STATE OF NEW MEXICO
WATER QUALITY CONTROL COMMISSION

IN THE MATTER OF PROPOSED AMENDMENTS
TO 20.6.2, THE COPPER MINE RULE,

No. WQCC 12-01(R)

New Mexico Environment Department,
Petitioner.

DIRECT TESTIMONY OF BRUCE THOMSON, Ph.D., P.E.

Introduction

Q: Will you please state your name and your employment.

A: My name is Bruce Thomson. I am a Professor of Civil Engineering and Director of the Water Resources Program at the University of New Mexico ("UNM"). I am presenting this testimony on behalf of the New Mexico Attorney General's office in the matter of the proposed amendments 20.6.7 NMAC, the Copper Mine Rule. Although my principal employer is the University of New Mexico, I want to emphasize that the testimony I am presenting represents my personal opinions and conclusions based on my own analysis; in the matter of this hearing I do not represent UNM in any manner.

Q: Will you please summarize your qualifications, especially in the areas of water quality and treatment, water resources, and mine waste management.

A: I hold a Bachelor of Science degree in Civil Engineering from the University of California, at Davis, and Master of Science and Ph.D. degrees in Environmental Science and Engineering from Rice University, Houston, Texas. I have been a faculty member in Civil Engineering at the University of New Mexico for nearly 35 years. I have been Director of the interdisciplinary Water Resources Program at UNM for seven years. Prior to joining UNM I was a Research Professor at Rice University and also worked for the United States Environmental Protection Agency in its permits branch in Region IX which is located in San Francisco. I am a Licensed Professional Engineer in the State of New Mexico.

My professional areas of expertise are in environmental and water resources engineering. I teach classes in environmental engineering, water resources, hydrogeology, and water chemistry. My research focus has principally been in areas dealing with chemistry, contamination and treatment of surface and ground waters by inorganic contaminants including arsenic, selenium, fluoride, uranium and other radionuclides. However, over the last three decades I have also been involved in many other investigations. Most of my research has been funded by external sources including federal, state, and local agencies as well as support from consulting firms and industrial organizations.

At many universities engineering faculty are encouraged to do some consulting as a way of bridging the gap between the theoretical aspects of science and engineering and the professional practice side of engineering. I have maintained a small consulting practice and have done work for federal, state, and local agencies, consulting firms, and some industries.

As stated, one of the continuing threads throughout my career has been my interest in chemistry and treatment of water impacted by inorganic contaminants. One of my very first externally funded research projects when I came to New Mexico in 1978 was working on ground water contamination from uranium mining and milling. I have continued to work in areas related to mining and milling ever since. I have done work on gold, copper, uranium and coal mines. I have supervised the research of approximately 150 Master of Water Resources, Master of Science, and Ph.D. students, and many of them have done work on these and related projects.

I believe that engineers and scientists should play an active role in the public discussion of technical challenges such as those posed by waste management and disposal. To this end, I have served on many federal, state, and local boards and panels that have dealt with these issues. Of special relevance to the Copper Mine Rule is my appointment and service as a member of the New Mexico Mining Commission. I was appointed by Governor Johnson as an alternate public member on the Mining Commission and served for three years until I was replaced by Governor Richardson. I also served as a member of the Task Force assembled by the New Mexico Environment Department ("NMED") to develop draft supplemental permitting requirements for dairy facilities which were promulgated by the Water Quality Control Commission ("Commission") as 20.6.6 NMAC.

Finally, I am familiar with the water resources of New Mexico. I have recently contributed a chapter titled "Water Resources of New Mexico" to a book titled Water Policy in New Mexico, that was published by Resources for the Future. I have worked with leading water resource firms in the state as a consultant and on many state and local committees on water resource and water quality challenges facing our communities.

I am pleased to be allowed to offer my views to the Commission.

My resume is attached as AGO Exhibit 17.

Summary of Testimony

Q: Please summarize the testimony you will give to the Commission.

A: I will present testimony on the water resources of Grant County, its uses, and importance to communities in the county. I will show that water resources in this area are over allocated which is resulting in declining ground water levels in public supply wells for the communities. Although numerous studies have considered this problem, there are few alternatives available for future water supply.

This discussion is relevant to the proposed Copper Mine Rule because it underscores the importance of protecting the state's ground water resources. Testimony previously given to the Water Quality Control Commission by managers of the Phelps Dodge Tyrone, Inc. ("Tyrone") mine and staff from the New Mexico Interstate Stream Commission suggest that following closure, the mine will maintain a ground water pumping and treatment program that will result in production of an estimated volume 4,000 acre-ft/year of water. This volume of water would satisfy most of the anticipated future demand in Grant and Luna Counties and in my opinion constitutes a reasonably foreseeable future use of water.

I will also discuss the impacts of copper mining on the ground water quality and comment on the nature of the contaminants and the difficulty of managing and remediating contaminated ground water from copper mine operations.

Background

Q: What materials have you reviewed to prepare your testimony?

A: I am attaching a list of the references I reviewed to my testimony. References I have consulted include the Southwest New Mexico Regional Water Plan, technical reports by staff from the New Mexico Office of the State Engineer and the Interstate Stream Commission, technical reports by independent consultants, a report by the New Mexico Office of the Natural Resources Trustee, reports and summary documents by staff with the New Mexico Bureau of Geology and Mineral Resources. I have also reviewed testimony provided by technical experts in the 2003 and 2007 Tyrone hearings before the Commission including that provided by staff from the Office of the State Engineer, the Interstate Stream Commission and New Mexico Environment Department, and testimony from Tyrone employees and their consultants.

Q: What experience and familiarity do you have with mining in New Mexico, and copper mining in particular?

A: I have worked on problems associated with hard rock and coal mining for most of my professional career. This has included externally funded research projects on uranium, gold, and coal mining and studies of acid generation resulting from oxidation of sulfide minerals. In addition I have done consulting on waste management from copper mines. I have taught a one semester course at UNM on mine waste management and have collaborated on teaching short courses on mine waste management in the United States and abroad. I have written a number of papers on these topics including writing reviews of the annual literature on mining and mine waste management for several years for the journal Water Environment Research.

Q: What is your familiarity with the copper mine sites in New Mexico?

A: In years past I have visited several copper mines in New Mexico including the Cobre mine near Silver City and the abandoned Nacimiento Pit near Cuba, New Mexico. About 12 years ago I collaborated with a colleague, Dr. Ingar Walder of SARB Consultants, on waste rock management projects for the Tyrone mine to develop strategies for controlling acid generation from waste rock. I visited the Copper Flats mine site a few years ago shortly before New Mexico Copper announced their plan to reopen this mine.

Q: What is your familiarity and experience with the process known as "acid rock drainage" at copper mine sites and other ground water contamination that can be caused by copper mining?

A: I am familiar with the theoretical concepts leading to acid generation by oxidation of pyrite materials and have also supervised experimental programs to measure acid rock drainage formation potential. Early in my career at UNM I supervised a graduate student who was investigating acid generation in the laboratory and we developed a one-dimensional model of acid migration and neutralization by materials down gradient from an acidic source. I have operated humidity cell equipment in my laboratory to determine the acid rock drainage potential for soils and rocks. I have used theoretical calculations and computer models to estimate production of acid solutions from sulfide minerals.

Q: What is your familiarity and experience with the Water Quality Act and Commission Regulations at 20.6.2 NMAC?

A: I am generally familiar with the Water Quality Act, the ground water quality regulations in 20.6.2 NMAC, as well as implementation of ground water protection policies by the New Mexico Environment Department. I have reviewed the draft regulations for 20.6.7 NMAC that were released for public review in October 2012.

Ground Water Resources in New Mexico

Q. Please provide an overview of the ground water resources in New Mexico, and the challenges facing New Mexico with managing this resources now and into the future.

A: The entire state of New Mexico is heavily dependent on ground water for its source of supply. The best data that summarize this dependence are contained in a 2008 report by John Longworth and collaborators who are with the New Mexico Office of the State Engineer. Their report shows that in 2005, the latest year for which data were compiled, ground water withdrawals provided nearly 90% of the water for public and domestic water supply in the state. In Grant County ground water provides in excess of 99% of the water for human consumption. Similar dependence on ground water for potable supply also occurs in the other counties of southwestern New Mexico.

Besides our dependence on ground water for potable supply, ground water provides nearly 50% of the supply of water for irrigated agriculture and livestock watering, and over 90% of the water for mining and industrial activities on a state wide basis. In Grant County the numbers are 13% for irrigated agriculture and livestock watering, and 100% of the water supply for mining and industrial activities.

It is this overwhelming dependence on ground water for public and private water supply and to support the economic drivers in New Mexico that led this state to develop some of the earliest and most protective ground water standards in the country. When I began my professional career at UNM, New Mexico was one of a very few states in the country that had statewide ground water quality standards. Passage of the Water Quality Act and development of these standards was recognition of the importance of this resource to the health of our residents, the quality of our environment, and the necessity of a high quality water supply for economic development.

Q: Please discuss the challenges facing Silver City and the Grant County area with its ground water resources now and into the future.

A: It is widely recognized that the water resources in New Mexico are not sufficient to meet current needs let alone support future growth. Virtually every public water supply agency, every irrigation and conservancy district, and every industrial sector in the state is facing imminent water shortages and all are looking for new sources of supply to meet current and future needs. These shortages of course extend beyond the state's borders and we are experiencing increased scrutiny of our water resources from all of our neighboring states as well as those on the lower Colorado River.

It was in large part due to the interest in New Mexico water by out of state entities, especially that of Texas on the Rio Grande and Pecos rivers, that the Interstate Stream Commission began to take development of a statewide water plan more seriously. The statewide plan was supported by preparation of 16 regional water plans throughout the state which were completed between 1999 and 2008. These plans were developed by local organizations, usually with the assistance of technical consultants, and were "charged with identifying water supply, projecting demand, and where water supply is determined to be inadequate to meet projected demand, which is almost always the case in New Mexico, regions must develop strategic alternatives to meet their water shortage challenges" (ISC web site).

The Southwest New Mexico Regional Water Plan (Region 4) is a plan for the region that encompasses Catron, Grant, Hidalgo, and Luna Counties [AGO Ex. 18]. The principal river basins are the Gila River and the Mimbres Basins. The plan is over 400 pages long, contains seven appendices and has extensive descriptions of the hydrogeology of the region, current water use and quality, and projected water use in the four counties. Nearly half of the document describes alternatives for meeting future demands. It is an extremely valuable resource that has been widely referenced in considering water supply issues in southwestern New Mexico. The regional water plan emphasizes rapidly declining ground water levels throughout the basin and

the need for conservation and new sources of water. The only significant source of "new" water identified in the report is the Gila River, which may be available as a result of the Arizona Water Settlements Act of 2004. The regional plan includes a discussion of ground water contamination from mining operations and the need to protect this resource from future contamination.

Because it discusses water issues for all four counties, the Southwest New Mexico Regional Water Plan is necessarily somewhat general. There have been a couple of recent studies that have focused on future water demand for Grant County that have made extensive use of ground water modeling to determine the amount of water available from ground water resources. Michael Johnson and colleagues with the Office of the State Engineer developed a ground water model and published the results in a report titled "Analysis of Ground-Water Development to Meet Projected Demands in Regional Planning District 4, Southwest New Mexico" (OSE Hydrology Report 02-04, Mar. 2002) [AGO Ex. 19]. They described the hydrogeologic conditions and ground water resources of Grant County in considerable detail and included estimates of population growth in developing estimates of future water demands. The model was then used to predict the sustainability of ground water resource for the municipalities in Grant County under two different management scenarios. They conclude that the well fields that supply Silver City, Santa Clara, and Bayard have no capacity for further development and that the communities will likely begin to experience water shortages by about 2040. Mr. Johnson summarized these findings in his testimony during the Tyrone hearings. M. Johnson Testimony (2007) [AGO Ex. 20].

In 2009 Romero and Cook with Balleau Groundwater Inc. investigated ground water recharge in Grant County to determine if enhanced recharge could be used to increase the water supply for municipal and domestic use. Technical Memorandum on Groundwater Recharge Analysis and Estimate of Recharge Option Costs (Balleau Groundwater, Inc. Oct. 15, 2009) [AGO Ex. 21]. They also constructed a computer model and quantified use. They included domestic wells in their analysis, an important category of water use that was not incorporated in Johnson's model.

The Romero and Cook model generally agrees with the Johnson model: Unless an additional source of supply is identified, severe water shortages will be expected in the next few decades. However, this report includes one component that was not part of the Johnson model. It includes a map of the ground water capture zone of the Silver City well fields. It shows that the drawdown from these well fields extends to within a few miles of the radius of influence of the Tyrone mine. It is not a true fate and transport model so cannot be used to determine if contamination from the mine might reach the well fields, however, the relative proximity and possible impacts of future ground water management alternatives in the basin suggest that this is a concern that should be considered.

Most recently, Cuddy and Keyes with the Hydrology Bureau of the New Mexico Office of the State Engineer published the results of a ground water modeling study of the Mimbres Basin in 2011. "Ground Water Model of the Mimbres Basin, Luna, Grant, Sierra, and Dona Ana Counties, New Mexico" (OSE, Jan. 2011) [AGO Ex. 22]. They included water withdrawals for

municipal, agricultural and industrial use, but as with Johnson's model, did not include withdrawals by domestic wells. Industrial use was almost entirely for mining operations and this report included pumping from 13 well fields operated by the mines for five year intervals dating back to 1935. The most recent data was reported for the year 2,000 in which wellfields associated with the mines pumped over 15,000 acre-ft/yr while the communities of Bayard, Columbus, Deming, Santa Clara, Silver City, and Tyrone pumped just over 8,000 acre-ft/yr. The Cuddy and Keyes model doesn't have the resolution of the Romero and Cook model and the study did not report on the long term sustainability of ground water resources in the basin. However, the impact of mining on the resource and on flow patterns in the vicinity of the mines can be interpreted from the data presented and the simulated drawdowns from model calculations. While mining withdrawals do not account for a large fraction of state water withdrawals, they do constitute a large percentage of total diversions in Grant County. According to the summary of New Mexico water use published by Longworth and colleagues in the Office of the State Engineer, ground water withdrawals in Grant County were nearly 22,000 acre feet in 2005 which constituted over 35% of the total withdrawals in the County and nearly 70% of the total ground water pumping. It is clear from the models that the mines at Tyrone, The mines at Tyrone, Chino and Cobre account for a large fraction of water pumped from the aquifer and have an important impact on the flow regime in the northern extent of the basin. Chino and Cobre have an important impact on the water resources and flow regime in the northern extent of the basin.

Q: What is the predicted effect of climate change on New Mexico's water resources?
While I am not a climatologist, I work closely with Dr. David Gutzler, Professor of Earth and Planetary Sciences at the University of New Mexico, an accomplished and respected climate scientist. I have read many reports and technical papers on the projected impacts of climate change in the southwestern United States. One of the best summaries is a chapter in the previously mentioned Water Policy in New Mexico book by Dr. Gutzler. In 2011 the United States Bureau of Reclamation released a report to Congress titled "SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water" that analyzes the impacts of climate change on major western watersheds including the Rio Grande.

Studies on the impacts of climate change on future water resources start by running climate models which are usually referred to as Global (or General) Circulation Models. These solve the complicated equations of atmospheric physics by dividing the globe up into cells, a process called discretization. This allows approximating the differential equations as a set of algebraic equations and solving them. Because of the complexity and the very large number of equations that result, the cells must be very large, typically on the same order of magnitude as the size of the state of New Mexico which results in poor resolution for individual watersheds such as the Gila or Mimbres basins. Furthermore, at different times of the year our climate is influenced by weather patterns from the Pacific Northwest, the South Pacific and Gulf of California, the Gulf of Mexico, and weather patterns from the northern Midwest. Finally, in contrast to most other locations in North America, we have enormous local climate variability ranging from alpine forests in the north to the Chihuahuan and Sonoran desert climates in the south. Thus, there is a

high degree of uncertainty in predictions of the specific effects of climate change in New Mexico. In particular, there is uncertainty among the models whether future annual precipitation will increase, decrease, or remain the same.

However, the models all agree that the climate of the New Mexico and the southwest will become warmer. This has three consequences. First, winters will be shorter and spring runoff will occur earlier in the spring. This is especially important in rivers such as the Gila, San Francisco and Rio Grande because most of their runoff is the result of snow melt.

The second consequence of a warming climate is that it will increase the length of the growing season. This has already been experienced in central New Mexico where the growing season begins roughly one week earlier in the spring and ends one week later in the fall. A longer growing season results in increased water demands for irrigated agriculture and to a lesser extent for municipalities whose residents water their lawns and gardens for a longer period of time.

The third consequence of warming is increased evaporation and transpiration. This will result in less runoff from mountain watersheds due to evaporation of the snowpack, increased evapotranspiration from undeveloped watersheds, and increased evapotranspiration from irrigated crops, lawns and gardens. The analogy I often use in explaining the impacts of climate warming is to compare Albuquerque and Carlsbad. Carlsbad which is commonly perceived as being more like a desert, actually receives about 35% more annual precipitation than Albuquerque. But because it's warmer, it experiences roughly 50% more evaporation. The consequence is a more arid environment.

In its 2011 report the Bureau of Reclamation projects that the mean annual runoff of the Rio Grande at Elephant Butte reservoir in 2050 will be 13.5 % than that of the 1990's.

The consequences of climate change and the reduction in surface water are:

1. All water resources in the state will become more valuable as demands increase and the supply becomes more scarce.

2. Ground water resources will increase in importance because they are not subject to evaporative losses. However, aquifers may see reduced recharge as upland watersheds experience increased evapotranspiration.

3. Increased demand and decreased availability for all water resources will, in my opinion, make interbasin transfers less likely because of the decreased supply and increased demands in all of the watersheds in the arid southwest.

Q: Please discuss the importance of protecting ground water resources in New Mexico and in the Grant County area in particular.

A: Virtually the only source of water for municipal and domestic supply in Grant County is ground water. Current round water pumping in the well fields which supply Silver City, Santa Clara, and Bayard already exceeds the recharge rate as evidenced by water level declines ranging from less than 0.5 ft/yr to greater than 3.0 ft/yr. The Southwest New Mexico Regional Water Plan, studies by hydrologists with the New Mexico Office of the State Engineer, and models done by consulting hydrogeologists all agree that water shortages affecting community systems will become evident in the next 30 to 40 years.

While the Regional Water Plan identifies the Gila River as a possible source of supply for Silver City, this is highly speculative in my opinion as municipal supply is only one of more than 20 proposed uses for this water.

Perhaps one of the more intriguing proposed sources of water for communities in Grant County and nearby is use of water from the Tyrone mine that was discussed by Craig Roepke in his testimony during the 2007 Tyrone hearing. Testimony of C. Roepke (2007) and Proposal (Sept. 24, 2003) [AGO Ex. 23]. Mr. Roepke, a water resource manager with the New Mexico Interstate Stream Commission described a proposal from Phelps Dodge, Inc. to the Interstate Stream Commission to treat and pump up to 6,600 acre-ft/yr after mine closure to provide water supply for the communities of Silver City, Deming, Hatch and Las Cruces. This demonstrates that there may be a significant amount of ground water for future use from the Tyrone mine that southern New Mexico communities may have an interest in. This underscores the importance of protecting the quality of this resource for reasonable future use.

Contamination of Ground Water from Mining Operations

Q: What is the nature of contamination from copper mine operations and why are the operations problematic?

A: I would like to direct my testimony now to issues associated with the quality of leachate from copper mine operations and potential impacts it may have if it underlying ground water becomes contaminated.

There are many different contaminants from copper mine operations. These have been described in previous testimony by Clint Marshall, a hydrogeologist with the NMED Ground Water Quality Bureau [AGO Exs. 12 and 13]. It is appropriate to divide these contaminants into two categories based on their chemistry, toxicology, and the regulated concentration established in New Mexico ground water standards. The first category includes major constituents, sometimes called major ions. These are contaminants regulated at concentrations of 100 milligrams per liter ("mg/L") or greater and include chloride, sulfate and total dissolved solids or TDS. The second category I will refer to as minor contaminants and these include those constituents regulated at concentrations of 10 mg/L or less. This second category mostly consists of metals ranging from aluminum to zinc as well as a few non-metals such as cyanide, fluoride, and nitrates. It is important to understand the differences between these two categories of contaminants.

Mr. Marshall described ground water at Tyrone with major constituents (TDS and sulfate) that exceeded the ground water standards by a factor of 10 or greater. TDS and sulfate are themselves not especially toxic to humans or animals, however, at high concentrations they render the water unusable for consumption or irrigation; it is simply too salty to drink or for irrigating crops. The high TDS and sulfate occur because of the use of sulfuric acid (H_2SO_4) in the leach cycle and as a result of the generation of sulfuric acid by microbial oxidation of sulfide minerals in the ore and waste rock.

In contrast to the major constituents, most of the minor contaminants are regulated because they are toxic, at varying degrees, to humans, livestock, and/or vegetation. Mr. Marshall referred to the presence of cobalt, nickel, and copper at concentrations 10 times above the ground water standard, and to aluminum, cadmium, iron, manganese and zinc at concentrations 100 times greater than the standard. These metals are naturally occurring in the ore and surrounding rock, but are dissolved and become mobilized as a result of leaching from the host minerals in the ore and waste rock by the low pH and high TDS of the leach solution and acid rock drainage.

In this testimony I make the distinction between the major contaminants and the minor contaminants because they present different management challenges. All of the minor contaminants listed above, from aluminum to zinc, are readily amenable to treatment by conventional industrial water treatment processes. Once the pH is raised most of these contaminants form sparingly soluble oxide, hydroxide and/or carbonate precipitates. Based on this chemistry and widespread industry experience I would expect that a treatment process consisting of simple lime neutralization, followed by precipitation and filtration would remove these contaminants to levels below the New Mexico ground water standards.

The major constituents of TDS and sulfate are difficult to treat and are also relatively mobile in ground water. With few exceptions, removing TDS and sulfate can only be accomplished by some form of filtration or desalination process such as reverse osmosis or distillation. I recently co-authored a summary of saline water considerations in New Mexico (Thomson and Howe, 2009) in which we described four problems with these processes:

1. They are very expensive and have both high capital and operating costs. The costs depend on several variables especially the TDS concentration and the chemical composition of the feed water. The treatment costs for inland desalination plants are from two to four or more times greater than that for conventional drinking water treatment.

2. Desalination is very energy intensive. These costs will increase as the price of energy increases. In southern New Mexico most of our energy is produced from fossil fuels which results in a very high carbon footprint for a desalination plant, a factor that may be an important consideration in the future.

3. Desalination wastes a lot of water in the form of a concentrate or brine solution that contains all of the salts that are removed from the purified water. For example the Kay Bailey Hutchison desalination plant in El Paso only recovers about half of the water pumped to the plant. Thus, only 50 gallons of pure water will be recovered for every 100 gallons of contaminated ground water treated. The rest must be disposed of.

4. Waste disposal. Desalination separates purified water from the salts. The salts are retained in the concentrate and must be disposed of. A desalination plant on the coast can simply return the salts to the ocean, but in New Mexico this option is not available. Concentrate from the Kay Bailey Hutchison Plant in El Paso is piped over 20 miles to a deep well injection field. Studies I have participated in and reviewed suggest that concentrate management and disposal for inland desalination facilities can constitute half of the total cost of the facility.

The plumes of contaminated ground water containing high concentrations of TDS and sulfate from copper mining and processing facilities in New Mexico are large because these contaminants readily migrate through the soil. Once they reach ground water they become very difficult to manage. Mine close out plans referred to in previous testimony mention treatment that apparently will continue forever. It is clear to me that measures taken today to minimize leachate from copper operations will, in the long run, be far more cost effective and more protective of the environment than allowing contamination today and future treatment in the future.

Point of Compliance Regulatory Structure

Q: In your opinion, does establishing a "point of compliance" regulatory system for sources of contamination represent sound water resource management policy for New Mexico?

A: I am troubled by provisions in the proposed Copper Mine Rule that would allow relaxation of the protection of ground water underneath a discharge site or that might designate a point of compliance adjacent to or outside of a discharge site. The NMED and the Water Quality Control Commission have always held that ground water must be protected at any place of withdrawal for present and reasonably foreseeable future use. I am concerned that establishing regulations which allow ground water underneath a tailings or waste rock pile to become contaminated establishes a dangerous precedent that other dischargers will seek to obtain.

One notable example is the proposed Roca Honda uranium mine near Mount Taylor that is in the final planning and permitting stages by Strathmore Minerals Corp. As with the copper mines of Grant County many of the historic and proposed uranium mines are located in very productive aquifers. The Roca Honda mine will require pumping up to 4,000 gal/min (6,500 acre-ft/yr) to dewater the mine. While the mine is operational impacts on the water quality will be protected by a wastewater treatment system. However, the mine is projected to have a life of less than 20 years. Once a precedent has been established that allows ground water contamination at a copper

mine it will be very difficult for the WQCC to deny a request for similar accommodation at a uranium mine. A similar argument could be made for a proposed gold mine, molybdenum mine, or even for a dairy feed lot.

Of all of the state's natural resources, water is our most precious. Protecting it requires continued dedication and vigilance. I am concerned that the proposed Copper Mine Rule does not provide adequate protection of this vital resource.

Recommendation

Q: Dr. Thomson, do you have a recommendation to the Commission as to how ground water under copper mine sites should be protected, consistent with the requirements of the state Water Quality Act, as you understand it.

A: Yes.

Q: What is that recommendation?

A: In my testimony I have tried to show the importance of ground water resources to municipal and domestic consumers in New Mexico and especially those living in Grant County. I have used technical reports and testimony previously provided to the Water Quality Control Commission to show that water resources in southwestern New Mexico are over allocated and that this is evidenced by falling water levels in well fields throughout the region. In particular I introduced studies which show that the communities of Silver City, Santa Clara and Bayard will likely begin to experience critical water shortages in next three decades. I have shown that options for additional supply are speculative at best and non-existent at worst. I have also summarized information on the impacts of climate change to show that the problem of inadequate water supplies are almost certain to be exacerbated by diminished runoff and ground water recharge as warming temperatures increase evaporation.

The purpose of my summary was to show that protecting all of the water resources in southwestern New Mexico, and indeed throughout the state, are critical to our water future. Thus, it is of paramount importance in my view that the New Mexico provide the highest degree of protection of our ground water resources.

The second part of my testimony focused on the nature of the constituents and summarized their behavior in a ground water environment and the difficulty of removing them from contaminated water. I suggest that there are two categories of contaminants. The first consists of major contaminants associated with very high concentrations (ground water standards greater than 100 mg/L) of TDS and sulfate. The second consist of trace concentrations (ground water standards less than 10 mg/L) which are metals ranging from aluminum to zinc. I state that the metals present a more manageable threat to underlying ground water resources because they are much easier to treat and generally do not migrate long distances through the aquifer. In contrast, TDS

and sulfate are very difficult to manage because they are more mobile and are much more difficult to treat.

Based on my testimony I will conclude by stating that the combination of three factors increase the economic, social, and cultural value of our ground water resources. These factors are: 1) limited existing water resources in New Mexico; 2) increasing demand for water to support urban, domestic, agricultural and other uses; and 3) the likely reduction in future water availability as a result of climate change. These considerations argue for maximum protection of our surface and ground water resources.

Copper mining and other mineral development requires consumptive use of large volumes of water that have resulted in significant regional depletion of important aquifers. However, mining and related activities also pose a threat to the quality of our ground water resources that will remain long after mine operations end. These impacts will likely require water treatment forever. This treatment will be expensive, complicated, and likely will have a large carbon footprint. More importantly, the requirement to treat water containing high total dissolved solids and sulfate concentrations will allow recovery of only a fraction of the contaminated water; the rest must be disposed of as highly concentrated brine.

Based on these considerations I urge the Water Quality Control Commission to adopt standards that will protect our most vital resource to the maximum extent possible.

Thank you for considering my professional opinions.

This ends my direct testimony, which is true and accurate to the best of my knowledge.

/s/ Bruce Thomson
Bruce Thomson, Ph.D., P.E.

February 22, 2013
Date