University of Delaware: Research Proposal Peer Reviews -- April 1998 (1 proposal)
Western Region's Water Resources Research Competitive Grants Program (administered through University of Wyoming Water Research Center): Research Proposal Peer Reviews -- May 1997 (1 proposal)
Abandoned Mine Lands Research Program, University of Wyoming: Research Proposal Peer Reviews -- March 2000 (1 proposal), March 1997 (1 proposal), April 1996 (1 proposal)
University of Wyoming Water Research Center: Research Proposal Peer Review Panel (as non-UW participant). Laramie, WY. 30 April 1987.

Reviews for Scientific and Governmental Organizations:

U.S. Environmental Protection Agency: Member, Aquatic Life Criteria Consultative Panel of the Science Advisory Board (SAB) of the U.S. Environmental Protection Agency (USEPA). Washington, DC. First panel meeting -- 21 September 2005.

U.S. Environmental Protection Agency: Member, Health and Ecological Effects Subcommittee (HEES) of the Advisory Council on Clean Air Compliance Analysis (ACCACA) of the Science Advisory Board (SAB) of the U.S. Environmental Protection Agency (USEPA). Washington, DC. First panel meeting -- 29-30 January 1998. Interim reviews until 2002.

Environment Canada: Member, Environmental Resource Group for the Assessment of Chloramine under the Canadian Environmental Protection Act. Document review and advice to be provided through panel meetings and teleconference calls from October 1996 through 1999. Workshops attended -- 7-8 March 1997 in Ottawa, Ontario; 28-29 May 1998 and 5 March 1999 in Vancouver, British Columbia.

U.S. Environmental Protection Agency: Member, Advisory Council on Clean Air Compliance Analysis Physical Effects Review Subcommittee (ACCACAPERS, formerly CAACACPERS) of the Science Advisory Board (SAB) of the U.S. Environmental Protection Agency (USEPA). Washington, DC. Four panel meetings -- October 18 and November 15-16, 1994; April 12 and May 18, 1995; and 4 June 1996. Additionally, documents were reviewed outside of panel meetings from 1994 to 1997.

U.S. Department of Energy: Review of documents addressing damages and benefits of various fuel cycles. Washington, DC and Seattle, WA. Four panel meetings -- November 17-18, 1992; January 21-22, March 30-April 1 and June 16, 1993.

Electric Power Research Institute: Review of report titled "Physiological, Toxicological and Population Responses of Smallmouth Bass to Acidification." January, 1991.

Ontario Ministry of the Environment: Review of document titled "Scientific Criteria Document for Standard Development: Benzene and Substituted Benzenes in the Aquatic Environment." April, 1985.

Advisory Panels and Committees:

U.S. Borax: Member, Boron Ecotoxicology Advisory Group, U.S. Borax, Valencia, CA. Term: March 2002 - present. Meetings: 1-2 July 2002, 16 November 2002, 29-31 October 2004.

Electric Power Research Institute: Member, Water Toxics Advisory Committee, Land and Water Quality Studies Program, Environment Division, Electric Power Research Institute, Palo Alto, CA. Term: March 1993 - December 1996. Meetings: 18-19 March 1993; 8-9 November 1994.

Invited Workshop or Symposium Participant:

Workshop on Modeling of Metal Mixtures. Convened by the International Copper Association, Ltd., the International Zinc Association, and the Nickel Producers Environmental Research Association. Brussels, Belgium. May 17-19, 2012.

Workshop on Metal Mixtures. Convened by the International Copper Association, Ltd. and the International Zinc Association. Toronto, Ontario, Canada. 27-28 June 2011.

Symposium on Prospective and Retrospective Environmental Risk Assessment of Mixtures: Moving from Research to Regulation. Third SETAC Europe Special Science Symposium. Brussels, Belgium. 2-3 February 2011.

Workshop on Tissue Residue Approaches. Organized by the Society of Environmental Toxicology and Chemistry. Leavenworth, WA. 7-12 June 2007.

Workshop on Ecological Risk Assessment. Convened by the Science Advisory Board of the U.S. Environmental Protection Agency. Washington, DC. 7-8 February 2006.

Workshop on Science for Valuation of EPA's Ecological Protection Decisions and Programs. Convened by the Science Advisory Board of the U.S. Environmental Protection Agency. Washington, DC. 13-14 December 2005.

Workshop on Dietborne Metal Toxicity to Aquatic Organisms. Organized by the Society of Environmental Toxicology and Chemistry (sponsored by Eastman Kodak Company, Electric Power Research Institute, Kennecott Utah Copper Corporation, U.S. Environmental Protection Agency, Environment Canada, Natural Resources Canada). Fairmont Hot Springs, British Columbia, Canada. 28-31 July 2002.

Workshop on the Development of a Marine Biotic Ligand Model. Sponsored by the International Copper Association and Woods Hole Oceanographic Institution. Woods Hole, MA. 23-24 July 2001.

Second Colloquium on Metals in the Environment. Sponsored by the Electric Power Research Institute, the International Copper Association, and Eastman Kodak Company. Washington, DC. 28-30 January 2001.

First International James M. McKim Species Extrapolation Workshop. Organized by the U.S. Environmental Protection Agency. Duluth, MN. 28 October 2000.

Workshop on Effects of Dietary Metal Uptake by Fish and Other Aquatic Organisms. Organized and sponsored by the U.S. Environmental Protection Agency. Duluth, MN. 1-2 March 2000.

Workshop on Re-evaluation of the State of the Science for Water Quality Criteria Development. Organized by the Society of Environmental Toxicology and Chemistry (sponsored by Eastman Kodak Company, Electric Power Research Institute, Kennecott Utah Copper Corporation, and U.S. Environmental Protection Agency). Anaconda, MT. 25-30 June 1998.

Workshop on Reassessment of Metals Criteria for Aquatic Life Protection: Priorities for Research and Implementation. Organized by the Society of Environmental Toxicology and Chemistry (sponsored by the Electric Power Research Institute, International Copper Association, and others). Pensacola, FL. 10-14 February 1996.

Workshop on Bioavailability of Organic Contaminants in Soils and Sediments. Sponsored by the U.S. Office of Naval Research, U.S. Air Force Office of Scientific Research, and U.S. Army Research Office. Monterey, CA. 9-12 April 1995.

Invited Workshop or Symposium Participant (cont.):

Workshop on Aquatic Life Criteria for Metals. Sponsored by the U.S. Environmental Protection Agency. Annapolis, MD. 25-29 January 1993.

Workshop on A Mechanistic Understanding of Bioavailability: Physical-chemical Interactions. Chair of session on dynamic environmental factors. Sponsored by the U.S. Environmental Protection Agency, and 12 other government agencies and private companies. Pellston, MI. 18-22 August 1992.

Workshop to Select Test Systems for Ecological Assessment and Monitoring. Sponsored by the U.S. Army Construction Engineering Research Laboratory. Monticello, IL. 19-22 January 1986.

Workshop on Hazard Assessment for Complex Effluents. Sponsored by the Electric Power Research Institute, the American Petroleum Institute, the Chemical Manufacturers Association, and the U.S. Environmental Protection Agency. Cody, WY. 22-27 August 1982.

HONORS AND AWARDS

2003	Extraordinary Merit in Advising, College of Arts and Sciences, University of Wyoming, Laramie, WY
2003	Excellence in Advising Award, University of Wyoming, Laramie, WY
2002	Presidential Citation for Exemplary Service, Society of Environmental Toxicology and Chemistry
2002	Excellence in Advising Award, University of Wyoming, Laramie, WY
2000	Extraordinary Merit in Research, College of Arts and Sciences, University of Wyoming, Laramie, WY
1999	Extraordinary Merit in Research, College of Arts and Sciences, University of Wyoming, Laramie, WY
1998	Excellence in Advising Award, University of Wyoming, Laramie, WY
1997	Excellence in Advising Award, University of Wyoming, Laramie, WY
1987-1988	NATO Postdoctoral Fellowship, U.S. National Science Foundation
1984	Kuehn Independent Study Award, University of Wyoming, Laramie, WY
1970-1973	Procter & Gamble Undergraduate Chemical Engineering Scholarship, Lehigh University, Bethlehem, PA

PAPERS PRESENTED/SYMPOSIA/INVITED LECTURES/PROFESSIONAL MEETINGS/WORKSHOPS

Abstracts of Presentations at Scientific Meetings:

Gensemer, R.W., C.A. Claytor, J. Gondek, D.K. DeForest, **J.S. Meyer** and J.W. Gorsuch. 2015. Regulatory implementation of the copper biotic ligand model for aquatic life protection: What have we learned and how are we doing? Submitted for presentation at the 2015 Water Environment Federation Technical Exhibition and Conference, Chicago, IL. September 26-30.

Anderson, P.D., **J.S. Meyer** and M.A. Beauchemin. 2014. Development of site-specific uptake factors for metals. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Basel, Switzerland, May 11-15.

DeForest, D.K., **J.S. Meyer**, R.W. Gensemer, J.W. Gorsuch and W.J. Adams. 2014. Protectiveness of copper aquatic life criteria/guidelines against olfactory impairment in fish: An international comparison. Presented at the 2014 Annual Meeting of the Society for Mining, Metallurgy, and Exploration, Salt Lake City, UT, February 23-26.

DeForest, D.K., **J.S. Meyer**, R.W. Gensemer, J.W. Gorsuch and W.J. Adams. 2014. Protectiveness of copper aquatic life criteria/guidelines against olfactory impairment in fish: An international comparison. Presented at the Thirty-fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, BC, November 9-13.

DeForest, D.K., **J.S. Meyer**, R.W. Gensemer, J.W. Gorsuch, B.K. Shephard, J.M. Zodrow and W.J. Adams. 2014. Protectiveness of aquatic life criteria for copper against olfactory and behavioral effects in freshwater and saltwater fish. Presented at the 2014 Salish Sea Ecosystem Conference, Seattle, WA, April 30 - May 2.

Dwyer, R.L., **J.S. Meyer** and J.W. Gorsuch. 2014. Misapplication of generic hazard-classification schemes for versatile, sustainable building materials: Copper as an example. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Basel, Switzerland, May 11-15.

Ebeling, K.A., J.F. Ranville, E.M. Traudt, S.A. Smith and **J.S. Meyer**. 2015. *D. magna* metal toxicity in a mining impacted stream: Comparing results in simulated and field-collected waters. To be presented at the 249th National Meeting of the American Chemical Society, Denver, CO, 22-26 March.

Farley, K.J. and **J.S. Meyer**. 2014. Evaluation of various approaches for modeling metal mixture toxicity. Presented at the Thirty-fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, BC, November 9-13.

Gensemer, R.W., C.A. Claytor, S.D. Baker, D.K. DeForest, **J.S. Meyer** and J.W. Gorsuch. 2014. Regulatory implementation of the copper BLM: What have we learned and how are we doing? Presented at the Thirty-fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, BC, November 9-13.

Meyer, J.S., D.K. DeForest, R.W. Gensemer, J.W. Gorsuch and W.J. Adams. 2014. Protectiveness of copper aquatic life criteria/guidelines against olfactory impairment in fish: An international comparison. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Basel, Switzerland, May 11-15.

Abstracts of Presentations at Scientific Meetings (cont.):

Meyer, J.S. and K.J. Farley. 2014. A randomization test for statistical significance of non-additive toxicity in metal mixtures. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Basel, Switzerland, May 11-15.

Meyer, J.S., A.S. Fowler and J.R. Loper. 2014. Reference envelopes and sediment toxicity: The bottom line? Presented at the Thirty-fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, BC, November 9-13.

Meyer, J.S. and Y. Iwasaki. 2014. Statistical tests for additivity of toxicity in metal mixtures. Presented at the Thirty-fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, BC, November 9-13.

Pastorinho, M.R., J.F. Ranville, J. Williamson and **J.S. Meyer**. 2014. Death in the fast lane: Ion imbalance in *Daphnia magna* exposed in situ in acid mine drainage-impacted waters.

Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Basel, Switzerland, May 11-15.

Smith, S.A., E.M. Traudt, K.A. Ebeling, J.F. Ranville and **J.S. Meyer**. 2015. Effect of *Daphnia magna* age on the variability of cadmium toxicity. To be presented at the 249th National Meeting of the American Chemical Society, Denver, CO, 22-26 March.

Traudt, E.M., J.F. Ranville, S.A. Smith, K.A. Ebeling and **J.S. Meyer**. 2015. Toxicity of binary and ternary mixtures of nickel, copper, zinc and cadmium to *Daphnia magna*. To be presented at the 249th National Meeting of the American Chemical Society, Denver, CO, 22-26 March.

Traudt, E.M., J.F. Ranville, J.L. Williamson, S.A. Smith and **J.S. Meyer**. 2014. Toxicity of ternary mixtures of nickel, copper, zinc and cadmium to *Daphnia magna*. Presented at the Twenty-seventh Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry, Denver, CO, USA, April 17-18.

Traudt, E.M., J.F. Ranville, J.L. Williamson, S.A. Smith, M.R. Pastorinho and **J.S. Meyer**. 2014. Toxicity of binary mixtures of nickel, copper, cadmium and zinc to *Daphnia magna*. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Basel, Switzerland, May 11-15.

Traudt, E., J.F. Ranville, J. Williamson, S. Smith and **J.S. Meyer**. 2014. Toxicity of ternary mixtures of nickel, copper, zinc and cadmium to *Daphnia magna*. Presented at the Thirty-fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, BC, November 9-13.

Williamson, J.L., P. Cadmus, M.R. Pastorinho, E. Traudt, W.H. Clements, **J.S. Meyer** and J.F. Ranville. 2014. A multidisiplinary study on the influence of biogeochemistry and metal bioavailability on the heath and potential recovery of a stream affected by acid mine drainage. Presented at the 2014 Annual Meeting of the National Institute of Environmental Health Sciences Superfund Research program, San José, CA, November 12-14.

Williamson, J.L., M.R. Pastorinho, J.F. Ranville, J.S. Meyer and W.H. Clements. 2015. Methods for simulating the restoration and recovery of acid mine drainage-impacted stream sediment. To be presented at the 249th National Meeting of the American Chemical Society, Denver, CO, 22-26 March.

Abstracts of Presentations at Scientific Meetings (cont.):

Williamson, J.L., J.F. Ranville, **J.S. Meyer**, P. Cadmus and W. Clements. 2014. Development of in-situ methods for investigating recovery of acid mine drainage contaminated sediments. Presented at the Twenty-seventh Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry, Denver, CO, USA, April 17-18.

Williamson, J.L., J.F. Ranville, **J.S. Meyer** and R. Pastorinho. 2014. Methodological development for geochemical analysis of AMD-contaminated stream sediments, with implications for recovery. Presented at the Thirty-fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Vancouver, BC, November 9-13.

DeForest, D.K. and **J.S. Meyer**. 2013. Dietborne-metal toxicity to aquatic organisms: A literature review. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Glasgow, Scotland, May 12-16.

Farley, K.J. and **J.S. Meyer**. 2013. A comparative evaluation of modeling approaches for metal mixture toxicity. Presented at the Thirty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN, November 17-21.

Jones, D.S., S.J. Young, A.R. Stojak, N.L. Bonnevie, L.W. Fontenot, B. Fulton, C.B. Meyer, J.S. Meyer, D. Buys, D.K. Rigg, T.H. Schlekat and N. Carriker. 2013. Ecological risk analysis of residual coal ash and associated metals and metalloids in a river reservoir system. Presented at the Thirty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN, November 17-21.

Meyer, C.B., **J.S. Meyer**, R. Hummell and W.J. Adams. 2013. Effects of metal mixtures on fish and benthic macroinvertebrate populations in a mining-impacted stream: Railroad Creek, Washington, USA. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Glasgow, Scotland, May 12-16.

Meyer, J.S., B. Anthony, D. Ludwig, H. Douglas and A.S. Fowler. 2013. Anniston PCB Site: Implications of sediment toxicity-testing results to an ecological risk assessment. Presented at the Seventh International Conference on Remediation of Contaminated Sediments, Dallas, TX, February 4-7.

Meyer, J.S. and D.K. DeForest. 2013. Dietborne-metal toxicity to aquatic organisms: A literature review. Presented at the Thirty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN, November 17-21.

Meyer, J.S., D.K. DeForest, R.W. Gensemer, J.W. Gorsuch and W.J. Adams. 2013. Aquatic life criteria are protective against copper-caused impairment of olfaction in salmonid fishes. Presented at the 2013 Annual Meeting of the Society for Mining, Metallurgy, and Exploration, Denver, CO, February 24-27.

Meyer, J.S., D.K. DeForest, R.W. Gensemer, B.K. Shephard, J.M. Zodrow, J.W. Gorsuch, W.J. Adams. 2013. U.S. EPA biotic ligand model-based aquatic life criteria are protective against copper-caused impairment of olfaction in salmonid fishes. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Glasgow, Scotland, May 12-16.

Meyer, J.S., J.W. Gorsuch and R.L. Dwyer. 2013. Misapplication of generic hazard classification schemes for versatile building materials: Copper as an example. Presented at the Thirty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN, November 17-21.

Abstracts of Presentations at Scientific Meetings (cont.):

Meyer, J.S., J.F. Ranville, R.C. Santore, A.C. Ryan, J.W. Gorsuch, W.J. Adams, E. Rogevich-Garman, C.E. Schlekat, R.L. Dwyer and K. Delbeke. 2013. Toxicity of metal mixtures to *Daphnia magna*: Competitive binding to dissolved organic matter and biotic ligand can explain non-additive interactions. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Glasgow, Scotland, May 12-16.

Ranville, J.F., J. Williamson, **J.S. Meyer**, R.C. Santore, A.C. Ryan, J.W. Gorsuch, E. Rogevich-Garman, C.E. Schlekat and R.L. Dwyer. 2013. Toxicity of metal mixtures to Daphnia magna: Comparison of laboratory and field investigations. Presented at the 2013 Mine Water Conference of the International Mine Water Association, Golden, CO, August 5-9.

Ryan, A.C., R.C. Santore, **J.S. Meyer** and J.F. Ranville. 2013. Modeling the toxicity of metal mixtures: A bioavailability-based approach using the Biotic Ligand Model framework. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Glasgow, Scotland, May 12-16.

Traudt, E.M., J.F. Ranville, J.L. Williamson, S.A. Smith, M.R. Pastorinho and **J.S. Meyer**. 2013. Toxicity of binary mixtures of nickel, copper, and cadmium to *Daphnia magna*. Presented at the Twenty-sixth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry, Denver, CO, April 18-19.

Traudt, E.M., J.F. Ranville, J.L. Williamson, S.A. Smith, M.R. Pastorinho and **J.S. Meyer**. 2013. Toxicity of binary mixtures of nickel, copper, cadmium and zinc to *Daphnia magna*. Presented at the Thirty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN, November 17-21.

Williamson, J.L., J.F. Ranville, **J.S. Meyer**, M.R. Pastorinho and E. Traudt. 2013. Geochemical and aquatic toxicological analysis of the mine waste impacted North Fork of Clear Creek. Presented at the Twenty-sixth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry, Denver, CO, April 18-19.

Williamson, J.L., J.F. Ranville, E.M. Traudt, **J.S. Meyer** and M.R. Pastorinho. 2013. Aquatic geochemical analysis and the toxicological implications of acid mine drainage inputs into the North Fork of Clear Creek. Presented at the Thirty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Nashville, TN, November 17-21.

Beauchemin, M., P. Anderson, N. Bonnevie, **J.S. Meyer** and D. Chin. 2012. Using site-specific data to derive clean-up levels that accurately reflect toxicity from creosote-based PAHs. Presented at the North Atlantic Chapter Meeting of SETAC, Rhode Island, June.

DeForest, D.K., R.W. Gensemer, J.W. Gorsuch, **J.S. Meyer**, R.C. Santore, B.K. Shephard and J. Zodrow. 2012. Effects of copper on the olfactory and behavioral responses of saltwater fish, and the protectiveness of regulatory aquatic life criteria using the biotic ligand model. Presented at the Sixteenth International Congress of Marine Corrosion and Fouling, Seattle, WA, June 24-28.

DeForest, D.K., R.W. Gensemer, J.W. Gorsuch, **J.S. Meyer**, R.C. Santore, B.K. Shephard and J. Zodrow. 2012. Effects of copper on olfactory and behavioral responses of saltwater fish and the protectiveness of biotic ligand model-based aquatic life criteria. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

Abstracts of Presentations at Scientific Meetings (cont.):

DeForest, **J.S. Meyer** and J.W. Gorsuch. 2012. A unified saltwater-freshwater biotic ligand model of copper-induced olfactory impairment to salmonid fishes. Presented at the One Hundred Forty-second Annual Meeting of the American Fisheries Society, St. Paul, MN, August 19-23.

Fulton, B.A., E.M. Schlenker, D.B. Edge, A.M. Thatcher and **J.S. Meyer**. 2012. Water-effect ratio model to support site-specific copper criteria across multiple drainages in an arid landscape. Presented at the Twenty-fifth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry, Fort Collins, CO, April 19-20.

Fulton, B.A., D.B. Edge, A.M. Thatcher and **J.S. Meyer**. 2012. Water effect ratio model to support site-specific copper criteria across multiple drainages in an arid landscape. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

Gensemer, R.W., D.K. DeForest, J.W. Gorsuch and **J.S. Meyer**. 2012. Regulatory implications of olfactory and behavioral effects of copper on fish. Presented at the Sixteenth International Congress of Marine Corrosion and Fouling, Seattle, WA, June 24-28.

Gensemer, R.W., D.K. DeForest, J.W. Gorsuch and **J.S. Meyer**. 2012. Regulatory implications of chemosensory and behavioral effects of anthropogenic chemicals to fish. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

Jones, D., M. Beauchemin, N. Bonnevie, D. Buys, L. Fontenot, B. Fulton, C. Meyer, **J. Meyer**, D. Rigg, T. Schlekat, A.R. Stojak, M. Wacksman; S. Young and N. Carriker. 2012. Ecological risk assessment for Phase 3 of the TVA Kingston Ash Recovery Project; Roane County, TN. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

Meyer, J.S., D.K. DeForest and J.W. Gorsuch. 2012. A unified freshwater-saltwater biotic ligand model of Cu-induced olfactory impairment to salmonid fishes. Presented at the Twenty-fifth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry, Fort Collins, CO, April 19-20.

Meyer, J.S., D.K. DeForest and J.W. Gorsuch. 2012. A unified saltwater-freshwater biotic ligand model to predict the olfactory effects of copper to salmonid fishes. Presented at the Sixteenth International Congress of Marine Corrosion and Fouling, Seattle, WA, June 24-28.

Meyer, J.S., D.K. DeForest and J.W. Gorsuch. 2012. A unified freshwater-saltwater biotic ligand model to predict olfactory effects of copper to salmonid fishes. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

Meyer, J.S. and G.G. Pyle. 2012. Summary and synthesis of chemosensory/behavior symposium. Presented at the One Hundred Forty-second Annual Meeting of the American Fisheries Society, St. Paul, MN, August 19-23.

Meyer, J.S., J.F. Ranville, R.C. Santore, A.C. Ryan, J.W. Gorsuch and W.J. Adams. 2012. Toxicity of metal mixtures to *Daphnia magna*: Implications for a multi-metal, multi-site biotic ligand model. Presented at the Twenty-second Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe, Berlin, Germany, May 20-24.

Abstracts of Presentations at Scientific Meetings (cont.):

Ryan, A.C., R.C. Santore, **J.S. Meyer** and J.F. Ranville. 2012. A bioavailability-based approach to modeling metal mixtures: Part 1. Model framework and conceptual considerations. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

Santore, R.C., A.C. Ryan, **J.S. Meyer** and J.F. Ranville. 2012. A bioavailability-based approach to modeling metal mixtures: Part 2. Model application. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

Schlekat, T.H., **J.S. Meyer**, C.B. Meyer and D. Jones. 2012. Incorporating bioaccessibility in estimating metal toxicity from incidentally ingested soil. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

Williamson, J.L., J.F. Ranville, K. Dahl, S. Smith, N. Albuquerque and **J.S. Meyer**. 2012. Geochemical characteristics of the mine-impacted North Fork of Clear Creek and implications for stream recovery. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

Adams, W.J. and **J.S. Meyer**. 2011. Avoidance of salmonids to copper: Does the BLM-based water quality criteria provide protection? Presented at the 141st Annual Meeting of the American Fisheries Society. Seattle, WA. 4-8 September 2011.

Anderson, P., T. Iannuzzi, **J. Meyer** and J. Patarcity. 2011. Absence of predicted toxicity from creosote-derived PAH in sediments: A meta-analysis. Presented at the Battelle Sixth International Conference on Remediation of Contaminated Sediments. New Orleans, LA. 7-10 February.

Anthony, B., **Meyer, J.S.**, D. Ludwig, H. Douglas, M.J. Shivell and A.S. Fowler. 2011. Anniston PCB Site: Implications of field and laboratory bioaccumulation results to an ecological risk assessment. Presented at the Thirty-second Annual Meeting of the Society of Environmental Toxicology and Chemistry. Boston, MA. 13-17 November.

Meyer, C. and **J.S. Meyer**. 2011. Implications of life history and model choice on bird population recovery estimates after pulsed contaminant exposure. Presented at the Thirty-second Annual Meeting of the Society of Environmental Toxicology and Chemistry. Boston, MA. 13-17 November.

Meyer, J.S., B. Anthony, D. Ludwig, H. Douglas and A.S. Fowler. 2011. Anniston PCB Site: Implications of sediment toxicity-testing results to an ecological risk assessment. Presented at the Thirty-second Annual Meeting of the Society of Environmental Toxicology and Chemistry. Boston, MA. 13-17 November.

Meyer, J.S., J.F. Ranville, M. Pontasch, R.C. Santore, J.W. Gorsuch and W.J. Adams. 2011. Toxicity of metal mixtures to *Daphnia magna*: A test of a multi-metal, multi-site biotic ligand model using Cu and Zn. Presented at the Twenty-first Annual Meeting of the Society of Environmental Toxicology and Chemistry – Europe. Milan, Italy. 15-19 May.

Meyer, J.S., J.F. Ranville, M. Pontasch, R.C. Santore, J.W. Gorsuch and W.J. Adams. 2011. Toxicity of Cu-Zn mixtures to *Daphnia magna*: Test of a multi-metal, multi-site biotic ligand model. Presented at the Twenty-fourth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Denver, CO. 19-20 May.

Abstracts of Presentations at Scientific Meetings (cont.):

Meyer, J.S., J.F. Ranville, M. Pontasch, R.C. Santore, A. Ryan, J.W. Gorsuch and W.J. Adams. 2011. Toxicity of metal mixtures to *Daphnia magna*: Implications for a multi-metal, multi-site biotic ligand model. Presented at the Thirty-second Annual Meeting of the Society of Environmental Toxicology and Chemistry. Boston, MA. 13-17 November.

Meyer, J.S., J.F. Ranville, R.C. Santore, M. Pontasch, J.W. Gorsuch and W.J. Adams. 2011. Toxicity of metal mixtures to *Daphnia magna*: A multi-metal, multi-site biotic ligand model can reconcile apparent synergisms/antagonisms to facilitate regulatory implementation. Presented at the Third Science Symposium of the Society of Environmental Toxicology and Chemistry – Europe "Prospective and Retrospective Environmental Risk Assessment of Mixtures: moving from Research to Regulation". Brussels, Belgium. 2-3 February.

Meyer, C., A. Francisco, K. Jenkins and **J. Meyer**. 2010. A tiered approach to applying population modeling when assessing ecological risk at contaminated sites in the U.S. and Europe. Presented at the Thirty-first Annual Meeting of the Society of Environmental Toxicology and Chemistry. Portland, OR. 7-11 November.

Meyer, J.S. and W.J. Adams. 2010. Protectiveness of hardness-based and BLM-based water quality criteria for copper against olfactory impairment in fish. Presented at the Thirty-first

Annual Meeting of the Society of Environmental Toxicology and Chemistry. Portland, OR. 7-11 November.

Meyer, J.S. and W.J. Adams. 2008. BLM-based water quality criteria are protective for copper avoidance and olfactory impairment in salmonid fish. Presented at the Twenty-ninth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Tampa, FL. 16-20 November.

Warne, M.St.J., S. Dyer, H. Leslie, **J. Meyer** and B. Escher. 2008. Integration of the tissue residue approach and mixture toxicology. Presented at the Fifth World Congress of the Society of Environmental Toxicology and Chemistry, Sydney, Australia. 3-7 August.

Meyer, J.S. 2008. The Rio de los Patos, Argentina: Rainbow trout in a high-elevation, high-boron desert stream. Presented at the Twenty-first Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry, Golden, CO. 17-18 April.

Adams, W.J., R. Blust, U. Borgmann, D. DeForest, A. Green, J. McGeer, **J. Meyer**, P. Paquin, P. Rainbow, and C. Wood. 2007. Metal tissue residue dose metrics for assessing effects in aquatic organisms. Presented at the Twenty-eighth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Milwaukee, WI. 11-15 November.

Johnson, L.A., C.J. Boese, B.A. Morris and **J.S. Meyer**. 2007. Longitudinal changes in potential toxicity of coal bed natural gas produced water along Beaver Creek in the Powder River Basin, Wyoming. Presented at the Twenty-eighth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Milwaukee, WI. 11-15 November.

Meyer, C.B., **J.S. Meyer**, P. Goodrum and A. Thatcher. 2007. Toxicity of acid metalliferous tailing ponds to migrating waterfowl. Presented at the Twenty-eighth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Milwaukee, WI. 11-15 November.

Meyer, J.S., R.C. Santore and W.J. Adams. 2007. A quantitative model of metal-mixture toxicity to aquatic organisms. Presented at the Twenty-eighth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Milwaukee, WI. 11-15 November.

Abstracts of Presentations at Scientific Meetings (cont.):

Clements, W.H., R. Zuellig, D. Kashian, M. Brooks and **J. Meyer**. 2006. The influence of climate-induced alterations in dissolved organic matter on metal bioavailability and UV-B radiation in Rocky Mountain streams. Presented at the Twenty-seventh Annual Meeting of the Society of Environmental Toxicology and Chemistry. Montreal, Québec, Canada. 5-9 November.

Meyer, J.S., C.J. Boese and J.M. Morris. 2006. Adapting the biotic ligand model to predict toxicity of time-variable Cu exposures to fathead minnows. Presented at the Twenty-seventh Annual Meeting of the Society of Environmental Toxicology and Chemistry. Montreal, Québec, Canada. 5-9 November.

Santore, R.C., P.R. Paquin, A.C. Ryan, **J. Meyer**, G. Rosen, I. Rivera-Duarte, D. Chadwick and P. Antunes. 2006. The use of metal accumulation data for understanding and predicting metal toxicity. Presented at the Twenty-seventh Annual Meeting of the Society of Environmental Toxicology and Chemistry. Montreal, Québec, Canada. 5-9 November.

Morris, J.M., A. Farag and **J.S. Meyer**. 2005. pH and Zn profiles in photosynthetic biofilm using ion-selective electrodes: An explanation for diel metal cycling? Presented at the Twenty-sixth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Baltimore, MD. 13-17 November.

Kolts, J.M., B.L. Denier, C.J. Boese, R.A. Bell and **J.S. Meyer**. 2004. Acute toxicity of waterborne silver to *Ceriodaphnia dubia* in the presence of dissolved organic matter. Presented at the Twenty-fifth Annual Meeting (Fourth World Congress) of the Society of Environmental Toxicology and Chemistry. Portland, OR. 14-18 November.

Morris, B.A., R.B. Bringolf, C.J. Boese and **J.S. Meyer**. 2004. Protective effects of inorganic salts against zinc toxicity to larval fathead minnows. Presented at the Seventeenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry, Laramie, Wyoming. 1-2 April.

Morris, B.A., A.M. Farag and **J.S. Meyer**. 2004. Chronic toxicity of $NaHCO_3$ to fathead minnows in water simulating the Tongue River, Montana, USA. Presented at the Twenty-fifth Annual Meeting (Fourth World Congress) of the Society of Environmental Toxicology and Chemistry. Portland, OR. 14-18 November.

Morris, J.M., B. Morris, A.M. Farag and **J.S. Meyer**. 2004. Photosynthetically mediated Zn uptake in biofilm in High Ore Creek, Montana. Presented at the Seventeenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry, Laramie, Wyoming. 1-2 April.

Morris, J.M., B. Morris, A.M. Farag, D.A. Nimick and **J.S. Meyer**. 2004. Photosynthetically mediated Zn uptake in biofilm in High Ore Creek, Montana. Presented at the Twenty-fifth Annual Meeting (Fourth World Congress) of the Society of Environmental Toxicology and Chemistry. Portland, OR. 14-18 November.

Schmidt, T.S., **J.S. Meyer** and W.H. Clements. 2004. Field test of the biotic ligand model in Colorado Rocky Mountain streams. Presented at the Twenty-fifth Annual Meeting (Fourth World Congress) of the Society of Environmental Toxicology and Chemistry. Portland, OR. 14-18 November.

Abstracts of Presentations at Scientific Meetings (cont.):

Bringolf, R.B., B.A. Morris, S.A. Collyard, C.J. Boese, R.C. Santore, H.E. Allen and **J.S. Meyer**. 2003. Effects of pH and dissolved organic matter on acute toxicity of zinc to larval fathead minnows. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Austin, TX. 9-13 November.

Forbes, M. and **J.S. Meyer**. 2003. A test of a major-ion toxicity model to predict the toxicity of coal bed methane product waters to aquatic biota. Presented at the Annual Fall Meeting of the American Geophysical Union. San Francisco, CA. 8-12 December.

Kolts, J.M., C.J. Boese and **J.S. Meyer**. 2003. Toxicity of dietborne and waterborne copper and silver to *Ceriodaphnia dubia*. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Austin, TX. 9-13 November.

Meyer, J.S. and C.E. Schlekat. 2003. Relationship between boron concentrations and rainbow trout in the Rio de Los Patos, Argentina. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Austin, TX. 9-13 November.

Morris, B.A., R.B. Bringolf, C.J. Boese and **J.S. Meyer**. 2003. Protective effects of inorganic salts against zinc toxicity to larval fathead ninnows. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Austin, TX. 9-13 November.

Morris, J.M., B. Mueller, A.M. Farag and **J.S. Meyer**. 2003. Profiling photosynthetic biofilm using miniaturized ion-selective electrodes. Presented at the Sixteenth Annual Meeting of

the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Denver, CO. 16 April.

Morris, J.M., D.A. Nimick, A.M. Farag and **J.S. Meyer**. 2003. Biotic influences on diel cycling of Zn in High Ore Creek, Montana. Presented at the Twenty-fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Austin, TX. 9-13 November.

Forbes, M.B., S.J. Clearwater, B.A. Morris and **J.S. Meyer**. 2002. Toxicity of coalbed methane product waters and receiving waters from the Powder River Basin, Wyoming. Presented at the Fifteenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Fort Collins, CO. 19 April.

Forbes, M.B., S.J. Clearwater, B.A. Morris and **J.S. Meyer**. 2002. Toxicity of coalbed methane product waters and receiving waters from the Powder River Basin, Wyoming. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry. Salt Lake City, UT. 16-20 November.

Lovvorn, M.B. and **J.S. Meyer**. 2002. Sunlight effects on natural waters: humic substances, copper complexation, and toxicity. Presented at the Fifteenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Fort Collins, CO. 19 April.

Lovvorn, M.B. and **J.S. Meyer**. 2002. Photoreactivity and copper complexation by wetland versus riverine DOM. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry. Salt Lake City, UT. 16-20 November.

Meyer, J.S., W.J. Adams, K.V. Brix, S.N. Luoma, D.R. Mount, W.A. Stubblefield, and C.M. Wood. 2002. Toxicity of dietborne metals to aquatic biota: emerging science and regulatory implications. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry. Salt Lake City, UT. 16-20 November.

Abstracts of Presentations at Scientific Meetings (cont.):

Morris, J.M., A.M. Farag, D.A. Nimick and **J.S. Meyer**. 2002. Biofilm and the diel cycling of aqueous metals in mountain streams. Presented at the Fifteenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Fort Collins, CO. 19 April.

Morris, J.M., A.M. Farag, D.A. Nimick and **J.S. Meyer**. 2002. Biofilm and the diel cycling of aqueous metals in mountain streams. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry. Salt Lake City, UT. 16-20 November.

Wu, K.B., V. Navab, R. Mathew, R.C. Santore, P.R. Paquin, **J.S. Meyer**, K.V. Brix and D.M. Di Toro. 2002. An application of the biotic ligand model (BLM) framework to nickel. Presented at the Twenty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry. Salt Lake City, UT. 16-20 November.

Lovvorn, M.B. and **J.S. Meyer**. 2001. Photochemically altered dissolved organic matter from natural waters: implications for copper-organic binding and toxicity. Presented at the Fourteenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Denver, CO. 6 April.

Lovvorn, M.B. and **J.S. Meyer**. 2001. Sunlight effects on natural waters: humic substances, copper complexation, and toxicity. Presented at the Twenty-second Annual Meeting of the Society of Environmental Toxicology and Chemistry. Baltimore, MD. 11-15 November.

Moffett, J.W. and **J.S. Meyer**. 2001. Application of the biotic ligand model to the marine environment: opportunities and challenges. Presented at the Twenty-second Annual Meeting

of the Society of Environmental Toxicology and Chemistry. Baltimore, MD. 11-15 November.

Morris, J.M., S.A. Collyard and **J.S. Meyer**. 2001. Does exposure to copper alter nutritional content of *Hyalella azteca*? Presented at the Twenty-second Annual Meeting of the Society of Environmental Toxicology and Chemistry. Baltimore, MD. 11-15 November.

Boese, C.J., S.A. Collyard, H.L. Bergman and **J.S. Meyer**. 2000. Whole-body Cu accumulation predicts acute toxicity to *Lumbriculus variegatus* as pH and Ca vary. Presented at the Thirteenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 7 April.

Clearwater, S.J., A.M. Farag and **J.S. Meyer**. 2000. Alternative perspectives on dietborne metal toxicity to fish. Presented at the Twenty-first Annual Meeting of the Society of Environmental Toxicology and Chemistry. Nashville, TN. 12-16 November.

Clearwater, S.J., M.J. Suedkamp, A.M. Farag, H.L. Bergman and **J.S. Meyer**. 2000. The relative importance of dietborne versus waterborne exposure in metals-contaminated aquatic ecosystems. Presented at the Thirteenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 7 April.

Collyard, S.A., C.J. Boese, H.L. Bergman and **J.S. Meyer**. 2000. Whole-body Cu accumulation predicts acute toxicity to *Hyalella azteca* as pH but not Ca varies. Presented at the Thirteenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 7 April.

Goldstein, J.N., W.A. Hubert, D.F. Woodward, A.M. Farag and **J.S. Meyer**. 2000. Differences in embryonic temperature tolerance affect the distributions of rainbow trout and brown trout in the Firehole River, Yellowstone National Park. Presented at the Annual Meeting of the Western Division of the American Fisheries Society. Telluride, CO. 16-20 July.

Abstracts of Presentations at Scientific Meetings (cont.):

Lovvorn, M.B. and **J.S. Meyer**. 2000. Photochemically altered dissolved organic matter from natural waters: implications for copper-organic binding and toxicity. Presented at the Twenty-first Annual Meeting of the Society of Environmental Toxicology and Chemistry. Nashville, TN. 12-16 November.

Meyer, J.S. 2000. Let's banish the elusive term "bioavailable fraction" for metals. Presented at the Thirteenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 7 April.

Meyer, J.S. 2000. Let's banish the elusive term "bioavailable fraction" for metals. Presented at the Third World Congress of the Society of Environmental Toxicology and Chemistry. Brighton, England. 21-25 May.

Meyer, J.S. 2000. The biotic ligand model for metals: What would McKim tell us to do next? Presented at the First International James M. McKim Species Extrapolation Workshop. Duluth, MN. 28 October 2000.

Meyer, J.S. and S.J. Clearwater. 2000. Effects of water-quality parameters on chronic toxicity of Cd, Cu, Ni, Pb and Zn. Presented at the Twenty-first Annual Meeting of the Society of Environmental Toxicology and Chemistry. Nashville, TN. 12-16 November.

Morris, J.M., M.J. Suedkamp, E. Snyder-Conn, R.A. Holt, H.M. Lease, S.J. Clearwater, J.S. Foott and **J.S. Meyer**. 2000. Survival of juvenile Lost River suckers challenged with bacteria during exposure to sublethal ammonia concentrations. Presented at the Twenty-first

Annual Meeting of the Society of Environmental Toxicology and Chemistry. Nashville, TN. 12-16 November.

Morris, J.M., M.J. Suedkamp, E. Snyder-Conn, R.A. Holt, H.M. Lease, S.J. Clearwater and **J.S. Meyer**. 2000. Survival and growth of juvenile Lost River suckers (*Deltistes luxatus*) challenged with a bacterial pathogen (*Flavobacterium columnare*) during exposure to sublethal ammonia concentrations at pH 9.5. Presented at the Thirteenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 7 April.

Boese, C.J., S.A. Collyard, H.L. Bergman and **J.S. Meyer**. 1999. Whole-body Cu accumulation predicts acute toxicity to *Lumbriculus variegatus* as pH and Ca vary. Presented at the Twentieth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Philadelphia, PA. 14-18 November.

Clearwater, S.J., M.J. Suedkamp, A.M. Farag, H.L. Bergman and **J.S. Meyer**. 1999. The relative importance of dietborne versus waterborne exposure in metals-contaminated aquatic ecosystems. Presented at the Twentieth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Philadelphia, PA. 14-18 November.

Collyard, S.A., C.J. Boese, H.L. Bergman and **J.S. Meyer**. 1999. Whole-body Cu accumulation predicts acute toxicity to *Hyalella azteca* as pH but not Ca varies. Presented at the Twentieth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Philadelphia, PA. 14-18 November.

Goldstein, J.N., W.A. Hubert, D.F. Woodward, A.M. Farag and **J.S. Meyer**. 1999. Effects of geothermal additions on the distribution of trout in the Firehole River, Yellowstone National Park, U.S.A. Presented at the Annual Meeting of the American Fisheries Society, Charlotte, NC. 29 August - 2 September.

Abstracts of Presentations at Scientific Meetings (cont.):

Kolm, K.E., K.C. Glover, J.C. Burton and **J.S. Meyer**. 1999. Developing integrated technical approaches to meet the ecosystem sustainability challenge: watershed, ground-water basin, and wetlands perspectives. Presented at the Annual Meeting of the Geological Society of America. Denver, CO. 25 October.

Lease, H.M., J.A. Hansen, H.L. Bergman and **J.S. Meyer**. 1999. Histopathological changes in gills of Lost River suckers (*Deltistes luxatus*) exposed to ammonia at high pH. Presented at the Twelfth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Denver, CO. 9 April.

Lease, H.M., J.A. Hansen, H.L. Bergman and **J.S. Meyer**. 1999. Gill structural changes as a potential indicator of eutrophic stress. Presented at the 1999 Annual Meeting of the Western Division of the American Fisheries Society. Moscow, ID. 12-14 July.

Lease, H.M., J.A. Hansen, L.D. DeBrey, C.J. Boese, H.L. Bergman and **J.S. Meyer**. 1999. Histopathological changes in gills of Lost River suckers exposed to elevated pH and ammonia. Presented at the Twentieth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Philadelphia, PA. 14-18 November.

Lease, H.M., **J.S. Meyer**, J.A. Hansen, L.D. DeBrey and H.L. Bergman. 1999. Chronic toxicity of low dissolved oxygen and elevated pH and ammonia to Lost River Suckers (*Deltistes luxatus*). Presented at the Third Klamath Basin Watershed Restoration and Research Conference. Klamath Falls, OR. 9-11 March.

Lovvorn, M.B. and **J.S. Meyer**. 1999. Photochemical alteration of dissolved organic matter

from natural waters: implications for copper bioavailability in natural waters. Presented at the Twelfth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Denver, CO. 9 April.

Lovvorn, M.B., R.G. Zepp and **J.S. Meyer**. 1999. Photochemical alteration of dissolved organic matter from natural waters: Implications for copper bioavailability. Presented at the Twentieth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Philadelphia, PA. 14-18 November.

Meyer, J.S. 1999. Dissolved organic matter can decrease the protective effect of calcium against waterborne metal toxicity. Presented at the Twentieth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Philadelphia, PA. 14-18 November.

Rockwell, R.W., K.H. Dahl, J.A. Lockwood and **J.S. Meyer**. 1999. Application of sediment quality guidelines for metals to a montane lotic ecosystem: Year 1 summary. Presented at the Twelfth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Denver, CO. 9 April.

Rockwell, R.W., K.H. Dahl, J.A. Lockwood and **J.S. Meyer**. 1999. Application of sediment quality guidelines for metals to a montane lotic ecosystem: Year 1 summary. Presented at the Twentieth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Philadelphia, PA. 14-18 November.

Allen, H.E., H.L. Bergman, D.M. DiToro, J.D. Mahony, **J.S. Meyer** and P.R. Paquin. 1998. Speciation: the key factor for appropriate risk assessment of metals in aquatic ecosystems. Presented at the Eighth Annual Meeting of the Society of Environmental Toxicology and Chemistry - Europe. Bordeaux, France. 14-18 April.

Abstracts of Presentations at Scientific Meetings (cont.):

Collyard, S.A., C.J. Boese, H.L. Bergman and **J.S. Meyer**. 1998. Relationships between LC50 and body burden of copper in the invertebrates Hyalella azteca and Daphnia magna. Presented at the Nineteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Charlotte, NC. 15-19 November.

Lovvorn, M.B. and **J.S. Meyer**. 1998. Photochemical alteration of humic acid: Implications for copper toxicity in natural waters. Presented at the Fourth Regional Animal Physiology Meeting. Boulder, CO. 2 May.

Lovvorn, M.B. and **J.S. Meyer**. 1998. Cation-exchange effects on DOM geochemistry collected by reverse osmosis from hard, alkaline waters. Presented at the 1998 Joint Meeting of the American Society of Limnology and Oceanography and the Ecological Society of America. St. Louis, MO. 8-13 June.

Lovvorn, M.B. and **J.S. Meyer**. 1998. Cation-exchange effects on dissolved organic matter collected by reverse osmosis from hard, alkaline waters. Presented at the Nineteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Charlotte, NC. 15-19 November.

Meyer, J.S. 1998. Why is the slope of the ln(LC50) vs. ln(hardness) adjustment equation for copper approximately equal to 1? Presented at the Nineteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Charlotte, NC. 15-19 November.

Paquin, P.R., H.E. Allen, H.L. Bergman, D.M. DiToro and **J.S. Meyer**. 1998. Speciation: a key factor for appropriate risk assessment of metals in aquatic ecosystems. Presented at the U.S. Environmental Protection Agency Meeting on Water Quality Standards, Water Quality Criteria, and Water Quality-based Permitting, Including Implementation. Philadelphia, PA.

24-27 August.

Suedkamp, M.J., A.M. Farag and **J.S. Meyer**. 1998. Dietary availability of metals incorporated into aquatic invertebrates: Are species and history of metals exposure important? Presented at the Nineteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Charlotte, NC. 15-19 November.

Allen, H.E., H.L. Bergman, D.M. DiToro, J.D. Mahony, **J.S. Meyer** and P.R. Paquin. 1997. Water quality criteria for metals: a new paradigm. Presented at the Seventh Annual Meeting of the Society of Environmental Toxicology and Chemistry - Europe. Amstersdam, The Netherlands. 6-10 April.

Camp, J., C. Martínez del Rio, T. H. Kerstetter and **J.S. Meyer**. 1997. Effects of a metals-contaminated macroinvertebrate diet on digestive function in rainbow trout. Presented at the Tenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 10-11 April.

Camp, J., C. Martínez del Rio, T. H. Kerstetter and **J.S. Meyer**. 1997. Effects of a metals-contaminated macroinvertebrate diet on digestive function in rainbow trout. Presented at the Third Annual Regional Animal Physiology Meeting, Laramie, WY. 19 April.

Camp, J., C. Martínez del Rio, T. H. Kerstetter and **J.S. Meyer**. 1997. Effects of metals-contaminated macroinvertebrate diet on digestive function in rainbow trout. Presented at the Eighteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. San Francisco, CA. 16-20 November.

Abstracts of Presentations at Scientific Meetings (cont.):

Camp, J., C. Martínez del Rio, T. H. Kerstetter and **J.S. Meyer**. 1997. Effects of a metals-contaminated macroinvertebrate diet and starvation on weight gain and hepatic ornithine decarboxylase activity in rainbow trout. Presented at the Tenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 10-11 April.

Camp, J., C. Martínez del Rio, T. H. Kerstetter and **J.S. Meyer**. 1997. Effects of a metals-contaminated macroinvertebrate diet and starvation on weight gain and hepatic ornithine decarboxylase activity in rainbow trout. Presented at the Third Annual Regional Animal Physiology Meeting, Laramie, WY. 19 April.

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Lovvorn, M.B. and **J.S. Meyer**. 1997. Photochemical alteration of humic acid: comparison of monochromatic UV to sunlight. Presented at the Tenth Annual Meeting of the Wyoming Section of the American Water Resources Association. Laramie, WY. 13-14 November.

Lovvorn, M.B. and **J.S. Meyer**. 1997. Photochemical alteration of humic acid: comparison of monochromatic UV to sunlight. Presented at the Eighteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. San Francisco, CA. 16-20 November.

Markwiese, J.T., **J.S. Meyer** and P.J.S. Colberg. 1997. Copper tolerance in iron-reducing bacteria: implications for copper mobilization in aquatic systems. Presented at the Tenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 10-11 April.

Markwiese, J.T., **J.S. Meyer** and P.J.S. Colberg. 1997. Copper tolerance in iron-reducing bacteria: implications for copper mobilization in sediments. Presented at the Eighteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. San Francisco, CA. 16-20 November.

Meyer, J.S., C. Boese, S.A. Collyard and H.L. Bergman. 1997. Chemistry of copper bioavailability. III. Affinities, capacities, and effects of copper binding to biotic ligands. Presented at the Eighteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. San Francisco, CA. 16-20 November.

Meyer, J.S., D.F. Woodward, J.N. Goldstein, A. M. Farag and W.A. Hubert. 1997. Relationships between boron concentrations and trout in the Firehole River, Wyoming, USA. Presented at the Second International Symposium on the Health Effects of Boron and Its Compounds. Irvine, CA. 22-24 October.

Sheridan, D.L., P.J.S. Colberg and **J.S. Meyer**. 1997. Investigation of microbial communities responsible for degradation of toluene in unexposed and exposed Laramie River sediments. Presented at the Tenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 10-11 April.

Sheridan, D.L., P.J.S. Colberg and **J.S. Meyer**. 1997. Investigation of microbial communities responsible for degradation of toluene in unexposed and exposed Laramie River sediments. Presented at the Eighteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. San Francisco, CA. 16-20 November.

Abstracts of Presentations at Scientific Meetings (cont.):

Suedkamp, M.J., **J.S. Meyer**, A.M. Farag and D.F. Woodward. 1997. Biochemical characterization of organo-metallic complexes and free metals found in metals-contaminated aquatic invertebrates. Presented at the Tenth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Laramie, WY. 10-11 April.

Elderkin, J.M., C. Martinez del Rio, **J.S. Meyer** and T. Kerstetter. 1996. Methods for studying physiological effects of dietary exposure to metals in rainbow trout. Presented at the Regional Animal Physiology Meeting. Colorado State University, Fort Collins, CO. 6 April.

Elderkin, J.M., C. Martinez del Rio, **J.S. Meyer** and T. Kerstetter. 1996. Methods for studying physiological effects of dietary exposure to metals in rainbow trout. Presented at the Ninth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Denver, CO. 19 April.

MacDonald, D. and **J. Meyer**. 1996. An ecological risk assessment of waterfowl feeding on plants and invertebrates containing heavy metals in the Arcata Marsh and Wildlife Sanctuary, Arcata, California. Presented at the Seventeenth Annual Meeting of the Society of Wetland Scientists. Kansas City, MO. 9-14 June.

Markwiese, J.T., **J.S. Meyer** and P.J.S. Colberg. 1996. Heavy metal mobilization resulting from microbial reduction of iron oxide. Presented at the Seventeenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Washington, DC. 17-21 November.

Shockley, D.L., **J.S. Meyer** and P.J.S. Colberg. 1996. Investigation of microbial communities responsible for degradation of toluene in exposed and unexposed river sediment. Presented at the Ninth Annual Meeting of the Rocky Mountain Chapter of the Society of Environmental Toxicology and Chemistry. Denver, CO. 19 April.

Suedkamp, M.J., **J.S. Meyer**, A.M. Farag and D.F. Woodward. 1996. Biochemical characterization of organo-metallic complexes and free metals found in metals-contaminated aquatic invertebrates. Presented at the Seventeenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Washington, DC. 17-21 November.

Bergman, H.L., R.K. MacRae and **J.S. Meyer**. 1995. Metal binding and toxicity in fish. Presented at the Workshop on Metal Speciation and Contamination of Surface Waters. Jekyll Island, GA. 25-28 June.

Farag, A.M., D.F. Woodward, W. Brumbaugh and **J.S. Meyer**. 1995. Concentrations of metals in biofilm, benthic macroinvertebrates, and fish in the Coeur d'Alene Basin, Idaho. Presented at the Second World Congress of the Society of Environmental Toxicology and Chemistry. Vancouver, British Columbia, Canada. 5-9 November.

Frankenbach, R.I. and **J.S. Meyer**. 1995. The fate of nitrogen in an emergent macrophyte wastewater treatment wetland. Presented at the Sixteenth Annual Meeting of the Society of Wetland Scientists. Cambridge, MA. 28 May - 2 June.

Hansen, J., H.L. Bergman, **J.S. Meyer**, R. MacRae, J. Marr, J. Lipton and D. Cacela. 1995. The avoidance of copper by salmonids as affected by metals concentration, organic content, and acclimation. Presented at the Second World Congress of the Society of Environmental Toxicology and Chemistry. Vancouver, British Columbia, Canada. 5-9 November.

Abstracts of Presentations at Scientific Meetings (cont.):

MacRae, R.K., **J.S. Meyer**, J.A. Hansen, H.L. Bergman, A. Maest, J. Marr, D. Beltman and J. Lipton. 1995. Determination of an organic-acid analog of DOC for use in copper toxicity studies on salmonids. Presented at the Second World Congress of the Society of Environmental Toxicology and Chemistry. Vancouver, British Columbia, Canada. 5-9 November.

Marr, J., J. Lipton, A. Maest, D. Cacela, **J.S. Meyer**, J. Hansen, R. MacRae and H.L. Bergman. 1995. Acute lethality and bioavailability of copper in the presence of dissolved organic carbon. Presented at the Second World Congress of the Society of Environmental Toxicology and Chemistry. Vancouver, British Columbia, Canada. 5-9 November.

Meyer, J.S., D. Beltman, A. Maest, J. Marr, J. Lipton, C. Cors, D. Cacela and R. MacRae. 1995. Use of geochemical and toxicity modeling to predict lethality of copper in a metals-impacted stream. Presented at the Second World Congress of the Society of Environmental Toxicology and Chemistry. Vancouver, British Columbia, Canada. 5-9 November.

Meyer, J.S., R.K. MacRae, J.C.A. Marr, D.E. Smith and H.L. Bergman. 1995. Effects of dissolved organic carbon on the bioavailability of copper to fish. Presented as a plenary lecture at a conference of the International Humic Substances Society. Atlanta, GA. 27 August - 1 September.

Meyer, J.S., C.S. Mazur, M.E. Bedessem, K.A. Rittle, J.I. Drever, N.G. Swoboda-Colberg and P.J.S. Colberg. 1995. Microbial transformations of environmental contaminants during sulfate reduction. Presented at the Tri-Service Workshop on Bioavailability of Organic Contaminants in Soils and Sediments. Monterey, CA. 9-12 April.

Reinharz, E., H. Bergman, L. McDonald, **J. Meyer**, R.B. Luthi and M. Holt. 1995. Injury assessment under OPA 90. Presented at the Fourteenth Biennial International Oil Spill Conference. Long Beach, CA. 27 February - 2 March.

Shockley, D.L., **J.S. Meyer** and P.J.S. Colberg. 1995. Investigation of microbial communities responsible for degradation of toluene in exposed and unexposed soils. Presented at the Twenty-fifth Annual Rocky Mountain Groundwater Conference, Jackson, WY. 4-6 October.

Boyce, M.S., **J.S. Meyer** and L. Irwin. 1994. Resource selection function model for viability of northern spotted owls. Presented at the First Annual Conference of the Wildlife Society. Albuquerque, NM. 21-24 September.

Meyer, J.S., R. Frankenbach, D. Camras and R.A. Gearheart. 1994. Nitrogen removal from constructed wetlands in the Arcata Marsh and Wildlife Sanctuary, California. Presented at the Fifteenth Annual Meeting of the Society of Wetland Scientists. Portland, OR. 30 May - 3 June.

Reinharz, E., R.B. Luthi, L. McDonald, H. Bergman and **J. Meyer**. 1994. Injury assessment for natural resources under Oil Pollution Act of 1990. Presented at the Fifteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Denver, CO. 30 October - 3 November.

Meyer, J.S., D.D. Gulley, M.S. Goodrich, D.C. Szmania and A.S. Brooks. 1993. Modeling toxicity due to intermittent exposure of freshwater fish to monochloramine. Presented at the Fourteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Houston, TX. 14-18 November.

Abstracts of Presentations at Scientific Meetings (cont.):

Meyer, J.S. 1992. Effects of pH, redox potential and light on physical-chemical interactions and bioavailability of chemicals in aquatic ecosystems. Presented at the Thirteenth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Cincinnati, OH. 8-12 November.

Payne, M.S., H. Vu, L. Crowser and **J.S. Meyer**. 1990. Identifying habitat mosaics and changes around Northern Spotted Owl sites on BLM land in western Oregon. Presented at the Seventh MOSS Users Conference. Portland, OR. 29 November.

Gächter, R., **J.S. Meyer** and A. Mares. 1988. Do bacteria contribute directly to release and fixation of phosphorus in lake sediments? Presented at the Annual Meeting of the American Society of Limnology and Oceanography. Boulder, CO. 12-16 June.

Meyer, J.S., R. Gächter and A. Mares. 1988. Bacterial contributions to release and fixation of phosphorus in lake sediments. Presented at the Second International Workshop on Phosphorus in Sediments. Fiskebckskil, Sweden. 14-16 September.

Zeyer, J. and J. Meyer. 1988. Ecotoxicological criteria for final storage quality -- possibilities and limits. Presented at the Swiss Workshop on Land Disposal of Solid Wastes. Gerzensee, Switzerland. 14-17 March.

Meyer, J.S. and C.L. Sowards. 1987. Geographic, species and age differences in element concentrations among South Dakota birds. Presented at the Eighth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Pensacola, FL. 9-12 November.

Crossey, M.J., A. Boelter and **J.S. Meyer**. 1986. Temporal variability of toxicity in a stream receiving industrial discharge. Presented at the Seventh Annual Meeting of the Society of Environmental Toxicology and Chemistry. Alexandria, VA. 2-5 November.

Crossey, M.J., A. Boelter and **J.S. Meyer**. 1986. Toxicological and chemical detection of contaminated ground water flowing into streams and rivers. Presented at the Eighth Annual Rocky Mountain Regional Meeting of the American Chemical Society. Denver, CO. 8-12 June.

Brookshire, D.C., D.D. Gulley and **J.S. Meyer**. 1985. Effect of diet and water formulation on survival and reproduction in Ceriodaphnia affinis/dubia. Presented at the Sixth Annual Meeting of the Society of Environmental Toxicology and Chemistry. St. Louis, MO. 10-13 November.

Meyer, J.S., C.G. Ingersoll and L.L. McDonald. 1984. Sensitivity analysis of population growth rates estimated from cladoceran chronic toxicity tests. Presented at the Fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Arlington, VA. 4-7 November.

Meyer, J.S., D.A. Sanchez, H.L. Bergman, D.B. McWhorter and T. Garland. 1984. Aquatic toxicity of raw and spent oil shale leachates. Presented at the Fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Arlington, VA. 4-7 November.

Sanchez, D.A., **J.S. Meyer** and H.L. Bergman. 1984. Toxicity of treated oil shale process waters to aquatic biota. Presented at the Fifth Annual Meeting of the Society of Environmental Toxicology and Chemistry. Arlington, VA. 4-7 November.

Baxter, G.T. and **J.S. Meyer**. 1982. The status and decline of the Wyoming Toad, Bufo hemiophrys baxteri. Presented at the Joint Meeting of the Colorado-Wyoming Academy of Science and the Central Rockies Chapter of the Ecological Society of America. Fort Collins, CO. 23-24 April.

Abstracts of Presentations at Scientific Meetings (cont.):

Bergman, H.L., **J.S. Meyer**, G.L. Linder and B.R. Parkhurst. 1982. Effluent toxicity testing vs. single-compound standards. Presented at the Workshop on Effects of Trace Elements on Aquatic Systems. Raleigh, NC. 23-24 March.

Bergman, H.L., **J.S. Meyer** and D.A. Sanchez. 1982. Assessing the effects of oil shale facilities on water quality: critique and alternatives. Presented at Oil Shale: The Environmental Challenges III. Vail, CO. 9-12 August.

Meyer, J.S. and H.L. Bergman. 1982. Identifying problem compounds in complex organic mixtures. Presented at the Fifth ORNL Life Sciences Symposium -- Synthetic Fossil Fuel Technologies: Results of Health and Environmental Studies. Gatlinburg, TN. 24-27 October.

Meyer, J.S., M.S. Boyce and H.L. Bergman. 1982. Predicting population-level effects of pollutants. Presented at the Third Annual Meeting of the Society of Environmental Toxicology and Chemistry. Arlington, VA. 14-17 November.

Bergman, H.L. and **J.S. Meyer**. 1981. Hazard assessment strategy for complex effluents: synfuel wastewater case study. Presented at the Second Annual Meeting of the Society of Environmental Toxicology and Chemistry. Arlington, VA. 22-25 November.

Linder, G.L., **J.S. Meyer**, B.L. Steadman and H.L. Bergman. 1981. Identification of bioaccumulated organics from synfuel process waters. Presented at the Joint Meeting of the Southwest Division of the American Association for the Advancement of Science and the Colorado-Wyoming Academy of Science. Greeley, CO. 20-24 April.

Meyer, J.S. 1981. Applications of population biology theory to aquatic toxicology. Presented at the Annual Meeting of the Guild of Rocky Mountain Population Biologists. Gothic, CO. 18-20 September.

Meyer, J.S., G. Linder and H.L. Bergman. 1981. An approach for bioaccumulation studies of complex organic effluents: extraction of representative organics from rainbow trout and

water. Presented at the Second Annual Meeting of the Society of Environmental Toxicology and Chemistry. Arlington, VA. 22-25 November.

Bergman, H.L., G.M. DeGraeve, D.L. Geiger, **J.S. Meyer** and M.D. Marcus. 1980. Aquatic ecosystem hazard assessment of underground coal gasification process waters. Presented at the 20th Hanford Life Sciences Symposium on Coal Conversion and the Environment. Richland, WA. 19-23 October.

Meyer, J.S., H.L. Bergman and M.D. Marcus. 1979. Inhibitory interactions of aromatic organics during microbial metabolism. Presented at the 30th Annual Meeting of the Ecological Society of America. Stillwater, OK. 12-17 August.

Fannin, T.E., H.L. Bergman, M. Parker, M.D. Marcus and **J.S. Meyer**. 1978. A simple screening system to identify environmentally persistent hydrocarbons. Presented at the 41st Annual Meeting of the American Society of Limnology and Oceanography. Victoria, BC. 19-22 June.

Invited Lectures and Other Presentations:

"Surface Water in New Mexico: Challenges, Changes, and Game Changers." Presented at the 73rd Annual Convention and Trade Show of the New Mexico Mining Association, Las Cruces, NM. September 7, 2012.

"Effects of Metal Mixtures on Fish Populations in a Mining-Impacted Stream: Railroad Creek, Washington, USA." Presented at 2nd Rio Tinto Aquatic Toxicology Symposium, Holden Village, WA. June 13, 2012.

"Diel Cycling of Zn in a Mining-Impacted Montane Stream: Mechanisms and Consequences." Presented at 1st Rio Tinto Aquatic Toxicology Symposium, Ryan Camp, Death Valley, CA. March 19, 2010.

"Contribution of Biofilm to Diel Zinc Cycling in a Mining-Impacted Stream." Presented at Environmental Research Laboratory of the U.S. Environmental Protection Agency's Mid-Continent Ecology Division, Duluth, MN. February 9, 2006.

"Review of the Chronic Toxicity of Waterborne Metals to Aquatic Biota." Presented at the Second Colloquium on Metals in the Environment, Electric Power Research Institute, Washington, DC. January 28-30, 2001.

"The biotic ligand model for metals: What would McKim tell us to do next?" Presented at the First International James M. McKim Species Extrapolation Workshop, U.S. Environmental Protection Agency Environmental Research Laboratory, Duluth, Minnesota. October 28, 2000.

"Effects of dietborne metals on aquatic biota: a few gut hunches." Presented at the Workshop on Effects of Dietary Metal Uptake by Fish and Other Aquatic Organisms, U.S. Environmental Protection Agency Environmental Research Laboratory, Duluth, Minnesota. March 1-2, 2000.

"Biotic-ligand model for establishing water quality criteria for lead." Presented at the 21st Annual Lead Occupational Health and Environmental Protection Conference, Whitefish, Montana. December 1-4, 1999.

"Free-ion activity and biotic-ligand models in ecotoxicology." Presented at Natural Waters and Water Technology: Chemical Speciation of Metals and Bioavailability, Eighth European Research Conference, Castelvecchio Pascoli, Italy. October 15-20, 1999.

"Physiological and behavioral mechanisms of metal toxicity in fish." Presented at the 20th Conference of the European Society for Comparative Physiology and Biochemistry,

Aarhus, Denmark (co-author with H.L. Bergman, who made the presentation, and J.A. Hansen). June 27-30, 1999.

"Biotic-ligand model predicts toxicity of copper and nickel to fish better than does free-ion-activity model." Presented at Limnological Research Center, EAWAG/ETH, Kastanienbaum, Switzerland. June 18, 1998.

Invited Lectures and Other Presentations (cont.):

"Removal of nitrogen from constructed wetlands in the Arcata Wastewater Treatment Plant and the Arcata Marsh and Wildlife Sanctuary, northern California." Presented at:

- Limnological Research Center, EAWAG/ETH, Kastanienbaum, Switzerland. June 18, 1998.
- Department of Zoology and Physiology, University of Wyoming, Laramie, WY. November 6, 1997.
- Department of Biology, Anhui University, Hefei, Anhui Province, People's Republic of China. May 27, 1997.
- Public Works Department, City of Albuquerque, NM. April 4, 1997.
- Student Chapter Meeting, American Society of Civil Engineers, University of Wyoming, Laramie, WY. October 4, 1995.
- State Water Forum, Cheyenne, WY. January 26, 1995.

"Aquatic effects of copper." Presented at Second Annual Meeting of the Environmental Planning Committee of the International Copper Association, Geneva, Switzerland. June 16, 1998.

"Bioavailability of metals to fish: Incorporating geochemical speciation modeling into aquatic toxicology." Presented at:

- Department of Resources and Environmental Science, Hefei University of Technology, Hefei, Anhui Province, People's Republic of China. May 27, 1997.
- Anhui Environmental Protection Bureau, Hefei, Anhui Province, People's Republic of China. May 20, 1997.
- Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM. April 3, 1997.

"Regulation of aqueous discharges of metals in the United States." Presented at Anhui Environmental Protection Bureau, Hefei, Anhui Province, People's Republic of China. May 20, 1997.

"Heavy metals in plants and benthic invertebrates in the Arcata Marsh and Wildlife Sanctuary, northern California." Presented at:

- Public Works Department, City of Albuquerque, NM. April 4, 1997.

"Aquatic toxicity research related to metals at the University of Wyoming." Presented at U.S. Environmental Protection Agency Annual Sediment Quality Criteria Planning Meeting, Duluth, MN. September 2, 1996.

"Biological considerations for establishing mechanistically based water quality criteria for metals." Presented at U.S. Environmental Protection Agency Office of Water, Washington, DC. November 22, 1996

"An overview of environmental contaminants research at the University of Wyoming." Presented at:

- Tyndall Air Force Base, Panama City, FL. August 25, 1995.
- Wright-Patterson Air Force Base, Dayton, OH. July 17, 1995

"Effects of biogeochemical processes on bioavailability of chemicals in sediments: What's the big stink?" Presented at Fort Johnson Marine Science Seminar Series, Medical University of South Carolina, Charleston, SC. October 21, 1994.

Invited Lectures and Other Presentations (cont.):

"Influence of habitat fragmentation on Spotted Owl site location, site occupancy, and reproductive status in western Oregon." Presented at:

- Zoology and Physiology Department Seminar, University of Wyoming. September 29, 1994.
- Wildlife Department Seminar, Humboldt State University, Arcata, CA. October 15, 1992.
- West Coast Regional Meeting of the National Council of the Paper Industry for Air and Stream Improvement, Portland, OR. September 30, 1992.

"Proposed groundwater remediation experiment using large column systems." Presented at EPSCoR Groundwater Cluster Seminar, University of Wyoming. March 3, 1994.

"Effects of biogeochemical processes on bioavailability of chemicals in aquatic ecosystems." Presented at Department of Zoology and Physiology Seminar, University of Wyoming. April 5, 1993.

"Do bacteria contribute directly to release and fixation of phosphorus in lake sediments?" Presented at:

- Institute for Inorganic, Analytical and Physical Chemistry, University of Bern, Bern, Switzerland. January 23, 1989.
- Swiss Federal Institute for Water Resources and Water Pollution Control (EAWAG/ETH), Dübendorf, Switzerland. November 4, 1988.
- W.K. Kellogg Biological Station, University of Michigan, Hickory Corners, MI. June 22, 1988.
- Center for Great Lakes Studies, University of Wisconsin-Milwaukee, Milwaukee, WI. June 20, 1988.

"Estimating uncertainty in cladoceran population growth rates." Presented at Lake Research Laboratory, Swiss Federal Institute for Water Resources and Water Pollution Control (EAWAG/ETH), Kastanienbaum, Switzerland. July 9, 1988.

"Population growth rate as an indicator of pollutant stress: Is it sensitive and does it tell us anything new?" Presented at U.S. Environmental Protection Agency, Environmental Research Laboratory, Duluth, MN. March 4, 1986.

"Review of aquatic toxicity database for synfuel-related waters." Presented at Second Annual User's Review of Integrated Health and Environmental Risk Analysis Program, U.S. Environmental Protection Agency, Washington, DC. September 24-25, 1982.

"A conceptual model of the population-level effects of pollutants." Presented at U.S. Environmental Protection Agency, Environmental Research Laboratory, Duluth, MN. March 10, 1982.

Invited Panel Discussion Participant:

"Riverbank Refineries: Assessing the Impacts on the Platte River." Held at Casper College, Casper, WY. November 16, 2000.

COMMITTEES

University Committees:

EPSCoR Committee, 2000-2002
Environment and Natural Resources Committee, 1994-1999
Conflict of Interest Committee, Fall 1995 and Fall & Spring 1996
Faculty Senate, 1994-1996

College Committees:

Self-designed Major Committee, Fall 1996

Department Committees:

Finance Committee, 2005-Present
L. Floyd Clarke Fund Committee, 2001-2005
Physiology/Cell Curriculum Committee, 1998-Present
Wildlife Biologist Search Committee, Fall 1995
Salary Committee, June 1995
Wildlife Biology and Ecology Curriculum Committee, 1994-Present

STUDENT ADVISING/GRADUATE SUPERVISION

Undergraduate Students:

Spring	2006	18 undergraduate advisees
Fall	2005	25 undergraduate advisees
Spring	2005	25 undergraduate advisees
Fall	2004	26 undergraduate advisees
Spring	2004	24 undergraduate advisees
Fall	2003	24 undergraduate advisees
Spring	2003	17 undergraduate advisees
Fall	2002	16 undergraduate advisees
Spring	2002	15 undergraduate advisees
Fall	2001	14 undergraduate advisees
Spring	2001	14 undergraduate advisees
Fall	2000	14 undergraduate advisees
Spring	2000	10 undergraduate advisees
Fall	1999	10 undergraduate advisees
Spring	1999	14 undergraduate advisees
Fall	1998	13 undergraduate advisees
Spring	1998	19 undergraduate advisees
Fall	1997	22 undergraduate advisees
Spring	1997	20 undergraduate advisees
Fall	1996	18 undergraduate advisees
Spring	1996	19 undergraduate advisees
Fall	1995	26 undergraduate advisees
Summer	1995	23 undergraduate advisees
Spring	1995	18 undergraduate advisees

Fall	1994	25 undergraduate advisees
Spring	1994	9 undergraduate advisees

Graduate Students:

Previous graduate committee memberships:
21 MS/MA (4 at Humboldt State University)
18 PhD

Previous external examiner for graduate theses:
1 PhD (McMaster University, Canada)
1 PhD (University of Waterloo, Canada)

Graduate degrees completed under my supervision:
David Camras - MS, 1995 (Wastewater Utilization, Humboldt State University)
Rolf Frankenbach - MS, 1996 (Wastewater Utilization, Humboldt State University)
Jeanine Elderkin - MS, 1997 (Zoology & Physiology, University of Wyoming; co-chair with Dr. Carlos Martinez del Rio)
Diana Sheridan - MS, 1997 (Zoology & Physiology, University of Wyoming; co-chair with Dr. Patricia Colberg)
Michael Suedkamp - MS, 1998 (Zoology & Physiology, University of Wyoming)
Hilary Lease - MS, 2000 (Zoology & Physiology, University of Wyoming; co-chair with Dr. Harold Bergman)
Scott Collyard - MS, 2002 (Zoology & Physiology, University of Wyoming)
Marjorie Brooks Lovvorn - PhD, 2003 (Zoology & Physiology, University of Wyoming)
Melanie Forbes - MS, 2003 (Zoology & Physiology, University of Wyoming)
Jason Kolts - MS, 2004 (Zoology & Physiology, University of Wyoming)
Jeffrey Morris - PhD, 2005 (Zoology & Physiology, University of Wyoming)
Laurie Johnson - MS, 2007 (Zoology & Physiology, University of Wyoming)

OTHER ACTIVITIES/ACCOMPLISHMENTS

Non-UW Students Mentored:

1994	Stoakley Lloyd, Summer Minority High School Student Research Apprenticeship Program (MHSSRAP) (co-mentored with Patricia Colberg).

University Service:

2004-2005	Member, Search Committee for Roy L. and Caryl L. Cline Distinguished Chair in Engineering, Environment, and Natural Resources (College of Engineering)
2004	Coordinator for distribution and collection of United Way pledge forms in the Department of Zoology and Physiology
2003-Present	Advisor to University of Wyoming's International Programs regarding acceptability of courses at foreign universities as transfer credit for UW students studying abroad
1996	Presentation about Department of Zoology and Physiology to visiting minority high school students for Arts and Sciences College. 29 October.

Reviewer DEPSCoR Program Proposals (2004 – 1)
Abandoned Coal Mine Land Research Program Proposals (1995 - 1, 1997 - 1, 2000 - 1)
EPSCoR Undergraduate Summer Research Fellowship Proposals (1996 - 10, 1998 - 9)
Western Region's Water Resources Research Competitive Grants Program Proposals (administered through Water Research Center) (1997 - 1, 1998 - 1)

Community Service:

2005-2006 Member of the non-partisan Board of Supervisors of the Laramie Rivers Conservation District.

1996 Volunteer phone answering for KUWR Radio Fall Membership Drive. 22 October.

1993 Member, Arcata Marsh Interpretive Center Displays Committee, City of Arcata, CA.

1992-1993 Member, Wetlands and Creeks Advisory Committee, City of Arcata, CA.

Federal Government Service:

2003-2004 Member, Search Committee for the Director of the U.S. Environmental Protection Agency's Mid-Continent Ecology Division, Duluth, MN (part of the National Health and Ecological Effects Research Laboratory).

International Service:

1997 Advisor on water pollution problems to Anhui Environmental Protection Bureau, Anhui Province, People's Republic of China; this included a trip to Anhui Province to confer with AEPB staff and visit field sites in May 1997.

Consulting Activities:

2002-2006 Member, Boron Ecotoxicology Advisory Group, Rio Tinto Borax, Valencia, CA.

2002-2006 Consultant to Rio Tinto Borax, Valencia, CA:
- Provided advice and oversight for a rainbow trout reproduction study in the altiplano of northwestern Argentina.

2001-2003 Consultant to the Office of Water, U.S. Environmental Protection Agency, Washington, DC:
- Assisted in writing draft document titled "2003 Update of Ambient Water Quality Criteria for Copper".
- Reviewed the completed draft document and related documents.

1997 Consultant to the Environmental Department, Anhui Province, Peoples' Republic of China:
- provided advice regarding water pollution problems (during visit to China in May 1997).

1994-2003 Consultant to the Science Advisory Board (SAB) of the U.S. Environmental Protection Agency (USEPA):
- Health and Ecological Effects Subcommittee (HEES) of the Advisory Council on Clean Air Compliance Analysis (ACCACA) (1998-2003).

- Advisory Council on Clean Air Compliance Analysis Physical Effects Review Subcommittee (ACCACAPERS, formerly CAACACPERS) (1994-1997).

1993 Scientific Advisor to Natural Resource Damage Assessment Trustees for Blackbird Mine, Idaho -- Research Review Meeting, Boulder, CO. December 13-14.

Expert Witness:

1995 Prepared a pre-trial expert narrative for a natural resource damage assessment case, in which federal and state trustees (National Oceanic and Atmospheric Administration, U.S. Department of Justice, U.S. Forest Service, and State of Idaho) sued Noranda Corporation for cleanup of an abandoned mine site in Idaho. This case was settled out of court before the trial began, with an overall projected value for cleanup and mitigation of about $60 million.

NOI EXHIBIT E: WRITTEN DIRECT TESTIMONY OF JOSEPH S. MEYER, PH.D.

TRIENNIAL REVIEW OF WATER QUALITY STANDARDS
NEW MEXICO WATER QUALITY CONTROL COMMISSION

EXPERT TESTIMONY OF JOSEPH S. MEYER, PH.D.

1. My name is Joseph S. Meyer. I live at 414 Anvil Way, Golden, Colorado 80401. Chino Mines Company has retained me as an expert on the toxicity of copper to fish and other aquatic organisms and on the derivation of site-specific aquatic life criteria for metals.
2. This testimony supports Chino's petition to the New Mexico Water Quality Control Commission (which I hereafter refer to as the "Commission"), to amend the regulations in Title 20, Chapter 6, Part 4 of the New Mexico Administrative Code (which I hereafter refer to as NMAC 20.6.4) The petition requests addition of site-specific aquatic life criteria for copper to NMAC 20.6.4 for certain surface waters located within the area known as the Chino Mines Smelter Tailings and Soil Investigation Unit (which I hereafter refer to as STSIU) near the towns of Bayard and Hurley in Grants County, New Mexico. See attached STSIU Surface Waters Map, attached hereto as Exhibit A.
3. In addition to using my professional experience and expertise when forming the opinions expressed below, I reviewed the cited documents.

PROFESSIONAL BACKGROUND AND QUALIFICATIONS

4. I am currently employed as a Technical Expert with ARCADIS U.S., Inc. I have worked on issues related to water quality for the past 38 years, including 17 years teaching and conducting research at the university level. That work has mainly focused on processes involved in the movement, interactions, and effects of chemicals, including copper, in aquatic systems. Based on my research and publications (see below), I am internationally known as an expert on the effects of metals to aquatic organisms, including fish and invertebrates.

5. I hold a Ph.D. in Zoology from the University of Wyoming (1986) and a B.S. in Chemical Engineering from Lehigh University (1973). I was a NATO Postdoctoral Research Fellow at the Swiss Federal Institute for Water Resources and Water Pollution Control

(EAWAG/ETH) from 1987 to 1988, followed by additional research at the same institute under Swiss funding from 1988 to 1989. From 1989 to 1990, I was a postdoctoral researcher with the University of Wyoming-National Park Service Research Center. During those years as an undergraduate and graduate student, I completed substantial coursework in biology, ecology, aquatic toxicology, chemistry, and the geochemistry of natural surface waters.

6. From 1990 through 1993, I was a Lecturer in the Fisheries Department at Humboldt State University (California), where I taught undergraduate-level courses in fish biology, freshwater fish ecology, limnology (the study of lakes, streams and wetlands), aquatic toxicology (the study of the effects of chemicals on aquatic organisms), and wastewater-treatment wetlands. I also supervised graduate students who investigated the fate of metals and nitrogen in the City of Arcata's wastewater treatment wetlands; and I oversaw state-mandated toxicity testing of the effluent from the City of Arcata's wastewater treatment system, which discharges into Humboldt Bay.

7. From 1994 through 2007, I was successively an Assistant Professor, Associate Professor, and Professor of Zoology at the University of Wyoming, where I taught undergraduate-level courses in general biology, general ecology, population biology, introduction to environment and natural resources, and risk analysis. Additionally, I taught graduate-level courses in aquatic toxicology, advanced limnology, and groundwater remediation. I also supervised graduate students who investigated the fate and effects of chemical pollutants in aquatic systems (e.g., boron, cadmium, copper, lead, nickel, selenium, silver, zinc; aromatic hydrocarbons in wastewaters from synthetic fossil fuel processes; and saline surface waters). While at the University of Wyoming, I was Director of the University's Red Buttes Environmental Biology Laboratory (1999-2004), which among other duties included responsibility for (a) conducting state-mandated toxicity testing and biomonitoring of the treated effluent discharged from the laboratory, (b) filing quarterly reports required for compliance with the laboratory's National Pollutant Discharge Elimination System (which I hereafter refer to as NPDES) permit, and (c) negotiating with the State of Wyoming for renewal of the NPDES permit for the laboratory.

8. Since 2007, I have been employed by ARCADIS U.S., Inc., where I consult on a wide variety of projects related to the processes involved in the movement, interactions, and effects of chemicals, including copper, in aquatic systems. Currently, I am the leader of the Surface Water Quality and Watershed Sciences group in ARCADIS's Environment Division.

9. I have lead-authored or co-authored 59 peer-reviewed articles in scientific journals, 1 peer-reviewed monograph, 12 book chapters, and 198 presentations at scientific meetings. I was lead editor of a peer-reviewed book titled "Toxicity of Dietborne Metals to Aquatic Organisms" (Meyer et al. 2005) and was lead author of a peer-reviewed book titled "Effects of Water Chemistry on Bioavailability and Toxicity of Waterborne Cadmium, Copper, Nickel, Lead, and Zinc to Freshwater Organisms" (Meyer et al. 2007). Additionally, I have participated in six SETAC-Pellston workshops on topics related to hazard assessment of effluents, bioavailability of chemicals, aquatic life criteria for metals, water quality criteria development, dietborne metal toxicity, and tissue-residue approaches to understanding the exposure to and effects of chemicals on aquatic organisms.

10. Thirty-two of the 59 peer-reviewed journal articles and both of the peer-reviewed books I lead-authored or lead-edited are related to the processes involved in the movement, interactions, or toxicity of copper in aquatic systems, with special emphasis on the way in which water chemistry parameters like pH, alkalinity, hardness, and dissolved organic carbon (DOC) concentration alter the toxicity of copper and other metals to aquatic organisms, including fish.

11. I was lead author or co-author of several of the peer-reviewed journal articles that led to the development of the Biotic Ligand Model (which I hereafter refer to as the BLM) as a regulatory tool for metals in aquatic systems (e.g., Meyer 1999, Meyer et al. 1999, Di Toro et al. 2001, Santore et al. 2001). The BLM explicitly accounts for the ways in which pH, alkalinity, hardness, and DOC modify the toxicity of metals like copper to fish and other aquatic organisms. In 2007, the U.S. Environmental Protection Agency (which I hereafter refer to as the USEPA) incorporated the BLM into its revision of the national freshwater

aquatic life criteria for copper, and I helped write the initial draft of that criteria document in 2003.

12. Therefore, I am well-qualified to discuss the importance of water chemistry on the bioavailability, or toxicity potential, of copper to fish and other aquatic organisms. I am also well-qualified to discuss the development and application of site-specific criteria that are scientifically valid and protective of aquatic life.

13. Of special bearing to Chino's petition to amend NMAC 20.6.4, I am co-author with Mr. Barry Fulton of the 2013 Revised Site-Specific Copper Toxicity Model Report for Smelter Tailings Soils IU Drainages – Chino Administrative Order on Consent, attached hereto as Exhibit B, and of a peer-reviewed paper titled "Development of a Regression Model to Predict Copper Toxicity to *Daphnia magna* and Site-Specific Copper Criteria across Multiple Surface-Water Drainages in an Arid Landscape", which was published in August 2014 in the scientific journal *Environmental Toxicology and Chemistry* (Fulton and Meyer 2014), attached hereto as Exhibit C. These documents reports the results of the study that forms the basis for the site-specific aquatic life criteria for copper that Chino has petitioned the Commission to adopt for certain waters in the Chino Mines STSIU.

14. My curriculum vitae is attached hereto as Exhibit D.

ASSESSMENT AND OPINIONS

15. I have been asked to offer scientific opinions about the site-specific aquatic life criteria for copper that have been proposed for certain waters in the Chino Mines STSIU. To derive the equation that is used to calculate those site-specific criteria, a series of copper toxicity tests was conducted in STSIU waters to provide data from which a statistical model to predict copper toxicity was developed. That statistical model is used to calculate the acute and chronic criteria for copper in STSIU waters, based on two important water chemistry parameters: alkalinity concentration and DOC concentration.

16. My opinion is that the proposed site-specific aquatic life criteria for copper are scientifically valid and will be protective of aquatic life in the specified waters in the Chino Mines STSIU. I base my opinions on the following reasons:

Reason #1: Water chemistry determines the bioavailability, or toxicity potential, of copper to aquatic organisms. Therefore, depending on water chemistries in distinct waters, the potential for copper to be toxic varies among waters that have different water chemistries. This is because the toxicity of copper decreases as concentrations of protective chemical parameters such as hardness, alkalinity, and DOC increase in the water.

Reason #2: Because the toxicity of copper differs when chemical composition differs among water bodies, it is scientifically valid to establish different aquatic life criteria for copper when the chemical compositions of receiving water bodies differ, particularly if such criteria remain protective of aquatic life. Stated simply, one size does not fit all, and default criteria thus can be overly-protective. For this reason, the USEPA and the NMAC allow for establishment of site-specific aquatic life criteria for different water bodies.

Reason #3: The current surface-water standards in the NMAC allow for adjustment of the aquatic life criteria for copper based on the hardness of the receiving water. However, water hardness is not the only water chemistry parameter that protects against copper toxicity.

Reason #4: Because the default aquatic life criteria for copper in New Mexico do not explicitly take into account all of the water chemistry parameters that can protect aquatic organisms against copper toxicity, more accurate criteria for copper can be developed by including other protective water chemistry parameters in the calculation of the criteria, namely alkalinity and DOC.

Reason #5: The site-specific aquatic life criteria for copper that have been proposed for certain waters in the Chino Mines STSIU are based on a scientifically-valid statistical regression equation. That statistical regression equation is scientifically valid because it was derived from results of copper toxicity tests that were conducted pursuant to the USEPA approved Water-Effect Ratio procedure in STSIU waters, which contain a wide range of water chemistries. These scientifically-valid copper toxicity tests were conducted using the USEPA Water-Effect Ratio procedure, which is a USEPA-approved method for establishing site-specific aquatic life criteria. The USEPA Water-Effect Ratio procedure is also an acceptable method for establishing site-specific aquatic life criteria in New Mexico (20.6.4.10.D.4 NMAC).

Reason #6: Because USEPA-specified methods were used to conduct the toxicity tests and calculate scientifically-valid adjustments to the hardness-based aquatic life criteria for copper in the Chino Mines STSIU waters, the proposed criteria provide the level of protection against copper toxicity that is intended by both the USEPA and, by reference, the NMAC. In fact, in STSIU water chemistries that contain low concentrations of protective chemical parameters, the proposed site-specific aquatic life criteria for copper are more stringent (i.e., even lower and thus more protective) than the corresponding hardness-based criteria.

Reason #7: The petition has been amended to state that the proposed site-specific copper criteria will not apply to water bodies that have been designated as habitat for the Chiricahua Leopard Frog. Therefore, potential concerns about whether the proposed site-specific criteria will protect this threatened species against copper toxicity are not relevant to consideration of the petition.

In the following paragraphs, I explain these reasons in more detail.

17. **Reason #1: Water chemistry determines the bioavailability, or toxicity potential, of copper to aquatic organisms. Therefore, depending on water chemistries in distinct**

waters, the potential for copper to be toxic varies among waters that have different water chemistries. This is because the toxicity of copper decreases as concentrations of protective chemical parameters such as hardness, alkalinity, and DOC increase in the water

18. It is well-established in scientific literature that the toxicity of copper to fish, invertebrates, and other aquatic organisms differs in waters that have different chemistries. For example, I summarized results of numerous studies that support that fact in a peer-reviewed book titled "*Effects of Water Chemistry on Bioavailability and Toxicity of Waterborne Cadmium, Copper, Nickel, Lead, and Zinc to Freshwater Organisms*" (Meyer et al. 2007).
19. Additionally, the USEPA's current aquatic life criteria document for copper (USEPA 2007) specifically states that chemical parameters such as pH, alkalinity, water hardness, and DOC can modify the toxicity of copper to aquatic organisms.
20. The pH of the water is a measure of its acidity (technically, it is a measure of the concentration of hydrogen ions in the water). The alkalinity of the water is a measure of its capacity to neutralize acidity (technically, it is a measure of the concentrations of the bicarbonate and carbonate ions in the water). The hardness is a measure of the concentrations of calcium and magnesium ions in the water. The DOC is a measure of the amount of natural organic chemicals that leach into the water from soil and organic matter (e.g., vegetation); and it is composed of, among other chemicals, humic and fulvic acids. Those acids are obvious as the tea-stained color in the water in ponds, bogs, ditches, ponds, etc., but they can be present in water at relevant concentrations even if the tea-stain color isn't visible.
21. The three water chemistry parameters that I emphasize in this testimony are hardness, alkalinity, and DOC concentration. They affect copper toxicity in two different ways.
22. In the first way that water chemistry parameters protect against copper toxicity, alkalinity ions and DOC can bind chemically with copper and thereby create chemical forms of copper that are less toxic to aquatic organisms because they are not available for the organism to uptake. This is an important distinction, because for a form of copper to be bioavailable (and thus be potentially toxic), it must be taken-up by an organism (Meyer et al. 2007). The copper bound to alkalinity ions and DOC is less toxic because the free, unbound copper ion (represented in chemical shorthand as Cu^{2+}) is the most available and most toxic form of

copper (USEPA 2007). As a consequence, as the alkalinity or DOC concentration increases in a given water, the toxicity of copper in that water decreases. Thereby, alkalinity concentration and DOC concentration protect against copper toxicity.

23. In the second way that water chemistry parameters protect against copper toxicity, the water hardness ions (represented in chemical shorthand as Ca^{2+} and Mg^{2+}) compete with copper ions for binding to aquatic organisms. If copper can't bind to an organism, it doesn't cause toxicity. As a consequence, as the hardness increases in a given water, less copper binds to the organisms; and thus, the toxicity of copper in that water decreases. Thereby, water hardness protects against copper toxicity.
24. Therefore, water chemistry determines the toxicity and availability of copper to aquatic organisms. When a range of water bodies that contain a range of chemical composition is considered, no one concentration of copper can be designated as the threshold for toxicity in all those water bodies. Instead, the threshold for copper toxicity will vary among those water bodies. This is the situation in the waters in the Chino Mines STSIU.
25. **Reason #2: Because the toxicity of copper differs when chemical composition differs among water bodies, it is scientifically valid to establish different aquatic life criteria for copper when the chemical compositions of receiving water bodies differ, particularly if such criteria remain protective of aquatic life. Stated simply, one size does not fit all, and default criteria thus can be overly-protective. For this reason, the USEPA and the NMAC allow for establishment of site-specific aquatic life criteria for different water bodies.**
26. The USEPA's current aquatic life criteria document and calculation procedure for copper in fresh water (USEPA 2007) allow for a sliding scale of national criteria for copper, depending on the chemical composition of the water body. The criteria are calculated by a computer program (the BLM), which uses site-specific input data about the chemical composition of a given water, including the hardness, alkalinity, and DOC concentration. As the hardness, alkalinity, or DOC concentration increases, the USEPA's national criteria concentration for copper increases.
27. The USEPA also allows site-specific aquatic life criteria for copper to be calculated using a water-effects ratio (which I hereafter refer to as WER) procedure. Briefly, in the WER procedure, the toxicity of copper is tested side-by-side in laboratory water and in water

collected from the site of interest. The laboratory water used in the WER procedure represents the types of water in which New Mexico's default aquatic life criteria for copper (i.e., the current acute and chronic aquatic life criteria for copper in 20.6.4.900.I NMAC, which are based only on the hardness concentration of the water) were derived in 1995 by the U.S. Environmental Protection Agency. If copper is less toxic in a water sample collected from the site of interest than it is in the laboratory water, the New Mexico criteria for copper are overly conservative (i.e., lower than necessary) and thus can validly be increased; and vice versa. The scientific basis for the WER method is described in the USEPA (1994) WER guidance document. As described in that document, when conducting a WER test, "if there is a difference in toxicity and it is not taken into account, the aquatic life criterion for the body of water will be more or less protective than intended by EPA's Guidelines for Deriving Numerical Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" (see first paragraph on page xi in USEPA 1994).

28. In New Mexico, 20.6.4.10.D.4 NMAC allows for site-specific aquatic life criteria for copper. That section of the administrative code specifies several ways by which site-specific criteria can be derived, including three that I mention in this testimony: (a) the USEPA (1994) WER procedure for metals; (b) the USEPA (2001) streamlined WER procedure for discharges of copper; and (c) the USEPA (2007) BLM. As described in the USEPA WER Guidance, "A site-specific criterion is intended to come closer to providing the intended level of protection to the aquatic life at the site, usually by taking into account the biological and/or chemical conditions (i.e., the species composition and/or water quality characteristics)" (see last paragraph on page 1 in USEPA 1994).
29. Both the BLM and the WER are scientifically valid procedures to derive site-specific criteria for copper.
30. The BLM explicitly accounts for the ways in which the chemical composition of a given water modifies copper toxicity. That is, the effect of each water chemistry parameter on copper toxicity can be determined by varying the value inputted into the BLM computer program and then evaluating the resulting change in toxicity. The BLM can also be used to calculate how the copper criteria would change when the chemistry of the water changes. The scientific basis for the BLM has been well-established in numerous peer-reviewed articles that have been published in scientific journals for more than a decade. For example,

two of the early publications (one of which I co-authored) that established the scientific legitimacy of the BLM are Di Toro et al. (2001) and Paquin et al. (2003). Additional publications demonstrating the scientific validity of BLM-type models are summarized in the peer-reviewed book about metal toxicity on which I was the lead author (Meyer et al. 2007).

31. The BLM provides a mechanistic underpinning for the equation that has been proposed for calculation of the site-specific aquatic life criteria for copper in the specified Chino Mines STSIU waters. However, that proposed equation was derived from results of WER toxicity tests conducted in STSIU waters, thus making it more specific to the chemical compositions of the STSIU waters than is the more general copper BLM.
32. In contrast to the BLM, the WER procedure implicitly accounts for the ways in which the chemical composition of a given water modifies copper toxicity. That is, the WER procedure does not explicitly identify which chemical(s) in the water are protecting against copper toxicity; instead, it only indicates whether a protective effect is or is not present. Instead, in accordance with the USEPA WER guidance (USEPA 1994, 2011), only the results of the WER testing are needed to derive the equation that has been proposed for calculation of site-specific aquatic life criteria for copper in the specified Chino Mines STSIU waters.
33. **Reason #3: The current surface-water standards in the NMAC allow for adjustment of the aquatic life criteria for copper based on the hardness of the receiving water. However, water hardness is not the only water chemistry parameter that protects against copper toxicity.**
34. The current acute and chronic aquatic life criteria for copper in 20.6.4.900.I NMAC are, in fact, site-specific criteria, because the criteria concentrations differ in waters containing different hardness. However, those hardness-based aquatic life criteria are not generally referred to as site-specific criteria. Instead, they are default criteria that are applicable statewide (but still dependent on the hardness of the given water instead of being a single number for all surface waters in New Mexico). In general usage, the term "site-specific" is reserved for criteria that are derived using the other procedures listed in 20.6.4.10.D.4 NMAC, such as the WER and BLM procedures.
35. Although the default aquatic life criteria in New Mexico are derived using only the hardness of the water in question, other chemicals in natural waters can also protect against copper toxicity. In fact, in the WER tests for surface waters in the Chino Mines STSIU, copper

toxicity was not well-correlated with hardness (i.e., hardness was a poor predictor of copper toxicity). Instead, the toxicity of copper varied by 12-fold within a narrow range of water hardness (see Section 3.2.1 in ARCADIS 2013, and page 1869 in Fulton and Meyer 2014). Alkalinity concentration and DOC concentration were much better predictors of copper toxicity in the STSIU waters. Specifically, water hardness only predicts 10 percent of the variation in copper toxicity among the various STSIU waters that were tested, whereas the combination of alkalinity concentration and DOC concentration used in the proposed WER equation predicts 85 percent of the variation in copper toxicity among the various STSIU waters that were tested (see Sections 3.2.1 and 3.2.4 in ARCADIS 2013, and Tables 2 and 3 in Fulton and Meyer 2014). In my experience, 85 percent predictability by any model is quite high for aquatic toxicity tests conducted in natural waters collected from the field, and it is even high predictability for aquatic toxicity tests conducted in laboratory waters.

36. **Reason #4: Because the default aquatic life criteria for copper in New Mexico do not explicitly take into account all of the water chemistry parameters that can protect aquatic organisms against copper toxicity, more accurate criteria for copper can be developed by including other protective water chemistry parameters in the calculation of the criteria, namely alkalinity and DOC.**

37. As stated in #26-#28 above, the USEPA has explicitly acknowledged this in two major ways by allowing for establishment of aquatic life criteria for copper based on other water chemistry parameters over the years. In turn, the NMAC explicitly allows development of site-specific criteria for copper based on USEPA guidance that differ from the default hardness-based criteria.

38. The New Mexico- and USEPA-approved procedures for deriving WER-based site-specific aquatic life criteria were followed in development of the equation that has been proposed for calculation of site-specific aquatic life criteria for copper in the specified Chino Mines STSIU waters.

39. **Reason #5: The site-specific aquatic life criteria for copper that have been proposed for certain waters in the Chino Mines STSIU are based on a scientifically-valid statistical regression equation. That statistical regression equation is scientifically valid because it was derived from results of copper toxicity tests that were conducted pursuant to the**

USEPA approved Water-Effect Ratio procedure in STSIU waters, which contain a wide range of water chemistries. These scientifically-valid copper toxicity tests were conducted using the USEPA Water-Effect Ratio procedure, which is a USEPA-approved method for establishing site-specific aquatic life criteria. The USEPA Water-Effect Ratio procedure is also an acceptable method for establishing site-specific aquatic life criteria in New Mexico (20.6.4.10.D.4 NMAC).

40. The basis for the proposed site-specific aquatic life criteria for copper is a series of WER toxicity tests conducted with copper added to laboratory water and to waters collected from various drainages in the Chino Mines STSIU during different times of the year. This range of water samples collected across locations in the STSIU and across time was intended to capture the range of chemical conditions that might modify the toxicity of copper to aquatic organisms.
41. Water chemistry varies across the Chino Mines STSIU because of localized differences in soils, geology (i.e., rock types), geomorphology (i.e., physical forms of geologic features, such as hills, valleys, slopes), hydrology (i.e., magnitude, frequency, and duration of water flow), and surrounding upland landscapes (i.e., types and amounts of vegetation) (see page 1866 in Fulton and Meyer 2014). In general, the water chemistry changes along the elevation gradients from the higher, mountainous portions of the STSIU down to the lower, valley-and-basin portions of the STSIU.
42. All of the WER toxicity tests were conducted according to USEPA (1994, 2001) guidance, as specified in 20.6.4.10.D.4 NMAC. This included using a standard aquatic toxicity-testing organism (the invertebrate *Daphnia magna*) that is recommended by USEPA (1994, 2001) for this type of WER test.
43. From the results of those WER toxicity tests, WER values were calculated for each water sample. A WER is the ratio of the concentration of copper that causes 50% mortality in the site water divided by the concentration of copper that causes 50% mortality in laboratory water containing the same or very similar hardness as the site water.
44. Therefore, the WER is the factor by which the default hardness-based aquatic life criteria for copper can be multiplied to derive site-specific criteria for a given water.
45. Typically, a WER is applied to one water body, usually downstream of a point source discharge of one or more chemicals. However, the Chino Mines STSIU covers approximately

60 square kilometers (i.e., approximately 23 square miles) and contains more than 100 miles of stream bed in 12 different drainages, the majority of which, are dry sandy arroyos/washes. Point-source discharges of copper do not occur in the STSIU surface waters. Instead, diffuse copper is present from historical emissions from mining smelting and from natural mineralized soil in some portions of the Chino Mines STSIU. Consequently, an approach was needed that would allow calculation of aquatic life criteria for copper not only in the STSIU waters that were tested during the WER-toxicity study, but also for any other STSIU water for which adequate water chemistry was available or could become available in the future.

46. To address that need, ARCADIS (2013; see Section 3.2.4) and Fulton and Meyer (2014; see pages 1869-1870) used the WER values calculated from the results of the WER-toxicity tests to derive an equation to predict the concentration of copper that would cause 50% mortality in any surface-water chemistry that might be found in the Chino Mines STSIU waters. Hereafter I refer to that concentration as the EC50 value for copper.

47. The resulting equation for predicting the copper EC50 values in STSIU waters is the result of a statistical regression of the EC50 values measured in the WER toxicity tests compared to the concentrations of various chemical parameters in the waters collected from the Chino Mines STSIU. That equation was derived using a well-accepted, scientifically-valid statistical regression method that is described in detail in ARCADIS (2013; see Sections 2.2 and 3.2.4) and Fulton and Meyer (2014; see pages 1867 and 1869-1870).

48. The combination of water chemistry parameters that best predicted the measured EC50s in the tested waters was chosen to predict the toxicity of copper in all STSIU waters. That choice is scientifically valid, because the ranges of water chemistry parameters in the tested STSIU waters are representative of water chemistries known to occur in the STSIU drainages. Water chemistry determines the toxicity of copper to aquatic organisms, as discussed in #18-#24 above. Therefore, because the predictive model was calibrated across the wide ranges of water chemistry parameters that occur in the STSIU, it is applicable to all waters in the STSIU.

49. The best predictor of copper toxicity in the Chino Mines STSIU waters was a combination of alkalinity concentration and DOC concentration. The resulting regression equation is:

$$\text{EC50 of copper} = 10^{0.588 + (0.703 \times \log \text{DOC}) + (0.395 \times \log \text{Alkalinity})}$$

where the EC50 is expressed in units of micrograms of copper per liter (□g Cu/L), the DOC concentration is expressed in units of milligrams of carbon per liter (mg C/L), and alkalinity is expressed in units of milligrams per liter (mg/L) as calcium carbonate. All of these units are standard ways of expressing the concentrations of metals, DOC, and alkalinity in water. This combination of alkalinity concentration and DOC concentration accounts for 85 percent of the variation in the toxicity of copper to *Daphnia magna* in the tested STSIU waters. Stated alternatively, 85 percent of the differences in toxicity of copper in the STSIU waters were accounted for by the different combinations of alkalinity concentration and DOC concentration in those waters. This is excellent predictability, given the wide variety of factors that can affect the toxicity of metals in natural waters (e.g., see Sprague 1985 for a discussion of variability of toxicity of chemicals to aquatic organisms). For comparison, only 10 percent of the differences in toxicity of copper in the STSIU waters were accounted for by water hardness, which is the parameter used to calculate the default aquatic life criteria for copper in New Mexico.

50. The equation shown in #49 above is part of the numerator of the proposed equation for calculating the WER in the specified waters in the STSIU, as shown on page 2 of the petition that requests site-specific aquatic life criteria for copper in certain Chino Mines STSIU waters (Chino 2014). The remaining terms in the numerator of the WER equation in the petition simply normalize the predicted copper toxicity to a common water hardness of 100 mg/L as calcium carbonate, for comparison to the EC50 value that would be predicted based only on the hardness of the STSIU water (i.e., the 19.31 in the denominator of the proposed WER equation). This hardness-normalization step is based on USEPA WER guidance (i.e., USEPA 1994, 2001). The "19.31" term in the denominator of the proposed WER equation comes from the USEPA WER guidance (USEPA 2001), and represents the average EC50 value for the tested species (*D. magna*) at a hardness of 100 mg/L based on 55 acceptable toxicity test results.
51. To calculate the proposed site-specific acute and chronic aquatic life criteria for any specified water in the Chino Mines STSIU, the WER value, calculated using the proposed WER

equation, is multiplied by the default acute or chronic hardness-based criterion (as determined using the hardness-based equations for copper in 20.6.4.900.I NMAC).

52. The use of a statistical-regression equation to calculate site-specific criteria for copper is exactly analogous to the way in which a statistical-regression equation is used to calculate the current hardness-based criteria for copper, except hardness is replaced by alkalinity concentration and DOC concentration as the determinants of the proposed site-specific criteria. Use of the proposed regression equation to calculate site-specific criteria for copper is also exactly analogous to the way in which a statistical regression equation is used to calculate the current chronic aquatic life criteria for ammonia, except temperature and pH are replaced by alkalinity concentration and DOC concentration as the determinants of the proposed site-specific criteria.
53. As stated by USEPA (1994, 2001), this WER procedure for deriving site-specific aquatic life criteria provides a scientifically-valid way to account for the toxicity-modifying effects of non-hardness chemicals (e.g., alkalinity and DOC) in any water, beyond the toxicity-modifying effects of water hardness that are already accounted for in the current hardness-based aquatic life criteria specified in 20.6.4.900.I NMAC.
54. As stated by USEPA (1994, 2001), a WER derived using the USEPA-prescribed procedures is valid for use in site-specific adjustment of both acute and chronic aquatic life criteria for copper.
55. And because the USEPA-approved procedures are scientifically valid and were used to conduct the WER-toxicity tests and to derive the WER values on which the proposed statistical-regression equation is based, the method to derive site-specific aquatic life criteria for copper that has been proposed for use with certain waters in the Chino Mines STSIU is scientifically valid.
56. Moreover, the USEPA-approved BLM for copper (USEPA 2007) provides a scientific underpinning for the alkalinity- and DOC-based statistical-regression equation that has been proposed for deriving site-specific aquatic life criteria for copper in certain STSIU waters. However, for the STSIU waters, the WER-based site-specific adjustments to the default hardness-based criteria are more reliable than the USEPA-recommended, BLM-based site-specific national criteria for copper, because the WER-based site-specific criteria are a result of WER-toxicity tests conducted in actual STSIU waters. Therefore, potential differences are

accounted for in, for example, the type of DOC in the STSIU waters compared to the more general type of DOC from wetter climates that was used to calibrate the USEPA-approved BLM for copper.

57. It is especially important to recognize that water hardness was not identified as a statistically significant predictor of copper toxicity to aquatic life in the Chino Mines STSIU waters, even though the default aquatic life criteria for copper in 20.6.4.900.I NMAC are based only on water hardness. This is not uncommon in natural waters, because alkalinity and/or DOC provide much stronger protection against copper toxicity than does water hardness. This is discussed in more detail in ARCADIS (2013; see Section 3.2.1) and Fulton and Meyer (2014; see pages 1869-1870), with reference to other studies in peer-reviewed scientific journals that reach similar conclusions. Therefore, the alkalinity- and DOC-based statistical-regression equation that has been proposed for deriving site-specific aquatic life criteria for copper in certain STSIU waters is supported by results of independent scientific studies. However, the actual equation derived for STSIU waters should not be applied to non-STSIU waters without confirmatory tests in those non-STSIU waters.
58. It is also important to recognize that pH was not identified as a statistically significant predictor of copper toxicity to aquatic life in the Chino Mines STSIU waters, even though pH is a chemical input for BLM predictions of copper toxicity and has been identified as a significant predictor of copper toxicity in some other waters (e.g., see the discussion on page 1870 in Fulton and Meyer 2014). More details about the results of the statistical analysis that led to this conclusion are provided in ARCADIS (2013; see Section 3.2.3) and Fulton and Meyer (2014; see pages 1869-1870).
59. **Reason #6: Because USEPA-specified methods were used to conduct the toxicity tests and calculate scientifically-valid adjustments to the hardness-based aquatic life criteria for copper in the Chino Mines STSIU waters, the proposed criteria provide the level of protection against copper toxicity that is intended by both the USEPA and, by reference, the NMAC. In fact, in STSIU water chemistries that contain low concentrations of protective chemical parameters, the proposed site-specific aquatic life criteria for copper are more stringent (i.e., even lower and thus more protective) than the corresponding hardness-based criteria.**

60. By definition, the USEPA's national aquatic life criteria for all chemical pollutants are intended to protect at least 95 percent of the species in a water body (Stephan et al. 1985). And because the default New Mexico aquatic life criteria for copper originate from a previous version of USEPA's national aquatic life criteria for copper (USEPA 1995), the aquatic life criteria for copper in 20.6.4.900.I NMAC are intended to protect at least 95% of the species in a water body.
61. In their guidance for deriving WER-based site-specific aquatic life criteria, USEPA (1994) specifically stated that when USEPA-recommended methods are used to conduct WER studies and then calculate the associated WER values, the resulting WER-based site-specific criteria for chemical pollutants will provide the same intended level of protection as the default national criteria. By reference through inclusion in 20.6.4.10.D.4 NMAC of the USEPA-recommended methods for deriving site-specific aquatic life criteria using the WER procedure (USEPA 1994, 2001), New Mexico also intends that WER-based site-specific criteria will provide the same intended level of protection as the default hardness-based criteria.
62. In fact, the proposed site-specific aquatic life criteria for copper can be even more stringent (i.e., lower and thus more protective) than the corresponding hardness-based criteria when applied to surface waters containing low DOC and/or alkalinity concentrations. As described in the petition, the proposed equation does not recommend a lower limit for DOC or alkalinity concentrations for an STSIU surface-water sample, thus allowing for low copper criteria when applicable. The following two examples illustrate this point.
    a. When the proposed WER equation is applied to a hardness concentration of 100 mg/L, an alkalinity concentration of 75 mg/L, and a DOC concentration of 0.5 mg/L, a WER value of 0.678 is calculated, which results in a site-specific acute criterion for dissolved copper of 9.1 micrograms per liter (µg/L). For comparison, the default hardness-based acute criterion for dissolved copper at 100 mg/L hardness is 13.3 µg/L.
    b. When the proposed WER equation is applied to a hardness concentration of 100 mg/L, an alkalinity concentration of 25 mg/L, and a DOC concentration of 1 mg/L, a WER value of 0.678 is calculated, which results in a site-specific acute criterion for dissolved copper of 9.6 µg/L, which again is lower (i.e., more restrictive) than the default 13.3 µg/L hardness-based acute criterion for dissolved copper at 100 mg/L hardness.

63. Reason #7: The petition has been amended to state that the proposed site-specific copper criteria will not apply to water bodies that have been designated as habitat for the Chiricahua Leopard Frog. Therefore, potential concerns about whether the proposed site-specific criteria will protect this threatened species against copper toxicity are not relevant to consideration of the petition.

64. The Chiricahua Leopard Frog currently is listed as a threatened species by the U.S. Fish and Wildlife Service, and some waters (Ash and Bolton Springs) in the Chino Mines STSIU are designated habitat for that species. No other aquatic species in the STSIU is listed as threatened, endangered, or otherwise of special concern.

65. ARCADIS (2013; see Appendix 5) applied the proposed regression equation to measured water chemistries reported in the only known study of copper toxicity to the Chiricahua Leopard Frog (Little and Calfee, 2008), and demonstrated that the resulting site-specific aquatic life criteria for copper would be protective of the most sensitive endpoint reported in that study. However, to provide a more-streamlined process and to minimize the amount of interagency interactions that would be required to fully address potential concerns about threatened-and-endangered species, this petition is not proposing to apply the site-specific copper criteria to the designated Chiricahua Leopard Frog habitat.

SUMMARY

66. 20.6.4.10.D.4 NMAC allows for the derivation of site-specific aquatic life criteria for copper.

67. The proposed site-specific aquatic life criteria for copper are scientifically valid and will provide the intended level of protection to aquatic life in the specified waters in the Chino Mines STSIU.

68. The proposed site-specific criteria for copper have been derived from results of scientifically-valid WER toxicity tests that were conducted according to USEPA (1994, 2001) guidance, which by reference are also approved in 20.6.4.10.D.4 NMAC. As suggested by the Surface Water Quality Branch of the New Mexico Environment Department, the methods and results of that study were published in a peer-reviewed article in scientific journal (Fulton and Meyer 2014), thus further supporting the

scientific validity and acceptability of the WER tests and the proposed regression-based site-specific copper criteria.

69. The statistical-regression-based equation that has been proposed for the calculation of site-specific criteria for copper in the specified waters in the Chino Mines STSIU was derived using a scientifically-valid statistical analysis.

70. The proposed WER-based site-specific criteria for copper have a scientifically-valid unperpinning in a vast body of peer-reviewed scientific publications that demonstrate the protectiveness of some water chemistry parameters (e.g., hardness, alkalinity, and DOC concentration) against copper toxicity to aquatic organisms (e.g., see a review of that literature in Meyer et al. 2007).

71. The USEPA's recently-adopted revision to the national aquatic life criteria for copper (USEPA 2007), which is based on the copper BLM, also provides a mechanistic underpinning for the proposed WER-based site-specific criteria for copper, because the copper BLM explicitly incorporates toxicity-modifying water chemistry parameters such as hardness, alkalinity, and DOC concentration into its predictions of copper toxicity and into its calculations of aquatic life criteria for copper. In both the BLM-based and the proposed WER-based calculations, copper toxicity decreases and thus the aquatic life criteria increase as hardness, alkalinity, and DOC concentration increase.

72. Despite differing from the default hardness-based aquatic life criteria for copper in 20.6.4.900.I NMAC, the proposed site-specific aquatic life criteria for copper will provide the intended level of protection to aquatic life in the specified waters in the Chino Mines STSIU.

73. The petition for site-specific aquatic life criteria for copper in certain waters in the Chino Mines STSIU specifically excludes Chiricahua Leopard Frog habitat from the list of waters to which the site-specific criteria will apply; and no other threatened, endangered, or other species of special concern occur in the STSIU waters.

74. Therefore, the Commission will not violate any USEPA regulatory constraints and it will not contradict the current NMAC by adopting the site-specific aquatic life criteria for copper that have been proposed by Chino (2014) for certain waters in the Chino Mines STSIU. Moreover, exclusion of designated habitat for the Chiricahua Leopard

Frog from the list of waters to which the proposed site-specific criteria apply will obviate potential regulatory concerns about effects on that federally-listed threatened species.

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NOI EXHIBIT F, RESUME OF BARRY FULTON

CURRICULUM VITAE

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EDUCATION

2009 M.S. Environmental Science, Baylor University, Waco, TX
2005 B.A. Ecology, B.A. Environmental Studies, Brevard College, Brevard, NC

EMPLOYMENT

2009-Present Senior Environmental Scientist, ARCADIS U.S., Inc., Lakewood, Colorado
2006-2009 Research Scientist, Center for Reservoir and Aquatic Systems Research, Baylor University, Baylor, Texas
2005-2006 Biology Laboratory Instructor, Brevard College, Brevard, North Carolina

PUBLISHED WORKS

Peer-reviewed Journal Articles:

Fulton, B.A. and J.S. Meyer. 2014. Development of a regression model to predict copper toxicity to *Daphnia magna* and site-specific copper criteria across multiple surface-water drainages in an arid landscape. *Environmental Toxicology and Chemistry* 33:1865-1873.

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Jones, D, M Beauchemin, N Bonnevie, D Buys, L Fontenot, **B Fulton**, C Meyer, J Meyer, D Rigg, T Schlekat, AR Stojak, M Wacksman; S Young and N Carriker. 2012. Ecological risk assessment for Phase 3 of the TVA Kingston Ash Recovery Project; Roane County, TN. Presented at the Thirty-third Annual Meeting of the Society of Environmental Toxicology and Chemistry, Long Beach, CA, November 11-15.

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RESEARCH GRANTS

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AWARDS AND SCHOLARSHIPS

2009	Baylor University Graduate School, Outstanding Masters Student
2008	Stark-Kaiser Environmental Science Fellowship, Baylor University $6,000
2007	Platform presentation Award (2nd place) at South Central Regional SETAC

2007 Best Student Platform Presentation at 110th Annual Meeting of the Texas Academy of Science, Waco, TX.

2005 Distinguished Student in Environmental Studies, Brevard College

2005 Distinguished Student in Ecology, Brevard College

2003-2005 Dean's List, Brevard College

PROFESSIONAL MEMBERSHIPS

2006-present Member, Society of Environmental Toxicology and Chemistry

NOI EXHIBIT G, DIRECT WRITTEN TESTIMONY OF BARRY FULTON

TRIENNIAL REVIEW OF WATER QUALITY STANDARDS
NEW MEXICO WATER QUALITY CONTROL COMMISSION

EXPERT TESTIMONY OF BARRY FULTON:

1. My name is Barry Fulton. I live at 10722 Timothys Road, Conifer, Colorado, 10722.

2. I am a Senior Scientist with ARCADIS U.S., Inc.

3. This testimony supports Freeport-McMoRan Chino Mines Company's ("Chino's") petition to the New Mexico Water Quality Control Commission (which I hereafter refer to as the "Commission"), to amend the regulations in Title 20, Chapter 6, Part 4 of the New Mexico Administrative Code (which I hereafter refer to as NMAC 20.6.4). The petition requests addition of site-specific aquatic life criteria for copper to NMAC 20.6.4 for certain surface waters located within the area known as the Chino Mines Smelter Tailings and Soil Investigation Unit (which I hereafter refer to as "STSIU") near the towns of Bayard and Hurley in Grant County, New Mexico. The proposed rule language which my testimony supports and pertains to is included in Exhibits H and I to Chino's Notice of Intent to Present Technical Testimony ("NOI").

4. In addition to using my professional experience and expertise when forming the opinions expressed below, I reviewed the cited documents.

PROFESSIONAL BACKGROUND AND QUALIFICATIONS

5. I hold Bachelor's Degrees in Ecology and Environmental Studies from the Brevard College, Brevard, North Carolina. Additionally, I hold a Master's Degree in Environmental Science from Baylor University, Waco, TX.

6. Since 2009, I have been employed as a Senior Environmental Scientist by ARCADIS U.S., Inc., Lakewood, Colorado. Between 2006 and 2009, I have worked as a research scientist

for the Center for Reservoir and Aquatic Systems Research, Baylor University, Baylor, Texas. Additionally, between 2005 and 2006, I have worked as a Biology Laboratory Instructor at Brevard College, Brevard, North Carolina.

7. Thus far, I have published six (6) different, peer-reviewed journal articles, and have co-authored sixteen (16) abstracts for scientific presentations.

8. I am also an active and productive member of the scientific community as evidenced by my membership of the Society of Environmental Toxicology and Chemistry, which I have been involved with since 2006.

SUBJECT MATTER BACKGROUND

History and Need to Develop Site-Specific Copper Criteria

9. My firm, ARCADIS, was engaged to conduct a detailed scientific investigation combining the hydrological, chemical, physiological, and toxicological disciplines to evaluate and support a proposal for site-specific standards for dissolved copper within an area known as the STSIU.

10. ARCADIS developed Site-Specific Criteria (hereinafter referred to as "SSC") work plan, including the plan for the required scientific investigation, which Chino submitted to NMED for review in early 2011. Subsequently, field sampling and laboratory testing took place in 2011. A draft interim report was prepared in 2012, and the Copper Toxicity Model Report was finalized in 2013.

11. I have direct knowledge of the scientific investigation and area geography due to having personally supervised the site sampling and laboratory testing and due to having been the primary author of the Copper Toxicity Model Report (ARCADIS 2013). Additionally, I am the lead author of a peer-reviewed paper titled "Development of a Regression Model to Predict

Copper Toxicity to Daphnia magna and Site-Specific Copper Criteria across Multiple Surface-Water Drainages in an Arid Landscape", which was published in August 2014 in the scientific journal *Environmental Toxicology and Chemistry* (Fulton and Meyer 2014). That journal article reports the results of the study that forms the basis for the site-specific aquatic life criteria for copper that Chino has petitioned the Commission to adopt for certain waters in the Chino Mines STSIU. Thus, my conclusions and opinions in this regard are based upon not only my review of the appropriate documents and my scientific expertise, but also on personal knowledge and involvement with the process.

Site Geography and Study Overview

12. The STSIU is one of several Investigation Units, or IUs, at Chino Mines. The sites includes areas affected by smelter emissions and tailings but does not include Hanover/Whitewater Creeks, Hurley Soils, and the Lampbright Area.

13. The area in question is set within rough, mountainous terrain. The drainages in the area comprise mostly ephemeral, limited flow streams that rely on monsoonal moisture between July and September in order to flow. In limited locations containing bedrock pools, water is present more persistently.

14. In the study I supervised, water samples were collected for toxicity testing and chemical analysis from 12 different locations in the Chino Mines STSIU. The sample locations were chosen based on their spatial diversity and the range of chemistries in the waters.

15. The results of the study were used to compile the toxicity report, *See Exhibit B*, which in turn was used to develop the regulatory proposal that is before the Commission. (Chino 2014).

ASSESSMENT AND OPINIONS

16. There are several possible approaches to developing site-specific standards for copper concentration in water. The approach used by the proposal before the Commission (Chino 2014) is known as the Water-Effect Ratio, or WER method.

17. The WER method is superior to other methods because it integrates the sciences of chemistry, physiology, and toxicology and incorporates the concept of bioavailability using empirical data results.

18. *Bioavailability* is defined as the proportion of metal that is available for the organism to accumulate.

19. Put another way, the WER approach illustrates the protective effect of water chemistry parameters on copper exposure to aquatic organisms.

20. Several chemical and physical properties of the water, including but not limited to pH, hardness, alkalinity, and concentration of humic and fulvic acids (two major forms of dissolved organic carbon or "DOC" in natural waters), can affect the toxicity of copper in the water.

21. Copper toxicity is affected in two ways. First, water chemistry parameters such as DOC and alkalinity protect against copper toxicity because they bind chemically with copper. The resulting copper compounds are much less toxic to aquatic organisms such as aquatic insects and fish.

22. Second, the water hardness ions actually compete with copper ions for binding to aquatic organisms, allowing less copper to be accumulated in the organism (i.e., decreasing the *bioavailability* of the copper).

23. Thus, chemical properties of water can affect the *bioavailability* of copper in the water or, put another way, if copper cannot bind to an organism, it cannot cause toxicity.

24. In my experience and professional judgment, the WER approach is the best currently available approach for evaluating copper toxicity for the STSIU geographic area.

25. I reviewed the rule language as set forth in Chino's NOI, Exhibit H. In my professional experience and judgment, the proposed rule language is supported by, incorporates the results of, and properly expresses the adjustment of the site-specific criteria for copper for the identified waters consistent with the results of ARCADIS' studies as presented in the Copper Toxicity Model Report submitted to and reviewed by NMED's Surface Water Quality Bureau.

26. I also reviewed the alternative rule language as set forth in Chino's NOI, Exhibit I. This language incorporates the classification of certain portions of the waters as ephemeral, and can be considered and adopted in lieu of the language in Chino's NOI Exhibit H if, and only if, the Commission adopts both the site-specific criteria proposed by Chino and the Hydrology Protocol-based Use-Attainability Analysis proposed by NMED.

EXCLUSION OF CLF CRITICAL HABITAT

27. I note that, despite the fact that the scientific analysis in Exhibit B supports the inclusion of the Chiricahua Leopard Frog (CLF) Critical Habitat within the scope of the regulation, Chino, due to NMED's comments and in order to allow for a proposal that can be approved by the Commission and EPA without raising questions about the need for interagency consultation, has amended its petition (Chino 2014) and is no longer proposing to apply the site-specific copper criteria to the designated Chiricahua Leopard Frog habitat. *See* Exhibit H.

Literature Cited

ARCADIS. 2013. Revised Site-Specific Copper Toxicity Model Report: Chino Mine, Vanadium, New Mexico. October, 2013.

Chino. 2014. Freeport-McMoRan Chino Mines Company's Petition to Amend the Surface Water Quality Standards (20.6.4 NMAC) and Request for Hearing. Submitted to the New Mexico Water Quality Control Commission.

Fulton, B.A. and J.S. Meyer. 2014. Development of a regression model to predict copper toxicity to *Daphnia magna* and site-specific copper criteria across multiple surface-water drainages in an arid landscape. *Environmental Toxicology and Chemistry* 33:1865-1873.

NOI EXHIBIT H: FIRST AMENDED PROPOSED RULE CHANGES

20.6.4.902 SITE-SPECIFIC STANDARDS

A. A site-specific adjustment to copper criteria for the applicable aquatic life designated use for a segment of Lampbright Draw and certain of its tributaries and certain tributaries of Whitewater Creek located in the Mimbres River Closed Basin shall be applied as described in this subsection.

(1) the criteria adjustment for copper described in paragraph (2) of this subsection shall apply only to the portions of the surface waters located within an area known as the Smelter Tailings Soil Investigation Unit ("STSIU") at the Chino Mines Company and described as follows:

(a) the mainstem of Lampbright Draw beginning at the confluence of Lampbright Draw with Rustler Canyon to the intersection of Lambright Draw with the southern STSIU boundary and all tributaries thereof that originate west of Lampbright Draw, including Rustler Canyon and Martin Canyon;

(b) Lucky Bill Canyon and all tributaries thereof;

(c) Chino Mines property Subwatershed Drainages A, B, C, D-1, D-2, D-3, D-4, and all tributaries thereof, <u>but excluding the portion of the northwest tributary in Subwatershed Drainage B containing Ash Spring and the Chiricahua Leopard Frog critical habitat transect, and reaches in Subwatershed Drainage C containing Bolton Spring and the Chiricahua Leopard Frog critical habitat transect; and</u>

(d) Chino Mines property Subwatershed Drainages E and all tributaries thereof.

(2) For the waters listed in paragraph (1) of this subsection, the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to their designated uses, except that the following segment-specific criteria apply: the acute and/or chronic aquatic life criteria for copper set forth in Subsection I of Section 900 shall be determined by multiplying that criteria by the Water Effect Ratio ("WER") adjustment expressed by the following equation:

$$WER = \frac{[10^{0.588+(0.703 \times \log DOC)+(0.395 \times \log Alkalinity)}] \times (\frac{100}{Hardness})^{0.9422}}{19.31}$$

For purposes of this paragraph, DOC is dissolved organic carbon, expressed in units of mg C/L; alkalinity is expressed in units of mg/L as $CaCO_3$; and hardness is expressed in units of mg/L as $CaCO_3$. In waters that contain alkalinity concentrations greater than 250 mg/L, a value of 250 mg/L shall be used in the equation. In waters that contain DOC concentrations greater than 16 mg C/L, a value of 16 mg C/L shall be used in the equation. In waters that contain hardness concentrations greater than 400 mg/L, a value of 400 mg/L shall be used in the equation. The alkalinity, hardness and DOC concentrations used to calculate the WER value are those measured in the subject water sample.

NOI EXHIBIT I: CONDITIONAL ALTERNATIVE PROPOSED RULE

20.6.4.808 CLOSED BASINS - Watercourses within Smelter Tailing Soils Investigation Unit lands at the Chino Mines Company, excluding those waters listed in section 809 and including but not limited to:

(i) the mainstem of Lampbright Draw beginning at the confluence of Lampbright Draw with Rustler Canyon (at DMS coordinates 32° 44' 42.591" N 108° 00' 05.082" W) and all tributaries that originate west of Lampbright Draw to the intersection of Lampbright Draw with Highway 180 (at DMS coordinates 32° 35' 50.422" N 108° 03' 09.858" W)

(ii) all tributaries of Whitewater Creek that originate east of Whitewater Creek from the confluence of Whitewater Creek with Bayard Canyon (at DMS coordinates 32° 45' 38.722" N 108° 07' 36.053" W) downstream to the intersection of Whitewater Creek with Highway 180 (at DMS coordinates DMS: 32° 35' 49.690" N 108° 05' 07)

A. Designated Uses: livestock watering, wildlife habitat, marginal warmwater aquatic life and primary contact.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: the acute and/or chronic aquatic life criteria for copper set forth in Subsection I of Section 900 shall be determined by multiplying that criteria by the Water Effect Ratio ("WER") adjustment expressed by the following equation:

$$WER = \frac{[10^{0.588+(0.703 \times \log DOC)+(0.395 \times \log Alkalinity)}] \times (\frac{100}{Hardness})^{0.9422}}{19.31}$$

For purposes of this section, DOC is dissolved organic carbon, expressed in units of mg C/L; alkalinity is expressed in units of mg/L as $CaCO_3$; and hardness is expressed in units of mg/L as $CaCO_3$. In waters that contain alkalinity concentrations greater than 250 mg/L, a value of 250 mg/L shall be used in the equation. In waters that contain DOC concentrations greater than 16 mg C/L, a value of 16 mg C/L shall be used in the equation. In waters that contain hardness concentrations greater than 400 mg/L, a value of 400 mg/L shall be used in the equation. The alkalinity, hardness and DOC concentrations used to calculate the WER value are those measured in the subject water sample.

20.6.4.809 CLOSED BASINS - Ephemeral watercourses within Smelter Tailing Soils Investigation Unit lands at the Chino Mines Company, limited to:

(i) Chino Mines property Subwatershed Drainage A and tributaries thereof;

(ii) Chino Mines property Subwatershed Drainage B and tributaries thereof (excluding the portion of the northwest tributary containing Ash Spring and the Chiricahua Leopard Frog critical habitat transect);

(iii) Chino Mines property Subwatershed Drainage C and tributaries thereof (excluding reaches containing Bolton Spring and the Chiricahua Leopard Frog critical habitat transect);

(iv) Subwatershed Drainage D and tributaries thereof (Drainages D-1, D-2, D-3, and D-4) and,

(v) Subwatershed Drainage E and all tributaries thereof.

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

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: the acute and/or chronic aquatic life criteria for copper set forth in Subsection I of Section 900 shall be determined by multiplying that criteria by the Water Effect Ratio ("WER") adjustment expressed by the following equation:

$$WER = \frac{[10^{\,0.588+(0.703 \times \log DOC)+(0.395 \times \log Alkalinity)}\,] \times (\frac{100}{Hardness})^{0.9422}}{19.31}$$

For purposes of this section, DOC is dissolved organic carbon, expressed in units of mg C/L; alkalinity is expressed in units of mg/L as $CaCO_3$; and hardness is expressed in units of mg/L as $CaCO_3$. In waters that contain alkalinity concentrations greater than 250 mg/L, a value of 250 mg/L shall be used in the equation. In waters that contain DOC concentrations greater than 16 mg C/L, a value of 16 mg C/L shall be used in the equation. In waters that contain hardness concentrations greater than 400 mg/L, a value of 400 mg/L shall be used in the equation. The alkalinity, hardness and DOC concentrations used to calculate the WER value are those measured in the subject water sample.