Evaluation of costs and benefits of a lower arsenic MCL—unprecedented high costs for uncertain benefits

by Floyd J. Frost*, Lovelace Clinic Foundation, 2425 Ridgeway Drive SE, Albuquerque, NM 87108; Gunther F. Craun, Gunther F. Craun and Associates, 101 W Frederick St., #104, Staunton, VA 24401; Kristine Tollestrup, University of New Mexico, Albuquerque, NM 87131; Robert Raucher, Stratus Consulting, 1881 Ninth St., Boulder, CO 80302; Joe Chvarka, CH2M Hill, 6001 Indian School Rd. NE, Albuquerque, NM 87110; and John Stomp, Public Works Department, City of Albuquerque, PO Box 1293, Albuquerque, NM 87103
*Corresponding author (frost@lrri.org)

The United States Environmental Protection Agency (US EPA) has recently proposed a reduction in the arsenic maximum contaminant level (MCL; US EPA, 2000) that will affect many United States community water systems. These communities are primarily located in areas of the country with high naturally occurring arsenic in surface and ground water, such as New England and the western states. Because of the expense of removing arsenic and the large number of systems affected, the costs of compliance will range from $55 million to over $2 billion annually, depending on the standard adopted (AWWARF, 2000). Based on an epidemiological study of a poor, undernourished Taiwanese population exposed to much higher levels of arsenic than found in the United States, the EPA estimates that the revised arsenic standard of 10 µg/L (10 ppb) will save between 6.9 and 33 bladder and lung cancer deaths each year (US EPA, 2000).

The EPA agrees that the revised arsenic standard will be expensive. However, they argue that costs of removing arsenic from drinking water are justified by savings from medical treatment and the value of avoiding cancer and premature death. The EPA estimates that each bladder cancer prevented will save $179,000 in health care costs over the duration of the disease (US EPA, 2000). The EPA also estimates that the average American is willing to pay $536,000 to avoid a nonfatal case of bladder cancer (US EPA, 2000). The EPA also estimates that the revised arsenic standard will be expensive. However, they argue that costs of removing arsenic from drinking water are justified by savings from medical treatment and the value of avoiding cancer and premature death. The EPA estimates that each bladder cancer prevented will save $179,000 in health care costs over the duration of the disease (US EPA, 2000). The EPA also estimates that the average American is willing to pay $536,000 to avoid a nonfatal case of bladder cancer (US EPA, 2000). Based on willingness-to-pay models, the EPA estimates that the average American will pay $373,516 in 1999 dollars for each year of life added or year of premature death prevented.

The willingness-to-pay estimates are not constrained by an ability to pay. Furthermore, the estimates of willingness-to-pay for a year of life added have never been validated. In health care and public health, cost-effectiveness of an intervention is based on years of life gained and the costs to achieve that gain. For example, if a $500,000 intervention avoids death for a young person, there are many years of life added to offset the cost. On the other hand, spending the same $500,000 to delay death in an old person will cost more per year of life gained because there are fewer expected years of life remaining. An evaluation of the cost-effectiveness of medical treatment is typically based on the cost of the treatment compared to the expected number of years of life the treatment will add. If the number of years gained is sufficient to offset a cost of $50,000 per year of life gained, then the treatment is recommended (Goldman et al., 1991; O’Brien et al., 1997; Kjekshus and Pedersen, 1997; Maini, 1999; Johannesson et al., 1997; Kerkliowskas et al., 1999; Pickin et al., 1999; and Smith and Hillner, 2000). We evaluated the national cost-effectiveness of the proposed revised arsenic MCL by calculating the costs per year of life gained. We used EPA’s estimated benefits of lung and bladder cancer deaths avoided (US EPA, 2000; Table 1) and used cost estimates for medical treatment to remove arsenic developed by the American Water

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**TABLE 1—Incremental annual costs and benefits for revising the arsenic MCL from the present standard of 50 µg/L (50 ppb) to 3 µg/L (3 ppb).**

<table>
<thead>
<tr>
<th>MCL change (µg/L)</th>
<th>Estimates of additional annual costs for the MCL change ($M/yr) (AWWARF estimates)</th>
<th>Additional cancer deaths per year prevented by revising the MCL (EPA estimates)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 to 20</td>
<td>$55 M</td>
<td>1.0 to 3.0</td>
</tr>
<tr>
<td>20 to 10</td>
<td>$550 M</td>
<td>1.3 to 2.5</td>
</tr>
<tr>
<td>10 to 5</td>
<td>$855 M</td>
<td>1.9 to 3.9</td>
</tr>
<tr>
<td>5 to 3</td>
<td>$1370 M</td>
<td>1.5</td>
</tr>
</tbody>
</table>

*The 10th and 90th percentile of deaths prevented. AWWARF = American Water Works Association Research Foundation.

**TABLE 2—Incremental deaths prevented and cost per death prevented for revising the arsenic MCL.**

<table>
<thead>
<tr>
<th>MCL (µg/L)</th>
<th>Additional bladder and lung cancer deaths prevented</th>
<th>Cost per death prevented for MCL revision (AWWARF cost estimates)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 to 20</td>
<td>3.0 to 18.0</td>
<td>$3.1 to 18.3 M</td>
</tr>
<tr>
<td>20 to 10</td>
<td>3.9 to 15.0</td>
<td>$56.7 to 141.0 M</td>
</tr>
<tr>
<td>10 to 5</td>
<td>5.7 to 23.4</td>
<td>$36.5 to 150.0 M</td>
</tr>
<tr>
<td>5 to 3</td>
<td>4.5 to 9.0</td>
<td>$152.2 to 304.4 M</td>
</tr>
</tbody>
</table>

*Estimates of additional annual costs for the MCL change (from Table 1) divided by additional deaths prevented.

**TABLE 3—Incremental compliance cost estimates and costs per year of life added from revising the arsenic MCL.**

<table>
<thead>
<tr>
<th>MCL (µg/L)</th>
<th>Medical intervention costs a</th>
<th>Water treatment costs minus medical costs b</th>
<th>Additional years of life added c</th>
<th>Costs per year of life added for this reduction</th>
<th>Lowest d</th>
<th>Highest e</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 to 20</td>
<td>$6.4 M</td>
<td>$48.6 M</td>
<td>42 to 252</td>
<td>$192,857</td>
<td>$1,157,143</td>
<td></td>
</tr>
<tr>
<td>20 to 10</td>
<td>$5.4 M</td>
<td>$54.4 M</td>
<td>54.7 to 210</td>
<td>$2,593,333</td>
<td>$9,974,359</td>
<td></td>
</tr>
<tr>
<td>10 to 5</td>
<td>$8.4 M</td>
<td>$84.6 M</td>
<td>79.8 to 327.6</td>
<td>$2,588,991</td>
<td>$10,609,023</td>
<td></td>
</tr>
<tr>
<td>5 to 3</td>
<td>$3.2 M</td>
<td>$136.8 M</td>
<td>63 to 126</td>
<td>$10,547,619</td>
<td>$21,695,238</td>
<td></td>
</tr>
</tbody>
</table>

a Medical costs averted assuming each cancer death would cost $179,000 to treat for the duration of their illness and that the number of cancer cases is twice the highest number of total estimated arsenic-related cancer deaths for both bladder and lung cancer as reported in Table 1.

b Water treatment compliance costs from Table 1 minus medical treatment costs.

c The 10th and 90th percentile of years of life saved for the entire US from the number of bladder cancer deaths that the EPA model predicts would be saved and assuming a range of from 2 to 5 lung cancer deaths for each bladder cancer death and that each death results in 13 yrs of life lost.

d Based on the maximum number of years of life saved divided by the incremental costs in Table 1 minus the savings from averterd medical treatment. These results do not reflect discounting over the latency period.

e Based on the minimum number of years of life saved divided by the incremental costs in Table 1 minus the savings from averterd medical treatment.
States and Europe (Lewis et al., 1999; Bates µg/L. Studies conducted in the United to waterborne arsenic at levels less than 50 concentrations of ingested arsenic" (NRC, 1999). There is currently no evidence of elevated cancer risks in United States or European populations exposed to waterborne arsenic at levels two to four times higher than our current standard. There are a variety of methods that could be used to extrapolate risks for low dose arsenic exposure, and there are few data to help determine which model is correct. The EPA uses a nearly linear model to estimate the risk at low doses. This means that the risk at 50 µg/L is approximately half that of 100 µg/L. EPA admits that there is uncertainty about which extrapolation model to use. The National Academy of Science panel that reviewed the arsenic standard estimated risks that were approximately 1⁄74 the EPA’s risk estimates. EPA noted in their background document that most of the data on modes of action for arsenic causes cancer suggest that the true risk is likely to be much lower than what their model predicts (US EPA, 2000). We believe that the true risks and benefits from the revised arsenic MCL are likely to be lower than the EPA predicted. If the true risks are only 1⁄74 that of the estimated risks, in the range of the NRC estimate, then the costs per year of life gained by reducing the MCL from 20 µg/L to 10 µg/L could be $738 million. This estimated benefit is scientifically more plausible because it better agrees with the nonlinear relationships between dose and effects seen in laboratory studies (US EPA, 2000). The EPA assumed that the public-health benefits begin on the day the standard is announced. More likely, the benefits, if any, will be delayed for many years. Using standard economic discounting techniques the cost-effectiveness increases dramatically, by much more than 10 times the original cost estimate. This increases the cost per year of life saved by reducing the MCL from 20 µg/L to 10 µg/L to more than perhps $7.4 billion. This is about $20 million for each day of life gained or enough to fund more than 400 yrs of life gained from cost-effective medical and public-health interventions. The justification for spending from $10 million to $7 billion per year of life gained from an uncertain waterborne arsenic risk is unclear. The EPA does not address the large disparity between acceptable costs per year of life gained from the revised arsenic MCL compared to other medical treatment or public-health screening programs. An argument often used is that environmental policy makers and scientific panels considering drinking-water regulations should use similar criteria for the quality of evidence as well as the cost per life served, as is used in evaluating medical treatment and screening. Levels of evidence have been formalized to assist practitioners in evaluating the validity of evidence about therapeutic and preventive procedures. In this system, randomized clinical trials are the gold standard. The types of epidemiological studies used to justify the change in the arsenic MCL are generally considered lower levels of evidence. Although a few cohort and case-control studies have been conducted, the EPA has relied primarily on ecological studies that are the least informative about risks. Furthermore, there is a high level of uncertainty about causal inferences for low exposures to waterborne arsenic because studies in United States and European populations with relatively low exposures to waterborne arsenic have not confirmed risks predicted from ecological studies (Smith et al., 1992). Although the epidemiological evidence is weaker than required for medical interventions, EPA’s actions are based on significantly higher costs. The costs per year of life added for the revised arsenic MCL are significantly higher than the costs of other public-health and medical interventions. For medical interventions, the cost-to-benefit criteria of $50,000 per year of life added is often used. Although Americans may be willing to pay more, we may not be able to afford the costs of medical treatment and screening. Cardiovascular diseases are the largest single cause of death in the United States. Their cost of treatment is $738 billion. Cardiovascular disease and cancer are typically beyond our control, and treatment is not voluntary. Exposure to many health-risk factors for diseases such as breast cancer or diabetes is typically beyond our control. Another oft-heard argument is that people are willing to pay more to prevent a premature death from cancer than from heart disease or diabetes. However, acceptable costs for cancer screening and treatment are not different from acceptable costs for heart disease or diabetes screening and treatment. Furthermore, those who have disabilities from premature heart disease or diabetes would likely not agree that a greater emphasis should be placed on cancer prevention and treatment.
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AWWARF, 2000, Cost implications of a lower standards considered. 5 µg/L, or 3 µg/L, the other alternative this level is more reasonable than 20 µg/L, ed, there are no health data to suggest that benefits. If a standard of 10 µg/L is adopt-

informed about the costs and the benefits, confidence in what the benefits will accrue. Before making a nation and may influence future environ-

mental policy decisions. Before making a costly public-health decision, additional information is needed to improve our con-

fidence in what the benefits will accrue. The public should also have a chance to be informed about the costs and the benefits, as well as the uncertainties about those benefits. If a standard of 10 µg/L is adopt-

ed, there are no health data to suggest that this level is more reasonable than 20 µg/L, 5 µg/L, or 3 µg/L, the other alternative standards considered.

References

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http://geoinfo.nmt.edu/nmgs/home.html or contact Brian Brister, General Chairman, (505) 835-5378, bbrister@gis.nmt.edu

NMGS Spring Meeting

The annual spring meeting will be held on Friday, March 23, 2001, at Macey Center on the campus of New Mexico Institute of Mining and Technology, Socorro, New Mexico. Four oral presentation ses-

sions and two poster sessions will focus on the geology of New Mexico and adjacent areas. This year’s special session will be Geological resources of New Mexico. This session will focus on current issues in the exploration for, and extraction of minerals, petroleum, geothermal energy, and ground water in the state. The session will conclude with an address by keynote speaker Robbie R. Gries, President-Elect of the American Association of Petroleum Geologists and President of Priority Oil and Gas LLC of Denver, Colorado. The title of the keynote lecture is “The geologist’s role in keeping up with future natural gas demands—individual efforts that have made a big difference.”

NMGS 52nd Fall Field Conference

This year’s fall field conference will be in east-central New Mexico—west Texas from 26–29 September 2001. The conference will be headquarters in Tucumcari, and the opening night registra-

tion party will be held there at the recently opened Mesalands Dinosaur Museum. The first day’s trip will be by bus to west Texas and will feature Palo Duro Canyon, the “Grand Canyon of Texas.” On day 2 participants will travel by caravan south to Clovis. High-

lights include a visit to Pyramid Mountain, where in 1853 Jules Marcou made the first scientific observations by a trained geolo-

gist in New Mexico. We will also visit Blackwater Locality No. 1, the world famous late Pleistocene type locality of the Clovis culture. Day 3 will take the participants by caravan through the Canadian River country and end at Conchas Dam. Trip leaders include Spencer Lucas, Adrian Hunt, Barry Kues, and Virginia McMleor. If you are interested in the Ogallala aquifer, problems of Mesozoic stratigraphy, sedimentation, and paleontology, or Pleistocene geoarcheology, this trip is for you!

For further information contact:

Spencer Lucas, New Mexico Museum of Natural History 1801 Mountain Road NW, Albuquerque, NM 87104 (505) 841-2873, slucas@nmnh.state.nm.us

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