Early Status of Sandia's Rural Arsenic Outreach Program, SAND2006-0088C

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Abstract:

Complying with the 10 ppb arsenic drinking water standard is particularly challenging in New Mexico by virtue of: (1) the desert climate, which makes wells the primary source of drinking water in many small rural communities and: (2) the high natural abundance of arsenic in several of the state's principal aquifers. Sandia National Laboratories has been tasked by the US Department of Energy with the job of aiding small rural communities to comply with the new drinking water standard.

Sandia's rural Outreach Program is a 1-year effort that started in August 2005 and is distinct from activities such as the Arsenic Water Technology Partnership (AwwaRF, WERC/NMSU, Sandia), which have been in operation for some years and have a significantly longer-term perspective. The Outreach Program started by coordinating its activities with personnel from other federal and state programs that are already hosting regional information meetings on the topic. Further, in cooperation with the Drinking Water Bureau of the New Mexico Environmental Department, we have also individually contact operators of many of the small systems seemingly in greatest need of help. These contacts go beyond the regional meetings to provide one-on-one site-specific help in assessing and overcoming barriers that are the greatest local impediment to progress. Sandia's substantial analytic capabilities will also be used fill information voids where data is unavailable on drinking water quality or the chemistry of nearby potential drinking water sources. Water quality data from across the state is also being compiled to identify new potential sources for low-arsenic water. Costing and decision analysis tools are being assimilated so that our Staff can work individually with operators to compare compliance strategies and assess likely costs. Finally, an important branch of our program provides the services of professionals knowledgeable in various funding strategies. The utility of these approaches is reviewed in light of the experience gained during the program's first six months of operation.

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Introduction:

Many factors conspire to make compliance with the new 10 ppb EPA mandated arsenic maximum concentration limit for drinking water (MCL) a particularly difficult problem for smaller water distribution systems in New Mexico. Volcanic activity, in conjunction with thick accumulations of relatively young sediments, makes trace amounts of arsenic a readily available commodity in many New Mexico aquifers. Secondly, because of the desert climate, these aquifers are often the only source of water in a community. In smaller systems it is also common to find that the water is not treated beyond chlorination. Consequently, many communities will be starting from scratch in constructing the infrastructure needed to address the arsenic (As) maximum contaminant limit (MCL, the EPA specified upper limit for a pollutant in drinking water). Finally, a socioeconomic structure based on agriculture has resulted in a substantial populace that resides small, widely dispersed farming (and ranching) communities. The great distances separating these communities, and the fact that median incomes are often close to the poverty level, preclude implementing policies that might, otherwise, be presumed to resolve this issue with little dislocation to the community.

A key step in formulating strategies to aid communities is to understand the scope of the problem relative to the statutory 10 ppb arsenic MCL and the number of people involved. Toward this end, data was obtained from the NMED (New Mexico Environmental Department) Drinking Water Bureau on the size (population served) of affected water systems and arsenic concentrations *thought to be* present (in most cases official compliance samples have yet to be taken so current data are just estimates). Arbitrarily, it was decided to not consider communities larger than Los Lunas (population listed as 11,353). In all, the total number of people covered by the survey came to 139,200. Further, if a system obtained water from several sources the populace was apportioned equally among the options. In detail this is a poor, but necessary, approximation given the absence of individual well production figures. Averaged over the state, though, the resulting picture is probably a reasonable representation of reality. Results are presented in the form of a cumulative plot showing what percentage of the affected populace receives water containing arsenic at between 10 ppb and a particular value of interest. For example, a technology that affordably treated water with 25 ppb As would solve the problem for about 85% of the impacted populace (brown lines, Fig. 1).

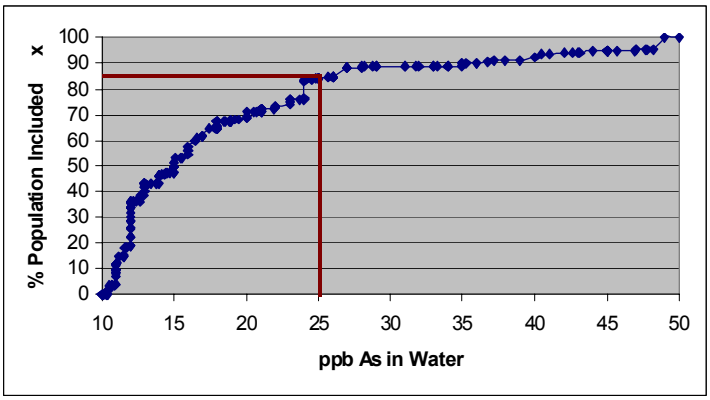

Fig. 1: Fraction of the impacted populace that receives water containing arsenic between 10 ppb and the level of interest.

Role of Outreach Program in Achieving Compliance:

Achieving compliance will involve the cooperation of many organizations and institutions, each with their own prerogatives and inherent scheduling constraints. To design a successful outreach program requires at least a general understanding of what the steps to compliance are, and the order in which they must be taken (Fig. 2). The situation presented to our working group is one in which a community will have to install a treatment plant, and is starting essentially from scratch (e.g., without a significant infrastructure already in place to treat some other aspect of water quality). Time and budget estimates were assembled from professionals in the relevant fields. Generally, when reviewed by professionals outside our working group it is remarked that, if anything, this is a rather optimistic perspective, and longer times or greater costs would not be at all surprising.

Two aspects of this analysis are of particular relevance to our Outreach Program; (1) the parts of the process accessible to outreach-based interventions are not, generally, steps likely to cause the longest delays (unless the delay that comes with not starting to deal with the problem at all is considered), and (2) in normal practice a water system (*without an exemption*) should not expect to reach compliance in time to avoid being found in violation of the MCL and, thus, having to enter into a compliance agreement with the NMED.

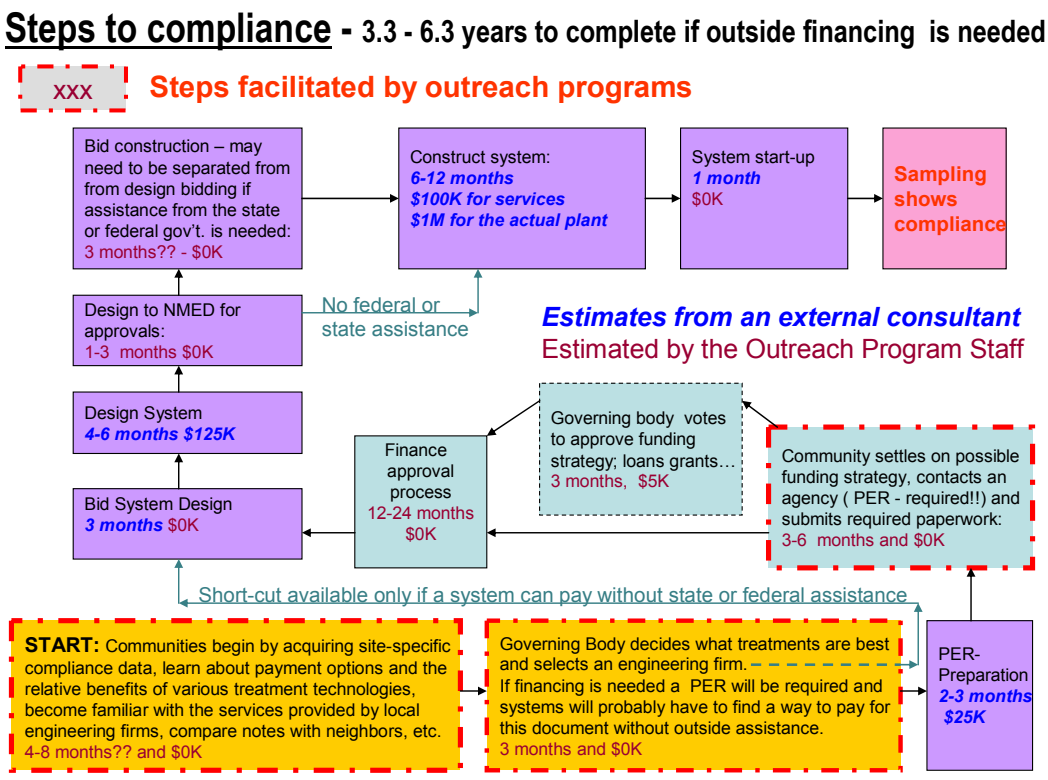

Fig. 2 Generalized flow diagram showing steps a community will follow to reach compliance with the 10 ppb As MCL. Parts of the process amenable to Outreach Program intervention have bold dashed borders.

Outreach Program Objectives:

Realistically, whether or not the actual compliance deadlines are met has little impact on the difficulty of (eventually) constructing a facility to extract the requisite amounts of arsenic, though the potential for fines, and other legal entanglements, would, obviously, motivate systems to expeditiously seek solutions to the problem. From Fig. 2, it is also apparent that evidence of overall success will be several years in coming, and will depend heavily on the initiative of the water systems themselves long after the 1-year tenure of the Outreach Program has expired. Thus, it was decided that a more tractable and immediate objective for the Outreach Program would be to assist water system personnel in becoming "smart customers" of the Preliminary Engineering Reports (PER) services that they will have to purchase from (local) architect/engineering firms.

A PER selects one technology from the many available options and advances a tentative, though site-specific, design. The design, however, is not a blueprint for construction; a task which must be bid separately at a later date. PER preparation is also the step where the first "real money" changes hands, since the architect/engineer will be need to be paid up-front, or the system will have to enter into a contract that includes the preparation fee as part of the overall construction cost. The latter option can be tricky since a completed PER is also commonly required *before* lending agencies will consider advancing the money needed to purchase (or contract for) a treatment system. In all, helping water providers to overcome the formidable psychological, technical and financial hurdles needed to lunch into PER preparation is what the Outreach Program is about.

Collaborations:

The Outreach Program is hardly the only resource available to aid communities in meeting their goals. Prior to funding of the Outreach Program (Aug. 2005, and expected to run for a year from that date) the RCAC (Rural Community Assistance Corporation) and WERC (originally the Waste-management, Education and Research Consortium) were holding regional workshops (the latter under Arsenic Water Technology Partnership auspices) to educate water system operators about the regulation, possible compliance technologies, and potential sources of financial aid. A major priority for the Outreach Program is to complement, rather than compete, with the resources that already existed to help impacted communities. In the case of WERC this collaboration has progressed to the point where it is possible to assign a (more or less) formal structure to the working relationship (Fig. 3).

Since the first round of workshops has been complete the future holds an increased emphasis on following up with individual water systems in one-on-one meetings. This, in turn, places an increasing emphasis on Sandia's participation. However, the shift toward Sandia will never reach 100% since there will always be cases where WERC, by virtue geography and of its long-term working relationships with particular organizations, will remain the appropriate contact. Early in 2006 the Outreach Program staff will meet with WERC to assign an appropriate case-worker to each system needing assistance, thus assuring a cooperative and coordinated approach to the problem.

Another important facet of the working relationship is an acknowledgement of the particular institutional strengths that it would be pointless (and impractical) for the other institution to duplicate. WERC (also under the continuing auspices of the Arsenic Water Technology Partnership) has specialized in developing computerized decision and cost assessment tools to aid in evaluating various treatment technologies (such as the CoAsT package available on line at: http://wercstation.nmsu.edu:8080/arsenic/dscript). In contrast, Sandia has significant analytic chemistry capabilities that are being used to feed the data needs of such programs and, potentially, provide answers to questions such as how to take advantage of the localized variations in water quality.

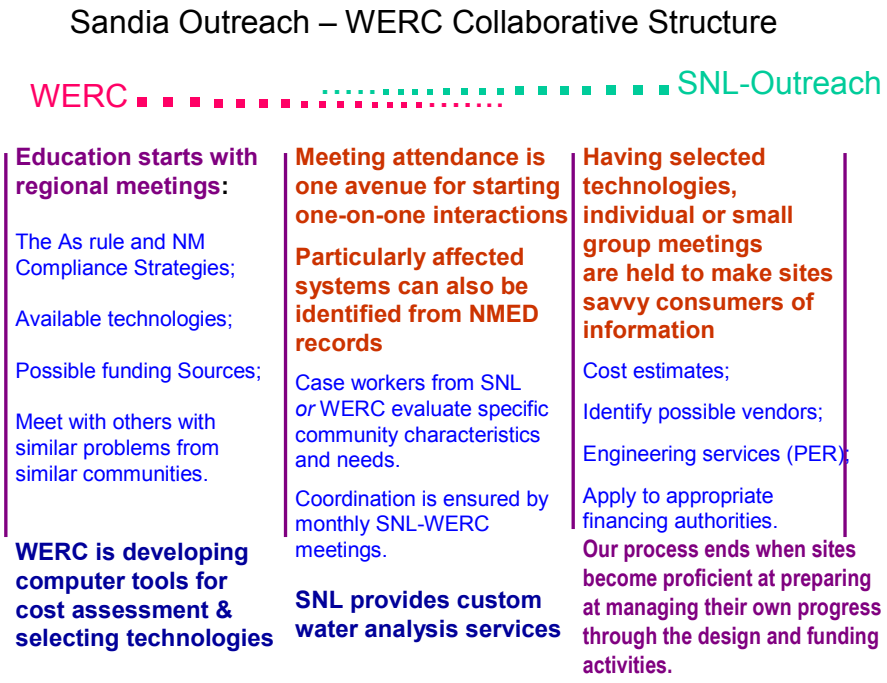

Fig. 3: Schematic for the WERC and the Sandia Outreach Program working relationship. Note, the schematic refers *just* to the scope of interactions with Sandia's Outreach Program. WERC, by virtue of its membership in the Arsenic Water Technology Partnership and its own internal programs, has a significantly longer-term involvement with outreach issues than is implied by the 1-year collaboration with Sandia's Outreach Program.

The internal structure of the Outreach Program is also inherently collaborative in nature. In addition to incorporating disciplines from several Sandia departments, staff from both the Civil Engineering Department at the University of New Mexico and the New Mexico Tech - Environmental Finance Center are contracted directly to the program. The program is also in the process of establishing a line of communication with the Indian Health Service and already has a good working relationship with personnel in the Drinking Water Bureau of the New Mexico Environment Department (Fig. 1 inputs, for example). The latter collaboration is of particular importance since the NMED is the ultimate arbitrator of when a system attains compliance, and their guidance is insures that Outreach Program activities remain channeled in productive directions.

Outreach Program Services:

As alluded to earlier, the Outreach program depends on the ability to meet face-to-face with individual water system operators (and their affiliated communities) in order to solve their individual problems. The core services that are the "engine" for this activity fall into several areas; (1) the collation, interpretation and application of data residing in external sources such as at the NMED, the NM Bureau of Mines, published geologic and hydrologic literature, etc., (2) the ability to provide comprehensive water analyses, (3) application of decision analysis tools to local needs, (4) regulatory interpretation and guidance, (5) assistance in applying for financial aid, (6) assistance with basic engineering questions (7) acting as a clearing house so that advances made by one system can be shared by others. The latter is of particular importance since many of the systems face very similar problems and it is not required (or even advisable) for each system to develop its own unique solution.

An example of the insights to be gained by exploiting existing databases is illustrated by applying data in Fig.1 to understanding whether a favored EPA compliance strategy ("dilution", EPA, 2003) is applicable in New Mexico. It is unlikely that a community here will find an alternate ground water source containing less than 4 ppb As, and there is probably no point to following a dilution strategy if the low-As to high-As water ratio in the mix is greater than one. This suggests that any system with greater than about 16 ppb As would find dilution to be impractical (20 ppb if the alternate source of water is from a RO unit that removes essentially all the arsenic). So, how useful is such a strategy likely to be in a place like New Mexico? Reference to Fig. 1 suggests that it could still solve the problem for roughly half the impacted populace, assuming that an alternate water source could be found. This, in turn, suggests that dilution could be a viable option in a significant number of cases, and that using Outreach Program analytic resources to find alternate low-As water sources is a reasonable courses to take.

In point of fact, very little is known about the local distribution of arsenic in NM aquifers so the ability of the Outreach Program to help communities understand the local variations in water quality could be of considerable help. This is particularly true in light of the fact that it is neither easy, nor inexpensive, for the communities to arrange for such work on their own. Beyond this application, the interface between the local water chemistry and the decision analysis tools also requires consideration. These tools may be essential to helping a community to choose the appropriate treatment technology and yet much of the essential information is not now available (or known). For example, the AwwaRF Model link in the CoAsT tool referred to earlier requires inputs on total As, the As(III) to As(V) ratio, pH, alkalinity (HCO_3^-), phosphate, silica, vanadium, and fluoride. Such data is not available for the individual wells in most water systems but will be provided by the Outreach Program. A process has also been initiated that will compile and compare cost estimates from the computerized tools with what is being sold on the market today.

As of this writing (Jan. 5, 2006) direct contacts have been made with 20 different water systems and samples analyzed for six of them (in both cases the number grows daily). In the twenty or so interactions to date it has become apparent that the community's greatest concerns relate to individualized matters such as what a system must do to apply for financing, whether a particular approach (typically being tried by a neighbor) might be workable, where the "good water is", and most often what the regulations actually mean and when they will be implemented. Because of this, it is typical for the Outreach Program to

arrange to have a spectrum of different professionals present at these meetings so that as many as possible of the questions can be addressed when they are first asked. In this way we intend to remove some of the amorphous uncertainty (and apprehension) surrounding the problem so that the discussion can transition quickly to topics that are essential for selecting an architect/engineering firm to aid in PER preparation.

Conclusions:

The present status of the individual systems determines how effectively the Outreach Program interventions will be at helping them to reach compliance. The program has made contact by mail with all of the potentially impacted systems, and has had one-on-one meetings with a considerable number of them. Consequently, we have assembled a standard list of "first concerns" and are in the process of developing answers to these issues. In parallel, we have established a number of very significant collaborations with the other "players" in the field. Finally, and perhaps of greatest importance, we were able to define where the Outreach Program "fits" into the overall compliance process (Fig. 2). Thus, we are increasingly better able to target our activities in areas where they will have the greatest benefit.

References:

USEPA, 2003, Arsenic Teatment Technology Evaluation Handbook for Small Systems, USEPA 816R030014.

Your Review and Approval request for document number 5238870, titled "Early Status of Sandia's Rural Arsenic Outreach Program", has been approved and assigned the following SAND Number: 2006-0088C. You may follow the link below for further information.