

# Cooperative Versus Individual Approaches to Treatment of Contaminated Groundwater by Rural Residents in the Northeast

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Point-of-use/point-of-entry treatment can provide an affordable means for rural residents on private wells to remedy groundwater contamination. Cooperation among homeowners was hypothesized to be a means of further reducing treatment costs due to quantity discounts and avoidance of dealer mark-ups. Data obtained through a mail survey of water treatment firms was used to test this hypothesis. Individual and group purchase, installation and maintenance costs and manufacturer and dealer costs were compared using analysis of variance. Results indicate a cooperative treatment approach may provide benefits due to quantity discounts but little potential exists for savings via direct manufacturer purchase.

Groundwater is an important rural resource; over 90% of rural households depend solely on underground water sources. Findings of contaminants in rural groundwater supplies have been reported with increasing frequency. Because of the spatial dispersion of homes in rural areas, residents relying on private wells have fewer economically feasible remedial options than residents in more populated areas. Water treatment within individual homes using point-of-use/point-of-entry (POU/POE) technology may provide an affordable means for rural residents to obtain safe potable water.

Solving water quality problems can be a complex matter. Information is needed on contaminants, possible health effects and safety standards, and appropriate methods for reducing exposure. An individual homeowner can be overwhelmed by the technical complexity of such decisions. If a number of homeowners draw water from the same polluted aquifer, contamination problems may be addressed more effectively through a cooperative approach. Cooperation in procurement of POU/POE systems would potentially reduce uncertainty and lead to

purchases of systems more appropriately matched to water quality problems. Forming a group may also permit homeowners to enjoy benefits unobtainable through individual action, such as a reduction in POU/POE treatment technology procurement, installation, and maintenance costs.

## *Previous Studies*

Sarnat used a dynamic risk assessment approach to evaluate treatment options in Whately, Massachusetts, where ethylene dibromide (EDB) and aldicarb, were detected in residential wells. Four alternatives were compared: do nothing, connect to a nearby community water system, construct a new water system, and POU/POE treatment. After future health risks associated with the contaminants were incorporated into the analysis, the "do nothing" option was determined to be the most economical. However, POU/POE treatment was found to be less costly than building a new community water system.

A case study of alternatives when pesticides were found in residential wells on Long Island also provides evidence that POU/POE units can be more economical than community systems (Baier). In Suffolk County, a variety of treatment alternatives were evaluated separately in different geographical areas. In three of five areas, the POU/POE option was the most economical and it ranked second in the other two areas.

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The authors gratefully acknowledge the helpful comments of Donald Epp and Jill Findeis, and anonymous reviewers of the Journal. The article is published as Journal Series Article No. 8121 of the Pennsylvania Agricultural Experiment Station. The research was funded by the Northeast Regional Center for Rural Development and the Pennsylvania Agricultural Experiment Station.

Given that POU/POE treatment will often cost rural residents less than community systems, a cooperative approach to use of POU/POE technology is hypothesized to be a means of further reducing costs. This study examined the potential for significantly reducing costs of POU/POE treatment through cooperation among homeowners and direct purchase from manufacturers.

### **Conceptual Analysis: Cooperative vs. Individual Approaches**

Homeowners interested in employing POU/POE water treatment technology to address groundwater quality problems can potentially save money in two ways. By cooperatively purchasing, installing, or maintaining treatment units, price discounts may be secured by purchasing larger quantities of products or services. Homeowners may also be able to procure treatment units directly from manufacturers and thus avoid payment of dealer-level mark-ups.

#### *Quantity Discounts*

At least two factors may contribute to the existence of quantity discounts—economies of size and group purchasing power. In the POU/POE industry, most manufacturing firms are relatively small and quantity discounts are not likely to be derived from production economies. However, price discounts could result from cost savings due to economies in the distribution of treatment units. Firms' costs are reduced when travelling to the same communities to distribute, install, and maintain units. Due to these cost savings, firms may be willing to offer reduced prices to large volume purchasers.

When a large number of treatment units are purchased, the buyer may obtain some bargaining leverage and ability to negotiate for a lower price. Since the POU/POE industry is not perfectly competitive, it can be expected that firms earn positive economic rents. If homeowners can increase their bargaining power by forming a purchasing group, they can capture some of these rents.

The existence of economies of size and the potential for exercise of consumer purchasing power against firms earning excess profits in an imperfectly competitive industry suggest a group purchasing arrangement may obtain per unit prices significantly lower than the single treatment unit price.

#### *Dealer Mark-Ups*

Homeowners may also save money by purchasing POU/POE units from manufacturers. Homeowners

that are willing to incur costs of search and other activities normally performed by the dealer and assume the possible risk of lower product support from manufacturers may be able to obtain a lower price.

Avoiding explicit payment does not necessarily mean a consumer has avoided all costs. Individuals who directly purchase from manufacturers must incur additional search and contractual costs. If these costs are less than expected benefits of making a direct manufacturer purchase, consumers are expected to be willing to make this transaction.

#### *Summary of Hypotheses*

Hypotheses regarding the potential feasibility of a cooperative approach to use of POU/POE treatment have been put forth. Specifically, the potential for reduced monetary costs through quantity discounts and the avoidance of dealer mark-ups are expected to make this treatment alternative less expensive than individual adoption of treatment units. Non-monetary factors, such as transaction costs and community characteristics, may also influence the success of a cooperative approach. The following sections empirically address hypotheses relating to monetary variables. A discussion of non-monetary factors affecting cooperative treatment can be found in Klinko.

#### **Data Collection**

To obtain data needed to make comparisons between individual and cooperative purchase costs and between manufacturer and dealer costs, a survey instrument was developed and administered via mail to a sample of industry firms. The survey was sent to manufacturers nationwide and dealers in the Northeast. For four treatment technologies, firms were asked to provide the selling price for one unit and the percentage discount they would give per unit if selling to groups of 10, 30, 70, and 100 people. Information was also requested for charges for installation and maintenance services.

The Total Design Method (Dillman) was used to develop the mail questionnaire and survey procedures. After three mailings, the response rate was 20%. Follow-up telephone interviews with a sample of 20 randomly selected non-responding firms indicated that the relatively low response rate resulted from the fact that a large proportion of non-respondents did not return the questionnaire because it did not apply to their firms' situations. Sample sizes ranged from 43 to 110 across the four technologies.

## Empirical Results

A greater percentage of manufacturers than dealers responded to the survey. Responses were geographically biased in favor of the northeastern United States because only dealers in this region were surveyed.

### *Savings from Cooperation*

Analysis of variance (ANOVA) was used to statistically compare the cost of a one-unit purchase to the per unit cost when purchased in quantity. If prices were found to be significantly different from each other, the hypothesis that collective procurement results in savings to homeowners in the form of quantity discounts was not rejected. This comparison was made for the mean purchase price only, the mean purchase price plus installation cost, and the mean yearly maintenance cost. All four treatment technologies were analyzed for group sizes of 10, 30, 70, and 100.

The results for the comparison of individual to group costs for the purchase price alone are presented in Table 1. For purchasing treatment units only, the results indicate that groups of 70 and 100 homeowners obtain significantly lower prices for most technologies, while prices for groups of 10 and 30 homeowners were not significantly lower than single unit purchases.

When installation costs are included (Table 2), the number of group sizes for which the difference in purchase price was significant at the 5% level

increased. Firms appear to be more willing to reduce installation charges than purchase prices, especially for smaller group sizes. However, little potential exists for groups to save on maintenance services (Table 3). In no case was the difference between the individual and group maintenance charge significantly different from zero.

In cases where individual and group prices were significantly different, the potential exists for a procurement group of that particular size to obtain savings in the form of quantity discounts. Based on the results for the four POU/POE treatment technologies studied, the potential for homeowners to obtain cost savings through cooperation, particularly for purchase and installation, appears to be considerable.

### *Savings from Direct Manufacturer Purchase*

Mean manufacturer and dealer prices were compared to determine the potential for savings through direct manufacturer purchase. In three of four cases, manufacturer prices were actually higher than dealer prices which is opposite of the expected relationship (Table 4). In no case were these differences statistically significant. Consequently, the hypothesis that manufacturer prices are lower than dealer prices was rejected for all four treatment technologies. These unexpected results do not necessarily imply that manufacturers' prices are not significantly lower than dealers'. Limitations in the survey or possible strategic firm behavior may have prevented measurement of actual price differences.

**Table 1. Mean Values and Statistical Significance of Differences in Purchase Prices by Group Size**

	$\bar{P}_1$	$\bar{P}_{10}$	$\bar{P}_{30}$	$\bar{P}_{70}$	$\bar{P}_{100}$
POU Carbon Filtration	416.63 [110]	395.30 (0.375) [101]	377.61 (0.693) [101]	358.36 (1.045) [99]	334.09 (1.503) [100]
Reverse Osmosis	701.00 [105]	641.00 (1.186) [99]	611.50* (1.857) [99]	580.22* (2.565) [98]	549.98* (3.276) [99]
POE Carbon Filtration	731.94 [105]	674.96 (1.232) [96]	640.32 (1.514) [95]	612.13* (2.000) [95]	574.16* (2.719) [96]
Chlorination	909.93 [79]	832.65 (0.886) [68]	777.11 (1.550) [67]	732.37* (2.145) [67]	680.29* (2.853) [69]

Numbers in parentheses are t-values for the one tailed test  $\bar{P}_1 = \bar{P}_2$

\*Significant at the 5% level.

Numbers in brackets are samples sizes (N).

**Table 2. Mean Values and Statistical Significance of Differences in Purchase and Installation Prices by Group Size**

	$\bar{P}_{I_1}$	$\bar{P}_{I_{10}}$	$\bar{P}_{I_{30}}$	$\bar{P}_{I_{70}}$	$\bar{P}_{I_{100}}$
POU Carbon Filtration	521.51 [86]	446.37 (1.371) [62]	427.82 (0.906) [61]	403.72* (2.181) [61]	394.89* (2.346) [62]
Reverse Osmosis	823.50 [93]	735.68 (1.350) [68]	711.10* (1.745) [65]	669.69* (2.626) [65]	629.91* (3.164) [67]
POE Carbon Filtration	935.51 [88]	814.68 (1.430) [62]	783.24* (1.808) [61]	737.02* (2.394) [62]	707.73* (2.778) [63]
Chlorination	1062.62 [65]	962.37 (0.934) [44]	930.09 (1.240) [43]	873.10* (1.820) [43]	801.36* (2.615) [45]

Numbers in parentheses are t-values for the one tailed test  $\bar{P}_{I_1} = \bar{P}_{I_z}$  where z represents the group size.

\*Significant at the 5% level.

Numbers in brackets are samples sizes (N).

**Table 3. Mean Value and Statistical Significance of Differences in Maintenance Charges by Group Size**

	$\bar{M}_1$	$\bar{M}_{10}$	$\bar{M}_{30}$	$\bar{M}_{70}$	$\bar{M}_{100}$
POE Carbon Filtration	278.63 [73]	253.16 (0.341) [49]	242.93 (0.487) [50]	235.67 (0.587) [49]	225.34 (0.741) [50]
Reverse Osmosis	117.70 [82]	99.84 (1.029) [50]	98.04 (1.129) [49]	93.71 (1.380) [49]	89.53 (1.638) [50]
POE Carbon Filtration	203.99 [69]	198.09 (0.215) [46]	189.13 (0.546) [47]	183.20 (0.771) [46]	172.29 (1.206) [48]
Chlorination	268.71 [57]	222.48 (0.560) [36]	221.55 (0.570) [35]	215.95 (0.638) [35]	205.03 (0.781) [36]

Numbers in parentheses are t-values for the one tailed test  $\bar{M}_1 = \bar{M}_z$  where z represents the group size.

Numbers in brackets are samples sizes (N).

**Table 4. Differences in Mean Manufacturer and Dealer Purchase Price**

	POU Carbon Filtration	Reverse Osmosis	POE Carbon Filtration	Chlorination
$P_D - P_M$	– \$ 107.61 (1.140) [28, 78]	– \$ 23.63 (0.315) [44, 60]	\$ 31.21 (0.296) [29, 77]	– \$ 193.93 (2.78) [33, 46]

Numbers in parentheses are t-values for the one-tailed test  $\bar{P}_D - \bar{P}_M$ .

Numbers in brackets are samples sizes for dealers and manufacturers, respectively.

Several alternative explanations for the unexpected results are offered here and elaborated upon by Klinko. Allowing firms to classify themselves into manufacturer or dealer categories may have limited the ability to compare price differences. For example, some firms that manufacture units and also have a franchised dealership classified themselves as dealers. Alternately, dealers who assemble components of various manufacturers into a treatment system may have classified themselves as manufacturers. The self-classification approach may have limited this study's ability to measure differences in manufacturer-dealer prices.

Firms may also have acted strategically when giving responses to the survey. For instance, manufacturers may have a varying price schedule, charging residential customers higher prices than they charge dealers in order to protect dealer franchises. Another possibility, given the results for quantity discounts above, is that dealers make greater profits on installation and maintenance services than on the product itself. This explanation is supported by survey results indicating that dealers are more likely to provide installation and maintenance services. Since manufacturers do not usually provide these services, they may need to make profits on the sale of units. In addition, larger manufacturers may be less interested in relatively small purchases from homeowners due to the higher transaction and shipping costs per unit compared to their normal customers.

In sum, there are strong theoretical reasons to expect manufacturer prices to be lower than dealer prices and for direct manufacturer purchases to yield cost savings. The empirical results suggest that manufacturer and dealer prices are not significantly lower than dealers. However, limitations in the research design or strategic firm behavior may have prevented measurement of actual price differences.

### **A Case Example: Lake Carmel Water Quality Improvement District**

Four applications of POU/POE treatment on an area or community-wide basis were identified in the U.S. Cooperative action by homeowners to procure and manage POU/POE technology only occurred in an application near Lake Carmel, in Putnam County, New York. In the other three applications, a government agency was the driving force behind the treatment decision. All residences in the vicinity of Lake Carmel, located approximately 50 miles north of New York City, have private wells and septic systems. Volatile organic chemicals were

detected in 110 residential wells. When individual action to address the contamination problem failed to produce results, affected homeowners formed a citizens' committee and enlisted the aid of their legislators. Subsequent investigations by state officials led to the recommendation that a public water system be constructed. Because of the expense of such a system, estimated at \$1200 per household per year, the citizens' committee chose to study the feasibility of POU/POE treatment. The committee gathered information on the contaminants and remedial alternatives, hired an engineer, and obtained a grant from the U.S. Department of Housing and Urban Development. Funds were administered through a local municipality and used to pay an engineer to design the systems and for purchasing and installation. The six components of the point-of-entry system that was designed were put out for bid separately resulting in a final cost of \$1317 per system. Sixty-seven of 110 affected homes elected to receive the treatment systems. The local municipality gave responsibility for operation and maintenance of the units to 67 homeowners who formed a non-profit corporation, the Lake Carmel Water Quality Improvement District. Homeowners in the district are provided with replacement cartridges and maintenance workers hired by the district repair and regularly clean the treatment units. The district's costs for monitoring, operations, and maintenance have been about \$250 per household per year for its first four years of operation (Stasko).

### **Concluding Comments**

Previous studies provide evidence that POU/POE treatment technology can be the most economic alternative for rural homeowners facing ground-water quality problems. Results from this study indicate a cooperative approach to using POU/POE systems may have monetary benefits due to quantity discounts. Cooperative action appears to be a viable means of reducing the cost per homeowner of purchasing and installing certain types of treatment units. However, the study results suggest that little potential exists for homeowner savings via direct manufacturer purchase.

Forming a group to cooperatively purchase POU/POE treatment devices is not a costless activity. Organizing the affected homeowners and reaching agreement can take considerable time and effort. Successful implementation of such approaches will depend on whether cost savings resulting from

quantity discounts exceeds the costs of collective decision-making.

The experience of the Lake Carmel Water Quality Improvement District provides some indication of the potential for cooperative approaches to using POU/POE treatment technology to address groundwater contamination. This application demonstrated that a cooperative POU/POE treatment can be a viable means of providing safe potable water at reasonable cost to rural homeowners. The Lake Carmel application suggests that cooperation also provides other benefits such as a reduction in transaction costs associated with complex water treatment decision-making.

Finally, an organized group should increase the likelihood that future maintenance of treatment units will not be neglected. Although, the survey results indicated little potential for discounts on maintenance services, a group approach to maintenance may provide other important benefits. If homeowners can organize to ensure proper maintenance of POU/POE units, these systems may gain further acceptance as not only an economical, but a safe water treatment alternative.

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