TESTIMONY IN SUPPORT OF ADDING THE SALAMANDER MUSSEL, THE RABBITSFOOT MUSSEL AND THE SNUFFBOX MUSSEL TO THE LIST OF ENDANGERED SPECIES AND ADDING THE SHEEPNOSE MUSSEL AND THE RAYED BEAN MUSSEL TO THE LIST OF THREATENED SPECIES

My name is Dr. Conrad D. Volz, and my testimony is in support of amending 58 Pa. Code Chapter 75 by adding the salamander mussel, the rabbitsfoot mussel and the snuffbox mussel to the list of endangered species and adding the sheepnose mussel and the rayed bean mussel to the list of threatened species. I am the Director of the Center for Healthy Environments and Communities (CHEC) and the Environmental Health Risk Assessment Certificate Program at the Graduate School of Public Health and an Assistant Professor in the Department of Environmental and Occupational Health.

The Center for Healthy Environments and Communities (CHEC) as part of the Allegheny River Stewardship Project (ARSP) conducted an experiment on the water quality outcomes of river mining for aggregate (Murry et al., 2008) in July of 2008. We found;

- Significantly higher levels of Arsenic (1.68X, $p < .0001$), Selenium (1.56X, $p = .027$) and Zinc (1.20X, $p = .018$) in river water after mining operations had been active for at least two hours compared to samples taken at 3AM before operation had begun. Further there was no rain or other weather events to change water indicators during this period.

- Turbidity (TSS) levels at all sampling stations at all depths were higher after at least 2 hours of mining operations than before mining turbidity samples (p, .0001).

- Turbidity (TSS) was found to be significantly different if the data are stratified by depth at all 3 depths (1 meter below surface, 3 meters depth and 1 meter above bottom). This indicates the TSS plume made by the mining operation was found to extend essentially from bank to bank and from the surface to the bottom of the river in the study area.

- Kriged concentration gradients of total dissolved solids (TDS), at 6 meters depth, were changed markedly after mining as compared to prior to mining operations (See Figure 1, Total Dissolved Solids Kriged Concentration Gradients in ppm (mg/L) Before Mining Operations and Figure 2, Total Dissolved Solids Kriged Concentration Gradients in ppm (mg/L) After Mining Operations Have Begun). The after mining Kriged concentration gradient shows a much larger area of higher TDS than before mining Kriged concentration gradients with some apparent funneling from the clamshell dredge area.

(Murry et al., 2008)

These Se, TSS, and TDS data along with evidence of significantly elevated Selenium (Se) bioaccumulation in Pools 5 and 6 in channel catfish over levels found in Pittsburgh Pool channel catfish are suggestive of ecotoxicological stress to mussels and the general aquatic ecosystem;

hypothesized due to Se runoff from agriculture and water discharges from coal-fired electrical generation plants as well as non-anthropogenic sources (Volz et al., 2007). River mining causes significant levels of river sediments to rise throughout the water column, with subsequent suspended solid deposition downstream, particularly where river velocity decreases, and causes increases in ionic metal and element species, made soluble by water. These three variables (Se, TSS and TDS) can impact mussels directly or through general ecosystem effects via the following mechanisms.

There are several concepts concerning the ecotoxicology of Se that can be stated. Elevated concentrations have degraded many freshwater ecosystems throughout the United States, and additional systems are expected to be affected as anthropogenic activities increasingly mobilize Se into aquatic systems. Se is a very toxic essential trace element. Toxic threshold concentrations in water, dietary items, and tissues are only 2-5 times normal background concentrations. Toxicity in freshwater ecosystems is the result of bioaccumulation, biotransformation, and cycling of Se in aquatic food chains (Maier and Knight, 1994). Organic selenium bioaccumulation and toxicity patterns in the freshwater bivalve sentinel species *Corbicula fluminea* have recently been demonstrated. Waterborne selenomethionine (SeMet) exposure was used to mimic dietary organo-Se uptake. Results of this study demonstrate that SeMet is accumulated to a relatively high extent with a concentration factor of 770 (wet weight basis). The higher uptake than depuration rates suggest that bivalves deal with high Se amounts using a strategy of detoxification based on Se sequestration that could involve granules, as shown by a strong increase of Se in the particulate subcellular fraction. Selenium is persistent in the cytosol of bivalves exposed to SeMet where it is found in proteins of a wide range of molecular mass, indicating a possible replacement of methionine by selenomethionine. A subsequent alteration of protein function might be one of the mechanisms of Se toxicity that could explain the histopathological effects observed in gills by using transmission electronic microscopy. Those analyses showed changes in gill filament ultrastructure and suggested mitochondria as the first target for SeMet cytotoxicity, with alterations of the outer membrane and of cristae morphology. Organo-Se would thus not only be toxic via indirect mechanisms of maternal transfer as it is suggested for fish but also directly (Adam-Guillermin et al., 2009).

Total dissolved solids cause toxicity through increases in salinity, changes in the ionic composition of the water and toxicity of individual ions. Increases in salinity have been shown to cause shifts in biotic communities, limit biodiversity, exclude less-tolerant species and cause acute or chronic effects at specific life stages (Weber-Scannell, PK., and Duffy, LK., 2007). A significant and negative correlation between concentrations of chlorophyll-a (an estimate of primary production) and concentrations of Na^{+}, Mg^{2+}, $SO4^{2-}$, HCO^{3-} and $CO3^{2-}$ have been observed in aquatic environments (Bierhuize, J.F.H. and E.E. Prepas, 1985). Dissolved solids also adversely impact aquatic life by altering the osmotic pressure of the external environment, which interferes with the organisms' osmoregulatory functions (Title 25 – ENVIRONMENTAL

PROTECTION ENVIRONMENTAL QUALITY BOARD [25 PA. CODE CH. 96] Water Quality Standards Implementation, November 20, 2001).

Excessive fine sediment impacts the benthic organisms that characterize a healthy stream. Sediment abrades aquatic organism gills during high water events and smothers them upon deposition. The embedding nature of fine sediment also causes the loss of microhabitat in the spaces between larger substrate particles (Reylea, 2000).

Figure 1, Total Dissolved Solids Kriged Concentration Gradients in ppm (mg/L) Before Mining Operations

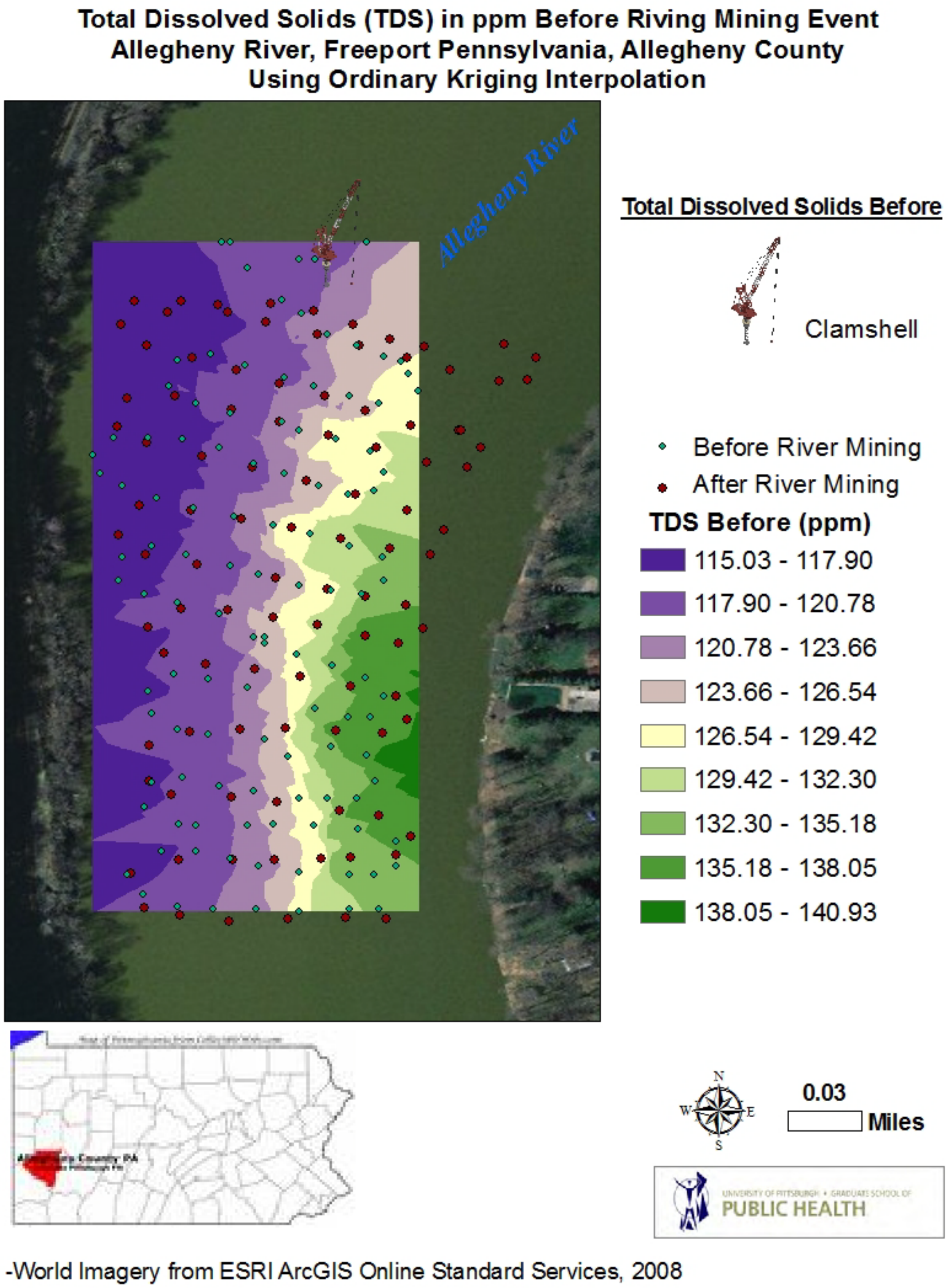
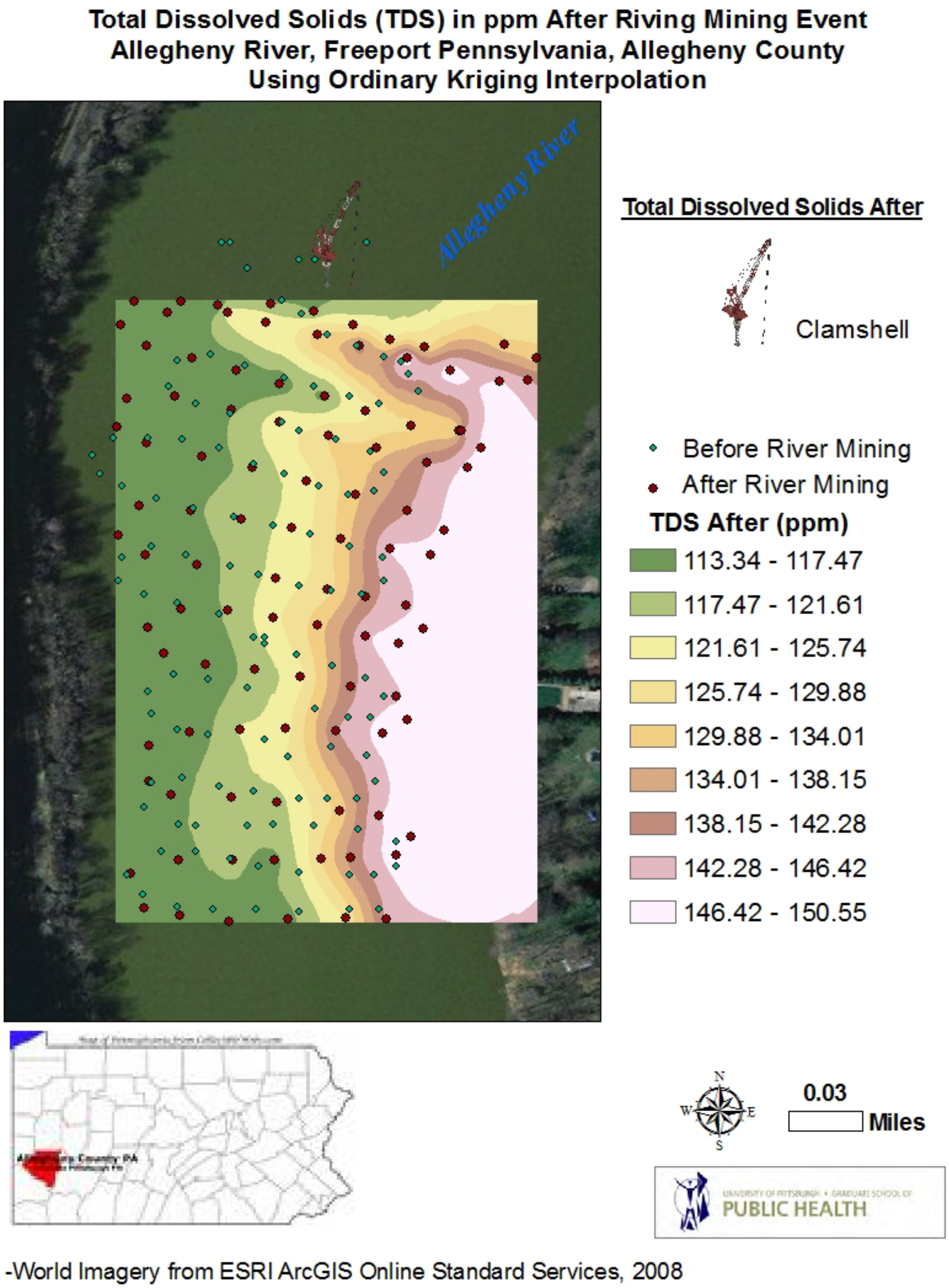


Figure 2, Total Dissolved Solids Kriged Concentration Gradients in ppm (mg/L) After Mining Operations Begin



Bier huiz e,

References;

Adam-Guillermin, et al., (2009). Biodynamics, subcellular partitioning, and ultrastructural effects of organic selenium in a freshwater bivalve. *Environ. Sci. Technol.*, Article ASAP DOI: 10.1021/es802891j Publication Date (Web): February 6, 2009 Copyright © 2009 American Chemical Society.

Bierhuize, J.F.H. and E.E. Prepas, (1985). Relationship between nutrients, dominant ions and phytoplankton standing crop in prairie saline lakes. Can. J. Fish. Aquat. Sci., 42: 1588-1594.

Title 25 – ENVIRONMENTAL PROTECTION ENVIRONMENTAL QUALITY BOARD [25 PA. CODE CH. 96] Water Quality Standards Implementation, November 20, 2001

Maier, KJ., Knight, AW.(1994).Ecotoxicology of selenium in freshwater systems. Rev. Environ. Contam. Toxicol.; 134: 31-48.

Murry et al., (2008). A comparison of water quality variables and concentrations of selected toxic and nuisance elements at various distances and depths downstream from Allegheny River gravel mining operations during periods of activity and inactivity.
Ohio River Basin Consortium for Research and Education Conference, ORBCRE Scientific Symposium 2008 October 29-31, 2008, Pittsburgh, PA.

Reylea, C.D., G.W. Mincshall, R.J. Danehy. 2000. Stream Insects as Bioindicators of Fine Sediment. Watershed Management 2000 Conference. Boise, ID. Boise Cascade Corporation.

Conrad Volz, DrPH, MPH, Yan Liu, BS Env Eng, Nancy Sussman, PhD, Sean Brady, BS, MA, Paul Caruso, Tiffany Green, BS, Myron Arnowitt, BA, Jim Peterson, PhD, Charles Christen, MEd, LPC, Maryann Donovan, MPH, PhD, Devra Lee Davis, PhD, MPH, Patricia Eagon, PhD, Kelly McMahon, MD, Ravi K. Sharma, PhD, 5041.0: Mercury, Arsenic and Selenium in Channel Catfish from the Allegheny, Monongahela and Ohio Rivers near Pittsburgh PA: Implications for metallotoxin source identification and fish consumption by local anglers . 2007 American Public Health Association Annual Meeting, Washington, DC.

Weber-Scannell, PK., and Duffy, LK., (2007). Effects of total dissolved solids on aquatic organisms: a review of literature and recommendation for salmonid species. American Journal of Environmental Sciences 3 (1): 1-6.

Submitted By; Conrad (Dan) Volz, DrPH, MPH
Bridgeside Point
100 Technology Drive
Suite 564, BRIDG
Pittsburgh, PA 15219-3130
office 412-648-8541 : cell 724-316-5408: Fax 412-624-3040
cdv5@pitt.edu Assistant Professor, Environmental and Occupational Health, University of Pittsburgh, Graduate School of Public Health http://www.pitt.edu/~cdv5/ ; Director-Center for

Healthy Environments and Communities http://www.chec.pitt.edu;
Director, Environmental Health Risk Assessment Certificate Program
http://www.publichealth.pitt.edu/interior.php?pageID=82

Home:
166 Shephard Road
Gibsonia, PA 15044
724-444-6112
Home office email: sierrakellydan@msn.com