



# COST EVALUATION OF POINT-OF-USE AND POINT-OF-ENTRY TREATMENT UNITS FOR SMALL SYSTEMS: COST ESTIMATING TOOL AND USER GUIDE

## **Acknowledgements**

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## **Disclaimer**

This document provides a description of a costing tool developed to assist stakeholders with estimating costs for a centrally managed POU or POE strategy to comply with drinking water regulations. This document does not establish regulatory requirements, nor is it a regulation, itself. With respect to the costing tool, neither the U.S. Environmental Protection Agency nor any of its employees makes any warranty, express or implied, regarding the cost estimates generated using this tool. Its cost outputs do not represent formal offers to provide equipment or services for products or services included in the price tables. In addition, mention of specific products does not constitute an endorsement by either the U.S. Environmental Protection Agency or any of its employees.

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## Acronyms

ANSI	American National Standards Institute
BLS	Bureau of Labor Statistics
GAC	granular activated carbon
gpd	gallons per day
mgd	million of gallons per day
NSF	NSF International (formerly National Sanitation Foundation)
O&M	operating and maintenance
POE	point-of-entry
POU	point-of-use
RO	reverse osmosis
SDWA	Safe Drinking Water Act
SSCT	Small System Compliance Technologies
SOC	synthetic organic compounds
U.S. EPA	U.S. Environmental Protection Agency
UV	ultraviolet
VOCs	volatile organic compounds

# 1. Introduction

The Safe Drinking Water Act (SDWA) Amendments of 1996, as well as a number of other statutes and executive orders, require that the U.S. Environmental Protection Agency (EPA, or the Agency) estimate regulatory compliance costs as part of its rulemaking process. EPA estimates these costs at a system level for central treatment technologies and for point-of-use (POU) and point-of-entry (POE) devices, which EPA has listed as Small System Compliance Technologies (SSCTs) for several contaminants.<sup>1</sup> Although POU and POE devices use the same contaminant removal processes as central treatment technologies, these devices treat smaller water volumes because they are installed at the user location and treat only the water that must meet certain health standards. A POU device treats the water used primarily for drinking and cooking and is often installed at a single water tap. A POE device is installed at the water entry point for a home or nonresidential facility to treat all the water entering the facility for use.

EPA estimates costs at the system level by identifying cost components such as equipment and labor requirements and applying unit costs based on vendor data and national labor rates. This cost build up method can also be used by small drinking water systems to estimate site-specific costs for a POU or POE compliance strategy. Consequently, EPA is making the cost estimating tool it developed for national cost analysis available to small systems that want to use it to develop site-specific estimates. In addition, EPA added features to enhance the tool's flexibility for site-specific use.

## 1.1 Purpose

This report serves as documentation for EPA's cost tool that estimates system-level costs for a POU or POE compliance strategy (the POU/POE model). The model was developed as a companion tool for the *Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems* (U.S. EPA, 2006; hereafter called "EPA Guidance"). The cost estimates generated by the POU/POE model include capital and operating and maintenance (O&M) costs to implement and maintain an effective program that uses POU or POE devices to comply with drinking water standards. EPA based the cost components in the POU/POE model on information contained in the EPA Guidance. This guidance provides additional information regarding regulatory requirements, technology options and considerations, and POU and POE program elements and considerations. In addition, document appendices to the EPA Guidance provide sample documents (e.g., model ordinance language and access agreements, sample monitoring and maintenance logs, and sample public education flyers). Finally, it contains case study summaries for several active compliance programs.

## 1.2 Document Organization

The documentation requirements for the POU/POE model are two-fold given its distribution as a tool for system-level cost analysis. Chapter 2 provides a description of the model structure and

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<sup>1</sup> EPA defines small systems as those serving 10,000 or fewer people.

contains documentation for the default assumptions and data in the model. These assumptions and data provide examples of the types of values that EPA may use when it develops cost estimates for policy analysis; they may not reflect conditions for a specific system. Chapter 3 contains a user guide that explains how to use the model to develop costs for a user-defined POU or POE program. It is important to note that the POU/POE model does not replace the need for systems to obtain professional engineering services noted in EPA Guidance. It is first and foremost a tool for EPA to use in conjunction with other cost tools for its national cost analysis. EPA has added the features described in Chapter 3 to allow stakeholders to easily replace default inputs with site-specific information, thereby creating a tool for rapid system-level cost modeling.



## 2. Cost Model Description

The cost tool for POU and POE devices provides cost estimates for the elements of a POU/POE compliance strategy as identified in EPA Guidance. The capital costs identified in the guidance pertain to device purchase and installation, public education, and various engineering, permitting, and legal activities, which are often referred to as indirect capital costs. The O&M costs in the guidance document include device maintenance, water quality monitoring, residual disposal, public education, and insurance coverage.

Exhibit 2.1 shows the costs included in the POU/POE model and provides general descriptions for cost calculations. In most instances, the model cost categories correspond with the EPA Guidance cost categories. Among the notable differences are that POU/POE model's capital costs include initial water quality monitoring costs and the model's O&M costs do not include line items for residual disposal or insurance coverage. Including an initial round of sampling in the capital cost section allows for differences between sampling requirements during the first year following installation and long-term monitoring requirements. Incremental insurance coverage costs are not likely, especially if POU or POE devices are installed by vendor representatives or licensed plumbers. Similarly, EPA assumes that most residual disposal will involve very small increases in traditional household waste streams (e.g., replaced filters are disposed in the household trash and sporadic flows for liquid wastes enter either a sanitary sewer system or a septic system).

**Exhibit 2-1. Cost Estimates Generated by the POU/POE Model**

Item	Description
<b>Capital Costs<sup>1</sup></b>	
Treatment device purchase	Cost to purchase treatment devices (cost per device x number of devices)
Treatment device installation	Labor costs for time to schedule and install treatment units (hours per device x number of devices x wage rate)
Educational materials	Labor costs and material costs to prepare and distribute materials that explain the treatment program to customers (hours or items per task x task frequency x wage rate or unit cost)
Initial water quality monitoring	Labor, shipping, and analysis costs for the initial sample taken during the first year following equipment installation (hours or costs per sample x number of samples x wage rate)
Indirect capital costs	Costs for permitting, pilot study, engineering, legal, and contingency (either cost multipliers or fixed dollar values)
<b>O&amp;M Costs<sup>2</sup></b>	
Device maintenance	Labor time and material costs to replace treatment device parts such as filters (labor or material costs per replacement x replacements per year)
Educational materials	Labor time and material costs to update and distribute materials that explain the treatment program to customers (hours or items per task x annual task frequency)
Annual water quality monitoring	Labor time, shipping, and analysis costs for the annual samples taken to monitor water quality (hours or costs per sample x number of samples per year)
1. Capital costs occur in the initial year, but do not occur again until complete replacement of the treatment units.	
2. O&M costs occur annually and include costs for regular equipment replacement such as filter cartridges.	

These cost estimates are transparent because the model allows a user to see the calculations and trace formula inputs back to their source data.<sup>2</sup> Source data include user-provided values and default values contained in the model. Input values identify the type of contaminant of concern and the type of technology used for treatment as well as factors that affect the number and cost of the items listed in Exhibit 2-1 such as the number of affected households.

The POU/POE model is a Microsoft Excel workbook that contains seven interactive worksheets, which are described in the following sections.<sup>3</sup> The names on the worksheet tabs are:

- Input
- User Input
- Capital Assumptions
- O&M Assumptions
- Control
- Price Tables
- Output.

## **2.1 Model Inputs – Input and User Inputs Worksheets**

The POU/POE model operates in two modes. The default mode, which is primarily intended for policy analysis, uses standard system sizes and default input assumptions to estimate costs. A second mode allows a user to define a system by specifying input assumptions and unit costs.

Each mode has its own input worksheet. The Input worksheet controls model settings for the default mode and the User Input worksheet controls model settings for the “user-defined” mode. Mode selection occurs on the Input worksheet. This chapter primarily focuses on the data and assumptions that apply in the default mode. These values can also be used in the user-defined mode when site-specific information is missing. Chapter 3 provides supplemental information on how to use the model and, in particular, how to enter user-defined values.

### **2.1.1 Target Contaminant and Treatment Technology**

Regardless of operating mode, the initial input requirements are the same. The first input is the target contaminant, which is selected from the drop-down list provided in the model. The second input is a treatment technology. The list of applicable technologies depends on the contaminant selected because treatment effectiveness varies by contaminant. Furthermore, the types of devices with third-party certifications for meeting ANSI/NSF standards also vary by contaminant. ANSI-accredited certification organizations include NSF International, the Water Quality Association, Underwriters Laboratories, and CSA International. Relationships between contaminants and approved technologies will evolve over time as new technologies are tested

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<sup>2</sup> Viewing formulas and using the Formula Auditing toolbar to help identify precedent and dependent cells requires a worksheet be unprotected. To unprotect a worksheet, select Tools, Protection, and Unprotect sheet. If you are prompted for a password, do not enter one; just leave the password space blank and click on OK.

<sup>3</sup> Development versions of the model will contain additional documentation sheets and may contain Visual Basic modules required by the model.

and approved and as the list of regulated contaminants changes. Exhibit 2-2 provides a summary of the contaminants and technologies in the current version of the POU/POE model. The model also provides an option to add UV disinfection to any POU/POE device. The model does not include pretreatment technologies that are not included in POU/POE devices. Such costs, if applicable, would need to be accounted for separately.

**Exhibit 2-2. Summary of Contaminants and Treatment Technologies in the POU/POE Model**

<b>Contaminant</b>	<b>Types of Devices Certified under ANSI/NSF Standards</b>
Radium	POU Reverse Osmosis, POE Cation Exchange
Arsenic	POU Adsorptive Media NSF53, POU Reverse Osmosis
VOCs	POE GAC <sup>1</sup>
SOCs	POU GAC, POE GAC <sup>1</sup>
Nitrate	POU Reverse Osmosis
Barium	POU Reverse Osmosis, POE Cation Exchange
Cadmium	POU Reverse Osmosis
Chromium	POU Reverse Osmosis
Copper	POU GAC, POU Reverse Osmosis
Fluoride	POU Reverse Osmosis
Lead	POU GAC, POU Reverse Osmosis
Mercury	POU GAC
VOCs = volatile organic compounds SOC = synthetic organic compounds GAC = granular activated carbon  1. There are no certified devices in this category so the price data indicate \$0/unit. To prevent this price from generating incorrect compliance cost estimates, POE GAC is not included in the treatment technology list on the Control worksheet. Similarly, to avoid missing technology data errors, VOCs will not be explicitly included in contaminant list until certified devices are available.	

The default assumptions such as installation time and default prices such as the price to purchase a treatment device correspond primarily to the treatment technologies. Nevertheless, some default assumptions or prices such as lab analysis costs are contaminant specific.

### **2.1.2 Service Population**

The model estimates costs on a per-household basis. For example, the cost estimate for a POU compliance strategy for 50 households will include equipment purchase and installation costs for all 50 households, as well as annual maintenance and monitoring costs for 50 households.

In the Standard System operating mode, the model derives service population estimates based on the design flow information provided on the Input worksheet. The model uses statistical relationships between the population and flow values that EPA estimated from survey data collected through the Community Water System Survey. These relationships vary by source

water.<sup>4</sup> Consequently, the Input worksheet contains a drop-down list with water source options (i.e., ground water or surface water). Chapter 3 describes two options for user-defined service population data in the User-Defined System mode.

## 2.2 Capital Assumptions Worksheet

The Capital Assumptions worksheet contains default values for the nonprice parameters or assumptions required to estimate capital costs; all price information is on a separate worksheet addressed in a later section. The default assumptions can vary by treatment technology, so in most cases there is a column of values for each treatment technology in the POU/POE model. Exhibit 2-3 provides a list of the capital assumptions in the POU/POE model. Chapter 3 describes how a user can override default assumptions such as these to include site-specific information.

Exhibit 2-3 also illustrates default values for two of the POU treatment technology options. For example, the model calculates equipment installation costs for the POU/POE treatment device selected and for UV if that option is selected. One assumption needed to estimate installation costs is the amount of time required to install the devices. The default values in Exhibit 2-3 indicate that the model includes a 1-hour installation time for the POU/POE device and a 30-minute period for administrative time and scheduling time (i.e., contacting the household to schedule installation) if the treatment technology is POU Adsorptive Media NSF53, which is approved for arsenic removal to meet the arsenic standard. If, however, the treatment technology is the rental option for POU reverse osmosis (RO), then there are zero hours for scheduling and installation because EPA assumed that these costs are included in a monthly or annual service contract. Consequently, they enter the cost analysis as O&M costs rather than capital costs.

The technology selection on the Input worksheet (or the User Input worksheet when operating the model in User-Defined System mode) dictates which column of default values appear in the Output worksheet and, therefore, generate capital costs. The following sections provide background information for the input parameters and the default assumptions in the POU/POE model. Note that the Capital Assumptions worksheet contains only quantity assumptions (e.g., number of hours or number of flyers). The prices assigned to various activities are on the Price Tables worksheet, which is addressed in a later section.

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<sup>4</sup> For ground water systems, the relationship is  $\text{population} = [(\text{design\_flow} * 1000) / 0.54992]^{(1 / 0.95538)}$ , where  $\text{design\_flow}$  is measured in million gallons per day (mgd). For surface water systems, the relationship is  $\text{population} = [(\text{design\_flow} * 1000) / 0.59028]^{(1 / 0.94573)}$ . In both instances, the population estimate is then converted to an estimate of households:  $\text{household connections} = \text{population} / \text{hh\_size}$ , where  $\text{hh\_size}$  is a parameter representing average household size. Systems that also serve nonresidential customers may need to incorporate costs for these customers one of two ways. The first method involves converting these customers to residential equivalents to use in the POU/POE model (e.g., if the POU device purchase and installation costs for each nonresidential customer are approximately three times higher than a residential customer, then convert each nonresidential customer to three household equivalents for modeling purposes). The second method is to estimate nonresidential costs separately without the model and aggregate residential and nonresidential costs.

**Exhibit 2-3. Summary of Design Assumptions for Capital Costs with Example Default Values for Two POU Technologies**

Parameter	Units	POU RO Rental	POU Adsorptive Media NSF53
<b>Equipment Installation</b>			
POU/POE Installation	hrs/household	0.00	1.00 <sup>1</sup>
Scheduling Time	hrs/household	0.00	0.50
UV Installation (when UV is excluded)	hrs/household	0.00	0.00
<b>Public Education Program</b>			
<b>Technical Staff Time:</b>			
Develop materials	hrs	10.0	10.0
Nitrate health effects	hrs	5.0	5.0
Meetings	hrs	2.0	2.0
Post-meeting	hrs	2.0	2.0
<b>Clerical Staff Time:</b>			
Develop materials	hrs	6.0	6.0
Nitrate health effects	hrs	5.0	5.0
Meetings	hrs	2.0	2.0
Post-meeting	hrs	2.0	2.0
<b>Education Materials:</b>			
Meeting flyers	flyers	10	10
Meeting ads	ads	1	1
Nitrate awareness flyers	flyers	10	10
Meeting handouts	pages/household	3	3
Billing mailers	pages/household	2	2
<b>Monitoring</b>			
Sampling time	hrs/sample	0.25 <sup>2</sup>	0.25 <sup>2</sup>
Sampling scheduling time	hrs/sample	0.00 <sup>2</sup>	0.00 <sup>2</sup>
Analysis	samples/household	1	1
Frequency	% households sampled	100.0%	100.0%
<p>1. Peer review comments indicated that default installation time assumptions should be 1 hour for most POU devices and 2 hours for POU RO and POE devices.</p> <p>2. Peer reviewers recommended that the initial monitoring sample be taken during the installation visit, which would minimize the incremental sampling time and avoid the need to schedule a sampling visit. The model retains the option, however, for installation and sampling to occur independently.</p>			

### **2.2.1 Equipment Installation**

Installation of the POU and POE devices will be the responsibility of the local water system or utility. The utility can, however, hire a licensed plumber or representative of the product manufacturer to install the devices. Based on the variety of plumbing issues encountered among older housing units in a rural community, NSF (2005) recommends using an experienced plumber to perform the installations. Units requiring power connections (e.g., aeration towers) may also require a professional electrician assist with the installation.

Equipment installation costs POU/POE model include labor costs for installation as well as the costs to purchase the devices. The model contains a default estimate of two hours per household to install most POU and POE devices. A variety of factors such as existing plumbing conditions and travel distance will affect installation times across sites. This estimate represents an average time across sites, taking into account differences in installation conditions and location. Section 2.5 describes the wage rate used to value installation costs as well as the purchase prices for the POU or POE devices.

The estimate is consistent with case study data. In the Grimes, CA arsenic demonstration program (NSF, 2005), POU adsorptive filter installation times ranged from 15 minutes to 3 hours depending on the accessibility of piping and the need for additional lines (e.g., to provide treated water to ice-makers). The mean installation time was one hour, but total plumber billing records indicated twice as much time spent on all installation-related activities. Study authors attributed the additional cost to time spent obtaining special plumbing fittings and return visits to homes when residents missed their appointments. Based on peer review suggestions, EPA selected a default average installation time value of one hour for less complex POU devices and two hours for more complex POU devices and POE devices. The model includes a contingency factor to account for unanticipated costs such as the need for special plumbing fittings.

The POU/POE model reflects the assumption that when UV devices are installed, they are supplemental treatment equipment, requiring incremental installation time. The default assumption for the incremental amount of on-site time to install a UV device is one hour per household for a POU device and two hours for a POE device. These installation times are only applicable when UV treatment is selected. If UV treatment is not selected, then the installation time will be zero on the Output worksheet despite any nonzero value in the assumptions worksheet.

Installation costs also include administrative time for utility staff for planning and to contact homeowners to schedule an installation appointment. The default assumption is an average of 30 minutes (0.5 hours) per household to contact homeowners. Scheduling effort is likely to vary across customers, with some being relatively easy to schedule while others require multiple calls to identify and contact the correct homeowners or to handle situations such as homeowner reluctance to participate or language barriers (U.S. EPA, 2006).

### **2.2.2 Public Education Program**

EPA Guidance (2006) recommends that systems “plan on investing resources in a public education program to obtain and maintain customer participation and long-term customer satisfaction” with the POU or POE program. The two main program elements recommended in U.S. EPA (2006) are:

- conduct one or more public meetings with all customers prior to installing any POU or POE devices to educate customers regarding the regulatory compliance requirements and the role of the POU/POE devices
- provide information updates in billing mailers and on information flyers posted in public locations such as a post office, a public library, or a website.

In addition, the EPA Guidance recommends having someone available to answer questions either by phone or through web-based communication.

The POU/POE model generates capital (or start-up) cost estimates for the two main educational program elements. These costs include:

- time for the system's technical and clerical staff to prepare information for at least one public meeting
- time for the system's technical and clerical staff to attend at least one meeting
- time for the system's technical and clerical staff to prepare an additional billing mailer following the meeting
- materials for information sheets provided to each household at the meeting
- materials for meeting announcements such as newspaper advertisements, posted fliers, and billing mailers.

EPA Guidance recommends that system staff be prepared to cover the following topics during the public meetings:

- inform customers of the current situation (e.g., the contaminant of concern, the applicable standard, current exposure levels, and potential health impacts)
- describe compliance options and the system's decision process (e.g., centralized treatment, source water blending, source water changes, and POU or POE alternatives)
- explain what POU/POE devices are and what they will do to improve water quality (e.g., the treatment devices will be installed in homes, but owned and maintained by the system, which will require access for installation, monitoring, and maintenance)
- address ownership or replacement issues regarding any existing POU/POE devices that homeowners previously installed in their homes
- explain the purpose and scope of a pilot study if one is planned or needed.

The default assumption in the POU/POE model is a total of 16 hours (10 hours for technical staff and 6 hours for administrative or clerical staff) to develop handout materials for a public meeting and advertise the meeting. This assumption reflects a scenario in which system staff:

- develop and insert a 1-page meeting announcement in a regularly scheduled billing one month prior to the meeting and a subsequent 1-page billing insert with program updates
- post meeting announcement flyers in prominent locations
- place an advertisement in the local newspaper and through public service announcements
- develop a 3-page information handout with information on POU or POE devices and general information on installation, maintenance, and monitoring of the devices for meeting attendees.

Associated material costs in the POU/POE model include copying costs for the billing insert (1 page per household) and the meeting handout (3 pages per household), printing costs for the posted flyers (10 full-color copies), and a public meeting announcement in the local newspaper. The model does not include material costs for public service announcements on the local radio and television stations, which are free of charge. It also does not include rental fees for a meeting site because EPA assumes that the meeting can be held in a public building.

The POU/POE model includes 4 hours (2 for technical staff and 2 hours for clerical staff) for public meeting attendance and another 4 hours (2 for technical staff and 2 hours for clerical staff) for post-meeting activities such as developing an additional 1-page billing flyer announcing POU/POE program updates.

EPA Guidance indicates that additional public education efforts may be needed when the regulated contaminant is nitrate because of the potential for nitrate to cause serious illness among infants (e.g., blue baby syndrome). The POU/POE model includes additional labor time and material costs to develop and communicate information on health impacts of acute exposure to elevated nitrate levels. The default assumptions in the POU/POE model include 10 hours (5 for technical staff and 5 for clerical staff) to prepare additional materials regarding nitrate health impacts for a public meeting and to develop and post 10 additional health information flyers. To assist systems with nitrate compliance needs, EPA Guidance provides a sample public education flyer with relevant health information and safety instructions for homeowners.

### **2.2.3 Initial Water Quality Monitoring**

Systems that implement a POU or POE compliance strategy will need to monitor the quality of water produced by the treatment devices to demonstrate compliance with the drinking water standard for the contaminant of concern. EPA Guidance notes that the system will need to work with the appropriate regulatory agency to establish an approved compliance-monitoring schedule. The resulting monitoring schedule may have sampling rates in initial year that differ from sampling rates in subsequent years. Consequently, the POU/POE model includes cost calculations for initial year monitoring as well as annual monitoring.

EPA Guidance provides an example of a monitoring schedule in which samples are taken from every unit during the first year to confirm that the units are working properly, and then monitoring frequency declines to one-third of units each subsequent year. EPA designed the POU/POE model to accommodate this kind of variation in monitoring frequency over time. Furthermore, the default assumptions in the model reflect this example schedule.

Initial water quality monitoring costs can include four types of costs: the time required to obtain samples from each location, time required to contact households to schedule sampling, shipping costs to send the samples to a certified laboratory, and fees paid to the laboratory for analysis and results. The POU/POE model generates estimates for each of these costs.

First, the model calculates the total number of initial sampling events. Two assumptions in the model affect the total number of sampling events in the first year – the share of households monitored and the number of samples per household. The default values are based on the scenario in the EPA Guidance: sampling occurs at 100% of the households receiving a POU or POE device, and there is one sampling event at each household. These frequency assumptions combine with the household estimate on the Output worksheet to establish the total number of sampling events.<sup>5</sup>

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<sup>5</sup> The results on the Output worksheet include an adjustment to address the overlap that occurs when capital costs for initial year monitoring are added to annual monitoring costs. The number of initial sampling events used in the capital cost estimate is the total initial year events minus the number of annual sampling events to prevent double counting that portion of the initial year sampling events.



System labor costs depend on the total number of sampling events and the average amount of time per event required to schedule and take samples. The default values reflect an assumption recommended by peer reviewers to have initial sampling occur during the installation visit. Therefore, the clerical labor to schedule each sampling event is zero and the technical labor to conduct the sampling is 15 minutes (0.25 hours). The scheduling labor assumption is consistent with EPA Guidance recommendations that systems attempt to coordinate monitoring activities with other site visits to minimize the burden on households as well as system resources. The Grimes case study cost analysis (NSF, 2005) used an estimate of 15 minutes per sampling event, which is consistent with the default assumption. The labor rates that the POU/POE model uses to value labor costs are addressed in the Price Tables section.

Shipping and analysis costs depend on the total number of samples and unit costs for shipping or analysis. Analysis costs include analytical fees for the contaminant of concern and total coliform as a pathogen indicator. Section 2.5 (Price Tables) addresses the default unit costs in the POU/POE model.

#### **2.2.4 Indirect Assumptions**

EPA Guidance identifies four types of indirect capital costs to include in a system-level cost estimate:

- permitting costs in cases where an operating permit or compliance plan review is required by local and/or State agencies
- pilot testing costs in cases where a system tests one or more devices evaluate their effectiveness under local conditions<sup>6</sup>
- legal costs, which may include developing an ordinance that defines the water system's and homeowners' responsibilities for POU or POE devices, providing advice on options for households that prefer not to participate, and developing agreements that will grant system personnel or contractors legal access to all compliance devices for maintenance and monitoring
- engineering costs to evaluate the system's compliance options (e.g., centralized treatment, new water source, and POU program) and select the appropriate POU or POE treatment technology.

The POU/POE model contains these costs and a fifth one – contingency – in the indirect portion of capital costs. Contingency cost accounts for unforeseen costs in installing POU or POE devices such as additional installation costs due to extra carpentry work or unusual plumbing conditions. Exhibit 2-3 shows that the default values for indirect costs are multipliers or percentages of installed equipment costs. For example, for every \$1,000 spent to purchase and install POU or POE devices, the model adds \$30 (3% x \$1,000) for permit costs.

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<sup>6</sup> U.S. EPA (2006) notes that “if the system uses a POE device, some form of field testing is required under 40 CFR Section 141.100. If POU or POE devices are used under a variance or exemption, 40 CFR Section 142.62(h) also requires field testing.”

**Exhibit 2-4. Indirect Cost Multipliers**

Parameter	Units	Default Assumption
Permitting	multiplier – percent of installed equipment cost	3.0%
Pilot Testing	multiplier – percent of installed equipment cost	3.0%
Legal	multiplier – percent of installed equipment cost	3.0%
Engineering	multiplier – percent of installed equipment cost	15.0%
Contingency	multiplier – percent of installed equipment cost	10.0%

Three of these estimates are based on information in *Guide for Implementing Phase I Water Treatment Cost Upgrade* (EPA, 1998): 3% for permitting, 3% for legal fees, and 15% for engineering. The engineering multiplier is also consistent with the results of the Grimes case study (NSF, 2005), which had engineering costs equal to 15% of installed costs (\$41 for engineering on installed costs of \$275). EPA assumed that the default multiplier for pilot testing was similar to permitting and legal fees because the devices being installed are NSF certified for drinking water treatment. Finally, the contingency cost multiplier adds 10% to the installed equipment cost estimate to account for unknown factors that increase costs. These might include additional time and materials to handle unusual plumbing conditions. For example, in the Grimes case study, some homes had water shut-off valves located underground in alleyways instead of inside the home.

### **2.2.5 Other Capital Assumptions**

The capital assumption worksheet has four additional assumptions used in the capital cost analysis. The first one is the average number of people per household, which the model uses to convert population estimates to household connection estimates. The default assumption is 2.6, which is the average household size reported for the most recent national census (U.S. Bureau of the Census, 2001).

The second and third assumptions are a discount rate and a discount period. The model uses these assumptions to calculate annualized capital costs, which affects total annual costs (annualized capital costs plus annual O&M costs). The default discount rate value is 7%, which EPA often uses for policy analysis. The default annualization period is 10 years, which is based on case studies in EPA Guidance and vendor information. This period reflects the expected time the devices will remain installed and operating given regular maintenance (e.g., filter replacement).

The fourth assumption is an average total daily per capita water consumption estimate of 100 gallons. This value is used only to calculate a cost per thousand gallons (\$/kgal) estimate, which can be compared with \$/kgal costs for centralized treatment options in a cost-effectiveness analysis. The estimate uses total consumption per person per day instead of the actual POU or POE treated volume because the cost-effectiveness comparison is between alternatives that achieve the same health risk reduction benefits. Because the benefits of the POU or POE strategy are the same as the benefits for central treatment, the cost-effectiveness measure must use comparable treated water quantities to generate comparable \$/kgal values.

## 2.3 O&M Assumptions Worksheet

This worksheet contains several matrices of default parameters for O&M costs. There is one large matrix with default values for parameters that are common to all technologies and several smaller matrices with technology-specific assumptions for equipment replacement. The default values for equipment replacement are based on vendor recommendations. Chapter 3 describes how a user can override these default values to include site-specific information.

Exhibit 2-5 provides a summary of the types of assumptions that affect system O&M costs for labor and materials, other than replacement parts. These include labor costs to maintain the POU or POE equipment, prepare and distribute educational program updates, and monitor water quality.

**Exhibit 2-5. Summary of Design Assumptions for O&M Costs with Example Default Values for Two POU Technologies**

Parameter	Units	POU RO Rental	POU Adsorptive Media NSF53
<b>Equipment Maintenance</b>			
POU/POE maintenance	hrs/visit	0.00	0.50
POU/POE replacement frequency	visits/household/yr	0.00	1.00
UV maintenance (when UV is excluded)	hrs/visit	0.00	0.00
UV maintenance frequency	visits/household/yr	0.00	0.00
Scheduling time	hrs/visit	0.00	0.50
<b>Education Program</b>			
Information updates- technical labor	hrs	12.0	12.0
Nitrate information updates- technical labor	hrs	20.0	20.0
Information updates- clerical labor	hrs	12.0	12.0
Nitrate information updates- clerical labor	hrs	20.0	20.0
Nitrate awareness flyers	flyers	10	10
Nitrate billing mailers	pages/household	3	3
<b>Monitoring</b>			
Sampling time	hrs/sample	0.25 <sup>1</sup>	0.25 <sup>1</sup>
Sampling scheduling time	hrs/sample	0.00 <sup>1</sup>	0.00 <sup>1</sup>
Analysis	sample/household	1	1
Frequency	% households/yr	33.3%	33.3%
<p>1. Peer reviewers recommended that the monitoring samples be taken during maintenance visits, which would minimize the incremental sampling time and avoid the need to schedule a sampling visit. The model retains the option, however, for maintenance and sampling to occur independently.</p>			

The exhibit also provides examples of the default values for two of the POU treatment technology options. For example, the default values POU for the Adsorptive Media NSF53 technology option indicate that the model includes a 30-minute site visit per maintenance trip for the POU/POE device and a 30-minute period to contact the household to schedule maintenance. The assumptions for the POU RO Rental treatment show zero hours for scheduling and maintenance because these costs are included in a single cost for annual service. This rental cost enters the O&M cost estimate through an equipment price, which is described below.

### 2.3.1 Equipment Replacement and Maintenance

Because a treatment technology can have multiple components that require replacement, the O&M assumptions worksheet contains several treatment-specific matrices with replacement assumptions. Exhibit 2-6 shows an example matrix for the POU RO treatment technology (purchase option instead of rental option). It shows that there are four items replaced at different frequencies based on vendor recommendations. The RO membrane is replaced once every three years based on average replacement schedules across vendors, and the other filter cartridges are changed once per year.

The cost model reflects the assumption that a cost-effective maintenance schedule will overlap equipment replacement trips whenever possible. Therefore, membranes will be replaced during a maintenance visit to change the filter cartridges.

**Exhibit 2-6. Example of Equipment Replacement for a Purchased RO Device**

Equipment	Replacement Frequency	Units
Sediment Pre-Filter	1	units/year
Pre-GAC Filter Cartridge	1	units/year
Post-GAC Filter Cartridge	1	units/year
RO Membrane	0.33	units/year

The default labor hours include 30 minutes of technical labor time per visit for equipment replacement and 30 minutes of clerical labor time for scheduling appointments and tracking the replacement schedule. The Grimes case study cost analysis (NSF, 2005) used an estimate of 15 minutes per filter change out, which suggests EPA's default assumptions (totaling one hour per visit) are potentially conservative (i.e., tending to overstate costs).

### 2.3.2 Education Updates

EPA Guidance recommends providing ongoing communication with the community to maintain a successful POU or POE program and to educate new customers. The POU/POE model contains costs for annual outreach activities and, if applicable, nitrate awareness. The general outreach activities are likely to involve responding to phone or email inquiries regarding the POU/POE program and devices and mailing an annual update on the program. EPA's default estimate is that these activities require an average of two hours per month or 24 hours per year. This incremental time requirement is minimal because EPA assumes that most consumer questions will arise during scheduling calls and maintenance visits. EPA evenly split these hours between technical and clerical staff for the default cost assumptions. In addition, the POU/POE model has a default copying cost for sending each household up to 3 pages of POU/POE program outreach material as a billing inserts each year.

When the contaminant of concern is nitrate, The POU/POE model includes additional labor time and material costs to update and communicate information on health impacts of acute exposure to elevated nitrate levels. The default assumptions in the POU/POE model include an additional week or 40 hours of labor time throughout the year to contact health care professionals and families with infants to remind them of the risks among infants of acute exposure to nitrate. EPA assumed these hours were evenly split between technical and clerical staff (20 hours each) for

costing purposes. The default costs include updating the 10 nitrate flyers posted in public areas each year and sending up to 3 additional pages of nitrate information as billing mailers.

### **2.3.3 Monitoring**

As noted in the initial monitoring section, the POU/POE model incorporates annual monitoring costs, and the default assumptions in the model reflect the example monitoring scenario in EPA Guidance. A system's approved monitoring plan may differ from this example, and the model can accommodate such differences (see Chapter 3). In the example scenario, all units are monitored during the first year of operation, and one-third of a system's connections are sampled in each subsequent year. Aside from the change in the number of households monitored per year, the default assumptions are identical to the initial monitoring assumptions.

The exception to this default frequency assumption is nitrate, which has annual monitoring for all devices. This assumption reflects the more frequent monitoring requirement for nitrate compared to other inorganic contaminants (40 CFR Section 141.23). Because of the health risks associated with acute nitrate exposure, more frequent sampling is needed to ensure adequate public health protection.

## **2.4 Control Worksheet**

As the name suggests, the Control worksheet controls the operation of the POU/POE model. It identifies which input model, contaminant, and treatment technology control the assumptions on the Output worksheet. It contains the list of the contaminants that appear in the drop-down lists on either of the input worksheets. It also contains the contaminant-specific treatment technologies. Finally, it contains parameters that pass the correct input information to the Output worksheet. The technology options include placeholders for technologies for which devices are not yet ANSI/NSF certified. These placeholders were included during the development phase so they will be easier to integrate should certified devices become available.

## **2.5 Price Tables Worksheet**

The Price Tables worksheet contains the default price data used in the POU/POE model. These data include prices for the POU or POE devices, replacement parts, labor rates, and prices for sample analysis and shipping. All prices have been escalated to current dollars using applicable price indices. Adjustments to labor rates utilize the Employment Cost Index (BLS, 2006b), and all other prices have been adjusted using the Consumer Price Index (BLS, 2006a). Chapter 3 describes how a user can override default prices to include site specific information.

The products listed in the Price Tables worksheet are randomly selected from among those that meet ANSI/NSF certification requirements. Information in this worksheet does not constitute an endorsement by EPA for these products. The average prices and price ranges across comparable products in the model are comparable to those reported in Raucher et al. (2004), which is a study of POU treatment costs sponsored by the American Water Works Association Research Foundation (AWWARF).

### **2.5.1 POU and POE Device Prices**

The price data for POU and POE devices are grouped by treatment technology. For each technology, there are two price tables. The first table contains the unit prices for complete

treatment systems that are used in the capital cost estimates. Each table is a schedule of unit prices for different purchase quantities. The unit price declines when vendors provide quantity discounts. These discounts can vary across vendors. Exhibit 2-7 shows an example of the price table for the POU Adsorptive Media NSF53 equipment. The first two columns show the range of households to which the unit prices apply and the third column shows the unit cost. For example, a system installing units in 20 households would pay \$263 per unit, while a larger system with 120 households would pay \$210 per unit.

Exhibit 2-7. Example of Unit Prices for POU Adsorptive Media NSF53 Equipment

Range for Number Households	Avg. Unit Cost
1 to 4	525
5 to 15	289
16 to 24	263
25 to 50	236
51 to 500	210
501 to 1,000	170

EPA Guidance notes that the POU and POE devices used as part of a compliance strategy must be ANSI/NSF certified. Therefore, the prices on the Price Table worksheet are for POU and POE devices that have been certified under one of the following ANSI/NSF standards.

- **ANSI/NSF Standard 53 – Health Effects:** This standard addresses POU and POE devices designed to reduce specific contaminants such as lead, VOCs, and arsenic. For example, the unit prices in Exhibit 2-7 are for an adsorptive media device that is certified for arsenic removal.
- **ANSI/NSF Standard 44 – Residential Cation Exchange Water Softeners:** This standard pertains to residential cation exchange water softeners that reduce hardness, and it also verifies a system’s ability to remove radium and barium.
- **ANSI/NSF Standard 58 – Reverse Osmosis Drinking Water Treatment Systems:** The contaminant removal capabilities for POU RO systems are certified under this standard.
- **ANSI/NSF Standard 55 –Ultraviolet Microbiological Drinking Water Treatment Systems:** This standard applies to POU and POE ultraviolet systems that are designed to provide safe levels of microbial disinfection in drinking water.

The Price Tables worksheet will contain average unit costs for POU and POE devices based on vendor data documented in the worksheet.<sup>7</sup> The mention of specific products or prices does not constitute an endorsement by EPA.

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<sup>7</sup> The format for the vendor section is the same database format used in the cost models for central treatment although some fields are not used. This format allows equipment price data to be adjusted for installation costs, transportation costs, and inflation factors. The POU unit prices are delivered prices so the transportation cost multipliers used for central treatment components are not applicable. Because installation costs are modeled explicitly in the POU/POE model, the installation cost columns in the database are not used. Nevertheless, the

The second price table for each technology comprises of replacement parts for the POE/POU units. To simplify the cost analysis, EPA did not develop price schedules with volume discount information for replacement parts. Therefore, O&M costs may be overstated. The volume discounts for replacement parts, however, are not likely to have the same impact as volume discounts for initial device purchases. First, replacement parts are less expensive and, depending on replacement frequency, are likely to be purchased in smaller quantities with purchases spread over time to minimize inventory costs.

### 2.5.2 Labor Costs

Costs for labor hours attributed to system technical and clerical staff are based on a wage rate study prepared for EPA (SAIC, 2003). The loaded hourly rates (wages plus benefits) for technical staff (\$26.06) and clerical staff (\$18.54) are based on national wage data for treatment operator and secretarial occupations, respectively, in the water supply industry. The default assumptions in the POU/POE model assign the operator wage rate to maintenance and sampling activities, and public education program activities. Cost estimates for the clerical hours depend on the clerical hourly rate.

Labor costs for device installation in the POU/POE model use an average loaded wage rate of \$33.04, which is based on national average wages for plumbers (\$21.40) and electricians (\$21.73) (BLS, 2006c) and a benefits multiplier of 1.48 (BLS, 2006b).

### 2.5.3 Monitoring Costs

Costs for laboratory analysis are based on average fees across a sample of laboratories. Exhibit 2-8 provides a sample of fees in the POU/POE model. The Price Tables worksheet documents data sources.

Exhibit 2-8. Average Cost Data for Laboratory Analyses

Contaminant	Cost of Analysis per Sample	Contaminant	Cost of Analysis per Sample
Arsenic	\$25.75	SOCs	\$183.33
Copper	\$19.50	Radium (226 and 228)	\$257.50
Nitrate	\$24.25	Total Coliform	\$16.50

Applying these analysis unit costs to every sample may overstate monitoring costs for one of two reasons. First, laboratories may offer quantity discounts for shipments with multiple samples. Second, systems may be able to submit composite samples across multiple devices rather than a single sample for each device. The latter strategy helped reduce analysis costs in the Grimes case study (NSF, 2005).

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database format for POU/POE prices must be consistent with the database format used in other models. Vendor names have been removed from the version of the model distributed to the public to avoid the appearance of product endorsement.

Shipping costs for samples are based on U.S. Postal Service rates for 2-day delivery. Exhibit 2.9 shows shipping costs for packaging containing selected ranges of samples. The average cost per sample declines as the number of samples increases.

Exhibit 2-9. Costs of Shipping Samples Using U.S. Postal Service

Number of Samples	Radium <sup>1</sup>	Nitrate, Arsenic, and other Inorganics <sup>2</sup>	SOCs <sup>3</sup>
15	\$11.00	\$9.00	\$9.00
16 to 50	\$24.00	\$11.00	\$11.00
51 to 100	\$48.00	\$21.00	\$21.00
101 to 200	\$96.00	\$42.00	\$42.00
201 to 500	\$250.00	\$100.00	\$100.00

1. Assumes sample is taken in a one-liter bottle and shipped on ice.  
2. Assumes sample is taken in 250 mL sample bottle and shipped on ice.  
3. Assumes sample is taken in two 40-mL vials for SOCs. All samples are shipped on ice.

#### 2.5.4 Other Annual Costs

There are several material costs associated with the educational program. These include \$0.08 per page to cover cost of copying the billing inserts and meeting handouts, \$2.00 per flyer for 10 posted flyers, and \$40 for an announcement in the local newspaper. The model does not include material costs for public service announcements on the local radio and television stations, which are free of charge. It also does not include rental fees for a meeting site because EPA assumes that the meeting can be held in a public building.

EPA assumed that disposal costs for POU and POE device residuals are negligible and, therefore, did not include them in the POU/POE model. For example, the media filters used in the Grimes case study were determined to be safe for disposal in the household trash by the California Department of Health, which tested the arsenic concentrations in the filters (NSF, 2005). The EPA Guidance provides information on disposal issues and considerations.

As noted above, the POU/POE model does not include a line item for annual incremental insurance to cover any increased liability associated with entering private residences. The capital cost estimate, however, includes installation by a plumber, which is intended to cover the cost for a licensed, bonded, and insured plumber. This assumption captures costs associated with the most likely source of risk to private residences – a poor installation.

## 2.6 Output Worksheet

The Output worksheet shows all of the cost components and the cost build-up. A partial example in Exhibit 2-10 provides shows the build-up for equipment costs. The top section is a summary of the contaminant, treatment, and system size information provided on the Input worksheet (or the User Input worksheet in the User-Defined System mode).

The next section on the Output worksheet shows the cost build-up for direct capital costs by component. The reporting format shown in Exhibit 2-10 illustrates the cost build-up for capital



costs. The cost build-up details include quantities (e.g., number of devices or hours per household), frequencies (usually the number of households affected), and unit costs (e.g., cost per device or per staff hour). Output includes total cost per component and, where applicable, a useful life estimate. This estimate generally reflects the expected life of the installed device. It is used in the POU/POE model to convert capital costs to annual costs, which can be added to O&M costs to obtain an annual cost estimate and an average unit cost (\$/kgal) designed for comparison with centralized treatment costs.

Exhibit 2-10. Example of Cost Details Provided on the Output worksheet

<b>System Description</b>	
<b>Households Served</b>	25
<b>Contaminant</b>	Arsenic
<b>Treatment Technology</b>	POU Reverse Osmosis
<b>Treatment Location</b>	POU
<b>UV Treatment</b>	no

Capital Costs		Design		Unit Cost	Total Cost
WBS #	Item	Quantity	Frequency		
<b>23.0</b>	<b>POU/POE Treatment</b>				
<b>23.1</b>	<b>Installed Treatment Equipment</b>				
23.1.1	POU/POE Unit Purchase	1 unit/household	25 households	\$ 561	\$ 14,023
23.1.2	POU/POE Installation	2.00 hours/household	25 households	\$ 33.12	\$ 1,656
23.1.3	Scheduling Time	0.50 hours/household	25 households	\$ 17.89	\$ 224
23.1.4	UV Purchase	0 unit/household	0 households	\$ -	\$ -
23.1.5	UV Installation	0.00 hours/household	0 households	\$ -	\$ -
<b>23.2</b>	<b>Public Education</b>				
<b>23.2.1</b>	<b>Technical Labor</b>				
23.2.1.1	Develop materials	10.00 hours		\$ 25.07	\$ 251
23.2.1.2	Nitrate health effects	0.00 hours		\$ 25.07	\$ -
23.2.1.3	Meetings	2.00 hours		\$ 25.07	\$ 50
23.2.1.4	Post-meeting	2.00 hours		\$ 25.07	\$ 50
<b>23.2.2</b>	<b>Clerical Labor</b>				
23.2.2.1	Develop materials	6.00 hours		\$ 17.89	\$ 107
23.2.2.2	Nitrate health effects	0.00 hours		\$ 17.89	\$ -
23.2.2.3	Meetings	2.00 hours		\$ 17.89	\$ 36
23.2.2.4	Post-meeting	2.00 hours		\$ 17.89	\$ 36
<b>23.2.3</b>	<b>Printed Material</b>				
23.2.3.1	Meeting flyers	10 flyers		\$ 2.12	\$ 21
23.2.3.2	Meeting ads	1 ads		\$ 42.46	\$ 42
23.2.3.3	Nitrate awareness flyers	0 flyers		\$ 2.12	\$ -
23.2.3.4	Meeting handouts	3 pages/household	25 households	\$ 0.08	\$ 6
23.2.3.5	Billing mailers	2 pages/household	25 households	\$ 0.08	\$ 4

## 2.7 References

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### 3. Cost Model Operation

This chapter contains a user guide that explains how to use the POU/POE model to develop costs for a user-defined POU or POE program. As stated in Chapters 1 and 2, the POU/POE model is a Microsoft Excel workbook that combines user-defined inputs with pre-programmed calculations to estimate total costs for a POU or POE strategy. These costs include upfront capital costs (to purchase and install POU or POE devices, develop and implement an educational program, and conduct initial water quality sampling to test the operating effectiveness of the devices) as well as O&M costs (for equipment replacement, customer education, and water quality monitoring). EPA designed the cost model to be easy to operate while also giving the user enough flexibility to alter key inputs such as unit prices and assumptions.

#### 3.1 Getting Started

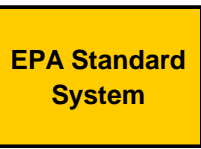
To use the POU/POE model as a stand-alone tool, copy the file called POU\_POE model.xls to any location on your computer's hard drive. You will need to have Microsoft Excel (Office 2000 or a later version) to open and operate the model. You can open the file by double clicking on the filename in a file browser, or open Excel first and browse for the file. If prompted, select "Enable Macros" to ensure the design macros used to run the model are functional.<sup>8</sup>

The file opens to show a **Cover** worksheet, which includes disclaimer information. Clicking on the Start link at the bottom of this worksheet will take you to the **Input** worksheet. The first step is to select the operation mode, shown in Exhibit 3-1. Click on the gold cell next to Step 1, and then click on the small down arrow at the lower right corner of the cell, to see a drop-down list with two options: Standard System or User-Defined System. Choose the type of system you want to model. If you choose Standard System, you can view costs for a system that matches a midpoint flow size in one of EPA's standard system size categories. Choosing User-Defined System, however, will allow you to enter data and estimate costs for a particular system. When you choose User-Defined System, a new instruction appears directing you to go to the **User Input** worksheet (see Exhibit 3-2). Clicking on the new orange cell ("To User-Defined System Page") will take you to the correct worksheet to use for user-defined inputs.

Exhibit 3-1. Step 1: Selecting the Operating Mode

**Step 1:**

Select a **User-Defined System** to estimate costs for a single system using site-specific information in addition to the default assumptions and prices, as needed. The **EPA Standard System** option will generate costs for the six standard designs shown in Step 4.



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<sup>8</sup> If you are not prompted to enable macros, your Excel security settings may be set to automatically disable macros. If this is the case, you will need to reset your security settings, close the workbook, and open it again. To check your security settings, go to the Tools menu and select Macro, then click on Security. In the Security dialog box, on the Security Level tab, make sure the radio button for "Medium" is selected. If the radio button "High" was selected when you first opened the dialog box, Excel automatically disabled macros when opening the workbook, and you must now close the POU-POE model and open it again (and choose to enable macros).

Exhibit 3-2. Step 1: Additional Instruction for User-Defined System Mode



### 3.2 User-Defined Model Inputs

Once you have chosen the operating mode, you can enter model inputs in the User Input worksheet. This section describes the contents of the User Input worksheet. On this worksheet, you will identify the following for the system you want to model:

- target contaminant
- treatment technology
- system size using either an average daily water flow rate or number of households
- assumptions to use for cost parameters and prices.

#### 3.2.1 Target Contaminant

After selecting the operating mode, the next step is to select a target contaminant. Click on the orange cell shown in Exhibit 3-3, then click on the down arrow to the right of the cell, to activate the contaminant drop-down list. You can use your mouse pointer to move the scroll bar on the right of the drop-down box to view the entire contaminant list. Select the contaminant you want by clicking on it.

Exhibit 3-3. Step 2: Select a Target Contaminant Using the Contaminant Drop-Down List

**Step 2:**

Choose a contaminant

Arsenic

Status: Contaminant selection OK

If you select a valid target contaminant from the list, the message below the contaminant name will say “Contaminant selection OK.” One of two warning messages will appear if your selection is not valid:

- **Please select a target contaminant** indicates the contaminant cell is blank; click on the cell again to activate the drop-down list and select one of the contaminants
- **Warning: Target contaminant is not valid** indicates the contaminant cell value is not valid; click on the cell again to activate the drop-down list and select one of the contaminants.

Warning messages may appear elsewhere after you select a target contaminant. These will vanish when you successfully complete Step 3.

### 3.2.2 Treatment Technology

After selecting a target contaminant, the next step is to select a treatment technology. Click on the larger orange cell shown in Exhibit 3-4, then click on the down arrow that appears to the right of the cell, to activate the treatment drop-down list. This list will vary depending on the target contaminant because the types of certified treatment devices differ by contaminant (see Chapter 2 for a list of certified treatment devices for each contaminant). Use your mouse pointer to click on the technology for which you wish to estimate costs. Then, click on the smaller orange cell below the treatment technology to show the drop-down arrow for this box, and after clicking on the arrow, select whether you plan to include ultraviolet (UV) disinfection with your POU or POE devices. A “yes” response will add UV equipment, installation, and maintenance costs to your cost estimate. A “no” response excludes UV-related costs.

Exhibit 3-4. Step 3: Select a Treatment Technology Using the Technology Drop-Down List

#### **Step 3:**

Choose a treatment technology, and indicate whether treatment includes UV disinfection.

POU Reverse Osmosis
no
Status: Treatment technology OK

If you select a valid technology from the list, the message area below the contaminant name will display the message “Treatment technology OK.” If your selection is not valid, one of three warning messages will appear:

- **Please select a certified treatment technology** indicates the treatment cell is blank; click on the cell again to activate the drop-down list and select one of the technologies
- **Warning: Treatment technology selected is not certified for target contaminant** indicates the treatment technology is not valid; click on the cell again to activate the drop-down list and select one of the technologies listed for the contaminant you selected (if a Microsoft error dialog box also appears, click on the Cancel button, then click on the cell again to select a technology)
- **Warning: Invalid target contaminant; unable to evaluate validity of treatment technology** indicates that you need to return to Step 2 and select a valid contaminant, then return to Step 3 to select a treatment technology.

### 3.2.3 System Size

There are two options for entering the information that the POU/POE model needs to estimate costs for your system. The first option is to enter an average daily flow in gallons per day (gpd); the second is to enter a number of households requiring treatment devices.<sup>9</sup> Click on the gold

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<sup>9</sup> The POU/POE model is designed to estimate costs for a system that has a homogenous customer base with uniform costs for treatment devices and services. A system that anticipates substantially nonuniform costs across its customer base (e.g., with small residential customers and large nonresidential customers) will need to use a modified

button next to item (a) of Step 4 (shown in Exhibit 3-5) to choose either “average flow” or “household connections.” After making this selection, you will be prompted to enter the required information.

### Exhibit 3-5. Step 4: Selecting System Size Option and Entering Size Data

**Step 4:**

Choose a method for entering system size. Then enter the required information in the **gold cell(s)**.

- a. Select method for system size input average flow
- b. Enter average daily system flow in gallons per day, and 8,800 gallons per day  
select a water source. surface water

Exhibit 3-5 shows that if you select the “average flow” option, the model will prompt you to enter average daily flow in gallons per day and the type of source water. Source water options are “ground water” or “surface water.” The POU/POE model provides an approximate estimate of the households served by the flow estimate you enter. If this estimate differs from the number of households you expect to provide with treatment equipment and services, then returning to Item 4 (a) and selecting the “household connections” option may provide a better cost estimate. Exhibit 3-6 shows that doing this will remove the entry prompts for system flow and source information, and activate a prompt to enter the number of household connections. This should be the number of households requiring a treatment device and related services.

### Exhibit 3-6. Step 4: Selecting the Household Connections Option for System Size Information

**Step 4:**

Choose a method for entering system size. Then enter the required information in the **gold cell(s)**.

- a. Select method for system size input household connections
- b. Enter number of household connections 50

At this point, you can end your data entry and use the cost estimates based on default assumptions and unit prices in the POU/POE model. A summary of the cost estimates appears to the right of Step 5 (see Exhibit 3-7), along with a link to the detailed cost breakdown at the top of the summary box. If, however, you have site-specific information, the next section provides instructions for entering this information.

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approach. One option is to convert all customers to a uniform measure (e.g., convert nonresidential customers to a comparable number of residential customer equivalents based on flow or treatment device needs). Another option is to run the POU/POE model more than once and combine capital and O&M cost results across customer groups.

### Exhibit 3-7. Cost Summary and Link to Cost Breakdown

<b>Results summary (see OUTPUT sheet for details)</b>
Direct Capital Cost: \$17,343
Total Capital Cost: \$22,750
Annual O&M Cost: \$4,471
Total \$/kgal: \$3.25

### 3.2.4 Additional User-Defined Inputs

After you have selected a contaminant, a treatment technology, and system size, the POU/POE model generates costs using its default assumptions and prices (see Chapter 2 for descriptions). The User Input worksheet reports these default values and also provides opportunities to override these defaults with user-defined values. Exhibit 3-8 provides an example for the first two components of capital costs – equipment purchase and installation. The default unit cost for the POU/POE treatment device (\$518.04 in Exhibit 3-8) is the average price from a database of vendor prices in the model. To override the default cost, enter the unit price you prefer to use in the blue cell to the left of the default value. Follow this procedure for all of the parameters shown in Step 5 – enter values in the blue cells when you do not want to use the default values in your cost estimate and leave the cells blank when you want to accept the default value. The following tables contain the parameters by cost category. Some parameters are only active when the treatment devices include a UV device; others are only active when the target contaminant is nitrate. When these parameters are not active, they appear in a light gray italics text.

Exhibit 3-8. Step 5: Enter User-Defined Values to Replace Model Default Values

<b>Capital Cost Assumptions</b>			
<b>Equipment Purchase</b>			<b>Default Values</b>
Unit cost of POE/POU device without installation		\$/unit	\$ 560.92
<i>Unit cost of UV system</i>		<i>\$/unit</i>	<i>\$ -</i>
<b>Equipment Installation</b>			<b>Default Values</b>
Wage rate for installation specialist (plumber/electrician)		\$/hour	\$ 33.12
Wage rate for system technical and maintenance labor		\$/hour	\$ 25.07
Wage rate for scheduling and administrative labor		\$/hour	\$ 17.89
POU/POE installation time		hours/household	2.00
POU/POE installation scheduling time		hours/household	0.50
<i>UV installation time</i>		<i>hours/household</i>	<i>-</i>

Exhibit 3-9 contains a list of the POU/POE equipment purchase and installation parameters that can be revised. They include unit prices for the treatment devices, labor time to install each POU/POE device, labor time to schedule each installation, and wage rates for three labor categories: contractors who will install the devices, system staff who will maintain the devices and system staff who will perform scheduling and administrative activities.

The POU/POE model includes start-up costs for an educational program. This program includes preparing and distributing educational materials to inform the affected customers about the POU/POE devices, treatment requirements, and utility activities. Exhibit 3-10 provides a list of

the parameters used to estimate costs for this program. They include staff time to implement the program as well as costs for various educational materials.

**Exhibit 3-9. List of POU/POE Model Parameters for Equipment Costs**

Parameter	Units	User-Defined Entry
<b>Equipment Purchase</b>		
Unit cost of POE/POU device without installation	\$/unit	Enter dollar value
Unit cost of UV system*	\$/unit	Enter dollar value
<b>Equipment Installation</b>		
Wage rate for installation	\$/hour	Enter dollar value
Wage rate for maintenance and technical labor	\$/hour	Enter dollar value
Wage rate for scheduling and administrative labor	\$/hour	Enter dollar value
POU/POE installation time	hours/household	Enter average time in hours
UV installation time*	hours/household	Enter average time in hours
Scheduling time	hours/household	Enter average time in hours
* Active only when treatment equipment includes a UV device.		

**Exhibit 3-10. List of POU/POE Model Parameters for Initial Public Education Costs**

Parameter	Units	User-Defined Entry
<b>Technical Labor to Support Educational Program</b>		
Develop technical content for educational materials	total hours	Enter average time in hours
Develop nitrate health impact information for stakeholders*	total hours	Enter average time in hours
Prepare for and attend public meetings	total hours	Enter average time in hours
Post-meeting stakeholder communication	total hours	Enter average time in hours
<b>Clerical Labor to Support Educational Program</b>		
Prepare educational materials for distribution	total hours	Enter average time in hours
Prepare nitrate health impact information for distribution*	total hours	Enter average time in hours
Prepare for and attend public meetings	total hours	Enter average time in hours
Prepare post-meeting materials for distribution	total hours	Enter average time in hours
<b>Communication Materials for Educational Program</b>		
Print flyers announcing public meetings	flyers	Enter number of flyers
Cost per flyer for printing	\$/flyer	Enter cost in dollars
Buy ads to announce public meetings	ads	Enter number of ads
Cost per meeting ad	\$/ad	Enter cost in dollars
Print nitrate health impact flyers*	flyers	Enter number of flyers
Print handouts for meetings	pages/household	Enter average pages per household for meeting handouts
Print inserts for billing mailers	pages/household	Enter average pages per household for billing mailers
Cost to print handouts and mailers	\$/page	Enter cost in dollars
* Active only when target contaminant is nitrate.		



The POU/POE model includes first-year monitoring costs that are separate from annual monitoring costs to allow monitoring assumptions to differ between the first year after equipment installation and subsequent years. Exhibit 3-11 shows the parameters that affect costs. They include the staff time required to take the sample (including travel time), the staff time to schedule the sampling event, the sampling frequency (i.e., the number of samples per household taken during the first year), and the fraction of households to include in the initial sampling event.<sup>10</sup>

**Exhibit 3-11. List of POU/POE Model Parameters for Initial Monitoring Costs**

Parameter	Units	User-Defined Entry
<b>First Year Water Quality Sampling</b>		
Time to take sample during first year	hours/sample	Enter average time in hours
Time to schedule sample event at household	hours/sample	Enter average time in hours
Number of samples per household during the first year	samples/household	Enter number of target contaminant samples per household
Fraction of households sampled during the first year	% households	Enter percent of total households included in sampling event
Laboratory analysis fee	\$/sample	Enter cost per sample
Sample shipping cost (bulk)	\$/bulk shipment	Enter package shipping cost

The final set of capital costs includes a series of indirect costs that account for permitting, pilot testing, legal, engineering design, and contingency costs. Chapter 2 provides descriptions of the types of costs to include in each category. As Exhibit 3-12 illustrates, there are two options for entering each of these costs. The first option is to enter a percentage, which will act as a multiplier on installed equipment costs to represent the indirect cost. For example, an indirect pilot study cost parameter of 3% will add \$3 of pilot study costs to every \$100 of installed equipment costs (including equipment and installation labor costs). The second option is to enter a dollar value. If pilot study costs are known and fixed, this option will provide a better result. In this section of the user input worksheet, enter the values in the blue cells and indicate the units using drop-down lists in the cells to the right of each blue cell.<sup>11</sup> The units can differ across the indirect costs, i.e., some can be percentages while others are dollar values.

<sup>10</sup> The model addresses the overlap between initial year sampling and annual sampling by subtracting annual sampling events from the initial year sampling events to estimate capital costs. If 33% of households are monitored annually and 100% are monitored during the first year, the overlap during the installation year leads to 133% of households sampled. By subtracting 33% from 100%, the sum of initial sampling events in capital costs and annual sampling events in O&M costs is 100% for the installation year.

<sup>11</sup> Note that if the unit selected is “% installed equipment cost,” the number in the cell will range from 0 to 100 (rather than a decimal between 0 and 1). The POU/POE model detects whether the range should be interpreted as a percentage or a dollar value based on the unit selected (“% installed equipment cost” or “\$ fixed cost”).

**Exhibit 3-12. List of POU/POE Model Parameters for Indirect Capital Costs**

Parameter	Units	User-Defined Entry
Cost to obtain operating permit Cost to conduct pilot test Cost for legal activities (e.g., ordinance changes) Cost for engineering activities (e.g., device selection) Contingency cost (unknown factors)	% installed equipment cost or dollar value	Enter a dollar value or a percentage (e.g., enter 5 for 5%) and select the correct units from the drop-down list that appears when you click the units cell

All of the input parameters in the preceding tables affect the POU/POE model’s estimate of capital costs. The remaining parameters, described below, affect annual O&M costs.

The first set of O&M cost parameters define the overall frequency of maintenance visits and the length of time per visit. Exhibit 3-13 shows that visit frequency and duration can vary for the primary treatment device and a UV device, if needed. The equations in the cost model reflect an assumption that these visits overlap. For example, if there are two trips per year for POU/POE device maintenance and one per year for UV device maintenance, then the total number of trips will be two. The maintenance labor hours, however, are additive across the POU/POE and UV devices, if both are used. Parameters for equipment costs are addressed in a later exhibit.

**Exhibit 3-13. List of POU/POE Model Parameters for Equipment Maintenance Labor Costs**

Parameter	Units	User-Defined Entry
POU/POE maintenance	hours/visit	Enter average time in hours
POU/POE replacement frequency	visits/household/yr	Enter average number of annual visits per household
UV maintenance*	hours/visit	Enter average time in hours
UV maintenance frequency*	visits/household/year	Enter average number of annual visits per household
Scheduling time	hours/visit	Enter average time in hours
* Active only when treatment equipment includes UV device.		

Exhibit 3-14 shows the parameters used to derive annual educational program costs. The activities include developing updates to materials that might be distributed during maintenance visits. If the target contaminant is nitrate, there are a few parameters for annual updates to information materials distributed to all customers.

**Exhibit 3-14. List of POU/POE Model Parameters for Annual Educational Costs**

Parameter	Units	User-Defined Entry
<b>Technical Labor to Support On-Going Education Program Activities</b>		
Develop updates to technical information	hours	Enter average annual hours
Develop updates for nitrate health effects*	hours	Enter average annual hours
<b>Clerical Labor to Support On-Going Education Program Activities</b>		
Prepare information updates for distribution	hours	Enter average annual hours
Prepare nitrate information updates for distribution*	hours	Enter average annual hours
<b>Communication Materials to Support On-Going Education Program Activities</b>		
Nitrate fliers*	flyers	Enter number of flyers
Billing mailers	pages/household	Enter average pages per household for billing mailers
* Active only when the target contaminant is nitrate.		

The POU/POE model includes annual monitoring costs. The relevant parameters shown in Exhibit 3-15 affect sampling frequency and duration.

**Exhibit 3-15. List of POU/POE Model Parameters for Annual Monitoring Costs**

Parameter	Units	User-Defined Entry
Sampling time (including travel)	hrs/sample	Enter average time in hours
Sampling scheduling time	hrs/sample	Enter average time in hours
Analysis frequency (samples)	samples/household/year	Enter number of annual samples per household included in the sampling event
Analysis frequency (percent)	% households/year	Enter percent of households included in the annual sampling event

The final O&M costs pertain to equipment replacement. The POU/POE model accommodates replacement schedules and costs for up to four device components, as well as UV lamp and sleeve replacement, when applicable. User-defined data can override one or more of the default equipment replacement frequencies or costs. Exhibit 3-16 shows the user input form for equipment replacement costs.

**Exhibit 3-16. List of POU/POE Model Parameters for Annual Equipment Replacement Costs**

Parameter	Units	User-Defined Entry
Parts Replacement		
Name of Replacement Part 1	NA – name of part	Enter equipment name
Unit Cost of Replacement Part 1	\$/part	Enter dollar value
Replacement Frequency	times/household/yr	Enter average annual replacement frequency
Name of Replacement Part 2		Enter equipment name
Unit Cost of Replacement Part 2	\$/part	Enter dollar value
Replacement Frequency	times/household/yr	Enter average annual replacement frequency
Name of Replacement Part 3		Enter equipment name
Unit Cost of Replacement Part 3	\$/part	Enter dollar value
Replacement Frequency	times/household/yr	Enter average annual replacement frequency
Name of Replacement Part 4		Enter equipment name
Unit Cost of Replacement Part 4	\$/part	Enter dollar value
Replacement Frequency	times/household/yr	Enter average annual replacement frequency
Replacement UV Lamp*	\$/part	Enter dollar value
Replacement Frequency*	times/yr	Enter average annual replacement frequency
Replacement UV Quartz Sleeve*	\$/part	Enter dollar value
Replacement Frequency*	times/yr	Enter average annual replacement frequency

### 3.3 Understanding the Output Worksheet

The **Output** worksheet shows all of the cost components and the cost build-up. Exhibit 3-17 provides an example of the elements reported for equipment costs. The top section of the Output worksheet provides a summary of the target contaminant, treatment, and system size information provided on the User Input worksheet (or, in the Standard Input mode, the Input worksheet).

The main section of the Output sheet shows the cost build-up for direct capital costs, with a line item for each component. Exhibit 3-17 illustrates the capital cost reporting elements for the POU/POE model. Each line item includes the name of the component, the quantity (e.g., number of devices or hours per household), frequency (usually the number of households affected), and unit cost (e.g., cost per device or per staff hour).

Each line item also includes the total cost for the component and, where applicable, a useful life estimate (or a dash indicating the useful life is not applicable). The useful life estimate generally reflects the expected life of the installed device, taking into account engineering constraints (e.g., the expected life of a component until it must be replaced) as well as regulatory change (e.g., the

potential for regulations to change, requiring equipment replacement even if the equipment still functions as designed). The useful life estimate is used to convert upfront capital costs to annualized capital costs, which can then be added to annual O&M costs to obtain an annual total cost estimate and an average unit cost (\$/kgal) designed for comparison with centralized treatment costs.

Exhibit 3-17. Example of Cost Details Provided on the Output Worksheet

<b>System Description</b>	
<b>Households Served</b>	25
<b>Contaminant</b>	Arsenic
<b>Treatment Technology</b>	POU Reverse Osmosis
<b>Treatment Location</b>	POU
<b>UV Treatment</b>	no

Capital Costs		Design		Unit Cost	Total Cost
WBS #	Item	Quantity	Frequency		
<b>23.0</b>	<b>POU/POE Treatment</b>				
<b>23.1</b>	<b>Installed Treatment Equipment</b>				
23.1.1	POU/POE Unit Purchase	1 unit/household	25 households	\$ 561	\$ 14,023
23.1.2	POU/POE Installation	2.00 hours/household	25 households	\$ 33.12	\$ 1,656
23.1.3	Scheduling Time	0.50 hours/household	25 households	\$ 17.89	\$ 224
23.1.4	UV Purchase	0 unit/household	0 households	\$ -	\$ -
23.1.5	UV Installation	0.00 hours/household	0 households	\$ -	\$ -
<b>23.2</b>	<b>Public Education</b>				
<b>23.2.1</b>	<b>Technical Labor</b>				
23.2.1.1	Develop materials	10.00 hours		\$ 25.07	\$ 251
23.2.1.2	Nitrate health effects	0.00 hours		\$ 25.07	\$ -
23.2.1.3	Meetings	2.00 hours		\$ 25.07	\$ 50
23.2.1.4	Post-meeting	2.00 hours		\$ 25.07	\$ 50
<b>23.2.2</b>	<b>Clerical Labor</b>				
23.2.2.1	Develop materials	6.00 hours		\$ 17.89	\$ 107
23.2.2.2	Nitrate health effects	0.00 hours		\$ 17.89	\$ -
23.2.2.3	Meetings	2.00 hours		\$ 17.89	\$ 36
23.2.2.4	Post-meeting	2.00 hours		\$ 17.89	\$ 36
<b>23.2.3</b>	<b>Printed Material</b>				
23.2.3.1	Meeting flyers	10 flyers		\$ 2.12	\$ 21
23.2.3.2	Meeting ads	1 ads		\$ 42.46	\$ 42
23.2.3.3	Nitrate awareness flyers	0 flyers		\$ 2.12	\$ -
23.2.3.4	Meeting handouts	3 pages/household	25 households	\$ 0.08	\$ 6
23.2.3.5	Billing mailers	2 pages/household	25 households	\$ 0.08	\$ 4