# A PRELIMINARY REVIEW OF CERTAIN COSTS OF THE SAFE DRINKING WATER ACT AMENDMENTS OF 1986 FOR COMMISSION-REGULATED GROUND WATER UTILITIES

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## Introduction

Amendments in 1986 to the Safe Drinking Water Act (SDWA) are leading to new water quality requirements for public water systems in the United States. In response to the request of the NARUC Water Committee, the National Regulatory Research Institute (NRRI) undertook an investigation of the economic impact of the SDWA on water utilities under the jurisdiction of state regulatory commissions. First, the NRRI completed a review of the literature on possible SDWA impacts. This task was finished in July 1987 with publication and distribution of the NRRI's Briefing Paper on the Economic Impact of the Safe Drinking Water Act Amendments of 1986. Second, the NRRI was to provide a preliminary empirical estimate of the economic impact of the SDWA on jurisdictional water utilities. This was to be done using existing financial models and currently available individual utility company data. This paper fulfills the second task. Costs for water utilities using ground water are highlighted here. The NRRI is concurrently preparing a paper on surface water treatment costs.

To establish general estimates of what the implementation of SDWA regulations might cost, the NRRI used financial data on private, commission-regulated water utilities in four states. The companies were not randomly selected, so conclusions about them cannot necessarily be applied to the population of water utilities regulated by the commissions nationally or within the four states sampled. In applying the conclusions of this paper, the reader must be aware that the extent of contamination of water supplies of commission-regulated water systems is not yet known. What a particular system has to pay for improved treatment under the SDWA depends on the actual occurrence of a contaminant at levels that must be treated and the choice of a treatment method.

The best available technique for estimating costs of the SDWA amendments within the short timeframe of our project turned out to be to apply EPA estimates of probable costs for various sizes of water systems faced with particular contamination problems to the utilities in our sample. It would have been costly, time-consuming, and redundant to attempt to parallel the highly complex decision analysis conducted by the EPA to estimate individual system costs, even though we have reservations about the accuracy of the EPA's model and have questioned whether the EPA estimates may be low.[1] The only other models that have been developed on costs of water quality improvements that we were able to identify required engineering and other data that were not included in the financial reports for our sample of water utilities.

Despite these caveats, the results of our analysis are suggestive of the range of likely costs of meeting SDWA requirements. EPA estimates of costs to treat various contaminants under the SDWA can be applied to water utilities like those in our sample to arrive at initial estimates of the increase in costs that an individual water company might face. According to EPA estimates, water companies like those in our sample might experience increases in annual bills of as little as $8 a year (for a medium-sized utility treating one contaminant) to as much as $797 a year (for a tiny utility treating multiple contaminants).

## Characteristics of Sample Water Utilities

The set of raw data immediately available to the NRRI to study the impact of the SDWA on commission-regulated water utilities was annual financial report data collected for a recent NRRI study (Mann, Dreese and Tucker, 1986). Commissions in Illinois, New York, and Missouri provided annual reports for 1984 for 26 investor-owned water companies under their jurisdiction. The North Carolina Public Utilities Commission in 1987 provided us with annual reports for 1985 for four more companies. Accordingly, companies in arid regions of the United States are not represented in this sample. Existing water bills are, of course, on average much higher in states with little rainfall.

We also had available aggregate financial data on small water utilities from the Survey of Operating and Financial Characteristics of Community Water Systems, prepared for the EPA in 1982 by Temple, Barker and Sloane, hereinafter referred to as "TB&S." The TB&S survey provides extensive information in tabular form on general characteristics, operating

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[1] These reservations are explored in the NRRI Briefing Paper on the Economic Impact of the Safe Drinking Water Act Amendments of 1986 (Columbus, NRRI, 1987).

characteristics, revenues and expenses, assets and liabilities, and trends for water systems across the United States. The survey used a random sample stratified on the basis of system size and ownership. The four ownership types were public, private, ancillary, and native American. "Private" water systems included those owned by homeowners' associations, investors, or a parent company. EPA has funded an update of the TB&S survey, to be released late in 1987. At the time of the writing of this paper, the new financial and operating data were not available.

Of the 30 water companies in our initial data set, 11 were eliminated from the sample. Nine were not used for lack of sufficient data. Two more were deleted from the sample because so few gallons were sold per connection that the companies appeared to serve seasonal populations. All of the 19 water utilities in the final sample use ground water as their source of supply.

The EPA generally defines water utilities serving 3,300 persons or less as "small." This corresponds to a system with 1,000 service connections, assumed to be serving 3.3 persons per connection. The most recent EPA estimates, however, assume 2.7 persons per connection. TB&S grouped water utilities by 12 size categories, four of them small. These groupings correspond to those used by the EPA for costs to individual utilities by system size. To compare the NRRI data with the TB&S data, we grouped our sample of water utilities into the EPA and TB&S size categories. The annual reports of the water utilities in the NRRI sample gave number of connections but not number of people served. To convert connections to population, we assumed each connection served three people and assigned the water utility to a population category accordingly. Since the conversion to population was only being used to assign the utility to a category, it was not necessary to be more accurate. No water utilities in the NRRI sample fall into the 501-1,000 population category. Table 1 shows characteristics of the NRRI sample and the averages for those characteristics for similarly sized private water utilities reported by TB&S.

The number of service connections for the water utilities in the NRRI sample ranges from 21 to 3186 (column 2). Four of the utilities are medium sized: they serve more than 3,300 people. In fact, those four companies serve closer to the "10,000 people served" that delineates the upper bound of the 3,301-10,000 person category than to the lower bound. The median

## TABLE 1

## PRODUCTION AND FINANCIAL CHARACTERISTICS OF SAMPLE WATER COMPANIES IN 1980, 1984 AND 1985

| (1) Population Category | (2) Number of Connections | (3) Gallons Sold (Millions) | (4) Gallons Sold per Connection (Column 3/ Column 2) | (5) Operating Revenues ($000) | (6) Water Revenue ($ per 1,000 Gallons) | (7) Water Bill per Connection (Column 4 times Column 6/1000) |
|---|---|---|---|---|---|---|
| 25-100 | | | | | | |
| Company H | 21 | 1.18 | 56,190 | 6.0 | 3.25 | 182.62 |
| NRRI Median (N=1) | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| NRRI Mean | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| TB&S Mean (N=21-30) | 36[1] | 2.95[2] | 82,800[3] | 6.1[4] | 2.06[5] | 170.57[6] |
| 101-500 | | | | | | |
| Company A | 66 | 5.00 | 75,758 | 5.3 | 1.06 | 80.30 |
| Company B | 82 | 7.04 | 85,854 | 24.3 | 3.42 | 293.62 |
| Company C | 115 | 10.43 | 90,696 | 22.5 | 2.13 | 193.18 |
| Company D | 79 | 5.77 | 73,038 | 17.6 | 3.05 | 222.77 |
| Company F | 52 | 3.61 | 69,423 | 9.5 | 2.64 | 183.28 |
| Company L | 71 | 9.94 | 140,000 | 38.1 | 3.83 | 536.20 |
| Company N | 81 | 6.46 | 79,753 | 25.3 | 3.99 | 318.21 |
| Company R | 72 | 5.21 | 72,361 | 14.0 | 2.69 | 194.65 |
| NRRI Median (N=8) | 79 | 6.46 | 79,753 | 17.6 | 2.69 | 222.77 |
| NRRI Mean | 77 | 6.68 | 85,860 | 19.6 | 2.85 | 252.78 |
| TB&S Mean (N=32-40) | 110 | 9.57 | 86,800 | 16.8 | 1.76 | 152.77 |
| 501-1,000 (NRRI N=0) | | | | | | |
| TB&S Mean (N=24-46) | 273 | 23.45 | 85,900 | 34.9 | 1.49 | 127.99 |
| 1,001-3,300 | | | | | | |
| Company E | 373 | 25.21 | 67,587 | 49.9 | 1.98 | 133.82 |
| Company S | 517 | 48.04 | 92,921 | 64.3 | 1.11 | 103.14 |
| Company T | 629 | 53.19 | 84,563 | 79.5 | 1.49 | 126.00 |

TABLE 1 (continued)

PRODUCTION AND FINANCIAL CHARACTERISTICS OF SAMPLE WATER COMPANIES IN 1980, 1984 AND 1985

| (1) Population Category | (2) Number of Connections | (3) Gallons Sold (Millions) | (4) Gallons Sold per Connection (Column 3/ Column 2) | (5) Operating Revenues ($000) | (6) Water Revenue ($ per 1,000 Gallons) | (7) Water Bill per Connection (Column 4 times Column 6/1000) |
|---|---|---|---|---|---|---|
| Company U | 413 | 120.70 | 292,252 | 285.6 | 2.37 | 692.64 |
| Company V | 359 | 27.79 | 77,409 | 49.5 | 1.73 | 133.92 |
| Company W | 565 | 22.58 | 39,965 | 63.5 | 2.26 | 90.32 |
| NRRI Median (N=6) | 517 | 48.04 | 84,563 | 64.3 | 1.73 | 133.82 |
| NRRI Mean | 476 | 49.59 | 109,116 | 98.7 | 1.82 | 213.31 |
| TB&S Mean (N=29-45) | 625 | 80.78 | 129,200 | 146.2 | 1.81 | 233.85 |
| 3,301-10,000 | | | | | | |
| Company AA | 3,186 | 343.20 | 107,721 | 415.0 | 1.21 | 130.34 |
| Company BB | 2,838 | 248.90 | 87,703 | 576.9 | 2.32 | 203.47 |
| Company CC | 3,134 | 243.60 | 77,728 | 688.8 | 2.83 | 219.97 |
| Company DD | 3,162 | 281.80 | 89,121 | 1,762.3 | 6.25 | 557.01 |
| NRRI Median (N=4) | 3,134 | 281.80 | 89,121 | 688.8 | 2.83 | 219.97 |
| NRRI Mean | 3,080 | 279.40 | 90,568 | 860.8 | 3.15 | 277.70 |
| TB&S Mean (N=29-47) | 1,840 | 282.50 | 153,500 | 361.6 | 1.28 | 196.48 |

Notes:

N.A. - Not applicable.

[1] Temple Barker and Sloane, II-5.

[2] Ibid, calculated from II-5 and III-5.

[3] Ibid, III-5.

[4] Ibid, II-5, III-5, and IV-5.

[5] Ibid, IV-5.

[6] Ibid, calculated from III-5 and IV-5.

Source: Annual reports of small private water systems from four states and Temple, Barker and Sloane, 1982.

number of connections served by the smaller water utilities in the sample (25-3,300 persons served) is 82, or about 250 people. The average number of connections in the TB&S sample was higher than for the NRRI sample for each population category.

Gallons sold annually ranged from five million to 343.2 million in the NRRI sample (column 3). TB&S averages were higher in every size category except the largest. Gallons sold per connection ranged from about 40,000 to almost 300,000 (column 4). TB&S averages were again substantially higher than those for the NRRI companies except in the 101-500 population category. Annual operating revenues from $5,300 to $1,762,300 were reported by the utilities in the NRRI sample (column 5). These were similar to the TB&S averages in the two smallest size categories, but not in the two larger ones. The lowest water revenue per 1,000 gallons in the NRRI sample was $1.06 (column 6), which for that company corresponded to an average annual water bill of $80.30 (column 7). The highest water revenue per 1,000 gallons for the NRRI companies was $6.25. The highest annual water bill was about $693.

For both water revenues per 1,000 gallons and annual water bill per connection, in the three size categories for which both NRRI and TB&S data were available, the NRRI mean exceeded the TB&S mean in two categories. This erratic pattern suggests that the small size of the NRRI sample explains some of the differences between the TB&S mean and the NRRI mean, as it does for the other variables reported. The TB&S sample of private water companies included homeowners' associations, which might have lower bills on average than investor-owned companies. Companies exceeding the TB&S means for water revenues and water bills could also have had more construction or have higher labor rates than those in the TB&S sample, and companies with water revenues and bills lower than the TB&S sample could have undertaken and paid for less construction and/or have lower labor costs. Inflation can explain some of the difference for the two categories where NRRI dollars were greater than TB&S dollars. TB&S data were in 1980 dollars and the commission-regulated companies' annual reports are from four and five years later. The consumer price index between 1980 and 1984 increased by 26 percent, and between 1980 and 1985 by 30 percent.

## Analytical Methods Reviewed

The NRRI reviewed several existing models for their applicability to our data but concluded that hand calculations using costs projected by EPA for various size water systems were the only feasible and most direct method.

The EPA's Water Utilities Policy Testing Model (PTm) was developed to compute national costs of compliance with maximum contaminant levels (MCLs). The model divides the population of water supply systems into ground and surface water sources, and within those categories into 12 system size categories. The model computes total fixed and variable costs of meeting a particular MCL. Inputs to the model are capital costs, operations and maintenance costs, occurrence of the contaminant, and treatment methods. Contaminant occurrence and treatment methods are used by the model as joint probabilities of occurrence of the contaminants at high levels and choices of particular treatment methods.

The PTm model runs on a mainframe computer. EPA has adapted PTm to run on an IBM microcomputer. We examined this IBM-AT version of PTm (called ATm) and found it unsuitable for simulation of the impact of the SDWA on individual companies without considerable manipulation of the software. As with the mainframe model, ATm is intended to generate aggregate national cost data. Nor was our data suitable for the ATm model. ATm requires inputs of actual or hypothetical data on influents and desired effluents of contaminants, which we did not have. Nor did we have available for our sample some of the production data necessary for the model.

The EPA's Water Engineering Research Laboratory in Cincinnati has developed a model that can be used for simulating costs of compliance for individual companies (Clark, 1984). But we lacked data on many of the key variables needed to use this model.

The Pluvius model, developed for EPA by Abt Associates, is an econometric model that estimates household water bills after new contaminant measures are put in place (Berry, 1985). Pluvius is based on data from 1980 for 357 water systems. As with the Engineering Research Laboratory model, the financial reports in our sample did not include data on some of the key variables necessary to estimate increased water bills under the model.

## Hypothetical Compliance Costs

Although we could not use our available data as inputs to the above models, it is possible to use the outputs from EPA models to calculate costs for hypothetical companies. These estimates can be computed by commissioners or commission staff using financial data available to them in company annual reports, without having to generate engineering or other data from sources outside the commissions.

Table 2 shows recent estimates by EPA of costs of treating various combinations of contaminants for water systems using ground water. Similar calculations are available for systems with surface water supplies. These estimates are examples that EPA culled from several "cost and technology" documents that are being prepared by EPA contractors as part of the information to be used in EPA's decision-making process in setting best available technologies (BATs) under the SDWA. Costs must be taken into consideration in setting BATs. The estimates quoted here are preliminary, but over the next year EPA plans to have published "cost and technology" documents for synthetic organic chemicals, inorganic chemicals, and radionuclides. The documents have already been completed for volatile organic chemicals and surface water treatment. In those documents, estimated costs by system size are to be given for each contaminant regulated under the SDWA. These cost figures can be used to provide a general estimate of the impact of treatment for a particular contaminant for a particular water utility.

The figures in table 2 can be combined with those in table 1 to present hypothetical cases of cost increases to commission-regulated water utilities. Table 3 gives some examples of the increases in water bills that hypothetical water companies similar to those in the NRRI sample, as shown in table 1, might experience if they were required to treat groups of contaminants such as those shown in table 2. Such a paper and pencil exercise can be conducted by individual commissioners or commission staff for water utilities in their states. This exercise is of course no substitute for an engineering study at a particular site, given the source and extent of a particular contaminant or group of contaminants.

TABLE 2

EPA PRELIMINARY ESTIMATES OF COSTS TO
GROUND WATER SYSTEMS FOR VARIOUS TREATMENT SCENARIOS

| Multiple Contaminant Scenarios | Treatments Required | Dollars per Household per Year System Size Categories (Population Served) 25-100 | 100-500 | 500-1000 | 1000-3300 | 3300-10K | 10K-25K | 25K-50K |
|---|---|---|---|---|---|---|---|---|
| Disinfected Groundwater Systems | | | | | | | | |
| Any scenario | New well + Chl | $235 | $138 | $86 | $55 | $31 | $16 | $13 |
| Aldicarb | GAC | 172 | 75 | 41 | 26 | 24 | 23 | 18 |
| TCE | Aeration | 135 | 51 | 24 | 13 | 8 | 8 | 8 |
| Nitrate | IE | 244 | 155 | 114 | 106 | 96 | 90 | 87 |
| Lead (natural) | IE | 160 | 90 | 61 | 55 | 52 | 46 | 44 |
| Aldicarb + Nitrate | GAC + IE | 416 | 230 | 155 | 132 | 120 | 113 | 105 |
| Nitrate + TCE | Aeration + IE | 379 | 206 | 138 | 119 | 114 | 98 | 95 |
| TCE + Lead (Corr) | Aeration + CI | 205 | 78 | 35 | 18 | 10 | 9 | 9 |
| Aldicarb + Nitrate + Lead (Corr) | GAC + IE + CI | 486 | 257 | 166 | 137 | 122 | 114 | 106 |
| Undisinfected Groundwater Systems | | | | | | | | |
| Any scenario | New well + Chl | 235 | 138 | 86 | 55 | 31 | 16 | 13 |
| Micro + Aldicarb | GAC + Chl | 311 | 126 | 64 | 37 | 30 | 27 | 21 |
| Micro + TCE | Aeration + Chl | 274 | 102 | 46 | 24 | 15 | 12 | 11 |
| Micro + Nitrate | IE + Chl | 555 | 281 | 178 | 143 | 126 | 117 | 108 |
| Micro + Lead (natural) | IE + Chl | 298 | 141 | 84 | 66 | 58 | 51 | 48 |
| Micro + Aldicarb + Nitrate | GAC + IE + Chl | 727 | 356 | 219 | 169 | 150 | 140 | 126 |
| Micro + Nitrate + TCE | Aeration + Chl + CI | 690 | 332 | 202 | 156 | 134 | 125 | 116 |
| Micro + TCE + Lead (Corr) | Aeration + Chl + CI | 344 | 129 | 57 | 29 | 17 | 13 | 12 |
| Micro + Aldicarb + Nitrate + Lead (corr) | GAC + IE + Chl + CI | 797 | 383 | 230 | 174 | 151 | 141 | 127 |

Key:
GAC = granular activated carbon; Aeration = packed tower aeration; IE = ion exchange; CI = corrosion inhibition; Chl = chlorination; TCE = trichloroethylene; corr. = corrosion; micro = microbiological contamination

Source: U.S. Environmental Protection Agency, "Total National Cost Estimate," handout by Michael Cook, Director, Office of Drinking Water, 10/13/87, dated 8/27/87.

TABLE 3

MINIMUM AND MAXIMUM TREATMENT BILLS FOR HYPOTHETICAL GROUND WATER SYSTEMS UNDER EPA MULTIPLE CONTAMINANT SCENARIOS, 1984,[1] 1985,[1] AND 1987[2]

| Type of Contaminant and Population Served | Current Water Bill | Additional Treatment Cost in Dollars | Total Treatment Cost in Dollars | Percent Increase |
|---|---|---|---|---|
| Trichloroethylene | | | | |
| 25-100 | $183 | $135 | $318 | 73.8% |
| 101-500 | 223 | 51 | 271 | 22.9 |
| 501-1000 | 128 | 24 | 152 | 18.8 |
| 1000-3300 | 134 | 13 | 147 | 9.7 |
| 3301-10,000 | 220 | 8 | 228 | 3.6 |
| Micro, Aldicarb, Nitrate and Lead | | | | |
| 25-100 | $183 | $797 | $980 | 435.5 |
| 101-500 | 223 | 383 | 606 | 1.72 |
| 501-1000 | 128 | 230 | 358 | 179.7 |
| 1001-3300 | 134 | 174 | 308 | 129.9 |
| 3301-10,000 | 220 | 151 | 371 | 68.6 |

Notes:

[1] Current water bills are derived from 1984 and 1985 annual reports of water utilities in the NRRI sample, except for the 501-1,000 population category, which uses TB&S data from 1980

[2] Additional treatment costs are in 1987 dollars, as computed by the EPA.

Source: Hypothetical current water bills are taken from the medians for the NRRI sample shown in table 1, except that for the 25-100 population category the one company in the NRRI sample is used, and for the 501-1000 population category the TB&S mean is used. Additional treatment costs are taken from the EPA estimates shown in table 2.

The examples in table 3 are given for the least costly and most costly EPA scenarios in table 2. Hypothetical current water bills are for the most part taken from the medians calculated for the NRRI sample in table 1. The data in the table suggest that the smallest size ground water system that already practiced disinfection and that had to install packed tower aeration to treat trichloroethylene (TCE), a volatile organic chemical, would need to increase its water bills by some 74 percent. At the other end of the spectrum, a very small ground water system not currently disinfecting that had to begin disinfection and install granular activated carbon, ion exchange, and corrosion inhibition to treat microbiological contaminants, two organic chemicals, and lead could be faced with water bills of $980 a year, an increase of 436 percent. The table shows the substantial economies of scale in treatment costs. Medium-sized systems such as the four in the NRRI sample would experience a 3.6 percent increase in annual water bills from treating TCE and a 68.6 percent increase from the most costly scenario.

## Next Steps

The effort to develop preliminary estimates of SDWA costs sets the stage for further work in program year 1988. The NRRI at this time is focusing efforts on upcoming EPA requirements for filtration and disinfection of water systems supplied by surface water. When the project on surface water is completed, we will be able to turn to other requirements of the SDWA. We will of course continue to track and analyze EPA information on costs, technologies, and regulatory impacts as it is developed. We will need to decide whether to develop data on ground water systems under commission jurisdiction similar to that on surface water systems. Such data gathering could be more structured, so that we can use either the cost model developed by the Water Engineering Research Laboratory or the Pluvius model developed by Abt Associates to estimate costs for individual companies. This is a decision that can be made after further review and analysis of the updated models and the updated EPA survey of operating and financial characteristics of water systems when it becomes available.

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