EPA Document No.
EPA-815R24012

# Technologies and Costs for Removing Per- and Polyfluoroalkyl Substances (PFAS) from Drinking Water

# Technologies and Costs for Removing Per- and Polyfluoroalkyl Substances (PFAS) from Drinking Water

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EPA Document Number: 815R24012

March 2024

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# Acronyms and Abbreviations

| | |
|---|---|
| ANSI | American National Standards Institute |
| BV | bed volumes |
| DOC | dissolved organic carbon |
| EBCT | empty bed contact time |
| EPA | U.S. Environmental Protection Agency |
| GAC | granular activated carbon |
| gfd | gallons per day per square foot |
| g/mol | grams per mole |
| gpm | gallons per minute |
| IX | ion exchange |
| LSI | Langelier saturation index |
| MCL | maximum contaminant level |
| MGD | million gallons per day |
| mg/L | milligrams per liter |
| MWCO | molecular weight cut off |
| NF | nanofiltration |
| ng/L | nanograms per liter |
| NPDES | National Pollutant Discharge Elimination System |
| NSF | NSF International, The Public Health and Safety Company [1] |
| O&M | operating and maintenance |
| PFAS | per- and polyfluoroalkyl substances |
| POE | point-of-entry |
| POU | point-of-use |
| RCRA | Resource Conservation and Recovery Act |
| RO | reverse osmosis |
| RSSCT | rapid small-scale column test |
| SDI | silt density index |
| SDWA | Safe Drinking Water Act |
| TDP | Technology Design Panel |
| TOC | total organic carbon |
| WBS | Work Breakdown Structure |
| WWTP | wastewater treatment plant |

See also Table 1-1 for abbreviations for individual PFAS compounds.

[1] Formerly National Sanitation Foundation

# 1.0 Introduction

## 1.1 Background

Per- and polyfluoroalkyl substances (PFAS) are a broad class of approximately 10,000 synthetic chemicals (Rogers et al., 2021; Weaver, 2020; USEPA, 2021d). Because of their water-resistant, stain-resistant, and non-stick properties, they are incorporated in or used as coatings for a variety of products. Household and industrial PFAS applications include use in carpeting, clothing, cookware, cosmetics, electronics, fire-fighting foam, glass, and packaging. The manufacture of PFAS and PFAS-containing products, along with the use and disposal of these products, have resulted in releases to air, soil, and water (ATSDR, 2021; Rogers et al., 2021; Weaver, 2020). The same properties that make PFAS useful in industry and commerce also make them stable and persistent in the environment (ATSDR, 2021).

The U.S. Environmental Protection Agency (EPA) is proposing a regulation for certain PFAS under the Safe Drinking Water Act (SDWA). To assist in evaluating and developing the national costs associated with the proposed regulation, this document describes treatment technologies that are known to effectively remove PFAS from drinking water. It also presents estimated costs associated with the engineering, installation, and operation and maintenance of these technologies. EPA is proposing MCLGs for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) at zero and the enforceable Maximum Contaminant Level (MCL) at 4.0 nanograms per liter (ng/L) or parts per trillion (ppt) for each of these contaminants. EPA is also proposing regulation of hexafluoropropylene oxide dimer acid (HFPO-DA), perfluorobutane sulfonic acid (PFBS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) through a Hazard Index (HI) approach. EPA is proposing to set the MCLG as a HI of 1.0 (unitless) and the enforceable MCL equal to the MCLG. Table 1-1 lists PFAS for which treatability data are available in the literature included in EPA's Drinking Water Treatability Database (USEPA, 2021a; 2021b; 2021c).

The two most frequently studied PFAS are PFOA, which refers to perfluorooctanoic acid or perfluorooctane carboxylate, and PFOS, which refers to perfluorooctane sulfonic acid or perfluorooctane sulfonate.[2] Figure 1-1 shows the chemical structure of these two PFAS. Both molecules incorporate a chain of fully fluorinated (perfluorinated) carbon atoms but differ in the functional group attached at the end of the chain. In PFOA, the terminal functional group is carboxylic acid ($CO_2H$) or carboxylate ($CO_2^-$) in the anion form. In PFOS, the terminal functional group is sulfonic acid ($SO_3H$) or sulfonate ($SO_3^-$) in the anion form.

Both PFOA and PFOS include a total of eight carbon atoms in their molecular chain. There are other perfluorinated PFAS that incorporate the same terminal functional groups but have a different number of carbon atoms in the chain. For example, PFHxA refers to a perfluorinated six-carbon compound with a carboxylic acid or carboxylate functional group. PFHxS refers to a perfluorinated six-carbon compound with a sulfonic acid or sulfonate functional group. In general, degree of fluorination, functional group, and chain length provide a means of classifying PFAS compounds, as shown in Table 1-2. Buck et al. (2011) and ITRC (2020) provide a more

[2] Although different sources within the literature may use the names for the acid and anion forms of PFOA, PFOS, and other perfluorinated PFAS interchangeably, they most frequently occur in the environment in their anion form (ITRC, 2020).

detailed and nuanced categorization of PFAS, but for purposes of discussing treatment technologies and costs this simplified categorization is useful.

**Table 1-1. PFAS with Treatability Data**

| Abbreviation | Full Name | Chemical Abstract Service (CAS) Number |
|---|---|---|
| ADONA | Ammonium 4,8-dioxa-3H-perfluorononanoate | 958445-44-8 or 919005-14-4 (as acid) |
| F-53B | A combination of 9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid and 11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid | 756426-58-1 and 763051-92-9 (respectively) |
| FtS 4:2 | Fluorotelomer sulfonate 4:2 | 414911-30-1 |
| FtS 6:2 | Fluorotelomer sulfonate 6:2 | 27619-97-2 |
| FtS 8:2 | Fluorotelomer sulfonate 8:2 | 39108-34-4 |
| HFPO-DA* | Ammonium perfluoro-2-methyl-3-oxahexanoate, Perfluoro-2-methyl-3-oxahexanoic acid | 62037-80-3 (as ammonium salt), 13252-13-6 (as acid) |
| Nafion BP2 | Perfluoro-2-{[perfluoro-3-(perfluoroethoxy)-2-propanyl]oxy}ethanesulfonic acid | 749836-20-2 |
| N-EtFOSAA | 2-(N-Ethyl-perfluorooctanesulfonamido)acetate | 2991-50-6 |
| N-MeFOSAA | 2-(N-Methylperfluorooctanesulfonamido)acetate | 909405-48-7 or 2355-31-9 (as acid) |
| PFBA | Perfluorobutanoic acid | 375-22-4 |
| PFBS | Perfluorobutyl sulfonic acid | 375-73-5 |
| PFBSA | Perfluorobutylsulfonamide | 30334-69-1 |
| PFDA | Perfluorodecanoic acid | 335-76-2 |
| PFDoA | Perfluorododecanoic acid | 307-55-1 |
| PFDS | Perfluorodecyl sulfonic acid | 335-77-3 |
| PFECHS | Perfluoro-4-(perfluoroethyl)cyclohexylsulfonate | 80988-54-1 |
| PFHpA | Perfluoroheptanoic acid | 375-85-9 |
| PFHpS | Perfluoroheptyl sulfonic acid | 375-92-8 |
| PFHxA | Perfluorohexanoic acid | 307-24-4 |
| PFHxS | Perfluorohexyl sulfonic acid | 355-46-4 |
| PFHxSA | Perfluorohexanesulfonamide | 41997-13-1 |
| PFMOAA | Difluoro(perfluoromethoxy)acetic acid, also known as perfluoro-2-methoxyacetic acid | 674-13-5 |
| PFMOBA | Perfluoro-4-methoxybutanoic acid | 863090-89-5 |
| PFMOPrA | Perfluoro-3-methoxypropanoic acid | 377-73-1 |
| PFNA | Perfluorononanoic acid | 375-95-1 |
| PFNS | Perfluorononane sulfonic acid | 68259-12-1 |
| PFO2HxA | Perfluoro-3,5-dioxahexanoic acid | 39492-88-1 |
| PFO3OA | Perfluoro-3,5,7-trioxaoctanoic acid | 39492-89-2 |
| PFO4DA | Perfluoro-3,5,7,9-butaoxadecanoic acid | 39492-90-5 |
| PFOA | Perfluorooctanoic acid | 335-67-1 |
| PFOS | Perfluorooctane sulfonic acid | 1763-23-1 |
| PFOSA | Perfluorooctanesulfonamide | 754-91-6 |
| PFPeA | Perfluoropentanoic acid | 2706-90-3 |
| PFPrS | Perfluoropropane sulfonate | 110676-15-8 |

| Abbreviation | Full Name | Chemical Abstract Service (CAS) Number |
|---|---|---|
| PFTriA | Perfluorotridecanoic acid | 72629-94-8 |
| PFUnA | Perfluoroundecanoic acid | 2058-94-8 |

[*] HFPO-DA is used in a processing aid technology developed by DuPont to make fluoropolymers without using PFOA. The chemicals associated with this process are commonly known as GenX Chemicals and the term is often used interchangeably for HFPO-DA along with its ammonium salt
Sources: USEPA, 2021a; 2021b; 2021c

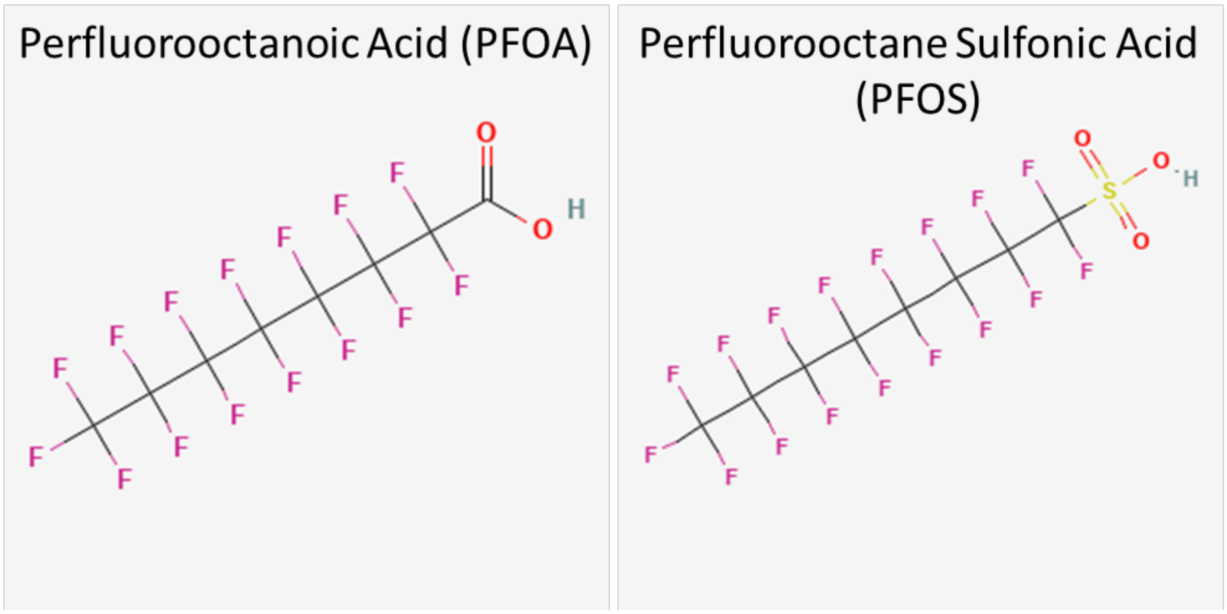


**Figure 1-1. Chemical Structure of PFOA and PFOS**

Sources: NCBI, 2021a; 2021b

**Table 1-2. PFAS Classified by Functional Group and Chain Length**

| Number of Carbons | Perfluorinated Carboxylic Acids/Carboxylates | Perfluorinated Sulfonic Acids/Sulfonates | Other Perfluorinated | Polyfluorinated |
|---|---|---|---|---|
| 3 | | PFPrS | | PFMOAA |
| 4 | PFBA | PFBS | PFBSA | FtS 4:2, PFO2HxA, PFMOPrA |
| 5 | PFPeA | PFPeS | | PFO3OA, PFMOBA |
| 6 | PFHxA | PFHxS | HFPO-DA, PFHxSA | FtS 6:2, PFO4DA |
| 7 | PFHpA | PFHpS | | ADONA, Nafion BP2 |
| 8 | PFOA | PFOS | PFOSA, PFECHS | FtS 8:2 |

| Number of Carbons | Perfluorinated Carboxylic Acids/Carboxylates | Perfluorinated Sulfonic Acids/Sulfonates | Other Perfluorinated | Polyfluorinated |
|---|---|---|---|---|
| 9 | PFNA | PFNS | | |
| 10 | PFDA | PFDS | | |
| 11 | PFUnA | | | N-MeFOSAA |
| 12 | PFDoA | | | N-EtFOSAA |
| 13 | PFTriA | | | |

Sources: ITRC, 2020; USEPA, 2021a; 2021b; 2021c

## 1.2 Organization and Overview

This report is organized as follows:

- Evaluation of treatment and nontreatment compliance options for potential PFAS standards (Chapters 2 through 6)
- Costs for treatment and nontreatment (Chapter 7).

The technology evaluations in Chapter 2 through 5 describe treatment technologies that can effectively remove PFAS from drinking water. Specifically, they address effectiveness for the following treatment technologies:

- Granular activated carbon (GAC) (Chapter 2)
- Ion exchange (IX) (Chapter 3)
- Reverse osmosis and nanofiltration (RO/NF) (Chapter 4)
- Point-of-use/point-of-entry (POU/POE) treatment (Chapter 5). [3]

For each technology, the corresponding chapter provides an overview of how the technology operates and summarizes its effectiveness for removal or destruction of PFAS. Each technology summary also incorporates available findings with respect to effectiveness under different source water conditions. Information on process waste characterization, handling, and management is also provided. Each summary concludes with a compilation of the PFAS-specific engineering design specifications obtained from the treatability literature reviewed.

Chapter 6 discusses nontreatment options that might be used in lieu of treatment options to comply with the proposed PFAS regulation. Chapter 7 (in combination with Appendices A and B) presents estimated costs associated with engineering, installation, operation, and maintenance of each of the treatment and nontreatment options discussed in Chapters 2 through 6. Appendix A provides complete cost equations for the treatment and nontreatment options. Appendix B

[3] POU devices are not currently a compliance option because the regulatory options under consideration require treatment to concentrations below the current NSF International/American National Standards Institute (NSF/ANSI) certification standard for POU device removal of PFAS. However, POU treatment might become a compliance option for small systems in the future if NSF/ANSI develop a new certification standard that mirrors EPA's proposed regulatory standard.

presents example cost model outputs for selected flow rates, allowing review of individual cost line items.

## 1.3 Information Sources

The information presented in this document is a summary of EPA's literature search to evaluate the state of science with respect to treatment options for PFAS-contaminated drinking source water. The objectives of the literature review were to:

- identify what technologies are being studied and tested
- summarize the data regarding effectiveness
- characterize other factors relevant for drinking water treatment (e.g., pre- and post-treatment requirements and waste characterization and management options)
- identify key research gaps.

## 1.4 References

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# 2.0 Granular Activated Carbon (GAC)

## 2.1 Operating Principle

GAC is a porous adsorptive media with extremely high internal surface area. GAC is manufactured from a variety of raw materials with porous structures including bituminous coal, lignite coal, peat, wood, coconut shells, and others. Physical and/or chemical manufacturing processes are applied to these raw materials to create and/or enlarge pores, resulting in a porous structure with a large surface area per unit mass.

When water is treated with GAC, it passes through treatment columns or beds containing GAC. The process separates dissolved contaminants from the water through adsorption to the surfaces in the pores of the GAC. In the case of PFAS, the literature suggests that the primary mechanisms of adsorption include both hydrophobic and electrostatic interactions (Ateia et al., 2019). In addition to removing PFAS, GAC can remove contaminants including taste and odor compounds, natural organic matter, volatile organic compounds, synthetic organic compounds, disinfection byproduct precursors, and radon. Organic compounds with high molecular weights are also readily adsorbable.

The contaminants are adsorbed by GAC until the carbon is no longer able to adsorb additional molecules at the influent feed concentration. At this point, the result is reduced removal of the contaminant, referred to as "breakthrough." Figure 2-1 is a conceptual diagram of the GAC treatment process, from initial adsorption to breakthrough. Once the contaminant concentration in the treated water reaches an unacceptable level, the carbon is considered "spent" and must be replaced by virgin or reactivated GAC. The length of time between GAC replacement events is known as "bed life," discussed in more detail in Section 2.2.2. Reactivation[4] is a process that removes adsorbed contaminants from adsorption sites on GAC so that it can be reused. Although different methods are available for GAC reactivation, the process most commonly involves high temperature thermal treatment in a specialized facility such as a multiple hearth furnace or rotary kiln (Matthis and Carr, 2018; USEPA, 2022). Section 2.5 provides more information on the fate of PFAS in the reactivation process.

GAC beds typically also require periodic backwash to prevent head loss or biomass accumulation. The backwash process must be designed to remove accumulated solids, while preventing the spent carbon at the top of the column from mixing with the unspent carbon at the bottom, creating a mixed bed and the possibility of "leakage" of the target contaminant.

[4] The terms "reactivation" and "regeneration" are sometimes used interchangeably in the drinking water industry. GAC vendors, however, make a distinction between the two processes. The appropriate term for the process used on spent GAC containing adsorbed PFAS is reactivation (Matthis and Carr, 2018).

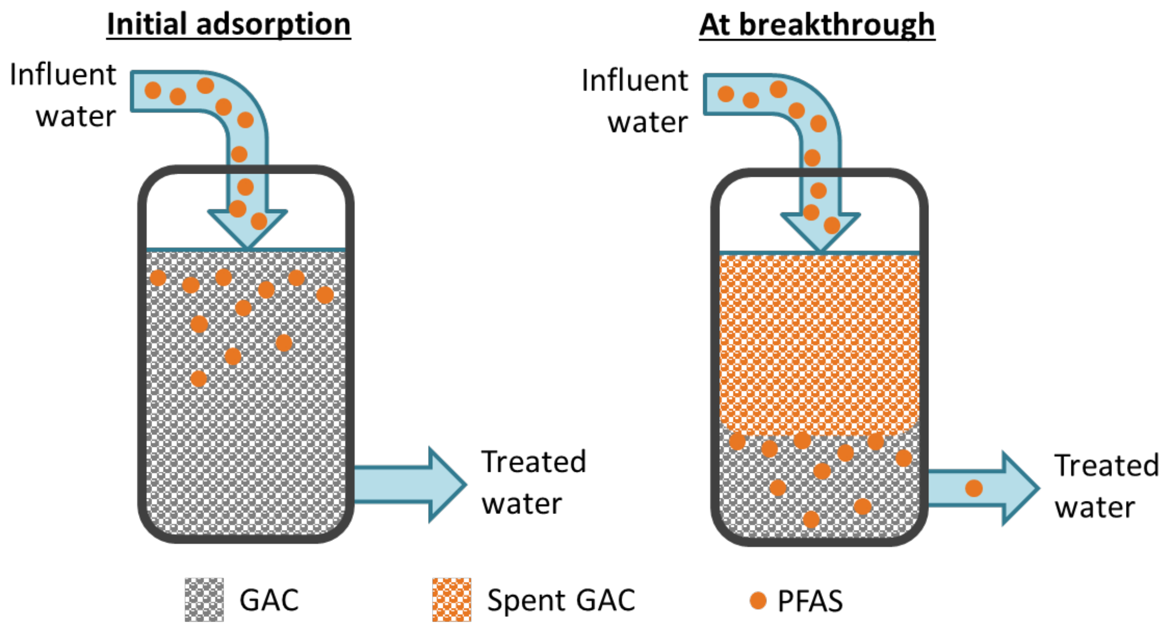


**Figure 2-1. Conceptual Diagram of the GAC Treatment Process**

The specific design of a GAC treatment facility depends on the type of contactor and the system configuration used. GAC can be set up in a single-stage, series, or parallel system. In drinking water treatment, GAC configuration generally is a downflow fixed (packed) bed system. The system can have single or multiple adsorbers operated under pressure or fed by gravity (Brady and Moran, 2012; Summers et al., 2011). Pressure contactors are more cost effective for small systems because they can be purchased off the shelf as prefabricated, packaged units. Pressure GAC systems can be operated at higher suspended solids concentrations with less frequent backwashing and over a wide range of flow rates due to the allowable pressure variances. Pressure GAC systems are also enclosed, so there is no visual observation of the system. Gravity contactor designs are generally used in larger installations (Brady and Moran, 2012; Summers et al., 2011). Gravity contactors can be sized larger than off-the-shelf pressure vessels and because common wall design can minimize space requirements. A gravity contactor design is better for systems that do not have large variances in flow, pressure, or turbidity (Summers et al., 2011). Figure 2-2 and Figure 2-3, respectively, provide schematic drawings for a pressure GAC facility and a gravity GAC facility.

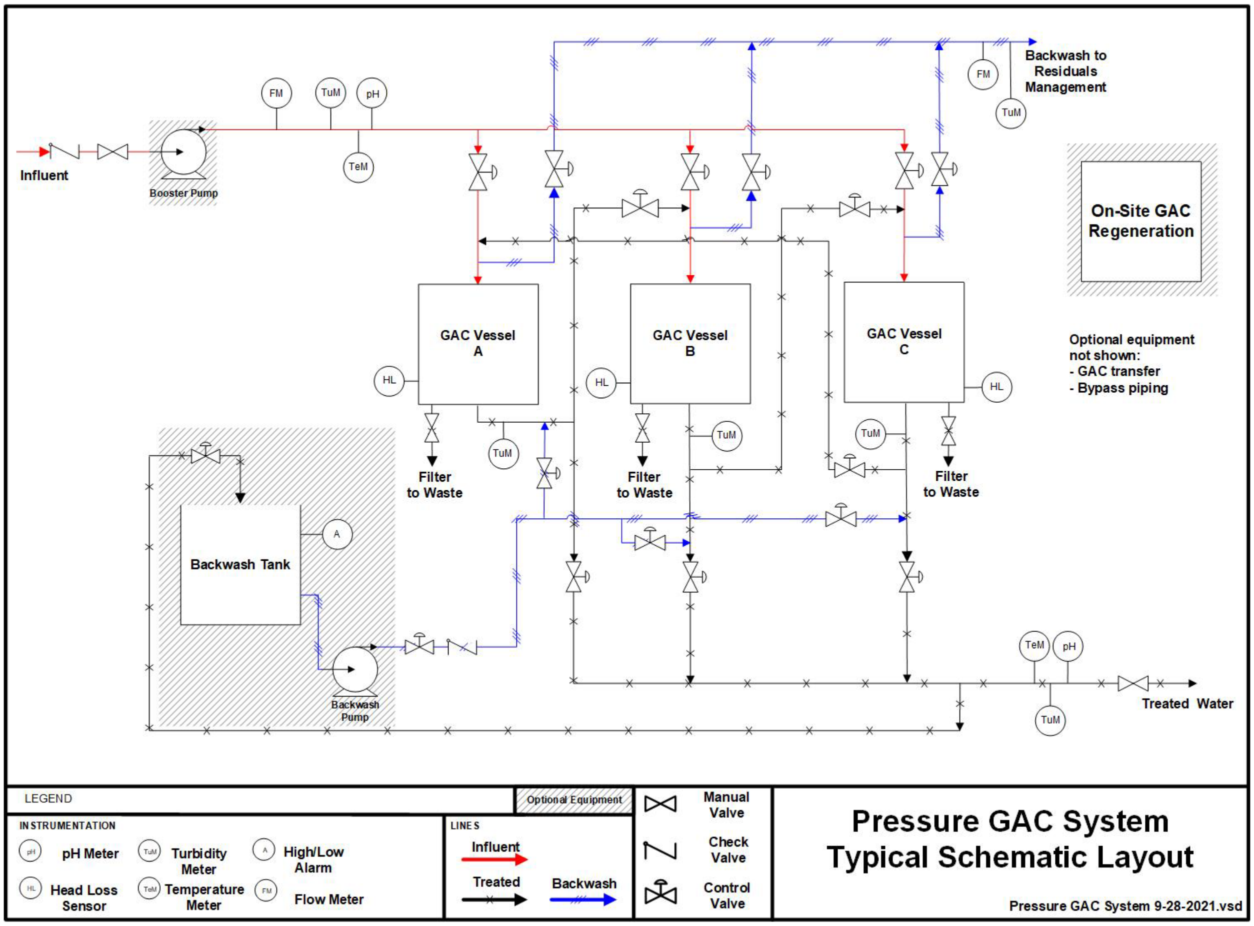


**Figure 2-2. Typical Schematic Layout for Pressure GAC Treatment Facility**

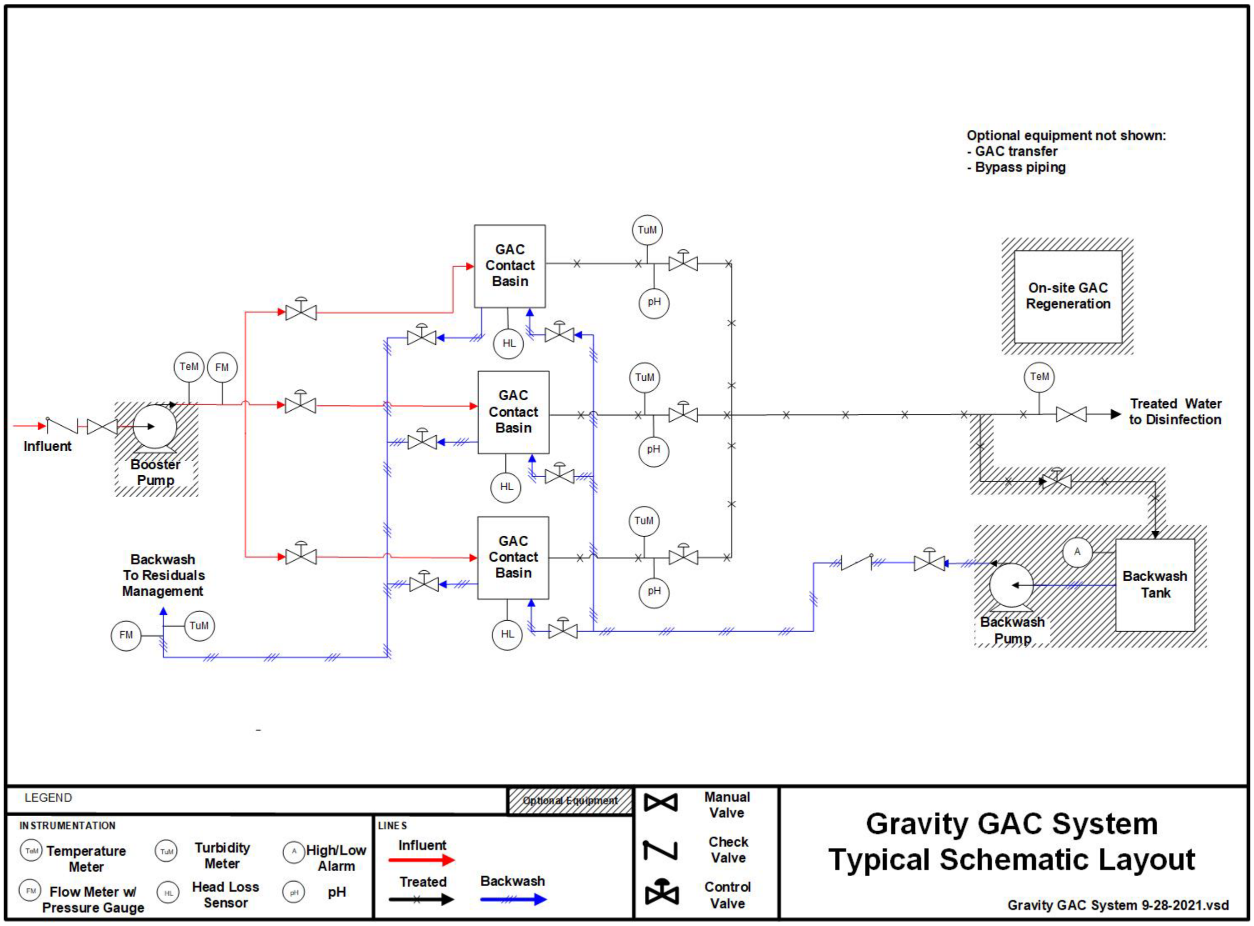


**Figure 2-3. Typical Schematic Layout for Gravity GAC Treatment Facility**

## 2.2 Effectiveness for PFAS Removal

### *2.2.1 Removal Efficiency*

EPA's Drinking Water Treatability Database (USEPA, 2021a; 2021b; 2021c) includes extensive data from the literature on PFAS removal by GAC. Results are available from studies conducted in the laboratory, in the field at pilot scale, and in full-scale application, as shown in Table 2-1, Table 2-2, and Table 2-3.[5] These tables present the number of studies at each scale, along with a key benchmark of technology effectiveness: maximum removal efficiency. Removal efficiency is the percentage of the influent concentration removed through treatment.

The literature demonstrates maximum GAC removal efficiencies of 90 percent or greater for all the carboxylate and sulfonate PFAS compounds for which data are available. The literature also shows that the technology often removes these compounds to levels below analytical detection limits. For PFOA and PFOS, maximum removal efficiencies are greater than 99 percent, also to below analytical detection limits and lower than the regulatory thresholds currently under consideration. There are fewer studies of GAC performance for other (non-carboxylate and non-

[5] Data shown in these tables are as of December 2021. EPA frequently updates the Drinking Water Treatability Database, so parties interested in results from recently published literature may wish to access the database directly at https://tdb.epa.gov/tdb/home.

sulfonate) PFAS compounds, but the available data show maximum removal efficiency of 90 percent or greater for many of these compounds, including HFPO-DA.

**Table 2-1. Studies of GAC Treatment for Carboxylate PFAS**

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum Removal Efficiency | Source(s) for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|
| PFBA | 4 | 8 | 5 | 5 | 99.5 | Westreich et al. 2018 |
| PFPeA | 5 | 7 | 5 | 5 | 90 | Appleman et al. 2013; McCleaf et al. 2017; Park et al. 2017; Lombardo et al. 2018; Kempisty et al. 2019; Liu et al. 2019; Park et al. 2020 |
| PFHxA | 6 | 12 | 6 | 6 | 99.5 | Westreich et al. 2018 |
| PFHpA | 7 | 9 | 5 | 7 | >99 | Zeng et al 2020 |
| PFOA | 8 | 23 | 9 | 17 | >99.8 | Forrester and Bostardi 2019 |
| PFNA | 9 | 6 | 3 | 8 | >99 | Zeng et al 2020 |
| PFDA | 10 | 6 | 1 | 4 | 97 | Appleman et al. 2013 |
| PFUnA | 11 | 1 | 0 | 1 | 90 | McCleaf et al. 2017 |
| PFDoA | 12 | 3 | 0 | 0 | 90 | McCleaf et al. 2017; Park et al. 2017 |
| PFTriA | 13 | 1 | 0 | 0 | 90 | McCleaf et al. 2017 |

Sources: USEPA, 2021a; 2021c

**Table 2-2. Studies of GAC Treatment for Sulfonate PFAS**

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum Removal Efficiency | Source for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|
| PFPrS | 3 | 0 | 1 | 0 | 90 | Liu et al. 2019 |
| PFBS | 4 | 13 | 7 | 8 | 99.5 | Westreich et al. 2018 |
| PFPeS | 5 | 2 | 2 | 0 | 90 | Liu et al. 2019 |
| PFHxS | 6 | 13 | 7 | 11 | 99.5 | Westreich et al. 2018 |
| PFHpS | 7 | 2 | 4 | 1 | >99 | Belkouteb et al. 2020 |
| PFOS | 8 | 24 | 10 | 15 | 99.7 | Woodard et al. 2017 |
| PFNS | 9 | 1 | 0 | 0 | 95.82 | Wang et al. 2020 |

Sources: USEPA, 2021b; 2021c

**Table 2-3. Studies of GAC Treatment for Other PFAS**

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum Removal Efficiency | Source for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|
| PFMOAA | 3 | 0 | 0 | 1 | 70 | Hopkins et al. 2018 |
| FtS 4:2 | 4 | 0 | 1 | 0 | Not reported | |
| PFBSA | 4 | 1 | 0 | 0 | 56 | Yan et al. 2020 |
| PFO2HxA | 4 | 0 | 0 | 1 | 90 | Hopkins et al. 2018 |
| PFO3OA | 5 | 0 | 0 | 1 | 90 | Hopkins et al. 2018 |
| FtS 6:2 | 6 | 1 | 3 | 0 | 88 | Casey et al. 2018 |
| HFPO-DA | 6 | 1 | 1 | 1 | 93 | Hopkins et al. 2018 |
| PFHxSA | 6 | 1 | 1 | 0 | 80 | Rodowa et al. 2020 |
| PFO4DA | 6 | 0 | 0 | 1 | 90 | Hopkins et al. 2018 |
| Nafion BP2 | 7 | 0 | 1 | 1 | >99 | Hopkins et al. 2018 |
| FtS 8:2 | 8 | 1 | 3 | 0 | 88 | Woodard et al. 2017 |
| PFOSA | 8 | 3 | 1 | 0 | 95 | Kothawala et al. 2017 |
| PFECHS | 8 | 1 | 0 | 0 | 65 | Yan et al. 2020 |

Source: USEPA, 2021c

### 2.2.2 Bed Life

In addition to removal efficiency, the effectiveness of GAC depends on bed life, which is the length of time the technology can maintain a target removal efficiency (e.g., 80 percent, 95 percent) or predefined concentration limit (such as an MCL). Bed life can be expressed as the number of days or months between GAC replacement events. It can also be expressed in bed volumes (BV), which is a measure of throughput: the volume of water treated during the bed life divided by the volume of the GAC bed. With either measure, a higher number indicates a longer bed life and more effective treatment.[6] Figure 2-4 illustrates the concepts of breakthrough and bed life on a typical "S-shaped" GAC breakthrough curve.

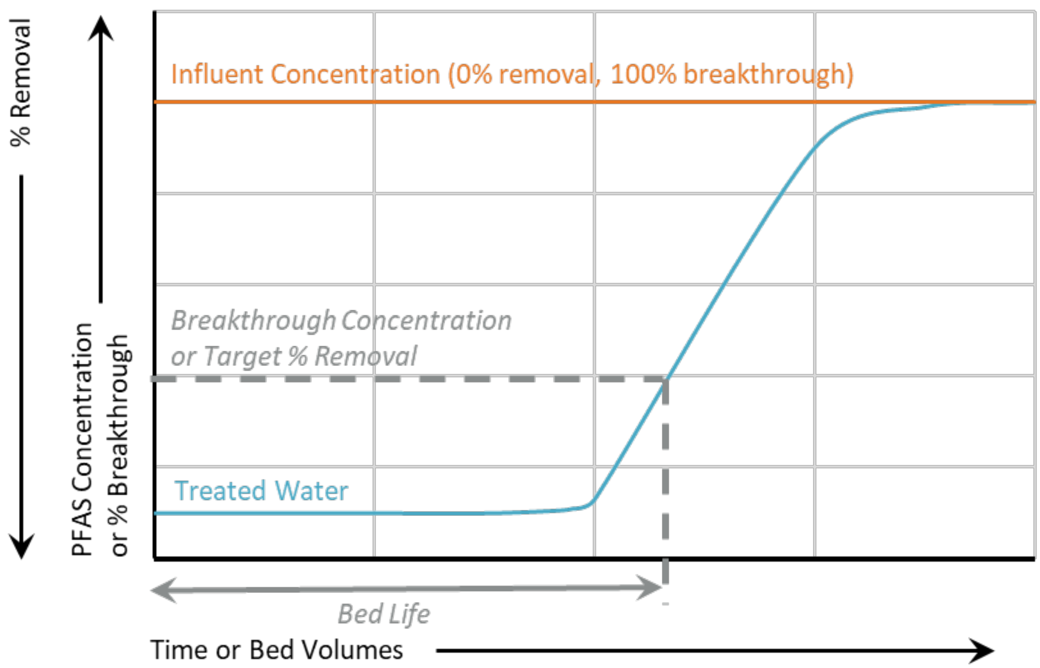


**Figure 2-4. Typical GAC Breakthrough Curve**

There is a consensus in the literature that GAC's capacity for a given PFAS compound is strongly influenced by chain length (i.e., number of carbon atoms) and functional group (i.e., carboxylate versus sulfonate). In general, all other factors (see below) being equal, GAC exhibits a greater capacity for longer chain compounds than shorter chain compounds and a greater capacity for sulfonate PFAS than carboxylate PFAS. The greater capacity translates to longer bed life and lower treatment costs (Appleman et al., 2013; Appleman et al., 2014; Berretta et al., 2021; Inyang and Dickenson, 2017; McCleaf et al., 2017; Zeng et al., 2020).

For GAC, chain length appears to be the more important factor, followed by functional group. The results from Berretta et al. (2021) provide an example of a typical order of breakthrough.

[6] A related measure is carbon use rate, which is often expressed in units of pounds of carbon used per 1,000 gallons of water treated. A lower carbon use rate reflects a longer bed life and more effective treatment. To avoid confusion, this document does not present data on carbon use rate.

From earliest breakthrough to latest, this typical sequence is as follows (with number of carbon atoms shown in parenthesis for ease of reference):

PFBA (4) > PFHxA (6) > PFBS (4) > PFOA (8) > PFHxS (6) > PFOS (8)

In addition to chain length and functional group, estimates of GAC bed life for PFAS removal depend on multiple factors. These additional factors can include the following:

- The target removal efficiency or predefined concentration at which the treated water quality is considered unacceptable (i.e., the "breakthrough" concentration)
- The influent concentration of the target PFAS compound(s)
- Other raw water quality parameters (see Section 2.3)
- Size of the GAC bed relative to the flow of water to be treated, measured by empty bed contact time (EBCT) (see Section 2.6.1)
- Adsorption properties of the specific GAC media (e.g., type of carbon, surface area, pore size distribution, and surface chemistry).

Because of these varying factors, comparing GAC bed life results across multiple studies is difficult. Section 2.6.3 discusses methods to estimate bed life as a critical parameter in the design and operation of GAC treatment.

### *2.2.3 Full-Scale Applications*

Additional support for the effectiveness of GAC for PFAS removal is evident from the number of full-scale facilities that are currently using the technology. As indicated in Section 2.1.1, there are numerous studies of GAC performance for PFAS removal at full-scale facilities. These effectiveness studies include results for GAC facilities designed specifically to target PFAS, in addition to facilities originally designed for other contaminants. In total, the literature identifies more than 30 full-scale GAC facilities that specifically target the removal of PFAS from drinking water. Table 2-4 identifies these facilities.

**Table 2-4. Full-scale GAC Systems Removing PFAS from Drinking Water**

| Location | Flow rate (MGD) | Groundwater or Surface Water | Year of Startup | Sources |
|---|---|---|---|---|
| Moose Creek, Fairbanks North Star Borough, Alaska | 2.2 | Groundwater | 2016 | Alaska Community Action on Toxics 2019; Forrester 2019 |
| Gustavus, Alaska | Not reported | Groundwater | 2018-2019 | Alaska Community Action on Toxics 2019 |
| Airline/Lambert Water Treatment Campus, Marana, Pima County, Arizona | Not reported | Groundwater | Not reported | Marana Water 2019 |
| Liberty Utilities, Litchfield Park, Arizona | 1.58 | Groundwater | 2017 | ADEQ 2021; Forrester 2019 |
| Picture Rocks Water Treatment Campus, Marana, Pima County, Arizona | Not reported | Groundwater | Not reported | Marana Water 2019 |
| Municipal Services Commission of the City of New Castle, New Castle, Delaware | 0.50 | Groundwater | 2015 | Mordock 2016; Forrester 2019 |

| Location | Flow rate (MGD) | Groundwater or Surface Water | Year of Startup | Sources |
|---|---|---|---|---|
| Emerald Coast Utilities Authority, Pensacola, Escambia County, Florida | 1.44 | Groundwater | 2017 | Robinson 2018; Forrester 2019 |
| Rome Water and Sewer Division, Rome, Georgia | 9 | Groundwater | Not reported | Forrester 2019; City of Rome 2019 |
| Former Naval Air Station, Brunswick, Maine | Not reported | Not reported | 2011 | Danko 2018 |
| Kennebunk, Kennebunkport & Wells Water District, Kennebunk, Maine | 2.90 | Groundwater | 2020 | Berretta et al. 2021; Business Wire 2018 |
| Mary Dunn Water Supply Wells, Hyannis & Town of Barnstable, Massachusetts | 1.44 | Groundwater | 2015 | Gallagher 2017; Forrester 2019 |
| City of Westfield Department of Public Works, Westfield, Massachusetts | Not reported | Groundwater | 2018 | Westfield 2019 |
| Plainfield Township, Kent County, Michigan | 9 | Groundwater | 2018 | Biolchini 2018 |
| Ann Arbor Water Treatment Plant, Ann Arbor, Michigan | 50 | Surface Water | 2018 | Stanton 2019; Page 2020 |
| Oakdale Public Works, Oakdale, Minnesota | 3.6 | Groundwater | 2006 | MDH 2010; ATSDR 2008 |
| Merrimack Village District Water Works, Merrimack, Hillsborough County, New Hampshire | Not reported | Groundwater | 2020 | Cronin 2020 |
| Pease International Tradeport Drinking Water System, Portsmouth, New Hampshire | 0.72 | Groundwater | 2019 | City of Portsmouth 2020; Forrester 2019 |
| Montclair Water Bureau, Montclair, New Jersey | 0.72 | Groundwater | Not reported | Forrester 2019; PFAS Project Lab 2021 |
| Passaic Valley Water Commission, Garfield, New Jersey | 0.5 | Groundwater | Not reported | Forrester 2019; Sobko 2021 |
| Hampton Bays Water District, Suffolk County, New York | 9 | Groundwater | 2018 | Gordon 2018 |
| Suffolk County Water Authority, New York | Not reported | Groundwater | 2017 | SCWA 2018 |
| Town of Petersburgh Water District, Petersburgh/Rensselaer County, New York | 0.07 | Not reported | 2017 | Forrester 2019; NYS DEC 2020a |
| Washington Lake Filtration Plant, Newburgh, New York | 8.86 | Groundwater | 2017 | Forrester 2019; NYS DEC 2020b |
| Little Hocking Water Association, Little Hocking, Ohio | Not reported | Groundwater | 2007 | Cummings et al 2015 |
| Village of Hoosick Falls, New York | 1.01 | Groundwater | Not reported | Forrester 2019; NYS DEC 2021 |

| Location | Flow rate (MGD) | Groundwater or Surface Water | Year of Startup | Sources |
|---|---|---|---|---|
| Sweeny Water Treatment Plant, Cape Fear Public Utilities Authority, North Carolina | 44 | Surface Water | 2022 | Vandermeyden and Hagerty 2020 |
| Wright-Patterson Air Force Base, Dayton, Ohio | 2.74 | Groundwater | 2017 | Barber 2017; Forrester 2019 |
| Aqua Pennsylvania, Chalfont Borough, Pennsylvania | 0.58 | Groundwater | Not reported | Forrester 2019; Chalfont Borough 2021 |
| Horsham Water and Sewer Authority, Horsham, Montgomery County, Pennsylvania | 1.44 | Groundwater | 2017 | Boodoo et al. 2019; Montgomery News 2017; Forrester 2019 |
| Warrington Township Water and Sewer Department, Warrington, Pennsylvania | 0.58 | Groundwater | Not reported | Forrester 2019; Warrington Township 2017 |
| City of El Campo Water Department, El Campo, Texas | Not reported | Groundwater | 2017 | Sullivan 2018 |
| Airway Heights Water System, City of Airway Heights, Washington | Not reported | Groundwater | 2018 | ATSDR 2020 |
| Joint Base Lewis-McChord, Washington | Not reported | Groundwater | Not reported | Sullivan 2018 |
| Issaquah, Washington | 4.32 | Groundwater | 2016 | City of Issaquah 2020; Mende 2019; Kwan and York 2017 |
| Parkersburg Utility Board, Parkersburg, West Virginia | Not reported | Not reported | Not reported | USEPA 2009 |

MGD = million gallons per day

## 2.3 Raw Water Quality Considerations

Natural organic matter, often measured as dissolved organic carbon (DOC) or total organic carbon (TOC), can interfere with GAC's capacity to adsorb PFAS (Appleman et al., 2013; Ateia et al., 2019; Berretta et al., 2021; Gagliano et al., 2020; Kothawala et al., 2017). The significance of this interference may depend on the specific type of natural organic matter present (Gagliano et al., 2020; Kothawala et al., 2017). However, in general, it does not necessarily reduce the maximum removal effectiveness of GAC. Instead, it shortens the time to breakthrough, meaning more frequent GAC replacement can be required at higher TOC concentrations, all other factors being equal. Therefore, it should be possible to reliably manage the impact of natural organic matter through piloting, selection of design parameters, and operational monitoring. For purposes of estimating national costs for GAC, EPA used a method to estimate bed life that explicitly includes consideration of influent TOC (see Sections 2.6.3 and 7.2.1).

The presence of other adsorbable contaminants can reduce GAC capacity for a target contaminant, as the contaminants compete for adsorption sites on the media. The extent of this competition depends on the relative concentrations and adsorbability of the contaminants. However, when a poorly adsorbed contaminant is present and not a treatment target, the system can allow the contaminant to breakthrough, reducing its impact on GAC capacity for the target contaminant(s) (Stenzel and Merz, 1989). When multiple target contaminants (e.g., multiple PFAS compounds) are present, GAC operation, specifically the selection of bed life, should consider competition among these contaminants. In extreme cases, where the GAC bed becomes highly saturated with contaminants, preferred contaminants in the influent can displace previously adsorbed, less preferred contaminants. Such cases can result in a phenomenon known as chromatographic peaking, where the treated concentration of a less preferred contaminant exceeds its influent concentration (Brady and Moran, 2012). Appleman et al. (2014) reported this phenomenon for PFBA at a full-scale GAC system removing PFAS. McCleaf et al. (2017) observed similar behavior for PFBA and PFPeA in column tests. Like TOC, the impact of competition among target contaminants, including the potential for chromatographic peaking, can be managed through piloting, selection of design parameters, and operational monitoring. For purposes of estimating national costs for GAC, EPA used a method to estimate bed life that is based on data from studies where multiple PFAS compounds were present in concentrations typical of PFAS-contaminated drinking water (see Sections 2.6.3 and 7.2.1).

## 2.4 Pre- and Post-Treatment Needs

Because GAC also works as a filtration medium, solids in influent water can accumulate in the GAC bed, causing excess pressure drop and increased backwash frequency. Therefore, under some circumstances, pre-filtration should be included. Such circumstances are site-specific, but examples include when upstream treatment includes coagulant addition for solids removal or when there is the potential for formation of iron and manganese precipitates (Stenzel and Merz, 1989; Summers et al., 2011). Chlorination prior to GAC treatment is not generally recommended because of the potential for the chlorine compounds to react with adsorbed compounds or the GAC itself (Brady and Moran, 2012; Summers et al., 2011).

In some cases, there can be temporary water chemistry changes immediately following GAC changeout, such as leaching of metals (e.g., arsenic, antimony), increases in pH, or release of fines which are small particles or powdered materials (Brady and Moran, 2012). These effects are readily managed by using pre-treated GAC media or diverting the first few bed volumes of treated water to waste and do not typically require post-treatment.

## 2.5 Waste Generation and Residuals Management Needs

The most likely management option for spent GAC containing adsorbed PFAS is reactivation. There are a number GAC vendor-operated reactivation facilities available, including some that hold Resource Conservation and Recovery Act (RCRA) permits to treat spent GAC that is classified as hazardous waste (USEPA, 2020; Matthis and Carr, 2021). Matthis and Carr (2021) report results from leaching tests on GAC used to remove PFAS from drinking water at full-scale after reactivation, also in a full-scale facility. They found that 15 of the 16 PFAS compounds analyzed were below analytical limits in the leachate. PFBA was present, but only at 1.9 parts per trillion. These results suggest that reactivated GAC should be suitable for reuse.

The full-scale study in Mathis and Carr (2021), however, did not fully address the fate of PFAS in the GAC reactivation process. There are a limited number of smaller scale studies that have examined whether PFAS compounds are transformed, volatilized, or destroyed/defluorinated during the process (e.g., Watanabe et al., 2016; Watanabe et al., 2018; Xiao, 2020). These studies suggest that the fate of PFAS in GAC reactivation depends on factors including PFAS chain length, reactivation temperature, and combustion atmosphere (Baghirzade et al., 2021). Additional full-scale research might be needed if future air quality regulations address PFAS emissions from GAC reactivation facilities. The results of this research might necessitate changes to spent GAC management practices. Future RCRA hazardous waste regulations for PFAS could also limit the available management options.

GAC systems also intermittently generate a liquid residual in the form of spent backwash. Like conventional filters, GAC contactors must be backwashed periodically to remove solids, maintain the desired hydraulic properties of the bed, and possibly to control biological growth. Backwash does not remove adsorbed contaminants from the GAC bed, although some attrition or loss of actual GAC particles may occur during the backwash process. Therefore, spent backwash water contains primarily suspended solids and not target contaminants. The interval between backwash occurrences is mainly a function of the turbidity in the influent water. Management options for spent backwash include discharge to surface water under a National Pollutant Discharge Elimination System (NPDES) permit, discharge to a wastewater treatment plant (WWTP), or recycle to the head of the treatment plant. For some small systems, another option may be discharge to an on-site septic system.

When averaged over the time between generation events, backwash flow is relatively low. Instantaneous flow during a backwash event, however, is much higher. If spent backwash is recycled to the head of a treatment plant, recommended engineering practice is that the recycle stream should be no more than 5 to 10 percent of total system flow (USEPA, 2002; USEPA, 1996). Thus, when backwash is recycled, the system should include a spent backwash holding tank to prevent recycle flow from exceeding this recommendation. Holding tanks also may be advisable for other backwash management options (e.g., to prevent instantaneous flow from overwhelming the capacity of a WWTP).

## 2.6 Critical Design Parameters

Critical design parameters for GAC systems removing PFAS are:

- EBCT
- Contactor configuration (number of vessels in series)
- Bed life
- Residuals management options.

Section 2.5 discusses residuals management options. The sections below discuss EBCT, contactor configuration, and bed life in more detail, including the data available in the literature for these parameters. Section 7.2.1 identifies the specific values for each parameter used in EPA's cost estimates. Values for other GAC design parameters (e.g., loading rate, backwash frequency), while not specifically addressed here, are well documented for GAC treatment in general. EPA has no reason to expect a significant difference in these parameters for GAC systems treating PFAS compounds.

### *2.6.1 Empty Bed Contact Time*

For a given set of site-specific conditions, there is a minimum EBCT required to produce water of a target quality. EBCT, measured in minutes, is defined by the following equation:

$$EBCT\ (in\ minutes) = \frac{Volume\ of\ GAC\ Bed}{Volumetric\ Flow\ Rate\ (per\ minute)}$$

The minimum EBCT required varies depending on the specific contaminant treated, the required contaminant removal percentage, the type of GAC used, and other influent water characteristics. Full-scale GAC treatment systems that are purpose-built for PFAS removal and for which EBCT data are available use EBCTs between 7.6 and 26 minutes (Appleman et al., 2014; Boodoo, 2018; Forrester and Mathis, 2018; Kwan and York, 2017; Vandermeyden and Hagerty, 2020). GAC vendors commonly recommend a minimum EBCT of 20 minutes for PFAS removal (Calgon Carbon, 2018; Forrester and Mathis, 2017; 2018).

### 2.6.2 Contactor Configuration

GAC treatment systems with multiple contactors can be configured in parallel or in series. The schematic diagrams in Section 2.1 show contactors in parallel (in Figure 2-2) and in series (in Figure 2-3). In a series (or lead/lag) configuration, water flows first through an initial contactor that serves as a roughing contactor, then through subsequent contactors that serve as polishing contactors. Each contactor in the series typically has an equal EBCT such that the total EBCT of the series provides the design EBCT. In a parallel configuration, flow is divided equally among the contactors, each of which provides the design EBCT (Brady and Moran, 2012).

A series (or lead/lag) configuration serves the purpose of treating a greater water volume than one contactor with similar bed volume. When GAC in the roughing contactor is spent, this media is replaced and the polishing contactor moves to the start of the series, becoming the roughing contactor. The use of vessels in series can allow the carbon in the lead vessel to reach saturation, increasing total capacity (Brady and Moran, 2012; Summers et al., 2011).

A parallel configuration can also increase total capacity by staggering GAC replacement events. In this arrangement, individual contactors can approach saturation, providing lower removal efficiency, while other, more recently replaced contactors are exceeding the required removal efficiency. Correctly operated, the resulting blended flow will meet the treatment goal (Brady and Moran, 2012; Summers et al., 2011). Systems can use a configuration that combines series and parallel operation (i.e., multiple trains in parallel, each train with contactors in series).

Full-scale GAC treatment systems that are purpose-built for PFAS removal and for which configuration data are available are pressure systems that use two vessels in series (Appleman et al., 2014; Berretta et al., 2021; Boodoo, 2018; Forrester and Mathis, 2018; Kwan and York, 2017; Vandermeyden and Hagerty, 2020). For pressure systems removing PFAS, design engineers and GAC vendors commonly recommend two vessels in series (Anderson et al., 2021; Calgon Carbon, 2018; Forrester and Mathis, 2017; 2018). Gravity systems typically do not use series operation.

### 2.6.3 Bed Life

As discussed in Section 2.2.2, GAC bed life depends on a number of factors. Designers should select EBCT and contactor configuration to maximize bed life. Although bed life data are available from full-scale systems removing PFAS, these data are of limited usefulness because of one or more of the following factors:

- Influent PFAS concentrations that are highly variable over time, with frequent non-detections
- A limited number of PFAS compounds monitored
- GAC reactivation or replacement prior to PFAS detection in treated water.

More extensive data are available in the literature from pilot studies and rapid small scale column tests (RSSCTs). RSSCTs are laboratory tests designed and operated under hydraulic and influent water conditions that are calibrated to simulate those in full-scale adsorbers. The simulation considers fluid dynamic parameters such as flow rate, GAC particle size, Reynolds number, diffusivity and others (Crittenden et al., 1991). RSSCTs have the advantage of being less time-consuming than pilot-studies or full-scale studies, where reaching breakthrough can require months or years.

Comparing and synthesizing bed life data from pilot studies and RSSCTs is complicated by variations in study design (e.g., water quality, EBCT, type of GAC). To develop a practical method of estimating bed life for purposes of estimating national costs for GAC, EPA used data from six studies covering 10 water quality conditions. EPA selected these studies for the following reasons:

- The studies are peer-reviewed publications
- Bed life data were tabulated in or readily interpolated from the published literature
- Multiple PFAS compounds were present in concentrations typical of PFAS-contaminated drinking water
- The studies measured natural organic matter (as TOC or DOC) and it was present in concentrations typical of drinking water sources
- The studies presented data for a EBCT of 10 minutes, providing a consistent and comparable measure of bed volumes across the studies.

**Table 2-5. Studies Used to Develop GAC Bed Life Estimates**

| Study | Study Type | Number of Water Quality Conditions | Influent TOC (mg/L) | PFAS Compounds Present and Monitored |
|---|---|---|---|---|
| Burkhardt et al., 2022 | Pilot | 3 | 1.8 to 3.2(a) | PFBA(b), PFPeA(b), PFHxA, PFOA, PFNA(b), PFDA(b), PFBS, PFPeS(b), PFHxS, PFOS, PFNS(b), HFPO-DA(c) |
| Liu et al., 2019 | Pilot | 1 | 2.7(d) | PFPeA(b), PFHxA, PFHpA, PFOA, PFPrS(b), PFBS, PFPeS(b), PFHpS(b), PFHxS, PFOS |
| McNamara et al., 2018 | CD-RSSCT | 1 | 1.42 | PFOA, PFOS |
| Park et al., 2020 | CD-RSSCT | 2 | 0.53 and 0.78 | PFPeA(b), PFHxA, PFHpA, PFOA, PFBS, PFOS |
| Patterson et al., 2018 | CD-RSSCT | 1 | 2.3 to 2.4 | PFHpA, PFOA, PFNA(b), PFBS, PFHxS, PFOS |
| Zeng et al., 2020 | CD-RSSCT | 2 | 0.4 and 0.88(d) | PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS |

CD-RSSCT = constant diffusivity rapid small scale column test; DOC = dissolved organic carbon; TOC = total organic carbon
Notes:
(a) Includes unpublished TOC data from PFAS pilot study
(b) EPA was not able to develop a breakthrough relationship for this compound
(c) Other non-carboxylate, non-sulfonate PFAS were also present and monitored
(d) Influent DOC

EPA pooled the data from all the studies. When the studies compared different types of GAC, EPA selected the data for the best performing GAC, assuming that systems would not use underperforming media in practice. EPA then used multiple linear regression to develop a model that results in compound-specific bed life equations.

EPA recognizes that PFAS breakthrough curves are not linear. However, to develop the equations, EPA specifically used the data from the last point of non-detection to the first instance of complete breakthrough (or the end of the study, whichever came first). By limiting the data to this range, EPA sought to characterize the portion of the breakthrough curve where bed life changes rapidly with removal efficiency. This portion of the curve is of most interest in selecting a target bed life for purposes of cost estimating and is expected to be more approximately linear than the curve overall. Figure 2-5 shows this concept graphically in relation to a typical theoretical breakthrough curve.

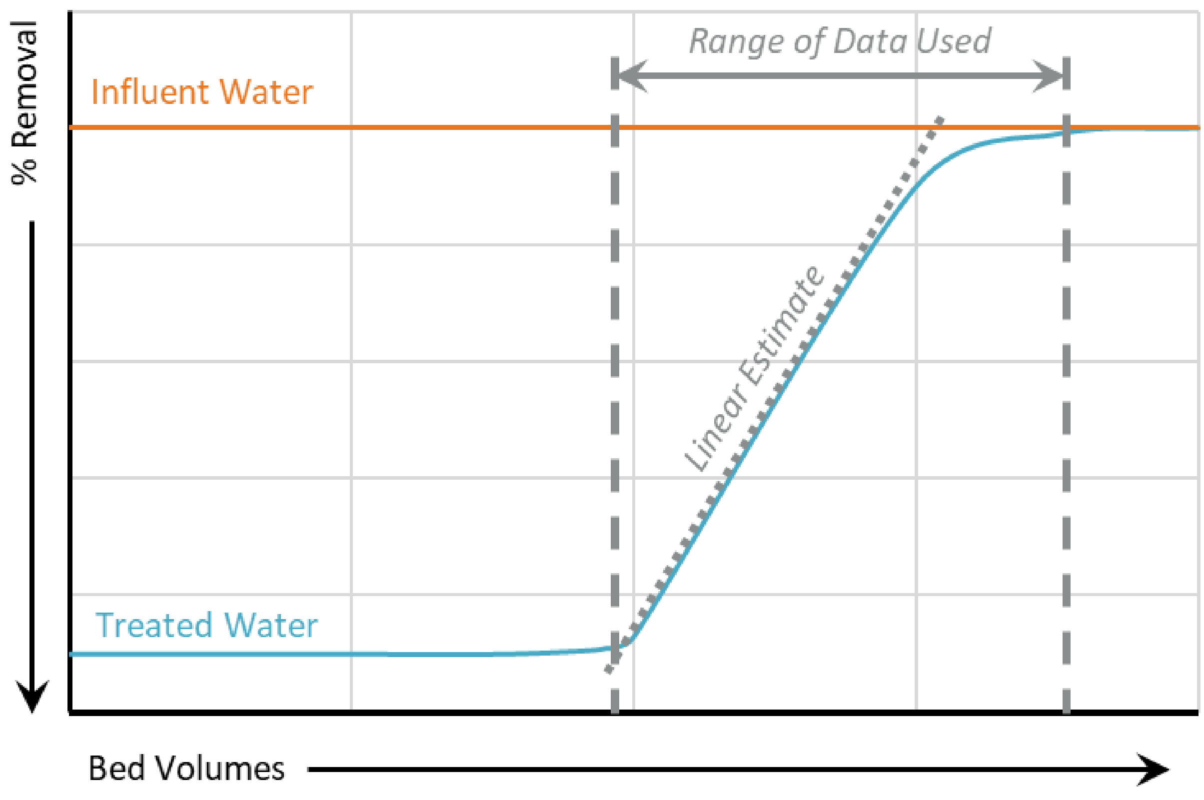


**Figure 2-5. Linear Bed Life Estimate in Relation to a Typical Breakthrough Curve**

The resulting PFAS compound-specific bed life equations for GAC take the following form:

$$BV_{contam,GAC} = A_{TOC} \times TOC + A_{R,GAC} \times \%R_{contam} + B_{contam,GAC}$$

Where:

- $BV_{contam,GAC}$ = GAC bed life for a given PFAS contaminant in BV
- TOC = influent TOC in milligrams per liter (mg/L)
- $\%R_{contam}$ = target percent removal of a given PFAS as a decimal (e.g., 0.8, 0.95)
- $A_{TOC}$, $A_{R,GAC}$, and $B_{contam,GAC}$ are parameters derived in the regression analysis. Table 2-6 shows their estimated values.

**Table 2-6. Estimated Parameter Values for GAC Bed Life Equations**

| Parameter | GAC Model Value |
|---|---|
| $A_{TOC}$ | -37,932 |
| $A_R$ | -36,309 |
| $B_{HFPO\text{-}DA}$ | 113,034 |
| $B_{PFHxA}$ | 113,967 |
| $B_{PFBS}$ | 129,357 |
| $B_{PFHpA}$ | 129,357 |
| $B_{PFHxS}$ | 129,357 |
| $B_{PFOA}$ | 139,862 |
| $B_{PFOS}$ | 143,731 |

The parameter values result in the following order of breakthrough from earliest to latest, given a constant influent TOC and target percent removal:

HFPO-DA > PFHxA > PFBS = PFHpA = PFHxS > PFOA > PFOS

This result is generally consistent with the typical expectation, as discussed in Section 2.2.2, that shorter chain compounds break through before longer chain compounds and carboxylates break through before sulfonates. The equations predict identical bed lives for PFBS, PFHpA, and PFHxS because the intercept terms for these compounds ($B_{PFBS}$, $B_{PFHpA}$, and $B_{PFHxS}$) were not significantly different from each other statistically. All compounds share the same slope term ($A_{TOC}$) for influent TOC (in mg/L) and the same slope term ($A_R$) for percent removal of the PFAS compound (as a decimal) because specifying the model this way results in a consistent order of breakthrough across the range of possible influent TOC values and percent removal values. The model has an adjusted $R^2$ of 0.62. The overall model and individual coefficients are statistically significant. Note that the equations are valid only up to a TOC of 3.2 mg/L, the maximum value in the data set used.

Because the equations are based on pooled data, they reflect central tendency results under varying water quality conditions. As such, the EPA believes they represent the best approach for estimating national cost given the data currently available in the literature. However, these equations should not be used in lieu of site-specific engineering analyses or pilot studies to guide the design or operation of specific treatment systems.

As discussed above, the equations are based in part on RSSCT data. For PFAS removal, there is no consensus in the literature regarding methods to scale up GAC from RSSCTs to full-scale.

There are concerns that RSSCT results may, in some cases, overestimate full-scale bed life (Hopkins, 2021; Kempisty et al., 2019; Meng et al., 2021; Redding et al., 2019). The degree of this potential overestimation is not certain. To compensate for this potential overestimation, when applying the bed life equations, EPA did not incorporate the increase in bed life that would be expected from operating multiple contactors in series or parallel (see Section 2.6.2). Section 7.2.1 discusses this topic, and the application of the bed life equations generally, in more detail.

## 2.7 References

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# 3.0 Ion Exchange (IX)

## 3.1 Operating Principle

IX is a physical/chemical separation process in which stronger binding ions such as PFAS in the feed water are exchanged for weaker binding ions (typically chloride) on a resin generally made of synthetic beads or gel. In application, feed water passes through a bed of resin in a vessel or column. In the case of PFAS removal, the IX process is categorized as anion exchange (as opposed to cation exchange), because the ions involved (PFAS compounds and chloride) are negatively charged. To remove PFAS compounds, vendors generally recommend using special PFAS-selective resins (Boodoo, 2018a; Boodoo et al., 2019; Lombardo et al., 2018; Woodard et al., 2017).

The IX process continues until the resin does not have sufficient exchange sites available for the target PFAS compounds. At this point, the result is reduced contaminant removal, referred to as "breakthrough." Figure 3-1 is a conceptual diagram of the IX treatment process, from initial adsorption to breakthrough. Once the contaminant concentration in the treated water reaches an unacceptable level, the resin is considered "spent." In IX processes removing more traditional anions (e.g., nitrate), the capacity of the spent resin is often restored by rinsing the media with a concentrated chloride solution. However, conventional regeneration solutions are not effective for restoring the capacity of PFAS-selective resins (Liu and Sun, 2021). Therefore, in drinking water applications using PFAS-selective resin, design engineers and IX vendors recommend a single-use approach where the spent resin is disposed and replaced with fresh resin (Anderson et al., 2021; Boodoo, 2018a; Lombardo et al., 2018). Section 3.5 provides more information on the management of spent PFAS-selective resin. The length of time between resin replacement events is known as "bed life," discussed in more detail in Section 3.2.2.

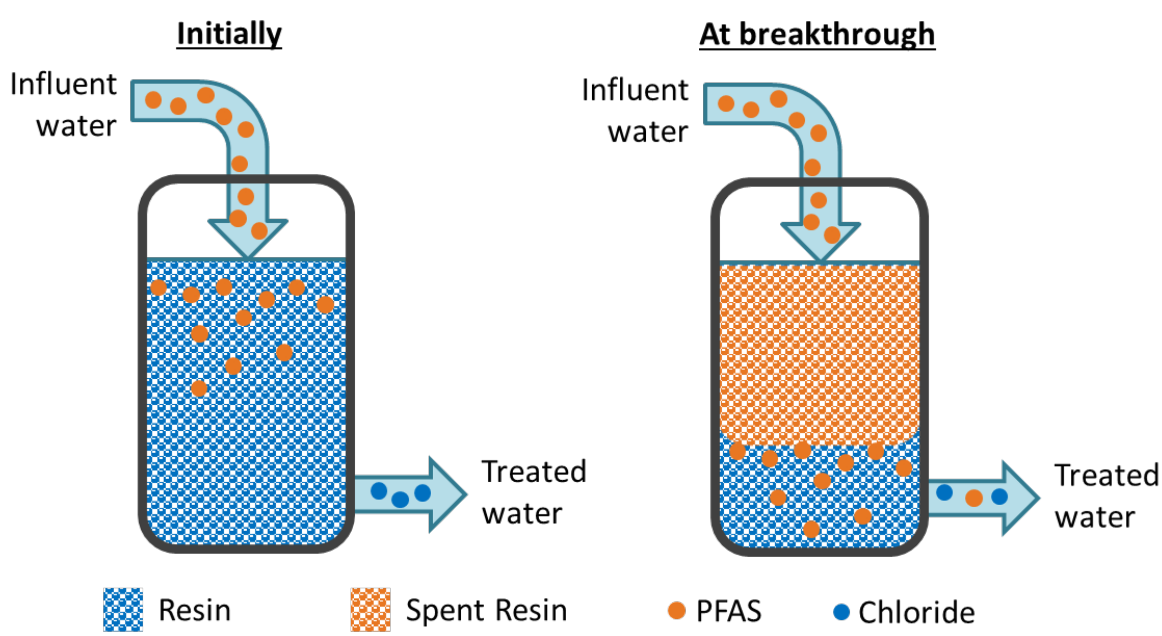


**Figure 3-1. Conceptual Diagram of the IX Treatment Process**

Figure 3-2 provides a schematic drawing for an IX system using disposable resin (i.e., without regeneration). The schematic shows a system with piping designed to enable operation with vessels in series, which is recommended for PFAS removal (see Section 3.6.1). In conventional IX processes, an optional backwashing step can be performed periodically during the resin's service cycle as needed to remove debris from the resin. In applications using PFAS-selective resins, backwashing is not recommended (Berretta et al., 2021). However, the resin often requires rinsing upon initial installation, with each replacement, and, in some cases, after periods of inactivity (Gottlieb and Watkins, 2012). Thus, the schematic shows optional tanks and pumps that may be required by some systems to accomplish this rinse.

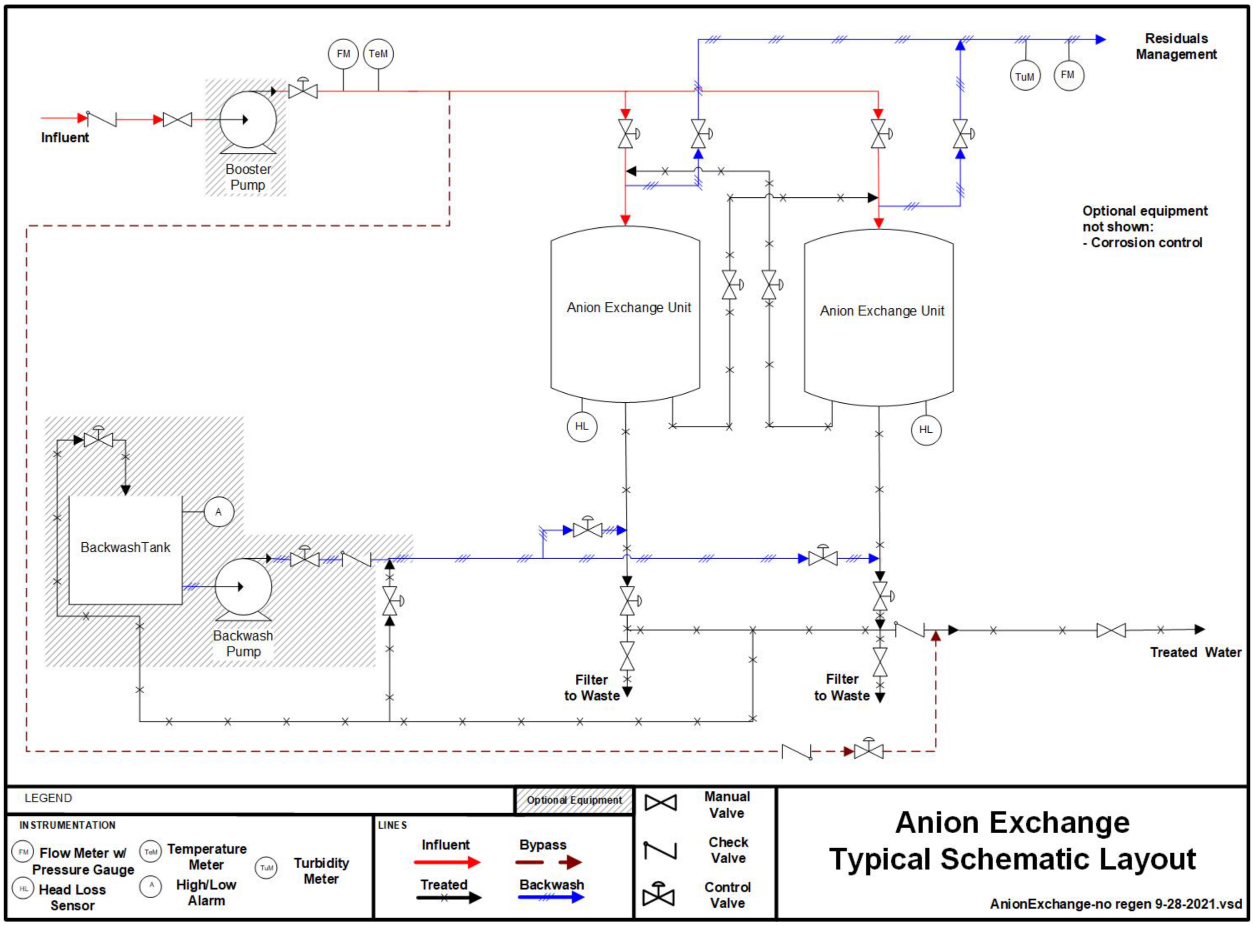


**Figure 3-2. Typical Schematic Layout for IX with Resin Disposal**

## 3.2 Effectiveness for PFAS Removal

### *3.2.1 Removal Efficiency*

EPA's Drinking Water Treatability Database (USEPA, 2021a; 2021b; 2021c) includes extensive data from the literature on PFAS removal by IX. Results are available from studies conducted in the laboratory, in the field at pilot scale, and in full-scale application, as shown in Table 3-1,

Table 3-2, and Table 3-3. [7] These tables present the number of studies at each scale, along with a key benchmark of technology effectiveness: maximum removal efficiency. Removal efficiency is the percentage of the influent concentration removed through treatment.

The literature demonstrates maximum IX removal efficiencies of 90 percent or greater from most of the carboxylate and sulfonate PFAS compounds for which data are available. [8] The literature also shows that the technology often removes these compounds to levels below analytical detection limits. For PFOA and PFOS, maximum removal efficiencies are greater than 99 percent, also to below analytical detection limits and lower than the regulatory thresholds currently under consideration. There are fewer studies of IX performance for other (non-carboxylate and non-sulfonate) PFAS compounds, but the available data show maximum removal efficiency of 97 percent or greater for all the other compounds for which data are available, including HFPO-DA. [9]

**Table 3-1. Studies of IX Treatment for Carboxylate PFAS**

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum Removal Efficiency | Source(s) for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|
| PFBA | 4 | 11 | 5 | 2 | 99.3 | Dixit et al. 2020; Dixit et al. 2021 |
| PFPeA | 5 | 7 | 3 | 2 | 95.5 | Schaefer et al. 2019 |
| PFHxA | 6 | 11 | 4 | 3 | >97 | Liu 2017 |
| PFHpA | 7 | 9 | 6 | 4 | >99 | Zeng et al. 2020 |
| PFOA | 8 | 15 | 7 | 4 | 99.3 | Mohseni et al. 2019; Dixit et al. 2020; Dixit et al. 2021 |
| PFNA | 9 | 6 | 3 | 2 | >99 | Zeng et al. 2020; Kumarasamy et al. 2020 |
| PFDA | 10 | 7 | 0 | 0 | >99 | Kumarasamy et al. 2020 |
| PFUnA | 11 | 1 | 0 | 0 | 90 | McCleaf et al. 2017 |
| PFDoA | 12 | 2 | 0 | 0 | 99.3 | Dixit et al. 2021 |
| PFTriA | 13 | 1 | 0 | 0 | 90 | McCleaf et al. 2017 |

Sources: USEPA, 2021a; 2021c

[7] Data shown in these tables are as of December 2021. EPA frequently updates the Drinking Water Treatability Database, so parties interested in results from recently published literature may wish to access the database directly at https://tdb.epa.gov/tdb/home.

[8] Exceptions are PFPeS and PFNS, but data for removal of these compounds by IX are available only from laboratory experiments in batch mode (Wang et al., 2020; Yan et al., 2020). These experiments are not designed to simulate the operation of an IX treatment process and, thus, may not reflect the result achievable at full scale.

[9] Note, however, that data are not available to estimate IX bed life for HFPO-DA, as discussed in Section 3.6.3.

**Table 3-2. Studies of IX Treatment for Sulfonate PFAS**

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum Removal Efficiency | Source(s) for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|
| PFBS | 4 | 12 | 8 | 4 | 99.3 | Dixit et al. 2020; Dixit et al. 2021 |
| PFPeS | 5 | 2 | 0 | 0 | 74 | Yan et al. 2020 |
| PFHxS | 6 | 11 | 7 | 4 | >99 | Zeng et al. 2020; Boodoo 2018a; Arevalo et al. 2014; Kumarasamy et al. 2020 |
| PFHpS | 7 | 2 | 3 | 0 | 93 | Yan et al. 2020 |
| PFOS | 8 | 16 | 8 | 4 | 99.7 | Woodard et al. 2017 |
| PFNS | 9 | 1 | 0 | 0 | 54.9 | Wang et al. 2020 |

Sources: USEPA, 2021b; 2021c

**Table 3-3. Studies of IX Treatment for Other PFAS**

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum Removal Efficiency | Source(s) for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|
| PFBSA | 4 | 1 | 0 | 0 | 98 | Yan et al. 2020 |
| PFMOPrA | 4 | 1 | 0 | 0 | 99.3 | Dixit et al. 2021 |
| PFMOBA | 5 | 1 | 0 | 0 | 99.3 | Dixit et al. 2021 |
| FtS 6:2 | 6 | 2 | 2 | 0 | 99.3 | Dixit et al. 2021 |
| HFPO-DA | 6 | 4 | 1 | 0 | 99.3 | Dixit et al. 2020; Dixit et al. 2021 |
| PFHxSA | 6 | 1 | 0 | 0 | 99 | Yan et al. 2020 |
| FtS 8:2 | 8 | 2 | 2 | 0 | 99.3 | Dixit et al. 2021 |
| PFOSA | 8 | 3 | 0 | 1 | 98 | Yan et al. 2020 |
| PFECHS | 8 | 1 | 0 | 0 | 97 | Yan et al. 2020 |

Source: USEPA, 2021c

### 3.2.2 Bed Life

In addition to removal efficiency, the effectiveness of IX depends on bed life, which is the length of time the technology can maintain a target removal efficiency (e.g., 80 percent, 95 percent) or predefined concentration limit (such as an MCL). Bed life can be expressed as the number of days or months between resin replacement events. It can also be expressed in BV, which is a measure of throughput: the volume of water treated during the bed life divided by the volume of the resin bed. With either measure, a higher number indicates a longer bed life and more effective treatment. Figure 3-3 illustrates the concepts of breakthrough and bed life on a typical "S-shaped" IX breakthrough curve.

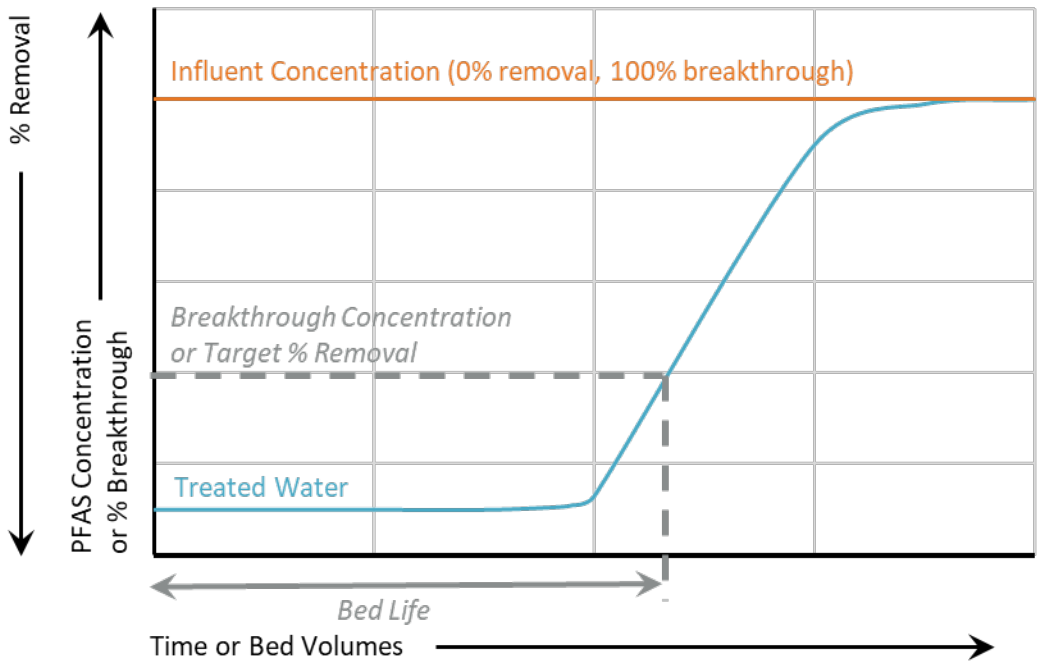


**Figure 3-3. Typical IX Breakthrough Curve**

There is a consensus in the literature that the capacity of IX resin for a given PFAS compound is strongly influenced by chain length (i.e., number of carbon atoms) and functional group (i.e., carboxylate versus sulfonate). In general, all other factors (see below) being equal, IX exhibits a greater capacity for sulfonate PFAS than carboxylate PFAS. Within these categories, the technology exhibits a greater capacity for longer chain compounds than shorter chain compounds. The greater capacity translates to longer bed life and lower treatment costs (Arevalo et al., 2014; Berretta et al., 2021; McCleaf et al., 2017; Schaefer et al., 2019; Zaggia et al., 2016; Zeng et al., 2020).

For IX, functional group is more significant than chain length, with carboxylates breaking through before sulfonates (Arevalo et al., 2014; Berretta et al., 2021; Schaefer et al., 2019; Zeng et al., 2020). An example IX breakthrough sequence from Zeng et al. (2020) is as follows (with number of carbon atoms shown in parenthesis for ease of reference):

PFHxA (6) > PFHpA (7) > PFOA (8) > PFBS (4) > PFHxS (6) > PFOS (8)

In addition to chain length and functional group, estimates of IX bed life for PFAS removal depend on multiple factors. These additional factors can include the following:

- The target removal efficiency or predefined concentration at which the treated water quality is considered unacceptable (i.e., the "breakthrough" concentration)
- The influent concentration of the target PFAS compound(s)
- Other raw water quality parameters (see Section 3.3)

- Size of the IX bed relative to the flow of water to be treated, measured by EBCT (see Section 3.6.2)
- The specific IX resin being employed.

Because of these varying factors, comparing IX bed life results across multiple studies is difficult. Section 3.6.3 discusses methods to estimate bed life as a critical parameter in the design and operation of IX treatment.

### *3.2.3 Full-Scale Applications*

Additional support for the effectiveness of IX for PFAS removal is evident from the number of full-scale facilities that are currently using the technology. Table 3-4 lists full-scale IX facilities identified in the literature. The effectiveness studies enumerated in Section 3.1.1 include results for some of these facilities. The first full-scale system treating drinking water using PFAS-selective IX commenced operation in 2017 (WWSD, 2018). Since that time, a number of additional drinking water systems have begun using the technology at full scale. Although IX remains a less common choice for PFAS removal than GAC, these recent installations suggest an increasing trend in the share of systems choosing IX. According to Berretta et al. (2021): "[n]ew suppliers are creating PFAS-selective resins, while those already in the market are improving their existing products."

**Table 3-4. Full-scale IX Systems Removing PFAS from Drinking Water**

| Location | Flow rate (MGD) | Groundwater or Surface Water | Year of Startup | Sources |
|---|---|---|---|---|
| Security Water and Sanitation Districts, Security, Colorado | 9 | Groundwater | 2019 | Jent 2020 |
| Stratmoor Hills Water District, Stratmoor Hills, El Paso County, Colorado | 1 | Groundwater | Not reported | Berretta et al. 2021 |
| Widefield Water and Sanitation District, Widefield, Colorado | Not reported | Groundwater | 2017 | WWSD 2018 |
| City of Stuart, Florida | 4 | Groundwater | 2018 | Aqueous Vets 2019 |
| Pease International Tradeport Drinking Water System, Portsmouth, New Hampshire | Not reported | Groundwater | 2019 | City of Portsmouth 2020 |
| Horsham Water and Sewer Authority, Horsham, Montgomery County, Pennsylvania | 0.14 | Groundwater | 2021 | Boodoo 2018a; Boodoo et al. 2019; HWSA 2021 |
| Warminster Municipal Authority, Warminster, Pennsylvania | Not reported | Not reported | Not reported | Boodoo 2018a; Boodoo 2018b |

MGD = million gallons per day

## 3.3 Raw Water Quality Considerations

PFAS-selective IX resin is less sensitive to TOC than GAC (Berretta et al., 2021; Boodoo, 2018; Lombardo et al., 2018). For IX, the greater concern is the presence of competing anions, such as nitrate, sulfate, bicarbonate, and chloride. PFAS-selective resins are designed to have higher affinity for PFAS than these other anions. However, these anions can be present in drinking water at concentrations many orders of magnitude higher than PFAS. Therefore, they can compete with PFAS for available exchange sites on the resin (Ateia et al., 2019; Berretta et al., 2021; Boodoo, 2021). Individual PFAS compounds also potentially compete with one another. In extreme cases, as more of the resin's exchange sites become occupied by influent anions, preferred anions in the influent can displace previously accumulated, less preferred anions. Such cases can result in a phenomenon known as chromatographic peaking, where the treated concentration of a less preferred anion exceeds its influent concentration (Clifford et al., 2011). McCleaf et al. (2017) observed this phenomenon for carboxylate PFAS in column tests that included both carboxylate and sulfonate PFAS in the influent.

In general, competition does not necessarily reduce the maximum removal effectiveness of the resin for PFAS. Instead, it shortens the time to breakthrough, meaning more frequent resin replacement may be required in the presence of competing anions, all other factors being equal. Therefore, it should be possible to reliably manage the impact of competition among anions, including the potential for chromatographic peaking, through piloting, selection of design parameters, and operational monitoring. As discussed in Section 3.6.3, for purposes of estimating national costs, EPA used a method to estimate bed life that explicitly includes consideration of total influent PFAS concentration. The inclusion of total PFAS concentration is intended to account for competition among PFAS compounds. The method to estimate bed life also is based on data from experiments where other competing anions, specifically nitrate and sulfate, were present in concentrations typical of drinking water.

## 3.4 Pre- and Post-Treatment Needs

In general, IX treatment can increase treated water corrosivity because of chloride ion addition and/or carbonate along with bicarbonate removal (Gottleib and Watkins, 2012). For example, Berlien (2003) reported this problem with a full-scale application of IX for perchlorate treatment. However, for PFAS-selective resins specifically, one vendor reports that corrosivity effect is limited to the first 200 BV of treatment for their product. During this initial period, pH in treated water will decrease by 1 to 1.5 units; then the alkalinity and pH of the treated water returns to normal (Boodoo, 2018b). In cases where increased corrosivity is a longer-term problem, it might require post-treatment corrosion control or alterations to existing corrosion control.

## 3.5 Waste Generation and Residuals Management Needs

There are no known full-scale studies of spent resin from IX facilities specifically for the removal of PFAS. In general, however, the characteristics and quantities of spent resin are predictable. The spent resin contains the PFAS compounds and other anions removed from the treated water. The generation rate of spent resin is a function of bed volume and replacement frequency.

In IX processes removing more traditional contaminants (e.g., nitrate), the capacity of the spent resin is often restored by rinsing the media with a concentrated chloride solution. However, conventional regeneration solutions are not effective for restoring the capacity of PFAS-selective resins (Liu and Sun, 2021). Therefore, in drinking water applications using PFAS-selective resin, design engineers and IX vendors recommend a single-use approach where the spent resin is disposed and replaced with fresh resin (Anderson et al., 2021; Boodoo, 2018a; Lombardo et al., 2018). Regeneration of selective resins may be possible using organic solvents (Boodoo, 2018a; Zaggia et al., 2016) or proprietary methods (Woodard et al., 2017). These alternative regeneration practices are generally practical or cost-effective only with very high influent concentrations, such as in remediation settings (Anderson et al., 2021; Boodoo, 2018a).

Under current regulations, spent resin is typically incinerated (Boodoo, 2018b). The literature is inconclusive regarding the fate of PFAS during incineration in general (USEPA, 2020) and there are no studies specific to incineration of IX resin. Additional full-scale research might be needed if future air quality regulations address PFAS emissions from incineration facilities. The results of this research might necessitate changes to spent resin management practices. Future RCRA hazardous waste regulations could also limit the available management options.

Although backwashing is not recommended for PFAS-selective resin (Berretta et al., 2021), IX systems also intermittently generate a liquid residual in the form of spent rinse water. Because the rinse follows immediately after fresh resin is installed, before the bed restarts service, it should not contain target contaminants. Management options for spent rinse water include discharge to surface water under a NPDES permit or discharge to a WWTP. When averaged over the time between generation events, spent rinse water flow is relatively low. Instantaneous flow during a rinse event, however, is much higher. Therefore, holding tanks might be advisable under certain conditions (e.g., to prevent instantaneous flow from overwhelming the capacity of a WWTP).

## 3.6 Critical Design Parameters

Critical design parameters that are specific to IX systems removing PFAS with selective resin are:

- EBCT
- Vessel configuration (i.e., number of vessels in series)
- Bed life
- Residuals management options.

Section 3.5 discusses residuals management options. The sections below discuss EBCT, vessel configuration, and bed life in more detail, including the data available in the literature for these parameters. Section 7.3.1 identifies the specific values for each parameter used in EPA's cost estimates. Values for other IX design parameters (e.g., loading rate, bed depth constraints, resin density), while not specifically addressed here, are well documented for IX treatment in general. EPA has no reason to expect a significant difference in these parameters for IX systems treating PFAS compounds.

### *3.6.1 Empty Bed Contact Time*

For a given set of site-specific conditions, there is a minimum EBCT required to produce water of a target quality. EBCT, measured in minutes, is defined by the following equation:

$$EBCT\ (in\ minutes) = \frac{Volume\ of\ Resin\ Bed}{Volumetric\ Flow\ Rate\ (per\ minute)}$$

The minimum EBCT required varies depending on the specific contaminant treated, the required contaminant removal percentage, the type of resin used, and other influent water characteristics (e.g., the presence of competing chemical species). Limited data are available on the EBCT employed at full-scale anion exchange systems that are purpose-built for PFAS removal. One pilot system was later permitted for permanent operation using two vessels in series with a total EBCT of 5.6 minutes (Boodoo et al., 2019). A common vendor recommendation is to use a total EBCT of 3 to 6 minutes (Boodoo, 2019; Boodoo et al., 2019; Boodoo, 2018; Lombardo et al., 2018).

### 3.6.2 Vessel Configuration

IX treatment systems with multiple vessels can be configured in series or in parallel. In a parallel configuration, flow is divided equally among the vessels, each of which provides the design EBCT. In a series (or lead/lag) configuration, water flow first through an initial vessel that serves as a roughing vessel, then through subsequent vessels that serve as polishing vessels (Clifford et al., 2011). Each vessel in the series typically has an equal EBCT such that the total EBCT of the series provides the design EBCT. A series (or lead/lag) configuration serves the purpose of treating a greater water volume than one vessel with similar bed volume. When resin in the roughing vessel is spent, this resin is replaced and the polishing vessel moves to the start of the series, becoming the roughing vessel. The use of vessels in series can allow the resin in the lead vessel to reach greater exhaustion, increasing total capacity (Clifford et al., 2011). For larger flow rates, systems can use a configuration that combines series and parallel operation (i.e., multiple trains in parallel, each train with contactors in series).

For PFAS removal, design engineers and vendors commonly recommend two vessels in series (Anderson et al., 2012; Berretta et al., 2021; Boodoo, 2019; Boodoo et al., 2019; Boodoo, 2018; Lombardo et al., 2018). Full-scale IX treatment systems for PFAS removal for which configuration data are available use two vessels in series (Aqueous Vets, 2019; Boodoo et al., 2019; WWSD, 2018). The schematic diagram (Figure 3-2) in Section 3.1 shows a system configured to operate with vessels in series. A system designed for operation with vessels in parallel (which is not typical for PFAS removal) would not require piping between the two anion exchange units.

### 3.6.3 Bed Life

As discussed in Section 3.2.2, IX bed life depends on a number of factors. Designers should select EBCT and vessel configuration to maximize bed life. Bed life data are not available for full-scale IX exchange systems using PFAS-selective resins. Although bed life data from pilot studies are available, comparing and synthesizing these data is complicated by variations in study design (e.g., water quality, EBCT, type of resin). For certain pilot studies, the bed life data have been presented, published, or otherwise provided to EPA, but are not from a peer-reviewed publications (e.g., Boodoo, 2018a; Boodoo et al., 2019; Lombardo et al., 2018). In other cases, the pilot study data reflect treatment of water with very high PFAS concentrations, more reflective of remediation conditions than drinking water (Newman and Berry, 2019; Woodard et al., 2017).

To develop a practical method of estimating bed life for purposes of estimating national costs for IX, EPA used data from Zeng et al. (2020). These data are from RSSCTs of IX treating actual groundwater, intended to simulate a full-scale EBCT of 3.3 minutes. The RSSCTs covered six different water quality conditions (different groundwater sources) and two different PFAS-selective resins. In each groundwater source, multiple PFAS compounds were present in concentrations typical of PFAS-contaminated drinking water. PFAS compounds monitored in the IX RSSCTs were: PFHxA, PFHpA, PFOA, PFNA,[10] PFBS, PFHxS, and PFOS. EPA pooled the data from the individual RSSCTs and used multiple linear regression to develop a model that results in compound-specific bed life equations.

EPA recognizes that PFAS breakthrough curves are not linear. However, to develop the equations, EPA specifically used the data from the last point of non-detection to the first instance of complete breakthrough (or the end of the study, whichever came first). By limiting the data to this range, EPA sought to characterize the portion of the breakthrough curve where bed life changes rapidly with removal efficiency. This portion of the curve is most interest in selecting a target bed life for purposes of cost estimating and is expected to be more approximately linear than the curve overall. Figure 3-4 shows this concept graphically in relation to a typical theoretical breakthrough curve.

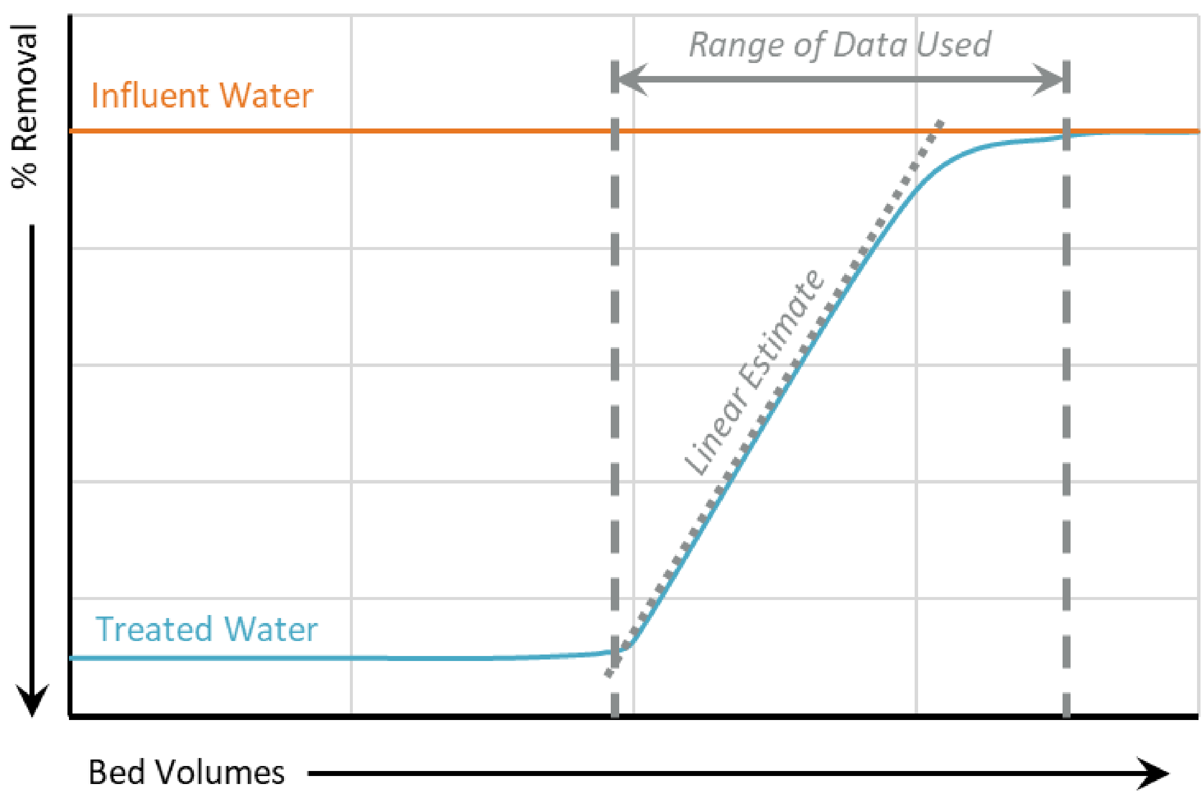


**Figure 3-4. Linear Bed Life Estimate in Relation to a Typical Breakthrough Curve**

The resulting PFAS compound-specific bed life equations for IX take the following form:

$$BV_{contam,IX} = A_{PFAS} \times PFAS_{total} + A_{R,IX} \times \%R_{contam} + B_{contam,IX}$$

[10] EPA was not able to develop a breakthrough relationship for this compound.

Where:

- $BV_{contam,IX}$ = IX bed life for a given PFAS contaminant in BV
- $PFAS_{total}$ = total influent concentration of PFAS compounds in ng/L
- $\%R_{contam}$ = target percent removal of a given PFAS as a decimal (e.g., 0.8, 0.95)
- $A_{PFAS}$, $A_{R,IX}$, and $B_{contam,IX}$ are parameters derived in the regression analysis. Table 3-5 shows their estimated values.

**Table 3-5. Estimated Parameter Values for IX Bed Life Equations**

| Parameter | IX Model Value |
|---|---|
| $A_{PFAS}$ | -6.04 |
| $A_R$ | -198,242 |
| $B_{PFHxA}$ | 212,867 |
| $B_{PFBS}$ | 439,515 |
| $B_{PFHpA}$ | 319,511 |
| $B_{PFHxS}$ | 439,515 |
| $B_{PFOA}$ | 390,787 |
| $B_{PFOS}$ | 439,515 |

The parameter values result in the following order of breakthrough from earliest to latest, given a constant total influent PFAS concentration and target percent removal:

PFHxA > PFHpA > PFOA > PFBS = PFHxS = PFOS

This result is generally consistent with the typical expectation, as discussed in Section 3.2.2, that carboxylates break through before sulfonates and shorter chain compounds break through before longer chain compounds. The equations predict identical bed lives for the three sulfonate compounds included in the analysis because the intercept terms for these compounds ($B_{PFBS}$, $B_{PFHxS}$, and $B_{PFOS}$) were not significantly different from each other statistically. All compounds share the same slope term ($A_{PFAS}$) for total influent PFAS (in ng/L) and the same slope term ($A_R$) for percent removal of the PFAS compound (as a decimal) and because specifying the model this way results in a consistent order of breakthrough across the range of possible influent PFAS values and percent removal values.

The model has an adjusted $R^2$ of 0.71. The overall model and individual coefficients are statistically significant. Although the effect of total PFAS concentration on bed life ($A_{PFAS}$) is small, it remains statistically significant and is included in the model to account for competition among PFAS compounds. Note that the equations are valid only up to a total influent PFAS of 7,044 ng/L, the maximum value in the data set used. Other competing anions, specifically nitrate and sulfate, were present in the water sources studied and measured by Zeng et al. (2020). However, the range of concentrations for these anions across the RSSCTs was not wide. Therefore, EPA was not able to incorporate them into the IX bed life model. Also note that, unlike the bed life model for GAC (see Section 2.6.3), data were not available to incorporate HFPO-DA into the IX model.

Because the equations are based on pooled data, they reflect central tendency results under varying water quality conditions. As such, the EPA believes they represent the best approach for estimating national cost given the data currently available in the literature. However, these equations should not be used in lieu of site-specific engineering analyses or pilot studies to guide the design or operation of specific treatment systems.

The use of RSSCTs to predict IX performance for PFAS removal is a recent development (Najm et al., 2021; Schaefer et al., 2019; Zeng et al., 2020), so there are no validated methods to scale up from these bench-scale results. When RSSCTs are used to estimate the performance of GAC for PFAS, there are concerns that the results may, in some cases, overestimate full-scale bed life (Hopkins, 2021; Kempisty et al., 2019; Meng et al., 2021; Redding et al., 2019). To compensate for the potential for similar overestimation concerns for IX, when applying the bed life equations, EPA did not incorporate the increase in bed life that would be expected from operating multiple vessels in series (see Section 3.6.2). Section 7.2.1 discusses this topic, and the application of the bed life equations generally, in more detail.

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# 4.0 Reverse Osmosis and Nanofiltration (RO/NF)

## 4.1 Operating Principle

RO and NF are membrane processes that separate contaminants from drinking water. These processes separate solutes such as PFAS compounds from solution by forcing the solvent to flow through a membrane at a pressure greater than the normal osmotic pressure. In drinking water treatment, these membranes are most often used in a spiral-wound configuration that consists of several membrane envelopes, layered with feed spacers and rolled together in around a central collection tube.

The membrane is semi-permeable, transporting different molecular species at different rates. The application of pressure splits the influent water passing over the membrane into two streams:

- Treated water or “permeate” that passes through the membrane layers along with solutes of lower molecular weight into the central collection tube
- Water containing higher molecular weight solutes that remains outside the membrane layers, called “reject,” “concentrate,” or “brine.”

“Recovery rate” and “rejection rate” are the percentages of influent water that are recovered as permeate and lost as reject, respectively.[11] Figure 4-1 is a conceptual diagram of this process as applied to water containing PFAS.

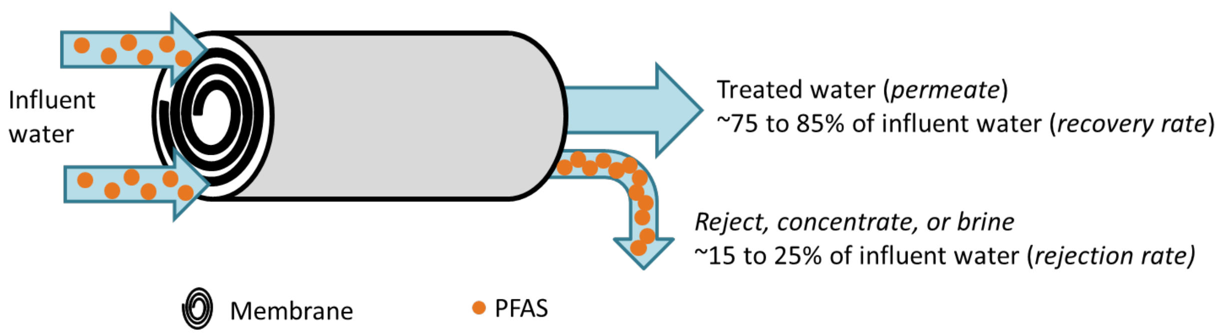


**Figure 4-1. Conceptual Diagram of the RO Treatment Process**

Specific membranes differ in the size of dissolved contaminants they can remove. In general, RO membranes are effective for smaller contaminants than NF membranes. However, even within the categories of RO and NF, individual membranes from different manufacturers vary in the minimum size and weight of contaminants they reject, as shown in Table 4-1. Membranes that remove smaller contaminants require higher feed pressure. Feed pressures for NF membranes are typically in the range of 50 to 150 pounds per square inch (psi). Feed pressures for RO membranes are in the range of 125 to 300 psi in low pressure applications targeting relatively large contaminants (such as PFAS compounds) but can be as high as 1,200 psi in applications such as seawater desalination (Bergman et al., 2012; USEPA, 2022c). As discussed in Section 4.2.1, both RO and NF membranes have the capacity to remove PFAS.

[11] Note that recovery and rejection rates are not directly related to removal efficiency, which is the percentage of influent PFAS removed from the treated water.

**Table 4-1. Minimum Effective Ranges for RO/NF Membranes**

| Technology | Contaminant Size (microns) | Contaminant Molecular Weight (g/mol) |
|---|---|---|
| RO | 0.0001 to ~0.0015 | <100 to ~200 |
| NF | 0.001 to ~0.006 | 200 to 1,000 |

~ = approximately; g/mol = grams per mole; NF = nanofiltration; RO = reverse osmosis
Sources: Bergman et al., 2012; DuPont, 2021; Duranceau and Taylor, 2011

A treatment system using RO or NF will employ multiple membrane elements, placed within a pressure vessel. To achieve a high recovery rate and contaminant removal efficiency, these pressure vessels often are arranged in sequential stages, typically up to three depending on the recovery to be achieved (Bergman et al., 2012; DuPont, 2021). When multiple stages are used, the number of pressure vessels decreases from stage to stage. Treated permeate is collected from each pressure vessel. The concentrate from the first membrane stage serves as the feed to the second and the concentrate from the second stage serves as the feed to the third. Consequently, each successive stage of the process increases the total system recovery. As the feed water travels through the membrane system and becomes more concentrated, its osmotic pressure increases. The feed pressure must overcome this osmotic pressure. The final concentration in the concentrate therefore has a major effect on the required feed pressure and energy use.

The membrane stages in combination make up an RO treatment train. A treatment system may have multiple trains. Figure 4-2 provides a schematic drawing for an RO treatment facility; each rectangular box within a train represents a pressure vessel that contains multiple membrane elements. An NF treatment facility would be nearly identical, with the primary difference being the type of membranes used and the operating pressures.

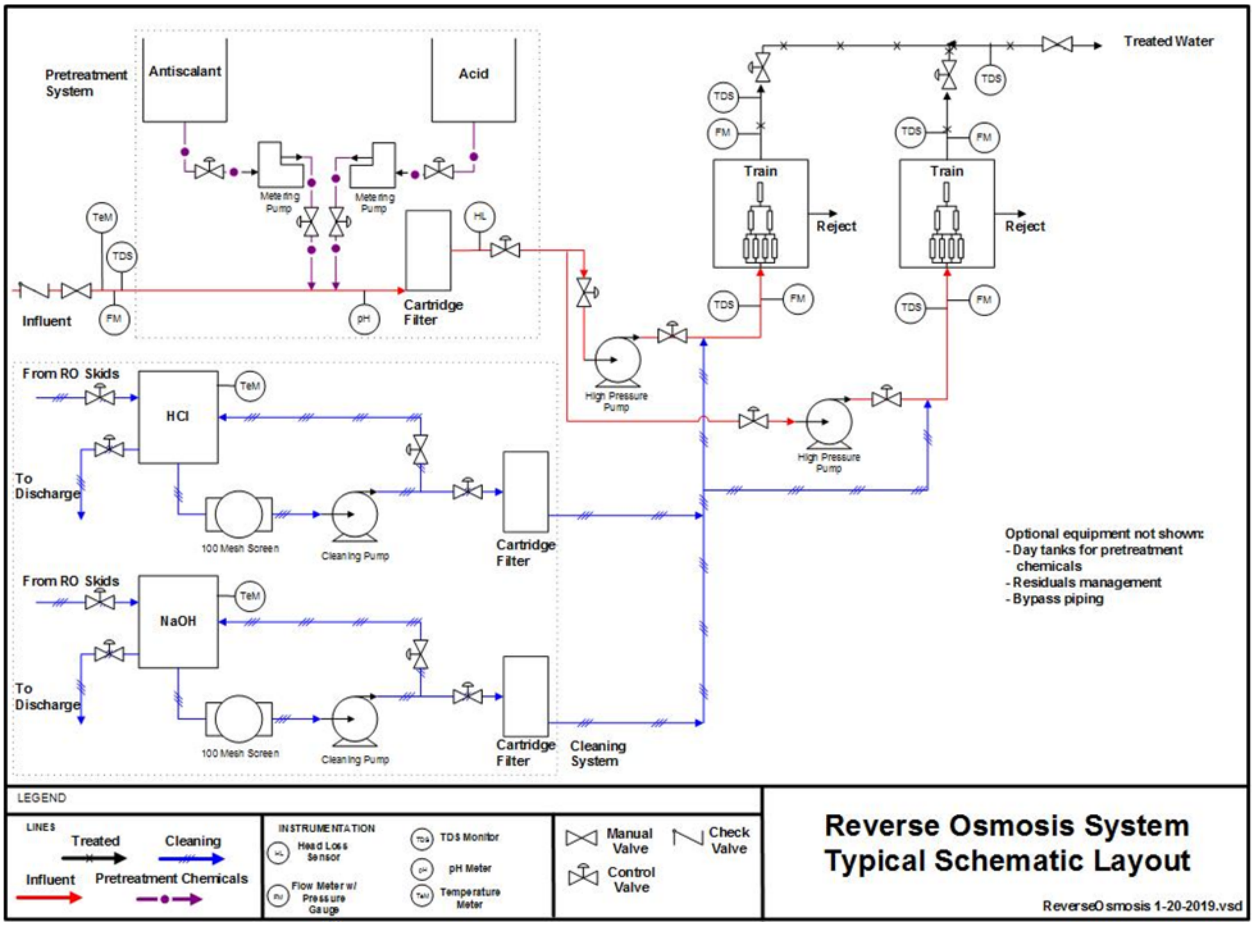


**Figure 4-2. Typical Schematic Layout for RO/NF**

## 4.2 Effectiveness for PFAS Removal

### *4.2.1 Removal Efficiency*

EPA's Drinking Water Treatability Database (USEPA, 2021a; 2021b; 2021c) includes extensive data from the literature on PFAS removal by RO and NF. Results are available from studies conducted in the laboratory, in the field at pilot scale, and in full-scale application, as shown in Table 4-2, Table 4-3, and Table 4-4. [12] These tables present the number of studies at each scale, along with a key benchmark of technology effectiveness: maximum removal efficiency. Removal efficiency is the percentage of the influent concentration removed through treatment.

[12] Data shown in these tables are as of December 2021. EPA frequently updates the Drinking Water Treatability Database, so parties interested in results from recently published literature may wish to access the database directly at https://tdb.epa.gov/tdb/home.

## Table 4-2. Studies of RO/NF Treatment for Carboxylate PFAS

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum NF Removal Efficiency | Maximum RO Removal Efficiency | Source(s) for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|---|
| PFBA | 4 | 2 | 1 | 2 | 99 | 99.9 | Lipp et al. 2010 |
| PFPeA | 5 | 2 | 3 | 2 | >99 | >99 | Horst et al. 2018; Liu et al. 2021; Dickenson and Higgins 2016 |
| PFHxA | 6 | 3 | 4 | 4 | >98 | 99.2 | Liu et al. 2021 |
| PFHpA | 7 | 1 | 2 | 3 | 99 | >99 | Steinle-Darling et al. 2008; Liu et al. 2021 |
| PFOA | 8 | 4 | 4 | 5 | 99.9 | 99.9 | Boonya-Atichart et al. 2016; Lipp et al. 2010 |
| PFNA | 9 | 2 | 1 | 4 | 99 | >98 | Steinle-Darling et al. 2008; Dickenson and Higgins 2016; Appleman et al. 2014 |
| PFDA | 10 | 2 | 0 | 4 | 99 | >99 | Steinle-Darling et al. 2008; Dickenson and Higgins 2016; Appleman et al. 2014 |
| PFUnA | 11 | 1 | 0 | 2 | 99 | >77 | Steinle-Darling et al. 2008; Dickenson and Higgins 2016; Appleman et al. 2014 |
| PFDoA | 12 | 0 | 0 | 2 | - | >87 | Dickenson and Higgins 2016; Appleman et al. 2014 |

- = no data; NF = nanofiltration; RO = reverse osmosis
Sources: USEPA, 2021a; 2021c

## Table 4-3. Studies of RO/NF Treatment for Sulfonate PFAS

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum NF Removal Efficiency | Maximum RO Removal Efficiency | Source(s) for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|---|
| PFPrS | 3 | 0 | 1 | 0 | >98 | >99 | Liu et al. 2021 |
| PFBS | 4 | 3 | 4 | 3 | 99.8 | 99.8 | Lipp et al. 2010 |
| PFPeS | 5 | 0 | 1 | 0 | >98 | >99 | Liu et al. 2021 |
| PFHxS | 6 | 2 | 4 | 4 | >99 | >99 | Appleman et al. 2013; Thompson et al. 2011; Liu et al. 2021 |

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum NF Removal Efficiency | Maximum RO Removal Efficiency | Source(s) for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|---|
| PFHpS | 7 | 0 | 1 | 0 | >98 | >99 | Liu et al. 2021 |
| PFOS | 8 | 6 | 4 | 5 | >99.9 | 99.9 | Lipp et al. 2010; 2163 |
| PFDS | 10 | 1 | 0 | 0 | 99 | - | Steinle-Darling et al. 2008 |

- = no data; NF = nanofiltration; RO = reverse osmosis
Sources: USEPA, 2021b; 2021c

### Table 4-4. Studies of RO/NF Treatment for Other PFAS

| PFAS Compound | Number of Carbons | Number of Bench Studies | Number of Pilot Studies | Number of Full-scale Studies | Maximum NF Removal Efficiency | Maximum RO Removal Efficiency | Source(s) for Maximum Removal Efficiency |
|---|---|---|---|---|---|---|---|
| PFMOAA | 3 | 0 | 1 | 0 | - | >98.5 | CDM Smith 2018 |
| PFO2HxA | 4 | 0 | 1 | 0 | - | >80.8 | CDM Smith 2018 |
| PFO3OA | 5 | 0 | 1 | 0 | - | >67.2 | CDM Smith 2018 |
| FtS 6:2 | 6 | 1 | 2 | 1 | 99.5 | >65.5 | Steinle-Darling et al. 2008; CDM Smith 2018 |
| HFPO-DA | 6 | 0 | 1 | 0 | - | >64.2 | CDM Smith 2018 |
| PFOSA | 8 | 2 | 0 | 1 | 98.5 | >13 | Steinle-Darling et al. 2008; Dickenson and Higgins 2016 |
| N-MeFOSAA | 11 | 0 | 0 | 2 | - | >84 | Dickenson and Higgins 2016 |
| N-EtFOSAA | 12 | 0 | 0 | 2 | - | >58 | Dickenson and Higgins 2016 |

- = no data; NF = nanofiltration; RO = reverse osmosis
Source: USEPA, 2021c

The literature demonstrates RO and NF removal efficiencies in the high 90 percent range for nearly all the carboxylate and sulfonate PFAS compounds for which data are available. The literature also shows that the technology often removes these compounds to levels below analytical detection limits. For PFOA and PFOS, maximum removal efficiencies are greater than 99 percent to levels lower than the regulatory thresholds currently under consideration. There are fewer studies of RO/NF performance for other (non-carboxylate and non-sulfonate) PFAS compounds. The apparently low removal values for these other PFAS compounds (e.g., greater than 64.2 percent removal for HFPO-DA) are an artifact of low influent levels relative to the detection or quantitation limits. As discussed below, higher removals than the values shown in Table 4-3 could be achievable for other PFAS that are similar in size and weight to the carboxylate and sulfonate compounds.

PFAS removal efficiency for specific membranes appears to be closely related to the characteristics of the membrane relative to the molecular weight of the target compound. For example, Yu et al. (2016) found only 55 percent removal of PFOS by a membrane with a membrane with a molecular weight cutoff (MWCO) of 1,000 grams per mole (g/mol), which is larger than the molecular weight of PFOS (500.13 g/mol). In the same study, a membrane with an MWCO of 200 g/mol achieved 95.5 to 97 percent removal of PFOS. Appleman et al. (2013) and Steinle-Darling and Reinhard (2008) also observed the effect of molecular weight on PFAS removal by NF, finding somewhat lower removal of lower molecular weight, shorter chain PFAS than higher molecular weight, longer chain PFAS. Accordingly, PFAS removal efficiency by NF membranes is not expected to vary substantially by functional group or chain length except to the extent that these factors influence molecular size and weight. RO membranes have a lower MWCO than NF membranes, often less than 100 g/mol (DuPont, 2021). Therefore, RO removal efficiency also is not expected to vary substantially by functional group or chain length. In addition, unlike GAC and IX, RO and NF do not exhibit "breakthrough" behavior. That is, removal efficiency tends to be steady-state and does not vary over time.

### *4.2.2 Full-Scale Applications*

Two drinking water systems, in North Carolina (Dowbiggin et al., 2021) and Alabama (Wetzel, 2021; WHNT News, 2019), recently constructed full-scale treatment plants using low-pressure (or "loose") RO. These are the first two treatment plants utilizing membrane technology specifically targeted at PFAS removal from drinking water. Although performance data are not yet available from these facilities, the effectiveness studies enumerated in Section 4.2.1 include results from full-scale facilities using membrane separation to treat other contaminants.

## 4.3 Raw Water Quality Considerations

In general, water quality affects the design (e.g., concentrate volume, cleaning frequency, antiscalant selection) of RO and NF systems, but not removal efficiency. The literature specifically for PFAS removal by membranes supports this conclusion. For example, Appleman et al. (2013) found that the effectiveness of NF for PFAS removal was not impaired by the presence of humic acid. Similarly, Steinle-Darling and Reinhard (2008) found that ionic strength did not have a significant effect on removal performance. Although these authors noted a significant effect from pH, this effect was observed at pH 2.8, substantially lower than typical drinking water influent. Boonya-Atichart et al. (2016) found no significant effect within a more typical range of pH (5.5 to 10). Although they observed a slight decrease in effectiveness with increasing total dissolved solids, this effect was not significant.

## 4.4 Pre- and Post-Treatment Needs

In general, pretreatment requirements for membrane technologies depend on influent water quality as well as the type of membrane used. Most RO and NF processes include a prescreen or cartridge filter to remove sediment that could damage the membranes. RO and NF membranes also often require pre-treatment acid or antiscalant addition for scaling control (Bergman et al., 2012; Duranceau and Taylor, 2011). Pretreatment requirements, however, typically are independent of the specific contaminant targeted for removal. Calculations such as the silt density index (SDI), found in ASTM standard D4189, can provide insight into the fouling problems that are inherent in any membrane system (Bergman et al., 2012; Duranceau and

Taylor, 2011). SDI measures the fouling potential of suspended solids. Manufacturers typically specify maximum SDIs of 3 to 5 for RO and NF elements (Bergman et al., 2012). In addition, it is important to model and conduct pilot studies to assess the potential for fouling from substances such as natural organic matter, calcium carbonate, silica, calcium fluoride, barium sulfate, calcium sulfate, strontium sulfate, and calcium phosphate. The Langelier saturation index (LSI), described in ASTM standard D3738, characterizes the potential for $CaCO_3$ scaling. The LSI is used to indicate the tendency of water to precipitate, dissolve, or be in equilibrium with calcium carbonate, and what pH change is required to bring the water back to equilibrium (Bergman et al., 2012). The scaling potential of other substances may be determined from a saturation calculation. There is nothing unique about PFAS removal by RO/NF that suggests a different relationship between the major water quality parameters and typical pretreatment and cleaning requirements.

The permeate from RO and, in some cases, NF can be corrosive. The extent of this impact is site-specific (Bergman et al., 2012). In other drinking water treatment applications, the permeate is often blended with untreated water to produce a less corrosive finished water (Mickley, 2018). If the source water has a sufficiently low concentration of PFAS and other contaminants, blending may reduce post-treatment requirements. In instances where blending is not possible, post-treatment (e.g., sodium hydroxide or lime addition) can be required to control corrosion impacts (Lipp et al., 2010).

## 4.5 Waste Generation and Residuals Management Needs

There are no full-scale studies of residuals from RO or NF facilities specifically for the removal of PFAS. In general, however, the characteristics of membrane concentrates are predictable, and handling and treatment options are well understood. This waste stream contains the PFAS compounds and other dissolved solids removed from the treated water. The two full-scale facilities identified in Section 4.2.2 are designed for recovery rates of 85 to 92 percent (Dowbiggin et al., 2021; Wetzel, 2021; WHNT News, 2019), which means that concentrate flows at these facilities would account for 8 to 15 percent of influent (i.e., 100 percent minus the recovery rate). Assuming these facilities achieve 95 percent removal efficiency, PFAS concentrations in this waste stream would be approximately 6 to 12 times the concentration in influent water. [13]

For disposal of membrane concentrate, most systems use surface water discharge or discharge to sanitary sewer. Deep well injection is common in Florida. A small percentage of systems use land application, evaporation ponds, or recycling (Mickley, 2018). The large volume of residuals is a well-known obstacle to adoption of membrane separation technology, in general. In the case of PFAS removal, the high PFAS concentration in the residuals might limit the disposal options or require additional treatment prior to disposal, depending on state and local discharge regulations.

Studies specific to treatment of concentrate containing PFAS currently are limited to lab- or pilot-scale (Franke et al. 2021; Tow et al., 2021). The Alabama facility identified under Question 4.2.1 initially planned to treat membrane concentrate through its existing GAC filters prior to

[13] The concentration in the reject stream can be calculated as the concentration in influent times the removal efficiency, divided by the rejection rate. In this example, 0.95 / 0.15 = 6.33 and 0.95 / 0.08 = 11.88.

discharge (WHNT News, 2019). More recent reports (Wetzel, 2021) do not address concentrate treatment at this facility. The North Carolina facility includes the construction of a discharge pipeline to a point "several miles" away, downstream of any drinking water intakes (Dowbiggin et al., 2021).

Periodic cleaning of the membrane system is necessary to recover productivity lost to fouling. This cleaning may include cycles of acid and caustic wash, depending on the nature of the fouling. Since the spent cleaning solution is generated infrequently and in small amounts, it is typically diluted by and handled with the concentrate.

## 4.6 Critical Design Parameters

Critical design parameters for membrane systems removing PFAS are:

- Pretreatment and cleaning requirements
- Membrane type
- Flux rate
- Recovery rate
- Residuals management options.

As discussed in Section 4.4, assumptions about pretreatment requirements and cleaning procedures, in general, are determined based on major water quality parameters, such as hardness parameters, chloride, sulfate, silica, pH, SDI, and total dissolved solids. They typically are not affected by trace contaminant influent concentrations or removal requirements. There is nothing unique about PFAS removal by membrane separation that suggests a different relationship between the major water quality parameters and typical pretreatment and cleaning requirements. Section 4.5 discusses residuals management options. The sections below discuss membrane type, flux rate, and recovery rate in more detail, including the range of values reported in the literature for these parameters. Section 7.4 identifies the specific values for each parameter used in EPA's cost estimates.

### *4.6.1 Membrane Type*

As discussed in Section 4.2.1, both RO and NF membranes can be effective at removing PFAS compounds. More specifically, RO membranes shown to be effective include those in the "loose" or low-pressure end of the RO category (Dowbiggin et al., 2021; Lipp et al., 2010). NF membranes shown to be effective are at the "tight" or low MWCO end of that category (Appleman et al., 2013; Steinle-Darling and Reinhard, 2008; Yu et al., 2016). The two current full-scale membrane system specifically designed for PFAS treatment both utilize RO membranes (Dowbiggin et al., 2021; Wetzel, 2021).

### *4.6.2 Flux Rate*

The flux of an RO/NF system is the rate of permeate water per unit of membrane area, typically measured in gallons per square foot per day (gfd). While each stage of a membrane system will have a different flux, the average flux over all elements is a fundamental design parameter. In general, the higher the quality of the feed water, the higher the flux that may be achieved. Operating with excessively high flux, however, leads to fouling of the membrane elements. Depending on the nature of the fouling, it may be reversed by cleaning, or may require replacement of the elements. As shown in Table 4-5, flux values found in the literature range from 6 to 44 gfd including bench scale studies. Data are not available for the flux rate employed at the two full-scale RO facilities constructed specifically for PFAS removal. Dickenson and Higgins (2016) report full-scale flux rates of approximately 12 gfd, but these are for potable reuse facilities. Bench-scale studies (Appleman et al., 2013; Lipp, 2010) show that RO and NF remain effective for PFAS removal at higher flux rates.

**Table 4-5. Flux Rates for PFAS Treatment Reported in the Literature**

| Study Scale and Membrane Type | Source Water | Flux (gfd) | Source |
|---|---|---|---|
| Full Scale RO | WWTP | 12 | Dickenson and Higgins, 2016 |
| Full Scale RO | WWTP | 11.6 | Dickenson and Higgins, 2016 |
| Bench Scale NF | Lab | 10 to 44 | Appleman et al., 2013 |
| Bench Scale RO | Lab | 17.6 to 23.5 | Lipp et al., 2010 |
| Bench Scale NF | Lab | 6 to 41 | Lipp et al., 2010 |

gfd = gallons per square foot per day; NF = nanofiltration; RO = reverse osmosis; WWTP = potable reuse facility receiving water from wastewater treatment plant

### *4.6.3 Recovery Rate*

As discussed in Section 4.1, the recovery rate is the percentage of the influent flow that is recovered as permeate. Increasing the recovery rate will increase the concentration of dissolved solids in the membrane reject water and will thus increase the required feed pressure and the potential for membrane scaling. Thus, the achievable recovery rate depends on the quality of the source water as well as the pretreatment of the water, and systems with high levels of total dissolved solids in their feed water will typically operate at lower recovery rates than systems with lower levels. As shown in Table 4-6, recovery rates found in the literature range from 78 to 92 percent.

**Table 4-6. Recovery Rates for PFAS Treatment Reported in the Literature**

| Study Scale and Membrane Type | Source Water | Recovery Rate | Source(s) |
|---|---|---|---|
| Full Scale RO | WWTP | 85% | Thompson et al., 2011 |
| Full Scale RO | WWTP | 85% | Dickenson and Higgins, 2016 |
| Full Scale RO | WWTP | 80% | Dickenson and Higgins, 2016 |
| Full Scale RO | Surface | 90% | Wetzel, 2021; WHNT News, 2019 |
| Pilot Scale NF | Ground | 78% | Franke et al., 2019 |
| Full Scale RO | Surface | 85 to 92% | Dowbiggin et al., 2021 |
| Bench Scale NF | Ground | 84% | Boonya-Atichart et al., 2016 |

NF = nanofiltration; RO = reverse osmosis; WWTP = potable reuse facility receiving water from wastewater treatment plant

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# 5.0 Point-of-Use/Point-of-Entry Treatment

## 5.1 Operating Principle

A POU/POE device uses a miniaturized version of a centralized treatment process to meet water quality standards at the household level. POU devices are sized to treat water for consumption at individual taps (e.g., a kitchen sink). POE devices are designed to treat water where the service line enters the house (e.g., in the basement). When a system installs, controls (i.e., owns), and maintains POU/POE devices at all customer locations where water is consumed (e.g., residences), it can forego centralized treatment (USEPA, 2006). Because POU/POE devices treat a fraction of the water delivered by a system, a compliance program that relies on POU/POE devices may be more cost-effective for smaller systems.

The NSF[14] committee of stakeholders has updated the NSF/American National Standards Institute (NSF/ANSI) standards applicable to POU/POE devices to incorporate requirements for PFAS removal. To be certified under the standards a device must reduce the total concentration of PFOA and PFOS to below 70 ng/L (NSF International, 2019). Several organizations (e.g., NSF International, Underwriters Laboratories, Water Quality Association) provide third-party testing and certification that POU/POE devices meet drinking water treatment standards.

The discussion in this section focuses on POU/POE RO devices because these are the most common type of device certified for PFAS removal. The operating principle for POU/POE RO devices is the same as centralized RO: they separate solutes such as PFAS compounds from solution by forcing the solvent to flow through a membrane at a pressure greater than the normal osmotic pressure. In addition to an RO membrane for dissolved contaminant removal, POU/POE RO devices often have a sediment pre-filter and a carbon filter in front of the RO membrane, a 3- to 5-gallon treated water storage tank, and a carbon filter between the tank and the tap.

POU/POE devices are not currently a compliance option because the regulatory options under consideration require treatment to concentrations below the current certification standard of 70 ng/L total of PFOA and PFOS. However, POU/POE treatment might become a compliance option for small systems in the future if NSF/ANSI develop a new certification standard that mirrors EPA’s proposed regulatory standard. To meet a PFAS drinking water standard, a system would need to purchase, install, and maintain certified devices for all customers. Usually, a system would install a single POU RO device at the kitchen tap for each residential customer. Nonresidential customers might require multiple POU devices (e.g., for drinking fountains) or a single POE device. Installation requires retrofitting the device into existing plumbing fixtures (e.g., tapping into the water supply line to insert a treated water line with a dedicated tap and adding a wastewater connection for the RO membrane concentrate or reject). Maintenance primarily consists of filter replacement, often on a fixed schedule that varies by filter type. Monitoring water quality at individual treated water taps will also be necessary to demonstrate compliance with a perchlorate drinking water standard.

[14] Formerly National Sanitation Foundation

## 5.2 Effectiveness for PFAS Removal

As discussed above, POU/POE devices certified under the current NSF/ANSI standards remove PFOA and PFOS to a total of less than 70 ng/L. There is evidence in the literature that POU/POE RO devices can achieve even lower concentrations. Patterson et al. (2019) tested three such RO devices for removal of PFBS, PFHxS, PFHpA, PFOS, PFOA, and PFNA. The devices were sized for POU use, but plumbed with additional equipment (storage tanks, booster pumps) to simulate POE usage. Two of the devices removed each of the PFAS compounds tested to below the quantitation limit (10 ng/L) throughout the test period. The third device removed the compounds to below the quantitation limit except for one sampling event. During this sampling event, which took place immediately upon startup after a five-day stagnation period, all the PFAS compounds except PFBS were detected in the treated water at concentrations from 11 to 77 ng/L. The concentrations returned to levels below the quantitation limit during the next sampling event four hours later. Additional support for the effectiveness of POU/POE programs for PFAS removal is evident from the number of community-scale applications of the technology, as listed in Table 5-1.

**Table 5-1. Community-Scale Applications of POU/POE Treatment to Remove PFAS from Drinking Water**

| Location | Number of Households | POU/POE | Year of Startup | Sources |
|---|---|---|---|---|
| Camp Grayling, Crawford County, Michigan | Not reported | Not reported | 2018 | Michigan DEGLE 2021b |
| House Street Disposal Area, Belmont, Kent County, Michigan | 781 | 546 POE and 235 POU | 2020 | Michigan DEGLE 2021c |
| Alpena Combat Readiness Training Center, Alpena County, Michigan | 31 | Not reported | Not reported | Michigan DEGLE 2021a |
| Former Washington County Landfill, Lake Elmo, Minnesota | 57 | POE | 2007 | ATSDR 2008 |
| Deepwater, Salem County, New Jersey | Not reported | Not reported | 2011 | Dunn 2011 |
| Bennington and North Bennington, Vermont | 255 | POE | 2020 | Danko 2018; VDEC 2020 |
| Hoosick Falls, New York | >800 | POE | Not reported | NYS DEC 2021 |

POE = Point-of Entry; POU = Point-of-Use

## 5.3 Raw Water Quality Considerations

Because the POU/POE RO devices will be installed at service taps that are downstream of a system's entry point to the distribution system, EPA assumes that the raw water entering a POU/POE RO device will be water that is suitable for consumption except for an exceedance of the proposed perchlorate regulatory standard. As noted in the next section, POU/POE RO devices include pre-filters to address potential interference of delivered water quality with RO performance.

## 5.4 Pre- and Post-Treatment Needs

POU/POE RO devices include various filters to address pre- and post-treatment concerns. Most devices include a sediment filter for solids removal to prevent membrane fouling and a pre-RO carbon filter to remove chlorine and organic compounds that could impair membrane function. They also include a carbon filter after the membrane and storage tank to remove any organics that may remain or bacterial growth that occurs during storage. Because the POU device is installed at the tap, there are no potential adverse impacts on the distribution system.

## 5.5 Waste Generation and Residuals Management Needs

The treatment process waste comprises wastewater and used filter cartridges. Waste disposal methods must comply with state and local requirements. The wastewater connection is generally plumbed to the household sewer system, which uses either an on-site septic system or a centralized wastewater collection system for disposal. Depending on state and local regulations, the used cartridge filters may be included in household solid waste (USEPA, 2006).

## 5.6 Critical Design Parameters

EPA's cost estimates for POU/POE treatment programs assume the use of POU, as opposed to POE, devices because ingestion is the primary route of concern for exposure to PFAS. In addition to the POU devices themselves, there are several components to the design of a POU program that are primary cost drivers. These include the following:

- POU RO device installation
- Public education program development
- POU device monitoring
- POU device maintenance.

Chapter 7 discusses each of these parameters in more detail and identifies the specific values for each used in EPA's cost estimates.

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# 6.0 Nontreatment Alternatives

## 6.1 Application Principle

For small water utilities that lack the financial and/or technical capacity to implement a new treatment-based compliance strategy, nontreatment options may offer a more cost-effective path to compliance. Nontreatment options essentially replace the contaminated water source with water that meets drinking water standards, including new standards for PFAS compounds.

Nontreatment solutions for drinking water compliance include the following (USEPA, 2006):

- well rehabilitation
- contaminant source elimination
- new well construction
- interconnecting with another system to purchase water.

The feasible nontreatment options will depend on site-specific circumstances such as system size, source water type, contaminant reduction needs, and proximity to alternative water sources. For small systems, neither well rehabilitation nor source elimination (e.g., remediation of PFAS-contaminated soils or groundwater) is likely to be feasible and cost-effective. Another option – blending water from existing wells – may be a feasible, low-cost option for systems that have multiple wells including some with PFAS concentrations substantially below the new standards. For systems that cannot blend water from existing sources to comply with the new PFAS regulations, two feasible nontreatment options include the following:

1. a new well to replace the contaminated source water
2. interconnection to purchase water from a supplier.

These two options (new wells and interconnection) are likely to have higher costs than the other options (well rehabilitation and source elimination) (USEPA, 2006).

The costs associated with drilling a new well include the initial hydrological assessment, pilot hole drilling, developing the final well design, drilling the well bore, installing well casings, screens, and filters, development of the well, and installation of the pump and power source (Harter, 2003). A hydrological assessment identifies groundwater sources of suitable quality and adequate long-term supply. When replacing an existing well, the costs will also include connecting the well to the existing water distribution system.

The interconnection option involves laying a pipeline to connect the affected system to the distribution network of a neighboring system that can provide adequate water that meets all applicable drinking water standards. Costs include the cost of purchased water as well as construction and maintenance of the interconnection pipeline. Pipeline costs will depend on proximity of the neighboring system, topography of the distance to be covered, and right-of-way requirements for pipes and booster pump stations.

## 6.2 Compliance Effectiveness

Nontreatment options achieve compliance by replacing a PFAS-contaminated water source with an alternative water source that complies with the new PFAS regulations. This strategy is inherently compliant if the new water source is not at risk for PFAS contamination. If the wholesale supplier of purchased water has PFAS contamination, it must implement an effective treatment process because the water it sells must comply with the PFAS standard before it can be distributed to the purchasing system.

Drinking water systems have successfully used nontreatment options to alleviate PFAS concerns. In response to PFAS contamination near Peterson Air Force Base in Colorado, three water districts turned off their wells and are purchasing surface water from another source (Sullivan, 2018). In March 2016, Fort Drum Public Works in New York took two drinking water wells out of service following detection of PFAS. Fort Drum dug five new wells with a maximum capacity of 2.2 MGD in August 2016 (Fort Drum, 2019).

## 6.3 Raw Water Quality Considerations

A system will need to determine whether the change in source water may affect other existing treatment processes (e.g., chlorination), or if changes in water quality may affect the distribution system (e.g., purchased water has a different pH). Changes in delivered water chemistry that trigger major process additions or adjustments could diminish the cost-effectiveness of nontreatment options.

## 6.4 Pre- and Post-Treatment Needs

By definition, there are no pre-treatment needs to consider with a change in source water. All treatment adjustments to account for differences in source water quality would necessarily occur after the point of source water connection. If the alternative water source has chemical parameters that differ substantially from the original source water and may affect water quality elsewhere in the system, then there may be additional treatment needs to adjust water chemistry.

## 6.5 Waste Generation and Residuals Management Needs

An interconnection or new well should not have incremental wastes or residuals requiring management.

## 6.6 Critical Design Assumptions

For new wells, key design parameters are the following:

- Total flow rate requirements and flow per well
- Well depth (and screened depth)
- Distance from well to distribution system.

For an interconnection option, key design parameters include:

- Flow rate requirements
- Distance to interconnection water supply
- Pressure at water supply source
- Cost of purchased water.

Chapter 7 discusses each of these parameters in more detail and identifies the specific values for each used in EPA's cost estimates.

## 6.7 References

Fort Drum Public Works (FDPW). 2019. *2018 Annual Drinking Water Quality Report.* Retrieved from: https://home.army.mil/drum/application/files/8615/5535/5022/2018_Fort_Drum_AWQR.pdf

Harter, T. 2003. *Water Well Design and Construction*. University of California, Division of Agricultural and Natural Resources.

Sullivan, M. 2018. *Addressing Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA).* U.S. Department of Defense. Retrieved from: https://denix.osd.mil/derp/home/documents/pfos-pfoa-briefing-to-the-hasc/

U.S. Environmental Protection Agency (USEPA). 2006. *Technology and Cost Document for the Final Ground Water Rule*. EPA-815-R-06-015.

# 7.0 Costs for Treatment and Nontreatment Options

## 7.1 Introduction

### 7.1.1 Overview and Cost Modeling Approach

This chapter presents estimated costs for installing and operating the technologies and nontreatment options discussed in Chapters 2 through 6. Based on the information in those chapters, particularly the data on engineering design specifications, EPA developed work breakdown structure (WBS) cost estimating models for each of the PFAS treatment technologies. The WBS models are spreadsheet-based engineering models for individual treatment technologies, linked to a central database of component unit costs. EPA developed the WBS model approach as part of an effort to address recommendations made by the Technology Design Panel (TDP), which convened in 1997 to review the Agency's methods for estimating drinking water compliance costs (USEPA, 1997). The TDP consisted of nationally recognized drinking water experts from the EPA, water treatment consulting companies, public and private water utilities and suppliers, equipment vendors, and Federal and State regulators in addition to cost estimating professionals.

In general, the WBS approach involves breaking a process down into discrete components for the purpose of estimating unit costs. The WBS models represent improvements over past cost estimating methods by increasing comprehensiveness, flexibility, and transparency. By adopting a WBS-based approach to identify the components that should be included in a cost analysis, the models produce a more comprehensive assessment of the capital and operating requirements for a treatment system. The documentation for the individual WBS models (USEPA, 2024a; 2024b; 2024c; 2024d) provides complete details on the structure, content, and use of the models. EPA used the WBS models to develop the costs presented in this chapter. The models and their documentation can be accessed at: https://www.epa.gov/dwregdev/drinking-water-treatment-technology-unit-cost-models-and-overview-technologies.

The remainder of this section provides a brief overview of the common elements of all the WBS models and information on the anticipated accuracy of the resulting cost estimates. Subsequent sections describe how EPA used each individual technology specific WBS model to estimate costs for PFAS treatment and present the resulting cost estimates.

### 7.1.2 Work Breakdown Structure (WBS) Models

Each WBS model contains the work breakdown for a particular treatment process and preprogrammed engineering criteria and equations that estimate equipment requirements for user-specified design requirements (e.g., system size and influent water quality). Each model also provides unit and total cost information by component (e.g., individual items of capital equipment) and totals the individual component costs to obtain a direct capital cost. Additionally, the models estimate add-on costs (permits, pilot study, and land acquisition costs for each technology), indirect capital costs, and annual operation and maintenance (O&M) costs, thereby producing a complete compliance cost estimate.

Primary inputs common to all the WBS models include design flow and average flow in million gallons per day (MGD). Each WBS model has default designs (input sets) that correspond to specified categories of flow, but the models can generate designs for many other combinations of flows. To estimate costs for PFAS compliance, EPA fit cost curves to the WBS estimates for up to 49 different flow rates. [15] Thus, the cost estimates in Sections 7.2 through 7.5, and Appendix A are in the form of equations.

Another input common to all the WBS models is "component level" or "cost level." This input drives the selection of materials for items of equipment that can be constructed of different materials. For example, a low-cost system might include fiberglass pressure vessels and PVC piping. A high-cost system might include stainless steel pressure vessels and stainless-steel piping. The component level input also drives other model assumptions that can affect the total cost of the system, such as building quality and heating and cooling. The component level input has three possible values: low cost, mid cost, and high cost. To estimate costs for PFAS treatment, EPA generated separate cost equations for each of the three component levels, thus creating a range of cost estimates for use in national compliance cost estimates.

The third input common at all the WBS models is system automation, which allows the design of treatment systems that are operated manually or with varying degrees of automation (i.e., with control systems that reduce the need for operator intervention). The cost estimates in the technology-specific sections below are for systems that are fully automated, minimizing the need for operator intervention and reducing operator labor costs.

The WBS models generate cost estimates that include a consistent set of capital, add-on, indirect, and O&M costs. Table 7-1 identifies these cost elements, which are common to all the WBS models and included in the cost estimates below. Sections 7.2 through 7.5 identify the technology-specific cost elements included in each model. The documentation for the WBS models (USEPA, 2024a; 2024b; 2024c; 2024d) provide more information on the methods and assumptions used in the WBS models to estimate the costs for both the technology-specific and common cost elements.

[15] Specifically, for each scenario modeled and separately for total capital and for O&M costs, EPA fit up to three curves: one covering small systems (less than 1 MGD design flow), one covering medium systems (1 MGD to less than 10 MGD design flow), and one covering large systems (10 MGD design flow and greater). For each curve fit, EPA chose from among several possible equation forms: linear, quadratic, cubic, power, exponential, and logarithmic. EPA chose the form that resulted in the best correlation coefficient ($R^2$), subject to the requirement that the equation must be monotonically increasing over the appropriate range of flow rates (i.e., within the flow rate category, the equation must always result in higher estimated costs for higher flow systems than for lower flow systems).

**Table 7-1. Cost Elements Included in All WBS Models**

| Cost Category | Components Included |
|---|---|
| **Direct Capital Costs** | • Technology-specific equipment (e.g., vessels, basins, pumps, treatment media, piping, valves)<br>• Instrumentation and system controls<br>• Buildings<br>• Residuals management equipment |
| **Add-on Costs** | • Land<br>• Permits<br>• Pilot testing |
| **Indirect Capital Costs** | • Mobilization and demobilization<br>• Architectural fees for treatment building<br>• Equipment delivery, installation, and contractor's overhead and profit<br>• Sitework<br>• Yard piping<br>• Geotechnical<br>• Standby power<br>• Electrical infrastructure<br>• Process engineering<br>• Contingency<br>• Miscellaneous allowance<br>• Legal, fiscal, and administrative<br>• Sales tax<br>• Financing during construction<br>• Construction management |
| **O&M Costs:** Technology-specific | • Operator labor for technology-specific tasks (e.g., managing backwash and media replacement)<br>• Materials for O&M of technology-specific equipment<br>• Technology-specific chemical usage<br>• Replacement of technology-specific equipment that occurs on an annual basis (e.g., treatment media)<br>• Energy for operation of technology-specific equipment (e.g., mixers) |
| **O&M Costs:** Labor | • Operator labor for O&M of process equipment<br>• Operator labor for building maintenance<br>• Managerial and clerical labor |
| **O&M Costs:** Materials | • Materials for maintenance of booster or influent pumps<br>• Materials for building maintenance |
| **O&M Costs:** Energy | • Energy for operation of booster or influent pumps<br>• Energy for lighting, ventilation, cooling, and heating |
| **O&M Costs:** Residuals | • Residuals management operator labor, materials, and energy<br>• Residuals disposal and discharge costs |

In addition to costs, the models also output an estimated useful life, in years, for each WBS component. The useful lives vary by component type (e.g., buildings generally last longer than mechanical equipment) and by material (e.g., steel tanks generally last longer than plastic tanks). The models use the component useful lives to calculate an average useful life for the entire system. The calculation uses a reciprocal weighted average approach, which is based on the relationship between a component's cost (C), its useful life (L) and its annual depreciation rate

(A) under a straight-line depreciation method. The formula below shows the reciprocal weighted average calculation:

$$\text{Average Useful Life} = \frac{\sum_{n=1}^{N} C_n}{\sum_{n=1}^{N} A_n} = \frac{C}{A}$$

where:

$C_n$ denotes the cost of component n, n=1 to N
C denotes total cost of all N components
$A_n$ denotes the annual depreciation for component n, which equals $C_n/L_n$
A denotes total annual depreciation for the N components.

### 7.1.3 WBS Model Accuracy

Costs for a given system can vary depending on site-specific conditions (e.g., raw water quality, climate, local labor rates, and location relative to equipment suppliers). The costs presented here are based on national average assumptions and include a range (represented by low-, mid-, and high-cost equations) intended to encompass the variation in costs that systems would incur to remove PFAS. To validate the engineering design methods used by the WBS models and increase the accuracy of the resulting cost estimates, EPA has subjected the individual models to a process of external peer review by nationally recognized technology experts.

The GAC model underwent peer review in 2006. Two of the three reviewers felt they had enough experience with GAC cost estimates to evaluate the model's accuracy. One of these reviewers expressed the opinion that resulting cost estimates would be in the range of budget estimates (+30 to -15 percent). The other reviewer did not provide a precise estimate of the model's accuracy range but commented that the resulting cost estimates were reasonable. EPA made substantial revisions to the GAC model in response to the peer review.

The IX model underwent peer review in 2005, during an early stage of its development. One peer reviewer responded that resulting cost estimates were in the range of budget estimates (+30 to -15 percent). The other two reviewers thought the estimates were order of magnitude estimates (+50 to -30 percent), with an emphasis on the estimates being high. The IX model has since undergone extensive revision, both in response to the peer review and to adapt it for PFAS treatment using selective resin.

The RO/NF model underwent peer review in 2007. The majority of peer reviewers who evaluated the model expressed the opinion that resulting cost estimates would be in the range of budget estimates (+30 to -15 percent). The RO model has since undergone substantial revision in response to the peer review comments.

EPA received peer review comments on the non-treatment model in May 2012. The first reviewer responded that cost estimates resulting from the non-treatment model were in the range of budget estimates (+30 to -15 percent). The second reviewer thought the cost estimates were order of magnitude estimates (+50 to -30 percent). The third reviewer felt the cost estimates were definitive (+15 to -5 percent), except for land costs, which were difficult to assess due to regional variations. EPA revised the nontreatment model in response to the peer review recommendations.

### 7.1.4 Model Updates for Final Rule

In response to public comments on the proposed PFAS rule, EPA made a number of updates to the WBS models. First, EPA updated the models' cost outputs to 2022 dollars. The Agency accomplished this by escalating unit costs using indices including the Bureau of Labor Statistics producer price indices (USBLS, 2010). EPA updated each unit cost using the change in the relevant price index from year 2020 to 2022. For example, the EPA applied the percent increase of the price of metal tanks and vessels to the price of metal tanks and vessels in the WBS cost models. The EPA also collected new vendor price quotes for cost driver equipment components (e.g., pressure vessels, treatment media). In addition, EPA made the following adjustments to the models' inputs and assumptions:

- EPA updated the pilot study costs included in each of the treatment technology models. As part of this update, EPA increased the estimated length of the pilot study and the frequency of sampling during the pilot study. Additionally, EPA added a full year of confirmation sampling after full-scale installation to the estimated pilot study costs.

- EPA changed its assumptions regarding contingency. Specifically, EPA incorporated contingency at all cost levels, not just the high-cost level. EPA also increased the complexity factor applied to estimate contingency for systems using GAC and non-treatment options. Taken together, these changes result in a contingency factor of 5 to 10 percent depending on total project cost at all cost levels.

- EPA changed the input assumptions for the nontreatment interconnection option to incorporate booster pumps designed to account for friction loss in interconnecting piping (see Section 7.6.3.3).

## 7.2 Costs for GAC

### 7.2.1 Model Components and Assumptions

USEPA (2024a) provides a complete description of the engineering design process used by the WBS model for GAC. The model can generate costs for two types of design:

- Pressure designs where the GAC bed is contained in stainless steel, carbon steel, or fiberglass pressure vessels
- Gravity designs where the GAC bed is contained in open concrete basins.

Table 7-2 shows the technology-specific capital equipment and O&M requirements included in the GAC model. These items are in addition to the common WBS cost elements listed in Table 7-1.

**Table 7-2. Technology-Specific Cost Elements Included in the GAC Model**

| Cost Category | Major Components Included |
|---|---|
| **Direct Capital Costs** | • Booster pumps for influent water (for gravity GAC designs)<br>• Contactors (either pressure vessels or concrete basins) that contain the GAC bed<br>• Tanks and pumps for backwashing the contactors<br>• GAC transfer and storage equipment<br>• Spent GAC reactivation facilities (if on-site reactivation is selected)<br>• Associated piping, valves and instrumentation |
| **O&M Costs:** Labor | • Operator labor for contactor maintenance (for gravity GAC designs)<br>• Operator labor for managing backwash events<br>• Operator labor for backwash pump maintenance (if backwash occurs weekly or more frequently)<br>• Operator labor for GAC transfer and replacement |
| **O&M Costs:** Materials | • Materials for contactor maintenance (accounts for vessel relining in pressure designs, because GAC can be corrosive, and for concrete and underdrain maintenance in gravity designs)<br>• Materials for backwash pump maintenance (if backwash occurs weekly or more frequently)<br>• Replacement virgin GAC (limited to loss replacement only if reactivation is selected) |
| **O&M Costs:** Energy | • Operating energy for backwash pumps |
| **O&M Costs:** Residuals | • Discharge fees for spent backwash<br>• Fees for reactivating spent GAC (if off-site reactivation is selected)<br>• Labor, materials, energy, and natural gas for reactivation facility (if on-site reactivation is selected)<br>• Disposal of spent GAC (if disposal is selected) |

For small systems (less than 1 MGD) using pressure designs, the GAC model assumes the use of package treatment systems that are pre-assembled in a factory, mounted on a skid, and transported to the site. The model estimates costs for package systems by costing all individual equipment line items (e.g., vessels, interconnecting piping and valves, instrumentation, and system controls) in the same manner as custom-engineered systems. This approach is based on vendor practices of partially engineering these types of package plants for specific systems (e.g., selecting vessel size to meet flow and treatment criteria). The model applies a variant set of design inputs and assumptions that are intended to simulate the use of a package plant and that reduce the size and cost of the treatment system. USEPA (2024a) provides complete details on the variant design assumptions used for package plants.

The paragraphs below describe the specific inputs and assumptions that EPA used to generate the costs in Section 7.2.2. Other inputs and assumptions not discussed below (e.g., loading rate, number of booster pumps, backwash frequency, bed expansion) remained as described in USEPA (2024a).

#### *7.2.1.1 Design Type*

Systems often choose between pressure and gravity GAC designs based on cost (Brady and Moran, 2012; Summers et al., 2011). However, groundwater systems are more likely to choose pressure designs to maintain their existing pressure head. For these systems, use of gravity contactors would entail installation and operation of new pumps to restore pressure after GAC treatment (Summers et al., 2011). Therefore, for treatment of groundwater, EPA generated cost equations for pressure designs only. For treatment of surface water, EPA generated separate cost equations for pressure and gravity designs.

#### 7.2.1.2 EBCT and Contactor Configuration

For pressure designs, the estimates below and in Appendix A assume two vessels in series with a minimum total EBCT of 20 minutes (i.e., 10 minutes per vessel). For gravity designs, they assume contactors in parallel with a minimum total EBCT of 20 minutes. These assumptions are consistent with design engineer and GAC vendor recommendations for PFAS removal as discussed in Sections 2.6.1 and 2.6.2. The EBCT per vessel is also consistent with the data used to derive the bed life equations (10 minutes).

#### 7.2.1.3 Bed Life

As discussed in Sections 2.2.2 and 2.6.3, GAC bed life depends on factors including target removal efficiency, influent water quality (particularly natural organic matter), and the specific PFAS compound(s) targeted. To accommodate variations in these factors, EPA generated separate cost equations at 5,000 BV increments for bed lives ranging from 5,000 to 75,000 BV. Each 5,000 BV increment corresponds to a 2- to 5-month shift in changeout frequency, depending on system size. To estimate national costs, EPA selected from among these cost equations using the bed life equations described in Section 2.6.3. EPA rounded results from the bed life equations down to the nearest 5,000 BV, which errs on the side of higher costs.

The bed life equations are based on data representative of a single contactor with an EBCT of 10 minutes. As discussed in Section 7.2.1.1, the estimates below assume two contactors in series, each with an EBCT of 10 minutes (for pressure systems) or multiple contactors in parallel, each with an EBCT of 20 minutes (for gravity systems). Either of these configurations should result in a longer bed life than estimated for a single, 10-minute EBCT contactor (see Section 2.6.2). EPA did not adjust the bed life results to account for the more efficient contactor configuration assumptions. Not incorporating an adjustment for configuration errs on the side of higher costs and is intended to compensate for the fact that the bed life equations are based in part on RSSCT data, which might overestimate full-scale bed life (see Section 2.6.3). Note that EPA does not have data on the degree to which RSSCTs might overestimate bed life or to quantify the bed life extension resulting from contactor configuration. Therefore, the net result of this compensating adjustment is uncertain.

#### 7.2.1.4 Residuals Management

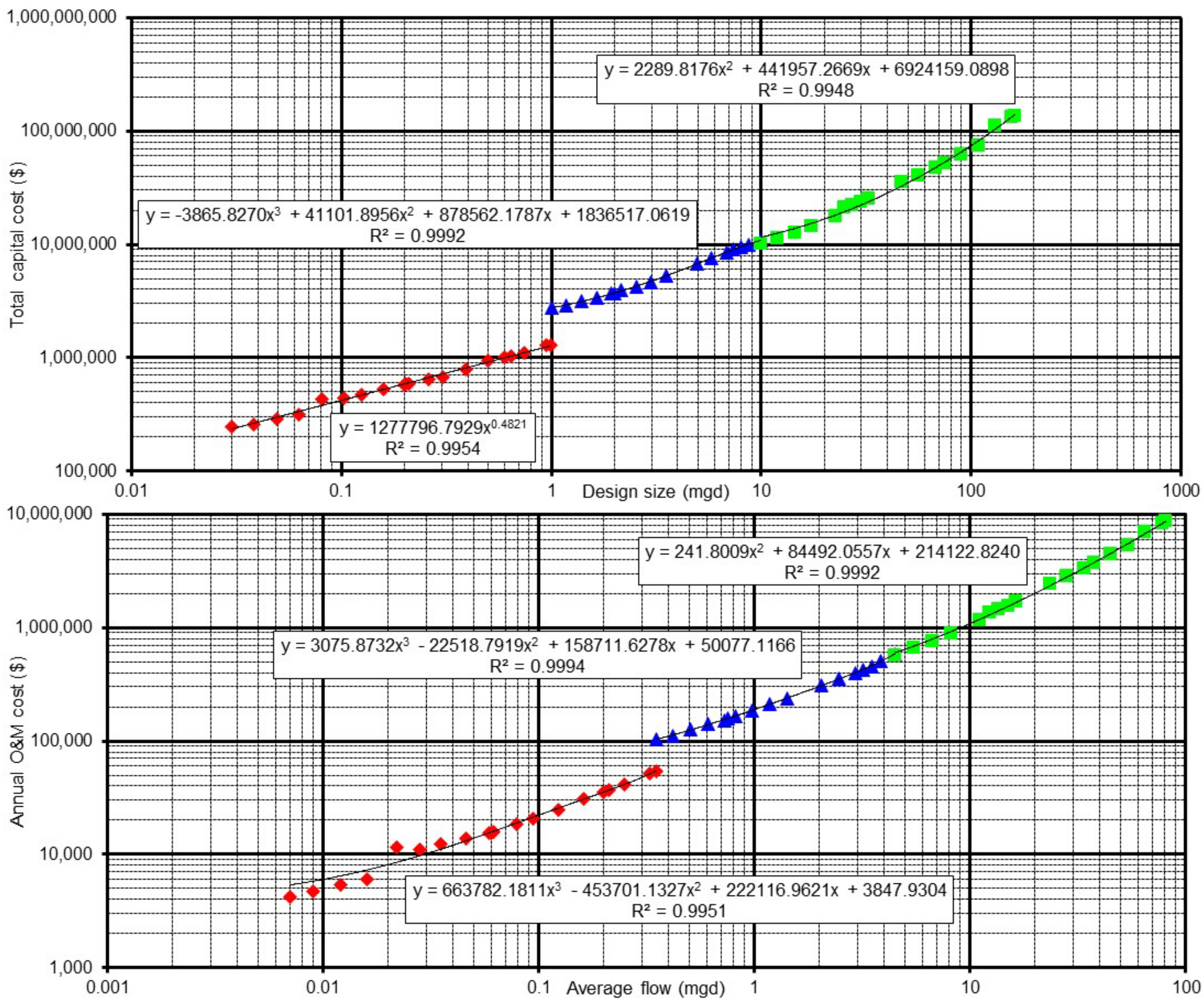
EPA generated separate cost equations for two spent GAC management scenarios:

- Off-site reactivation under current RCRA non-hazardous waste regulations
- Off-site disposal as a hazardous waste and replacement with virgin GAC (i.e., single use operation).

The first scenario reflects typical management practices under current regulations. The second scenario provides an upper bound on other options that might emerge under future air quality regulations (e.g., off-site disposal as a non-hazardous waste and replacement with virgin GAC) or RCRA hazardous waste regulations (e.g., off-site reactivation as a hazardous waste,).

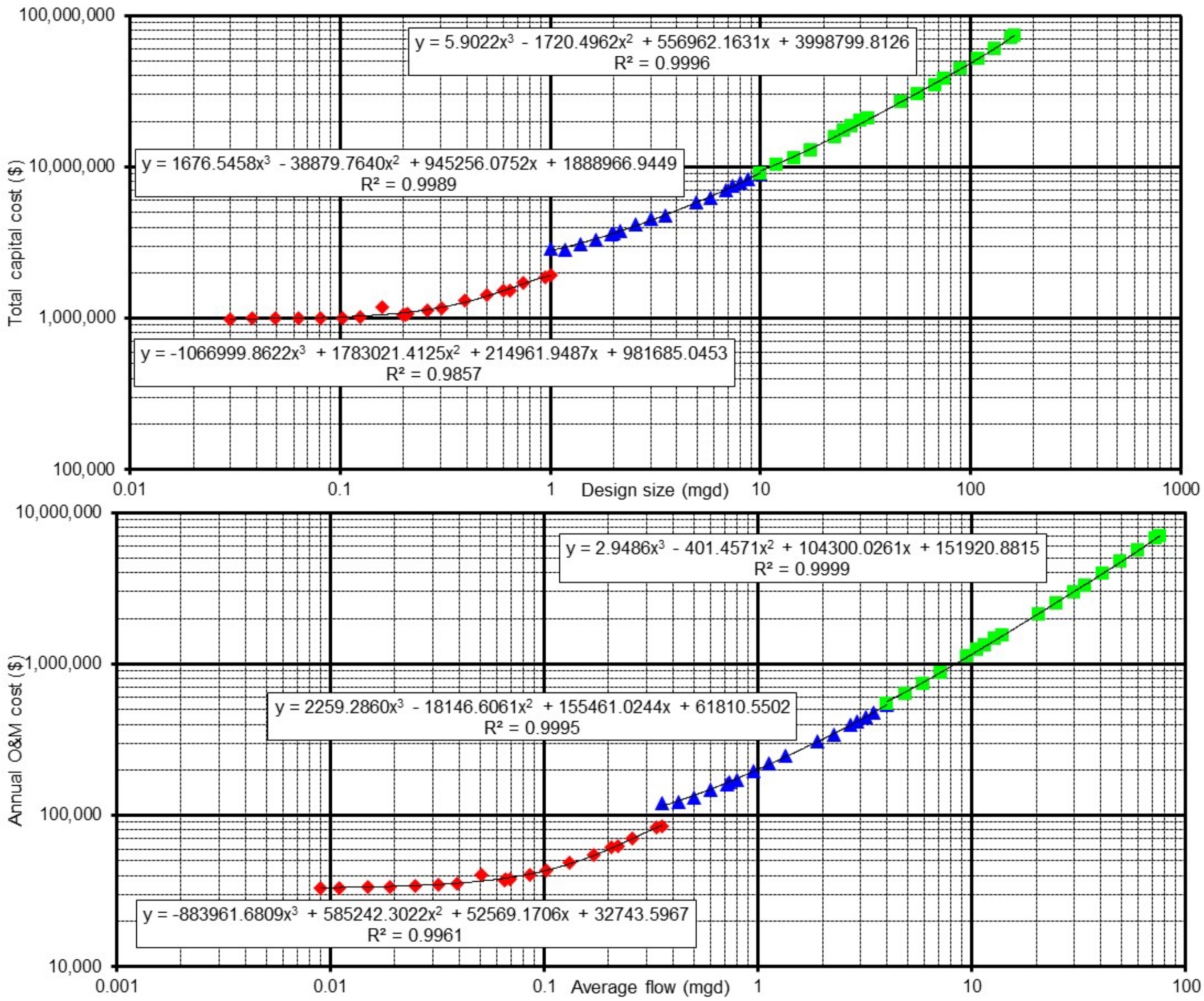
## 7.2.2 Cost Estimates

The graphs below plot WBS cost model results in 2022 dollars at the mid cost level for removal of PFAS from groundwater using pressure GAC (Figure 7-1) and surface water using gravity GAC (Figure 7-2), assuming a bed life of 50,000 BV and off-site GAC reactivation as a non-hazardous waste. In these exhibits, note that costs increase at 1 MGD design flow (0.355 MGD average flow) because of the transition from package systems (used by small systems) to custom-engineered systems (used by large systems). Appendix A provides complete cost equations for across the range of bed life and residuals management scenarios, including the high, mid, and low-cost levels and for treatment of groundwater and surface water. Appendix B presents example WBS model outputs at selected flow rates, allowing review of individual cost line items.




Note: costs shown assume bed life of 50,000 BV and off-site reactivation of spent GAC as a non-hazardous waste

**Figure 7-1. Mid Cost Results for Removal of PFAS from Groundwater Using Pressure GAC (2022 dollars)**




Note: costs shown assume bed life of 50,000 BV and off-site reactivation of spent GAC as a non-hazardous waste

**Figure 7-2. Mid Cost Results for Removal of PFAS from Surface Water Using Gravity GAC (2022 dollars)**

# 7.3 Costs for IX

## *7.3.1 Model Components and Assumptions*

USEPA (2024d) provides a complete description of the engineering design process used by the WBS model for PFAS-selective IX. Table 7-3 shows the technology-specific capital equipment and O&M requirements included in the model. These items are in addition to the common WBS cost elements listed in Table 7-1.

**Table 7-3. Technology-Specific Cost Elements Included in the PFAS-selective IX Model**

| Cost Category | Major Components Included |
|---|---|
| **Direct Capital Costs** | • Pre-treatment cartridge filters<br>• Pressure vessels that contain the resin bed<br>• Tanks and pumps for initial rinse and (optionally) backwash of the resin bed<br>• Tanks (with secondary containment), pumps and mixers for delivering sodium hydroxide for use in post-treatment corrosion control (optional)<br>• Associated piping, valves, and instrumentation |
| **O&M Costs:** Labor | • Operator labor for pre-treatment filters<br>• Operator labor for managing backwash/rinse events<br>• Operator labor for backwash pump maintenance (only if backwash occurs weekly or more frequently)<br>• Operator labor for resin replacement |
| **O&M Costs:** Materials | • Replacement cartridges for pre-treatment filters<br>• Materials for backwash pump maintenance (only if backwash occurs weekly or more frequently)<br>• Chemical usage (if post-treatment corrosion control is selected)<br>• Replacement virgin PFAS-selective resin |
| **O&M Costs:** Energy | • Operating energy for backwash/rinse pumps |
| **O&M Costs:** Residuals | • Disposal of spent cartridge filters<br>• Discharge fees for spent backwash/rinse<br>• Disposal of spent resin |

For small systems (less than 1 MGD), the PFAS-selective IX model assumes the use of package treatment systems that are pre-assembled in a factory, mounted on a skid, and transported to the site. The model estimates costs for package systems by costing all individual equipment line items (e.g., vessels, interconnecting piping and valves, instrumentation, and system controls) in the same manner as custom-engineered systems. This approach is based on vendor practices of partially engineering these types of package plants for specific systems (e.g., selecting vessel size to meet flow and treatment criteria). The model applies a variant set of design inputs and assumptions that are intended to simulate the use of a package plant and that reduce the size and cost of the treatment system. USEPA (2024d) provides complete details on the variant design assumptions used for package plants.

The paragraphs below describe the specific inputs and assumptions that EPA used to generate the costs in Section 7.3.2. Other inputs and assumptions not discussed below (e.g., number of booster pumps, treated water corrosion control, bed expansion) remained as described in USEPA (2024d).

#### 7.3.1.1 EBCT and Vessel Configuration

The estimates below and in Appendix A assume two vessels in series with a minimum total EBCT of 6 minutes (i.e., 3 minutes per vessel). The use of two vessels in series is consistent with full-scale practice and design engineer and IX vendor recommendations for PFAS removal as discussed in Section 3.6.2. The total EBCT is at the upper bound of the recommended range discussed in Section 3.6.1 and, therefore, errs on the side of higher cost. It also results in an EBCT per vessel roughly consistent with the data used to derive the bed life equations (3.3 minutes).

#### 7.3.1.2 Bed Life

As discussed in Sections 3.2.2 and 3.6.3, IX bed life depends on factors including target removal efficiency, influent water quality, and the specific PFAS compound(s) targeted. To accommodate variations in these factors, EPA generated separate cost equations at 20,000 BV increments for bed lives ranging from 20,000 to 260,000 BV. Each 20,000 BV increment corresponds to a 3- to 4-month shift in changeout frequency, depending on system size. To estimate national costs, EPA selected from among these cost equations using the bed life equations described in Section 2.6.3. EPA rounded results from the bed life equations down to the nearest 20,000 BV, which errs on the side of higher costs.

The bed life equations are based on data representative of a single vessel with an EBCT of 3.3 minutes. As discussed in Section 7.3.1.1, the estimates below assume two vessel in series, each with an EBCT of 3 minutes. The use of vessels in series should result in a longer bed life than estimated for a single, 3.3-minute EBCT vessel (see Section 3.6.2). EPA did not adjust the bed life results to account for the more efficient vessel configuration. Not incorporating an adjustment for configuration errs on the side of higher costs and is intended to compensate for the fact that the bed life equations are based on RSSCT data, which might overestimate full-scale bed life (see Section 3.6.3). Note that EPA does not have data on the degree to which RSSCTs might overestimate bed life or to quantify the bed life extension resulting from vessel configuration. Therefore, the net result of this compensating adjustment is uncertain.

#### 7.3.1.3 Residuals Management

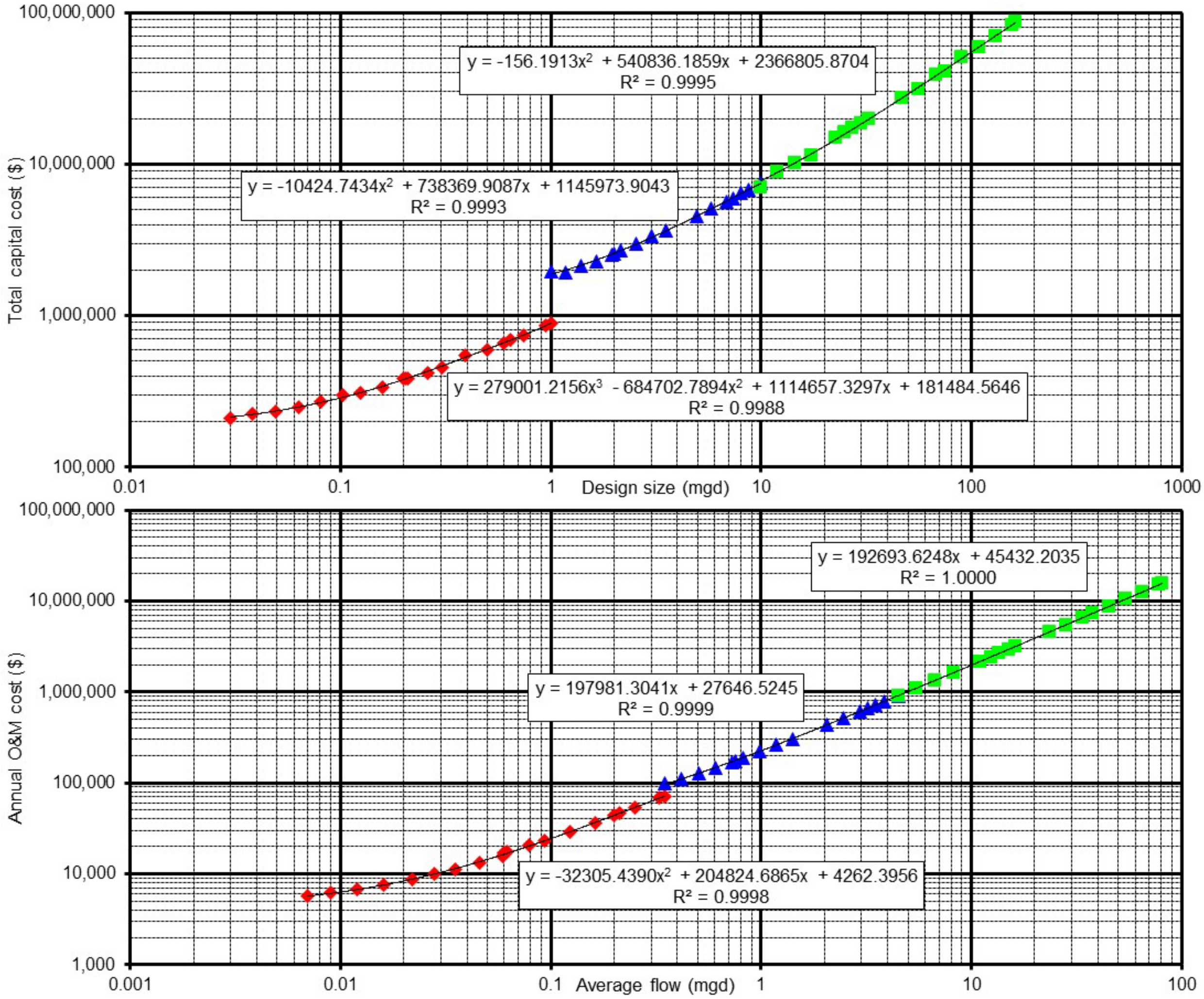
EPA generated separate cost equations for two spent resin management scenarios:

- Spent resin managed as non-hazardous and sent off-site for incineration
- Spent resin managed as hazardous and sent off-site for incineration.

In both cases, the spent resin is replaced with virgin resin. The first scenario reflects typical management practices under current regulations. The second scenario provides an upper bound on other options that might emerge under future air quality regulations (e.g., off-site disposal in a non-hazardous waste landfill) or RCRA hazardous waste regulations (e.g., off-site disposal in a hazardous waste landfill).

### 7.3.2 Cost Estimates

The graphs below (Figure 7-4) plot WBS cost model results in 2022 dollars at the mid cost level for removal of PFAS from groundwater using PFAS-selective IX, assuming a bed life of 160,000 BV. In the exhibit, note that costs increase at 1 MGD design flow (0.355 MGD average flow) because of the transition from package systems (used by small systems) to custom-engineered systems (used by large systems). Appendix A provides complete cost equations for across the range of bed life and residuals management scenarios, including the high, mid, and low-cost levels and for treatment of groundwater and surface water. Appendix B presents example WBS model outputs at selected flow rates, allowing review of individual cost line items.




Note: costs shown assume bed life of 120,000 BV and incineration of spent resin as a non-hazardous waste

**Figure 7-3. Mid Cost Results for Removal of PFAS from Groundwater Using IX (2022 dollars)**

# 7.4 Costs for RO/NF

## *7.4.1 Model Components and Assumptions*

USEPA (2024c) provides a complete description of the engineering design process used by the WBS model for RO/NF. Table 7-4 shows the technology-specific capital equipment and O&M requirements included in the model. These items are in addition to the common WBS cost elements listed in Table 7-1.

**Table 7-4. Technology-Specific Cost Elements Included in the RO/NF Model**

| Cost Category | Major Components Included |
|---|---|
| **Direct Capital Costs** | • High-pressure pumps for influent water and (optionally) interstage pressure boost<br>• Pre-treatment cartridge filters<br>• Tanks, pumps, and mixers for pretreatment chemicals<br>• Pressure vessels, membrane elements, piping, connectors, and steel structure for the membrane racks<br>• Valves for concentrate control and (optionally) per-stage throttle<br>• Tanks, pumps, screens, cartridge filters, and heaters for membrane cleaning<br>• Equipment, including dedicated concentrate discharge piping, for managing RO concentrate and spent cleaning chemicals<br>• Associated pipes, valves, and instrumentation |
| **O&M Costs:** Labor | • Operator labor for pre-treatment filters<br>• Operator labor for routine O&M of membrane units<br>• Operator labor to maintain membrane cleaning equipment |
| **O&M Costs:** Materials | • Replacement cartridges for pre-treatment filters<br>• Chemical usage for pretreatment<br>• Maintenance materials for pre-treatment, membrane process, and cleaning equipment<br>• Replacement membrane elements<br>• Chemical usage for cleaning |
| **O&M Costs:** Energy | • Energy for high-pressure pumping |
| **O&M Costs:** Residuals | • Disposal costs for spent cartridge filters and membrane elements<br>• Concentrate discharge fees* |

* Not applicable under the residuals management used in the estimates below (direct discharge to a non-potable water body).

The paragraphs below describe specific inputs and assumptions that EPA used to generate the costs in Section 7.4.2. Other inputs and assumptions not discussed below (e.g., cleaning interval, permeate throttling and interstage boost, membrane life) were as described in USEPA (2024c).

#### 7.4.1.1 Water Type

The WBS model for RO/NF includes three default groundwaters and three default surface waters, ranging from high to low quality (i.e., from low to high total dissolved solids and scaling potential). The default water parameters are based on a survey of membrane feed water characteristics in the literature. The cost estimates below and in Appendix A are intended to reflect the incremental cost of removing PFAS from otherwise potable water using RO/NF. Therefore, the estimates use the default high quality water parameters built in to the WBS model. Total dissolved solids for the high-quality surface water is approximately 360 mg/L; for high-quality groundwater, total dissolved solids is approximately 500 mg/L. USEPA (2024c) documents the other relevant characteristics of these default waters.

#### 7.4.1.2 Membrane Type

The WBS model includes the option of NF, low-pressure RO, or brackish water RO membrane elements, with a diameter of 4 inches, 8 inches, or 16 to 18 inches.[16] As discussed in Section 4.6.1, both low MWCO (or "tight") NF membranes and low-pressure (or "loose") RO membranes are effective for PFAS removal. Therefore, EPA used the WBS model to compare

[16] Not all manufacturers use the same size for their largest diameter elements, but the model is independent of the exact diameter.

costs using NF membranes to those using low-pressure (or "loose") RO membranes, holding the other inputs and assumptions documented here constant. The difference in annualized cost between the two membrane types varied by system size, component level, and water source (groundwater versus surface water), but was at most 10 percent. For simplicity, given the small difference in cost, the cost estimates below and in Appendix A assume use of low-pressure (or "loose") RO membrane elements. This assumption tends to err on the side of higher cost, because RO was more frequently (although not always) the more expensive option in EPA's comparisons. This assumption is also consistent with the types of membrane elements used at the two full-scale membrane facilities designed for PFAS removal (see Section 4.6.1). For very small systems, the cost estimates use 4-inch diameter elements; for larger systems, the estimates use 8-inch elements. The switch from 4-inch to 8-inch elements takes place at a flow rate of about 75,000 gallons per day.

#### *7.4.1.3 Flux Rate*

The flux rate, in combination with the system design flow, determines the total membrane area in the system, and therefore the total number of membrane elements to be used. Flux rates are based on the recommendations of various manufacturers for waters of different challenge. For groundwater, the cost estimates below and in Appendix A use a flux rate of 19 gfd. For surface water, the rates are 15 to 16 gfd. These flux rates fall within the range reported in the literature for PFAS removal (see Section 4.6.3).

#### *7.4.1.4 Target Recovery Rate*

For systems larger than approximately 0.5 MGD, the cost estimates below and in Appendix A use target recovery rates of 80 percent for groundwater and 85 percent for surface water. [17] These recovery rates fall within the range reported in the literature for PFAS removal (see Section 4.6.3). At small flows, the minimum size of membrane elements limits flexibility in the system design; therefore, estimates up to about 500,000 gallons per day may use recovery rates as low as 70 to 75 percent.

#### *7.4.1.5 Residuals Management*

The cost estimates below and in Appendix A assume direct discharge of concentrate to a permitted outfall on a non-potable water body (e.g., ocean or brackish estuary) via 10,000 feet of buried dedicated piping. As discussed in Section 4.5, this assumption is consistent with the management practice planned at the full-scale membrane facility in North Carolina designed for PFAS removal. It is also the most common management practice for RO/NF facilities in general. Since spent cleaning solution is generated infrequently and in small amounts, the estimates her assume that it will be diluted and discharged with membrane concentrate.

### *7.4.2 Cost Estimates*

The graphs below (Figure 7-4) plot WBS cost model results in 2022 dollars at the mid cost level for removal of PFAS from groundwater using RO. Because RO/NF can continuously achieve high removal efficiencies for PFAS, systems that require lower removals may be able to treat a portion of their total flow and blend treated water and untreated water to meet a regulatory

[17] Note that recovery rate is the percent of influent flow that is recovered as useable treated water (permeate), as opposed to lost as residual concentrate. It is not directly related to percent removal of PFAS

standard. When blending is possible, it will reduce treatment costs and potential post-treatment requirements (see Section 4.4). EPA assumes systems using RO/NF will employ blending when they require less than 95 percent removal. Because RO/NF can achieve greater than 95 percent removal efficiency for most PFAS compounds (see Section 4.2.1), this assumption errs on the side of higher costs. The flow rates shown on the x-axes in Figure 7-4 and as the independent variables in the equations below and in Appendix A are treatment process flows. To account for blending in the cost estimates, these treatment process flows should be calculated from entry point flows by incorporating a blending ratio as follows:

$$B = \frac{\%R_{required}}{0.95}$$

$$Q_{treated,design} = B\ x\ Q_{total,design}$$

$$Q_{treated,average} = B\ x\ Q_{total,design}$$

Where:

- B = the blending ratio expressed as a decimal
- $\%R_{required}$ = removal required to meet regulatory standard, expressed as a decimal
- 0.95 = assumption about the continuous removal achieved by RO/NF (see above)
- $Q_{treated}$ = treated portion of entry point flow in MGD
- $Q_{total}$ = total entry point flow in MGD

Appendix A provides complete cost equations for the high, mid, and low-cost levels and for treatment of groundwater and surface water. Appendix B presents example WBS model outputs at selected flow rates, allowing review of individual cost line items.

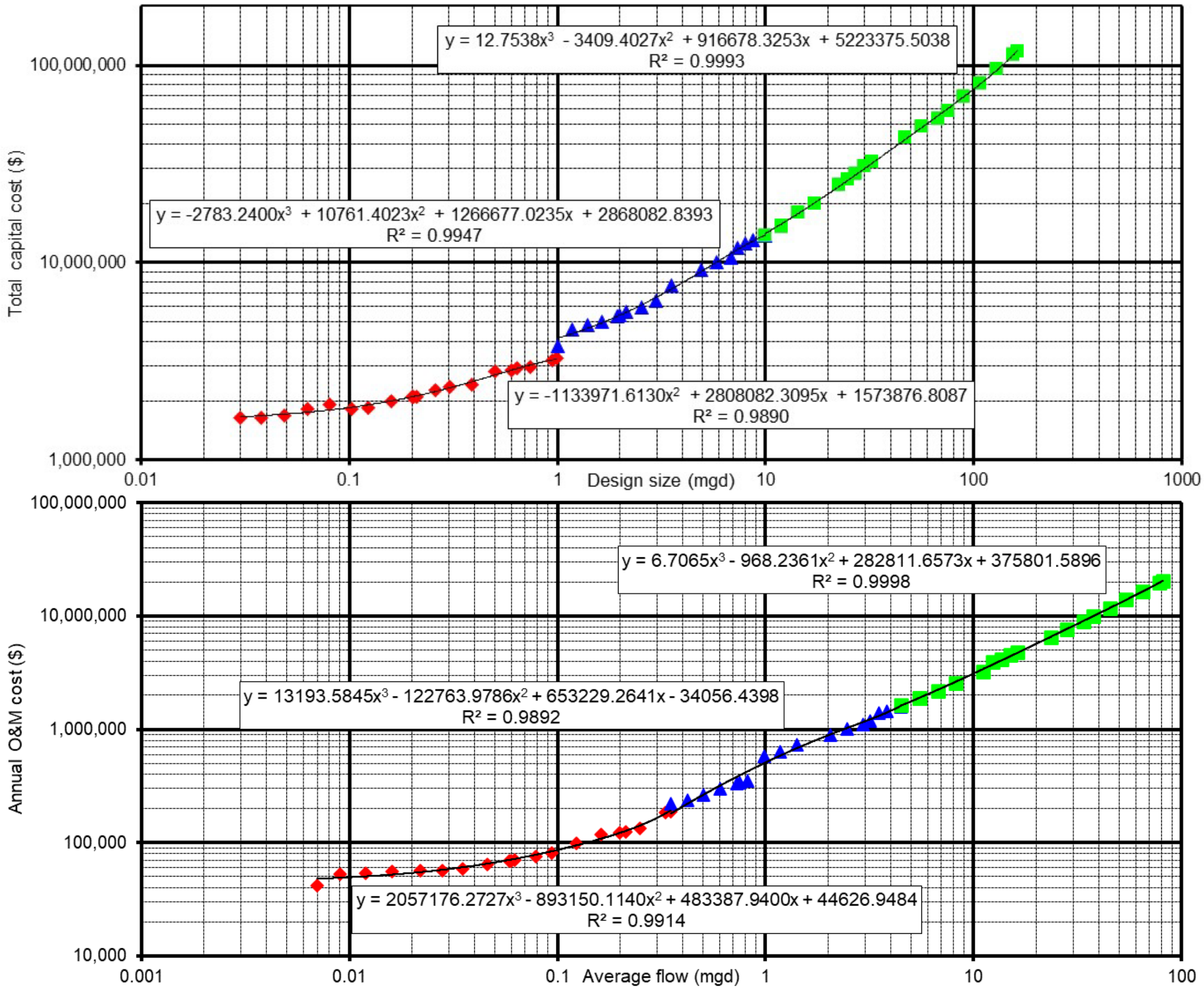



**Figure 7-4. Mid Cost Results for Removal of PFAS from Groundwater Using Reverse Osmosis (2022 dollars)**

# 7.5 Costs for POU Treatment

## *7.5.1 Model Components and Assumptions*

The document *Cost Evaluation of Point-of-Use and Point-of-Entry Treatment Units for Small Systems: Cost Estimating Tool and User Guide* (USEPA, 2023) provides a complete description of the WBS model for POU/POE technologies. The POU/POE model is capable of estimating equipment costs for a variety of POU/POE devices. To use the POU/POE model in estimating costs for PFAS, EPA selected a program using POU RO devices. EPA assumed the use of POU, as opposed to POE, devices because ingestion is the primary route of concern for exposure to PFAS. In addition to the costs of the POU RO devices and replacement filters, the WBS model also includes the cost of the following other components of a complete POU program:

- POU RO device installation

- Public education program development
- POU device monitoring
- POU device maintenance.

Because only small systems would be expected to use POU programs, the model does not cover systems serving greater than 3,300 people (greater than 1 MGD design flow). Also, the model does not include assumptions or materials of construction that vary based on a "component level" or "cost level" input. Therefore, unlike the other models, it does not generate separate estimates for low-, mid-, and high-cost scenarios.

To use the model for PFAS removal, EPA collected cost data for POU RO devices certified for PFOA and PFOS removal under the current standard. EPA also updated all other unit costs (e.g., analytical costs, labor rates, printed material costs). Table 7-5 identifies the values used for parameters other than unit costs that drive the costs of a POU RO program. EPA developed these assumptions based on EPA guidance (USEPA, 2006) and case study data, as discussed in detail in the paragraphs below.

**Table 7-5. POU Model Assumptions for PFAS Removal**

| Parameter Category | Value |
|---|---|
| **Installation labor time** | • Plumber installation time: 2 hours per POU device (NSF International, 2005)<br>• Scheduling time: 0.5 hours per household (USEPA, 2006) |
| **Public education program** | • Public meeting-related time: 20 hours<br>• Other outreach time (e.g., program updates in a billing mailer): 4 hours |
| **Monitoring requirements** | • Initial monitoring for all units; annual monitoring for 1/3 of units (USEPA, 2006)<br>• Sampling time: 0.25 hours per sampling event (NSF International, 2005) |
| **Filter replacement** | • Replacement schedule: RO element (3 years); post-RO carbon filter (1 year); pre-RO filters (9 months) (manufacturer recommendations)<br>• Filter replacement time: 0.5 hour per change-out (NSF International, 2005)<br>• Scheduling time: 0.5 hours per household (USEPA, 2006) |

### *7.5.1.1 POU RO Device Installation*

Installation of the POU RO devices will be the responsibility of the water system. 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 International (2005) recommends using an experienced plumber to perform the installations.

The POU model contains a default estimate of two hours per household to install the POU RO. A variety of factors such as existing plumbing conditions and travel distance will affect installation times across sites. The estimate is consistent with case study data. In a Grimes, California, arsenic demonstration program (NSF International, 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 device installation time was one hour, but total plumber billing records indicated that twice as much time was spent on all installation-related activities (e.g., additional time to obtain special plumbing fittings and return visits to homes when residents missed their appointments).

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

#### 7.5.1.2 Public Education Program

EPA guidance (2006) recommends that systems implement a public education program to obtain and maintain customer participation and long-term customer satisfaction with the POU program. The two main program elements recommended in USEPA (2006) are: public meetings prior to installing any POU devices to educate customers about the regulatory compliance requirements and the role of the POU devices; and POU program updates in billing mailers and on information flyers posted in public locations such as a post office, a public library, or a website. The POU model includes labor costs for the following program elements:

- preparing information for one public meeting
- attending the meeting
- preparing an additional billing mailer with program updates.

Public education program costs are not available from POU case studies. USEPA (2023) provides a detailed breakdown of the assumptions used to generate the time estimates shown in Table 7-5. It also describes the costs for materials such as information flyers for the public meeting, meeting announcements, and billing mailers.

#### 7.5.1.3 POU Device Monitoring

A system that implements a POU compliance strategy will need to monitor the quality of water produced by the treatment devices to demonstrate compliance with a PFAS standard. The system will need to work with the appropriate regulatory agency to establish an approved compliance-monitoring schedule (USEPA, 2006). The resulting monitoring schedule may have sampling rates in initial year that differ from sampling rates in subsequent years. EPA Guidance (2006) 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's cost estimates incorporate these monitoring frequencies.

Monitoring costs include sampling time, shipping fees, and laboratory analysis fees. The average sampling is 15 minutes (0.25 hours). To minimize the burden on households as well as system resources, EPA assumes that sampling occurs during installation or maintenance trips. The assumption is consistent with the Grimes case study cost analysis (NSF International, 2005) used an estimate of 15 minutes per sampling event.

#### 7.5.1.4 POU Device Maintenance

Maintenance for the POU RO device primarily includes replacing the four filters: RO membrane, two carbon filters, and the sediment filter. Replacement schedules reflect average useful lives based on vendor recommendations. On average, 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.

In addition to replacement filter costs, maintenance costs include scheduling time and time to change filters. The Grimes case study cost analysis (NSF International, 2005) used an estimate of 15 minutes per filter change out. EPA assumed the average length of a maintenance call 30 minutes (0.5 hours) because the most frequent type of visit involves changing two filters. EPA used the same 30-minute scheduling time assumption that it used for initial installation.

### 7.5.2 Cost Estimates

POU RO is not currently a compliance option because the regulatory options under consideration require treatment to concentrations below 70 ng/L total of PFOA and PFOS, the current certification standard for POU devices. However, POU treatment might become a compliance option for small systems in the future if NSF/ANSI develops a new certification standard that mirrors or is more stringent than EPA's proposed regulatory standard. The cost estimates presented here for POU RO reflect the costs of devices certified under the current testing standard, which might differ from the costs of devices certified under a future standard. Therefore, the POU RO costs should be considered preliminary estimates. Additionally, EPA notes that it did not develop estimates for POU GAC devices; however, these may also potentially be a future compliance option if they are certified to the new testing standard.

Figure 7-5 plots WBS cost model results in 2022 dollars for removal of PFAS from groundwater using POU treatment. EPA limits the POU model to a maximum of approximately 1,000 households served because implementing and maintaining a POU program for a greater number of households is likely to be impractical. Therefore, the graphs do not extend beyond a maximum of 1 MGD design flow, which corresponds to this limit on the number of households. As discussed above, the POU model also does not generate separate high, mid, and low-cost estimates. Appendix A contains complete cost equations for POU treatment, including for groundwater and surface water. Appendix B presents example WBS model outputs for selected flow rates, allowing review of individual cost line items.

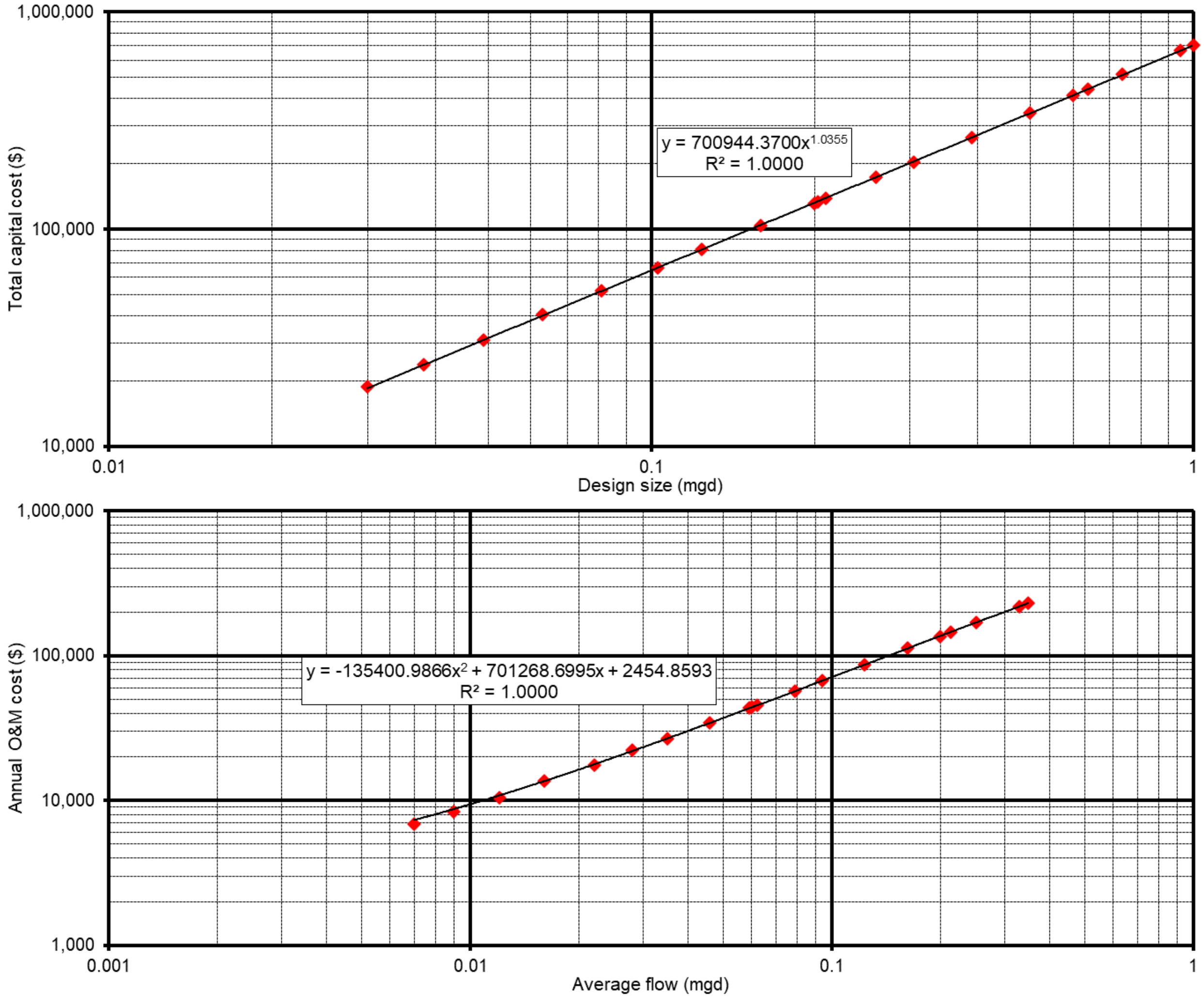



**Figure 7-5. Cost Results for POU RO Removal of PFAS from Groundwater (2022 dollars)**

## 7.6 Costs for Nontreatment Options

### *7.6.1 Model Components*

USEPA (2024b) provides a complete description of the engineering design process used by the WBS model for nontreatment actions. The model can estimate costs for two nontreatment alternatives: interconnection with another system and drilling new wells to replace a contaminated source. Table 7-6 shows the technology-specific capital equipment and O&M requirements included in the model for each alternative. The interconnection alternative does not include any buildings. It includes all the indirect capital costs shown in Table 7-1 except for yard piping, site work, and architectural fees. The new well alternative includes a small shed or other low-cost building at the well site along with materials and labor for maintenance of this building. It includes all the indirect capital costs shown in Table 7-1 except for yard piping

**Table 7-6. Technology-Specific Cost Elements Included in the Non-treatment Model**

| Cost Category | Major Components Included for Interconnection | Major Components Included for New Wells |
|---|---|---|
| **Direct Capital Costs** | • Booster pumps or pressure reducing valves (depending on pressure at supply source)<br>• Concrete vaults (buried) for booster pumps or pressure reducing valves<br>• Interconnecting piping (buried) and valves | • Well casing, screens, and plugs<br>• Well installation costs including drilling, development, gravel pack, and surface seals<br>• Well pumps<br>• Piping (buried) and valves to connect the new well to the system |
| **O&M Costs:** Labor | • Operator labor for O&M of booster pumps or pressure reducing valves (depending on pressure at supply source) and interconnecting valves | • Operator labor for operating and maintaining well pumps and valves |
| **O&M Costs:** Materials | • Cost of purchased water<br>• Materials for maintaining booster pumps (if required by pressure at supply source) | • Materials for maintaining well pumps |
| **O&M Costs:** Energy | • Energy for operating booster pumps (if required by pressure at supply source) | • Energy for operating well pumps |

Nontreatment options are less likely to be available for larger systems because of the large water quantities required. Therefore, EPA's WBS nontreatment cost model generates costs only for systems serving less than 10,000 people. As discussed in Section 6.1, the two options covered by the WBS nontreatment model (new wells or interconnection) are likely to have higher costs than other nontreatment options available for PFAS. The sections below describe the specific inputs and assumptions that EPA used to generate the costs for each option in Section 7.6.4. For both options, the cost estimates assume that systems choosing a nontreatment option do so because they have an alternative source that will not require additional water treatment to address changes in raw water quality (i.e., no post-treatment). Because of this, they further assume no incremental waste or residuals management costs.

## 7.6.2 Assumptions for New Wells

The sections below describe specific inputs and assumptions used to generate costs under the new well nontreatment option. Other inputs and assumptions not discussed below (e.g., pump type, gravel pack and grout requirement, screen and casing length ratios, well pressure and footprint) were as described in USEPA (2024b).

### 7.6.2.1 Total Flow Rate Requirements and Flow per Well

As with other WBS models, design and average flow are inputs to the nontreatment model. In the case of nontreatment approaches, however, "design" flow is the peak flow required by the system, rather than the design capacity of a treatment plant. In the new well nontreatment option, the flow rate requirements determine the number of new wells required. The cost estimates below and in Appendix A assume A maximum well capacity of 500 gallons per minute (gpm), such that one new well is installed per 500 gpm of water production capacity required.

#### 7.6.2.2 Well Depth

Well depth will vary for each site depending on the geological formations and aquifer depths. Geophysical studies prior to well installation will provide guidance on optimum well depths. The WBS model has cost data for pumps to serve wells up to 1,350 feet in depth. The cost estimates below and in Appendix A assume a 250-foot well depth.

#### 7.6.2.3 Distance from Well to Distribution System

The distance between a new well and the distribution system affects pipe installation costs. Distance will vary depending on distribution system geography relative to the extent of aquifer contamination. The cost estimates below and in Appendix A assume a distance of 500 feet.

### 7.6.3 Assumptions for Interconnection

The sections below describe specific inputs and assumptions used to generate costs under the interconnection nontreatment option. Other inputs and assumptions not discussed below (e.g., trench dimensions, concrete thickness) were as described in USEPA (2024b).

#### 7.6.3.1 Flow Rate Requirements

As with other WBS models, design and average flow are inputs to the nontreatment model. In the case of nontreatment approaches, however, "design" flow is the peak flow required by the system, rather than the design capacity of a treatment plant. In the interconnection nontreatment option, the flow rate requirements determine a number of system and equipment parameters, including pipeline and valve size and pump capacity and energy use (if required by pressure at the supply source).

#### 7.6.3.2 Distance to Interconnection Water Supply

For utilities able to purchase water from a neighboring system, the capital cost of the interconnection project will depend on the distance between the two systems. If the systems are far apart geographically, the cost of installing a pipeline may be too high to make an interconnection project feasible. Also, a larger booster pump will be required to overcome friction losses along longer pipelines. The cost estimates below and in Appendix A assume an average interconnection distance of 10,000 feet, based on comments from the peer review of the nontreatment model.

#### 7.6.3.3 Pressure at Supply Water Source

The water pressure of purchased water may require adjustment prior to entering the purchasing system's distribution network (e.g., to account for elevation differences). If the wholesale supplier does not have enough pressure to meet the distribution needs of the interconnection project, then booster pumps are needed to move water from the supply source into the distribution system. The booster pump size is based on flow rate as well as distance and grade to the distribution system. If the supply source has more pressure than necessary, then pressure reducing valves are needed. The cost estimates below and in Appendix A assume that differences in pressure between the supplier and the purchasing system are minimal, but that booster pumps are still needed to overcome friction loss in the interconnecting piping between the two systems.

#### 7.6.3.4 Cost of Purchased Water

An interconnection project will include one or more water rates paid to the wholesale system by the purchasing system. The model assumption is a single water rate for the average cost in dollars per thousand gallons of purchased water. The cost estimates below and in Appendix A assume a higher cost of purchased water of $3.17 per thousand gallons, based on recent data from wholesaling and purchasing systems that published their agreed rates online.

### 7.6.4 Cost Estimates

The graphs below plot WBS cost model results in 2022 dollars at the mid cost level for the two nontreatment options for systems using groundwater: new wells (Figure 7-6) and interconnection (Figure 7-7). The graphs do not extend beyond 3.536 MGD design flow, because the nontreatment model does not generate costs for larger systems. Appendix A provides complete cost equations for both nontreatment options, including the high, mid, and low-cost levels and for interconnection of groundwater and surface water systems. Appendix B presents example WBS model outputs for selected flow rates, allowing review of individual cost line items.

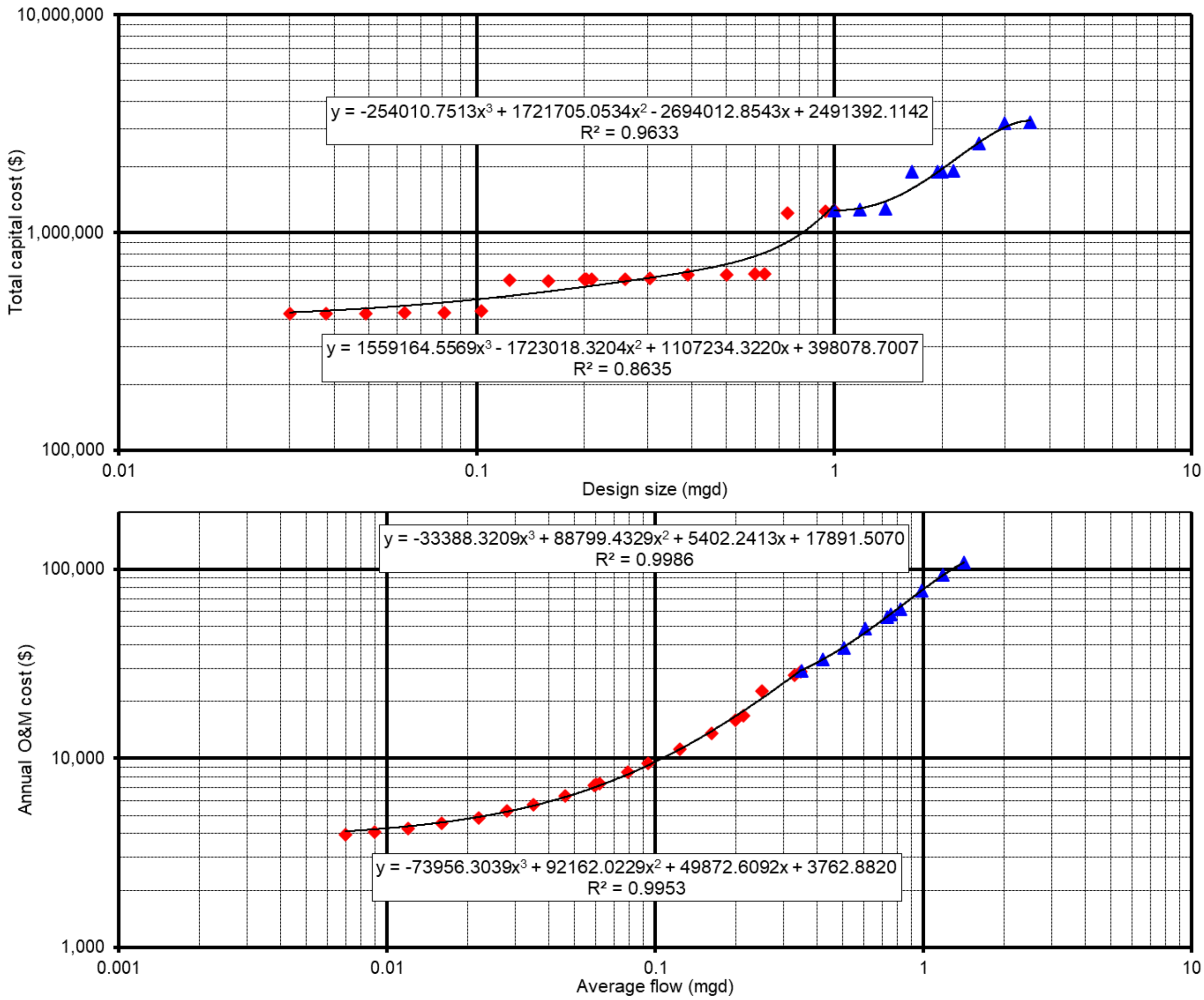



**Figure 7-6. Mid Cost Results for PFAS Compliance Using New Wells at Groundwater Systems (2022 dollars)**

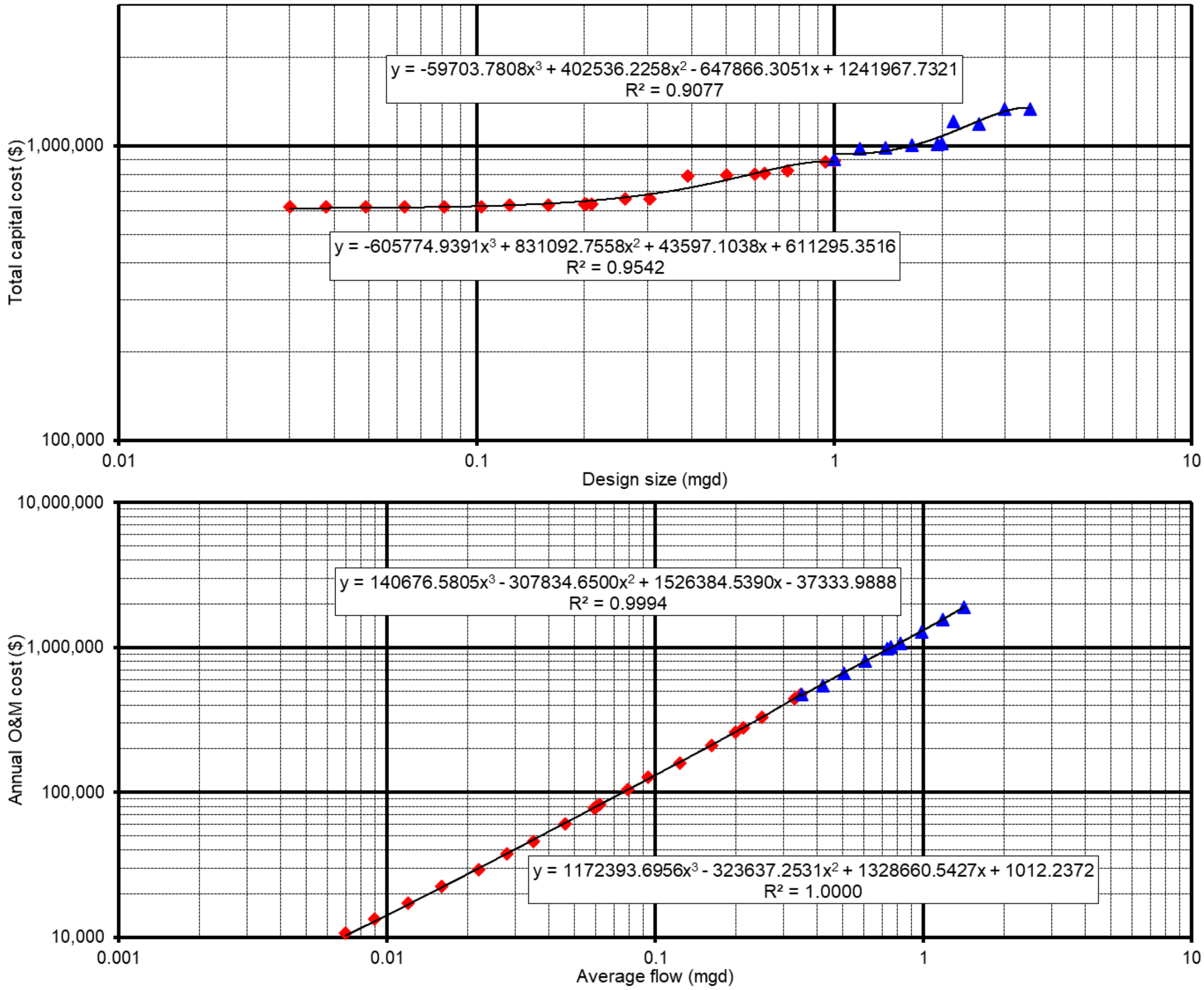



**Figure 7-7. Mid Cost Results for PFAS Compliance Using Interconnection at Groundwater Systems (2022 dollars)**

## 7.7 References

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# Appendix A. Cost Equations

Notes:

- Cost equations presented here take one of the following forms, identified by which coefficients (C1 through C10) are nonzero:

$$Cost = C1\ Q^{C2}$$

or $$Cost = C3\ Ln(Q) + C4$$

or $$Cost = C5\ e^{(C6\ Q)}$$

or $$Cost = C7\ Q^3 + C8\ Q^2 + C9\ Q + C10$$

  where Q is design flow in MGD for total capital costs, or average flow in MGD for annual O&M costs. Resulting costs are in 2022 dollars.

- Equations are designated as for small, medium, or large systems. These equations apply as follows:
  - Small system equations apply where design flow (Q) is less than 1 MGD
  - Medium system equations apply where design flow (Q) is 1 MGD or greater, but less than 10 MGD
  - Large system equations apply where design flow (Q) is 10 MGD or greater, but less than 162 MGD

  Note: although the independent variable Q in the O&M equations is average flow, selection between O&M equations for small, medium, and large systems is made based on design flow.

- EPA developed each equation using the method described in Section 7.1.
- For GAC, equations are not presented for gravity designs for groundwater systems, because groundwater systems are unlikely to use this design type.
- For POU RO, costs do not vary by component level input (high, mid, low); equations are not presented for medium and large systems.
- For Nontreatment, medium system size curves are valid only up to 3.536 MGD design flow (1.417 MGD groundwater average flow and 1.345 MGD surface water average flow); equations are not presented for systems of greater size.

# A.1 Capital and Annual O&M Cost Equation Parameters for GAC

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | Low | Pressure | 5000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 5000 | non-haz | Total Capital | 34.018 | 0 | 0 | 0 | 0 | 0 | 0 | -2486.3578 | 27414.1362 | 747627.6848 | 1517889.733 |
| GW | Large | Low | Pressure | 5000 | non-haz | Total Capital | 35.758 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4254 | -429.7729 | 541257.9754 | 3500298.704 |
| GW | Small | Mid | Pressure | 5000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 5000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 5000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1721 | -239.2412 | 605710.8055 | 4654699.52 |
| GW | Small | High | Pressure | 5000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 5000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 5000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0331 | -691.4953 | 859964.47 | 6895608.343 |
| GW | Small | Low | Pressure | 10000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 10000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 10000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.466 | -440.2387 | 541837.5065 | 3493395.48 |
| GW | Small | Mid | Pressure | 10000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 10000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 10000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.2128 | -249.7072 | 606290.3518 | 4647796.121 |
| GW | Small | High | Pressure | 10000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 10000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 10000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0727 | -701.7678 | 860535.54 | 6888790.727 |
| GW | Small | Low | Pressure | 15000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 15000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 15000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 15000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 15000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 15000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 15000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 15000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 15000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 20000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 20000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 20000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 20000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 20000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 20000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 20000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 20000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 20000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 25000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 25000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 25000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 25000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 25000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 25000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW | Small | High | Pressure | 25000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 25000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 25000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 5000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 3501541.999 | -2165452.331 | 877869.7948 | 3263.1157 |
| GW | Medium | Low | Pressure | 5000 | non-haz | Annual O&M | 34.018 | 0 | 0 | 0 | 0 | 0 | 0 | 3250.4356 | -23665.12 | 561526.7756 | 43752.593 |
| GW | Large | Low | Pressure | 5000 | non-haz | Annual O&M | 35.758 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 252.5515 | 486878.1261 | 218860.293 |
| GW | Small | Mid | Pressure | 5000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 3113884.66 | -1945691.778 | 853757.4075 | 3978.2238 |
| GW | Medium | Mid | Pressure | 5000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3424.1855 | -24777.0461 | 565525.6523 | 46646.6871 |
| GW | Large | Mid | Pressure | 5000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 263.1991 | 486763.8627 | 220014.9753 |
| GW | Small | High | Pressure | 5000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 3284292.916 | -2055922.467 | 881706.9102 | 4989.1575 |
| GW | Medium | High | Pressure | 5000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -2327.4254 | 531454.5345 | 68105.0319 |
| GW | Large | High | Pressure | 5000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 331.5468 | 487871.3966 | 243989.805 |
| GW | Small | Low | Pressure | 10000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1163798.788 | -956594.5385 | 521753.5662 | 3212.0126 |
| GW | Medium | Low | Pressure | 10000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 969.2297 | 285541.4468 | 67721.8084 |
| GW | Large | Low | Pressure | 10000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 239.8974 | 263461.4869 | 215052.1595 |
| GW | Small | Mid | Pressure | 10000 | non-haz | Annual O&M | 21.815 | 272277.1609 | 0.7634 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 10000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 2222.7632 | -14796.6698 | 318314.1199 | 57626.1513 |
| GW | Large | Mid | Pressure | 10000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 251.2656 | 263284.0211 | 216656.4233 |
| GW | Small | High | Pressure | 10000 | non-haz | Annual O&M | 24.3 | 270585.7863 | 0.7334 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | High | Pressure | 10000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 1605.1331 | -12529.8744 | 324256.8748 | 60919.5312 |
| GW | Large | High | Pressure | 10000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4754 | 15.1504 | 274030.553 | 176296.6942 |
| GW | Small | Low | Pressure | 15000 | non-haz | Annual O&M | 21.59 | 206605.9939 | 0.7477 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Low | Pressure | 15000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 1825.2098 | -11514.6751 | 233300.3448 | 59869.4318 |
| GW | Large | Low | Pressure | 15000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 235.6792 | 188989.2911 | 213782.4452 |
| GW | Small | Mid | Pressure | 15000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 691543.6845 | -571481.5178 | 382986.5369 | 3892.2745 |
| GW | Medium | Mid | Pressure | 15000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 2008.9206 | -12691.1516 | 237388.4202 | 62712.6846 |
| GW | Large | Mid | Pressure | 15000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1787 | -21.9534 | 197385.7524 | 158121.9551 |
| GW | Small | High | Pressure | 15000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 862231.7763 | -681929.6582 | 410966.5325 | 4902.4442 |
| GW | Medium | High | Pressure | 15000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 1371.455 | -10316.7192 | 243231.1483 | 66015.6036 |
| GW | Large | High | Pressure | 15000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 317.5582 | 189729.6626 | 240710.6887 |
| GW | Small | Low | Pressure | 20000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1059149.591 | -733383.2022 | 349657.4428 | 3161.0361 |
| GW | Medium | Low | Pressure | 20000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2078.4966 | -13333.9665 | 199191.3219 | 59530.7251 |
| GW | Large | Low | Pressure | 20000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 233.5701 | 151753.1858 | 213147.8234 |
| GW | Small | Mid | Pressure | 20000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 671818.9964 | -513793.35 | 325560.0534 | 3876.0166 |
| GW | Medium | Mid | Pressure | 20000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 2261.8236 | -14507.3435 | 203271.6442 | 62375.6333 |
| GW | Large | Mid | Pressure | 20000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 245.2989 | 151544.1032 | 214976.8352 |
| GW | Small | High | Pressure | 20000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 842340.7288 | -624162.4319 | 353530.0089 | 4886.4332 |
| GW | Medium | High | Pressure | 20000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 1614.331 | -12078.3942 | 209063.6135 | 65682.8412 |
| GW | Large | High | Pressure | 20000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4526 | 12.7192 | 162137.5397 | 175667.6539 |
| GW | Small | Low | Pressure | 25000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1053276.065 | -707093.9765 | 315190.3657 | 3151.4118 |
| GW | Medium | Low | Pressure | 25000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2435.2004 | -16095.8916 | 182512.996 | 57615.2662 |
| GW | Large | Low | Pressure | 25000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 232.3049 | 129411.5 | 212767.1982 |
| GW | Small | Mid | Pressure | 25000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 665773.6095 | -487425.8037 | 291085.3975 | 3866.5236 |
| GW | Medium | Mid | Pressure | 25000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 2618.2081 | -17266.6799 | 186587.5011 | 60460.8336 |
| GW | Large | Mid | Pressure | 25000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 244.1057 | 129196.1015 | 214641.3671 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | Pressure | 25000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 836343.5993 | -597800.2384 | 319049.6204 | 4877.2396 |
| GW | Medium | High | Pressure | 25000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 1964.7923 | -14805.5973 | 192349.6102 | 63770.941 |
| GW | Large | High | Pressure | 25000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 314.7601 | 130101.3384 | 240054.6892 |
| SW | Small | Low | Pressure | 5000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 5000 | non-haz | Total Capital | 34.018 | 0 | 0 | 0 | 0 | 0 | 0 | -2492.0991 | 27485.0084 | 747380.7199 | 1518120.093 |
| SW | Large | Low | Pressure | 5000 | non-haz | Total Capital | 35.758 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4199 | -428.2096 | 541142.2803 | 3500765.618 |
| SW | Small | Mid | Pressure | 5000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 5000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 5000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1667 | -237.6853 | 605595.6021 | 4655161.709 |
| SW | Small | High | Pressure | 5000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 5000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 5000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0276 | -689.8981 | 859843.855 | 6896164.069 |
| SW | Small | Low | Pressure | 10000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 10000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 10000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4606 | -438.6757 | 541721.8267 | 3493862.219 |
| SW | Small | Mid | Pressure | 10000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 10000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 10000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.2074 | -248.1514 | 606175.1485 | 4648258.31 |
| SW | Small | High | Pressure | 10000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 10000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 10000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0673 | -700.1708 | 860414.9396 | 6889346.279 |
| SW | Small | Low | Pressure | 15000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 15000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 15000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 15000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 15000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 15000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 15000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 15000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 15000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 20000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 20000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 20000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 20000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 20000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 20000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 20000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 20000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 20000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 25000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 25000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 25000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 25000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 25000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 25000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Pressure | 25000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 25000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 25000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 5000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 3302567.774 | -2081398.277 | 870268.9005 | 2938.6808 |
| SW | Medium | Low | Pressure | 5000 | non-haz | Annual O&M | 34.018 | 0 | 0 | 0 | 0 | 0 | 0 | 4313.4488 | -27486.8763 | 570649.6103 | 40003.1272 |
| SW | Large | Low | Pressure | 5000 | non-haz | Annual O&M | 35.758 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 221.9261 | 494506.3018 | 215974.1184 |
| SW | Small | Mid | Pressure | 5000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 2944918.421 | -1870870.423 | 845780.859 | 3710.478 |
| SW | Medium | Mid | Pressure | 5000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4569.1534 | -28952.3395 | 575248.9642 | 42671.8935 |
| SW | Large | Mid | Pressure | 5000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 233.3974 | 494442.9562 | 216763.0629 |
| SW | Small | High | Pressure | 5000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 3098112.413 | -1972311.373 | 872697.3103 | 4665.8707 |
| SW | Medium | High | Pressure | 5000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 3574.3541 | -25007.3054 | 579438.2808 | 46607.892 |
| SW | Large | High | Pressure | 5000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 304.6488 | 496178.8936 | 238680.4656 |
| SW | Small | Low | Pressure | 10000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1093428.716 | -920680.956 | 517235.5887 | 2834.5612 |
| SW | Medium | Low | Pressure | 10000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2700.7403 | -15285.9116 | 320511.2896 | 52086.6939 |
| SW | Large | Low | Pressure | 10000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 208.7677 | 271054.2329 | 212814.7354 |
| SW | Small | Mid | Pressure | 10000 | non-haz | Annual O&M | 21.815 | 280824.6354 | 0.7841 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 10000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 2965.0399 | -16801.6269 | 325173.1824 | 54721.0283 |
| SW | Large | Mid | Pressure | 10000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 221.0012 | 270928.9862 | 213992.647 |
| SW | Small | High | Pressure | 10000 | non-haz | Annual O&M | 24.3 | 279844.8693 | 0.7557 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | High | Pressure | 10000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 306120.8072 | 68664.6156 |
| SW | Large | High | Pressure | 10000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 293.7762 | 272541.1358 | 236688.5244 |
| SW | Small | Low | Pressure | 15000 | non-haz | Annual O&M | 21.59 | 214214.9983 | 0.7723 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Low | Pressure | 15000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2504.9836 | -13374.8687 | 240156.1568 | 56910.5463 |
| SW | Large | Low | Pressure | 15000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 204.3817 | 196570.2069 | 211761.5245 |
| SW | Small | Mid | Pressure | 15000 | non-haz | Annual O&M | 21.815 | 215132.9271 | 0.766 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 15000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 2768.0717 | -14881.3544 | 244797.3115 | 59549.7187 |
| SW | Large | Mid | Pressure | 15000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0439 | -133.5236 | 206771.9515 | 150482.5302 |
| SW | Small | High | Pressure | 15000 | non-haz | Annual O&M | 24.3 | 215424.7458 | 0.7334 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | High | Pressure | 15000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 1661.7265 | -10369.0046 | 248430.1075 | 63575.3329 |
| SW | Large | High | Pressure | 15000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2632 | -85.4788 | 209088.137 | 168930.2015 |
| SW | Small | Low | Pressure | 20000 | non-haz | Annual O&M | 21.59 | 176686.4915 | 0.7532 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Low | Pressure | 20000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2835.7301 | -15509.6714 | 206207.3203 | 56658.0803 |
| SW | Large | Low | Pressure | 20000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0896 | -153.4612 | 169831.0651 | 147709.2076 |
| SW | Small | Mid | Pressure | 20000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 613007.1981 | -476871.8362 | 319262.4672 | 3577.2498 |
| SW | Medium | Mid | Pressure | 20000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3098.138 | -17011.1381 | 210837.5923 | 59299.6617 |
| SW | Large | Mid | Pressure | 20000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 3.035 | -134.5656 | 169489.3809 | 150203.6821 |
| SW | Small | High | Pressure | 20000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 766445.309 | -578490.4263 | 346197.5326 | 4532.3768 |
| SW | Medium | High | Pressure | 20000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 1977.7496 | -12427.1976 | 214399.5842 | 63336.7015 |
| SW | Large | High | Pressure | 20000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 288.3396 | 160722.2831 | 235692.1656 |
| SW | Small | Low | Pressure | 25000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 960644.7055 | -658812.2569 | 308974.9826 | 2800.5673 |
| SW | Medium | Low | Pressure | 25000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3390.0666 | -19518.8507 | 191722.1325 | 53879.3413 |
| SW | Large | Low | Pressure | 25000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0829 | -154.008 | 147463.1415 | 147530.9253 |
| SW | Small | Mid | Pressure | 25000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 603083.5751 | -448355.8108 | 284492.5907 | 3572.3717 |
| SW | Medium | Mid | Pressure | 25000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3652.1782 | -21018.2377 | 196347.947 | 56521.342 |
| SW | Large | Mid | Pressure | 25000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0297 | -135.188 | 147119.7477 | 150037.0852 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Pressure | 25000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 756298.5321 | -549863.178 | 311413.059 | 4527.8226 |
| SW | Medium | High | Pressure | 25000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2523.3883 | -16391.2858 | 199866.8573 | 60565.9163 |
| SW | Large | High | Pressure | 25000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2561 | -87.5621 | 149427.3076 | 168544.487 |
| GW | Small | Low | Pressure | 30000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 30000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 30000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 30000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 30000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 30000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 30000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 30000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 30000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 35000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 35000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 35000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 35000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 35000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 35000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 35000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 35000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 35000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 40000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 40000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 40000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 40000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 40000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 40000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 40000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 40000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 40000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 45000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 45000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 45000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 45000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 45000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 45000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 45000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 45000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 45000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 50000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 50000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 50000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 50000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 50000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 50000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2289.8176 | 441957.2669 | 6924159.09 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | Pressure | 50000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 50000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 50000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 30000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1051141.904 | -692934.4954 | 292190.9296 | 3145.5028 |
| GW | Medium | Low | Pressure | 30000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2767.7757 | -18932.5039 | 174322.7649 | 54468.6203 |
| GW | Large | Low | Pressure | 30000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1726 | -37.029 | 123088.1148 | 155258.537 |
| GW | Small | Mid | Pressure | 30000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 663764.4023 | -473327.8748 | 268092.018 | 3860.3504 |
| GW | Medium | Mid | Pressure | 30000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 2950.5643 | -20101.5473 | 178393.16 | 57315.1854 |
| GW | Large | Mid | Pressure | 30000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 243.3099 | 114297.4674 | 214417.3268 |
| GW | Small | High | Pressure | 30000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 834373.5222 | -583736.1006 | 296062.6744 | 4871.1499 |
| GW | Medium | High | Pressure | 30000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2293.2451 | -17619.4796 | 184136.7044 | 60626.2742 |
| GW | Large | High | Pressure | 30000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 314.0608 | 115194.2438 | 239890.8457 |
| GW | Small | Low | Pressure | 35000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1050701.23 | -684671.0949 | 275779.2456 | 3140.7884 |
| GW | Medium | Low | Pressure | 35000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2989.8076 | -21043.9416 | 169305.4423 | 51442.9965 |
| GW | Large | Low | Pressure | 35000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1684 | -37.1164 | 112432.7865 | 155186.8196 |
| GW | Small | Mid | Pressure | 35000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 663295.9165 | -465035.0621 | 251673.4867 | 3856.0778 |
| GW | Medium | Mid | Pressure | 35000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3172.4462 | -22211.7175 | 173372.7568 | 54290.288 |
| GW | Large | Mid | Pressure | 35000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 242.7417 | 103655.5653 | 214257.384 |
| GW | Small | High | Pressure | 35000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 833873.4295 | -575424.0179 | 279640.7141 | 4866.652 |
| GW | Medium | High | Pressure | 35000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2512.2641 | -19714.0549 | 179101.4647 | 57602.9132 |
| GW | Large | High | Pressure | 35000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4428 | 11.6775 | 114183.3942 | 175398.0029 |
| GW | Small | Low | Pressure | 40000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1050650.785 | -679339.9491 | 263456.6527 | 3137.7255 |
| GW | Medium | Low | Pressure | 40000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3025.6693 | -21863.7255 | 164727.9711 | 49178.799 |
| GW | Large | Low | Pressure | 40000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 230.4062 | 95899.0549 | 212195.5581 |
| GW | Small | Mid | Pressure | 40000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 663367.5014 | -459784.2717 | 239364.5068 | 3852.4774 |
| GW | Medium | Mid | Pressure | 40000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3208.3008 | -23031.3452 | 168794.49 | 52026.0338 |
| GW | Large | Mid | Pressure | 40000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.148 | -23.1372 | 104148.2091 | 157530.4598 |
| GW | Small | High | Pressure | 40000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 833834.5078 | -570107.4833 | 267320.266 | 4863.568 |
| GW | Medium | High | Pressure | 40000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2545.9635 | -20521.9677 | 174512.3998 | 55339.6614 |
| GW | Large | High | Pressure | 40000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4412 | 11.5051 | 106190.9781 | 175353.6841 |
| GW | Small | Low | Pressure | 45000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1051045.013 | -675883.4231 | 253890.9976 | 3134.8134 |
| GW | Medium | Low | Pressure | 45000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2934.6611 | -21541.0477 | 159218.15 | 48095.5502 |
| GW | Large | Low | Pressure | 45000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 230.0551 | 89693.0039 | 212090.1986 |
| GW | Small | Mid | Pressure | 45000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 663481.7506 | -456191.4893 | 229781.4541 | 3850.1469 |
| GW | Medium | Mid | Pressure | 45000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3117.1448 | -22707.6083 | 163282.4621 | 50943.3523 |
| GW | Large | Mid | Pressure | 45000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.146 | -23.218 | 97932.4374 | 157490.538 |
| GW | Small | High | Pressure | 45000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 834103.4367 | -566589.0825 | 257747.8571 | 4860.6901 |
| GW | Medium | High | Pressure | 45000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2453.0981 | -20188.8066 | 168990.8939 | 54258.3791 |
| GW | Large | High | Pressure | 45000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4399 | 11.3689 | 99974.7456 | 175318.1043 |
| GW | Small | Low | Pressure | 50000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1051207.181 | -673322.271 | 246214.8668 | 3133.234 |
| GW | Medium | Low | Pressure | 50000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2893.5592 | -21353.4903 | 154649.9594 | 47228.3517 |
| GW | Large | Low | Pressure | 50000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.156 | -36.5863 | 93225.7735 | 155340.7325 |
| GW | Small | Mid | Pressure | 50000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 663782.1811 | -453701.1327 | 222116.9621 | 3847.9304 |
| GW | Medium | Mid | Pressure | 50000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3075.8732 | -22518.7919 | 158711.6278 | 50077.1166 |
| GW | Large | Mid | Pressure | 50000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 241.8009 | 84492.0557 | 214122.824 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | Pressure | 50000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 834539.0852 | -564173.3772 | 250093.156 | 4858.4905 |
| GW | Medium | High | Pressure | 50000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2410.6022 | -19993.5814 | 164415.1863 | 53391.7044 |
| GW | Large | High | Pressure | 50000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 2.434 | 11.9469 | 94974.379 | 175571.9043 |
| SW | Small | Low | Pressure | 30000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 30000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 30000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 30000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 30000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 30000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 30000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 30000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 30000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 35000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 35000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 35000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 35000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 35000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 35000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 35000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 35000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 35000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 40000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 40000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 40000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 40000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 40000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 40000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 40000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 40000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 40000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 45000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 45000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 45000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 45000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 45000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 45000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 45000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 45000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 45000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 50000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 50000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 50000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 50000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 50000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 50000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Pressure | 50000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 50000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 50000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 30000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 955965.2204 | -643254.5548 | 285786.8427 | 2797.4999 |
| SW | Medium | Low | Pressure | 30000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3816.278 | -22964.8201 | 184626.3964 | 50276.4631 |
| SW | Large | Low | Pressure | 30000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0784 | -154.3709 | 132551.1557 | 147411.9536 |
| SW | Small | Mid | Pressure | 30000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 598433.4043 | -432810.7858 | 261305.5919 | 3569.1401 |
| SW | Medium | Mid | Pressure | 30000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4078.0859 | -24461.9644 | 189247.631 | 52919.2762 |
| SW | Large | Mid | Pressure | 30000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0261 | -135.6065 | 132206.7702 | 149925.1606 |
| SW | Small | High | Pressure | 30000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 751655.1286 | -534327.8711 | 288228.0663 | 4524.4536 |
| SW | Medium | High | Pressure | 30000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2943.6423 | -19806.3099 | 192738.3336 | 56968.538 |
| SW | Large | High | Pressure | 30000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 286.5277 | 123449.3073 | 235360.4482 |
| SW | Small | Low | Pressure | 35000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 953505.3376 | -633867.9327 | 269220.1286 | 2795.2815 |
| SW | Medium | Low | Pressure | 35000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3914.4434 | -24359.674 | 178584.8408 | 47598.3294 |
| SW | Large | Low | Pressure | 35000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0753 | -154.6315 | 121899.7621 | 147326.9488 |
| SW | Small | Mid | Pressure | 35000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 596060.3449 | -423476.1233 | 244747.3907 | 3566.5944 |
| SW | Medium | Mid | Pressure | 35000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4176.0443 | -25855.2067 | 183202.4108 | 50242.1327 |
| SW | Large | Mid | Pressure | 35000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0236 | -135.9023 | 121554.5476 | 149845.9022 |
| SW | Small | High | Pressure | 35000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 749225.2399 | -524948.0294 | 271659.5722 | 4522.4061 |
| SW | Medium | High | Pressure | 35000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 3037.8493 | -21180.8968 | 186676.3684 | 54293.0442 |
| SW | Large | High | Pressure | 35000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.253 | -88.4546 | 123858.3753 | 168379.3967 |
| SW | Small | Low | Pressure | 40000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 952133.0586 | -627820.4304 | 256802.0682 | 2793.3344 |
| SW | Medium | Low | Pressure | 40000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3850.247 | -24522.6197 | 172809.5532 | 45826.9615 |
| SW | Large | Low | Pressure | 40000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 198.8992 | 103465.1699 | 210445.2031 |
| SW | Small | Mid | Pressure | 40000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 594582.4798 | -417366.3086 | 232320.4832 | 3565.0348 |
| SW | Medium | Mid | Pressure | 40000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4111.7833 | -26017.6931 | 177426.1941 | 48470.4455 |
| SW | Large | Mid | Pressure | 40000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0217 | -136.1257 | 113565.4428 | 149785.8976 |
| SW | Small | High | Pressure | 40000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 747995.476 | -518983.8208 | 259253.1904 | 4520.4163 |
| SW | Medium | High | Pressure | 40000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2970.54 | -21327.6173 | 180883.826 | 52524.6784 |
| SW | Large | High | Pressure | 40000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2521 | -88.7344 | 115868.1112 | 168327.5636 |
| SW | Small | Low | Pressure | 45000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 951264.0907 | -623670.9617 | 247142.4408 | 2792.0187 |
| SW | Medium | Low | Pressure | 45000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3823.5285 | -24545.0403 | 167711.4627 | 44594.5756 |
| SW | Large | Low | Pressure | 45000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0647 | -154.1576 | 107667.6308 | 147498.7525 |
| SW | Small | Mid | Pressure | 45000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 593666.1209 | -413187.2858 | 222655.5888 | 3563.9621 |
| SW | Medium | Mid | Pressure | 45000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4084.777 | -26038.1494 | 172324.1606 | 47239.6459 |
| SW | Large | Mid | Pressure | 45000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0139 | -135.4792 | 107321.4126 | 150024.6267 |
| SW | Small | High | Pressure | 45000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 746966.487 | -514755.1408 | 249583.304 | 4519.2441 |
| SW | Medium | High | Pressure | 45000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2941.213 | -21336.2678 | 175770.2134 | 51295.7591 |
| SW | Large | High | Pressure | 45000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2451 | -88.1312 | 109623.187 | 168572.3915 |
| SW | Small | Low | Pressure | 50000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 950618.3806 | -620670.7397 | 239410.1623 | 2790.7886 |
| SW | Medium | Low | Pressure | 50000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3982.0822 | -25543.5244 | 165110.7659 | 42934.5469 |
| SW | Large | Low | Pressure | 50000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0464 | -152.0757 | 102615.6846 | 148224.9821 |
| SW | Small | Mid | Pressure | 50000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 593126.7025 | -410248.3687 | 214931.5065 | 3562.4396 |
| SW | Medium | Mid | Pressure | 50000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4243.3673 | -27036.7421 | 169723.3838 | 45579.2149 |
| SW | Large | Mid | Pressure | 50000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9958 | -133.4133 | 102269.0808 | 150753.5222 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW | Small | High | Pressure | 50000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 746406.5724 | -511800.3213 | 241858.6306 | 4517.8884 |
| SW | Medium | High | Pressure | 50000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 3097.9246 | -22325.1882 | 173159.521 | 49637.1184 |
| SW | Large | High | Pressure | 50000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2276 | -86.0997 | 104570.1034 | 169306.4934 |
| GW | Small | Low | Pressure | 55000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 55000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 55000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 55000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 55000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 55000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 55000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 55000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 55000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 60000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 60000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 60000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 60000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 60000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 60000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 60000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 60000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 60000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 65000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 65000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 65000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 65000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 65000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 65000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 65000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 65000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 65000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 70000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 70000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 70000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 70000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 70000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 70000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |
| GW | Small | High | Pressure | 70000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 70000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 70000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 75000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| GW | Medium | Low | Pressure | 75000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2523.6675 | 28012.9376 | 745181.4392 | 1520377.017 |
| GW | Large | Low | Pressure | 75000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4227 | -431.4662 | 541371.2133 | 3499016.173 |
| GW | Small | Mid | Pressure | 75000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 75000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3865.827 | 41101.8956 | 878562.1787 | 1836517.062 |
| GW | Large | Mid | Pressure | 75000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1694 | -240.9347 | 605824.0587 | 4653416.815 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | Pressure | 75000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| GW | Medium | High | Pressure | 75000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8303.065 | 98339.2387 | 1117284.869 | 2553290.209 |
| GW | Large | High | Pressure | 75000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0278 | -692.6687 | 860051.8917 | 6894620.619 |
| GW | Small | Low | Pressure | 55000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1051487.85 | -671495.3174 | 239941.5572 | 3131.4827 |
| GW | Medium | Low | Pressure | 55000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 2998.2731 | -22105.5277 | 152596.27 | 45725.9479 |
| GW | Large | Low | Pressure | 55000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1414 | -34.783 | 89084.1176 | 156068.482 |
| GW | Small | Mid | Pressure | 55000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 664042.2761 | -451861.7824 | 215839.0456 | 3846.5693 |
| GW | Medium | Mid | Pressure | 55000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3180.6831 | -23271.5188 | 156659.2527 | 48573.7688 |
| GW | Large | Mid | Pressure | 55000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.125 | -20.8072 | 88790.5215 | 158470.9514 |
| GW | Small | High | Pressure | 55000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 834746.977 | -562323.0152 | 243816.8128 | 4856.9243 |
| GW | Medium | High | Pressure | 55000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2514.2357 | -20739.6958 | 162355.7008 | 51889.7037 |
| GW | Large | High | Pressure | 55000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4201 | 13.6971 | 90832.2101 | 176304.8982 |
| GW | Small | Low | Pressure | 60000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1051928.601 | -670233.6193 | 234725.6653 | 3129.9095 |
| GW | Medium | Low | Pressure | 60000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3079.9742 | -22724.4535 | 150910.5624 | 44396.2028 |
| GW | Large | Low | Pressure | 60000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1283 | -33.1649 | 85627.6546 | 156738.2673 |
| GW | Small | Mid | Pressure | 60000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 664488.9941 | -450598.222 | 210623.526 | 3844.9784 |
| GW | Medium | Mid | Pressure | 60000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3262.3048 | -23889.6464 | 154971.4487 | 47244.7886 |
| GW | Large | Mid | Pressure | 60000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1122 | -19.2076 | 85334.0544 | 159140.9232 |
| GW | Small | High | Pressure | 60000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 835165.1069 | -561030.7638 | 238595.4854 | 4855.5342 |
| GW | Medium | High | Pressure | 60000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2594.8965 | -21352.521 | 160662.5334 | 50561.6169 |
| GW | Large | High | Pressure | 60000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 312.8143 | 77876.8354 | 240428.6751 |
| GW | Small | Low | Pressure | 65000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1052140.665 | -669181.4993 | 230300.7575 | 3128.8802 |
| GW | Medium | Low | Pressure | 65000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3125.9312 | -23145.3942 | 149431.5651 | 43215.621 |
| GW | Large | Low | Pressure | 65000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1031 | -29.7577 | 82618.5538 | 158243.3079 |
| GW | Small | Mid | Pressure | 65000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 664689.8822 | -449526.034 | 206194.2018 | 3843.9901 |
| GW | Medium | Mid | Pressure | 65000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3308.2587 | -24310.4691 | 153491.9113 | 46064.3463 |
| GW | Large | Mid | Pressure | 65000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 242.1217 | 74090.7367 | 215651.2511 |
| GW | Small | High | Pressure | 65000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 835414.6956 | -560011.9572 | 234177.1846 | 4854.0687 |
| GW | Medium | High | Pressure | 65000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2640.305 | -21770.6708 | 159181.7676 | 49380.495 |
| GW | Large | High | Pressure | 65000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 2.383 | 18.6403 | 84365.878 | 178487.2218 |
| GW | Small | Low | Pressure | 70000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1052485.171 | -668417.4884 | 226510.8158 | 3127.9062 |
| GW | Medium | Low | Pressure | 70000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3149.1213 | -23418.0077 | 148047.4413 | 42207.4667 |
| GW | Large | Low | Pressure | 70000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.0845 | -27.2669 | 80056.8966 | 159342.7227 |
| GW | Small | Mid | Pressure | 70000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 665040.8806 | -448776.385 | 202408.9398 | 3842.7964 |
| GW | Medium | Mid | Pressure | 70000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3331.3959 | -24582.7754 | 152107.2619 | 45056.3122 |
| GW | Large | Mid | Pressure | 70000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.0687 | -13.3332 | 79763.0556 | 161747.892 |
| GW | Small | High | Pressure | 70000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 835725.9595 | -559224.6179 | 230382.2482 | 4853.4064 |
| GW | Medium | High | Pressure | 70000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2662.7004 | -22038.9572 | 157793.3837 | 48372.5616 |
| GW | Large | High | Pressure | 70000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 2.3649 | 21.0925 | 81804.1441 | 179587.854 |
| GW | Small | Low | Pressure | 75000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 1052836.508 | -667858.8762 | 223237.2973 | 3126.7443 |
| GW | Medium | Low | Pressure | 75000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 3152.5713 | -23524.8441 | 146552.403 | 41443.6053 |
| GW | Large | Low | Pressure | 75000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.0684 | -25.0936 | 77834.9085 | 160343.4075 |
| GW | Small | Mid | Pressure | 75000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 665299.3562 | -448183.9852 | 199131.0486 | 3841.9003 |
| GW | Medium | Mid | Pressure | 75000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 3334.6995 | -24688.4978 | 150609.8777 | 44293.4464 |
| GW | Large | Mid | Pressure | 75000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 242.511 | 69442.7456 | 216845.7353 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | Pressure | 75000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 835948.2948 | -558596.8236 | 227098.4232 | 4852.419 |
| GW | Medium | High | Pressure | 75000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 2665.4201 | -22141.4758 | 156292.7991 | 47610.199 |
| GW | Large | High | Pressure | 75000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 313.5505 | 70314.212 | 242499.6385 |
| SW | Small | Low | Pressure | 55000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 55000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 55000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 55000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 55000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 55000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 55000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 55000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 55000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 60000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 60000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 60000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 60000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 60000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 60000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 60000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 60000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 60000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 65000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 65000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 65000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 65000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 65000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 65000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 65000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 65000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 65000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 70000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 70000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 70000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 70000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 70000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 70000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |
| SW | Small | High | Pressure | 70000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 70000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 70000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 75000 | non-haz | Total Capital | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 155873.3869 | -801906.4663 | 1575613.983 | 150079.049 |
| SW | Medium | Low | Pressure | 75000 | non-haz | Total Capital | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | -2529.4088 | 28083.8097 | 744934.4742 | 1520607.377 |
| SW | Large | Low | Pressure | 75000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 8.4173 | -429.9031 | 541255.5335 | 3499482.913 |
| SW | Small | Mid | Pressure | 75000 | non-haz | Total Capital | 21.815 | 1277796.793 | 0.4821 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 75000 | non-haz | Total Capital | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | -3871.5568 | 41172.6101 | 878315.7892 | 1836746.876 |
| SW | Large | Mid | Pressure | 75000 | non-haz | Total Capital | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1641 | -239.3788 | 605708.8553 | 4653879.004 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Pressure | 75000 | non-haz | Total Capital | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 925760.6399 | -2223622.419 | 2700805.487 | 376429.0306 |
| SW | Medium | High | Pressure | 75000 | non-haz | Total Capital | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | -8308.7991 | 98410.0174 | 1117038.242 | 2553520.247 |
| SW | Large | High | Pressure | 75000 | non-haz | Total Capital | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 21.0223 | -691.0717 | 859931.2914 | 6895176.171 |
| SW | Small | Low | Pressure | 55000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 950092.0731 | -618391.689 | 233070.6105 | 2790.634 |
| SW | Medium | Low | Pressure | 55000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 4117.4978 | -26502.795 | 163436.6769 | 41273.0511 |
| SW | Large | Low | Pressure | 55000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0219 | -149.1208 | 98434.2177 | 149310.834 |
| SW | Small | Mid | Pressure | 55000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 592637.4292 | -407992.379 | 208596.0103 | 3562.1402 |
| SW | Medium | Mid | Pressure | 55000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4378.7314 | -27995.6544 | 168048.6336 | 43917.7999 |
| SW | Large | Mid | Pressure | 55000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9716 | -130.4739 | 98087.3514 | 151841.0148 |
| SW | Small | High | Pressure | 55000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 746088.1792 | -509620.5717 | 235529.7626 | 4517.2656 |
| SW | Medium | High | Pressure | 55000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 3231.6757 | -23275.8786 | 171476.466 | 47977.1551 |
| SW | Large | High | Pressure | 55000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2039 | -83.188 | 100387.7581 | 170398.3601 |
| SW | Small | Low | Pressure | 60000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 949787.6394 | -616725.9835 | 227804.7086 | 2789.5582 |
| SW | Medium | Low | Pressure | 60000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 4186.1387 | -27086.7101 | 161803.2371 | 39894.6085 |
| SW | Large | Low | Pressure | 60000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9921 | -145.3879 | 94900.9922 | 150711.1839 |
| SW | Small | Mid | Pressure | 60000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 592347.5938 | -406335.5071 | 203331.5653 | 3560.9672 |
| SW | Medium | Mid | Pressure | 60000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4447.1753 | -28578.257 | 166412.5954 | 42540.338 |
| SW | Large | Mid | Pressure | 60000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.942 | -126.7549 | 94553.9088 | 153243.2467 |
| SW | Small | High | Pressure | 60000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 745742.9278 | -507935.0201 | 230259.8365 | 4516.483 |
| SW | Medium | High | Pressure | 60000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 3298.9504 | -23852.5656 | 169834.8393 | 46600.4764 |
| SW | Large | High | Pressure | 60000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1746 | -79.4923 | 96853.8186 | 171803.9049 |
| SW | Small | Low | Pressure | 65000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 949554.8885 | -615417.3828 | 223341.6858 | 2789.0941 |
| SW | Medium | Low | Pressure | 65000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 4212.2868 | -27417.5551 | 160215.5626 | 38750.3239 |
| SW | Large | Low | Pressure | 65000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9694 | -142.5621 | 91923.256 | 151791.1841 |
| SW | Small | Mid | Pressure | 65000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 592017.1141 | -404975.9893 | 198861.671 | 3560.8398 |
| SW | Medium | Mid | Pressure | 65000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4473.4515 | -28909.7759 | 164825.7147 | 41395.5749 |
| SW | Large | Mid | Pressure | 65000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9194 | -123.9348 | 91575.8336 | 154325.4757 |
| SW | Small | High | Pressure | 65000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 745476.595 | -506604.85 | 225794.7019 | 4516.0066 |
| SW | Medium | High | Pressure | 65000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 3324.1222 | -24178.6815 | 168243.4119 | 45455.9618 |
| SW | Large | High | Pressure | 65000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1525 | -76.694 | 93875.3771 | 172888.7017 |
| SW | Small | Low | Pressure | 70000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 949479.7863 | -614438.2948 | 219526.3145 | 2788.3379 |
| SW | Medium | Low | Pressure | 70000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 4184.3886 | -27384.6656 | 158308.9578 | 37955.7208 |
| SW | Large | Low | Pressure | 70000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9478 | -139.8365 | 89357.4594 | 152890.9067 |
| SW | Small | Mid | Pressure | 70000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 592089.2104 | -404062.1835 | 195051.5266 | 3560.0089 |
| SW | Medium | Mid | Pressure | 70000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4445.4153 | -28875.9823 | 162917.5472 | 40601.4264 |
| SW | Large | Mid | Pressure | 70000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.8981 | -121.2188 | 89009.8736 | 155426.7095 |
| SW | Small | High | Pressure | 70000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 745306.413 | -505584.7727 | 221974.8855 | 4515.3339 |
| SW | Medium | High | Pressure | 70000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 3295.1688 | -24140.071 | 166330.046 | 44662.9419 |
| SW | Large | High | Pressure | 70000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1314 | -73.9976 | 91309.1417 | 173991.8195 |
| SW | Small | Low | Pressure | 75000 | non-haz | Annual O&M | 21.59 | 0 | 0 | 0 | 0 | 0 | 0 | 949302.455 | -613591.1715 | 216213.0828 | 2787.8809 |
| SW | Medium | Low | Pressure | 75000 | non-haz | Annual O&M | 34.029 | 0 | 0 | 0 | 0 | 0 | 0 | 4062.3849 | -26778.8205 | 155796.5998 | 37555.9996 |
| SW | Large | Low | Pressure | 75000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9323 | -137.8857 | 87149.5367 | 153683.0801 |
| SW | Small | Mid | Pressure | 75000 | non-haz | Annual O&M | 21.815 | 0 | 0 | 0 | 0 | 0 | 0 | 591810.0308 | -403155.9502 | 191729.2146 | 3559.8187 |
| SW | Medium | Mid | Pressure | 75000 | non-haz | Annual O&M | 33.359 | 0 | 0 | 0 | 0 | 0 | 0 | 4323.3091 | -28269.2417 | 160402.9802 | 40202.825 |
| SW | Large | Mid | Pressure | 75000 | non-haz | Annual O&M | 34.463 | 0 | 0 | 0 | 0 | 0 | 0 | 2.8826 | -119.2754 | 86801.8137 | 156219.7272 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW | Small | High | Pressure | 75000 | non-haz | Annual O&M | 24.3 | 0 | 0 | 0 | 0 | 0 | 0 | 745048.072 | -504701.3898 | 218656.7362 | 4515.0366 |
| SW | Medium | High | Pressure | 75000 | non-haz | Annual O&M | 35.282 | 0 | 0 | 0 | 0 | 0 | 0 | 3172.2839 | -23529.4898 | 163811.9583 | 44264.8187 |
| SW | Large | High | Pressure | 75000 | non-haz | Annual O&M | 35.505 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1162 | -72.0675 | 89100.692 | 174787.9504 |
| SW | Small | Low | Gravity | 5000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 5000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2215.9319 | -47607.7405 | 905378.5464 | 1498796.203 |
| SW | Large | Low | Gravity | 5000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 5000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 5000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 5000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 5000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 5000 | non-haz | Total Capital | 34.735 | 0 | 0 | 0 | 0 | 0 | 0 | 1747.5957 | -40783.7296 | 1021445.793 | 2016353.85 |
| SW | Large | High | Gravity | 5000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 10000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 10000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2215.9319 | -47607.7405 | 905378.5464 | 1498796.203 |
| SW | Large | Low | Gravity | 10000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 10000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 10000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 10000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 10000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 10000 | non-haz | Total Capital | 34.735 | 0 | 0 | 0 | 0 | 0 | 0 | 1747.5957 | -40783.7296 | 1021445.793 | 2016353.85 |
| SW | Large | High | Gravity | 10000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 15000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 15000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 15000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 15000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 15000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 15000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 15000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 15000 | non-haz | Total Capital | 34.735 | 0 | 0 | 0 | 0 | 0 | 0 | 1747.5957 | -40783.7296 | 1021445.793 | 2016353.85 |
| SW | Large | High | Gravity | 15000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 20000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 20000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 20000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 20000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 20000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 20000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 20000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 20000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 20000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 25000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 25000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 25000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 25000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 25000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 25000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Gravity | 25000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 25000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 25000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 5000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | 1553949.451 | -941766.8848 | 688128.7417 | 28094.6299 |
| SW | Medium | Low | Gravity | 5000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 513388.8313 | 77224.2648 |
| SW | Large | Low | Gravity | 5000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 491422.8766 | 266976.5986 |
| SW | Small | Mid | Gravity | 5000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | 1468267.845 | -875616.7882 | 683466.1672 | 32890.4998 |
| SW | Medium | Mid | Gravity | 5000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 516837.2312 | 80596.7135 |
| SW | Large | Mid | Gravity | 5000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 491762.1239 | 261806.4982 |
| SW | Small | High | Gravity | 5000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | 1456223.479 | -861545.1655 | 686493.8491 | 34783.2849 |
| SW | Medium | High | Gravity | 5000 | non-haz | Annual O&M | 34.735 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 516776.5238 | 80843.8182 |
| SW | Large | High | Gravity | 5000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 492327.3661 | 258618.4294 |
| SW | Small | Low | Gravity | 10000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -655303.9056 | 218997.6708 | 335086.1423 | 27990.8175 |
| SW | Medium | Low | Gravity | 10000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 289485.5994 | 76609.9675 |
| SW | Large | Low | Gravity | 10000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -64.0104 | 272817.0482 | 217003.2373 |
| SW | Small | Mid | Gravity | 10000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -740910.4421 | 285105.4996 | 330420.1886 | 32786.6026 |
| SW | Medium | Mid | Gravity | 10000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 292910.9422 | 79968.9438 |
| SW | Large | Mid | Gravity | 10000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 268372.5944 | 259801.6116 |
| SW | Small | High | Gravity | 10000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -752949.8049 | 299131.2227 | 333447.1147 | 34679.0468 |
| SW | Medium | High | Gravity | 10000 | non-haz | Annual O&M | 34.735 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 292667.775 | 80353.2715 |
| SW | Large | High | Gravity | 10000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 268933.9874 | 256193.2518 |
| SW | Small | Low | Gravity | 15000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -751960.4934 | 391063.6776 | 219511.3385 | 27970.303 |
| SW | Medium | Low | Gravity | 15000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 214010.0674 | 78884.2913 |
| SW | Large | Low | Gravity | 15000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1063 | -421.9722 | 208947.5263 | 151995.2586 |
| SW | Small | Mid | Gravity | 15000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -837704.5411 | 457220.6587 | 214842.2504 | 32766.1011 |
| SW | Medium | Mid | Gravity | 15000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 217550.3678 | 82107.4056 |
| SW | Large | Mid | Gravity | 15000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9574 | -402.2759 | 208570.5531 | 152504.0607 |
| SW | Small | High | Gravity | 15000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -849615.2934 | 471182.5701 | 217870.8876 | 34658.6047 |
| SW | Medium | High | Gravity | 15000 | non-haz | Annual O&M | 34.735 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1270.5219 | 222367.9636 | 79291.6673 |
| SW | Large | High | Gravity | 15000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0435 | -407.9239 | 209105.8333 | 150142.6098 |
| SW | Small | Low | Gravity | 20000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -778132.9298 | 452322.1283 | 161597.3902 | 27961.7537 |
| SW | Medium | Low | Gravity | 20000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 176291.9677 | 80242.4254 |
| SW | Large | Low | Gravity | 20000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -64.597 | 161173.3565 | 215294.8982 |
| SW | Small | Mid | Gravity | 20000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -863805.9837 | 518451.297 | 156927.9439 | 32757.4523 |
| SW | Medium | Mid | Gravity | 20000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 179840.8933 | 83450.2078 |
| SW | Large | Mid | Gravity | 20000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9625 | -403.0647 | 171370.9449 | 151920.3755 |
| SW | Small | High | Gravity | 20000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -875945.8327 | 532521.2453 | 159943.4493 | 34650.1788 |
| SW | Medium | High | Gravity | 20000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1358.7924 | 184867.9854 | 80535.6235 |
| SW | Large | High | Gravity | 20000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0482 | -408.7308 | 171908.9806 | 149450.0447 |
| SW | Small | Low | Gravity | 25000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -788043.8064 | 480858.0533 | 126819.2983 | 27957.146 |
| SW | Medium | Low | Gravity | 25000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 1639.6414 | -12072.3682 | 178644.5597 | 69404.543 |
| SW | Large | Low | Gravity | 25000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -64.7145 | 138844.6306 | 214952.8326 |
| SW | Small | Mid | Gravity | 25000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -873705.9321 | 546961.6412 | 122156.7658 | 32752.6553 |
| SW | Medium | Mid | Gravity | 25000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1704.2299 | -12327.776 | 182293.9488 | 72697.2791 |
| SW | Large | Mid | Gravity | 25000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -62.1558 | 138969.6671 | 212547.342 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Gravity | 25000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -885729.7813 | 560967.9696 | 125178.4708 | 34645.4088 |
| SW | Medium | High | Gravity | 25000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1804.6317 | 164050.9995 | 80446.4376 |
| SW | Large | High | Gravity | 25000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -57.9972 | 139218.9217 | 211767.9863 |
| SW | Small | Low | Gravity | 30000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 30000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 30000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 30000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 30000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 30000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 30000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 30000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 30000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 35000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 35000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 35000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 35000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 35000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 35000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 35000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 35000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 35000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 40000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 40000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 40000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 40000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 40000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 40000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 40000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 40000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 40000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 45000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 45000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 45000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 45000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 45000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 45000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 45000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 45000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 45000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 50000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 50000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 50000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 50000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 50000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 50000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Gravity | 50000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 50000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 50000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 30000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -792740.8478 | 496414.8729 | 103633.3399 | 27953.766 |
| SW | Medium | Low | Gravity | 30000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2047.557 | -15421.1073 | 171442.7273 | 65831.0802 |
| SW | Large | Low | Gravity | 30000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1102 | -422.8136 | 134531.6902 | 150775.723 |
| SW | Small | Mid | Gravity | 30000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -878471.3832 | 562564.7983 | 98963.68 | 32749.4115 |
| SW | Medium | Mid | Gravity | 30000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2118.0777 | -15704.8655 | 175123.9301 | 69114.0348 |
| SW | Large | Mid | Gravity | 30000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -62.2335 | 124082.8211 | 212356.094 |
| SW | Small | High | Gravity | 30000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -890499.1756 | 576568.7048 | 101984.1109 | 34642.1435 |
| SW | Medium | High | Gravity | 30000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1644.9738 | -13172.3627 | 171270.7288 | 70698.2142 |
| SW | Large | High | Gravity | 30000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.053 | -409.5376 | 134712.1612 | 148756.874 |
| SW | Small | Low | Gravity | 35000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -795216.6807 | 505806.6316 | 87066.7389 | 27951.5145 |
| SW | Medium | Low | Gravity | 35000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2132.5829 | -16745.919 | 165323.9016 | 63174.8008 |
| SW | Large | Low | Gravity | 35000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1108 | -422.9335 | 123900.8299 | 150601.9529 |
| SW | Small | Mid | Gravity | 35000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -880846.5024 | 571910.0793 | 82399.2614 | 32747.429 |
| SW | Medium | Mid | Gravity | 35000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2207.463 | -17050.8762 | 169029.9264 | 66449.6158 |
| SW | Large | Mid | Gravity | 35000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9692 | -404.0768 | 123542.8391 | 151170.0719 |
| SW | Small | High | Gravity | 35000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -892855.2136 | 585898.0543 | 85423.5131 | 34639.8375 |
| SW | Medium | High | Gravity | 35000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1731.4305 | -14505.7019 | 165157.4931 | 68040.4418 |
| SW | Large | High | Gravity | 35000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0544 | -409.7709 | 124084.5918 | 148558.1653 |
| SW | Small | Low | Gravity | 40000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -796693.6716 | 511916.2254 | 74639.3036 | 27950.1144 |
| SW | Medium | Low | Gravity | 40000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2058.7078 | -16857.3892 | 159492.2997 | 61419.2535 |
| SW | Large | Low | Gravity | 40000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1112 | -423.022 | 115927.6642 | 150471.5136 |
| SW | Small | Mid | Gravity | 40000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -882321.9354 | 578003.3076 | 69976.3566 | 32745.6989 |
| SW | Medium | Mid | Gravity | 40000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2136.7483 | -17177.4629 | 163215.5664 | 64688.3825 |
| SW | Large | Mid | Gravity | 40000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9703 | -404.2462 | 115571.4953 | 151045.2538 |
| SW | Small | High | Gravity | 40000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -894441.0717 | 592070.9271 | 72985.6315 | 34638.4544 |
| SW | Medium | High | Gravity | 40000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1658.5773 | -14623.25 | 159329.8202 | 66283.5528 |
| SW | Large | High | Gravity | 40000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0554 | -409.9439 | 116113.8503 | 148409.4416 |
| SW | Small | Low | Gravity | 45000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -797502.071 | 516042.7921 | 64980.425 | 27948.7228 |
| SW | Medium | Low | Gravity | 45000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2024.1324 | -16837.7963 | 154347.2972 | 60200.2876 |
| SW | Large | Low | Gravity | 45000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1052 | -422.2712 | 109696.076 | 150654.8602 |
| SW | Small | Mid | Gravity | 45000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -883279.2412 | 582206.4885 | 60308.6259 | 32744.4316 |
| SW | Medium | Mid | Gravity | 45000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2104.7814 | -17170.7089 | 158085.9229 | 63464.3535 |
| SW | Large | Mid | Gravity | 45000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9649 | -403.5568 | 109341.2889 | 151233.0796 |
| SW | Small | High | Gravity | 45000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -895261.9097 | 596197.9994 | 63326.6218 | 34637.1461 |
| SW | Medium | High | Gravity | 45000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1624.7661 | -14608.1542 | 154186.9743 | 65064.5713 |
| SW | Large | High | Gravity | 45000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0499 | -409.2575 | 109884.0834 | 148579.4744 |
| SW | Small | Low | Gravity | 50000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -798180.1361 | 519054.1014 | 57247.895 | 27947.6639 |
| SW | Medium | Low | Gravity | 50000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2176.7898 | -17805.0707 | 151713.082 | 58549.3672 |
| SW | Large | Low | Gravity | 50000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0886 | -420.1243 | 104653.7158 | 151339.7045 |
| SW | Small | Mid | Gravity | 50000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -883961.6809 | 585242.3022 | 52569.1706 | 32743.5967 |
| SW | Medium | Mid | Gravity | 50000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2259.286 | -18146.6061 | 155461.0244 | 61810.5502 |
| SW | Large | Mid | Gravity | 50000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9486 | -401.4571 | 104300.0261 | 151920.8815 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Gravity | 50000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -895889.3295 | 599181.0501 | 55597.6706 | 34636.1334 |
| SW | Medium | High | Gravity | 50000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1777.9698 | -15578.522 | 151553.7949 | 63413.5349 |
| SW | Large | High | Gravity | 50000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0337 | -407.1606 | 104843.1765 | 149253.1411 |
| SW | Small | Low | Gravity | 55000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 55000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 55000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 55000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 55000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 55000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 55000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 55000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 55000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 60000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 60000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 60000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 60000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 60000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 60000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 60000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 60000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 60000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 65000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 65000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 65000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 65000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 65000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 65000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 65000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 65000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 65000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 70000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 70000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 70000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 70000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 70000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 70000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |
| SW | Small | High | Gravity | 70000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 70000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 70000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 75000 | non-haz | Total Capital | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -1281459.361 | 2163339.033 | -89735.902 | 829825.997 |
| SW | Medium | Low | Gravity | 75000 | non-haz | Total Capital | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2323.6228 | -49013.6019 | 910462.7037 | 1493951.594 |
| SW | Large | Low | Gravity | 75000 | non-haz | Total Capital | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 6.5064 | -1948.8489 | 565732.9385 | 2532745.806 |
| SW | Small | Mid | Gravity | 75000 | non-haz | Total Capital | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -1066999.862 | 1783021.413 | 214961.9487 | 981685.0453 |
| SW | Medium | Mid | Gravity | 75000 | non-haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1676.5458 | -38879.764 | 945256.0752 | 1888966.945 |
| SW | Large | Mid | Gravity | 75000 | non-haz | Total Capital | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 5.9022 | -1720.4962 | 556962.1631 | 3998799.813 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Gravity | 75000 | non-haz | Total Capital | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -841567.548 | 1416348.991 | 453411.6132 | 1037706.132 |
| SW | Medium | High | Gravity | 75000 | non-haz | Total Capital | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1718.4988 | -40235.0004 | 1018912.538 | 2019122.046 |
| SW | Large | High | Gravity | 75000 | non-haz | Total Capital | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 6.9161 | -2183.0783 | 643185.9908 | 4001841.938 |
| SW | Small | Low | Gravity | 55000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -798709.8227 | 521316.6563 | 50915.3064 | 27946.7883 |
| SW | Medium | Low | Gravity | 55000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2307.2584 | -18738.2912 | 150011.3168 | 56895.3275 |
| SW | Large | Low | Gravity | 55000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0656 | -417.1154 | 100480.0918 | 152391.2826 |
| SW | Small | Mid | Gravity | 55000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -884184.3144 | 587338.0875 | 46258.8618 | 32742.2695 |
| SW | Medium | Mid | Gravity | 55000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2391.3872 | -19087.5486 | 153767.6283 | 60153.962 |
| SW | Large | Mid | Gravity | 55000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.926 | -398.4906 | 100127.3529 | 152975.2363 |
| SW | Small | High | Gravity | 55000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -896340.1072 | 601395.1837 | 49273.3809 | 34634.9209 |
| SW | Medium | High | Gravity | 55000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1908.8452 | -16513.9601 | 149851.7392 | 61760.2244 |
| SW | Large | High | Gravity | 55000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 3.011 | -404.1937 | 100670.7427 | 150296.0063 |
| SW | Small | Low | Gravity | 60000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -798896.9431 | 522929.4901 | 45653.1341 | 27945.9024 |
| SW | Medium | Low | Gravity | 60000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2371.6519 | -19299.5146 | 148352.5729 | 55524.1078 |
| SW | Large | Low | Gravity | 60000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0369 | -413.3366 | 96953.3533 | 153763.7771 |
| SW | Small | Mid | Gravity | 60000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -884586.5539 | 589066.5937 | 40979.2476 | 32741.8711 |
| SW | Medium | Mid | Gravity | 60000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2457.1279 | -19655.1467 | 152115.8062 | 58780.8074 |
| SW | Large | Mid | Gravity | 60000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.8976 | -394.7458 | 96601.3844 | 154350.1202 |
| SW | Small | High | Gravity | 60000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -896499.9137 | 603004.741 | 44008.3979 | 34634.2059 |
| SW | Medium | High | Gravity | 60000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1973.7208 | -17078.1529 | 148195.5015 | 60387.9226 |
| SW | Large | High | Gravity | 60000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9825 | -400.4507 | 97145.0546 | 151660.4727 |
| SW | Small | Low | Gravity | 65000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -799019.5728 | 524173.5958 | 41200.0943 | 27945.095 |
| SW | Medium | Low | Gravity | 65000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2394.4022 | -19612.4851 | 146745.9935 | 54384.9443 |
| SW | Large | Low | Gravity | 65000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0152 | -410.472 | 93981.1132 | 154820.1533 |
| SW | Small | Mid | Gravity | 65000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -884762.6872 | 590315.3621 | 36532.4174 | 32740.5935 |
| SW | Medium | Mid | Gravity | 65000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2481.0166 | -19973.6181 | 150515.6671 | 57639.317 |
| SW | Large | Mid | Gravity | 65000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.8762 | -391.9073 | 93629.7202 | 155408.7094 |
| SW | Small | High | Gravity | 65000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -896841.4237 | 604375.4337 | 39537.7676 | 34633.8644 |
| SW | Medium | High | Gravity | 65000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1996.7203 | -17392.4915 | 146588.6921 | 59249.2033 |
| SW | Large | High | Gravity | 65000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.961 | -397.614 | 94173.6072 | 152710.8236 |
| SW | Small | Low | Gravity | 70000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -799118.2751 | 525170.0815 | 37381.2242 | 27944.5198 |
| SW | Medium | Low | Gravity | 70000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2363.4202 | -19562.9464 | 144820.4818 | 53595.8589 |
| SW | Large | Low | Gravity | 70000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9945 | -407.7157 | 91420.1207 | 155899.0953 |
| SW | Small | Mid | Gravity | 70000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -884975.2452 | 591384.0789 | 32700.2692 | 32740.6734 |
| SW | Medium | Mid | Gravity | 70000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2451.1416 | -19929.7702 | 148597.5566 | 56847.7182 |
| SW | Large | Mid | Gravity | 70000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.8557 | -389.1765 | 91069.297 | 156489.3416 |
| SW | Small | High | Gravity | 70000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -897102.2317 | 605439.2713 | 35712.2536 | 34633.2716 |
| SW | Medium | High | Gravity | 70000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1966.1943 | -17345.7537 | 144666.0297 | 58458.9849 |
| SW | Large | High | Gravity | 70000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9406 | -394.8844 | 91613.3536 | 153784.3556 |
| SW | Small | Low | Gravity | 75000 | non-haz | Annual O&M | 30.095 | 0 | 0 | 0 | 0 | 0 | 0 | -799441.3448 | 526106.8602 | 34053.1854 | 27944.3783 |
| SW | Medium | Low | Gravity | 75000 | non-haz | Annual O&M | 34.024 | 0 | 0 | 0 | 0 | 0 | 0 | 2238.9038 | -18943.6832 | 142293.3968 | 53200.4987 |
| SW | Large | Low | Gravity | 75000 | non-haz | Annual O&M | 35.621 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9797 | -405.7372 | 89216.3198 | 156673.3209 |
| SW | Small | Mid | Gravity | 75000 | non-haz | Annual O&M | 29.22 | 0 | 0 | 0 | 0 | 0 | 0 | -885151.1359 | 592235.4329 | 29385.5761 | 32740.0709 |
| SW | Medium | Mid | Gravity | 75000 | non-haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2327.2884 | -19313.2678 | 146072.378 | 56452.1888 |
| SW | Large | Mid | Gravity | 75000 | non-haz | Annual O&M | 35.079 | 0 | 0 | 0 | 0 | 0 | 0 | 2.8411 | -387.2179 | 88865.9545 | 157265.0755 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW | Small | High | Gravity | 75000 | non-haz | Annual O&M | 31.155 | 0 | 0 | 0 | 0 | 0 | 0 | -897249.4508 | 606285.2461 | 32395.6695 | 34632.7775 |
| SW | Medium | High | Gravity | 75000 | non-haz | Annual O&M | 34.729 | 0 | 0 | 0 | 0 | 0 | 0 | 1841.7892 | -16726.9892 | 142137.5816 | 58064.6618 |
| SW | Large | High | Gravity | 75000 | non-haz | Annual O&M | 35.763 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9259 | -392.9276 | 89410.1847 | 154553.8478 |
| GW | Small | Low | Pressure | 5000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 5000 | haz | Total Capital | 34.165 | 0 | 0 | 0 | 0 | 0 | 0 | -2204.6567 | 23830.3241 | 793506.3115 | 1504948.47 |
| GW | Large | Low | Pressure | 5000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5738 | -476.4487 | 581178.4286 | 3451620.657 |
| GW | Small | Mid | Pressure | 5000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 5000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 5000 | haz | Total Capital | 34.7 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1298 | -237.2104 | 642538.8427 | 4627318.984 |
| GW | Small | High | Pressure | 5000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 5000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 5000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3087 | -748.0259 | 900892.6186 | 6851542.74 |
| GW | Small | Low | Pressure | 10000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 10000 | haz | Total Capital | 34.165 | 0 | 0 | 0 | 0 | 0 | 0 | -2204.6567 | 23830.3241 | 793506.3115 | 1504948.47 |
| GW | Large | Low | Pressure | 10000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.6145 | -486.9148 | 581757.9749 | 3444717.259 |
| GW | Small | Mid | Pressure | 10000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 10000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 10000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1705 | -247.6765 | 643118.3891 | 4620415.585 |
| GW | Small | High | Pressure | 10000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 10000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 10000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3483 | -758.2982 | 901463.688 | 6844725.123 |
| GW | Small | Low | Pressure | 15000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 15000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 15000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 15000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 15000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 15000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 15000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 15000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 15000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 20000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 20000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 20000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 20000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 20000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 20000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 20000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 20000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 20000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 25000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 25000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 25000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 25000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 25000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 25000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW | Small | High | Pressure | 25000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 25000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 25000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 5000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 3285811.774 | -1884614.614 | 992203.0012 | 14540.3991 |
| GW | Medium | Low | Pressure | 5000 | haz | Annual O&M | 34.165 | 0 | 0 | 0 | 0 | 0 | 0 | 3670.2654 | -27110.0642 | 789604.6564 | 46659.716 |
| GW | Large | Low | Pressure | 5000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 251.4776 | 706757.962 | 224250.4486 |
| GW | Small | Mid | Pressure | 5000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 2898587.198 | -1664639.247 | 967989.6747 | 15253.2076 |
| GW | Medium | Mid | Pressure | 5000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 3851.1402 | -28284.4413 | 793768.0138 | 49438.6324 |
| GW | Large | Mid | Pressure | 5000 | haz | Annual O&M | 34.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 262.125 | 706643.7074 | 225405.3004 |
| GW | Small | High | Pressure | 5000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 3068948.195 | -1774852.693 | 995939.8754 | 16264.2607 |
| GW | Medium | High | Pressure | 5000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 3326.9129 | -26499.0659 | 800046.1726 | 52798.2026 |
| GW | Large | High | Pressure | 5000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 330.4724 | 707751.2699 | 249379.4795 |
| GW | Small | Low | Pressure | 10000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 2081176.324 | -1413690.873 | 644829.5458 | 7806.4536 |
| GW | Medium | Low | Pressure | 10000 | haz | Annual O&M | 34.165 | 0 | 0 | 0 | 0 | 0 | 0 | 2856.565 | -20721.0328 | 442852.841 | 44606.206 |
| GW | Large | Low | Pressure | 10000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 239.3601 | 373401.431 | 217746.9589 |
| GW | Small | Mid | Pressure | 10000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 1696739.621 | -1195173.088 | 620777.3535 | 8518.8389 |
| GW | Medium | Mid | Pressure | 10000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 3056.0727 | -22015.2897 | 447177.6246 | 47333.3259 |
| GW | Large | Mid | Pressure | 10000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 250.7288 | 373223.9263 | 219351.7504 |
| GW | Small | High | Pressure | 10000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 1867181.477 | -1305464.053 | 648736.9652 | 9529.4393 |
| GW | Medium | High | Pressure | 10000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 408618.1177 | 72942.7622 |
| GW | Large | High | Pressure | 10000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 320.5178 | 374205.0545 | 244225.0083 |
| GW | Small | Low | Pressure | 15000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1196707.509 | -910060.6597 | 476002.5482 | 6445.1888 |
| GW | Medium | Low | Pressure | 15000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2419.6735 | -17225.3409 | 323953.9255 | 46012.0459 |
| GW | Large | Low | Pressure | 15000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 235.3214 | 262282.5426 | 215579.5436 |
| GW | Small | Mid | Pressure | 15000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 813050.7627 | -691948.7761 | 451995.9777 | 7157.5312 |
| GW | Medium | Mid | Pressure | 15000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2606.3426 | -18426.8915 | 328104.6116 | 48813.6144 |
| GW | Large | Mid | Pressure | 15000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 246.9299 | 262084.01 | 217333.6852 |
| GW | Small | High | Pressure | 15000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 983652.2656 | -802333.0567 | 479964.4663 | 8168.0709 |
| GW | Medium | High | Pressure | 15000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1980.1897 | -16105.5618 | 333960.5309 | 52146.5982 |
| GW | Large | High | Pressure | 15000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 317.1999 | 263022.9602 | 242507.3443 |
| GW | Small | Low | Pressure | 20000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1140974.411 | -812524.1342 | 401294.8294 | 5612.7464 |
| GW | Medium | Low | Pressure | 20000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 1906.3315 | -13038.943 | 258558.2515 | 50636.6859 |
| GW | Large | Low | Pressure | 20000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 2.2281 | -42.0438 | 215513.024 | 155778.7925 |
| GW | Small | Mid | Pressure | 20000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 757707.9488 | -594628.022 | 377313.8654 | 6324.9529 |
| GW | Medium | Mid | Pressure | 20000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2091.7803 | -14230.1686 | 262683.4462 | 53450.8223 |
| GW | Large | Mid | Pressure | 20000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 245.0305 | 206514.0567 | 216324.5611 |
| GW | Small | High | Pressure | 20000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 928431.2688 | -705077.0014 | 405288.7887 | 7335.5771 |
| GW | Medium | High | Pressure | 20000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1452.7697 | -11841.0226 | 268484.9258 | 56781.3304 |
| GW | Large | High | Pressure | 20000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 315.5406 | 207431.9414 | 241648.0166 |
| GW | Small | Low | Pressure | 25000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1115441.217 | -765254.1605 | 356449.8008 | 5113.7132 |
| GW | Medium | Low | Pressure | 25000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 1648.4901 | -10873.4609 | 219891.7785 | 53404.5979 |
| GW | Large | Low | Pressure | 25000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 232.0899 | 173387.4837 | 213845.1138 |
| GW | Small | Mid | Pressure | 25000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 732677.9165 | -547602.5568 | 332495.7345 | 5825.6666 |
| GW | Medium | Mid | Pressure | 25000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1833.2475 | -12059.0903 | 224003.2961 | 56225.4992 |
| GW | Large | Mid | Pressure | 25000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1918 | -26.9695 | 181818.7861 | 157959.0742 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | Pressure | 25000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 903105.4377 | -657899.375 | 360449.0258 | 6836.7152 |
| GW | Medium | High | Pressure | 25000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 208047.2175 | 70457.075 |
| GW | Large | High | Pressure | 25000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4807 | 7.9757 | 183863.9531 | 175758.0129 |
| GW | Small | Low | Pressure | 30000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 30000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 30000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 30000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 30000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 30000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 30000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 30000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 30000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 35000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 35000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 35000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 35000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 35000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 35000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 35000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 35000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 35000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 40000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 40000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 40000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 40000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 40000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 40000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 40000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 40000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 40000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 45000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 45000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 45000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 45000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 45000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 45000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 45000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 45000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 45000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 50000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 50000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 50000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 50000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 50000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 50000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW | Small | High | Pressure | 50000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 50000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 50000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 30000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1101251.169 | -738527.8953 | 326552.953 | 4780.7093 |
| GW | Medium | Low | Pressure | 30000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 1618.2908 | -10474.3191 | 196127.7573 | 54687.4971 |
| GW | Large | Low | Pressure | 30000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 231.2821 | 151163.7209 | 213411.5815 |
| GW | Small | Mid | Pressure | 30000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 718568.0164 | -520908.42 | 302598.3397 | 5493.1154 |
| GW | Medium | Mid | Pressure | 30000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1802.6081 | -11656.055 | 200229.4727 | 57513.0856 |
| GW | Large | Mid | Pressure | 30000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 243.1308 | 150944.1091 | 215315.6385 |
| GW | Small | High | Pressure | 30000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 889193.3837 | -631314.1166 | 330567.1825 | 6503.7062 |
| GW | Medium | High | Pressure | 30000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 185524.1248 | 71001.4732 |
| GW | Large | High | Pressure | 30000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4722 | 8.3629 | 161593.998 | 175638.299 |
| GW | Small | Low | Pressure | 35000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1092344.139 | -721804.8905 | 305195.6377 | 4543.151 |
| GW | Medium | Low | Pressure | 35000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 1708.9666 | -11040.3143 | 180897.2984 | 54945.9382 |
| GW | Large | Low | Pressure | 35000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1918 | -40.1558 | 143936.3114 | 155341.768 |
| GW | Small | Mid | Pressure | 35000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 709612.879 | -504186.2669 | 281244.6344 | 5255.5251 |
| GW | Medium | Mid | Pressure | 35000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 1892.8691 | -12218.7814 | 184991.3478 | 57775.2345 |
| GW | Large | Mid | Pressure | 35000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 242.5883 | 135066.9753 | 215027.1845 |
| GW | Small | High | Pressure | 35000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 880329.7582 | -614632.6979 | 309216.8012 | 6266.0274 |
| GW | Medium | High | Pressure | 35000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -889.8801 | 173319.4724 | 68955.7446 |
| GW | Large | High | Pressure | 35000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4662 | 8.6385 | 145686.9073 | 175552.735 |
| GW | Small | Low | Pressure | 40000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1086251.157 | -710570.0411 | 289178.6981 | 4365.0519 |
| GW | Medium | Low | Pressure | 40000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 1867.0334 | -12185.5992 | 171104.2014 | 54299.3673 |
| GW | Large | Low | Pressure | 40000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 230.2721 | 123384.0258 | 212869.3839 |
| GW | Small | Mid | Pressure | 40000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 703550.7018 | -492984.0388 | 265234.5988 | 5077.1823 |
| GW | Medium | Mid | Pressure | 40000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2050.7025 | -13362.046 | 175192.9549 | 57131.6563 |
| GW | Large | Mid | Pressure | 40000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 242.181 | 123159.1407 | 214810.8664 |
| GW | Small | High | Pressure | 40000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 874196.844 | -603396.8446 | 293202.7476 | 6087.9336 |
| GW | Medium | High | Pressure | 40000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1392.556 | -10872.1882 | 180914.7001 | 60457.1982 |
| GW | Large | High | Pressure | 40000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 313.0522 | 124045.3645 | 240359.7897 |
| GW | Small | Low | Pressure | 45000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1081624.069 | -702512.3398 | 276712.6855 | 4226.4445 |
| GW | Medium | Low | Pressure | 45000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2037.9582 | -13478.6488 | 164461.6167 | 53217.2043 |
| GW | Large | Low | Pressure | 45000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 2.181 | -39.5963 | 122728.3986 | 155212.1184 |
| GW | Small | Mid | Pressure | 45000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 698992.175 | -484951.1709 | 252768.5712 | 4938.7754 |
| GW | Medium | Mid | Pressure | 45000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2221.4044 | -14653.0322 | 168544.9848 | 56052.0861 |
| GW | Large | Mid | Pressure | 45000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 241.8644 | 113897.4831 | 214642.7825 |
| GW | Small | High | Pressure | 45000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 869714.251 | -595396.5428 | 280739.1672 | 5949.4919 |
| GW | Medium | High | Pressure | 45000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1561.1847 | -12152.4767 | 174259.2478 | 59376.3143 |
| GW | Large | High | Pressure | 45000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 312.7756 | 114780.204 | 240216.5051 |
| GW | Small | Low | Pressure | 50000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1078400.583 | -696708.3029 | 266758.4471 | 4115.1883 |
| GW | Medium | Low | Pressure | 50000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2203.3087 | -14755.626 | 159745.5173 | 51982.009 |
| GW | Large | Low | Pressure | 50000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 229.6666 | 106716.1619 | 212544.6376 |
| GW | Small | Mid | Pressure | 50000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 695771.0923 | -479141.9062 | 242811.6575 | 4827.8253 |
| GW | Medium | Mid | Pressure | 50000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2386.7205 | -15929.7597 | 163828.0943 | 54817.3424 |
| GW | Large | Mid | Pressure | 50000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1607 | -25.4067 | 115012.1689 | 157567.8858 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | Pressure | 50000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 866345.0556 | -589523.5063 | 270777.4909 | 5838.5553 |
| GW | Medium | High | Pressure | 50000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1724.7951 | -13420.145 | 169534.8175 | 58141.6034 |
| GW | Large | High | Pressure | 50000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 312.5546 | 107368.0533 | 240102.0653 |
| GW | Small | Low | Pressure | 55000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 55000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 55000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 55000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 55000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 55000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 55000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 55000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 55000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 60000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 60000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 60000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 60000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 60000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 60000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 60000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 60000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 60000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 65000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 65000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 65000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 65000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 65000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 65000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 65000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 65000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 65000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 70000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 70000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 70000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 70000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 70000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 70000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| GW | Small | High | Pressure | 70000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 70000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 70000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 75000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| GW | Medium | Low | Pressure | 75000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| GW | Large | Low | Pressure | 75000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| GW | Small | Mid | Pressure | 75000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Medium | Mid | Pressure | 75000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| GW | Large | Mid | Pressure | 75000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | Pressure | 75000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| GW | Medium | High | Pressure | 75000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| GW | Large | High | Pressure | 75000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| GW | Small | Low | Pressure | 55000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1075515.641 | -692112.1552 | 258595.8439 | 4024.6782 |
| GW | Medium | Low | Pressure | 55000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2396.8344 | -16288.149 | 157037.703 | 50384.589 |
| GW | Large | Low | Pressure | 55000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1742 | -39.2415 | 109232.4883 | 155129.4071 |
| GW | Small | Mid | Pressure | 55000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 693299.4201 | -474752.2609 | 234673.9645 | 4736.6583 |
| GW | Medium | Mid | Pressure | 55000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2580.0342 | -17460.6307 | 161116.4324 | 53221.9092 |
| GW | Large | Mid | Pressure | 55000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1579 | -25.2659 | 108938.88 | 157532.2266 |
| GW | Small | High | Pressure | 55000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 863752.9907 | -585061.296 | 262628.2431 | 5747.7697 |
| GW | Medium | High | Pressure | 55000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1916.7185 | -14943.7378 | 166817.5799 | 56545.5598 |
| GW | Large | High | Pressure | 55000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4529 | 9.2394 | 110980.573 | 175365.676 |
| GW | Small | Low | Pressure | 60000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1073308.67 | -688554.8895 | 251796.0847 | 3949.3629 |
| GW | Medium | Low | Pressure | 60000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2551.1818 | -17523.5722 | 154742.4822 | 48993.0812 |
| GW | Large | Low | Pressure | 60000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 229.2626 | 95604.2888 | 212327.7746 |
| GW | Small | Mid | Pressure | 60000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 691038.1543 | -471164.7043 | 227869.8097 | 4661.4595 |
| GW | Medium | Mid | Pressure | 60000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2734.2339 | -18694.8488 | 158818.4998 | 51831.6247 |
| GW | Large | Mid | Pressure | 60000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1555 | -25.1488 | 103877.8418 | 157501.7994 |
| GW | Small | High | Pressure | 60000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 861848.6207 | -581690.0709 | 255857.8485 | 5671.569 |
| GW | Medium | High | Pressure | 60000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2069.7629 | -16171.8988 | 164514.9368 | 55154.9051 |
| GW | Large | High | Pressure | 60000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 2.451 | 9.3265 | 105919.2395 | 175338.3943 |
| GW | Small | Low | Pressure | 65000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1071743.115 | -685844.0678 | 246063.8973 | 3884.8817 |
| GW | Medium | Low | Pressure | 65000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2659.0441 | -18396.1353 | 152457.752 | 47902.3891 |
| GW | Large | Low | Pressure | 65000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1695 | -38.9958 | 99889.1588 | 155072.3305 |
| GW | Small | Mid | Pressure | 65000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 689263.914 | -468367.6915 | 222130.3133 | 4597.2236 |
| GW | Medium | Mid | Pressure | 65000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2842.0031 | -19566.5392 | 156531.4821 | 50742.0732 |
| GW | Large | Mid | Pressure | 65000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 241.0855 | 91099.5221 | 214228.9703 |
| GW | Small | High | Pressure | 65000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 859811.9176 | -578721.3285 | 250088.1805 | 5608.0875 |
| GW | Medium | High | Pressure | 65000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2176.4972 | -17038.0233 | 162222.7943 | 54065.9791 |
| GW | Large | High | Pressure | 65000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 312.095 | 91973.6221 | 239864.0016 |
| GW | Small | Low | Pressure | 70000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1070021.56 | -683428.5497 | 241122.7437 | 3830.2835 |
| GW | Medium | Low | Pressure | 70000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2734.2814 | -19013.0776 | 150239.138 | 47034.6904 |
| GW | Large | Low | Pressure | 70000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 228.9738 | 87667.2478 | 212172.6554 |
| GW | Small | Mid | Pressure | 70000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 687715.4419 | -466021.8537 | 217194.5419 | 4542.6289 |
| GW | Medium | Mid | Pressure | 70000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2917.1851 | -20183.1488 | 154312.1986 | 49874.6058 |
| GW | Large | Mid | Pressure | 70000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1518 | -24.9642 | 95924.7173 | 157454.9004 |
| GW | Small | High | Pressure | 70000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 858466.1508 | -576498.7779 | 245172.2671 | 5553.0164 |
| GW | Medium | High | Pressure | 70000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2250.9296 | -17650.8327 | 160001.2786 | 53197.4986 |
| GW | Large | High | Pressure | 70000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 2.448 | 9.4625 | 97965.7632 | 175294.9723 |
| GW | Small | Low | Pressure | 75000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1068823.161 | -681555.232 | 236859.0566 | 3782.5948 |
| GW | Medium | Low | Pressure | 75000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2796.4715 | -19546.0465 | 148377.3514 | 46210.5023 |
| GW | Large | Low | Pressure | 75000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 2.166 | -38.8151 | 93037.3837 | 155030.2859 |
| GW | Small | Mid | Pressure | 75000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 686549.9831 | -464173.0724 | 212934.0728 | 4494.8488 |
| GW | Medium | Mid | Pressure | 75000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2979.2482 | -20715.0917 | 152448.0697 | 49051.58 |
| GW | Large | Mid | Pressure | 75000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 240.8516 | 84260.1517 | 214104.8537 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW | Small | High | Pressure | 75000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 857117.2271 | -574550.5218 | 240897.9619 | 5505.635 |
| GW | Medium | High | Pressure | 75000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2312.2738 | -18179.062 | 158134.6934 | 52373.7192 |
| GW | Large | High | Pressure | 75000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 2.4468 | 9.5181 | 94784.3396 | 175277.9677 |
| SW | Small | Low | Pressure | 5000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 5000 | haz | Total Capital | 34.165 | 0 | 0 | 0 | 0 | 0 | 0 | -2204.6567 | 23830.3241 | 793506.3115 | 1504948.47 |
| SW | Large | Low | Pressure | 5000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5738 | -476.4487 | 581178.4286 | 3451620.657 |
| SW | Small | Mid | Pressure | 5000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 5000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 5000 | haz | Total Capital | 34.7 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1298 | -237.2104 | 642538.8427 | 4627318.984 |
| SW | Small | High | Pressure | 5000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 5000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 5000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3087 | -748.0259 | 900892.6186 | 6851542.74 |
| SW | Small | Low | Pressure | 10000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 10000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 10000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.6145 | -486.9148 | 581757.9749 | 3444717.259 |
| SW | Small | Mid | Pressure | 10000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 10000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 10000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1705 | -247.6765 | 643118.3891 | 4620415.585 |
| SW | Small | High | Pressure | 10000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 10000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 10000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3483 | -758.2982 | 901463.688 | 6844725.123 |
| SW | Small | Low | Pressure | 15000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 15000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 15000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 15000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 15000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 15000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 15000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 15000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 15000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 20000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 20000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 20000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 20000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 20000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 20000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 20000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 20000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 20000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 25000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 25000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 25000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 25000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 25000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 25000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW | Small | High | Pressure | 25000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 25000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 25000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 5000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 2890926.402 | -1670769.014 | 956710.8322 | 16629.4625 |
| SW | Medium | Low | Pressure | 5000 | haz | Annual O&M | 34.165 | 0 | 0 | 0 | 0 | 0 | 0 | 4929.6376 | -31983.6205 | 799889.4083 | 42534.8851 |
| SW | Large | Low | Pressure | 5000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 221.0659 | 714369.4437 | 220811.0287 |
| SW | Small | Mid | Pressure | 5000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 2532635.499 | -1459462.205 | 932043.4326 | 17400.6598 |
| SW | Medium | Mid | Pressure | 5000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 5194.9748 | -33526.0301 | 804674.9625 | 45081.0048 |
| SW | Large | Mid | Pressure | 5000 | haz | Annual O&M | 34.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 232.5375 | 714306.0752 | 221600.1435 |
| SW | Small | High | Pressure | 5000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 2685714.58 | -1560847.612 | 958955.2788 | 18356.132 |
| SW | Medium | High | Pressure | 5000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 750295.6461 | 76080.7752 |
| SW | Large | High | Pressure | 5000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 303.7888 | 716042.0219 | 243517.3907 |
| SW | Small | Low | Pressure | 10000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 2019366.736 | -1372032.785 | 634940.6118 | 8390.8391 |
| SW | Medium | Low | Pressure | 10000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 3819.1009 | -24101.7936 | 451592.7703 | 40990.8607 |
| SW | Large | Low | Pressure | 10000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 208.3377 | 380985.7991 | 215233.19 |
| SW | Small | Mid | Pressure | 10000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 1664210.968 | -1162418.922 | 610476.6453 | 9160.6073 |
| SW | Medium | Mid | Pressure | 10000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 4089.3901 | -25663.1268 | 456358.4549 | 43559.9785 |
| SW | Large | Mid | Pressure | 10000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 220.5709 | 380860.5644 | 216411.1249 |
| SW | Small | High | Pressure | 10000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 1817408.027 | -1263901.629 | 637397.7058 | 10115.863 |
| SW | Medium | High | Pressure | 10000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1724.1421 | 424759.679 | 62767.5285 |
| SW | Large | High | Pressure | 10000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 293.3462 | 382472.6998 | 239107.0445 |
| SW | Small | Low | Pressure | 15000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1075855.772 | -841832.2426 | 464424.0859 | 6787.1082 |
| SW | Medium | Low | Pressure | 15000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 3202.7614 | -19659.3262 | 331558.2597 | 42741.2435 |
| SW | Large | Low | Pressure | 15000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 204.0949 | 269857.9315 | 213373.5803 |
| SW | Small | Mid | Pressure | 15000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 721729.6563 | -632772.5865 | 440026.3297 | 7556.488 |
| SW | Medium | Mid | Pressure | 15000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 3469.7484 | -21195.9149 | 336268.8414 | 45336.4075 |
| SW | Large | Mid | Pressure | 15000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 216.582 | 269712.0631 | 214681.3858 |
| SW | Small | High | Pressure | 15000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 874986.8192 | -734316.2616 | 466959.2727 | 8511.4242 |
| SW | Medium | High | Pressure | 15000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2379.5739 | -16756.3053 | 339936.2909 | 49384.6496 |
| SW | Large | High | Pressure | 15000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 289.8654 | 271282.914 | 237637.1565 |
| SW | Small | Low | Pressure | 20000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1023546.939 | -747267.0123 | 390780.7556 | 5785.9255 |
| SW | Medium | Low | Pressure | 20000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2466.936 | -14221.7036 | 264346.2365 | 48039.167 |
| SW | Large | Low | Pressure | 20000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 201.9738 | 214293.9674 | 212444.4452 |
| SW | Small | Mid | Pressure | 20000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 670002.4158 | -538524.6035 | 366425.3494 | 6554.621 |
| SW | Medium | Mid | Pressure | 20000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2732.2733 | -15745.9421 | 269029.4726 | 50647.2651 |
| SW | Large | Mid | Pressure | 20000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 214.5879 | 214137.7846 | 213816.6608 |
| SW | Small | High | Pressure | 20000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 823164.8135 | -639985.2779 | 393336.8626 | 7510.3042 |
| SW | Medium | High | Pressure | 20000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 250891.2807 | 64575.8752 |
| SW | Large | High | Pressure | 20000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 288.1247 | 215688.0524 | 236901.686 |
| SW | Small | Low | Pressure | 25000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 1000038.313 | -701714.3863 | 346559.4451 | 5185.6192 |
| SW | Medium | Low | Pressure | 25000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2103.8421 | -11450.1471 | 224765.5493 | 51179.5438 |
| SW | Large | Low | Pressure | 25000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 200.7009 | 180955.6073 | 211886.5957 |
| SW | Small | Mid | Pressure | 25000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 646618.5232 | -493042.1035 | 322209.0159 | 5954.6807 |
| SW | Medium | Mid | Pressure | 25000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2368.3564 | -12967.7543 | 229432.8491 | 53795.3041 |
| SW | Large | Mid | Pressure | 25000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 213.3914 | 180793.2197 | 213298.1493 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW | Small | High | Pressure | 25000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 799783.5367 | -594538.5988 | 349131.2948 | 6909.938 |
| SW | Medium | High | Pressure | 25000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 217242.7092 | 64826.5446 |
| SW | Large | High | Pressure | 25000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 287.0805 | 182331.1243 | 236460.6054 |
| SW | Small | Low | Pressure | 30000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 30000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 30000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 30000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 30000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 30000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 30000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 30000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 30000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 35000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 35000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 35000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 35000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 35000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 35000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 35000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 35000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 35000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 40000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 40000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 40000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 40000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 40000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 40000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 40000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 40000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 40000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 45000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 45000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 45000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 45000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 45000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 45000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 45000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 45000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 45000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 50000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 50000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 50000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 50000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 50000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 50000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW | Small | High | Pressure | 50000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 50000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 50000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 30000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 986869.2019 | -675992.3584 | 317062.7512 | 4785.9369 |
| SW | Medium | Low | Pressure | 30000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2113.6374 | -11286.1063 | 201355.7255 | 52445.103 |
| SW | Large | Low | Pressure | 30000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1071 | -157.8156 | 169292.5148 | 147628.3044 |
| SW | Small | Mid | Pressure | 30000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 633906.7037 | -467560.0613 | 292741.8788 | 5554.3607 |
| SW | Medium | Mid | Pressure | 30000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2377.366 | -12797.9694 | 206010.7635 | 55066.3453 |
| SW | Large | Mid | Pressure | 30000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0548 | -139.0496 | 168948.0618 | 150142.2971 |
| SW | Small | High | Pressure | 30000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 787081.0177 | -569048.1749 | 319660.9646 | 6509.7182 |
| SW | Medium | High | Pressure | 30000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1251.2875 | -8180.5148 | 209522.1061 | 59125.8332 |
| SW | Large | High | Pressure | 30000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 286.3842 | 160093.1637 | 236166.7669 |
| SW | Small | Low | Pressure | 35000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 978856.237 | -660094.0225 | 296011.9364 | 4499.4376 |
| SW | Medium | Low | Pressure | 35000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2278.2451 | -12276.927 | 186807.5069 | 52425.1561 |
| SW | Large | Low | Pressure | 35000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 199.2463 | 142854.6166 | 211249.0464 |
| SW | Small | Mid | Pressure | 35000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 625847.5558 | -451650.4404 | 271691.1889 | 5268.1248 |
| SW | Medium | Mid | Pressure | 35000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2541.6061 | -13785.9422 | 191455.7972 | 55049.9154 |
| SW | Large | Mid | Pressure | 35000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 212.0239 | 142685.1476 | 212705.3888 |
| SW | Small | High | Pressure | 35000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 779110.2715 | -553181.2539 | 298612.7971 | 6223.6016 |
| SW | Medium | High | Pressure | 35000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1410.133 | -9141.2771 | 194941.5394 | 59112.1271 |
| SW | Large | High | Pressure | 35000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 285.887 | 144208.9135 | 235956.5428 |
| SW | Small | Low | Pressure | 40000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 973281.1373 | -649373.6409 | 280204.474 | 4285.7078 |
| SW | Medium | Low | Pressure | 40000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2510.2309 | -13816.9867 | 177578.0054 | 51549.1067 |
| SW | Large | Low | Pressure | 40000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0944 | -157.4074 | 141467.1487 | 147426.0405 |
| SW | Small | Mid | Pressure | 40000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 620498.1994 | -441039.6389 | 255895.2922 | 5054.2087 |
| SW | Medium | Mid | Pressure | 40000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 2773.1589 | -15322.8765 | 182219.6537 | 54176.8164 |
| SW | Large | Mid | Pressure | 40000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 211.5965 | 130776.3909 | 212519.7663 |
| SW | Small | High | Pressure | 40000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 773720.0047 | -542562.373 | 282819.9726 | 6009.4074 |
| SW | Medium | High | Pressure | 40000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1637.9059 | -10659.5942 | 185689.357 | 58240.1381 |
| SW | Large | High | Pressure | 40000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 285.5143 | 132295.7057 | 235799.1894 |
| SW | Small | Low | Pressure | 45000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 969188.2219 | -641785.4522 | 267911.5758 | 4119.0252 |
| SW | Medium | Low | Pressure | 45000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 2802.9337 | -15849.1183 | 172169.2986 | 49994.1316 |
| SW | Large | Low | Pressure | 45000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0902 | -157.2758 | 132192.1589 | 147357.856 |
| SW | Small | Mid | Pressure | 45000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 616531.5626 | -433525.6869 | 243614.5333 | 4887.1181 |
| SW | Medium | Mid | Pressure | 45000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 3065.6836 | -17353.2976 | 176806.3348 | 52624.3419 |
| SW | Large | Mid | Pressure | 45000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0393 | -138.5947 | 131845.8898 | 149883.9721 |
| SW | Small | High | Pressure | 45000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 769840.61 | -535090.874 | 270543.198 | 5842.3218 |
| SW | Medium | High | Pressure | 45000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 1927.3526 | -12674.9055 | 180263.1488 | 56688.1915 |
| SW | Large | High | Pressure | 45000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 285.224 | 123029.9063 | 235676.5093 |
| SW | Small | Low | Pressure | 50000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 966212.2017 | -636278.384 | 258089.519 | 3985.4487 |
| SW | Medium | Low | Pressure | 50000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 3063.5142 | -17699.2944 | 168407.3354 | 48376.4542 |
| SW | Large | Low | Pressure | 50000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 198.1551 | 114278.8914 | 210770.7357 |
| SW | Small | Mid | Pressure | 50000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 613543.3051 | -428003.6619 | 233787.4532 | 4753.9807 |
| SW | Medium | Mid | Pressure | 50000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 3326.0389 | -19201.9666 | 173041.3544 | 51007.7675 |
| SW | Large | Mid | Pressure | 50000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0362 | -138.5055 | 124425.4834 | 149832.3021 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Pressure | 50000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 766669.1461 | -529476.1454 | 260704.5452 | 5709.2522 |
| SW | Medium | High | Pressure | 50000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2185.4553 | -14512.3438 | 176488.2952 | 55072.377 |
| SW | Large | High | Pressure | 50000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 284.9919 | 115617.255 | 235578.6756 |
| SW | Small | Low | Pressure | 55000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 55000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 55000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 55000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 55000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 55000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 55000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 55000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 55000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 60000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 60000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 60000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 60000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 60000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 60000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 60000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 60000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 60000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 65000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 65000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 65000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 65000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 65000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 65000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 65000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 65000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 65000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 70000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 70000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 70000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 70000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 70000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 70000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |
| SW | Small | High | Pressure | 70000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 70000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 70000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 75000 | haz | Total Capital | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 218205.7779 | -879696.1705 | 1619582.503 | 149347.4904 |
| SW | Medium | Low | Pressure | 75000 | haz | Total Capital | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | -2241.9665 | 24429.1255 | 791060.0658 | 1507435.754 |
| SW | Large | Low | Pressure | 75000 | haz | Total Capital | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 8.5711 | -478.1422 | 581291.6818 | 3450337.952 |
| SW | Small | Mid | Pressure | 75000 | haz | Total Capital | 21.865 | 1300023.414 | 0.4864 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Medium | Mid | Pressure | 75000 | haz | Total Capital | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | -3706.0774 | 39849.5823 | 913457.546 | 1835718.028 |
| SW | Large | Mid | Pressure | 75000 | haz | Total Capital | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 10.1271 | -238.9039 | 642652.0959 | 4626036.279 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Pressure | 75000 | haz | Total Capital | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 906888.8213 | -2194035.54 | 2716802.713 | 377083.5384 |
| SW | Medium | High | Pressure | 75000 | haz | Total Capital | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | -8214.9816 | 97767.571 | 1153481.446 | 2550759.106 |
| SW | Large | High | Pressure | 75000 | haz | Total Capital | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 21.3034 | -749.1992 | 900980.0398 | 6850555.015 |
| SW | Small | Low | Pressure | 55000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 963767.8412 | -632020.7847 | 250041.0491 | 3876.4248 |
| SW | Medium | Low | Pressure | 55000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 3336.3605 | -19675.8926 | 166355.8921 | 46531.7191 |
| SW | Large | Low | Pressure | 55000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 3.084 | -157.0782 | 118701.0923 | 147259.6674 |
| SW | Small | Mid | Pressure | 55000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 611075.8724 | -423739.0678 | 225738.2937 | 4645.0162 |
| SW | Medium | Mid | Pressure | 55000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 3598.618 | -21176.5874 | 170985.7551 | 49165.0171 |
| SW | Large | Mid | Pressure | 55000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 210.7808 | 108041.4559 | 212166.0538 |
| SW | Small | High | Pressure | 55000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 764497.1217 | -525361.468 | 252674.1438 | 5599.9552 |
| SW | Medium | High | Pressure | 55000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2456.0581 | -16477.1153 | 174423.7373 | 53230.4908 |
| SW | Large | High | Pressure | 55000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2659 | -91.1444 | 120654.6075 | 168347.3055 |
| SW | Small | Low | Pressure | 60000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 961783.4013 | -628705.0085 | 243337.9145 | 3785.5637 |
| SW | Medium | Low | Pressure | 60000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 3522.784 | -21040.1066 | 164130.0309 | 45127.8597 |
| SW | Large | Low | Pressure | 60000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 197.7308 | 103166.1062 | 210584.9877 |
| SW | Small | Mid | Pressure | 60000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 609315.5293 | -420547.7401 | 219053.4562 | 4553.4736 |
| SW | Medium | Mid | Pressure | 60000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 3784.7942 | -22539.1289 | 168756.516 | 47762.8022 |
| SW | Large | Mid | Pressure | 60000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0315 | -138.3687 | 113294.8012 | 149755.1487 |
| SW | Small | High | Pressure | 60000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 762611.2107 | -522085.8239 | 245972.9061 | 5509.2068 |
| SW | Medium | High | Pressure | 60000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2640.6431 | -17832.105 | 172189.0703 | 51827.6361 |
| SW | Large | High | Pressure | 60000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2642 | -91.1078 | 115594.7666 | 168315.6357 |
| SW | Small | Low | Pressure | 65000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 960135.4373 | -626021.5858 | 237657.8204 | 3708.7404 |
| SW | Medium | Low | Pressure | 65000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 3650.15 | -21984.7006 | 161863.8582 | 44039.9406 |
| SW | Large | Low | Pressure | 65000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0797 | -156.9425 | 109361.1719 | 147191.0892 |
| SW | Small | Mid | Pressure | 65000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 607556.9523 | -417810.0117 | 213365.0682 | 4477.1505 |
| SW | Medium | Mid | Pressure | 65000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 3912.1813 | -23483.6765 | 166489.8108 | 46674.9609 |
| SW | Large | Mid | Pressure | 65000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 210.4457 | 98714.3291 | 212020.8786 |
| SW | Small | High | Pressure | 65000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 761053.4143 | -519472.6105 | 240305.7888 | 5432.1176 |
| SW | Medium | High | Pressure | 65000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2766.5165 | -18768.8194 | 169914.1223 | 50741.5143 |
| SW | Large | High | Pressure | 65000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2628 | -91.0763 | 111313.3621 | 168288.422 |
| SW | Small | Low | Pressure | 70000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 958787.5976 | -623871.8389 | 232795.7258 | 3642.9355 |
| SW | Medium | Low | Pressure | 70000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 3749.3399 | -22754.8195 | 159928.244 | 43047.1421 |
| SW | Large | Low | Pressure | 70000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 3.078 | -156.886 | 105691.8112 | 147165.0078 |
| SW | Small | Mid | Pressure | 70000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 606341.7162 | -415725.1036 | 208509.8501 | 4411.2676 |
| SW | Medium | Mid | Pressure | 70000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 4011.324 | -24253.2956 | 164552.7432 | 45683.0346 |
| SW | Large | Mid | Pressure | 70000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0282 | -138.272 | 105344.3711 | 149699.5207 |
| SW | Small | High | Pressure | 70000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 759623.94 | -517283.9302 | 235438.2792 | 5366.4686 |
| SW | Medium | High | Pressure | 70000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2864.5197 | -19532.8815 | 167972.5947 | 49749.4955 |
| SW | Large | High | Pressure | 70000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 284.3956 | 96556.1183 | 235326.9234 |
| SW | Small | Low | Pressure | 75000 | haz | Annual O&M | 21.605 | 0 | 0 | 0 | 0 | 0 | 0 | 957710.6467 | -622138.859 | 228589.2907 | 3585.4977 |
| SW | Medium | Low | Pressure | 75000 | haz | Annual O&M | 34.171 | 0 | 0 | 0 | 0 | 0 | 0 | 3852.2364 | -23617.3076 | 158817.4489 | 41881.607 |
| SW | Large | Low | Pressure | 75000 | haz | Annual O&M | 35.979 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0765 | -156.8393 | 102511.7662 | 147141.9184 |
| SW | Small | Mid | Pressure | 75000 | haz | Annual O&M | 21.865 | 0 | 0 | 0 | 0 | 0 | 0 | 605239.6298 | -413976.8568 | 204302.4117 | 4353.8888 |
| SW | Medium | Mid | Pressure | 75000 | haz | Annual O&M | 33.482 | 0 | 0 | 0 | 0 | 0 | 0 | 4113.876 | -25113.4517 | 163437.594 | 44519.3666 |
| SW | Large | Mid | Pressure | 75000 | haz | Annual O&M | 34.711 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0269 | -138.2329 | 102164.1469 | 149678.0902 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Pressure | 75000 | haz | Annual O&M | 24.33 | 0 | 0 | 0 | 0 | 0 | 0 | 758522.8602 | -515534.8091 | 231228.6167 | 5309.2146 |
| SW | Medium | High | Pressure | 75000 | haz | Annual O&M | 35.324 | 0 | 0 | 0 | 0 | 0 | 0 | 2966.0938 | -20388.3053 | 166853.6582 | 48585.6621 |
| SW | Large | High | Pressure | 75000 | haz | Annual O&M | 35.642 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2605 | -91.0247 | 104463.0547 | 168245.6235 |
| SW | Small | Low | Gravity | 5000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 5000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2305.6323 | -47510.7565 | 970665.0402 | 1507746.82 |
| SW | Large | Low | Gravity | 5000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 5000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 5000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 5000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 5000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 5000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1733.4111 | -39746.9636 | 1086122.427 | 2021702.383 |
| SW | Large | High | Gravity | 5000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 10000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 10000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2305.6323 | -47510.7565 | 970665.0402 | 1507746.82 |
| SW | Large | Low | Gravity | 10000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 10000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 10000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 10000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 10000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 10000 | haz | Total Capital | 34.947 | 0 | 0 | 0 | 0 | 0 | 0 | 1710.5042 | -39314.9705 | 1084128.094 | 2023881.676 |
| SW | Large | High | Gravity | 10000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 15000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 15000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2305.6323 | -47510.7565 | 970665.0402 | 1507746.82 |
| SW | Large | Low | Gravity | 15000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 15000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 15000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 15000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 15000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 15000 | haz | Total Capital | 34.947 | 0 | 0 | 0 | 0 | 0 | 0 | 1710.5042 | -39314.9705 | 1084128.094 | 2023881.676 |
| SW | Large | High | Gravity | 15000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 20000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 20000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2305.6323 | -47510.7565 | 970665.0402 | 1507746.82 |
| SW | Large | Low | Gravity | 20000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 20000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 20000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 20000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 20000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 20000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 20000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 25000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 25000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 25000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 25000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 25000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 25000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW | Small | High | Gravity | 25000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 25000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 25000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 5000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | 1430890.047 | -607724.481 | 790430.8213 | 33781.7538 |
| SW | Medium | Low | Gravity | 5000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 3900.0251 | -28227.7788 | 790146.1782 | 55129.5735 |
| SW | Large | Low | Gravity | 5000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 711199.4198 | 270134.9983 |
| SW | Small | Mid | Gravity | 5000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | 1346987.762 | -542189.6111 | 785872.9296 | 38574.7787 |
| SW | Medium | Mid | Gravity | 5000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 3855.0968 | -28100.9759 | 793659.5509 | 58387.2114 |
| SW | Large | Mid | Gravity | 5000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 711552.5541 | 264208.9841 |
| SW | Small | High | Gravity | 5000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | 1335162.41 | -528214.2694 | 788917.2038 | 40467.3302 |
| SW | Medium | High | Gravity | 5000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 3578.0134 | -26343.2737 | 790593.5323 | 59809.8904 |
| SW | Large | High | Gravity | 5000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 712099.7813 | 262005.3046 |
| SW | Small | Low | Gravity | 10000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | 417681.0738 | -271908.3328 | 460833.1774 | 29543.3928 |
| SW | Medium | Low | Gravity | 10000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 400879.427 | 74115.9984 |
| SW | Large | Low | Gravity | 10000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 377936.3502 | 266007.9695 |
| SW | Small | Mid | Gravity | 10000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -31106.6477 | 433217.7308 | 34891.0934 |
| SW | Medium | Mid | Gravity | 10000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 404200.0209 | 77576.1303 |
| SW | Large | Mid | Gravity | 10000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 378274.4814 | 260645.316 |
| SW | Small | High | Gravity | 10000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | 320653.6944 | -191936.3269 | 459228.79 | 36231.0225 |
| SW | Medium | High | Gravity | 10000 | haz | Annual O&M | 34.947 | 0 | 0 | 0 | 0 | 0 | 0 | 2045.5686 | -16331.3178 | 440193.7569 | 59861.3858 |
| SW | Large | High | Gravity | 10000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 378820.1876 | 257886.9068 |
| SW | Small | Low | Gravity | 15000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -572923.2279 | 270587.5938 | 287716.7552 | 29272.7914 |
| SW | Medium | Low | Gravity | 15000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 1742.9522 | -13695.2371 | 320074.6439 | 57079.7327 |
| SW | Large | Low | Gravity | 15000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -64.5206 | 271655.64 | 216828.7558 |
| SW | Small | Mid | Gravity | 15000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -658019.7952 | 336510.9611 | 283085.4427 | 34067.6325 |
| SW | Medium | Mid | Gravity | 15000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1720.9617 | -13656.3651 | 323538.6312 | 60386.8618 |
| SW | Large | Mid | Gravity | 15000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 267181.7865 | 259457.4779 |
| SW | Small | High | Gravity | 15000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -670018.8695 | 350515.7455 | 286110.8822 | 35960.2387 |
| SW | Medium | High | Gravity | 15000 | haz | Annual O&M | 34.947 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -2815.7091 | 304410.8133 | 68582.8542 |
| SW | Large | High | Gravity | 15000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 267726.9961 | 256513.9085 |
| SW | Small | Low | Gravity | 20000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -648968.2182 | 371417.8195 | 212754.4958 | 28938.7052 |
| SW | Medium | Low | Gravity | 20000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1801.0629 | 241521.5694 | 67358.5244 |
| SW | Large | Low | Gravity | 20000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1116 | -422.8647 | 226701.686 | 152040.821 |
| SW | Small | Mid | Gravity | 20000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -734161.7435 | 437376.6622 | 208113.6969 | 33733.697 |
| SW | Medium | Mid | Gravity | 20000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1897.3957 | 245203.5696 | 70575.7178 |
| SW | Large | Mid | Gravity | 20000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -62.6223 | 216300.9903 | 212466.4821 |
| SW | Small | High | Gravity | 20000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -746239.6027 | 451406.8775 | 211136.1843 | 35626.1863 |
| SW | Medium | High | Gravity | 20000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 237283.4584 | 75898.2724 |
| SW | Large | High | Gravity | 20000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -57.8984 | 216494.0017 | 212930.3297 |
| SW | Small | Low | Gravity | 25000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -686686.2807 | 420685.9188 | 167751.5742 | 28738.4701 |
| SW | Medium | Low | Gravity | 25000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1634.5978 | 207112.0291 | 68283.1264 |
| SW | Large | Low | Gravity | 25000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1121 | -423.0218 | 193384.4828 | 151544.1887 |
| SW | Small | Mid | Gravity | 25000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -772055.9228 | 486708.4954 | 163102.4582 | 33533.6622 |
| SW | Medium | Mid | Gravity | 25000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1518.7439 | 210083.2867 | 71882.5568 |
| SW | Large | Mid | Gravity | 25000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9788 | -405.6184 | 193106.8501 | 150788.6256 |

**Cost Equation Parameters for GAC**

| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW | Small | High | Gravity | 25000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -784169.9158 | 500763.7248 | 166116.2936 | 35426.6152 |
| SW | Medium | High | Gravity | 25000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -2096.5894 | 212110.4302 | 70890.512 |
| SW | Large | High | Gravity | 25000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0532 | -409.4974 | 193555.7366 | 149635.7467 |
| SW | Small | Low | Gravity | 30000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 30000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 30000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 30000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 30000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 30000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 30000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 30000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 30000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 35000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 35000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 35000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 35000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 35000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 35000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 35000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 35000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 35000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 40000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 40000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 40000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 40000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 40000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 40000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 40000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 40000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 40000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 45000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 45000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 45000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 45000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 45000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 45000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 45000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 45000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 45000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 50000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 50000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 50000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 50000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 50000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 50000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Gravity | 50000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 50000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 50000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 30000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -709196.2955 | 448835.512 | 137736.6189 | 28605.2837 |
| SW | Medium | Low | Gravity | 30000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1441.2403 | 183769.8892 | 69567.1796 |
| SW | Large | Low | Gravity | 30000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -64.8521 | 160592.6543 | 215207.3545 |
| SW | Small | Mid | Gravity | 30000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -794529.666 | 514837.4045 | 133086.5805 | 33400.6437 |
| SW | Medium | Mid | Gravity | 30000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1317.3739 | 186708.9037 | 73183.7538 |
| SW | Large | Mid | Gravity | 30000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9806 | -405.893 | 170899.4056 | 150464.5781 |
| SW | Small | High | Gravity | 30000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -806572.3044 | 528846.5315 | 136109.3429 | 35293.0815 |
| SW | Medium | High | Gravity | 30000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 181075.798 | 77040.0261 |
| SW | Large | High | Gravity | 30000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0547 | -409.7748 | 171349.594 | 149257.7323 |
| SW | Small | Low | Gravity | 35000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -723954.714 | 466496.1952 | 116312.5789 | 28509.4686 |
| SW | Medium | Low | Gravity | 35000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1389.3427 | 167430.6551 | 70348.4185 |
| SW | Large | Low | Gravity | 35000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -64.8993 | 144726.4983 | 214975.9265 |
| SW | Small | Mid | Gravity | 35000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -809435.2463 | 532569.4971 | 111652.9968 | 33304.9954 |
| SW | Medium | Mid | Gravity | 35000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1259.6444 | 170346.1251 | 73977.6576 |
| SW | Large | Mid | Gravity | 35000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -62.8355 | 144900.1458 | 211544.7824 |
| SW | Small | High | Gravity | 35000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -821537.3002 | 546621.5496 | 114667.4149 | 35197.6814 |
| SW | Medium | High | Gravity | 35000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1821.1465 | 172272.2837 | 73037.6901 |
| SW | Large | High | Gravity | 35000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -58.2055 | 145099.8283 | 211820.2739 |
| SW | Small | Low | Gravity | 40000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -734605.5015 | 478549.7906 | 100228.0297 | 28438.1746 |
| SW | Medium | Low | Gravity | 40000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1443.7247 | 155591.011 | 70616.0689 |
| SW | Large | Low | Gravity | 40000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -64.9347 | 132826.88 | 214802.3395 |
| SW | Small | Mid | Gravity | 40000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -820076.7308 | 544601.9474 | 95571.4598 | 33233.5587 |
| SW | Medium | Mid | Gravity | 40000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1309.7295 | 158489.2406 | 74254.2121 |
| SW | Large | Mid | Gravity | 40000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -62.8711 | 133000.013 | 211391.159 |
| SW | Small | High | Gravity | 40000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -832157.1618 | 558633.0026 | 98589.2549 | 35126.2271 |
| SW | Medium | High | Gravity | 40000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1866.1049 | 160383.7189 | 73330.9648 |
| SW | Large | High | Gravity | 40000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -58.2567 | 133200.7987 | 211635.3631 |
| SW | Small | Low | Gravity | 45000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -742541.8574 | 487108.5107 | 87726.9115 | 28382.4104 |
| SW | Medium | Low | Gravity | 45000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 1029.6676 | -8268.1208 | 158859.3801 | 65365.144 |
| SW | Large | Low | Gravity | 45000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.113 | -423.3051 | 134154.052 | 150660.2181 |
| SW | Small | Mid | Gravity | 45000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -828098.323 | 553217.583 | 83058.7308 | 33178.3437 |
| SW | Medium | Mid | Gravity | 45000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1180.4778 | -9108.4343 | 163504.0701 | 68256.3772 |
| SW | Large | Mid | Gravity | 45000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -62.8989 | 123744.3568 | 211271.7521 |
| SW | Small | High | Gravity | 45000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -840256.9384 | 567287.2897 | 86071.7804 | 35071.1264 |
| SW | Medium | High | Gravity | 45000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -2007.3883 | 151596.2321 | 73246.4668 |
| SW | Large | High | Gravity | 45000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0573 | -410.2336 | 134339.224 | 148629.0446 |
| SW | Small | Low | Gravity | 50000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -748770.3461 | 493518.6015 | 77715.3472 | 28338.3235 |
| SW | Medium | Low | Gravity | 50000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 1281.6919 | -10074.3516 | 155058.9874 | 63779.2959 |
| SW | Large | Low | Gravity | 50000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1131 | -423.3374 | 126750.1484 | 150550.3987 |
| SW | Small | Mid | Gravity | 50000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -834286.9579 | 559570.3028 | 73061.7484 | 33133.5255 |
| SW | Medium | Mid | Gravity | 50000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1434.1383 | -10922.5149 | 159711.5222 | 66668.7351 |
| SW | Large | Mid | Gravity | 50000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9842 | -406.4414 | 126484.4917 | 149816.9148 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Gravity | 50000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -846364.3144 | 573613.9926 | 76073.8415 | 35026.3668 |
| SW | Medium | High | Gravity | 50000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -2173.6854 | 144823.2723 | 72936.9971 |
| SW | Large | High | Gravity | 50000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0579 | -410.3248 | 126937.144 | 148503.0647 |
| SW | Small | Low | Gravity | 55000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 55000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 55000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 55000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 55000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 55000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 55000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 55000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 55000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 60000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 60000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 60000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 60000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 60000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 60000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 60000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 60000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 60000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 65000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 65000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 65000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 65000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 65000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 65000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 65000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 65000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 65000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 70000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 70000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 70000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 70000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 70000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 70000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |
| SW | Small | High | Gravity | 70000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 70000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 70000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 75000 | haz | Total Capital | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -1290650.747 | 2183545.961 | -44745.7357 | 831220.478 |
| SW | Medium | Low | Gravity | 75000 | haz | Total Capital | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2438.6353 | -49247.0571 | 976944.1976 | 1501763.516 |
| SW | Large | Low | Gravity | 75000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7058 | -2008.5071 | 656104.6466 | 2291190.469 |
| SW | Small | Mid | Gravity | 75000 | haz | Total Capital | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -1076120.098 | 1802620.601 | 259930.1507 | 983021.2525 |
| SW | Medium | Mid | Gravity | 75000 | haz | Total Capital | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1894.7388 | -41884.8618 | 1029811.453 | 1874136.517 |
| SW | Large | Mid | Gravity | 75000 | haz | Total Capital | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 6.137 | -1786.4645 | 647268.4015 | 3787188.37 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Gravity | 75000 | haz | Total Capital | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -850266.0535 | 1435347.569 | 498569.2441 | 1039031.084 |
| SW | Medium | High | Gravity | 75000 | haz | Total Capital | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1748.1779 | -39470.2013 | 1081870.567 | 2028101.829 |
| SW | Large | High | Gravity | 75000 | haz | Total Capital | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 6.3666 | -2105.3529 | 726477.3605 | 3837805.245 |
| SW | Small | Low | Gravity | 55000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -753826.5767 | 498462.6422 | 69522.8939 | 28302.1371 |
| SW | Medium | Low | Gravity | 55000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 1547.4196 | -12014.0256 | 152973.52 | 61962.5501 |
| SW | Large | Low | Gravity | 55000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1132 | -423.366 | 120692.4695 | 150460.1927 |
| SW | Small | Mid | Gravity | 55000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -839264.4939 | 564486.5963 | 64869.5053 | 33097.3735 |
| SW | Medium | Mid | Gravity | 55000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1701.2723 | -12868.9941 | 157633.2406 | 64849.7131 |
| SW | Large | Mid | Gravity | 55000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9847 | -406.5172 | 120427.9559 | 149728.1761 |
| SW | Small | High | Gravity | 55000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -851373.7293 | 578523.424 | 67887.4348 | 34989.9743 |
| SW | Medium | High | Gravity | 55000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1160.4777 | -9909.5472 | 153156.0211 | 66660.7073 |
| SW | Large | High | Gravity | 55000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0583 | -410.4006 | 120880.9234 | 148400.0628 |
| SW | Small | Low | Gravity | 60000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -757885.6705 | 502305.5133 | 62706.9977 | 28271.5758 |
| SW | Medium | Low | Gravity | 60000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 1727.7584 | -13346.696 | 150718.5671 | 60581.8019 |
| SW | Large | Low | Gravity | 60000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1132 | -423.3871 | 115644.3366 | 150385.3312 |
| SW | Small | Mid | Gravity | 60000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -843348.6609 | 568359.3136 | 58045.9036 | 33067.0804 |
| SW | Medium | Mid | Gravity | 60000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 1882.6612 | -14206.7284 | 155383.6335 | 63467.1506 |
| SW | Large | Mid | Gravity | 60000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9851 | -406.5801 | 115380.8211 | 149654.5421 |
| SW | Small | High | Gravity | 60000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -855363.945 | 582341.5104 | 61069.546 | 34959.7398 |
| SW | Medium | High | Gravity | 60000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1340.358 | -11235.0627 | 150874.3407 | 65293.2054 |
| SW | Large | High | Gravity | 60000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0586 | -410.4631 | 115834.0436 | 148314.3156 |
| SW | Small | Low | Gravity | 65000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -761264.4588 | 505409.1873 | 56934.6204 | 28245.9731 |
| SW | Medium | Low | Gravity | 65000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 1850.4101 | -14267.3281 | 148432.4491 | 59511.4575 |
| SW | Large | Low | Gravity | 65000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1133 | -423.4124 | 111373.0331 | 150320.971 |
| SW | Small | Mid | Gravity | 65000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -846895.5962 | 571524.1654 | 52269.6631 | 33041.5324 |
| SW | Medium | Mid | Gravity | 65000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 2006.0157 | -15130.2946 | 153099.0901 | 62396.9941 |
| SW | Large | Mid | Gravity | 65000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9855 | -406.6311 | 111110.0853 | 149592.9427 |
| SW | Small | High | Gravity | 65000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -858925.4612 | 585533.2347 | 55287.3509 | 34934.2148 |
| SW | Medium | High | Gravity | 65000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1462.3373 | -12148.0472 | 148563.0443 | 64235.5151 |
| SW | Large | High | Gravity | 65000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0589 | -410.514 | 111563.5683 | 148242.149 |
| SW | Small | Low | Gravity | 70000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -764130.4573 | 507950.182 | 51988.3524 | 28223.9884 |
| SW | Medium | Low | Gravity | 70000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 1945.1833 | -15014.2301 | 146474.3711 | 58536.2482 |
| SW | Large | Low | Gravity | 70000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1134 | -423.4289 | 107711.7962 | 150266.3529 |
| SW | Small | Mid | Gravity | 70000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -849818.7944 | 574092.5785 | 47319.4272 | 33019.7083 |
| SW | Medium | Mid | Gravity | 70000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 2101.9039 | -15883.334 | 151149.6667 | 61418.2862 |
| SW | Large | Mid | Gravity | 70000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2.9858 | -406.6786 | 107449.6092 | 149538.7299 |
| SW | Small | High | Gravity | 70000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -861862.1753 | 588110.4729 | 50335.3112 | 34912.3704 |
| SW | Medium | High | Gravity | 70000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1556.8234 | -12890.2175 | 146586.719 | 63269.4969 |
| SW | Large | High | Gravity | 70000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0592 | -410.5609 | 107903.2388 | 148179.5654 |
| SW | Small | Low | Gravity | 75000 | haz | Annual O&M | 30.19 | 0 | 0 | 0 | 0 | 0 | 0 | -766599.3915 | 510047.3296 | 47707.5709 | 28204.7397 |
| SW | Medium | Low | Gravity | 75000 | haz | Annual O&M | 34.318 | 0 | 0 | 0 | 0 | 0 | 0 | 2044.1762 | -15856.2408 | 145343.9392 | 57386.0757 |
| SW | Large | Low | Gravity | 75000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1134 | -423.4404 | 104538.6286 | 150219.7718 |
| SW | Small | Mid | Gravity | 75000 | haz | Annual O&M | 29.295 | 0 | 0 | 0 | 0 | 0 | 0 | -852306.3978 | 576210.5083 | 43035.3266 | 33000.3067 |
| SW | Medium | Mid | Gravity | 75000 | haz | Annual O&M | 33.771 | 0 | 0 | 0 | 0 | 0 | 0 | 2201.4646 | -16727.8702 | 150021.2677 | 60267.7096 |
| SW | Large | Mid | Gravity | 75000 | haz | Annual O&M | 35.7 | 0 | 0 | 0 | 0 | 0 | 0 | 2.986 | -406.7174 | 104277.0895 | 149492.9147 |

| Cost Equation Parameters for GAC | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | Gravity | 75000 | haz | Annual O&M | 31.24 | 0 | 0 | 0 | 0 | 0 | 0 | -864209.306 | 590152.131 | 46061.3542 | 34892.8944 |
| SW | Medium | High | Gravity | 75000 | haz | Annual O&M | 34.953 | 0 | 0 | 0 | 0 | 0 | 0 | 1655.5058 | -13727.7496 | 145439.8751 | 62127.283 |
| SW | Large | High | Gravity | 75000 | haz | Annual O&M | 36.221 | 0 | 0 | 0 | 0 | 0 | 0 | 3.0594 | -410.5992 | 104730.9097 | 148125.6365 |

# A.2 Capital and Annual O&M Cost Equation Parameters for IX

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | Low | 20000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 20000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 20000 | non-haz | Total Capital | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -138.0534 | 520295.2314 | 2097973.873 |
| GW | Small | Mid | 20000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 20000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 20000 | non-haz | Total Capital | 36.047 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -154.0817 | 540783.5033 | 2366181.96 |
| GW | Small | High | 20000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 20000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 20000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -203.4804 | 693808.3856 | 3816368.881 |
| GW | Small | Low | 40000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 40000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 40000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -136.6756 | 519963.9788 | 2105105.946 |
| GW | Small | Mid | 40000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 40000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 40000 | non-haz | Total Capital | 36.053 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -152.704 | 540452.2565 | 2373313.916 |
| GW | Small | High | 40000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 40000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 40000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -202.1057 | 693478.446 | 3823469.173 |
| GW | Small | Low | 60000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 60000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 60000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -138.1552 | 520116.175 | 2102649.929 |
| GW | Small | Mid | 60000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 60000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 60000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -154.1836 | 540604.4527 | 2370857.899 |
| GW | Small | High | 60000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 60000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 60000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -203.5853 | 693630.6422 | 3821013.156 |
| GW | Small | Low | 80000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 80000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 80000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 80000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 80000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 80000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 80000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 80000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 80000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 100000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 100000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 100000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 100000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 100000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 100000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | 100000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 100000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 100000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 20000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1064723.853 | 4675.891 |
| GW | Medium | Low | 20000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1068385.932 | 26095.6274 |
| GW | Large | Low | 20000 | non-haz | Annual O&M | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1064120.695 | 43944.6759 |
| GW | Small | Mid | 20000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1064729.974 | 4663.4818 |
| GW | Medium | Mid | 20000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1068957.152 | 27422.7465 |
| GW | Large | Mid | 20000 | non-haz | Annual O&M | 36.047 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1064398.826 | 41319.191 |
| GW | Small | High | 20000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1066125.186 | 4745.1175 |
| GW | Medium | High | 20000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1069190 | 26924.9391 |
| GW | Large | High | 20000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1064974.626 | 34924.4203 |
| GW | Small | Low | 40000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30138.106 | 552285.9443 | 4297.6004 |
| GW | Medium | Low | 40000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 545808.3357 | 26229.6665 |
| GW | Large | Low | 40000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 541179.6902 | 45589.3443 |
| GW | Small | Mid | 40000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29112.2037 | 551957.6386 | 4300.2747 |
| GW | Medium | Mid | 40000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 546371.5684 | 27557.1583 |
| GW | Large | Mid | 40000 | non-haz | Annual O&M | 36.053 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 541400.35 | 43365.7935 |
| GW | Small | High | 40000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30689.569 | 553867.8181 | 4361.7912 |
| GW | Medium | High | 40000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 546577.1301 | 27097.0258 |
| GW | Large | High | 40000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 541860.8292 | 37800.2376 |
| GW | Small | Low | 60000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 368373.2371 | 4678.2524 |
| GW | Medium | Low | 60000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 371615.8462 | 26274.3289 |
| GW | Large | Low | 60000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 366855.7558 | 46312.9986 |
| GW | Small | Mid | 60000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 368379.563 | 4668.6211 |
| GW | Medium | Mid | 60000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 372176.3948 | 27601.8267 |
| GW | Large | Mid | 60000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 367046.99 | 44398.8966 |
| GW | Small | High | 60000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 369773.2427 | 4750.2218 |
| GW | Medium | High | 60000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 372372.8373 | 27154.4911 |
| GW | Large | High | 60000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 367448.4879 | 39460.7017 |
| GW | Small | Low | 80000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32422.4192 | 291900.9894 | 4269.51 |
| GW | Medium | Low | 80000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 284519.5327 | 26296.8118 |
| GW | Large | Low | 80000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 279705.0725 | 46478.8316 |
| GW | Small | Mid | 80000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -31512.6076 | 291610.6109 | 4271.7118 |
| GW | Medium | Mid | 80000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 285078.8952 | 27623.9473 |
| GW | Large | Mid | 80000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 279870.3118 | 44915.4253 |
| GW | Small | High | 80000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33098.6247 | 293521.5326 | 4333.293 |
| GW | Medium | High | 80000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 285270.7183 | 27183.1163 |
| GW | Large | High | 80000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 280242.3235 | 40290.6772 |
| GW | Small | Low | 100000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32866.5403 | 239817.8443 | 4264.2081 |
| GW | Medium | Low | 100000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 232261.8317 | 26310.0878 |
| GW | Large | Low | 100000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 227407.8657 | 46696.2751 |
| GW | Small | Mid | 100000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -31986.6029 | 239537.2918 | 4266.2738 |
| GW | Medium | Mid | 100000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 232820.3085 | 27637.5622 |
| GW | Large | Mid | 100000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 227564.2981 | 45225.4834 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | 100000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33583.7301 | 241454.8296 | 4327.3424 |
| GW | Medium | High | 100000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 233009.4792 | 27200.328 |
| GW | Large | High | 100000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 227918.6218 | 40788.7716 |
| SW | Small | Low | 20000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 20000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 20000 | non-haz | Total Capital | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -138.0534 | 520295.2314 | 2097973.873 |
| SW | Small | Mid | 20000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 20000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 20000 | non-haz | Total Capital | 36.047 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -154.0817 | 540783.5033 | 2366181.96 |
| SW | Small | High | 20000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 20000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 20000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -203.4804 | 693808.3856 | 3816368.881 |
| SW | Small | Low | 40000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 40000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 40000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -136.6756 | 519963.9788 | 2105105.946 |
| SW | Small | Mid | 40000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 40000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 40000 | non-haz | Total Capital | 36.053 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -152.704 | 540452.2565 | 2373313.916 |
| SW | Small | High | 40000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 40000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 40000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -202.1057 | 693478.446 | 3823469.173 |
| SW | Small | Low | 60000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 60000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 60000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -138.1552 | 520116.175 | 2102649.929 |
| SW | Small | Mid | 60000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 60000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 60000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -154.1836 | 540604.4527 | 2370857.899 |
| SW | Small | High | 60000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 60000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 60000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -203.5853 | 693630.6422 | 3821013.156 |
| SW | Small | Low | 80000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 80000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 80000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 80000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 80000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 80000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 80000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 80000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 80000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| SW | Small | Low | 100000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 100000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 100000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 100000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 100000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 100000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | 100000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 100000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 100000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| SW | Small | Low | 20000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1064266.215 | 4689.7346 |
| SW | Medium | Low | 20000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1071107.126 | 24446.2211 |
| SW | Large | Low | 20000 | non-haz | Annual O&M | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1065231.958 | 60706.4346 |
| SW | Small | Mid | 20000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1064269.612 | 4677.299 |
| SW | Medium | Mid | 20000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1071747.413 | 25731.5582 |
| SW | Large | Mid | 20000 | non-haz | Annual O&M | 36.047 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1065525.652 | 58259.0692 |
| SW | Small | High | 20000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1065648.754 | 4752.4664 |
| SW | Medium | High | 20000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1072005.198 | 25219.1389 |
| SW | Large | High | 20000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1066133.339 | 52256.6105 |
| SW | Small | Low | 40000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 542127.5219 | 4642.0763 |
| SW | Medium | Low | 40000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 548527.6053 | 24576.6829 |
| SW | Large | Low | 40000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 542286.5529 | 62212.0042 |
| SW | Small | Mid | 40000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 542131.5543 | 4631.8186 |
| SW | Medium | Mid | 40000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 549159.9235 | 25862.2108 |
| SW | Large | Mid | 40000 | non-haz | Annual O&M | 36.053 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 542516.5272 | 60209.4175 |
| SW | Small | High | 40000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 543510.2393 | 4706.9878 |
| SW | Medium | High | 40000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 549389.3484 | 25387.7067 |
| SW | Large | High | 40000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 542996.4236 | 55118.3653 |
| SW | Small | Low | 60000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29091.8475 | 377812.3059 | 4222.5195 |
| SW | Medium | Low | 60000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 374334.5154 | 24619.9539 |
| SW | Large | Low | 60000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 367963.2854 | 62838.1265 |
| SW | Small | Mid | 60000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -28121.2039 | 377491.9025 | 4226.451 |
| SW | Medium | Mid | 60000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 374963.9123 | 25906.1196 |
| SW | Large | Mid | 60000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 368163.8659 | 61108.5217 |
| SW | Small | High | 60000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29400.8472 | 379296.0441 | 4284.2095 |
| SW | Medium | High | 60000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 375184.0142 | 25443.8034 |
| SW | Large | High | 60000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 368584.8766 | 56570.2412 |
| SW | Small | Low | 80000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29482.7766 | 290918.001 | 4209.2912 |
| SW | Medium | Low | 80000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 287237.9703 | 24641.6485 |
| SW | Large | Low | 80000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 280813.8532 | 62961.7627 |
| SW | Small | Mid | 80000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -28558.6135 | 290613.2665 | 4212.9641 |
| SW | Medium | Mid | 80000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 287866.231 | 25927.5102 |
| SW | Large | Mid | 80000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 280987.5434 | 61557.941 |
| SW | Small | High | 80000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29845.5249 | 292422.6578 | 4270.2018 |
| SW | Medium | High | 80000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 288081.3102 | 25472.0596 |
| SW | Large | High | 80000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 281379.1135 | 57296.0667 |
| SW | Small | Low | 100000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29710.15 | 238782.0626 | 4201.198 |
| SW | Medium | Low | 100000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 234980.0984 | 24654.6213 |
| SW | Large | Low | 100000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 228516.8401 | 63149.8734 |
| SW | Small | Mid | 100000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -28809.2271 | 238485.1626 | 4204.7415 |
| SW | Medium | Mid | 100000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 235607.355 | 25940.7848 |
| SW | Large | Mid | 100000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 228681.7426 | 61827.6959 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | 100000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30114.2164 | 240299.6672 | 4261.9344 |
| SW | Medium | High | 100000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 235819.6943 | 25488.9673 |
| SW | Large | High | 100000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 229055.6548 | 57731.5199 |
| GW | Small | Low | 120000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 120000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 120000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 120000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 120000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 120000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 120000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 120000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 120000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 140000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 140000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 140000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 140000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 140000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 140000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 140000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 140000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 140000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 160000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 160000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 160000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 160000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 160000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 160000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 160000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 160000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 160000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 180000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 180000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 180000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 180000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 180000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 180000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 180000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 180000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 180000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 120000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33173.7674 | 205101.4462 | 4260.3771 |
| GW | Medium | Low | 120000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 197423.3529 | 26318.9393 |
| GW | Large | Low | 120000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 192543.0476 | 46841.6819 |
| GW | Small | Mid | 120000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32305.439 | 204824.6865 | 4262.3956 |
| GW | Medium | Mid | 120000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 197981.3041 | 27646.5245 |
| GW | Large | Mid | 120000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 192693.6248 | 45432.2035 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | 120000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33895.2093 | 206738.1821 | 4323.6841 |
| GW | Medium | High | 120000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 198168.53 | 27211.9235 |
| GW | Large | High | 120000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 193036.1521 | 41121.0624 |
| GW | Small | Low | 140000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 35681.5845 | -51721.7763 | 182631.0521 | 4205.9804 |
| GW | Medium | Low | 140000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -880.1279 | 176426.3238 | 23722.2794 |
| GW | Large | Low | 140000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 167639.6152 | 46945.2426 |
| GW | Small | Mid | 140000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32540.2454 | 180030.313 | 4259.6831 |
| GW | Medium | Mid | 140000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -890.3845 | 177029.1365 | 25019.671 |
| GW | Large | Mid | 140000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 167786.0028 | 45579.7341 |
| GW | Small | High | 140000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34138.93 | 181947.0208 | 4320.9262 |
| GW | Medium | High | 140000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 230.0847 | -2590.2057 | 180688.3221 | 22967.8686 |
| GW | Large | High | 140000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 168120.1043 | 41358.2373 |
| GW | Small | Low | 160000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33554.2091 | 161702.2379 | 4255.8323 |
| GW | Medium | Low | 160000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 153875.1246 | 26330.3668 |
| GW | Large | Low | 160000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 148962.0377 | 47022.8481 |
| GW | Small | Mid | 160000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32707.3957 | 161432.3752 | 4257.7921 |
| GW | Medium | Mid | 160000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 154432.4544 | 27657.7623 |
| GW | Large | Mid | 160000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 149105.2866 | 45690.2555 |
| GW | Small | High | 160000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34306.6957 | 163349.3479 | 4319.0205 |
| GW | Medium | High | 160000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 154617.4865 | 27226.2958 |
| GW | Large | High | 160000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 149433.0726 | 41535.8937 |
| GW | Small | Low | 180000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33688.3305 | 147239.4745 | 4254.0898 |
| GW | Medium | Low | 180000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -883.6657 | 143262.3106 | 23720.6991 |
| GW | Large | Low | 180000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 134435.0337 | 47083.4506 |
| GW | Small | Mid | 180000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32848.1732 | 146971.8524 | 4256.0081 |
| GW | Medium | Mid | 180000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -894.0329 | 143865.0956 | 25017.6807 |
| GW | Large | Mid | 180000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 134575.8435 | 45776.4166 |
| GW | Small | High | 180000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34440.1492 | 148885.8696 | 4317.44 |
| GW | Medium | High | 180000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -947.713 | 144286.5944 | 24428.1293 |
| GW | Large | High | 180000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 134898.7126 | 41674.1754 |
| SW | Small | Low | 120000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 120000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 120000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 120000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 120000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 120000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 120000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 120000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 120000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| SW | Small | Low | 140000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 140000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 140000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 140000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 140000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 140000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | 140000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 140000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 140000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| SW | Small | Low | 160000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 160000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 160000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 160000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 160000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 160000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 160000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 160000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 160000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| SW | Small | Low | 180000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 180000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 180000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 180000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 180000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 180000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 180000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 180000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 180000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| SW | Small | Low | 120000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29870.3672 | 204025.3474 | 4195.945 |
| SW | Medium | Low | 120000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -785.3175 | 203307.1247 | 22656.9849 |
| SW | Large | Low | 120000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 193652.1592 | 63275.6516 |
| SW | Small | Mid | 120000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -28986.1033 | 203733.9984 | 4199.4099 |
| SW | Medium | Mid | 120000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -788.917 | 203948.4194 | 23933.6705 |
| SW | Large | Mid | 120000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 193811.2144 | 62007.4224 |
| SW | Small | High | 120000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30287.3573 | 205549.1764 | 4256.4363 |
| SW | Medium | High | 120000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -853.9895 | 204421.3476 | 23317.9075 |
| SW | Large | High | 120000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 194173.3414 | 58021.967 |
| SW | Small | Low | 140000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29988.8551 | 179202.1335 | 4191.7844 |
| SW | Medium | Low | 140000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 175256.5747 | 24669.8708 |
| SW | Large | Low | 140000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 168748.8189 | 63365.4619 |
| SW | Small | Mid | 140000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29116.2113 | 178914.7017 | 4195.1846 |
| SW | Medium | Mid | 140000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 175883.0472 | 25955.6205 |
| SW | Large | Mid | 140000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 168903.691 | 62136.0331 |
| SW | Small | High | 140000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30422.1307 | 180729.2743 | 4252.4421 |
| SW | Medium | High | 140000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 176092.2195 | 25508.1987 |
| SW | Large | High | 140000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 169257.4064 | 58229.3041 |
| SW | Small | Low | 160000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30070.9946 | 160581.1649 | 4189.0431 |
| SW | Medium | Low | 160000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 156593.12 | 24674.2441 |
| SW | Large | Low | 160000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150071.3192 | 63432.5207 |
| SW | Small | Mid | 160000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29204.9321 | 160296.0166 | 4192.3927 |
| SW | Medium | Mid | 160000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 157219.2857 | 25960.0878 |
| SW | Large | Mid | 160000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150223.0494 | 62232.2821 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | 160000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30503.2219 | 162109.5074 | 4249.6393 |
| SW | Medium | High | 160000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -859.2921 | 160891.3121 | 23318.614 |
| SW | Large | High | 160000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150570.4554 | 58385.0229 |
| SW | Small | Low | 180000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30133.6436 | 146098.465 | 4186.9389 |
| SW | Medium | Low | 180000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 142076.9559 | 24677.9414 |
| SW | Large | Low | 180000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 135544.3644 | 63485.0017 |
| SW | Small | Mid | 180000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29279.2012 | 145817.234 | 4190.2238 |
| SW | Medium | Mid | 180000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 142702.8819 | 25964.0623 |
| SW | Large | Mid | 180000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 135693.6582 | 62307.2731 |
| SW | Small | High | 180000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30567.8121 | 147627.0909 | 4247.6496 |
| SW | Medium | High | 180000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 142910.1884 | 25518.9507 |
| SW | Large | High | 180000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 136036.1583 | 58506.1043 |
| GW | Small | Low | 200000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 200000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 200000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 200000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 200000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 200000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 200000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 200000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 200000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 220000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 220000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 220000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 220000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 220000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 220000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 220000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 220000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 220000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 240000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 240000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 240000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 240000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 240000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 240000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 240000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 240000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 240000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 260000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 260000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 260000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 260000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 260000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 260000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | 260000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 260000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 260000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 |
| GW | Small | Low | 200000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33798.2383 | 135669.7703 | 4252.67 |
| GW | Medium | Low | 200000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 127746.3893 | 26336.7118 |
| GW | Large | Low | 200000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 122813.4321 | 47131.7902 |
| GW | Small | Mid | 200000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32969.69 | 135405.9409 | 4254.5411 |
| GW | Medium | Mid | 200000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 128303.1611 | 27664.6285 |
| GW | Large | Mid | 200000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 122952.2806 | 45845.4708 |
| GW | Small | High | 200000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34551.2737 | 137315.3692 | 4316.2833 |
| GW | Medium | High | 200000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 128486.8527 | 27234.9565 |
| GW | Large | High | 200000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 123271.2207 | 41784.9972 |
| GW | Small | Low | 220000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33868.8508 | 126196.8521 | 4251.9422 |
| GW | Medium | Low | 220000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -885.8967 | 122157.9913 | 23719.0935 |
| GW | Large | Low | 220000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 113304.8412 | 47171.4792 |
| GW | Small | Mid | 220000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33040.3026 | 125933.0227 | 4253.8132 |
| GW | Medium | Mid | 220000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -896.4758 | 122761.3683 | 25015.6484 |
| GW | Large | Mid | 220000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 113442.0975 | 45901.667 |
| GW | Small | High | 220000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34634.165 | 127847.5618 | 4315.1813 |
| GW | Medium | High | 220000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -949.9843 | 123180.9943 | 24428.3505 |
| GW | Large | High | 220000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 113757.8195 | 41875.5432 |
| GW | Small | Low | 240000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33956.2504 | 118312.7024 | 4250.6317 |
| GW | Medium | Low | 240000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110326.9847 | 26341.5783 |
| GW | Large | Low | 240000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 105381.0235 | 47204.4006 |
| GW | Small | Mid | 240000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33127.7021 | 118048.8729 | 4252.5027 |
| GW | Medium | Mid | 240000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110883.6108 | 27669.1069 |
| GW | Large | Mid | 240000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 105516.9518 | 45948.4232 |
| GW | Small | High | 240000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34713.1249 | 119959.5503 | 4314.0969 |
| GW | Medium | High | 240000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 111066.4262 | 27240.6392 |
| GW | Large | High | 240000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 105829.9857 | 41951.0947 |
| GW | Small | Low | 260000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34011.6325 | 111633.5752 | 4250.2699 |
| GW | Medium | Low | 260000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -887.4488 | 107547.1826 | 23718.5241 |
| GW | Large | Low | 260000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 98676.2546 | 47232.1872 |
| GW | Small | Mid | 260000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33183.0843 | 111369.7458 | 4252.1409 |
| GW | Medium | Mid | 260000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -898.0611 | 108150.6294 | 25014.7053 |
| GW | Large | Mid | 260000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 98811.0468 | 45988.4927 |
| GW | Small | High | 260000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34768.944 | 113282.5745 | 4313.5132 |
| GW | Medium | High | 260000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -951.5776 | 108569.3121 | 24428.6524 |
| GW | Large | High | 260000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 99121.8235 | 42014.7232 |
| SW | Small | Low | 200000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 200000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 200000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 200000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 200000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 200000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | |
| SW | Small | High | 200000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 | |
| SW | Medium | High | 200000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 | |
| SW | Large | High | 200000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 | |
| SW | Small | Low | 220000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 | |
| SW | Medium | Low | 220000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 | |
| SW | Large | Low | 220000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 | |
| SW | Small | Mid | 220000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 | |
| SW | Medium | Mid | 220000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 | |
| SW | Large | Mid | 220000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 | |
| SW | Small | High | 220000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 | |
| SW | Medium | High | 220000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 | |
| SW | Large | High | 220000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 | |
| SW | Small | Low | 240000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 | |
| SW | Medium | Low | 240000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 | |
| SW | Large | Low | 240000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 | |
| SW | Small | Mid | 240000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 | |
| SW | Medium | Mid | 240000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 | |
| SW | Large | Mid | 240000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 | |
| SW | Small | High | 240000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 | |
| SW | Medium | High | 240000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 | |
| SW | Large | High | 240000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 | |
| SW | Small | Low | 260000 | non-haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 | |
| SW | Medium | Low | 260000 | non-haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 | |
| SW | Large | Low | 260000 | non-haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 | |
| SW | Small | Mid | 260000 | non-haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 | |
| SW | Medium | Mid | 260000 | non-haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 | |
| SW | Large | Mid | 260000 | non-haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 | |
| SW | Small | High | 260000 | non-haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 | |
| SW | Medium | High | 260000 | non-haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 | |
| SW | Large | High | 260000 | non-haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.5931 | 693862.3754 | 3816961.127 | |
| SW | Small | Low | 200000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30194.3778 | 134516.8087 | 4184.8201 | |
| SW | Medium | Low | 200000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -793.8364 | 133664.2158 | 22652.5618 | |
| SW | Large | Low | 200000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 123922.8044 | 63526.8681 | |
| SW | Small | Mid | 200000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29351.5556 | 134239.4948 | 4188.0403 | |
| SW | Medium | Mid | 200000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -797.8781 | 134306.2869 | 23928.0697 | |
| SW | Large | Mid | 200000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 124070.1545 | 62367.0703 | |
| SW | Small | High | 200000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30627.7053 | 136044.6805 | 4245.5961 | |
| SW | Medium | High | 200000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -862.6789 | 134774.1228 | 23318.4116 | |
| SW | Large | High | 200000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 124408.7274 | 58602.6347 | |
| SW | Small | Low | 220000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30232.6951 | 125034.6276 | 4183.5207 | |
| SW | Medium | Low | 220000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -795.1449 | 124167.9595 | 22651.7415 | |
| SW | Large | Low | 220000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 114414.2607 | 63560.9425 | |
| SW | Small | Mid | 220000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29389.8729 | 124757.3137 | 4186.741 | |
| SW | Medium | Mid | 220000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 121588.2765 | 25969.0497 | |
| SW | Large | Mid | 220000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 114560.0013 | 62416.3472 | |

**Cost Equation Parameters for IX**

| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW | Small | High | 220000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30680.8907 | 126568.1362 | 4244.1152 |
| SW | Medium | High | 220000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 121794.5032 | 25525.6587 |
| SW | Large | High | 220000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 114895.3639 | 58681.9855 |
| SW | Small | Low | 240000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 34111.3809 | -48204.2389 | 119495.4572 | 4125.4844 |
| SW | Medium | Low | 240000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -796.0656 | 116253.8965 | 22651.0577 |
| SW | Large | Low | 240000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 106490.4701 | 63589.5704 |
| SW | Small | Mid | 240000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29437.7121 | 116863.1798 | 4185.3777 |
| SW | Medium | Mid | 240000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -800.0942 | 116895.6647 | 23926.6584 |
| SW | Large | Mid | 240000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 106634.8768 | 62457.2321 |
| SW | Small | High | 240000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30730.8174 | 118673.543 | 4242.7044 |
| SW | Medium | High | 240000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -864.7682 | 117362.0011 | 23318.7766 |
| SW | Large | High | 240000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 106967.5648 | 58748.0391 |
| SW | Small | Low | 260000 | non-haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30306.5688 | 110454.9454 | 4181.2444 |
| SW | Medium | Low | 260000 | non-haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 106344.9169 | 24686.9299 |
| SW | Large | Low | 260000 | non-haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 99785.7195 | 63613.8768 |
| SW | Small | Mid | 260000 | non-haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -29468.7854 | 110179.2654 | 4184.4506 |
| SW | Medium | Mid | 260000 | non-haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 106970.4309 | 25972.8474 |
| SW | Large | Mid | 260000 | non-haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 99929.01 | 62491.7234 |
| SW | Small | High | 260000 | non-haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30745.8108 | 111984.3804 | 4241.9855 |
| SW | Medium | High | 260000 | non-haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 107175.8448 | 25530.443 |
| SW | Large | High | 260000 | non-haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100259.4392 | 58803.5869 |
| GW | Small | Low | 20000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 20000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 20000 | haz | Total Capital | 36.495 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -150.8093 | 522541.2956 | 2067509.667 |
| GW | Small | Mid | 20000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 20000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 20000 | haz | Total Capital | 36.026 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -172.5454 | 543990.233 | 2331807.921 |
| GW | Small | High | 20000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 20000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 20000 | haz | Total Capital | 36.195 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -256.1575 | 703098.5076 | 3662722.799 |
| GW | Small | Low | 40000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 40000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 40000 | haz | Total Capital | 36.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -149.4315 | 522210.043 | 2074641.74 |
| GW | Small | Mid | 40000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 40000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 40000 | haz | Total Capital | 36.053 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -176.9949 | 544836.3714 | 2291858.692 |
| GW | Small | High | 40000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 40000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 40000 | haz | Total Capital | 36.205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -207.7629 | 694310.5292 | 3821848.318 |
| GW | Small | Low | 60000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 60000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 60000 | haz | Total Capital | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -153.5159 | 522888.5227 | 2051140.741 |
| GW | Small | Mid | 60000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 60000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 60000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -154.1836 | 540604.4527 | 2370857.899 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | 60000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 60000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 60000 | haz | Total Capital | 36.205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -209.2425 | 694462.7254 | 3819392.301 |
| GW | Small | Low | 80000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 80000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 80000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 80000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 80000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 80000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 80000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 80000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 80000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 100000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 100000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 100000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 100000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 100000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 100000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 100000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 100000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 100000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 20000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1132465.103 | 13709.2584 |
| GW | Medium | Low | 20000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1137724.597 | 31072.6805 |
| GW | Large | Low | 20000 | haz | Annual O&M | 36.495 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2292.4161 | 1126369.202 | 25983.9344 |
| GW | Small | Mid | 20000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1132470.871 | 13692.0872 |
| GW | Medium | Mid | 20000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1138294.683 | 32403.5805 |
| GW | Large | Mid | 20000 | haz | Annual O&M | 36.026 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2295.4536 | 1126398.055 | 26004.3217 |
| GW | Small | High | 20000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1133864.645 | 13773.7777 |
| GW | Medium | High | 20000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1138531.44 | 31895.4706 |
| GW | Large | High | 20000 | haz | Annual O&M | 36.195 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2303.1177 | 1126282.481 | 30701.0611 |
| GW | Small | Low | 40000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -50293.4697 | 592728.4597 | 8559.9633 |
| GW | Medium | Low | 40000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 580477.7028 | 28717.9842 |
| GW | Large | Low | 40000 | haz | Annual O&M | 36.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1148.4666 | 572123.0632 | 39211.2295 |
| GW | Small | Mid | 40000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -48983.9971 | 592307.5766 | 8563.7776 |
| GW | Medium | Mid | 40000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 581040.3428 | 30047.5296 |
| GW | Large | Mid | 40000 | haz | Annual O&M | 36.053 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1152.5943 | 571987.8749 | 41646.3404 |
| GW | Small | High | 40000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -50566.9793 | 594219.927 | 8625.1866 |
| GW | Medium | High | 40000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 581247.8772 | 29582.3025 |
| GW | Large | High | 40000 | haz | Annual O&M | 36.205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1147.9067 | 572899.984 | 34073.9924 |
| GW | Small | Low | 60000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 122493.1151 | -108031.2566 | 413657.567 | 6942.6325 |
| GW | Medium | Low | 60000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 394728.8393 | 27933.0818 |
| GW | Large | Low | 60000 | haz | Annual O&M | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 767.0541 | 387365.3749 | 44057.421 |
| GW | Small | Mid | 60000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 108982.9597 | -99949.046 | 412409.3797 | 6965.3688 |
| GW | Medium | Mid | 60000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 395288.9627 | 29262.1589 |
| GW | Large | Mid | 60000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 763.6199 | 387888.1306 | 39523.5666 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | 60000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 109900.112 | -102007.6368 | 414379.5813 | 7025.9161 |
| GW | Medium | High | 60000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 395486.6706 | 28811.3389 |
| GW | Large | High | 60000 | haz | Annual O&M | 36.205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 768.0014 | 387922.1561 | 39429.2806 |
| GW | Small | Low | 80000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -42504.0836 | 312121.9359 | 6400.8146 |
| GW | Medium | Low | 80000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 301854.2032 | 27541.0821 |
| GW | Large | Low | 80000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 572.6012 | 295345.0426 | 42721.5719 |
| GW | Small | Mid | 80000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -41454.9632 | 311786.0448 | 6403.5835 |
| GW | Medium | Mid | 80000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 302413.2703 | 28869.4486 |
| GW | Large | Mid | 80000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 574.1815 | 295383.6898 | 42554.8397 |
| GW | Small | High | 80000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -43043.0386 | 313698.7428 | 6465.0197 |
| GW | Medium | High | 80000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 302606.0853 | 28425.7369 |
| GW | Large | High | 80000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 576.2445 | 295568.8722 | 41776.6191 |
| GW | Small | Low | 100000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -40944.0833 | 256000.1505 | 5968.7789 |
| GW | Medium | Low | 100000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 246129.6134 | 27305.3883 |
| GW | Large | Low | 100000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 459.0429 | 239842.7739 | 44540.9458 |
| GW | Small | Mid | 100000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -39948.0553 | 255681.6708 | 5971.3172 |
| GW | Medium | Mid | 100000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 246687.8583 | 28633.8044 |
| GW | Large | Mid | 100000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 460.5186 | 239881.0109 | 44374.0576 |
| GW | Small | High | 100000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -41534.8612 | 257594.0324 | 6032.9111 |
| GW | Medium | High | 100000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 246877.8538 | 28194.3394 |
| GW | Large | High | 100000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 462.6563 | 240046.7066 | 43453.3144 |
| GW | Small | Low | 120000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 120000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 120000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 120000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 120000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 120000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 120000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 120000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 120000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 140000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 140000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 140000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 140000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 140000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 140000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 140000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 140000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 140000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 160000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 160000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 160000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 160000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 160000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 160000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |

**Cost Equation Parameters for IX**

| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW | Small | High | 160000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 160000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 160000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 180000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 180000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 180000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 180000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 180000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 180000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 180000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 180000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 180000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 120000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -39896.7686 | 218582.633 | 5681.1796 |
| GW | Medium | Low | 120000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 208979.7041 | 27148.6036 |
| GW | Large | Low | 120000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 383.3372 | 202841.2893 | 45753.4555 |
| GW | Small | Mid | 120000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -38933.8646 | 218274.8432 | 5683.612 |
| GW | Medium | Mid | 120000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 209537.5087 | 28476.8022 |
| GW | Large | Mid | 120000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 384.7431 | 202879.2466 | 45586.4222 |
| GW | Small | High | 120000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -40522.3364 | 220188.9822 | 5744.9019 |
| GW | Medium | High | 120000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 209725.5435 | 28040.1752 |
| GW | Large | High | 120000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 386.9311 | 203031.9133 | 44571.1588 |
| GW | Small | Low | 140000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -39166.0171 | 191862.1159 | 5475.3864 |
| GW | Medium | Low | 140000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 182444.1765 | 27036.4567 |
| GW | Large | Low | 140000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 329.262 | 176411.6174 | 46620.0948 |
| GW | Small | Mid | 140000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -38228.0344 | 191562.5998 | 5477.6885 |
| GW | Medium | Mid | 140000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 183001.5174 | 28364.7147 |
| GW | Large | Mid | 140000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 330.6177 | 176449.4169 | 46452.4731 |
| GW | Small | High | 140000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -39810.4962 | 193474.0953 | 5539.2778 |
| GW | Medium | High | 140000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 183188.2598 | 27929.9142 |
| GW | Large | High | 140000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 332.8416 | 176592.7649 | 45370.0295 |
| GW | Small | Low | 160000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -38609.9431 | 171819.5852 | 5321.0546 |
| GW | Medium | Low | 160000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -796.2984 | 166059.8652 | 24597.289 |
| GW | Large | Low | 160000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 288.7054 | 156589.3905 | 47269.6799 |
| GW | Small | Mid | 160000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -37695.1785 | 171527.6546 | 5323.2621 |
| GW | Medium | Mid | 160000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -806.4886 | 166661.8556 | 25895.464 |
| GW | Large | Mid | 160000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 290.0236 | 156627.0422 | 47102.2133 |
| GW | Small | High | 160000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -39268.8513 | 173436.0934 | 5384.8829 |
| GW | Medium | High | 160000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 209.888 | -2362.5219 | 170039.7217 | 23969.6138 |
| GW | Large | High | 160000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 292.2746 | 156763.4065 | 45968.9184 |
| GW | Small | Low | 180000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 78068.9263 | -78282.0736 | 161326.5979 | 5087.8603 |
| GW | Medium | Low | 180000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 147063.4792 | 26886.8773 |
| GW | Large | Low | 180000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 257.1614 | 141172.0956 | 47774.9908 |
| GW | Small | Mid | 180000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -37272.9131 | 155941.3656 | 5203.2539 |
| GW | Medium | Mid | 180000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 147620.3149 | 28215.2097 |
| GW | Large | Mid | 180000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 258.4507 | 141209.6341 | 47607.4356 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | 180000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -38861.8381 | 157854.8108 | 5264.8788 |
| GW | Medium | High | 180000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 147805.0507 | 27783.2698 |
| GW | Large | High | 180000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 260.7223 | 141340.5837 | 46434.6796 |
| GW | Small | Low | 200000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 200000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 200000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 200000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 200000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 200000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 200000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 200000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 200000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 220000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 220000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 220000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 220000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 220000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 220000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 220000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 220000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 220000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 240000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 240000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 240000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 240000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 240000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 240000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 240000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 240000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 240000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 260000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| GW | Medium | Low | 260000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| GW | Large | Low | 260000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| GW | Small | Mid | 260000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| GW | Medium | Mid | 260000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| GW | Large | Mid | 260000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| GW | Small | High | 260000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| GW | Medium | High | 260000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| GW | Large | High | 260000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| GW | Small | Low | 200000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -37831.5372 | 143758.8355 | 5105.2822 |
| GW | Medium | Low | 200000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -816.2719 | 138285.6377 | 24420.5624 |
| GW | Large | Low | 200000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 231.9265 | 128838.2344 | 48179.5795 |
| GW | Small | Mid | 200000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -36939.9907 | 143474.4904 | 5107.3952 |
| GW | Medium | Mid | 200000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -826.5915 | 138887.9876 | 25718.2024 |
| GW | Large | Mid | 200000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 233.1925 | 128875.6834 | 48011.898 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | High | 200000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -38518.7319 | 145385.5363 | 5168.6993 |
| GW | Medium | High | 200000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -880.7598 | 139311.2399 | 25127.3351 |
| GW | Large | High | 200000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 235.4805 | 129002.3241 | 46807.4062 |
| GW | Small | Low | 220000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -37540.5642 | 133552.1076 | 5026.6995 |
| GW | Medium | Low | 220000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 124548.3337 | 26791.8558 |
| GW | Large | Low | 220000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 211.2795 | 118746.9247 | 48510.2016 |
| GW | Small | Mid | 220000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -36660.6268 | 133271.5551 | 5028.7653 |
| GW | Medium | Mid | 220000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 125105.0141 | 28119.9349 |
| GW | Large | Mid | 220000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 212.5263 | 118784.2966 | 48342.5463 |
| GW | Small | High | 220000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -38245.2789 | 135183.9941 | 5090.3023 |
| GW | Medium | High | 220000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 125288.4993 | 27690.1004 |
| GW | Large | High | 220000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 214.8279 | 118907.3981 | 47112.1926 |
| GW | Small | Low | 240000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 72528.9363 | -74565.592 | 129783.4891 | 4856.3968 |
| GW | Medium | Low | 240000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -829.4844 | 119769.0458 | 24303.2381 |
| GW | Large | Low | 240000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 194.0736 | 110337.4978 | 48785.7821 |
| GW | Small | Mid | 240000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 61702.8777 | -68129.2204 | 128797.7545 | 4874.1543 |
| GW | Medium | Mid | 240000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 116661.7765 | 28084.2212 |
| GW | Large | Mid | 240000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 195.3045 | 110374.8269 | 48617.6724 |
| GW | Small | High | 240000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -38012.8869 | 126681.6138 | 5024.8796 |
| GW | Medium | High | 240000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -894.0657 | 120794.0535 | 25010.5832 |
| GW | Large | High | 240000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 197.6175 | 110494.9585 | 47365.7587 |
| GW | Small | Low | 260000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -37096.1693 | 117851.5198 | 4906.1034 |
| GW | Medium | Low | 260000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -834.6212 | 112647.6343 | 24257.6439 |
| GW | Large | Low | 260000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 179.5149 | 103221.8169 | 49019.1355 |
| GW | Small | Mid | 260000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -36221.1848 | 117572.5195 | 4908.1634 |
| GW | Medium | Mid | 260000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -845.2031 | 113250.7518 | 25554.3797 |
| GW | Large | Mid | 260000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 180.7325 | 103259.0856 | 48851.0268 |
| GW | Small | High | 260000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -37809.7182 | 119484.8867 | 4969.6955 |
| GW | Medium | High | 260000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -899.1682 | 113671.8617 | 24966.0901 |
| GW | Large | High | 260000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 183.0554 | 103376.6913 | 47581.3258 |
| SW | Small | Low | 20000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 20000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 20000 | haz | Total Capital | 36.495 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -150.8093 | 522541.2956 | 2067509.667 |
| SW | Small | Mid | 20000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 20000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 20000 | haz | Total Capital | 36.026 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -172.5454 | 543990.233 | 2331807.921 |
| SW | Small | High | 20000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 20000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 20000 | haz | Total Capital | 36.195 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -256.1575 | 703098.5076 | 3662722.799 |
| SW | Small | Low | 40000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 40000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 40000 | haz | Total Capital | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -152.0363 | 522736.3265 | 2053596.758 |
| SW | Small | Mid | 40000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 40000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 40000 | haz | Total Capital | 36.053 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -176.9949 | 544836.3714 | 2291858.692 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | 40000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 40000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 40000 | haz | Total Capital | 36.205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -207.7629 | 694310.5292 | 3821848.318 |
| SW | Small | Low | 60000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 60000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 60000 | haz | Total Capital | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -153.5159 | 522888.5227 | 2051140.741 |
| SW | Small | Mid | 60000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 60000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 60000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -154.1836 | 540604.4527 | 2370857.899 |
| SW | Small | High | 60000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 60000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 60000 | haz | Total Capital | 36.205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -209.2425 | 694462.7254 | 3819392.301 |
| SW | Small | Low | 80000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 80000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 80000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 80000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 80000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 80000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 80000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 80000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 80000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 100000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 100000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 100000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 100000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 100000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 100000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 100000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 100000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 100000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 20000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1127565.43 | 15190.8237 |
| SW | Medium | Low | 20000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1140259.936 | 29511.3306 |
| SW | Large | Low | 20000 | haz | Annual O&M | 36.495 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2333.0175 | 1136975.889 | -11493.1372 |
| SW | Small | Mid | 20000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1127567.203 | 15173.3724 |
| SW | Medium | Mid | 20000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1140898.477 | 30801.3688 |
| SW | Large | Mid | 20000 | haz | Annual O&M | 36.026 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2336.4828 | 1137005.279 | -11422.7473 |
| SW | Small | High | 20000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1128945.407 | 15248.5963 |
| SW | Medium | High | 20000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1141160.969 | 30277.7233 |
| SW | Large | High | 20000 | haz | Annual O&M | 36.195 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2344.6023 | 1136936.744 | -7684.5959 |
| SW | Small | Low | 40000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -40372.6016 | 587279.479 | 9332.6657 |
| SW | Medium | Low | 40000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 583103.929 | 27109.2544 |
| SW | Large | Low | 40000 | haz | Annual O&M | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1160.0166 | 578626.5735 | 22700.2023 |
| SW | Small | Mid | 40000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -39013.455 | 586828.1732 | 9338.745 |
| SW | Medium | Mid | 40000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 583735.3861 | 28397.2601 |
| SW | Large | Mid | 40000 | haz | Annual O&M | 36.053 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1163.4006 | 578598.4996 | 23151.8542 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | 40000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -40309.8755 | 588640.9229 | 9396.0306 |
| SW | Medium | High | 40000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 583967.0983 | 27917.0455 |
| SW | Large | High | 40000 | haz | Annual O&M | 36.205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1158.1616 | 579538.7787 | 16218.4027 |
| SW | Small | Low | 60000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -37152.7767 | 401607.3829 | 7611.0782 |
| SW | Medium | Low | 60000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 397385.341 | 26308.5463 |
| SW | Large | Low | 60000 | haz | Annual O&M | 36.511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 767.7803 | 392611.2986 | 32435.4587 |
| SW | Small | Mid | 60000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -35984.5909 | 401220.3866 | 7616.1089 |
| SW | Medium | Mid | 60000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 398014.4663 | 27595.6301 |
| SW | Large | Mid | 60000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 764.2051 | 393129.1073 | 28511.9361 |
| SW | Small | High | 60000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -37262.9915 | 403025.1764 | 7673.7138 |
| SW | Medium | High | 60000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 398235.9186 | 27129.9121 |
| SW | Large | High | 60000 | haz | Annual O&M | 36.205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 768.6568 | 393203.101 | 28120.3998 |
| SW | Small | Low | 80000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -35529.903 | 308766.4718 | 6750.4741 |
| SW | Medium | Low | 80000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -550.8987 | 306746.7604 | 24500.7429 |
| SW | Large | Low | 80000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 568.3848 | 299893.0895 | 34981.0376 |
| SW | Small | Mid | 80000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34454.6782 | 308410.8133 | 6754.9876 |
| SW | Medium | Mid | 80000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -553.8979 | 307386.7869 | 25779.6526 |
| SW | Large | Mid | 80000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 569.9745 | 299948.3367 | 34755.1763 |
| SW | Small | High | 80000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -35743.6805 | 310220.6897 | 6812.4206 |
| SW | Medium | High | 80000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 305370.2349 | 26736.6176 |
| SW | Large | High | 80000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 572.2209 | 300151.5081 | 33937.4031 |
| SW | Small | Low | 100000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34556.6593 | 253061.8726 | 6234.2492 |
| SW | Medium | Low | 100000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 248810.5844 | 25667.8628 |
| SW | Large | Low | 100000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 451.9539 | 243985.4043 | 38725.1007 |
| SW | Small | Mid | 100000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33532.9539 | 252723.5169 | 6238.49 |
| SW | Medium | Mid | 100000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 249437.6047 | 26954.651 |
| SW | Large | Mid | 100000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 453.4356 | 244039.9172 | 38500.5095 |
| SW | Small | High | 100000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34817.9626 | 254531.5492 | 6296.0361 |
| SW | Medium | High | 100000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 249650.8648 | 26500.6689 |
| SW | Large | High | 100000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 455.731 | 244225.8463 | 37536.9871 |
| SW | Small | Low | 120000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 120000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 120000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 120000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 120000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 120000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 120000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 120000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 120000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 140000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 140000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 140000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 140000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 140000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 140000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | 140000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 140000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 140000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 160000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 160000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 160000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 160000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 160000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 160000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 160000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 160000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 160000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 180000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 180000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 180000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 180000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 180000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 180000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 180000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 180000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 180000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 120000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33900.4382 | 215924.0368 | 5890.0342 |
| SW | Medium | Low | 120000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 211666.7607 | 25507.7665 |
| SW | Large | Low | 120000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 374.3328 | 206713.6466 | 41220.6732 |
| SW | Small | Mid | 120000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32918.1745 | 215599.7161 | 5894.0304 |
| SW | Medium | Mid | 120000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 212293.369 | 26794.4102 |
| SW | Large | Mid | 120000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 375.7431 | 206767.6276 | 40997.6054 |
| SW | Small | High | 120000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -34205.6675 | 217407.2924 | 5951.6382 |
| SW | Medium | High | 120000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 212504.7011 | 26343.0173 |
| SW | Large | High | 120000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 378.0706 | 206942.1029 | 39936.2611 |
| SW | Small | Low | 140000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33439.3211 | 189399.3522 | 5644.1269 |
| SW | Medium | Low | 140000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -660.5507 | 187798.374 | 23705.5598 |
| SW | Large | Low | 140000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 318.8896 | 180090.9314 | 43003.9659 |
| SW | Small | Mid | 140000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32480.2976 | 189082.8661 | 5647.9938 |
| SW | Medium | Mid | 140000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -664.1618 | 188439.1035 | 24982.8715 |
| SW | Large | Mid | 140000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 320.2488 | 180144.5379 | 42781.5828 |
| SW | Small | High | 140000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33769.9418 | 190891.5498 | 5705.6276 |
| SW | Medium | High | 140000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -730.1226 | 188914.9671 | 24365.1968 |
| SW | Large | High | 140000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 322.5993 | 180310.8197 | 41650.5338 |
| SW | Small | Low | 160000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 63488.5129 | -66457.9691 | 173889.5337 | 5354.3148 |
| SW | Medium | Low | 160000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 165237.1063 | 25307.4841 |
| SW | Large | Low | 160000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 277.307 | 160123.92 | 44340.8107 |
| SW | Small | Mid | 160000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32146.4113 | 169192.4714 | 5463.6098 |
| SW | Medium | Mid | 160000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 165863.1827 | 26593.8867 |
| SW | Large | Mid | 160000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 278.6275 | 160177.2595 | 44119.0894 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | 160000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33437.2181 | 171001.8918 | 5521.288 |
| SW | Medium | High | 160000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 166071.8611 | 26146.4553 |
| SW | Large | High | 160000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 280.9959 | 160337.3635 | 42936.0562 |
| SW | Small | Low | 180000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32817.3744 | 154030.5068 | 5316.3073 |
| SW | Medium | Low | 180000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 149760.5538 | 25240.7839 |
| SW | Large | Low | 180000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 244.965 | 144594.0105 | 45380.8076 |
| SW | Small | Mid | 180000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -31893.2113 | 153725.7723 | 5319.9801 |
| SW | Medium | Mid | 180000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150386.333 | 26527.2055 |
| SW | Large | Mid | 180000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 246.2556 | 144647.1468 | 45159.37 |
| SW | Small | High | 180000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -33193.2691 | 155537.8739 | 5377.427 |
| SW | Medium | High | 180000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150594.2405 | 26080.9857 |
| SW | Large | High | 180000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 248.6372 | 144802.4835 | 43935.5475 |
| SW | Small | Low | 200000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 200000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 200000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 200000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 200000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 200000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 200000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 200000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 200000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 220000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 220000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 220000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 220000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 220000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 220000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 220000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 220000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 220000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 240000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 240000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 240000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 240000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 240000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 240000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |
| SW | Small | High | 240000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 240000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 240000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 260000 | haz | Total Capital | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | -123193.7377 | -79962.4309 | 875448.755 | 145384.5687 |
| SW | Medium | Low | 260000 | haz | Total Capital | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -6421.767 | 658890.1107 | 1055907.247 |
| SW | Large | Low | 260000 | haz | Total Capital | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -142.3532 | 520600.7049 | 2094177.562 |
| SW | Small | Mid | 260000 | haz | Total Capital | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 279001.2156 | -684702.7894 | 1114657.33 | 181484.5646 |
| SW | Medium | Mid | 260000 | haz | Total Capital | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -10424.7434 | 738369.9087 | 1145973.904 |
| SW | Large | Mid | 260000 | haz | Total Capital | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -156.1913 | 540836.1859 | 2366805.87 |

| Cost Equation Parameters for IX | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Bed Volumes | Spent Media | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | High | 260000 | haz | Total Capital | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 942863.789 | -1917858.317 | 2035549.745 | 296537.0341 |
| SW | Medium | High | 260000 | haz | Total Capital | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -11186.2438 | 943432.6253 | 1827403.638 |
| SW | Large | High | 260000 | haz | Total Capital | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -205.4211 | 693814.6627 | 3820071.758 |
| SW | Small | Low | 200000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32612.8967 | 141654.1386 | 5201.6989 |
| SW | Medium | Low | 200000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 137379.3115 | 25187.6006 |
| SW | Large | Low | 200000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 219.0913 | 132170.0842 | 46212.6382 |
| SW | Small | Mid | 200000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -31700.3538 | 141353.3214 | 5205.3071 |
| SW | Medium | Mid | 200000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 138005.0096 | 26473.7442 |
| SW | Large | Mid | 200000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 220.3583 | 132223.0395 | 45991.888 |
| SW | Small | High | 200000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 47582.6992 | -58001.1186 | 146451.4913 | 5183.5116 |
| SW | Medium | High | 200000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 138212.1074 | 26028.447 |
| SW | Large | High | 200000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 222.7507 | 132374.5332 | 44735.9563 |
| SW | Small | Low | 220000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32443.0172 | 131529.127 | 5107.445 |
| SW | Medium | Low | 220000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 127249.091 | 25143.9686 |
| SW | Large | Low | 220000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 197.922 | 122005.0527 | 46893.7223 |
| SW | Small | Mid | 220000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -31547.1331 | 131233.8608 | 5110.9746 |
| SW | Medium | Mid | 220000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 127874.7079 | 26430.1872 |
| SW | Large | Mid | 220000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 199.1691 | 122057.8891 | 46672.7612 |
| SW | Small | High | 220000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32824.4526 | 133038.9559 | 5168.6688 |
| SW | Medium | High | 220000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -782.9687 | 131237.5948 | 23985.0851 |
| SW | Large | High | 220000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 201.5707 | 122206.2415 | 45390.2146 |
| SW | Small | Low | 240000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32286.9815 | 123086.1834 | 5029.46 |
| SW | Medium | Low | 240000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 118807.5267 | 25107.196 |
| SW | Large | Low | 240000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 180.2811 | 113534.1838 | 47460.8947 |
| SW | Small | Mid | 240000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -31396.1364 | 122792.551 | 5032.9755 |
| SW | Medium | Mid | 240000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 119432.8595 | 26393.5887 |
| SW | Large | Mid | 240000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 181.5122 | 113586.8837 | 47240.2875 |
| SW | Small | High | 240000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32686.3565 | 124602.8057 | 5090.3449 |
| SW | Medium | High | 240000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 119639.0762 | 25949.6259 |
| SW | Large | High | 240000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 183.9209 | 113732.6369 | 45935.8979 |
| SW | Small | Low | 260000 | haz | Annual O&M | 18.625 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -32150.6672 | 115941.1012 | 4963.2928 |
| SW | Medium | Low | 260000 | haz | Annual O&M | 34.653 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 111664.4849 | 25076.5171 |
| SW | Large | Low | 260000 | haz | Annual O&M | 36.516 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 165.3538 | 106366.5505 | 47940.7627 |
| SW | Small | Mid | 260000 | haz | Annual O&M | 19.55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -31266.4033 | 115649.7522 | 4966.7577 |
| SW | Medium | Mid | 260000 | haz | Annual O&M | 34.335 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 112289.8773 | 26362.694 |
| SW | Large | Mid | 260000 | haz | Annual O&M | 36.058 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 166.5714 | 106419.1291 | 47720.7135 |
| SW | Small | High | 260000 | haz | Annual O&M | 21.435 | 0 | 0 | 0 | 0 | 0 | 0 | 42655.2744 | -54989.4188 | 120410.252 | 4953.2804 |
| SW | Medium | High | 260000 | haz | Annual O&M | 35.459 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -797.2389 | 115709.1932 | 23882.7022 |
| SW | Large | High | 260000 | haz | Annual O&M | 36.211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 168.9858 | 106562.7197 | 46396.821 |

# A.3 Capital and Annual O&M Cost Equation Parameters for RO/NF

| Cost Equation Parameters for RO/NF | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| GW | Small | Low | Total Capital | 23.115 | 0 | 0 | 0 | 0 | 0 | 0 | 437053.0639 | -1156916.569 | 1967488.564 | 1463918.156 |
| GW | Medium | Low | Total Capital | 28.99411765 | 0 | 0 | 0 | 0 | 0 | 0 | -2261.2437 | 7544.8133 | 1088868.815 | 2219118.011 |
| GW | Large | Low | Total Capital | 29.67368421 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -162.9871 | 693831.825 | 4788367.47 |
| GW | Small | Mid | Total Capital | 22.415 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1133971.613 | 2808082.31 | 1573876.809 |
| GW | Medium | Mid | Total Capital | 27.92941176 | 0 | 0 | 0 | 0 | 0 | 0 | -2783.24 | 10761.4023 | 1266677.024 | 2868082.839 |
| GW | Large | Mid | Total Capital | 28.66315789 | 0 | 0 | 0 | 0 | 0 | 0 | 12.7538 | -3409.4027 | 916678.3253 | 5223375.504 |
| GW | Small | High | Total Capital | 25.465 | 0 | 0 | 0 | 0 | 0 | 0 | 712817.9297 | -2529832.211 | 3763165.486 | 1868182.212 |
| GW | Medium | High | Total Capital | 30.34705882 | 0 | 0 | 0 | 0 | 0 | 0 | -2435.4521 | 2389.2312 | 1333865.778 | 3447474.127 |
| GW | Large | High | Total Capital | 30.17894737 | 0 | 0 | 0 | 0 | 0 | 0 | 3.8507 | -1269.4529 | 844084.419 | 6296610.515 |
| GW | Small | Low | Annual O&M | 23.115 | 0 | 0 | 0 | 0 | 0 | 0 | 2063047.154 | -897216.0192 | 484242.8872 | 44574.8113 |
| GW | Medium | Low | Annual O&M | 28.99411765 | 0 | 0 | 0 | 0 | 0 | 0 | 13193.5845 | -122763.9786 | 653229.2641 | -34056.4398 |
| GW | Large | Low | Annual O&M | 29.67368421 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7065 | -968.2361 | 282811.6573 | 375801.5896 |
| GW | Small | Mid | Annual O&M | 22.415 | 0 | 0 | 0 | 0 | 0 | 0 | 2057176.273 | -893150.114 | 483387.94 | 44626.9484 |
| GW | Medium | Mid | Annual O&M | 27.92941176 | 0 | 0 | 0 | 0 | 0 | 0 | 13193.5845 | -122763.9786 | 653229.2641 | -34056.4398 |
| GW | Large | Mid | Annual O&M | 28.66315789 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7065 | -968.2361 | 282811.6573 | 375801.5896 |
| GW | Small | High | Annual O&M | 25.465 | 0 | 0 | 0 | 0 | 0 | 0 | 2067561.843 | -900342.6879 | 484900.339 | 44534.718 |
| GW | Medium | High | Annual O&M | 30.34705882 | 0 | 0 | 0 | 0 | 0 | 0 | 13193.5845 | -122763.9786 | 653229.2641 | -34056.4398 |
| GW | Large | High | Annual O&M | 30.17894737 | 0 | 0 | 0 | 0 | 0 | 0 | 6.7065 | -968.2361 | 282811.6573 | 375801.5896 |
| SW | Small | Low | Total Capital | 23.17 | 0 | 0 | 0 | 0 | 0 | 0 | 792516.8148 | -2008873.791 | 2491357.216 | 1428953.402 |
| SW | Medium | Low | Total Capital | 29.3 | 0 | 0 | 0 | 0 | 0 | 0 | 3012.7737 | -81899.4104 | 1466243.733 | 1847192.192 |
| SW | Large | Low | Total Capital | 30.78947368 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -290.3761 | 644985.4841 | 4675860.549 |
| SW | Small | Mid | Total Capital | 22.445 | 0 | 0 | 0 | 0 | 0 | 0 | 4158066.618 | -7581773.041 | 5272114.206 | 1424299.434 |
| SW | Medium | Mid | Total Capital | 28.21764706 | 0 | 0 | 0 | 0 | 0 | 0 | 10041.0742 | -208062.7703 | 2260952.426 | 1637438.777 |
| SW | Large | Mid | Total Capital | 29.5 | 0 | 0 | 0 | 0 | 0 | 0 | 8.3787 | -2744.4363 | 851006.8369 | 4837119.648 |
| SW | Small | High | Total Capital | 25.54 | 0 | 0 | 0 | 0 | 0 | 0 | 2628171.02 | -5820941.321 | 5245655.252 | 1790788.574 |
| SW | Medium | High | Total Capital | 30.46470588 | 0 | 0 | 0 | 0 | 0 | 0 | 7631.6394 | -169559.7783 | 2107573.492 | 2557744.787 |
| SW | Large | High | Total Capital | 31.04210526 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -484.018 | 737323.2359 | 6841317.778 |
| SW | Small | Low | Annual O&M | 23.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -153633.167 | 551973.2284 | 45651.642 |
| SW | Medium | Low | Annual O&M | 29.3 | 0 | 0 | 0 | 0 | 0 | 0 | 17482.5751 | -161274.0615 | 821907.5954 | -56588.3578 |
| SW | Large | Low | Annual O&M | 30.78947368 | 0 | 0 | 0 | 0 | 0 | 0 | 11.4871 | -1669.1707 | 338108.3881 | 486893.4377 |
| SW | Small | Mid | Annual O&M | 22.445 | 0 | 0 | 0 | 0 | 0 | 0 | 2480041.671 | -1391655.414 | 686771.0419 | 42971.874 |
| SW | Medium | Mid | Annual O&M | 28.21764706 | 0 | 0 | 0 | 0 | 0 | 0 | 18853.7351 | -171558.7816 | 844811.586 | -70541.8011 |
| SW | Large | Mid | Annual O&M | 29.5 | 0 | 0 | 0 | 0 | 0 | 0 | 11.4871 | -1669.1707 | 338108.3881 | 486893.4377 |
| SW | Small | High | Annual O&M | 25.54 | 0 | 0 | 0 | 0 | 0 | 0 | 1479601.694 | -893288.7439 | 632978.4064 | 44029.8274 |
| SW | Medium | High | Annual O&M | 30.46470588 | 0 | 0 | 0 | 0 | 0 | 0 | 17842.5314 | -163974.0014 | 827920.3403 | -60251.4092 |
| SW | Large | High | Annual O&M | 31.04210526 | 0 | 0 | 0 | 0 | 0 | 0 | 11.4871 | -1669.1707 | 338108.3881 | 486893.4377 |

# A.4 Capital and Annual O&M Cost Equation Parameters for POU RO

**Cost Equation Parameters for POU RO**

| GW/SW | Size Category | Comp Level | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW | Small | n/a | Total Capital | 10 | 700944.37 | 1.0355 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GW | Small | n/a | Annual O&M | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -135400.9866 | 701268.6995 | 2454.8593 |
| SW | Small | n/a | Total Capital | 10 | 705013.194 | 1.0465 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SW | Small | n/a | Annual O&M | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 652386.1744 | 690.4192 |

## A.5 Capital and Annual O&M Cost Equation Parameters for Nontreatment Options

**Cost Equation Parameters for Nontreatment Options**

| GW/SW | Size Category | Comp Level | Design Type | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW | Small | Low | Interconnection | Total Capital | 17.21 | 0 | 0 | 0 | 0 | 0 | 0 | -560032.442 | 771721.5229 | 51365.9263 | 600231.0091 |
| GW | Medium | Low | Interconnection | Total Capital | 22.05 | 0 | 0 | 0 | 0 | 0 | 0 | -55058.6273 | 363044.7555 | -566594.58 | 1173013.79 |
| GW | Small | Mid | Interconnection | Total Capital | 17.23 | 0 | 0 | 0 | 0 | 0 | 0 | -605774.9391 | 831092.7558 | 43597.1038 | 611295.3516 |
| GW | Medium | Mid | Interconnection | Total Capital | 22.17 | 0 | 0 | 0 | 0 | 0 | 0 | -59703.7808 | 402536.2258 | -647866.3051 | 1241967.732 |
| GW | Small | High | Interconnection | Total Capital | 33.93 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -631069.7282 | 1385198.056 | 1313780.871 |
| GW | Medium | High | Interconnection | Total Capital | 38.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -116324.7782 | 965237.1476 | 1292920.326 |
| GW | Small | Low | Interconnection | Annual O&M | 17.21 | 0 | 0 | 0 | 0 | 0 | 0 | 1172393.696 | -323637.2531 | 1328660.543 | 1012.2372 |
| GW | Medium | Low | Interconnection | Annual O&M | 22.05 | 0 | 0 | 0 | 0 | 0 | 0 | 140676.5805 | -307834.65 | 1526384.539 | -37333.9888 |
| GW | Small | Mid | Interconnection | Annual O&M | 17.23 | 0 | 0 | 0 | 0 | 0 | 0 | 1172393.696 | -323637.2531 | 1328660.543 | 1012.2372 |
| GW | Medium | Mid | Interconnection | Annual O&M | 22.17 | 0 | 0 | 0 | 0 | 0 | 0 | 140676.5805 | -307834.65 | 1526384.539 | -37333.9888 |
| GW | Small | High | Interconnection | Annual O&M | 33.93 | 0 | 0 | 0 | 0 | 0 | 0 | 964898.8074 | -258272.7146 | 1319201.805 | 1130.9069 |
| GW | Medium | High | Interconnection | Annual O&M | 38.17 | 0 | 0 | 0 | 0 | 0 | 0 | 122049.6952 | -267262.8612 | 1494257.446 | -32645.9798 |
| GW | Small | Low | New Well Construction | Total Capital | 24.83 | 0 | 0 | 0 | 0 | 0 | 0 | 628206.1808 | -605771.3415 | 437758.3298 | 220003.705 |
| GW | Medium | Low | New Well Construction | Total Capital | 28.36 | 0 | 0 | 0 | 0 | 0 | 0 | -128668.7397 | 872536.2865 | -1339364.867 | 1258633.582 |
| GW | Small | Mid | New Well Construction | Total Capital | 25.75 | 0 | 0 | 0 | 0 | 0 | 0 | 1559164.557 | -1723018.32 | 1107234.322 | 398078.7007 |
| GW | Medium | Mid | New Well Construction | Total Capital | 29.01 | 0 | 0 | 0 | 0 | 0 | 0 | -254010.7513 | 1721705.053 | -2694012.854 | 2491392.114 |
| GW | Small | High | New Well Construction | Total Capital | 26.23 | 0 | 0 | 0 | 0 | 0 | 0 | 1765114.84 | -2018136.542 | 1397596.137 | 422042.282 |
| GW | Medium | High | New Well Construction | Total Capital | 29.84 | 0 | 0 | 0 | 0 | 0 | 0 | -296012.9238 | 2006412.029 | -3148814.65 | 2912158.263 |
| GW | Small | Low | New Well Construction | Annual O&M | 24.83 | 0 | 0 | 0 | 0 | 0 | 0 | -73956.3039 | 92162.0229 | 49872.6092 | 3762.882 |
| GW | Medium | Low | New Well Construction | Annual O&M | 28.36 | 0 | 0 | 0 | 0 | 0 | 0 | -33388.3209 | 88799.4329 | 5402.2413 | 17891.507 |
| GW | Small | Mid | New Well Construction | Annual O&M | 25.75 | 0 | 0 | 0 | 0 | 0 | 0 | -73956.3039 | 92162.0229 | 49872.6092 | 3762.882 |
| GW | Medium | Mid | New Well Construction | Annual O&M | 29.01 | 0 | 0 | 0 | 0 | 0 | 0 | -33388.3209 | 88799.4329 | 5402.2413 | 17891.507 |
| GW | Small | High | New Well Construction | Annual O&M | 26.23 | 0 | 0 | 0 | 0 | 0 | 0 | -73956.3039 | 92162.0229 | 49872.6092 | 3762.882 |
| GW | Medium | High | New Well Construction | Annual O&M | 29.84 | 0 | 0 | 0 | 0 | 0 | 0 | -33388.3209 | 88799.4329 | 5402.2413 | 17891.507 |
| SW | Small | Low | Interconnection | Total Capital | 17.21 | 0 | 0 | 0 | 0 | 0 | 0 | -560032.442 | 771721.5229 | 51365.9263 | 600231.0091 |
| SW | Medium | Low | Interconnection | Total Capital | 22.05 | 0 | 0 | 0 | 0 | 0 | 0 | -55058.6273 | 363044.7555 | -566594.58 | 1173013.79 |
| SW | Small | Mid | Interconnection | Total Capital | 17.23 | 0 | 0 | 0 | 0 | 0 | 0 | -605774.9391 | 831092.7558 | 43597.1038 | 611295.3516 |
| SW | Medium | Mid | Interconnection | Total Capital | 22.17 | 0 | 0 | 0 | 0 | 0 | 0 | -59703.7808 | 402536.2258 | -647866.3051 | 1241967.732 |
| SW | Small | High | Interconnection | Total Capital | 33.93 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -631069.7282 | 1385198.056 | 1313780.871 |
| SW | Medium | High | Interconnection | Total Capital | 38.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -116324.7782 | 965237.1476 | 1292920.326 |
| SW | Small | Low | Interconnection | Annual O&M | 17.21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 271230.0319 | 1251910.323 | 2876.94 |
| SW | Medium | Low | Interconnection | Annual O&M | 22.05 | 0 | 0 | 0 | 0 | 0 | 0 | 164523.1139 | -347590.2383 | 1546276.037 | -40406.7767 |
| SW | Small | Mid | Interconnection | Annual O&M | 17.23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 271230.0319 | 1251910.323 | 2876.94 |
| SW | Medium | Mid | Interconnection | Annual O&M | 22.17 | 0 | 0 | 0 | 0 | 0 | 0 | 164523.1139 | -347590.2383 | 1546276.037 | -40406.7767 |
| SW | Small | High | Interconnection | Annual O&M | 33.93 | 0 | 0 | 0 | 0 | 0 | 0 | 1174540.783 | -386902.7001 | 1337372.888 | 723.1604 |
| SW | Medium | High | Interconnection | Annual O&M | 38.17 | 0 | 0 | 0 | 0 | 0 | 0 | 142753.0832 | -301809.514 | 1511610.796 | -35345.6582 |
| SW | Small | Low | New Well Construction | Total Capital | 24.83 | 0 | 0 | 0 | 0 | 0 | 0 | 628206.1808 | -605771.3415 | 437758.3298 | 220003.705 |
| SW | Medium | Low | New Well Construction | Total Capital | 28.36 | 0 | 0 | 0 | 0 | 0 | 0 | -128668.7397 | 872536.2865 | -1339364.867 | 1258633.582 |
| SW | Small | Mid | New Well Construction | Total Capital | 25.75 | 0 | 0 | 0 | 0 | 0 | 0 | 1559164.557 | -1723018.32 | 1107234.322 | 398078.7007 |
| SW | Medium | Mid | New Well Construction | Total Capital | 29.01 | 0 | 0 | 0 | 0 | 0 | 0 | -254010.7513 | 1721705.053 | -2694012.854 | 2491392.114 |
| SW | Small | High | New Well Construction | Total Capital | 26.23 | 0 | 0 | 0 | 0 | 0 | 0 | 1765114.84 | -2018136.542 | 1397596.137 | 422042.282 |
| SW | Medium | High | New Well Construction | Total Capital | 29.84 | 0 | 0 | 0 | 0 | 0 | 0 | -296012.9238 | 2006412.029 | -3148814.65 | 2912158.263 |

| Cost Equation Parameters for Nontreatment Options | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GW/SW | Size Category | Comp Level | Design Type | Cost Type | Useful Life | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
| SW | Small | Low | New Well Construction | Annual O&M | 24.83 | 0 | 0 | 0 | 0 | 0 | 0 | -35362.6715 | 73214.0449 | 51411.2015 | 3756.6482 |
| SW | Medium | Low | New Well Construction | Annual O&M | 28.36 | 0 | 0 | 0 | 0 | 0 | 0 | -41326.1706 | 106550.8195 | -5783.4687 | 20024.7684 |
| SW | Small | Mid | New Well Construction | Annual O&M | 25.75 | 0 | 0 | 0 | 0 | 0 | 0 | -35362.6715 | 73214.0449 | 51411.2015 | 3756.6482 |
| SW | Medium | Mid | New Well Construction | Annual O&M | 29.01 | 0 | 0 | 0 | 0 | 0 | 0 | -41326.1706 | 106550.8195 | -5783.4687 | 20024.7684 |
| SW | Small | High | New Well Construction | Annual O&M | 26.23 | 0 | 0 | 0 | 0 | 0 | 0 | -35362.6715 | 73214.0449 | 51411.2015 | 3756.6482 |
| SW | Medium | High | New Well Construction | Annual O&M | 29.84 | 0 | 0 | 0 | 0 | 0 | 0 | -41326.1706 | 106550.8195 | -5783.4687 | 20024.7684 |

# Appendix B. Example WBS Model Outputs

Notes:

- To show the variations among both system size and cost level, the examples chosen for each scenario modeled typically include a low-cost small system, a mid-cost medium system, and a high-cost large system.
- Each of the examples is among the individual flow rate-specific estimates used to generate the cost equations presented in Appendix A (see Section 7.1 for details on the method used to develop the equations).

## B.1 Example Outputs for GAC

**Granular Activated Carbon(GAC), design 0.500 mgd, average 0.162 mgd**
**Groundwater**
**Low-Cost Components**
**Design Type: Pressure**
**Bed Volumes: 50000**
**Spent Media: regen off-site (non-haz) (Default)**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1.1 | Pressure Vessels - Carbon Steel - Plastic Internals | 160,077 | 30 |
| 2.2.1 | Residuals Holding Tanks/Basins - Fiberglass Tanks | 87,354 | 20 |
| 3.1.1 | Process Piping - PVC | 969 | 17 |
| 3.2.1 | Backwash Piping - PVC | 1,646 | 17 |
| 3.3.1 | Influent and Treated Water Piping - PVC | 969 | 17 |
| 3.4.1 | Residuals Piping - PVC | 168 | 17 |
| 3.4.2 | Residuals Piping - Excavation | 1,006 | 17 |
| 3.4.3 | Residuals Piping - Bedding | 46 | 17 |
| 3.4.5 | Residuals Piping - Backfill and Compaction | 607 | 17 |
| 3.4.6 | Residuals Piping - Thrust Blocks | 122 | 17 |
| 4.1.1 | Motor/Air Operated (on/off) Valves - Process - Polypropylene/PVC | 12,880 | 20 |
| 4.1.2 | Motor/Air Operated (on/off) Valves - Backwash - Polypropylene/PVC | 12,788 | 20 |
| 4.1.3 | Motor/Air Operated (on/off) Valves - Residuals - Polypropylene/PVC | 2,163 | 20 |
| 4.2.1 | Manual Valves - Influent and treated water - Polypropylene/PVC | 1,791 | 20 |
| 4.2.2 | Manual Valves - Process - Polypropylene/PVC | 1,791 | 20 |
| 4.3.1 | Check Valves - Backwash - Polypropylene/PVC | 2,167 | 20 |
| 4.3.2 | Check Valves - Residuals - Polypropylene/PVC | 240 | 20 |
| 4.3.5 | Check Valves - Influent - Polypropylene/PVC | 1,306 | 20 |
| 5.3 | Pumps - Residuals | 9,616 | 17 |
| 6.1.1 | Instrumentation - Flow Meters - Influent and Treated Water - Propeller | 4,796 | 14 |
| 6.3.1 | Instrumentation - Flow Meters - Backwash - Propeller | 5,645 | 14 |
| 6.4.1 | Instrumentation - Flow Meters - Residuals - Propeller | 2,238 | 14 |
| 6.7 | High/Low Alarm (for holding tanks) | 644 | 14 |
| 6.12.1 | Sampling Ports - Carbon Steel | 250 | 22 |
| 7.1.1 | System Controls - PLC Units - PLC racks/power supplies | 1,020 | 8 |
| 7.1.2 | System Controls - PLC Units - CPUs | 851 | 8 |
| 7.1.3 | System Controls - PLC Units - I/O discrete input modules | 430 | 8 |
| 7.1.4 | System Controls - PLC Units - I/O discrete output modules | 382 | 8 |
| 7.1.5 | System Controls - PLC Units - I/O combination analog modules | 1,879 | 8 |
| 7.1.6 | System Controls - PLC Units - Ethernet modules | 3,016 | 8 |
| 7.1.9 | System Controls - PLC Units - UPSs | 986 | 8 |
| 7.2.1 | System Controls - Operator Equipment - Drive controllers | 2,790 | 14 |
| 7.2.2 | System Controls - Operator Equipment - Operator interface units | 10,492 | 8 |
| 9.1 | Media - Initial GAC Charge | 55,512 | N/A |
| 12.1 | Solids drying pad | 493 | 37 |
| 14.1.1 | Building Structures and HVAC - Building 1 - Low Quality | 55,667 | 37 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 14.5 | Building Structures and HVAC - Concrete Pad | 3,449 | 37 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 333,296 | 37 |
| | **Process Cost** | **448,246** | |
| | **System Cost** | **781,542** | |
| | **O&M Cost** | **29,459** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Mobilization and Demobilization | 0 |
| Architectural Fees for Treatment Building | 0 |
| Site Work | 9,590 |
| Yard Piping | 3,988 |
| Geotechnical | 0 |
| Standby Power | 0 |
| Electrical (including yard wiring) | 38,913 |
| Contingency | 71,372 |
| Process Engineering | 89,649 |
| Construction Management and GC Overhead | 9,248 |
| Permits | 4,141 |
| Pilot Study | 51,042 |
| Land Cost | 1,564 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 44,825 |
| Legal, Fiscal, and Administrative (2.0%) | 8,965 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (0.0%) | 0 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (14 hrs/yr @ $52.3563/hr) | 716 |
| Clerical (14 hrs/yr @ $34.0099/hr) | 465 |
| Operator (137 hrs/yr @ $35.3133/hr) | 4,831 |
| Materials for residuals pumps (calculated as a percentage of capital) | 96 |
| Materials for GAC contactors (calculated as a percentage of capital) | 1,601 |
| Building and HVAC maintenance (materials and labor) (550 sf @ $6.6975/sf/yr) | 3,684 |
| Makeup GAC (1403 lbs/yr @ $2.4322/lb) | 3,413 |
| Off-site GAC regeneration (3275 lbs/yr @ $1.9491/lb) | 6,383 |
| Energy for backwash pumps (0 Mwh/yr @ $0.1225/kWh) | 15 |
| Energy for residuals pumps (0 Mwh/yr @ $0.1225/kwh) | 26 |
| Energy for lighting (0 Mwh/yr @ $0.1225/kwh) | 3 |
| Energy for ventilation (0 Mwh/yr @ $0.1225/kwh) | 46 |
| POTW discharge fees (887471 gal/yr @ $0.0062/gal) | 5,490 |
| Holding tanks solids disposal (0 ton/yr @ $119.7706/ton) | 11 |
| Miscellaneous Allowance (0 @ $) | 2,678 |

**Granular Activated Carbon(GAC), design 5.809 mgd, average 2.455 mgd**
**Groundwater**
**Mid-Cost Components**
**Design Type: Pressure**
**Bed Volumes: 50000**
**Spent Media: regen off-site (non-haz) (Default)**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1.1 | Pressure Vessels - Carbon Steel - Plastic Internals | 1,528,099 | 35 |
| 2.1.1 | Backwash Tanks/Basins - Fiberglass Tanks | 83,665 | 25 |
| 2.2.1 | Residuals Holding Tanks/Basins - Fiberglass Tanks | 131,466 | 25 |
| 3.1.1 | Process Piping - CPVC | 15,770 | 22 |
| 3.2.1 | Backwash Piping - CPVC | 40,951 | 22 |
| 3.3.1 | Influent and Treated Water Piping - CPVC | 42,529 | 22 |
| 3.4.1 | Residuals Piping - CPVC | 3,153 | 22 |
| 3.4.2 | Residuals Piping - Excavation | 1,089 | 22 |
| 3.4.3 | Residuals Piping - Bedding | 51 | 22 |
| 3.4.5 | Residuals Piping - Backfill and Compaction | 658 | 22 |
| 3.4.6 | Residuals Piping - Thrust Blocks | 252 | 22 |
| 4.1.1 | Motor/Air Operated (on/off) Valves - Process - Cast Iron | 299,736 | 25 |
| 4.1.2 | Motor/Air Operated (on/off) Valves - Backwash - Cast Iron | 401,768 | 25 |
| 4.1.3 | Motor/Air Operated (on/off) Valves - Residuals - Cast Iron | 7,700 | 25 |
| 4.2.1 | Manual Valves - Influent and treated water - Cast Iron | 5,870 | 25 |
| 4.2.2 | Manual Valves - Process - Cast Iron | 20,540 | 25 |
| 4.3.1 | Check Valves - Backwash - Cast Iron | 21,096 | 25 |
| 4.3.2 | Check Valves - Residuals - Cast Iron | 1,508 | 25 |
| 4.3.5 | Check Valves - Influent - Cast Iron | 14,924 | 25 |
| 5.2 | Pumps - Backwash | 66,971 | 20 |
| 5.3 | Pumps - Residuals | 11,072 | 20 |
| 6.1.1 | Instrumentation - Flow Meters - Influent and Treated Water - Venturi | 4,557 | 15 |
| 6.3.1 | Instrumentation - Flow Meters - Backwash - Venturi | 4,025 | 15 |
| 6.4.1 | Instrumentation - Flow Meters - Residuals - Venturi | 2,396 | 15 |
| 6.6 | High/Low Alarms (for backwash tanks) | 644 | 15 |
| 6.7 | High/Low Alarm (for holding tanks) | 644 | 15 |
| 6.8 | pH Meters | 6,094 | 15 |
| 6.9 | Temperature meters | 1,590 | 15 |
| 6.1 | Turbidity meters | 18,551 | 15 |
| 6.11 | Head loss sensors | 33,445 | 15 |
| 6.12.1 | Sampling Ports - Stainless Steel | 850 | 35 |
| 7.1.1 | System Controls - PLC Units - PLC racks/power supplies | 3,060 | 10 |
| 7.1.2 | System Controls - PLC Units - CPUs | 851 | 10 |
| 7.1.3 | System Controls - PLC Units - I/O discrete input modules | 860 | 10 |
| 7.1.4 | System Controls - PLC Units - I/O discrete output modules | 382 | 10 |
| 7.1.5 | System Controls - PLC Units - I/O combination analog modules | 8,767 | 10 |
| 7.1.6 | System Controls - PLC Units - Ethernet modules | 3,016 | 10 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 7.1.7 | System Controls - PLC Units - Base expansion modules | 321 | 10 |
| 7.1.8 | System Controls - PLC Units - Base expansion controller modules | 618 | 10 |
| 7.1.9 | System Controls - PLC Units - UPSs | 986 | 10 |
| 7.2.1 | System Controls - Operator Equipment - Drive controllers | 8,371 | 15 |
| 7.2.2 | System Controls - Operator Equipment - Operator interface units | 3,537 | 10 |
| 7.2.3 | System Controls - Operator Equipment - PC Workstations | 4,326 | 10 |
| 7.2.4 | System Controls - Operator Equipment - Printers - laser jet | 391 | 10 |
| 7.3.1 | System Controls - Controls Software - Operator interface software | 91 | 10 |
| 7.3.2 | System Controls - Controls Software - PLC programming software | 622 | 10 |
| 7.3.3 | System Controls - Controls Software - PLC data collection software | 671 | 10 |
| 7.3.4 | System Controls - Controls Software - Plant intelligence software | 20,681 | 10 |
| 8.1.1 | Solids Transfer - Eductors for GAC Transfer | 11,195 | 45 |
| 9.1 | Media - Initial GAC Charge | 683,428 | N/A |
| 12.1 | Solids drying pad | 986 | 40 |
| 14.1.1 | Building Structures and HVAC - Building 1 - Medium Quality | 849,810 | 40 |
| 14.1.3.1 | Building Structures and HVAC - Building 1 - Heating and Cooling System - Heat pump | 8,152 | 25 |
| 14.5 | Building Structures and HVAC - Concrete Pad | 81,304 | 40 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 3,147,862 | 40 |
| | **Process Cost** | **4,464,088** | |
| | **System Cost** | **7,611,950** | |
| | **O&M Cost** | **353,108** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Mobilization and Demobilization | 218,818 |
| Architectural Fees for Treatment Building | 65,749 |
| Site Work | 157,888 |
| Yard Piping | 43,634 |
| Geotechnical | 0 |
| Standby Power | 5,940 |
| Electrical (including yard wiring) | 352,482 |
| Contingency | 521,172 |
| Process Engineering | 535,691 |
| Construction Management and GC Overhead | 281,613 |
| Permits | 10,308 |
| Pilot Study | 166,936 |
| Land Cost | 28,735 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 446,409 |
| Legal, Fiscal, and Administrative (2.0%) | 89,282 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 223,204 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (79 hrs/yr @ $66.7054/hr) | 5,240 |
| Clerical (79 hrs/yr @ $43.9163/hr) | 3,450 |
| Operator (786 hrs/yr @ $39.756/hr) | 31,233 |
| Materials for backwash pumps (calculated as a percentage of capital) | 670 |
| Materials for residuals pumps (calculated as a percentage of capital) | 111 |
| Materials for GAC contactors (calculated as a percentage of capital) | 15,281 |
| Building and HVAC maintenance (materials and labor) (9160 sf @ $6.9362/sf/yr) | 63,535 |
| Makeup GAC (21268 lbs/yr @ $2.0848/lb) | 44,340 |
| Off-site GAC regeneration (49625 lbs/yr @ $1.2355/lb) | 61,311 |
| Energy for backwash pumps (2 Mwh/yr @ $0.1225/kWh) | 197 |
| Energy for residuals pumps (3 Mwh/yr @ $0.1225/kwh) | 344 |
| Energy for lighting (4 Mwh/yr @ $0.1225/kwh) | 529 |
| Energy for ventilation (9 Mwh/yr @ $0.1225/kwh) | 1,134 |
| Heat pump (cooling mode) (51 Mwh/yr @ $0.1225/kwh) | 6,294 |
| Heat pump (146 Mwh/yr @ $0.1225/kwh) | 17,900 |
| POTW discharge fees (11628900 gal/yr @ $0.006/gal) | 69,269 |
| Holding tanks solids disposal (1 ton/yr @ $119.7706/ton) | 168 |
| Miscellaneous Allowance (0  @ $) | 32,101 |

**Granular Activated Carbon(GAC), design 56.271 mgd, average 24.863 mgd**
**Surface Water**
**High-Cost Components**
**Design Type: Gravity**
**Bed Volumes: 50000**
**Spent Media: regen off-site (non-haz) (Default)**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.2.1 | GAC Contact Basins - Concrete | 979,731 | 40 |
| 1.2.2 | GAC Contact Basins - Internals (Underdrain/Backwash System) | 4,336,193 | 40 |
| 1.2.3 | GAC Contact Basins - Aluminum Railing | 40,920 | 40 |
| 1.2.4 | GAC Contact Basins - Aluminum Stairs | 6,900 | 40 |
| 1.2.5 | GAC Contact Basins - Excavation | 418,200 | 40 |
| 1.2.6 | GAC Contact Basins - Backfill and Compaction | 83,827 | 40 |
| 2.2.1 | Residuals Holding Tanks/Basins - Steel Tanks | 165,120 | 35 |
| 3.1.1 | Process Piping - CPVC | 76,552 | 22 |
| 3.2.1 | Backwash Piping - PVC | 26,200 | 22 |
| 3.3.1 | Influent and Treated Water Piping - PVC | 32,276 | 22 |
| 3.4.1 | Residuals Piping - CPVC | 17,347 | 22 |
| 3.4.2 | Residuals Piping - Excavation | 1,326 | 22 |
| 3.4.3 | Residuals Piping - Bedding | 64 | 22 |
| 3.4.5 | Residuals Piping - Backfill and Compaction | 801 | 22 |
| 3.4.6 | Residuals Piping - Thrust Blocks | 1,316 | 22 |
| 4.1.1 | Motor/Air Operated (on/off) Valves - Process - Cast Iron | 609,373 | 25 |
| 4.1.2 | Motor/Air Operated (on/off) Valves - Backwash - Cast Iron | 931,909 | 25 |
| 4.1.3 | Motor/Air Operated (on/off) Valves - Residuals - Cast Iron | 21,410 | 25 |
| 4.2.1 | Manual Valves - Influent and treated water - Cast Iron | 37,235 | 25 |
| 4.3.1 | Check Valves - Backwash - Cast Iron | 118,377 | 25 |
| 4.3.2 | Check Valves - Residuals - Cast Iron | 7,979 | 25 |
| 4.3.5 | Check Valves - Influent - Stainless Steel | 49,272 | 25 |
| 5.1 | Pumps - Booster | 783,275 | 20 |
| 5.2 | Pumps - Backwash | 315,622 | 20 |
| 5.3 | Pumps - Residuals | 20,205 | 20 |
| 6.1.1 | Instrumentation - Flow Meters - Influent and Treated Water - Magnetic | 25,132 | 15 |
| 6.3.1 | Instrumentation - Flow Meters - Backwash - Magnetic | 16,128 | 15 |
| 6.4.1 | Instrumentation - Flow Meters - Residuals - Magnetic | 6,629 | 15 |
| 6.5 | Level Switches/Alarms (for vessels) | 9,011 | 15 |
| 6.7 | High/Low Alarm (for holding tanks) | 644 | 15 |
| 6.8 | pH Meters | 42,660 | 15 |
| 6.9 | Temperature meters | 1,590 | 15 |
| 6.1 | Turbidity meters | 98,939 | 15 |
| 6.11 | Head loss sensors | 33,445 | 15 |
| 6.12.1 | Sampling Ports - Stainless Steel | 850 | 35 |
| 7.1.1 | System Controls - PLC Units - PLC racks/power supplies | 3,060 | 10 |
| 7.1.2 | System Controls - PLC Units - CPUs | 851 | 10 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 7.1.3 | System Controls - PLC Units - I/O discrete input modules | 1,720 | 10 |
| 7.1.4 | System Controls - PLC Units - I/O discrete output modules | 382 | 10 |
| 7.1.5 | System Controls - PLC Units - I/O combination analog modules | 10,019 | 10 |
| 7.1.6 | System Controls - PLC Units - Ethernet modules | 3,016 | 10 |
| 7.1.7 | System Controls - PLC Units - Base expansion modules | 321 | 10 |
| 7.1.8 | System Controls - PLC Units - Base expansion controller modules | 618 | 10 |
| 7.1.9 | System Controls - PLC Units - UPSs | 986 | 10 |
| 7.2.1 | System Controls - Operator Equipment - Drive controllers | 23,717 | 15 |
| 7.2.2 | System Controls - Operator Equipment - Operator interface units | 3,537 | 10 |
| 7.2.3 | System Controls - Operator Equipment - PC Workstations | 4,326 | 10 |
| 7.2.4 | System Controls - Operator Equipment - Printers - laser jet | 391 | 10 |
| 7.3.1 | System Controls - Controls Software - Operator interface software | 91 | 10 |
| 7.3.2 | System Controls - Controls Software - PLC programming software | 622 | 10 |
| 7.3.3 | System Controls - Controls Software - PLC data collection software | 671 | 10 |
| 7.3.4 | System Controls - Controls Software - Plant intelligence software | 20,681 | 10 |
| 8.1.1 | Solids Transfer - Eductors for GAC Transfer | 96,667 | 45 |
| 9.1 | Media - Initial GAC Charge | 6,610,302 | N/A |
| 12.1 | Solids drying pad | 5,420 | 40 |
| 14.1.1 | Building Structures and HVAC - Building 1 - Medium Quality | 2,120,933 | 40 |
| 14.1.2.1 | Building Structures and HVAC - Building 1 - Heating System - Natural gas condensing furnace | 93,485 | 25 |
| 14.1.3.1 | Building Structures and HVAC - Building 1 - Cooling System - Air conditioner | 42,794 | 25 |
| 14.2.1 | Building Structures and HVAC - Building 2 - Medium Quality | 532,409 | 40 |
| 14.2.2.1 | Building Structures and HVAC - Building 2 - Heating System - Natural gas condensing furnace | 53,140 | 25 |
| 14.2.3.1 | Building Structures and HVAC - Building 2 - Cooling System - Air conditioner | 94,831 | 25 |
| 14.5 | Building Structures and HVAC - Concrete Pad | 272,984 | 40 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 11,145,151 | 40 |
| | **Process Cost** | **19,314,431** | |
| | **System Cost** | **30,459,582** | |
| | **O&M Cost** | **2,522,462** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Mobilization and Demobilization | 475,842 |
| Architectural Fees for Treatment Building | 199,056 |
| Site Work | 534,800 |
| Yard Piping | 116,303 |
| Geotechnical | 185,650 |
| Standby Power | 99,082 |
| Electrical (including yard wiring) | 1,610,386 |
| Contingency | 1,764,733 |
| Process Engineering | 1,545,155 |
| Construction Management and GC Overhead | 819,367 |
| Permits | 24,819 |
| Pilot Study | 166,936 |
| Land Cost | 319,568 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 1,931,443 |
| Legal, Fiscal, and Administrative (2.0%) | 386,289 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 965,722 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (310 hrs/yr @ $83.1618/hr) | 25,755 |
| Clerical (310 hrs/yr @ $43.9163/hr) | 13,601 |
| Operator (3097 hrs/yr @ $48.511/hr) | 150,240 |
| Materials for booster pumps (calculated as a percentage of capital) | 7,833 |
| Materials for backwash pumps (calculated as a percentage of capital) | 3,156 |
| Materials for residuals pumps (calculated as a percentage of capital) | 202 |
| Materials for GAC contactors (calculated as a percentage of capital) | 53,637 |
| Building and HVAC maintenance (materials and labor) (30660 sf @ $6.9362/sf/yr) | 212,663 |
| Makeup GAC (215391 lbs/yr @ $1.8028/lb) | 388,315 |
| Off-site GAC regeneration (502578 lbs/yr @ $1.2355/lb) | 620,930 |
| Energy for booster pumps (1672 Mwh/yr @ $0.1225/kwh) | 204,732 |
| Energy for backwash pumps (11 Mwh/yr @ $0.1225/kWh) | 1,334 |
| Energy for residuals pumps (19 Mwh/yr @ $0.1225/kwh) | 2,331 |
| Energy for lighting (57 Mwh/yr @ $0.1225/kwh) | 6,977 |
| Energy for ventilation (56 Mwh/yr @ $0.1225/kwh) | 6,850 |
| Air conditioning (467 Mwh/yr @ $0.1225/kwh) | 57,141 |
| Natural gas condensing furnace (71192 therms/yr @ $0.9468/therm) | 67,402 |
| POTW discharge fees (78840000 gal/yr @ $0.0059/gal) | 468,345 |
| Holding tanks solids disposal (14 ton/yr @ $119.7706/ton) | 1,701 |
| Miscellaneous Allowance (0 @ $) | 229,315 |

## B.2 Example Outputs for IX

**Anion Exchange for PFAS(AX_PFAS), design 0.500 mgd, average 0.162 mgd**
**Groundwater**
**Low-Cost Components**
**Bed Volumes: 120000**
**Spent Media: incineration (non-hazardous)**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1 | Pressure Vessels - Carbon Steel - Plastic Internals | 105,615 | 30 |
| 2.1 | Ion Exchange Resin - PFAS-Selective | 92,584 | N/A |
| 4.1 | Cartridge Filters - Cartridge Filters | 21,811 | 30 |
| 5.1.1 | Backwash Piping - PVC | 525 | 17 |
| 5.3.1 | Process Piping - PVC | 646 | 17 |
| 5.5.1 | Influent and Treated Water Piping - PVC | 646 | 17 |
| 5.7.1 | Residuals Piping - PVC | 301 | 17 |
| 5.7.2 | Residuals Piping - Excavation | 1,057 | 17 |
| 5.7.3 | Residuals Piping - Bedding | 49 | 17 |
| 5.7.4 | Residuals Piping - Backfill and Compaction | 638 | 17 |
| 5.7.5 | Residuals Piping - Thrust Blocks | 118 | 17 |
| 6.1.1 | Valves and Fittings - Motor/Air Operated (on/off) - Process - Polypropylene/PVC | 12,880 | 20 |
| 6.1.2 | Valves and Fittings - Motor/Air Operated (on/off) - Backwash - Polypropylene/PVC | 8,385 | 20 |
| 6.2.1 | Valves and Fittings - Manual - Influent and treated water - Polypropylene/PVC | 1,791 | 20 |
| 6.2.2 | Valves and Fittings - Manual - Process - Polypropylene/PVC | 1,791 | 20 |
| 6.3.2 | Valves and Fittings - Check Valves - Influent and Treated Water - Polypropylene/PVC | 2,611 | 20 |
| 6.3.5 | Valves and Fittings - Check Valves - Residuals - Polypropylene/PVC | 246 | 20 |
| 11.1.1 | Instrumentation and Controls - Flow Meters - Influent and Treated Water - Propeller | 4,796 | 14 |
| 11.3.1 | Instrumentation and Controls - Flow Meters - Backwash - Propeller | 3,860 | 14 |
| 11.4.1 | Instrumentation and Controls - Flow Meters - Residuals - Propeller | 2,812 | 14 |
| 11.12 | Instrumentation and Controls - Head loss sensors | 4,778 | 14 |
| 11.13.1 | Instrumentation and Controls - Sampling Ports - Stainless Steel | 250 | 30 |
| 12.1.1 | System Controls - PLC Units - PLC racks/power supplies | 1,020 | 8 |
| 12.1.2 | System Controls - PLC Units - CPUs | 851 | 8 |
| 12.1.3 | System Controls - PLC Units - I/O discrete input modules | 430 | 8 |
| 12.1.5 | System Controls - PLC Units - I/O combination analog modules | 1,879 | 8 |
| 12.1.6 | System Controls - PLC Units - Ethernet modules | 3,016 | 8 |
| 12.1.9 | System Controls - PLC Units - UPSs | 986 | 8 |
| 12.2.2 | System Controls - Operator Equipment - Operator interface units | 10,492 | 8 |
| 13.1.1 | Building Structures and HVAC - Building 1 - Small Low Cost Shed | 17,160 | 20 |
| 13.3 | Building Structures and HVAC - Concrete Pad | 1,971 | 37 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 247,902 | 20 |
| | **Process Cost** | **305,996** | |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| | **System Cost** | **553,898** | |
| | **O&M Cost** | **36,008** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Construction Management | 6,630 |
| Process Engineering | 61,199 |
| Site Work | 5,137 |
| Yard Piping | 3,723 |
| Geotechnical | 0 |
| Standby Power | 0 |
| Electrical (including yard wiring) | 28,686 |
| Mobilization and Demobilization | 0 |
| Architectural Fees for Treatment Building | 0 |
| Permits | 2,949 |
| Pilot Study | 51,042 |
| Land Cost | 1,232 |
| Contingency | 50,583 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 30,600 |
| Legal, Fiscal, and Administrative (2.0%) | 6,120 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (7 hrs/yr @ $52.3563/hr) | 385 |
| Clerical (7 hrs/yr @ $34.0099/hr) | 250 |
| Operator (73 hrs/yr @ $35.3133/hr) | 2,593 |
| Cartridge filter replacement (7 filters/yr @ $207.9779/sf/yr) | 1,497 |
| Building and HVAC maintenance (materials and labor) (300 sf @ $6.6975/sf/yr) | 2,009 |
| PFAS-selective (66 cf/yr @ $328.9104/cf) | 21,667 |
| Energy for backwash/rinse pumps (0 Mwh/yr @ $0.1225/kwh) | 0 |
| Energy for lighting (0 Mwh/yr @ $0.1225/kwh) | 1 |
| Energy for ventilation (0 Mwh/yr @ $0.1225/kwh) | 10 |
| POTW discharge fees (848 gal/yr @ $0.5134/gal) | 435 |
| Spent resin disposal (1 ton/yr @ $2737.1421/ton) | 3,877 |
| Spent cartridge filter disposal (0 ton/yr @ $119.7706/ton) | 10 |
| Miscellaneous Allowance (0 @ $) | 3,273 |

**Anion Exchange for PFAS(AX_PFAS), design 5.809 mgd, average 2.455 mgd**
**Groundwater**
**Mid-Cost Components**
**Bed Volumes: 160000**
**Spent Media: incineration (non-hazardous)**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1 | Pressure Vessels - Carbon Steel - Plastic Internals | 617,823 | 35 |
| 2.1 | Ion Exchange Resin - PFAS-Selective | 1,243,192 | N/A |
| 3.1.1 | Backwash/Rinse Tanks - Fiberglass | 36,246 | 25 |
| 4.1 | Cartridge Filters - Cartridge Filters | 128,792 | 35 |
| 5.1.1 | Backwash Piping - CPVC | 13,799 | 22 |
| 5.3.1 | Process Piping - CPVC | 16,663 | 22 |
| 5.5.1 | Influent and Treated Water Piping - CPVC | 29,770 | 22 |
| 5.7.1 | Residuals Piping - CPVC | 3,216 | 22 |
| 5.7.2 | Residuals Piping - Excavation | 1,115 | 22 |
| 5.7.3 | Residuals Piping - Bedding | 53 | 22 |
| 5.7.4 | Residuals Piping - Backfill and Compaction | 674 | 22 |
| 5.7.5 | Residuals Piping - Thrust Blocks | 248 | 22 |
| 6.1.1 | Valves and Fittings - Motor/Air Operated (on/off) - Process - Cast Iron | 43,481 | 25 |
| 6.1.2 | Valves and Fittings - Motor/Air Operated (on/off) - Backwash - Cast Iron | 128,458 | 25 |
| 6.2.1 | Valves and Fittings - Manual - Influent and treated water - Cast Iron | 5,870 | 25 |
| 6.2.2 | Valves and Fittings - Manual - Process - Cast Iron | 13,695 | 25 |
| 6.3.1 | Valves and Fittings - Check Valves - Backwash - Cast Iron | 7,979 | 25 |
| 6.3.2 | Valves and Fittings - Check Valves - Influent and Treated Water - Cast Iron | 29,848 | 25 |
| 6.3.5 | Valves and Fittings - Check Valves - Residuals - Cast Iron | 1,066 | 25 |
| 7.2 | Pumps - Backwash/Rinse | 22,639 | 20 |
| 11.1.1 | Instrumentation and Controls - Flow Meters - Influent and Treated Water - Venturi | 4,557 | 15 |
| 11.3.1 | Instrumentation and Controls - Flow Meters - Backwash - Venturi | 3,077 | 15 |
| 11.4.1 | Instrumentation and Controls - Flow Meters - Residuals - Venturi | 2,483 | 15 |
| 11.6 | Instrumentation and Controls - High/Low Alarm (for backwash tanks) | 644 | 15 |
| 11.11 | Instrumentation and Controls - Temperature meters | 795 | 15 |
| 11.12 | Instrumentation and Controls - Head loss sensors | 23,889 | 15 |
| 11.13.1 | Instrumentation and Controls - Sampling Ports - Carbon Steel | 500 | 25 |
| 11.17 | Instrumentation and Controls - Turbidity meters | 6,184 | 15 |
| 12.1.1 | System Controls - PLC Units - PLC racks/power supplies | 2,040 | 10 |
| 12.1.2 | System Controls - PLC Units - CPUs | 851 | 10 |
| 12.1.3 | System Controls - PLC Units - I/O discrete input modules | 430 | 10 |
| 12.1.4 | System Controls - PLC Units - I/O discrete output modules | 382 | 10 |
| 12.1.5 | System Controls - PLC Units - I/O combination analog modules | 4,383 | 10 |
| 12.1.6 | System Controls - PLC Units - Ethernet modules | 3,016 | 10 |
| 12.1.7 | System Controls - PLC Units - Base expansion modules | 160 | 10 |
| 12.1.8 | System Controls - PLC Units - Base expansion controller modules | 309 | 10 |
| 12.1.9 | System Controls - PLC Units - UPSs | 986 | 10 |
| 12.2.1 | System Controls - Operator Equipment - Drive controllers | 2,790 | 15 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 12.2.2 | System Controls - Operator Equipment - Operator interface units | 3,537 | 10 |
| 12.2.3 | System Controls - Operator Equipment - PC Workstations | 4,326 | 10 |
| 12.2.4 | System Controls - Operator Equipment - Printers - laser jet | 391 | 10 |
| 12.3.1 | System Controls - Controls Software - Operator interface software | 91 | 10 |
| 12.3.2 | System Controls - Controls Software - PLC programming software | 622 | 10 |
| 12.3.3 | System Controls - Controls Software - PLC data collection software | 671 | 10 |
| 12.3.4 | System Controls - Controls Software - Plant intelligence software | 20,681 | 10 |
| 13.1.1 | Building Structures and HVAC - Building 1 - Medium Quality | 439,853 | 40 |
| 13.1.3.1 | Building Structures and HVAC - Building 1 - Heating and Cooling System - Heat pump | 4,970 | 25 |
| 13.3 | Building Structures and HVAC - Concrete Pad | 37,942 | 40 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 2,165,457 | 40 |
| | **Process Cost** | **2,915,191** | |
| | **System Cost** | **5,080,648** | |
| | **O&M Cost** | **518,460** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Construction Management | 187,285 |
| Process Engineering | 349,823 |
| Site Work | 75,691 |
| Yard Piping | 36,395 |
| Geotechnical | 0 |
| Standby Power | 2,640 |
| Electrical (including yard wiring) | 243,243 |
| Mobilization and Demobilization | 142,587 |
| Architectural Fees for Treatment Building | 38,621 |
| Permits | 2,942 |
| Pilot Study | 166,936 |
| Land Cost | 17,072 |
| Contingency | 406,639 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 291,519 |
| Legal, Fiscal, and Administrative (2.0%) | 58,304 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 145,760 |
| Instrumentation and Control (0.0%) | 0 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (39 hrs/yr @ $66.7054/hr) | 2,572 |
| Clerical (39 hrs/yr @ $43.9163/hr) | 1,693 |
| Operator (386 hrs/yr @ $39.756/hr) | 15,330 |
| Cartridge filter replacement (96 filters/yr @ $225.0723/sf/yr) | 21,607 |
| Building and HVAC maintenance (materials and labor) (4420 sf @ $6.9362/sf/yr) | 30,658 |
| PFAS-selective (998 cf/yr @ $328.9104/cf) | 328,352 |
| Energy for backwash/rinse pumps (0 Mwh/yr @ $0.1225/kwh) | 0 |
| Energy for lighting (1 Mwh/yr @ $0.1225/kwh) | 125 |
| Energy for ventilation (3 Mwh/yr @ $0.1225/kwh) | 399 |
| Heat pump (cooling mode) (15 Mwh/yr @ $0.1225/kwh) | 1,874 |
| Heat pump (52 Mwh/yr @ $0.1225/kwh) | 6,379 |
| POTW discharge fees (8164 gal/yr @ $0.4228/gal) | 3,452 |
| Spent resin disposal (21 ton/yr @ $2737.1421/ton) | 58,749 |
| Spent cartridge filter disposal (1 ton/yr @ $119.7706/ton) | 138 |
| Miscellaneous Allowance (0  @ $) | 47,133 |

**Anion Exchange for PFAS(AX_PFAS), design 56.271 mgd, average 24.863 mgd**
**Surface Water**
**High-Cost Components**
**Bed Volumes: 120000**
**Spent Media: incineration (non-hazardous)**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1 | Pressure Vessels - Stainless Steel | 7,661,480 | 35 |
| 2.1 | Ion Exchange Resin - PFAS-Selective | 11,733,230 | N/A |
| 4.1 | Cartridge Filters - Cartridge Filters | 884,649 | 35 |
| 5.1.1 | Backwash Piping - Stainless Steel | 138,044 | 45 |
| 5.3.1 | Process Piping - Stainless Steel | 166,329 | 45 |
| 5.5.1 | Influent and Treated Water Piping - Stainless Steel | 419,669 | 45 |
| 5.7.1 | Residuals Piping - Stainless Steel | 34,728 | 45 |
| 5.7.2 | Residuals Piping - Excavation | 1,180 | 45 |
| 5.7.3 | Residuals Piping - Bedding | 57 | 45 |
| 5.7.4 | Residuals Piping - Backfill and Compaction | 713 | 45 |
| 5.7.5 | Residuals Piping - Thrust Blocks | 504 | 45 |
| 6.1.1 | Valves and Fittings - Motor/Air Operated (on/off) - Process - Stainless Steel | 1,272,989 | 25 |
| 6.1.2 | Valves and Fittings - Motor/Air Operated (on/off) - Backwash - Stainless Steel | 599,105 | 25 |
| 6.2.1 | Valves and Fittings - Manual - Influent and treated water - Cast Iron | 37,235 | 25 |
| 6.2.2 | Valves and Fittings - Manual - Process - Stainless Steel | 79,944 | 25 |
| 6.3.1 | Valves and Fittings - Check Valves - Backwash - Stainless Steel | 9,520 | 25 |
| 6.3.2 | Valves and Fittings - Check Valves - Influent and Treated Water - Stainless Steel | 98,545 | 25 |
| 6.3.5 | Valves and Fittings - Check Valves - Residuals - Stainless Steel | 1,672 | 25 |
| 7.2 | Pumps - Backwash/Rinse | 46,124 | 20 |
| 11.1.1 | Instrumentation and Controls - Flow Meters - Influent and Treated Water - Magnetic | 25,132 | 15 |
| 11.3.1 | Instrumentation and Controls - Flow Meters - Backwash - Magnetic | 7,811 | 15 |
| 11.4.1 | Instrumentation and Controls - Flow Meters - Residuals - Magnetic | 5,493 | 15 |
| 11.11 | Instrumentation and Controls - Temperature meters | 795 | 15 |
| 11.12 | Instrumentation and Controls - Head loss sensors | 102,724 | 15 |
| 11.13.1 | Instrumentation and Controls - Sampling Ports - Carbon Steel | 1,500 | 25 |
| 11.17 | Instrumentation and Controls - Turbidity meters | 6,184 | 15 |
| 12.1.1 | System Controls - PLC Units - PLC racks/power supplies | 4,080 | 10 |
| 12.1.2 | System Controls - PLC Units - CPUs | 851 | 10 |
| 12.1.3 | System Controls - PLC Units - I/O discrete input modules | 1,290 | 10 |
| 12.1.4 | System Controls - PLC Units - I/O discrete output modules | 382 | 10 |
| 12.1.5 | System Controls - PLC Units - I/O combination analog modules | 13,777 | 10 |
| 12.1.6 | System Controls - PLC Units - Ethernet modules | 3,016 | 10 |
| 12.1.7 | System Controls - PLC Units - Base expansion modules | 481 | 10 |
| 12.1.8 | System Controls - PLC Units - Base expansion controller modules | 927 | 10 |
| 12.1.9 | System Controls - PLC Units - UPSs | 986 | 10 |
| 12.2.1 | System Controls - Operator Equipment - Drive controllers | 2,790 | 15 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 12.2.2 | System Controls - Operator Equipment - Operator interface units | 3,537 | 10 |
| 12.2.3 | System Controls - Operator Equipment - PC Workstations | 4,326 | 10 |
| 12.2.4 | System Controls - Operator Equipment - Printers - laser jet | 391 | 10 |
| 12.3.1 | System Controls - Controls Software - Operator interface software | 91 | 10 |
| 12.3.2 | System Controls - Controls Software - PLC programming software | 622 | 10 |
| 12.3.3 | System Controls - Controls Software - PLC data collection software | 671 | 10 |
| 12.3.4 | System Controls - Controls Software - Plant intelligence software | 20,681 | 10 |
| 13.1.1 | Building Structures and HVAC - Building 1 - High Quality | 2,217,211 | 40 |
| 13.1.2.1 | Building Structures and HVAC - Building 1 - Heating System - Natural gas condensing furnace | 67,071 | 25 |
| 13.1.3.1 | Building Structures and HVAC - Building 1 - Cooling System - Air conditioner | 26,109 | 25 |
| 13.2.1 | Building Structures and HVAC - Building 2 - High Quality | 307,005 | 40 |
| 13.2.3.1 | Building Structures and HVAC - Building 2 - Heating and Cooling System - Heat pump | 4,103 | 25 |
| 13.3 | Building Structures and HVAC - Concrete Pad | 195,622 | 40 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 14,498,491 | 40 |
| | **Process Cost** | **26,211,376** | |
| | **System Cost** | **40,709,867** | |
| | **O&M Cost** | **4,888,971** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Construction Management | 1,104,901 |
| Process Engineering | 2,096,910 |
| Site Work | 379,994 |
| Yard Piping | 488,667 |
| Geotechnical | 31,500 |
| Standby Power | 15,906 |
| Electrical (including yard wiring) | 2,339,426 |
| Mobilization and Demobilization | 641,760 |
| Architectural Fees for Treatment Building | 174,661 |
| Permits | 2,973 |
| Pilot Study | 166,936 |
| Land Cost | 240,321 |
| Contingency | 2,358,603 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 2,621,138 |
| Legal, Fiscal, and Administrative (2.0%) | 524,228 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 1,310,569 |
| Instrumentation and Control (0.0%) | 0 |

| Breakdown of O&M costs | |
|---|---|
| Manager (195 hrs/yr @ $83.1618/hr) | 16,257 |
| Clerical (195 hrs/yr @ $43.9163/hr) | 8,585 |
| Operator (1955 hrs/yr @ $48.511/hr) | 94,831 |
| Cartridge filter replacement (672 filters/yr @ $234.0797/sf/yr) | 157,302 |
| Building and HVAC maintenance (materials and labor) (22190 sf @ $6.9362/sf/yr) | 153,914 |
| PFAS-selective (10110 cf/yr @ $328.9104/cf) | 3,325,379 |
| Energy for backwash/rinse pumps (0 Mwh/yr @ $0.1225/kwh) | 4 |
| Energy for lighting (52 Mwh/yr @ $0.1225/kwh) | 6,374 |
| Energy for ventilation (26 Mwh/yr @ $0.1225/kwh) | 3,198 |
| Air conditioning (73 Mwh/yr @ $0.1225/kwh) | 8,934 |
| Heat pump (cooling mode) (73 Mwh/yr @ $0.1225/kwh) | 8,934 |
| Heat pump (20 Mwh/yr @ $0.1225/kwh) | 2,425 |
| Natural gas condensing furnace (31092 therms/yr @ $0.9468/therm) | 29,437 |
| POTW discharge fees (93663 gal/yr @ $0.3524/gal) | 33,003 |
| Spent resin disposal (217 ton/yr @ $2737.1421/ton) | 594,976 |
| Spent cartridge filter disposal (8 ton/yr @ $119.7706/ton) | 966 |
| Miscellaneous Allowance (0  @ $) | 444,452 |

# B.3 Example Outputs for RO/NF

**Reverse Osmosis / Nanofiltration(RONF), design 0.500 mgd, average 0.162 mgd**
**Groundwater**
**Low-Cost Components**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1 | Membrane Process - Membrane Elements | 50,119 | N/A |
| 1.2 | Membrane Process - RO Pressure Vessels | 17,677 | 17 |
| 1.3.1 | Membrane Process - Feed Line Connectors - Victaulic, Painted | 3,037 | 20 |
| 1.5.1 | Membrane Process - Piping On Rack - Feed - Stainless Steel | 13,214 | 40 |
| 1.5.2 | Membrane Process - Piping On Rack - Permeate - PVC | 504 | 17 |
| 1.5.3 | Membrane Process - Piping On Rack - Concentrate - Stainless Steel | 8,773 | 40 |
| 1.6 | Membrane Process - Vessel Support Rack - Steel Beams | 15,861 | 20 |
| 1.7 | Membrane Process - Markup for Rack Assembly | 36,574 | 23.03638685 |
| 2.1.1 | Pretreatment Acid Storage Tanks - Plastic (HXLPE) | 977 | 7 |
| 2.1.2 | Pretreatment Acid Storage Tanks - Secondary Containment - Concrete Curbing | 1,479 | 37 |
| 2.1.3 | Pretreatment Acid Storage Tanks - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2.2.1 | Pretreatment Acid Day Tanks - Plastic/XLPE | 806 | 7 |
| 2.2.2 | Pretreatment Acid Day Tanks - Secondary Containment - Concrete Curbing | 740 | 37 |
| 2.2.3 | Pretreatment Acid Day Tanks - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2.3.1 | Pretreatment Antiscalant Tanks - Plastic (XLPE) | 814 | 7 |
| 2.3.2 | Pretreatment Antiscalant Tanks - Secondary Containment - Concrete Curbing | 740 | 37 |
| 2.3.3 | Pretreatment Antiscalant Tanks - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2,7,1 | Cleaning Solution Makeup Tanks - Plastic (XLPE) | 2,167 | 7 |
| 2.8.1 | Cleaning Chemical Storage Tanks - Acid - Plastic (XLPE) | 794 | 7 |
| 2.8.2 | Cleaning Chemical Storage Tanks - Acid - Secondary Containment - Concrete Curbing | 740 | 37 |
| 2.8.3 | Cleaning Chemical Storage Tanks - Acid - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2.8.4 | Cleaning Chemical Storage Tanks - High pH - Plastic (XLPE) | 794 | 7 |
| 2.8.5 | Cleaning Chemical Storage Tanks - High pH - Secondary Containment - Concrete Curbing | 740 | 37 |
| 2.8.6 | Cleaning Chemical Storage Tanks - High pH - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 3.1.1 | Influent and Treated Water Piping - PVC | 1,293 | 17 |
| 3.2.1 | Cleaning System Piping - PVC | 420 | 17 |
| 3.3.1 | Residuals Piping - PVC | 111,214 | 17 |
| 3.3.2 | Residuals Piping - Excavation | 308,438 | 17 |
| 3.3.3 | Residuals Piping - Bedding | 14,937 | 17 |
| 3.3.4 | Residuals Piping - Backfill and Compaction | 186,281 | 17 |
| 3.3.5 | Residuals Piping - Thrust Blocks | 59,263 | 17 |
| 4.1.1 | Motor/Air Operated (on/off) Valves - Pretreatment acid - Polypropylene/PVC | 1,891 | 20 |
| 4.1.2 | Motor/Air Operated (on/off) Valves - Antiscalant - Polypropylene/PVC | 1,891 | 20 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 4.1.3 | Motor/Air Operated (on/off) Valves - Feed line - Polypropylene/PVC | 8,587 | 20 |
| 4.1.4 | Motor/Air Operated (on/off) Valves - Concentrate control - Cast Iron | 5,134 | 20 |
| 4.1.10 | Motor/Air Operated (on/off) Valves - Cleaning - Polypropylene/PVC | 40,248 | 20 |
| 4.2.1 | Manual Valves - Influent and treated water - Polypropylene/PVC | 1,791 | 20 |
| 4.3.1 | Check Valves - Residuals - Polypropylene/PVC | 665 | 20 |
| 4.3.2 | Check Valves - Influent - Polypropylene/PVC | 1,306 | 20 |
| 4.3.4 | Check Valves - Feed pumps - Polypropylene/PVC | 2,611 | 20 |
| 4.3.5 | Check Valves - Cleaning - Polypropylene/PVC | 1,996 | 20 |
| 5.1.1 | Acid Metering Pumps for Pretreatment - PVC - Electric | 2,510 | 15 |
| 5.2.1 | Antiscalant Metering Pumps for Pretreatment - PVC - Electric | 2,419 | 15 |
| 5.4 | Pumps - Feed Water | 57,482 | 17 |
| 5.7 | Pumps - Cleaning Pumps (separate for acid and caustic) | 1,138 | 17 |
| 6.1 | Screens and Filters - Cartridge Filters for Feed | 27,306 | 30 |
| 6.2.1 | Screens and Filters - Security Screens for Cleaning - Simplex Basket Screens | 7,431 | 30 |
| 6.3 | Screens and Filters - Cartridge Filters for Cleaning | 16,126 | 30 |
| 8.1 | Teflon Immersion Heaters for Cleaning Tanks | 4,307 | 14 |
| 9.1.1 | Instrumentation - Flow Meters - Influent and Treated Water Line - Propeller | 9,592 | 14 |
| 9.2.1 | Instrumentation - Flow Meters - Membrane Trains - Feed Line - Propeller | 9,592 | 14 |
| 9.3.1 | Instrumentation - Flow Meters - Membrane Trains - Permeate Line - Propeller | 7,719 | 14 |
| 9.3.1 | Instrumentation - Flow Meters - Membrane Trains - Concentrate Line - Propeller | 6,171 | 14 |
| 9.4.1 | Instrumentation - Flow Meters - Cleaning - Propeller | 14,388 | 14 |
| 9.5.1 | Instrumentation - Propeller | 3,860 | 14 |
| 9.6 | Instrumentation - Level Switches/Alarms (for cleaning tanks) | 1,287 | 14 |
| 9.7 | Instrumentation - High/Low Alarms (for pretreatment chemical tanks) | 1,287 | 14 |
| 9.8 | Instrumentation - High/Low Alarms (for cleaning chemical storage tanks) | 1,287 | 14 |
| 9.1 | Instrumentation - pH meters | 12,188 | 14 |
| 9.11 | Instrumentation - Temperature meters | 2,384 | 14 |
| 9.12 | Instrumentation - Conductivity meters | 18,244 | 14 |
| 9.13 | Instrumentation - Head loss sensors | 9,556 | 14 |
| 9.14.1 | Instrumentation - Sampling ports - Carbon Steel | 900 | 22 |
| 10.1.1 | System Controls - PLC Units - PLC racks/power supplies | 2,040 | 8 |
| 10.1.2 | System Controls - PLC Units - CPUs | 851 | 8 |
| 10.1.3 | System Controls - PLC Units - I/O discrete input modules | 860 | 8 |
| 10.1.4 | System Controls - PLC Units - I/O discrete output modules | 382 | 8 |
| 10.1.5 | System Controls - PLC Units - I/O combination analog modules | 5,636 | 8 |
| 10.1.6 | System Controls - PLC Units - Ethernet modules | 3,016 | 8 |
| 10.1.7 | System Controls - PLC Units - Base expansion modules | 160 | 8 |
| 10.1.8 | System Controls - PLC Units - Base expansion controller modules | 309 | 8 |
| 10.1.9 | System Controls - PLC Units - UPSs | 986 | 8 |
| 10.2.1 | System Controls - Operator Equipment - Drive controllers | 12,556 | 14 |
| 10.2.2 | System Controls - Operator Equipment - Operator interface units | 10,492 | 8 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 11.1.1 | Building Structures and HVAC - Building 1 - Low Quality | 142,973 | 37 |
| 11.4 | Building Structures and HVAC - Concrete Pad | 13,797 | 37 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 955,062 | 37 |
| | **Process Cost** | **1,317,693** | |
| | **System Cost** | **2,272,755** | |
| | **O&M Cost** | **117,342** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Mobilization and Demobilization | 79,800 |
| Construction Management and GC Overhead | 87,042 |
| Contingency | 181,904 |
| Process Engineering | 263,539 |
| Site Work | 26,714 |
| Yard Piping | 3,725 |
| Geotechnical | 0 |
| Standby Power | 0 |
| Electrical (including yard wiring) | 116,092 |
| Architectural Fees for Treatment Building | 0 |
| Pilot Study | 1,243 |
| Land Cost | 2,559 |
| Permits | 34,321 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 131,769 |
| Legal, Fiscal, and Administrative (2.0%) | 26,354 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (0.0%) | 0 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (124 hrs/yr @ $52.3563/hr) | 6,496 |
| Administrative (124 hrs/yr @ $34.0099/hr) | 4,220 |
| Operator (1241 hrs/yr @ $35.3133/hr) | 43,815 |
| Materials for pretreatment (calculated as a percentage of capital) | 322 |
| Cartridge filter replacement (19 filters/yr @ $188.4333/filter) | 3,553 |
| Materials for membrane process (calculated as a percentage of capital) | 501 |
| Membrane replacement (10 element/yr @ $668.2566/element) | 6,873 |
| Materials for cleaning (calculated as a percentage of capital) | 247 |
| Materials for feed water and booster pumps (calculated as a percentage of capital) | 575 |
| Building and HVAC maintenance (materials and labor) (1560 sf @ $6.6975/sf/yr) | 10,448 |
| Sulfuric Acid - Small Qty (23565 lbs/yr @ $0.223/lb) | 5,256 |
| Antiscalant - Basic (2468 lbs/yr @ $3.3516/lb) | 8,271 |
| Membrane Cleaner - Low pH Sulfate Control (13 gal/yr @ $39.192/gal) | 497 |
| Membrane Cleaner - High pH Detergent (13 gal/yr @ $44.8439/gal) | 569 |
| Energy for feed water and booster pumps (119 Mwh/yr @ $0.1225/kwh) | 14,533 |
| Energy for lighting (1 Mwh/yr @ $0.1225/kwh) | 71 |
| Energy for ventilation (3 Mwh/yr @ $0.1225/kwh) | 367 |
| Spent cartridge filter disposal (0 ton/yr @ $119.7706/ton) | 37 |
| Spent membrane element disposal (0 ton/yr @ $119.7706/ton) | 23 |
| Miscellaneous Allowance (0  @ $) | 10,667 |

**Reverse Osmosis / Nanofiltration(RONF), design 5.809 mgd, average 2.455 mgd**
**Groundwater**
**Mid-Cost Components**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1 | Membrane Process - Membrane Elements | 803,996 | N/A |
| 1.2 | Membrane Process - RO Pressure Vessels | 264,211 | 22 |
| 1.3.1 | Membrane Process - Feed Line Connectors - Victaulic, Galvanized | 52,755 | 25 |
| 1.5.1 | Membrane Process - Piping On Rack - Feed - Stainless Steel | 242,957 | 45 |
| 1.5.2 | Membrane Process - Piping On Rack - Permeate - PVC | 10,663 | 22 |
| 1.5.3 | Membrane Process - Piping On Rack - Concentrate - Stainless Steel | 181,692 | 45 |
| 1.6 | Membrane Process - Vessel Support Rack - Steel Beams | 66,014 | 25 |
| 1.7 | Membrane Process - Markup for Rack Assembly | 371,978 | 30.76375793 |
| 2.1.1 | Pretreatment Acid Storage Tanks - Fiberglass | 15,193 | 10 |
| 2.1.2 | Pretreatment Acid Storage Tanks - Secondary Containment - Concrete Curbing | 2,958 | 40 |
| 2.1.3 | Pretreatment Acid Storage Tanks - Secondary Containment - Chemical Resistant Coating | 1,167 | 10 |
| 2.2.1 | Pretreatment Acid Day Tanks - Fiberglass | 3,778 | 10 |
| 2.2.2 | Pretreatment Acid Day Tanks - Secondary Containment - Concrete Curbing | 740 | 40 |
| 2.2.3 | Pretreatment Acid Day Tanks - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2.3.1 | Pretreatment Antiscalant Tanks - Fiberglass | 5,386 | 10 |
| 2.3.2 | Pretreatment Antiscalant Tanks - Secondary Containment - Concrete Curbing | 1,479 | 40 |
| 2.3.3 | Pretreatment Antiscalant Tanks - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2.4.1 | Pretreatment Antiscalant Day Tanks - Fiberglass | 1,369 | 10 |
| 2.4.2 | Pretreatment Antiscalant Day Tanks - Secondary Containment - Concrete Curbing | 740 | 40 |
| 2.4.3 | Pretreatment Antiscalant Day Tanks - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2,7,1 | Cleaning Solution Makeup Tanks - Fiberglass | 39,164 | 10 |
| 2.8.1 | Cleaning Chemical Storage Tanks - Acid - Fiberglass | 2,595 | 10 |
| 2.8.2 | Cleaning Chemical Storage Tanks - Acid - Secondary Containment - Concrete Curbing | 740 | 40 |
| 2.8.3 | Cleaning Chemical Storage Tanks - Acid - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2.8.4 | Cleaning Chemical Storage Tanks - High pH - Fiberglass | 2,595 | 10 |
| 2.8.5 | Cleaning Chemical Storage Tanks - High pH - Secondary Containment - Concrete Curbing | 2,219 | 40 |
| 2.8.6 | Cleaning Chemical Storage Tanks - High pH - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 3.1.1 | Influent and Treated Water Piping - CPVC | 42,422 | 22 |
| 3.2.1 | Cleaning System Piping - CPVC | 3,531 | 22 |
| 3.3.1 | Residuals Piping - CPVC | 1,266,369 | 22 |
| 3.3.2 | Residuals Piping - Excavation | 375,051 | 22 |
| 3.3.3 | Residuals Piping - Bedding | 19,102 | 22 |
| 3.3.4 | Residuals Piping - Backfill and Compaction | 226,512 | 22 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 3.3.5 | Residuals Piping - Thrust Blocks | 208,364 | 22 |
| 4.1.1 | Motor/Air Operated (on/off) Valves - Pretreatment acid - Stainless Steel | 990 | 25 |
| 4.1.2 | Motor/Air Operated (on/off) Valves - Antiscalant - Stainless Steel | 990 | 25 |
| 4.1.3 | Motor/Air Operated (on/off) Valves - Feed line - Cast Iron | 69,907 | 25 |
| 4.1.4 | Motor/Air Operated (on/off) Valves - Concentrate control - Stainless Steel | 21,371 | 25 |
| 4.1.10 | Motor/Air Operated (on/off) Valves - Cleaning - Stainless Steel | 222,326 | 25 |
| 4.2.1 | Manual Valves - Influent and treated water - Cast Iron | 10,552 | 25 |
| 4.3.1 | Check Valves - Residuals - Cast Iron | 6,898 | 25 |
| 4.3.2 | Check Valves - Influent - Cast Iron | 20,013 | 25 |
| 4.3.4 | Check Valves - Feed pumps - Cast Iron | 27,592 | 25 |
| 4.3.5 | Check Valves - Cleaning - Cast Iron | 5,532 | 25 |
| 5.1.1 | Acid Metering Pumps for Pretreatment - PVC - Electric | 3,467 | 20 |
| 5.2.1 | Antiscalant Metering Pumps for Pretreatment - Stainless Steel - Electric | 4,927 | 20 |
| 5.4 | Pumps - Feed Water | 532,976 | 20 |
| 5.7 | Pumps - Cleaning Pumps (separate for acid and caustic) | 6,253 | 20 |
| 6.1 | Screens and Filters - Cartridge Filters for Feed | 153,356 | 35 |
| 6.2.1 | Screens and Filters - Security Screens for Cleaning - Simplex Basket Screens | 38,236 | 35 |
| 6.3 | Screens and Filters - Cartridge Filters for Cleaning | 93,117 | 35 |
| 8.1 | Teflon Immersion Heaters for Cleaning Tanks | 30,166 | 15 |
| 9.1.1 | Instrumentation - Flow Meters - Influent and Treated Water Line - Venturi | 10,244 | 15 |
| 9.2.1 | Instrumentation - Flow Meters - Membrane Trains - Feed Line - Venturi | 10,590 | 15 |
| 9.3.1 | Instrumentation - Flow Meters - Membrane Trains - Permeate Line - Venturi | 9,230 | 15 |
| 9.3.1 | Instrumentation - Flow Meters - Membrane Trains - Concentrate Line - Venturi | 9,230 | 15 |
| 9.4.1 | Instrumentation - Flow Meters - Cleaning - Venturi | 76,828 | 15 |
| 9.5.1 | Instrumentation - Venturi | 3,530 | 15 |
| 9.6 | Instrumentation - Level Switches/Alarms (for cleaning tanks) | 1,287 | 15 |
| 9.7 | Instrumentation - High/Low Alarms (for pretreatment chemical tanks) | 1,287 | 15 |
| 9.8 | Instrumentation - High/Low Alarms (for cleaning chemical storage tanks) | 1,287 | 15 |
| 9.1 | Instrumentation - pH meters | 12,188 | 15 |
| 9.11 | Instrumentation - Temperature meters | 2,384 | 15 |
| 9.12 | Instrumentation - Conductivity meters | 25,085 | 15 |
| 9.13 | Instrumentation - Head loss sensors | 14,334 | 15 |
| 9.14.1 | Instrumentation - Sampling ports - Stainless Steel | 8,650 | 35 |
| 10.1.1 | System Controls - PLC Units - PLC racks/power supplies | 4,080 | 10 |
| 10.1.2 | System Controls - PLC Units - CPUs | 851 | 10 |
| 10.1.3 | System Controls - PLC Units - I/O discrete input modules | 3,440 | 10 |
| 10.1.4 | System Controls - PLC Units - I/O discrete output modules | 382 | 10 |
| 10.1.5 | System Controls - PLC Units - I/O combination analog modules | 10,019 | 10 |
| 10.1.6 | System Controls - PLC Units - Ethernet modules | 3,016 | 10 |
| 10.1.7 | System Controls - PLC Units - Base expansion modules | 481 | 10 |
| 10.1.8 | System Controls - PLC Units - Base expansion controller modules | 927 | 10 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 10.1.9 | System Controls - PLC Units - UPSs | 986 | 10 |
| 10.2.1 | System Controls - Operator Equipment - Drive controllers | 32,088 | 15 |
| 10.2.2 | System Controls - Operator Equipment - Operator interface units | 3,537 | 10 |
| 10.2.3 | System Controls - Operator Equipment - PC Workstations | 4,326 | 10 |
| 10.2.4 | System Controls - Operator Equipment - Printers - laser jet | 391 | 10 |
| 10.3.1 | System Controls - Controls Software - Operator interface software | 91 | 10 |
| 10.3.2 | System Controls - Controls Software - PLC programming software | 622 | 10 |
| 10.3.3 | System Controls - Controls Software - PLC data collection software | 671 | 10 |
| 10.3.4 | System Controls - Controls Software - Plant intelligence software | 20,681 | 10 |
| 11.1.1 | Building Structures and HVAC - Building 1 - Medium Quality | 524,472 | 40 |
| 11.1.2.1 | Building Structures and HVAC - Building 1 - Heating System - Natural gas condensing furnace | 64,500 | 25 |
| 11.4 | Building Structures and HVAC - Concrete Pad | 58,637 | 40 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 3,634,458 | 40 |
| | **Process Cost** | **6,386,707** | |
| | **System Cost** | **10,021,165** | |
| | **O&M Cost** | **1,005,211** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Mobilization and Demobilization | 248,717 |
| Construction Management and GC Overhead | 265,845 |
| Contingency | 577,576 |
| Process Engineering | 603,798 |
| Site Work | 91,959 |
| Yard Piping | 15,910 |
| Geotechnical | 0 |
| Standby Power | 128,125 |
| Electrical (including yard wiring) | 447,100 |
| Architectural Fees for Treatment Building | 39,246 |
| Pilot Study | 72,728 |
| Land Cost | 19,439 |
| Permits | 38,274 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 638,671 |
| Legal, Fiscal, and Administrative (2.0%) | 127,734 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 319,335 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (604 hrs/yr @ $66.7054/hr) | 40,263 |
| Administrative (604 hrs/yr @ $43.9163/hr) | 26,508 |
| Operator (6036 hrs/yr @ $39.756/hr) | 239,968 |
| Materials for pretreatment (calculated as a percentage of capital) | 1,594 |
| Cartridge filter replacement (96 filters/yr @ $231.2489/filter) | 22,200 |
| Materials for membrane process (calculated as a percentage of capital) | 8,040 |
| Membrane replacement (165 element/yr @ $626.4905/element) | 103,371 |
| Materials for cleaning (calculated as a percentage of capital) | 1,376 |
| Materials for feed water and booster pumps (calculated as a percentage of capital) | 5,330 |
| Building and HVAC maintenance (materials and labor) (5370 sf @ $6.8511/sf/yr) | 36,790 |
| Sulfuric Acid - Small Qty (253899 lbs/yr @ $0.223/lb) | 56,630 |
| Antiscalant - Basic (28052 lbs/yr @ $3.3516/lb) | 94,022 |
| Membrane Cleaner - Low pH Sulfate Control (203 gal/yr @ $39.192/gal) | 7,959 |
| Membrane Cleaner - High pH Detergent (203 gal/yr @ $44.8439/gal) | 9,107 |
| Energy for feed water and booster pumps (1872 Mwh/yr @ $0.1225/kwh) | 229,218 |
| Energy for lighting (10 Mwh/yr @ $0.1225/kwh) | 1,191 |
| Energy for ventilation (15 Mwh/yr @ $0.1225/kwh) | 1,858 |
| Natural gas condensing furnace (29515 therms/yr @ $0.9468/therm) | 27,944 |
| Spent cartridge filter disposal (2 ton/yr @ $119.7706/ton) | 197 |
| Spent membrane element disposal (2 ton/yr @ $119.7706/ton) | 263 |
| Miscellaneous Allowance (0  @ $) | 91,383 |

**Reverse Osmosis / Nanofiltration(RONF), design 56.271 mgd, average 24.863 mgd**
**Surface Water**
**High-Cost Components**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1 | Membrane Process - Membrane Elements | 6,459,814 | N/A |
| 1.2 | Membrane Process - RO Pressure Vessels | 2,006,152 | 22 |
| 1.3.1 | Membrane Process - Feed Line Connectors - Victaulic, Galvanized | 370,881 | 25 |
| 1.5.1 | Membrane Process - Piping On Rack - Feed - Stainless Steel | 1,708,064 | 45 |
| 1.5.2 | Membrane Process - Piping On Rack - Permeate - PVC | 74,966 | 22 |
| 1.5.3 | Membrane Process - Piping On Rack - Concentrate - Stainless Steel | 1,277,350 | 45 |
| 1.6 | Membrane Process - Vessel Support Rack - Steel Beams | 486,047 | 25 |
| 1.7 | Membrane Process - Markup for Rack Assembly | 2,785,737 | 30.42915982 |
| 2.1.1 | Pretreatment Acid Storage Tanks - Fiberglass | 68,975 | 10 |
| 2.1.2 | Pretreatment Acid Storage Tanks - Secondary Containment - Concrete Curbing | 21,449 | 40 |
| 2.1.3 | Pretreatment Acid Storage Tanks - Secondary Containment - Chemical Resistant Coating | 5,059 | 10 |
| 2.2.1 | Pretreatment Acid Day Tanks - Fiberglass | 16,724 | 10 |
| 2.2.2 | Pretreatment Acid Day Tanks - Secondary Containment - Concrete Curbing | 3,698 | 40 |
| 2.2.3 | Pretreatment Acid Day Tanks - Secondary Containment - Chemical Resistant Coating | 1,557 | 10 |
| 2.3.1 | Pretreatment Antiscalant Tanks - Stainless Steel | 14,625 | 35 |
| 2.3.2 | Pretreatment Antiscalant Tanks - Secondary Containment - Concrete Curbing | 2,958 | 40 |
| 2.3.3 | Pretreatment Antiscalant Tanks - Secondary Containment - Chemical Resistant Coating | 1,167 | 10 |
| 2.4.1 | Pretreatment Antiscalant Day Tanks - Stainless Steel | 2,210 | 35 |
| 2.4.2 | Pretreatment Antiscalant Day Tanks - Secondary Containment - Concrete Curbing | 740 | 40 |
| 2.4.3 | Pretreatment Antiscalant Day Tanks - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2,7,1 | Cleaning Solution Makeup Tanks - Stainless Steel | 45,951 | 35 |
| 2.8.1 | Cleaning Chemical Storage Tanks - Acid - Fiberglass | 4,712 | 10 |
| 2.8.2 | Cleaning Chemical Storage Tanks - Acid - Secondary Containment - Concrete Curbing | 1,479 | 40 |
| 2.8.3 | Cleaning Chemical Storage Tanks - Acid - Secondary Containment - Chemical Resistant Coating | 389 | 10 |
| 2.8.4 | Cleaning Chemical Storage Tanks - High pH - Stainless Steel | 2,897 | 35 |
| 2.8.5 | Cleaning Chemical Storage Tanks - High pH - Secondary Containment - Concrete Curbing | 4,438 | 40 |
| 2.8.6 | Cleaning Chemical Storage Tanks - High pH - Secondary Containment - Chemical Resistant Coating | 778 | 10 |
| 3.1.1 | Influent and Treated Water Piping - Stainless Steel | 447,647 | 45 |
| 3.2.1 | Cleaning System Piping - Stainless Steel | 29,245 | 45 |
| 3.3.1 | Residuals Piping - Steel | 2,945,204 | 35 |
| 3.3.2 | Residuals Piping - Excavation | 533,347 | 22 |
| 3.3.3 | Residuals Piping - Bedding | 28,372 | 22 |
| 3.3.4 | Residuals Piping - Backfill and Compaction | 322,116 | 22 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 3.3.5 | Residuals Piping - Thrust Blocks | 721,352 | 22 |
| 4.1.1 | Motor/Air Operated (on/off) Valves - Pretreatment acid - Stainless Steel | 990 | 25 |
| 4.1.2 | Motor/Air Operated (on/off) Valves - Antiscalant - Stainless Steel | 990 | 25 |
| 4.1.3 | Motor/Air Operated (on/off) Valves - Feed line - Stainless Steel | 493,999 | 25 |
| 4.1.4 | Motor/Air Operated (on/off) Valves - Concentrate control - Stainless Steel | 142,470 | 25 |
| 4.1.5 | Motor/Air Operated (on/off) Valves - Stage 2 boost - Stainless Steel | 21,371 | 25 |
| 4.1.10 | Motor/Air Operated (on/off) Valves - Cleaning - Stainless Steel | 658,743 | 25 |
| 4.2.1 | Manual Valves - Influent and treated water - Cast Iron | 37,235 | 25 |
| 4.3.1 | Check Valves - Residuals - Stainless Steel | 15,557 | 25 |
| 4.3.2 | Check Valves - Influent - Stainless Steel | 49,272 | 25 |
| 4.3.4 | Check Valves - Feed pumps - Stainless Steel | 138,044 | 25 |
| 4.3.5 | Check Valves - Cleaning - Stainless Steel | 5,015 | 25 |
| 5.1.1 | Acid Metering Pumps for Pretreatment - PVC - Motor Driven | 14,074 | 20 |
| 5.2.1 | Antiscalant Metering Pumps for Pretreatment - PVC - Motor Driven | 7,570 | 20 |
| 5.4 | Pumps - Feed Water | 1,535,722 | 20 |
| 5.5 | Pumps - Booster pumps, stage 2 | 77,650 | 20 |
| 5.7 | Pumps - Cleaning Pumps (separate for acid and caustic) | 7,007 | 20 |
| 6.1 | Screens and Filters - Cartridge Filters for Feed | 1,022,414 | 35 |
| 6.2.1 | Screens and Filters - Security Screens for Cleaning - Simplex Basket Screens | 42,748 | 35 |
| 6.3 | Screens and Filters - Cartridge Filters for Cleaning | 100,666 | 35 |
| 8.1 | Teflon Immersion Heaters for Cleaning Tanks | 33,585 | 15 |
| 9.1.1 | Instrumentation - Flow Meters - Influent and Treated Water Line - Magnetic | 50,265 | 15 |
| 9.2.1 | Instrumentation - Flow Meters - Membrane Trains - Feed Line - Magnetic | 156,229 | 15 |
| 9.3.1 | Instrumentation - Flow Meters - Membrane Trains - Permeate Line - Magnetic | 132,579 | 15 |
| 9.3.1 | Instrumentation - Flow Meters - Membrane Trains - Concentrate Line - Magnetic | 132,579 | 15 |
| 9.4.1 | Instrumentation - Flow Meters - Cleaning - Magnetic | 427,252 | 15 |
| 9.5.1 | Instrumentation - Magnetic | 13,094 | 15 |
| 9.6 | Instrumentation - Level Switches/Alarms (for cleaning tanks) | 1,287 | 15 |
| 9.7 | Instrumentation - High/Low Alarms (for pretreatment chemical tanks) | 1,287 | 15 |
| 9.8 | Instrumentation - High/Low Alarms (for cleaning chemical storage tanks) | 1,287 | 15 |
| 9.1 | Instrumentation - pH meters | 12,188 | 15 |
| 9.11 | Instrumentation - Temperature meters | 2,384 | 15 |
| 9.12 | Instrumentation - Conductivity meters | 141,389 | 15 |
| 9.13 | Instrumentation - Head loss sensors | 90,780 | 15 |
| 9.14.1 | Instrumentation - Sampling ports - Stainless Steel | 60,000 | 35 |
| 10.1.1 | System Controls - PLC Units - PLC racks/power supplies | 15,300 | 10 |
| 10.1.2 | System Controls - PLC Units - CPUs | 851 | 10 |
| 10.1.3 | System Controls - PLC Units - I/O discrete input modules | 18,919 | 10 |
| 10.1.4 | System Controls - PLC Units - I/O discrete output modules | 765 | 10 |
| 10.1.5 | System Controls - PLC Units - I/O combination analog modules | 41,330 | 10 |

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 10.1.6 | System Controls - PLC Units - Ethernet modules | 3,016 | 10 |
| 10.1.7 | System Controls - PLC Units - Base expansion modules | 2,244 | 10 |
| 10.1.8 | System Controls - PLC Units - Base expansion controller modules | 4,327 | 10 |
| 10.1.9 | System Controls - PLC Units - UPSs | 986 | 10 |
| 10.2.1 | System Controls - Operator Equipment - Drive controllers | 73,943 | 15 |
| 10.2.2 | System Controls - Operator Equipment - Operator interface units | 3,537 | 10 |
| 10.2.3 | System Controls - Operator Equipment - PC Workstations | 21,632 | 10 |
| 10.2.4 | System Controls - Operator Equipment - Printers - laser jet | 782 | 10 |
| 10.3.1 | System Controls - Controls Software - Operator interface software | 91 | 10 |
| 10.3.2 | System Controls - Controls Software - PLC programming software | 3,110 | 10 |
| 10.3.3 | System Controls - Controls Software - PLC data collection software | 3,355 | 10 |
| 10.3.4 | System Controls - Controls Software - Plant intelligence software | 103,404 | 10 |
| 10.3.5 | System Controls - Controls Software - Early warning software | 116,745 | 10 |
| 11.1.1 | Building Structures and HVAC - Building 1 - High Quality | 740,869 | 40 |
| 11.1.2.1 | Building Structures and HVAC - Building 1 - Heating System - Natural gas condensing furnace | 148,374 | 25 |
| 11.1.3.1 | Building Structures and HVAC - Building 1 - Heating and Cooling System - Air conditioner | 580,415 | 25 |
| 11.2.1 | Building Structures and HVAC - Building 2 - High Quality | 382,285 | 40 |
| 11.2.3.1 | Building Structures and HVAC - Building 2 - Heating and Cooling System - Heat pump | 3,719 | 25 |
| 11.3.1 | Building Structures and HVAC - Building 3 - High Quality | 1,883,430 | 40 |
| 11.3.3.1 | Building Structures and HVAC - Building 3 - Heating and Cooling System - Heat pump | 5,535 | 25 |
| 11.4 | Building Structures and HVAC - Concrete Pad | 310,925 | 40 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 15,495,113 | 40 |
| | **Process Cost** | **30,494,099** | |
| | **System Cost** | **45,989,212** | |
| | **O&M Cost** | **7,976,137** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Mobilization and Demobilization | 620,762 |
| Construction Management and GC Overhead | 1,049,501 |
| Contingency | 2,283,454 |
| Process Engineering | 1,989,857 |
| Site Work | 427,600 |
| Yard Piping | 102,278 |
| Geotechnical | 0 |
| Standby Power | 956,084 |
| Electrical (including yard wiring) | 2,191,608 |
| Architectural Fees for Treatment Building | 183,343 |
| Pilot Study | 152,123 |
| Land Cost | 295,730 |
| Permits | 58,777 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 3,049,410 |
| Legal, Fiscal, and Administrative (2.0%) | 609,882 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 1,524,705 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (3074 hrs/yr @ $83.1618/hr) | 255,674 |
| Administrative (3074 hrs/yr @ $43.9163/hr) | 135,017 |
| Operator (30744 hrs/yr @ $48.511/hr) | 1,491,431 |
| Materials for pretreatment (calculated as a percentage of capital) | 10,400 |
| Cartridge filter replacement (1440 filters/yr @ $235.0601/filter) | 338,487 |
| Materials for membrane process (calculated as a percentage of capital) | 64,598 |
| Membrane replacement (1856 element/yr @ $626.4905/element) | 1,162,766 |
| Materials for cleaning (calculated as a percentage of capital) | 1,504 |
| Materials for feed water and booster pumps (calculated as a percentage of capital) | 16,134 |
| Building and HVAC maintenance (materials and labor) (24970 sf @ $6.9362/sf/yr) | 173,196 |
| Sulfuric Acid - Large Qty (4008879 lbs/yr @ $0.1567/lb) | 628,329 |
| Antiscalant - Basic (201471 lbs/yr @ $3.3516/lb) | 675,261 |
| Membrane Cleaner - Low pH Sulfate Control (2194 gal/yr @ $39.192/gal) | 85,970 |
| Membrane Cleaner - High pH Detergent (2194 gal/yr @ $44.8439/gal) | 98,368 |
| Energy for feed water and booster pumps (15114 Mwh/yr @ $0.1225/kwh) | 1,850,830 |
| Energy for lighting (66 Mwh/yr @ $0.1225/kwh) | 8,036 |
| Energy for ventilation (97 Mwh/yr @ $0.1225/kwh) | 11,826 |
| Air conditioning (1258 Mwh/yr @ $0.1225/kwh) | 154,057 |
| Heat pump (31 Mwh/yr @ $0.1225/kwh) | 3,803 |
| Heat pump (96 Mwh/yr @ $0.1225/kwh) | 11,720 |
| Natural gas condensing furnace (71125 therms/yr @ $0.9468/therm) | 67,339 |
| Spent cartridge filter disposal (17 ton/yr @ $119.7706/ton) | 2,070 |
| Spent membrane element disposal (35 ton/yr @ $119.7706/ton) | 4,216 |
| Miscellaneous Allowance (0  @ $) | 725,103 |

## B.4 Example Outputs for POU RO

**Point of Use/Point of Entry(POU), design 0.500 mgd, average 0.162 mgd (481 households)**
**Groundwater**
**Contaminant: PFAS**
**Treatment Technology: POU Reverse Osmosis**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1 | Installed Treatment Equipment - POU/POE Unit Purchase | 112,927 | 10 |
| 1.2 | Installed Treatment Equipment - POU/POE Installation | 44,933 | 10 |
| 1.3 | Installed Treatment Equipment - Scheduling Time | 8,400 | N/A |
| 2.1.1 | Public Education - Technical Labor - Develop materials | 353 | N/A |
| 2.1.3 | Public Education - Technical Labor - Meetings | 71 | N/A |
| 2.1.4 | Public Education - Technical Labor - Post-meeting | 71 | N/A |
| 2.2.1 | Public Education - Clerical Labor - Develop materials | 204 | N/A |
| 2.2.3 | Public Education - Clerical Labor - Meetings | 68 | N/A |
| 2.2.4 | Public Education - Clerical Labor - Post-meeting | 68 | N/A |
| 2.3.1 | Public Education - Printed Material - Meeting flyers | 19 | N/A |
| 2.3.2 | Public Education - Printed Material - Meeting ads | 74 | N/A |
| 2.3.4 | Public Education - Printed Material - Meeting handouts | 277 | N/A |
| 2.3.5 | Public Education - Printed Material - Billing mailers | 185 | N/A |
| 3.1 | Initial Year Monitoring 1 - Sampling time | 2,905 | N/A |
| 3.3 | Initial Year Monitoring 1 - Analysis | 102,708 | N/A |
| 3.4 | Initial Year Monitoring 1 - Analysis (total coliform) | 11,128 | N/A |
| 3.5 | Initial Year Monitoring 1 - Shipping | 1,033 | N/A |
| Indirect | Indirect and Add-On Costs (contingency from model) | 56,529 | 10 |
| | **Process Cost** | **285,425** | |
| | **System Cost** | **341,954** | |
| | **O&M Cost** | **112,626** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Permitting | 4,988 |
| Pilot Testing | 4,988 |
| Legal | 4,988 |
| Engineering | 24,939 |
| Contingency | 16,626 |

| Breakdown of O&M costs | |
|---|---|
| POU/POE Maintenance | 11,339 |
| Information updates | 424 |
| Maintenance Scheduling | 10,921 |
| Information updates | 408 |
| Sediment Pre-Filter | 6,683 |
| Pre-GAC Filter Cartridge | 11,425 |
| Post-GAC Filter Cartridge | 6,480 |
| RO Membrane | 5,602 |
| Billing mailers | 277 |
| Sampling time | 1,457 |
| Analysis | 51,510 |
| Shipping | 519 |

## B.5 Example Outputs for Nontreatment Options

**Non-Treatment(NON), design 0.500 mgd, average 0.162 mgd**
**Groundwater**
**Low-Cost Components**
**Design Type: Interconnection**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 2.1.1 | Vaults - Booster Pump - Concrete | 4,911 | 37 |
| 2.1.2 | Vaults - Booster Pump - Excavation | 5,789 | 37 |
| 2.1.3 | Vaults - Booster Pump - Backfill and Compaction | 2,317 | 37 |
| 3.1.1 | Piping - Interconnect - PVC | 161,565 | 17 |
| 3.1.2 | Piping - Interconnect - Excavation | 90,543 | 17 |
| 3.1.3 | Piping - Interconnect - Backfill and Compaction | 54,684 | 17 |
| 3.1.4 | Piping - Interconnect - Asphalt Patch | 93,519 | 17 |
| 4.1.1 | Valves - Isolation and Street - Ductile Iron | 22,950 | 20 |
| 4.2.1 | Valves - Motor/Air Operated (on/off) - Booster Pump - Polypropylene/PVC | 1,791 | 20 |
| 5.1 | Pumps - Interconnect Booster Pump | 22,852 | 17 |
| 6.1.1 | Instrumentation - Flow Meters - Interconnect - Propeller | 4,796 | 14 |
| 7.1 | System Controls - Remote Telemetry Units (RTUs) | 1,215 | 8 |
| 7.3 | System Controls - Drive Controllers | 1,395 | 14 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 310,723 | 17 |
| | **Process Cost** | **468,328** | |
| | **System Cost** | **779,051** | |
| | **O&M Cost** | **211,778** | |

*Totals are computed before component costs are rounded*

| Breakdown of indirect and add-on costs | |
|---|---|
| Contingency | 48,821 |
| Process Engineering | 93,387 |
| Construction Management and GC Overhead | 37,608 |
| Site Work | 0 |
| Yard Piping | 0 |
| Geotechnical | 0 |
| Standby Power | 0 |
| Electrical (including yard wiring) | 46,693 |
| Mobilization and Demobilization | 28,016 |
| Architectural Fees for Treatment Building | 0 |
| Permits | 0 |
| Pilot Study | 0 |
| Land Cost | 0 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 46,833 |
| Legal, Fiscal, and Administrative (2.0%) | 9,367 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (0.0%) | 0 |

| Breakdown of O&M costs | |
|---|---|
| Manager (3 hrs/yr @ $52.3563/hr) | 164 |
| Administrative (3 hrs/yr @ $35.3133/hr) | 111 |
| Operator (31 hrs/yr @ $34.0099/hr) | 1,066 |
| Purchased Water (59130 K gal @ $3.1748K gal) | 187,729 |
| Booster pump (calculated as a percentage of capital) | 229 |
| Energy for booster pumps (26 Mwh/yr @ $0.1225/kwh) | 3,228 |
| Miscellaneous Allowance (0 @ $) | 19,253 |

**Non-Treatment(NON), design 0.500 mgd, average 0.162 mgd**
**Groundwater**
**Low-Cost Components**
**Design Type: New Well Construction**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1.1 | Well Items - Well Casing - PVC | 13,474 | 27 |
| 1.2.1 | Well Items - Well screen - PVC Schedule 40 | 14,356 | 27 |
| 1.3.1 | Well Items - Plugs - PVC | 312 | 27 |
| 1.4 | Well Items - Well Drilling | 72,085 | 27 |
| 1.5 | Well Items - Gravel Pack | 10,244 | 27 |
| 1.6 | Well Items - Well Development | 770 | 27 |
| 1.7 | Well Items - Grout Seal | 3,072 | 27 |
| 3.2.1 | Piping - Well - PVC | 8,078 | 17 |
| 3.2.2 | Piping - Well - Excavation | 4,527 | 17 |
| 3.2.3 | Piping - Well - Backfill and Compaction | 2,734 | 17 |
| 4.2.2 | Valves - Motor/Air Operated (on/off) - Well Pump - Polypropylene/PVC | 1,791 | 20 |
| 5.2 | Pumps - Well Pump | 16,821 | 17 |
| 6.2.1 | Instrumentation - Flow Meters - Well - Propeller | 4,796 | 14 |
| 7.1 | System Controls - Remote Telemetry Units (RTUs) | 1,215 | 8 |
| 7.2 | System Controls - Well Pump - Soft Start Control | 418 | 8 |
| 7.3 | System Controls - Drive Controllers | 1,395 | 14 |
| 8.1.1 | Building Structures - Building 1 - Small Low Cost Shed | 11,440 | 20 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 167,015 | 27 |
| | **Process Cost** | **167,528** | |
| | **System Cost** | **334,542** | |
| | **O&M Cost** | **13,630** | |

*Totals are computed before component costs are rounded*

| Breakdown of indirect and add-on costs | |
|---|---|
| Contingency | 20,879 |
| Process Engineering | 33,143 |
| Construction Management and GC Overhead | 18,963 |
| Site Work | 3,425 |
| Yard Piping | 0 |
| Geotechnical | 22,180 |
| Standby Power | 0 |
| Electrical (including yard wiring) | 15,427 |
| Mobilization and Demobilization | 11,166 |
| Architectural Fees for Treatment Building | 0 |
| Permits | 0 |
| Pilot Study | 0 |
| Land Cost | 21,727 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 16,753 |
| Legal, Fiscal, and Administrative (2.0%) | 3,351 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (0.0%) | 0 |

| Breakdown of O&M costs | |
|---|---|
| Manager (4 hrs/yr @ $52.3563/hr) | 223 |
| Administrative (4 hrs/yr @ $35.3133/hr) | 150 |
| Operator (43 hrs/yr @ $34.0099/hr) | 1,448 |
| Building maintenance (materials and labor) (200 sf @ $6.6975/sf/yr) | 1,339 |
| Well pump (calculated as a percentage of capital) | 168 |
| Energy for well pumps (74 Mwh/yr @ $0.1225/kwh) | 9,062 |
| Miscellaneous Allowance (0  @ $) | 1,239 |

**Non-Treatment(NON), design 1.000 mgd, average 0.350 mgd**
**Groundwater**
**Mid-Cost Components**
**Design Type: Interconnection**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 2.1.1 | Vaults - Booster Pump - Concrete | 8,546 | 40 |
| 2.1.2 | Vaults - Booster Pump - Excavation | 9,050 | 40 |
| 2.1.3 | Vaults - Booster Pump - Backfill and Compaction | 3,015 | 40 |
| 3.1.1 | Piping - Interconnect - PVC | 161,565 | 22 |
| 3.1.2 | Piping - Interconnect - Excavation | 90,543 | 22 |
| 3.1.3 | Piping - Interconnect - Backfill and Compaction | 54,684 | 22 |
| 3.1.4 | Piping - Interconnect - Asphalt Patch | 93,519 | 22 |
| 4.1.1 | Valves - Isolation and Street - Ductile Iron | 22,950 | 25 |
| 4.2.1 | Valves - Motor/Air Operated (on/off) - Booster Pump - Cast Iron | 14,273 | 25 |
| 5.1 | Pumps - Interconnect Booster Pump | 75,685 | 20 |
| 6.1.1 | Instrumentation - Flow Meters - Interconnect - Venturi | 3,077 | 15 |
| 7.1 | System Controls - Remote Telemetry Units (RTUs) | 1,215 | 10 |
| 7.3 | System Controls - Drive Controllers | 1,395 | 15 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 361,760 | 22 |
| | **Process Cost** | **539,516** | |
| | **System Cost** | **901,275** | |
| | **O&M Cost** | **476,182** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Contingency | 49,319 |
| Process Engineering | 64,574 |
| Construction Management and GC Overhead | 42,998 |
| Site Work | 0 |
| Yard Piping | 0 |
| Geotechnical | 0 |
| Standby Power | 32,220 |
| Electrical (including yard wiring) | 53,812 |
| Mobilization and Demobilization | 27,119 |
| Architectural Fees for Treatment Building | 0 |
| Permits | 0 |
| Pilot Study | 0 |
| Land Cost | 0 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 53,952 |
| Legal, Fiscal, and Administrative (2.0%) | 10,790 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 26,976 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (3 hrs/yr @ $59.8839/hr) | 188 |
| Administrative (3 hrs/yr @ $37.6596/hr) | 118 |
| Operator (31 hrs/yr @ $34.0099/hr) | 1,066 |
| Purchased Water (127750 K gal @ $3.1748K gal) | 405,587 |
| Booster pump (calculated as a percentage of capital) | 757 |
| Energy for booster pumps (206 Mwh/yr @ $0.1225/kwh) | 25,178 |
| Miscellaneous Allowance (0  @ $) | 43,289 |

**Non-Treatment(NON), design 1.000 mgd, average 0.350 mgd**
**Groundwater**
**Mid-Cost Components**
**Design Type: New Well Construction**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1.1 | Well Items - Well Casing - Stainless Steel | 377,507 | 30 |
| 1.2.1 | Well Items - Well screen - PVC Schedule 80 | 33,038 | 30 |
| 1.3.1 | Well Items - Plugs - PVC | 623 | 30 |
| 1.4 | Well Items - Well Drilling | 144,169 | 30 |
| 1.5 | Well Items - Gravel Pack | 20,489 | 30 |
| 1.6 | Well Items - Well Development | 1,540 | 30 |
| 1.7 | Well Items - Grout Seal | 6,143 | 30 |
| 3.2.1 | Piping - Well - PVC | 16,156 | 22 |
| 3.2.2 | Piping - Well - Excavation | 9,054 | 22 |
| 3.2.3 | Piping - Well - Backfill and Compaction | 5,468 | 22 |
| 4.2.2 | Valves - Motor/Air Operated (on/off) - Well Pump - Cast Iron | 28,546 | 25 |
| 5.2 | Pumps - Well Pump | 33,641 | 20 |
| 6.2.1 | Instrumentation - Flow Meters - Well - Venturi | 3,077 | 15 |
| 7.1 | System Controls - Remote Telemetry Units (RTUs) | 2,430 | 10 |
| 7.2 | System Controls - Well Pump - Soft Start Control | 835 | 10 |
| 7.3 | System Controls - Drive Controllers | 2,790 | 15 |
| 8.1.1 | Building Structures - Building 1 - Small Low Cost Shed | 22,880 | 25 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 552,043 | 30 |
| | **Process Cost** | **708,388** | |
| | **System Cost** | **1,260,431** | |
| | **O&M Cost** | **28,953** | |

*Totals are computed before component costs are rounded*

| Breakdown of indirect and add-on costs | |
|---|---|
| Contingency | 68,865 |
| Process Engineering | 84,572 |
| Construction Management and GC Overhead | 55,230 |
| Site Work | 6,850 |
| Yard Piping | 0 |
| Geotechnical | 44,360 |
| Standby Power | 27,563 |
| Electrical (including yard wiring) | 68,188 |
| Mobilization and Demobilization | 36,888 |
| Architectural Fees for Treatment Building | 2,059 |
| Permits | 0 |
| Pilot Study | 0 |
| Land Cost | 37,043 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 70,839 |
| Legal, Fiscal, and Administrative (2.0%) | 14,168 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 35,419 |

| Breakdown of O&M costs | |
|---|---|
| Manager (9 hrs/yr @ $59.8839/hr) | 510 |
| Administrative (9 hrs/yr @ $37.6596/hr) | 321 |
| Operator (85 hrs/yr @ $34.0099/hr) | 2,897 |
| Building maintenance (materials and labor) (400 sf @ $6.6975/sf/yr) | 2,679 |
| Well pump (calculated as a percentage of capital) | 336 |
| Energy for well pumps (160 Mwh/yr @ $0.1225/kwh) | 19,578 |
| Miscellaneous Allowance (0 @ $) | 2,632 |

**Non-Treatment(NON), design 3.536 mgd, average 1.345 mgd**
**Surface Water**
**High-Cost Components**
**Design Type: Interconnection**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 2.1.1 | Vaults - Booster Pump - Concrete | 10,277 | 40 |
| 2.1.2 | Vaults - Booster Pump - Excavation | 10,579 | 40 |
| 2.1.3 | Vaults - Booster Pump - Backfill and Compaction | 3,296 | 40 |
| 3.1.1 | Piping - Interconnect - Ductile Iron | 1,442,458 | 40 |
| 3.1.2 | Piping - Interconnect - Excavation | 102,616 | 40 |
| 3.1.3 | Piping - Interconnect - Backfill and Compaction | 61,975 | 40 |
| 3.1.4 | Piping - Interconnect - Asphalt Patch | 105,988 | 40 |
| 4.1.1 | Valves - Isolation and Street - Ductile Iron | 61,530 | 25 |
| 4.2.1 | Valves - Motor/Air Operated (on/off) - Booster Pump - Stainless Steel | 56,849 | 25 |
| 5.1 | Pumps - Interconnect Booster Pump | 106,073 | 20 |
| 6.1.1 | Instrumentation - Flow Meters - Interconnect - Magnetic | 9,045 | 15 |
| 7.1 | System Controls - Remote Telemetry Units (RTUs) | 1,215 | 10 |
| 7.3 | System Controls - Drive Controllers | 2,790 | 15 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 1,235,017 | 40 |
| | **Process Cost** | **1,974,692** | |
| | **System Cost** | **3,209,708** | |
| | **O&M Cost** | **1,799,495** | |

*Totals are computed before component costs are rounded*

| **Breakdown of indirect and add-on costs** | |
|---|---|
| Contingency | 175,779 |
| Process Engineering | 236,628 |
| Construction Management and GC Overhead | 128,519 |
| Site Work | 0 |
| Yard Piping | 0 |
| Geotechnical | 0 |
| Standby Power | 63,993 |
| Electrical (including yard wiring) | 197,190 |
| Mobilization and Demobilization | 97,211 |
| Architectural Fees for Treatment Building | 0 |
| Permits | 0 |
| Pilot Study | 0 |
| Land Cost | 0 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 197,469 |
| Legal, Fiscal, and Administrative (2.0%) | 39,494 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 98,735 |

| **Breakdown of O&M costs** | |
|---|---|
| Manager (6 hrs/yr @ $66.7054/hr) | 412 |
| Administrative (6 hrs/yr @ $39.756/hr) | 245 |
| Operator (62 hrs/yr @ $43.9163/hr) | 2,712 |
| Purchased Water (490925 K gal @ $3.1748K gal) | 1,558,612 |
| Booster pump (calculated as a percentage of capital) | 1,061 |
| Energy for booster pumps (595 Mwh/yr @ $0.1225/kwh) | 72,863 |
| Miscellaneous Allowance (0  @ $) | 163,590 |

**Non-Treatment(NON), design 3.536 mgd, average 1.417 mgd**
**Groundwater**
**High-Cost Components**
**Design Type: New Well Construction**

| WBS # | Item | Total Cost ($) | Useful Life (yrs) |
|---|---|---|---|
| 1.1.1 | Well Items - Well Casing - Stainless Steel | 943,768 | 30 |
| 1.2.1 | Well Items - Well screen - Stainless Steel | 216,209 | 30 |
| 1.3.1 | Well Items - Plugs - PVC | 1,558 | 30 |
| 1.4 | Well Items - Well Drilling | 360,423 | 30 |
| 1.5 | Well Items - Gravel Pack | 51,222 | 30 |
| 1.6 | Well Items - Well Development | 3,850 | 30 |
| 1.7 | Well Items - Grout Seal | 15,358 | 30 |
| 3.2.1 | Piping - Well - Ductile Iron | 223,135 | 40 |
| 3.2.2 | Piping - Well - Excavation | 22,636 | 40 |
| 3.2.3 | Piping - Well - Backfill and Compaction | 13,671 | 40 |
| 4.2.2 | Valves - Motor/Air Operated (on/off) - Well Pump - Stainless Steel | 71,235 | 25 |
| 5.2 | Pumps - Well Pump | 112,124 | 20 |
| 6.2.1 | Instrumentation - Flow Meters - Well - Magnetic | 6,629 | 15 |
| 7.1 | System Controls - Remote Telemetry Units (RTUs) | 6,075 | 10 |
| 7.2 | System Controls - Well Pump - Soft Start Control | 2,088 | 10 |
| 7.3 | System Controls - Drive Controllers | 6,976 | 15 |
| 8.1.1 | Building Structures - Building 1 - Low Quality | 95,613 | 40 |
| Indirect | Indirect and Add-On Costs (contingency from model) | 1,576,160 | 30 |
| | **Process Cost** | **2,152,569** | |
| | **System Cost** | **3,728,729** | |
| | **O&M Cost** | **108,570** | |

*Totals are computed before component costs are rounded*

| Breakdown of indirect and add-on costs | |
|---|---|
| Contingency | 203,829 |
| Process Engineering | 257,221 |
| Construction Management and GC Overhead | 139,398 |
| Site Work | 17,125 |
| Yard Piping | 0 |
| Geotechnical | 110,900 |
| Standby Power | 65,959 |
| Electrical (including yard wiring) | 204,789 |
| Mobilization and Demobilization | 110,265 |
| Architectural Fees for Treatment Building | 8,605 |
| Permits | 1,449 |
| Pilot Study | 0 |
| Land Cost | 90,684 |
| Installation, Transportation, and O&P (0.0%) | 0 |
| Instrumentation and Control (0.0%) | 0 |
| Miscellaneous Allowance (10.0%) | 215,257 |
| Legal, Fiscal, and Administrative (2.0%) | 43,051 |
| Sales Tax (0.0%) | 0 |
| Financing during Construction (5.0%) | 107,628 |

| Breakdown of O&M costs | |
|---|---|
| Manager (21 hrs/yr @ $66.7054/hr) | 1,420 |
| Administrative (21 hrs/yr @ $39.756/hr) | 846 |
| Operator (213 hrs/yr @ $43.9163/hr) | 9,351 |
| Building maintenance (materials and labor) (1000 sf @ $6.6975/sf/yr) | 6,697 |
| Well pump (calculated as a percentage of capital) | 1,121 |
| Energy for well pumps (647 Mwh/yr @ $0.1225/kwh) | 79,264 |
| Miscellaneous Allowance (0 @ $) | 9,870 |