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

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, 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

(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.