# ENGINEERING EVALUATION AND COST ANALYSIS
# NON-TIME CRITICAL REMOVAL ACTION
# WIDEFIELD WATER AND SANITATION DISTRICT, CO

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## TABLE OF CONTENTS

**Page**

**TABLE OF CONTENTS (Continued)**

**Page**

## LIST OF TABLES



## LIST OF FIGURES



## LIST OF APPENDICES

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AFB | Air Force Base |
| AFFF | aqueous film-forming foam |
| AM | action memorandum |
| ARAR | applicable or relevant and appropriate requirements |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act, 42 USC §§ 9601-9675 |
| CFR | Code of Federal Regulations |
| DERP | Defense Environmental Restoration Program, 10 USC §§ 2701-2711 |
| District | Widefield Water and Sanitation District |
| DoD | (U.S.) Department of Defense |
| DoDI 4715.01 | Department of Defense Instruction 4715.07, *Defense Environmental Restoration Program (DERP)*, May 21, 2013 |
| DoDM 4715.20 | Department of Defense Manual 4715.20, *Defense Environmental Restoration Program (DERP) Management*, March 9, 2012 |
| EE/CA | engineering evaluation and cost analysis |
| EO 12580 | Executive Order 12580, *Superfund Implementation*, January 23, 1987 |
| EPA | (U.S.) Environmental Protection Agency |
| GAC | granular activated carbon |
| LHA | lifetime health advisory |
| mgd | million gallons per day |
| μg/L | microgram per liter |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300 |
| NTCRA | non-time critical removal action |
| PFOA | perfluorooctanoic acid |
| PFOS | perfluorooctane sulfonic acid |
| ppt | parts per trillion |
| RAO | removal action objective |
| SARA | Superfund Amendments and Reauthorization Act, Public Law 99-499 (1986) |
| TBC | to be considered |
| TCRA | time critical removal action |

## LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

| | |
|---|---|
| USAF | U.S. Air Force |
| USC | U.S. Code |

# EXECUTIVE SUMMARY

The U.S. Air Force (USAF) will conduct a non-time critical removal action (NTCRA) to address the probable releases from USAF activities of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) that contaminated some of the groundwater used as a drinking water source by the Widefield Water and Sanitation District (District), Colorado. Current PFOS and PFOA concentrations exceed U.S. Environmental Protection Agency (EPA) lifetime health advisory (LHA) action levels, thereby precluding the District from using all of its groundwater as a source of drinking water without treatment. This engineering evaluation and cost analysis (EE/CA) identifies and evaluates proposed alternatives for completing the NTCRA. The EE/CA identifies the removal action objective (RAO); identifies and evaluates potential alternatives for conducting the removal action; and recommends the best-suited removal action alternative. This proposed action will protect human health from exposure to PFOS and PFOA in the groundwater in excess of the EPA LHA action levels.

Each month, the District is obligated to purchase a fixed amount of surface water from the Fountain Valley Authority (FVA). This water comes from Pueblo Reservoir and is not contaminated. The District uses groundwater to meet the demands that cannot be met by the surface water purchase. The District has the right to obtain water from 17 groundwater supply wells. Of these 17 wells, there are ten active wells screened in the Widefield aquifer and three active wells screened in the Jimmy Camp aquifer. Four wells are inactive and would require re-drilling or rehabilitation before use. However, these four wells are screened in the Widefield aquifer which is contaminated with PFOS and PFOA. Each of the Widefield aquifer wells has a combined PFOS and PFOA concentration greater than the LHA action levels. Groundwater from the Jimmy Camp aquifer wells complies with the LHA action levels.

The PFOS and PFOA concentrations in the District's supply wells met the provisional health advisory action levels of 0.2 micrograms per liter (μg/L) for PFOS and 0.4 μg/L for PFOA in effect before May 2016. EPA health advisories are not enforceable and are not regulatory standards. Instead, they provide technical information to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination. In May 2016, the EPA issued LHA action levels of 0.07 μg/L, which is equal to 70 parts per trillion (ppt), for PFOS and PFOA individually and combined. The combined PFOS and PFOA concentrations in the ten supply wells in the Widefield aquifer are greater than the 2016 LHA action levels. To prevent exposure of its customers to PFOS and PFOA concentrations greater than the LHA action levels, the District conducted a pilot study to test potential treatment technologies for PFOS/PFOA removal and, based on the pilot test results, installed an ion exchange treatment system. The ion exchange system started operation in May 2017. Currently, PFOS and PFOA in groundwater from three wells are being removed by the ion exchange system. In addition to FVA water purchases, these wells can meet the District's immediate needs but do not provide redundancy if a well must be taken out of service or if other conditions change. Under a time critical removal action being performed by the USAF, two additional supply wells will be connected to the existing ion exchange system in summer 2018. The ion exchange system, however, can treat only a portion of the groundwater provided by the District's contaminated supply wells. There are five contaminated supply wells that are not connected to a PFOS/PFOA removal system. To provide assurance of adequate groundwater supply to meet peak demand, the

District needs to be able to use all of its active supply wells. In addition, the District must be able to show continued ability to use each well in order to avoid abandonment of the water rights. If these five remaining wells are not connected to a treatment system, the District will not be able to use these wells and could lose the rights to the water surrounding these wells.

The scope of this NTCRA is to enable the District to resume use of all of its existing supply wells by decreasing PFOS and PFOA concentrations to less than EPA's 2016 LHA action levels in the five contaminated wells that are not currently connected to a treatment system. EPA's LHA action levels are the removal action criteria. The RAO is to prevent exposure of the District's drinking water system users to groundwater which contains PFOS and PFOA concentrations that, individually or in combination, exceed the removal action criteria.

The following alternatives for achieving the RAO and removal action criterion were evaluated. All three alternatives require the continued purchase of water from the FVA and operation of the existing treatment system.

- Alternative 1 – no action alternative. This alternative was evaluated to provide a baseline against which to compare the other alternatives. With this alternative, the District would purchase additional surface water as needed and as available to meet peak demand.
- Alternative 2 – treatment of the water from the five remaining untreated supply wells with granular activated carbon (GAC) to remove both PFOS and PFOA. With this alternative, treatment for the five supply wells would be consolidated at a single location. This alternative includes installation of piping to convey the groundwater to the treatment facility.
- Alternative 3 – treatment of the water from the five remaining untreated supply wells with ion exchange resin to remove both PFOS and PFOA. With this alternative, treatment for the five supply wells would be consolidated at a single location. This alternative includes installation of piping to convey the groundwater to the treatment facility.

Because it is more expensive to operate five individual treatment systems at each supply well than to consolidate the treatment system at a single location, "well-head" treatment was not included in the alternatives. The three removal action alternatives were evaluated with respect to effectiveness, implementability, and cost. Alternative 1 is the least effective and least implementable of the three removal action alternatives. For these reasons, alternative 1 is not recommended.

Alternatives 2 and 3 are similar in their effectiveness. Alternative 3 would be more easily implemented by the District than alternative 2. Alternative 3, ex situ treatment with ion exchange, is less expensive on a present worth basis than alternative 2. Based on cost, alternative 3 is the recommended removal action alternative.

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## 1.0 INTRODUCTION

### 1.1 PURPOSE AND OBJECTIVE

The U.S. Air Force (USAF) will conduct a non-time critical removal action (NTCRA) to address the probable releases from USAF activities of two pollutants or contaminants into the environment that caused perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) levels in the groundwater that Widefield Water and Sanitation District (District), Colorado uses as a drinking water source to exceed U.S. Environmental Protection Agency (EPA) lifetime health advisory (LHA) action levels. This engineering evaluation and cost analysis (EE/CA) identifies and evaluates proposed alternatives for completing the NTCRA to remove PFOA and PFOS from groundwater extracted for drinking water use. The EE/CA identifies the removal action objective (RAO); identifies and evaluates potential alternatives for conducting the removal action; and recommends the best-suited removal action alternative. This proposed action will protect human health from exposure to PFOS and PFOA in the groundwater in excess of the EPA LHA action levels.

The U.S. Department of Defense (DoD) has the authority to undertake this removal action pursuant to Sections 104 and 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S. Code (USC) §§ 9604, 9620; Section 2701 of the Defense Environmental Restoration Program (DERP), 10 USC § 2701; Section 300.415 of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) § 300.415; Executive Order (EO) 12580, as amended; and EPA, DoD, and USAF guidance. This EE/CA was prepared for Peterson Air Force Base (AFB), the Air Force Civil Engineer Center, and the U.S. Army Corps of Engineers, Omaha District, under Contract Number W9128F-16-D-0044, Delivery Order W9128F18F0028, in accordance with the *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA, 1993).

### 1.2 STATUTORY FRAMEWORK

CERCLA and the NCP provide authority for the lead Federal agency to take action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release of a pollutant or contaminant the agency determines poses an imminent and substantial danger to public health or welfare, and the lead Federal agency determines that such action is appropriate based on consideration of several factors, to include actual or potential exposure to nearby human populations, and actual or potential contamination of potential drinking water supplies. EPA has categorized removal actions in three ways (emergency, time-critical, and non-time critical) based on the type of situation, the urgency and threat of the release or potential release, and the subsequent time frame in which the action must be initiated. CERCLA and NCP define removal actions to include such actions as may necessarily be taken in the event of the threat of release of pollutants or contaminants into the environment, such action as may be necessary to monitor, assess, and evaluate the release or threat of release, the disposal of removal material, or the taking of such other actions as may be necessary to prevent, minimize or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release.

Removal actions are usually interim measures that, to the extent practicable, must contribute to the efficient performance of any anticipated, long-term remedial action. One example of a removal action listed in 40 CFR 300.415(e) is provision of an alternate water supply until a permanent remedy can be implemented. With respect to the PFOS/PFOA contamination in the District, one potential removal action is to remove the PFOS and PFOA from the groundwater after it is extracted but before it enters the District's distribution system; whereas a potential long-term remedial action may be to eliminate or contain contamination in the groundwater in situ.

USAF is the lead Federal agency for a removal action to address PFOS and PFOA contamination in drinking water that it determines is probably attributable, at least in part, to USAF activities and poses an imminent and substantial danger to public health or welfare (i.e., exceeds the EPA LHA action levels). As such, USAF has final approval authority, with state concurrence, over the recommended alternative and all public participation activities. This EE/CA complies with the requirements of CERCLA, the Superfund Amendments and Reauthorization Act (SARA), the NCP, DERP, and EO No. 12580. This removal action has been determined to be appropriate because factors under 40 CFR § 300.415(b)(2)(ii) apply, namely that there is actual contamination of drinking water supplies.

## 1.3 REPORT ORGANIZATION

The remainder of this EE/CA is organized in the following sections:

- Section 2.0 provides site characterization information such as site description, site investigation, and a streamlined risk assessment.
- Section 3.0 defines RAOs and discusses applicable or relevant and appropriate requirements (ARARs) for the proposed removal action.
- Section 4.0 presents the identification and analysis of removal action alternatives.
- Section 5.0 provides a comparative analysis of removal action alternatives.
- Section 6.0 identifies the recommended removal action alternative.
- Section 7.0 provides references used in preparation of this report.
- Appendix A presents the cost estimate for each alternative.

# 2.0 SITE CHARACTERIZATION

## 2.1 SITE DESCRIPTION AND BACKGROUND

The site consists of groundwater contamination reported in water supply wells in the District. Widefield, Colorado, is a census-designated place located in El Paso County near the city of Colorado Springs (Figure 2.1). Each month, the District is obligated to purchase a fixed amount of surface water from the Fountain Valley Authority (FVA). This water comes from Pueblo Reservoir and is not contaminated. The District uses groundwater to meet the demands that cannot be met by the surface water purchase. The District has the right to obtain water from 17 groundwater supply wells. Of these 17 wells, there are ten active wells screened in the Widefield aquifer and three active wells screened in the Jimmy Camp aquifer. Four wells are inactive and would require re-drilling or rehabilitation before use. These wells, however, are screened in the Widefield aquifer, which is contaminated with PFOS and PFOA. Each of the Widefield aquifer wells has a combined PFOS and PFOA concentration greater than the LHA action levels. Groundwater from the Jimmy Camp aquifer wells complies with the LHA action levels.

Prior to 2016, the PFOS and PFOA concentrations in the District's supply wells met the provisional LHA action levels. EPA health advisories are not enforceable and are not regulatory standards. Instead, they provide technical information to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination. The provisional LHA action levels for PFOS and PFOA were 0.2 micrograms per liter (μg/L) and 0.4 μg/L, respectively.

In May 2016, the EPA issued LHA action levels of 0.07 μg/L, which is equal to 70 parts per trillion (ppt), for PFOS and PFOA individually and combined, which is much lower than the provisional values. The combined PFOS and PFOA concentrations in each of the ten supply wells in the Widefield aquifer are greater than the LHA action levels. To prevent exposure of its customers to PFOS and PFOA concentrations greater than the LHA action levels, the District conducted a pilot study (JDS-Hydro Consultants, Inc., 2018) to test potential treatment technologies for PFOS/PFOA removal and, based on the pilot test results, installed an ion exchange treatment system. The treatment system started operation in May 2017. Currently, PFOS and PFOA in groundwater from three wells are being removed by the ion exchange system. These three wells provide a flow rate of 1,800 gallons per minute (gpm), and the treatment system has a capacity of 2,200 gpm. In addition to the FVA water purchases, these three wells have been able to meet the District's immediate needs but do not provide redundancy if a well must be taken out of service or if other conditions change. Under a time critical removal action (TCRA) being performed by the USAF, two additional supply wells will be connected to the ion exchange system in summer 2018. The treatment system, however, can treat only a portion of the groundwater provided by the District's contaminated supply wells. There are five contaminated supply wells that are not connected to a PFOS/POFOA removal system. To provide assurance of adequate groundwater supply to meet peak demand, the District needs to be able to use all of its active supply wells. Because groundwater is a less expensive water source than surface water, it is important for the District to find a long-term solution that will allow it to use all of its groundwater sources. In addition, the District owns rights to the groundwater that are too valuable a resource not to be able to use. The District must be able to show continued ability to use each well in order to avoid abandonment of the water rights.

## 2.2 PREVIOUS REMOVAL ACTIONS

The USAF completed a preliminary assessment in 2016 to identify areas where PFOS and PFOA may have been used and released to the environment. These potential source areas were sampled during a site investigation completed in July 2017 (Aerostar SES, LLC, 2017).

In 2017, the USAF prepared an Action Memorandum (AM) (USAF, 2017) for a TCRA for groundwater south of Peterson AFB that is contaminated with PFOS and PFOA, including the vicinity of the District. This TCRA included the following planned actions:

- Point-of-use water treatment devices for private well, single family residences.
- Whole-home carbon treatment system for impacted larger private well users (e.g., a small mobile home park and a small farm).
- Provide assistance to connect two non-residence locations with private wells to municipal water sources.
- One-time property transfer of granular activated carbon (GAC) systems to municipal water districts of Stratmoor Hills, Fountain, Security and Widefield.

As noted in Section 2.1, the TCRA also includes connecting two of the contaminated supply wells in the Widefield aquifer to the ion exchange system that the District installed and began operation in May 2017.

The NTCRA being evaluated in this document is a follow-on to the TCRA, and all removal actions are part of the USAF's larger, long-term response action to the groundwater contamination.

## 2.3 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The District is downgradient of Peterson AFB and the Colorado Springs Municipal Airport, which, since 1942, has been used by DoD. In addition, the USAF provides the airport with emergency response support for crashes and fires. Peterson AFB abuts the northern, upgradient, border of the airport.

Aqueous film-forming foams (AFFF) were developed in the 1960s to extinguish petroleum fires. The USAF started using AFFF in 1970. Because of their ability to put out fires and suppress re-ignition, use of AFFFs became widespread at airports, both military and civilian. AFFF, which contains both PFOS and PFOA, would have been used during fire training exercises, during suppression of actual fires, and in fire suppression systems. These historical uses could have released AFFF to the ground surface at Peterson AFB and the municipal airport, where the AFFF could percolate through the soil to the underlying groundwater.

A preliminary assessment, completed in March 2016, identified six sites at Peterson AFB and one site on the municipal airport where AFFF could have been used and released to the environment.

Soil and groundwater at these locations were sampled during the 2017 site investigation. At several monitoring wells, the combined PFOS and PFOA concentration exceeded the LHA action levels (Aerostar SES, LLC, 2017). The investigated areas are upgradient of the District. Based on the presence of PFOS and PFOA contamination in groundwater at Peterson AFB and the location of the contamination relative to the District, it is likely that historical USAF operations at Peterson AFB contributed to the PFOA and PFOS contamination.

Other common sources of PFOS and PFOA include manufacturing facilities, areas where industrial waste was disposed of, municipal solid waste landfills, and wastewater treatment facilities (http://pfas-1.itrcweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_history_and_use__11_13_17.pdf).

## 2.4 ANALYTICAL DATA

In May and August 2016, water samples were collected from the District's distribution system and analyzed for PFOS and PFOA. In portions of the distribution system, the combined PFOA and PFOS concentration was greater than the LHA action level of 0.07 μg/L (70 ppt). The maximum combined PFOS and PFOA concentration was 0.137 μg/L (137 ppt). Each of the ten active water supply wells owned by the District and screened in the Widefield aquifer has a combined PFOA and PFOS concentration greater than the LHA action levels.

## 2.5 STREAMLINED RISK EVALUATION

In 2016, EPA published the current LHA action levels of 0.07 μg/L (70 ppt) for PFOS and PFOA individually, and 0.07 μg/L (70 ppt) for the two compounds in combination (EPA, 2016a and 2016b). The EPA used a two-step process, explained in the following paragraphs, to calculate the LHA action levels.

First, the EPA calculated the water concentration that a lactating woman could drink with no health effects. A lactating woman was used in this calculation because this individual represents a sensitive population (newborns can be exposed to PFOA and PFOS through breast milk) and, on a body weight basis, this individual drinks more water than other adults. For these reasons, a lactating woman is the most conservative receptor for exposure to PFOS and PFOA through drinking water. The resulting safe concentration, called the drinking water equivalent level, is 0.37 μg/L (370 ppt). This concentration is protective of people who are exposed to PFOS and PFOA solely through drinking water.

Historically, PFOS and PFOA were used in many consumer goods, including carpets, stain-resistant upholstery, food packaging, non-stick cookware, textiles, and leather goods. Most manufacturing of PFOS in the United States was discontinued in 2002, and the phaseout of PFOA manufacturing began in 2006. The USAF is in the process of phasing out the use of AFFF containing PFOS and PFOA at Peterson AFB and nationwide. Because of the historical uses of PFOS and PFOA, these compounds are widespread throughout the environment and are found in many food products such as eggs, meat, milk, fish, and root vegetables. PFOS and PFOA have been measured in indoor dust. The primary routes by which people are exposed to PFOS and PFOA are food and indoor dust (EPA, 2016a and 2016b).

To account for the cumulative health effects of exposure to PFOS and PFOA from sources other than drinking water (e.g., food, indoor dust), EPA multiplied the drinking water equivalent level of 0.37 μg/L (370 ppt) by a relative source contribution factor of 20% (or 0.2). The resulting number is the LHA action level of 0.07 μg/L (70 ppt).

As noted above, the maximum combined PFOS and PFOA concentration in the 2016 water samples from the District's distribution system are greater than the LHA action levels. In addition, the combined PFOS and PFOA concentration at each active supply well in the Widefield aquifer is greater than the LHA action levels. Treatment of these supply wells is necessary to prevent an imminent and substantial risk to human health when groundwater is introduced into the District's water supply.

# 3.0 REMOVAL ACTION OBJECTIVES AND APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section identifies the statutory framework of removal actions and determines the removal scope based on the RAO, ARARs, and cleanup criteria.

## 3.1 STATUTORY FRAMEWORK

This removal action is performed pursuant to CERCLA and the NCP under the authority delegated by the Office of the President of the United States through EO 12580 as re-delegated. This order, as implemented through Department of Defense Instruction (DoDI) 4715.07 and Department of Defense Manual (DoDM) 4715.20 as amended, provides USAF with authorization to conduct removal actions. DERP provides funding to USAF for removal actions conducted under CERCLA. This removal action is non-time critical because the planning period from the time a removal action was determined to be necessary to the time when the removal action will be initiated is greater than 6 months. Because this is not a Superfund-lead site, the $2 million and 12-month statutory limits for Superfund-financed removal actions pursuant to Section 104(c)(1) of CERCLA do not apply.

This EE/CA provides an analysis of three removal alternatives for the site and recommends a removal action alternative. This EE/CA complies with the requirements of CERCLA, SARA, NCP, DERP, and EO 12580. This EE/CA is undertaken pursuant to 40 CFR, Part 300.415(b)(4)(i). The requirements for this EE/CA and its mandated public comment period provide an opportunity for public input with regard to the cleanup process.

## 3.2 SCOPE OF THE REMOVAL ACTION

The scope of this removal action is to enable the District to provide drinking water to its customers by decreasing PFOS and PFOA concentrations in its system to below EPA's 2016 LHA action levels. A secondary objective is to allow the District to resume use of its existing drinking water supply wells to meet customer needs and to retain the District's water rights.

### 3.2.1 Removal Action Objective

The RAO specifies what the proposed removal action is expected to accomplish. In other words, it defines the goals for the removal action. As such, RAOs are site-specific and are influenced by the nature and extent of chemical contamination, current and potentially threatened resources, and the potential for human and environmental exposure. Based on the scope of the removal action, which is to decrease the PFOS and PFOA concentrations in the District's underground drinking water sources to less than the EPA LHA action levels, the following RAO was developed:

- Prevent exposure of District's drinking water system users to groundwater which contains PFOS and PFOA concentrations that, individually or in combination, exceed the EPA LHA action levels of 0.07 μg/L (70 ppt).

### 3.2.2 Applicable and Relevant or Appropriate Requirements

The USAF, as a matter of policy, has decided, consistent with DoD policy, to attain ARARs to the extent practicable considering the exigencies of the situation. "Applicable requirements" are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that specifically address hazardous substances, pollutants, contaminants, location, or other circumstances found at a CERCLA site (which for purposes of this EE/CA include District's underground drinking water sources). A Federal cleanup requirement that pertains to a CERCLA site is "applicable." State requirements associated with a site are not "applicable" unless they are more stringent than applicable Federal requirements. If a cleanup standard or requirement is not "applicable," then it is evaluated to determine whether it is "relevant and appropriate."

"Relevant and appropriate requirements" are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that, while not "applicable" to the response action to a hazardous substance, pollutant, contaminant, location, or other circumstance at a CERCLA site, address problems or situations similar to the circumstances at the CERCLA site and their use is well suited to the particular site. Only state standards that are more stringent than Federal requirements may be "relevant and appropriate."

The criteria for determining if a standard or requirement is "applicable" or "relevant and appropriate" are listed in 40 CFR § 300.400(g). They include:

- The purpose of both the requirement and the CERCLA action;
- The medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;
- The substances regulated by the requirement and the substances found at the CERCLA site;
- The actions or activities regulated by the requirement and the response action contemplated at the CERCLA site;
- Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site;
- The type of place regulated and the type of place affected by the release or CERCLA action;
- The type and size of structure or facility regulated and the type and size of structure or facility affected by the release or proposed in the CERCLA action; and
- Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site.

According to CERCLA ARARs guidance (EPA, 1992), a requirement may be “applicable” or “relevant and appropriate,” but not both. ARARs must be identified on a site-specific basis and involve a two-part analysis: first, it must be determined whether a given requirement is applicable;

then, if it is not applicable, it must be determined whether it is both relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

Furthermore, only those state requirements or standards that are promulgated, identified by the state in a timely manner, and are more stringent than Federal requirements or standards may be "applicable" or "relevant and appropriate." In this context, “promulgated” means that the standards are of general applicability and are legally enforceable.

In addition to ARARs, advisories, criteria, or guidance may be identified as to be considered (TBC) material. These advisories, criteria, or guidance are developed by EPA, other federal agencies, or states and may be useful in developing the removal action. An example of a TBC item is the LHA action levels for PFOS and PFOA developed by EPA. TBC material complement ARARs but do not override them.

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered to be ARARs. Provisions of generally relevant Federal and state statutes and regulations determined to be procedural or non-environmental, including permit requirements, are not considered to be ARARs.

Pursuant to EPA guidance, ARARs are generally divided into three categories: chemical-, location-, and action-specific requirements:

- **Chemical-Specific ARARs** usually are either health- or risk-based methodologies or numerical values that limit the amount or concentration of a chemical that may remain in or be discharged to the environment. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied.
- **Location-Specific ARARs** generally are requirements that limit concentrations of chemicals or restrict certain activities solely because of geographical or land use concerns. These requirements may limit the boundaries of the remedial action and may impose additional constraints on the cleanup action. For example, location-specific ARARs may restrict activities in the vicinity of wetlands, floodplains, sensitive ecosystems or habitats, or areas of historical or cultural significance.
- **Action-Specific ARARs** are requirements that apply to specific actions that may be associated with site cleanup. They usually are restrictions on the conduct of certain activities or the operation of certain technologies at a specific site. For example, acceptable handling, treatment, and disposal procedures for hazardous substances, and requirements for erosion and sediment control during construction of treatment system buildings.

Potential ARARs and TBC requirements for the removal action are presented in Table 3.1. Proposed removal action alternatives are evaluated with respect to compliance with ARARs. The identification of ARARs is an iterative process, and the final determination of ARARs will be made in the AM, which will be submitted after public review of this EE/CA as part of the selection process for this response action. The AM is the primary Decision Document for NTCRAs and provides a concise, written record of the decision to select an appropriate removal action. It substantiates the need for a removal action, identifies the proposed action, and explains the rationale for the removal action selection.

## 3.3 REMOVAL ACTION CRITERIA

The removal action criteria are the contaminant concentrations that the removal action alternative must achieve. As noted in Table 3.1, there are no chemical-specific ARARs for PFOS and PFOA that can be used as criteria. In the absence of chemical-specific ARARs, the current EPA LHA action level of 0.07 μg/L (70 ppt) for the combined PFOS and PFOA concentration is the removal action criterion.

## 3.4 REMOVAL SCHEDULE

The removal schedule calls for completing the AM and advertising a remedial response contract for the removal action in summer 2018. Proposals would be evaluated and a contract awarded before the end of September 2018. The selected firm would then plan and construct the removal action and complete operational testing before March 2020. This schedule includes review and approval of the treatment system design documents and construction specifications by the Colorado Department of Public Health and Environment.

## 3.5 PLANNED REMEDIAL ACTIVITIES

At this time, specific remedial activities are not planned because investigation of the potential source area(s) is ongoing. Until the source(s) and migration pathways between the source(s) and District wells are characterized, potential remedial activities cannot be identified.

# 4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section identifies remedial technologies that could achieve the RAO, develops removal action alternatives based on these technologies, and evaluates each removal action alternative in terms of effectiveness, implementability, and cost. EPA guidance on NTCRAs (EPA, 1993) lists the following considerations for effectiveness, implementability, and cost:

- **Effectiveness:** An alternative's effectiveness is its ability to meet the objective within the scope of the removal action. This criterion considers protection of public health, the community, workers during implementation, and the environment; and compliance with ARARs. The following factors are also considered:
  - Long-term effectiveness and permanence: the extent and effectiveness of controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes.
  - Reduction of toxicity, mobility, or volume through treatment.
  - Short-term effectiveness, which addresses the effects of the alternative during implementation before the RAO has been met.
- **Implementability:** This criterion evaluates the technical and administrative feasibility of each alternative, and the availability of the services and materials needed to implement the alternative. This criterion also considers state and community acceptance. The acceptance of an alternative will be evaluated during the public comment period and preparation of the AM. The final version of this EE/CA will be made available for a 30-day public comment period, and all comments received will be summarized and addressed in the responsiveness summary section of the AM.
  - <u>Technical feasibility</u>: the ability of the technology to implement the remedy and the technology's reliability. Technical feasibility is evaluated from construction through operation and maintenance of the removal action. This factor also evaluates whether an alternative will contribute to the anticipated performance of any remedial activity.
  - <u>Administrative feasibility</u>: this factor evaluates those activities needed to coordinate with other offices and agencies, the need for permits, adherence to applicable non-environmental laws, and concerns of other regulatory agencies.
  - <u>Availability of services and materials</u>: this factor considers whether the requisite personnel, equipment, and materials will be available during the removal action schedule; the adequacy of off-site treatment capacity if the alternative includes off-site removal and treatment of waste; and whether the technology has been sufficiently developed for full-scale application.
- **Cost:** The direct and indirect capital, operation, and maintenance costs are estimated for each alternative. Costs are calculated on a present worth basis for any removal action lasting longer than 12 months.

## 4.1 POTENTIAL REMOVAL TECHNOLOGIES

Technologies for removing contaminants from groundwater can be divided into two broad categories: in situ (meaning the contaminants are treated in the ground), and ex situ (meaning the contaminants are treated in extracted groundwater). Currently, there are no viable technologies for in situ treatment of PFOS and PFOA. For this reason, only ex situ treatment of the extracted groundwater was considered.

There are three established technologies for the ex situ treatment of PFOS and PFOA: GAC, ion exchange, and reverse osmosis/membrane filtration. Other technologies, such as electrochemical degradation, are still being developed and thus are not yet suitable for full-scale implementation in a drinking water supply system. The three established technologies are described below. The pilot test of GAC and ion exchange completed by the District is described in Section 4.1.4.

### 4.1.1 Granular Activated Carbon

GAC is a well-established technology for the removal of chemicals from water. It consists of an adsorption medium made from a carbon source, such as coconut shells, bituminous coal, or lignite coal, which is activated using either heat or chemicals. The surface of the activated carbon has an affinity for hydrophobic molecules (the literal meaning of hydrophobic is "water-fearing;" hydrophobic chemicals do not mix well with water). PFOS and PFOA are both large molecules with a hydrophobic segment. The hydrophobic portion of PFOS and PFOA has an affinity for GAC. The GAC is placed in a large vessel or tank, and water is pumped via groundwater wells equipped with a Variable Frequency Drive to maintain adequate flows through the vessel. As the water flows past the GAC, PFOS and PFOA adsorb to the GAC surface and are thereby removed from the water. With time, the adsorption sites on the GAC are filled with PFOS and PFOA molecules, and any other hydrophobic chemicals that the water contains, and the GAC no longer has the capacity to remove the contaminants. When this stage is reached, the spent GAC is removed from the vessel and replaced with fresh GAC. It is USAF policy to incinerate spent GAC to ensure the PFOS and PFOA molecules are destroyed.

GAC is not selective for PFOS and PFOA. In other words, the GAC will adsorb other chemicals from the water in addition to PFOS and PFOA. The potential for other chemicals to compete with PFOA and PFOS for the GAC's adsorption sites is taken into account when designing a GAC treatment system. GAC is of a moderate cost to install, operate, and maintain, and the associated waste stream (i.e., spent GAC) is easy to manage and dispose of. Based on implementability and cost, GAC was retained for consideration in the removal action alternatives.

### 4.1.2 Ion Exchange

Ion exchange is a well-established technology for the removal of either positively-charged (cation exchange) or negatively-charged (anion exchange) chemicals from water. Both PFOS and PFOA have a negatively charged end that can associate with the anion exchange resin. Similar to GAC, a vessel or tank is filled with the ion exchange resin. As the contaminated water flows through the vessel, the anions in the groundwater, including PFOS and PFOA, associate with the resin. Once the exchange sites are filled, the resin can no longer remove PFOS and PFOA from the water, and the spent resin is replaced with fresh resin. Similar to GAC, the spent ion exchange resin is incinerated to ensure that the PFOS and PFOA molecules are completely destroyed.

The ion exchange resins used for PFOS and PFOA can also remove other anions from the groundwater. Nitrate and sulfate are examples of anions commonly found in groundwater that can be removed by these resins. The presence of other anions that can compete for the exchange sites on the resin is considered during design of the ion exchange system. Ion exchange is of a moderate cost to install, operate, and maintain; and it is easy to manage and dispose of the associated waste stream (i.e., spent resin). Ion exchange systems can be readily implemented and operated at a moderate cost. Based on implementability and cost, ion exchange was retained for consideration in the removal action alternatives.

### 4.1.3 Reverse Osmosis/Membrane Filtration

Reverse osmosis and membrane filtration use semipermeable membranes to filter chemicals out of water. Water is forced through the membrane at high pressure, and the membrane can block the passage of chemicals dissolved in the water. A portion of the influent water is retained by the membrane. This water, sometimes called the reject water, is concentrated with PFOS, PFOA, and natural constituents, such as salts. Because of the PFOS, PFOA, and high salt concentrations, the reject water cannot be discharged to the wastewater treatment facility. Evaporating the reject water takes a very large, open space that would be difficult to find in the District. This technology is energy intensive to operate and typically has high capital and operating costs. Because of the need to manage the reject water and the high costs, reverse osmosis/membrane filtration was not retained as a potential technology for the removal action.

### 4.1.4 Widefield Pilot Study

In October 2016, JDS-Hydro Consultants, Inc. conducted a pilot for the District initiated a pilot study to evaluate the use of GAC and ion exchange to remove PFOS and PFOA from the District's groundwater. This study tested one GAC and four ion exchange resins: Calgon Filtrasorb® 400, which is a GAC; Calgon Purolite CalRes™ 120, which is an ion exchange resin selective for PFOS/PFOA; Dow Dowex™ PSR2 Plus gel, an ion exchange resin; Evoqua APR-1 macroporous, an ion exchange resin; and Calgon Dow CalRes™ 2109 macroporous, an ion exchange resin (JDS-Hydro Consultants, 2018).

The pilot study lasted 24 weeks. The ion exchange resin Calgon Dow CalRes™ 2109 macroporous was added to the pilot study approximately 3 months after testing of the other four products had been started. Due to poor performance relative to the other ion exchange resins, testing of Evoqua APR-1 stopped partway through the pilot test. The average, combined, influent PFOS and PFOA concentration throughout the pilot test was 0.122 μg/L (122 ppt). Relative to the ion exchange resins, the GAC treated less water before PFOS and PFOA could be detected in the effluent. The three ion exchange resins exhibited similar performance. At the end of the pilot study, the effluent concentrations for the three ion exchange resins were still less than the LHA action levels. The test results indicated that ion exchange resins Calgon Purolite CalRes™ 120, Dow Dowex™ PSR2 Plus, and Calgon Dow CalRes™ 2109 had a higher PFOS and PFOA capacity than the GAC Calgon Filtrasorb® 400. Both technologies, however, were capable of removing PFOS and PFOA from the groundwater to concentrations less than the LHA action levels.

The pilot study also evaluated the potential for nitrate concentration in the effluent to spike after the treatment system had been shut down temporarily. During prior operation of a GAC system in the District, spikes in nitrate concentration were noted after the GAC unit had been shut down temporarily. The pilot study results indicated that re-starting the GAC columns after a temporary (3-day to 5-day) shutdown caused an increase in the nitrate concentration above the EPA established Maximum Contaminant Level in the column effluent for approximately a day. A similar increase in nitrate concentration was not observed for the ion exchange resins after a temporary shutdown.

## 4.2 POTENTIAL TREATMENT SYSTEM CONFIGURATIONS

As described above, the existing ion exchange system is currently connected to three supply wells and is in the process of being connected to two additional supply wells. The treatment system has a capacity of 2,200 gpm. The existing ion exchange system will not be able to treat five of the District's active supply wells. It is possible to install a treatment system at each of the untreated supply wells. Installation of five temporary units, however, would be more expensive and difficult to implement than one or two centralized treatment systems. Whether GAC or ion exchange is used for the treatment process, each temporary unit would need to be operated 2 to 3 times per week to prevent biofouling of the treatment medium. Operating five individual systems weekly would require more operator time than operating a single system or two systems. Each treatment system would require a heated and maintained protective structure to ensure the water lines do not freeze and sampling to monitor performance. For this reason, each removal action alternative involving treatment consists of consolidating the treatment units at a single location.

There are small treatment units capable of removing PFOS and PFOA that can be installed in residences and businesses. There are thousands of households within the District's limits. It would be difficult and expensive to install a treatment unit in each house and monitor it to ensure that the spent treatment medium is replaced in a timely manner.

## 4.3 POTENTIAL NON-TREATMENT APPROACHES

Non-treatment approaches to meeting the District's water demand include purchasing extra surface water, installing new supply wells, or re-drilling the inactive wells. Additional surface water must be purchased in December of the prior year in which the surface water may be needed. It also requires that there is sufficient surface water available. Colorado experiences unpredictable drought cycles that make knowing if additional surface water is needed very difficult. During wet periods, there may be adequate surface water to meet the needs of the communities surrounding the District. However, during drought periods, there may not be enough surface water to meet all of the rights placed upon it. In this situation, it may not be possible for the District to obtain additional surface water beyond its existing rights.

Because of the widespread nature of the PFOS and PFOA contamination in the groundwater, there is no location within the District where a new well can be installed in the Widefield aquifer and not be contaminated. Theoretically it is possible to purchase water from existing wells outside of the District. However, it would be necessary to construct, operate, and maintain piping and pumps to convey the water from the well to the District. It would be difficult for the District to install and maintain a piping system outside of its limits.

## 4.4 REMOVAL ACTION ALTERNATIVES

The following alternatives for achieving the RAO and removal action criterion were developed and evaluated. All three alternatives require the continued purchase of water from the FVA and operation of the existing treatment system.

- Alternative 1, no action. This alternative consists of not implementing a removal action and provides a baseline against which other alternatives can be compared. With this alternative, the District would purchase additional surface water as needed and as available to meet peak demand.
- Alternative 2, GAC ex situ treatment of groundwater from the five supply wells not connected to the existing ion exchange system. With this alternative, treatment for the five supply wells would be consolidated at a single location. This alternative includes installation of piping to convey the groundwater to the treatment facility.
- Alternative 3, ion exchange ex situ treatment of groundwater from the five supply wells not connected to the existing ion exchange system. With this alternative, treatment for the five supply wells would be consolidated at a single location. This alternative includes installation of piping to convey the groundwater to the treatment facility.

Each alternative is described and evaluated below.

### 4.4.1 Alternative 1 – No Action

As noted above, the no action alternative consists of not implementing a removal action. With this alternative, the District would not use five of its ten active wells screened in the Widefield aquifer and would continue to operate the five contaminated wells that are connected to the existing ion exchange system. The District would also continue to obtain the contractual obligation portion of its water from Pueblo Reservoir and use the three Jimmy Camp aquifer wells along with purchasing additional surface water to meet peak demand and to provide redundancy should something happen to existing groundwater sources (i.e., the five wells that are connected to the existing ion exchange system).

#### 4.4.1.1 <u>Effectiveness</u>

By continuing to prevent exposure to PFOS and PFOA in the District groundwater through operation of the existing ion exchange system and continued purchase of uncontaminated surface water, the no action alternative would be protective of the public and the community. Because there is no discharge of contaminated groundwater to surface water, there is no risk to the environment under the status quo. This alternative would not affect workers in the short-term because no action would be taken.

This alternative would not trigger location-specific ARARs (e.g., Migratory Bird Treaty Act, National Historical Preservation Act, etc.) or action-specific ARARs. By preventing people from consuming the contaminated groundwater, maintenance of the status quo would achieve the RAO. The no action alternative would comply with ARARs.

Maintaining the status quo does not provide redundancy if one of the contaminated wells connected to the existing ion exchange system needs to be shut down for repair, nor does it provide assurance that the District will be able to use groundwater to meet peak demand. In addition, the District must be able to show continued ability to use each well in order to avoid abandonment of the water rights. If no action is taken to allow all ten Widefield aquifer wells to be used, then the District could lose its rights to those wells not connected to the existing treatment system.

Operation of the existing treatment system will reduce the toxicity, mobility, and volume of the contaminated groundwater through extracting it, transferring PFOS and PFOA to the ion exchange resin, and incinerating the spent resin.

#### 4.4.1.2 <u>Implementability</u>

In the short-term, the no action alternative is readily implementable. The District has the skilled labor needed to operate the existing ion exchange system. No additional skilled labor, specialty equipment, or materials aside from operation and maintenance of the existing ion exchange system are needed to maintain the status quo. By extracting and treating contaminated groundwater, alternative 1 would contribute to any remedial activity planned for the groundwater plume.

In the long-term, this alternative may be administratively difficult to implement and may not be feasible if the District needs to seek alternate water supplies if one or more of the wells connected to the existing treatment system is taken offline or if the District loses its rights to the water associated with the contaminated supply wells that are not connected to the existing system.

#### 4.4.1.3 <u>Cost</u>

The estimated cost for alternative 1 is provided in Appendix A. Because the system has been built, this alternative has no capital costs. The annual operating and maintenance costs are estimated to be $429,000. Over a 20-year operating period using a discount rate of 3 percent, the present worth of alternative 1 is $6,570,000. These costs do not include the ongoing, monthly purchase of surface water nor the purchase of additional surface water if the existing system is unable to meet all of the District's peak demand. If the District must purchase additional surface water beyond its current allotment to meet peak demand, there is an estimated capital cost of $11,400,000 plus maintenance costs.

### 4.4.2 Alternative 2 – Ex Situ Treatment with Granular Activated Carbon

Alternative 2 consists of building, operating, and maintaining a GAC treatment system to treat the water from the five contaminated supply wells that are not connected to the existing ion exchange system. These five wells supply, in combination, 3,300 gallons per minute. This alternative includes installation of piping to convey the raw water to the treatment system and installation of a structure to protect the system from weather and prevent the pipes and vessels from freezing during winter. As noted earlier, this alternative includes continued operation of the existing ion exchange treatment system and the purchase of the contractual obligation of water from FVA.

A typical configuration for GAC is for the water to flow through two GAC vessels in series: a lead vessel and a lag vessel. With this approach, the bulk of the contaminants is removed by the lead vessel, and the lag vessel acts as a polishing step. The contaminant concentrations between the lead and lag vessel are monitored to determine when the GAC in the lead vessel is spent and must be replaced. When the GAC in the lead vessel is spent, the lead vessel is taken offline, the spent GAC is removed, and fresh GAC is placed in the vessel. The vessel with the fresh GAC is used as the lag vessel for polishing, the previously used lag vessel becomes the lead vessel, and the process repeats when the new lead vessel requires GAC replacement. It is typical to divide the water flow across multiple pairs of lead/lag vessels in parallel to provide redundant capacity in case one pair of vessels is offline for maintenance. The spent GAC would be transported offsite for incineration.

#### 4.4.2.1 Effectiveness

The results of the District's pilot study, described in Section 4.1.4, indicated that GAC can effectively decrease PFOS and PFOA concentrations in the District's groundwater to less than the LHA action levels. The GAC portion of the pilot test consisted of three columns filled with GAC in series. Over the course of 24-weeks, the PFOS and PFOA concentrations in the effluent from the second GAC column remained less than the LHA action levels. These results demonstrate GAC's effectiveness in removing PFOS and PFOA from groundwater.

During the pilot test, a temporary increase in nitrate concentration above the EPA established Maximum Contaminant Level was observed when the GAC column was re-started after being taken offline. In a full-scale system, the temporary increase in nitrate concentration can be managed through wasting the water (for example, discharging it to a wastewater treatment facility) or recycling the water back through the treatment system. This process could take days depending on the nitrate concentration levels and could require property with access to adequate sanitary sewer; which wouldn't be efficient or feasible.

The pilot test results indicate that operation of both GAC and ion exchange treatment systems would be protective of public health and the community. As noted for the no action alternative, the environment is protected because there is no discharge pathway of groundwater to surface water. Any potential risks to human health during construction of the treatment facility would be those associated with conventional construction projects and would be mitigated through use of standard construction safety protocols. Thus, alternative 2 is protective of workers.

All construction activities would comply with location-specific and action-specific ARARs. By decreasing PFOS and PFOA concentrations in the extracted groundwater to less than the LHA actions levels, this alternative would achieve the RAO.

Through proper operation and maintenance, GAC offers a long-term effective solution. PFOS and PFOA would be permanently removed from the extracted groundwater and transferred to an adsorbent medium. When spent, the adsorbent medium would be incinerated, thereby destroying the PFOS and PFOA molecules. Continued operation of the existing ion exchange system would also permanently remove PFOS and PFOA from the groundwater and destroy the contaminants during incineration of the spent resin. Through the adsorption/ion exchange and incineration processes, this alternative would decrease contaminant mobility, volume, and toxicity.

As noted above, any potential risks to workers in the short-term would be those associated with conventional construction projects. Such risks can be readily managed through standard practices.

#### 4.4.2.2 Implementability

As noted previously, GAC is a well-established treatment technology. It has been used for water treatment for approximately 100 years. This technology is technically feasible, as demonstrated by the results of the pilot test. By extracting and treating contaminated groundwater, Alternative 2 would contribute in the long-term to any remedial activity planned for the groundwater plume.

Alternative 2 is administratively feasible. Two sites for the new treatment system have been selected. The District has begun the process of acquiring either site on which the system will be installed, and holds or can readily obtain easements for land for installation of the new piping. This alternative can meet the schedule listed in Section 3.4, which specifies that the new system will be operational by the start of the peak water demand season in 2020.

The labor, equipment, and materials needed to install, operate, and maintain a GAC treatment system and to continue to operate the existing system are readily available. Both technologies included in alternative 2 are used to remove a wide range of chemicals from water and have been sufficiently developed for full-scale application.

#### 4.4.2.3 Cost

The cost analysis is based on installation of a single GAC system with a capacity of 3,300 gallons per minute, operation and maintenance of the GAC system, and operation and maintenance of the existing ion exchange system. The present worth analysis for the 20-year life cycle cost is based on a discount rate of 3 percent. The cost estimate is provided in Appendix A.

The capital cost, including project management, construction management, and contingencies, is estimated to be $6,250,000. The annual operating and maintenance costs for both treatment systems included in this alternative are estimated to be $832,000. This cost does not include the ongoing, monthly purchase of surface water from the FVA. The net present worth of the capital, operating, and maintenance costs combined is estimated to be $18,100,000.

### 4.4.3 Alternative 3 – Ex Situ Treatment with Ion Exchange

Alternative 3 consists of building, operating, and maintaining an ion exchange system to treat the water from the five contaminated supply wells that are not connected to the existing ion exchange system, as well as operating and maintaining the existing ion exchange system and the purchase of the contractual obligation of water from FVA. Similar to alternative 2, the capacity of the new treatment system is assumed to be 3,300 gallons per minute. This alternative includes installation of piping to convey the raw water to the treatment system and installation of a structure to protect the system from weather and prevent the pipes and vessels from freezing during winter.

An ion exchange treatment system is typically configured in the same manner as described for the GAC treatment system in alternative 2. The influent water is typically divided among multiple trains of lead/lag vessels filled with the ion exchange resin. When the PFOS and PFOA concentrations between the lead and lag vessels reach a pre-defined concentration, the resin in the lead vessel is removed and replaced with fresh resin. The former lag vessel becomes the lead vessel, the vessel with the fresh resin becomes the lag vessel, and the process repeats. The spent resin would be incinerated offsite.

#### 4.4.3.1 Effectiveness

As discussed in Section 4.1.4, three of the ion exchange resins tested in the pilot study were effective in removing PFOS and PFOA from the District’s groundwater. In addition, operation of the existing ion exchange system has confirmed this technology’s effectiveness in removing PFOA and PFOS. An ion exchange system would be protective of public health and the community. As noted for the no action alternative, the environment is protected because there is no discharge pathway of groundwater to surface water. Any potential risks to human health during construction of the treatment facility would be those associated with conventional construction projects and would be mitigated through use of standard construction safety protocols. Thus, alternative 3 is protective of workers.

All construction activities would comply with location-specific and action-specific ARARs. By decreasing PFOS and PFOA concentrations in the extracted groundwater to less than the LHA actions levels, this alternative would achieve the RAO.

Through proper operation and maintenance, ion exchange offers a long-term effective solution. PFOS and PFOA would be permanently removed from the extracted groundwater and transferred to the ion exchange resin. When spent, the resin would be incinerated, thereby destroying the PFOS and PFOA molecules. Through the ion exchange and incineration processes, this alternative would decrease contaminant mobility, volume, and toxicity.

As noted above, any potential risks to workers in the short-term would be those associated with conventional construction projects. Such risks can be readily managed through standard practices.

#### 4.4.3.2 Implementability

Ion exchange is a well-established treatment technology that is routinely used for drinking water treatment and groundwater treatment. This technology is technically feasible, as demonstrated by the results of the pilot test and the District’s operation of a full-scale ion exchange system since May 2017. By extracting and treating contaminated groundwater, alternative 3 would contribute in the long-term to any remedial activity planned for the groundwater plume.

Alternative 3 is administratively feasible. Two sites for the new treatment system have been selected. The District has begun the process of acquiring either site on which the system will be installed, and holds or can readily obtain easements for land for installation of the new piping. This alternative can meet the schedule listed in Section 3.4, which specifies that the new system will be operational by the start of the peak water demand season in 2020.

The labor, equipment, and materials needed to install, operate, and maintain an ion exchange treatment system are readily available. Ion exchange is currently used by the District to remove

PFOS and PFOA. Use of resins selective for PFOS and PFOA is relatively new, but current operation of the District's existing ion exchange system indicates that this technology is highly effective for PFOS and PFOA removal.

#### 4.4.3.3 Cost

The cost analysis is based on installation of a single ion exchange system with a capacity of 3,300 gallons per minute, operation and maintenance of the new system, and operation and maintenance of the existing ion exchange system. The present worth analysis for the 20-year life cycle cost is based on a discount rate of 3 percent. The cost estimate is provided in Appendix A.

The capital cost, including project management, construction management, and contingencies, is estimated to be $6,360,000. The annual operating and maintenance costs for both treatment systems included in this alternative are estimated to be $801,000. This cost does not include the ongoing, monthly purchase of surface water from the FVA. The net present worth of the capital, operating, and maintenance costs combined is estimated to be $17,800,000.

# 5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section provides a comparative analysis of the three removal action alternatives described and evaluated in Section 4.

## 5.1 EFFECTIVENESS

Because the existing ion exchange system does not provide redundancy in case a supply well must be taken offline, the District might not be able to meet all of its water needs if the status quo is maintained. Finally, in the long-term, the District could lose its rights to the water associated with the five supply wells that are not connected to the existing ion exchange system. Particularly in times of drought, it is also unlikely the District would be able to find alternate sources of water. For these reasons, alternative 1 has the lowest effectiveness of the three alternatives.

Alternatives 2 and 3 have similar degrees of effectiveness. The ability of both GAC and ion exchange to remove PFOS and PFOA from groundwater was demonstrated by the pilot test (Section 4.1.4). Because GAC has a lower capacity for PFOS and PFOA than ion exchange resins, the GAC alternative would require a larger volume of adsorption medium with more frequent change-outs than the ion exchange alternative. Both alternatives would decrease contaminant toxicity, mobility, and volume through concentrating PFOS and PFOA on the GAC or resin and incinerating the spent media.

Both alternatives 2 and 3 have similar short-term effectiveness. For both alternatives, the short-term risks to workers are those associated with conventional construction projects that can be mitigated through standard health and safety practices.

All alternatives would be implemented in a manner that complies with ARARs and would achieve the RAO.

## 5.2 IMPLEMENTABILITY

Alternative 1, no action, is readily implementable in the short-term. In the long-term, this alternative may be administratively difficult to implement and may not be feasible if the District needs to seek alternate water supplies if one or more of the wells connected to the existing ion exchange system is taken offline or if the District loses its rights to the water associated with the contaminated supply wells that are not connected to the existing ion exchange system. In addition, alternative 1 would contribute the least to the long-term remediation of the groundwater contamination because a smaller volume of contaminated groundwater would be extracted and treated as compared to alternatives 2 and 3.

Both alternatives 2 and 3 use established technologies that are sufficiently developed for full-scale application. For both alternatives, the labor, equipment, and materials necessary to construct, operate, and maintain the treatment systems are readily available. Alternatives 2 and 3 would need to comply with the same local regulations, guidelines, and zoning concerning siting of the treatment system building, and the District would need to obtain the same utility crossing permits. In addition, both alternatives would contribute to long-term plume remediation through extracting and treating the contaminated groundwater. The ion exchange system in alternative 3 would require less frequent changeouts as compared to GAC, which would result in easier operation and maintenance as compared to alternative 2. The GAC system would require procedures for managing temporary increases in the nitrate concentration when the system is turned on after a shutdown period. In addition, the District already has staff trained to operate and maintain an ion exchange system. The ion exchange system in alternative 3 would be easier for the District to implement than the GAC system in alternative 2.

## 5.3 COST

The costs for each alternative are summarized below. Alternative 1 has the lowest cost, but this cost does not include the potential costs associated with purchasing surface water to meet peak demand if the existing treatment system is unable to supply the required groundwater. As stated in Section 4.4.1.3, the cost for the District to acquire surface water beyond its current rights should that water even be available would be $11,400,000 plus maintenance costs.

| Cost | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|
| Capital | Not applicable | $6,250,000 | $6,360,000 |
| Annual Operation and Maintenance | $429,000 | $832,000 | $801,000 |
| Total Present Worth | $6,570,000 | $18,100,000 | $17,800,000 |

# 6.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

As described in Section 5, alternative 1 is the least effective and least implementable of the three removal action alternatives. For these reasons, alternative 1 is not recommended.

Alternatives 2 and 3 are similar in their effectiveness. Alternative 3 would be more easily implemented by the District than alternative 2. Alternative 3, ex situ treatment with ion exchange, is less expensive on a present worth basis than alternative 2. Based on cost and implementability, alternative 3 is the recommended removal action alternative.

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**TABLE 3.1**

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**Table 3.1**
**Potential Applicable or Relevant and Appropriate Requirements**
**Widefield Water and Sanitation District, Colorado**

| Federal or State Statute, Regulation, or Guidance | Requirement | Type of ARAR | Status | Actions to be Taken to Attain Requirement |
|---|---|---|---|---|
| Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS), EPA Docket No. 822-R-16-004 (EPA, May 2016)<br><br>Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA), EPA Docket No. 822-R-16-005 (EPA, May 2016) | Provide drinking water system operators information on the health risks of PFOS and PFOA and recommendations about reducing exposure to PFOS and PFOA in drinking water. | Not applicable (N/A) | These are not ARARs but are to be considered (TBC) because they provide response criteria that are useable in the absence of ARARs. | The health advisory level will be the concentration that the removal action is designed to achieve. |
| Migratory Bird Treaty Act and implementing regulations, 16 USC § 703-716,<br>50 CFR § 10.13. | Prohibits the unlawful taking, possession, or sale of any migratory birds native to the U.S. (including commonwealths and territories) | Applicable | | Any construction selected will be carried out in a manner to avoid adversely affecting migratory bird species, including individual birds or their nests. |
| Preservation of Historical and Archeological Data and implementing regulations, 54 USC 312501-312508; 36 CFR § 79.5 and § 79.9 – 79.11. | Requires that Federal agencies take action to recover, protect, and preserve any significant scientific, prehistorical, historical, or archeological data that may be irreparably lost or destroyed as a result of the alteration of terrain caused by Federal activities. | Applicable | Applicable depending on location of proposed action. | Any construction will be preceded by actions to recover, protect, and preserve any significant scientific, prehistorical, historical, or archeological data present at the site of the action. |
| The National Historical Preservation Act and implementing regulations, 54 USC 300101-.307108; 36 CFR 800 Subpart B. | Requires that Federal agencies take actions to avoid adverse effects in historic properties. | Applicable | Applicable depending on location of proposed action. | Any construction will be preceded by actions to avoid adverse effects to historic properties. |
| EO 13690, Establishing a Federal Flood Risk Management Standard. | Any activity located in a floodplain must comply with the provisions of this EO. The Order requires that Federal activities in floodplains must reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and | N/A | TBC if the proposed action is located in a floodplain. | Any construction in a floodplain will be designed to comply with the EO. |

**Table 3.1 (Continued)**
**Potential Applicable or Relevant and Appropriate Requirements**
**Widefield Water and Sanitation District, Colorado**

| Federal or State Statute, Regulation, or Guidance | Summary | Type of ARAR | Applicability, Relevance, and Appropriateness |
|---|---|---|---|
| EO 13690, Establishing a Federal Flood Risk Management Standard.<br><br>(Continued) | Preserve the natural and beneficial values served by floodplains. All actions located in floodplains should be: designed or modified to minimize potential harm to or within the floodplain; constructed in accordance with standards and criteria and to be consistent with the intent of those under the National Flood Insurance Program; and include accepted floodproofing and other flood protection measures. Where possible, an agency shall use natural systems, ecosystem processes, and nature-based approaches when developing alternatives for consideration. | | |
| Endangered Species Act, 16 USC §§ 1531-1544, 50 CFR Parts 17, 402, 424 | Requires a determination as to whether any action is likely to jeopardize the continued existence of any endangered species or the critical habitat designated for such species. Biological assessments must be conducted to determine whether endangered species or their habitats are present and, if so, to take reasonable mitigation and enhancement measures. | Applicable depending on the presence of endangered species at the location of the proposed action. | The removal action design will include an assessment of the presence of endangered species and/or their habitat. If such species or habitat is present, any construction will include measures to mitigate potential effects to these species and/or habitat. |
| Bald and Golden Eagle Protection Act and implementing regulations, 16 USC §§ 668-668d; 50 CFR 22 | Prohibits the taking, possession, sale, purchase, barter, transport, export/import at any time or in any manner, any bald (American) or any golden eagle, alive or dead or any part, nest or egg; establishes civil and criminal penalties (where "take" has been construed to affect habitat as well as physical possession of the eagles). | Applicable depending on the presence of bald and golden eagle habitat the location of the proposed action. | The removal action design will include an assessment of the presence of bald and/or golden eagles. If bald or golden eagles are present, any construction will include measures to mitigate adverse effects on the birds and their habitat. |

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**FIGURE 2.1**

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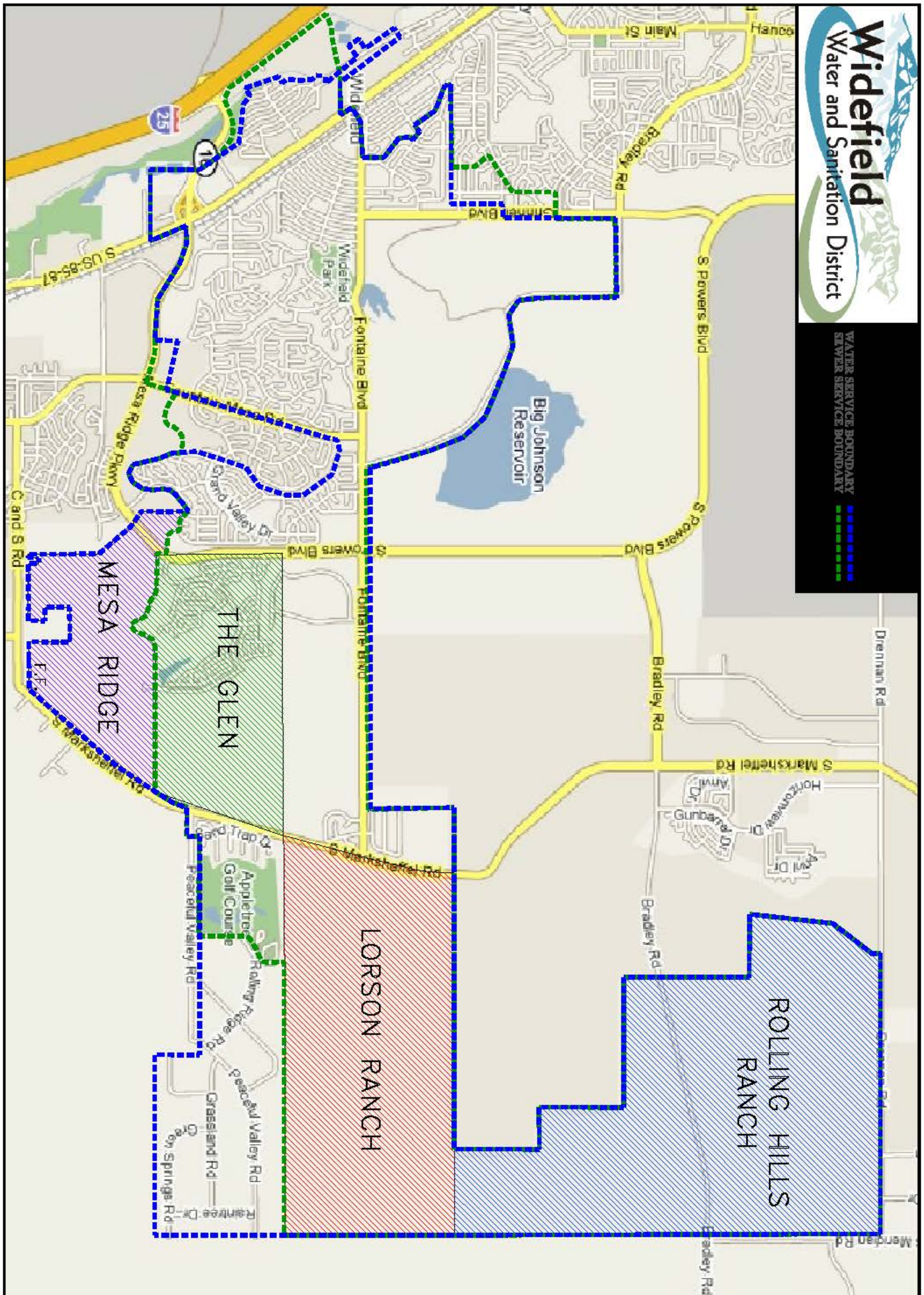
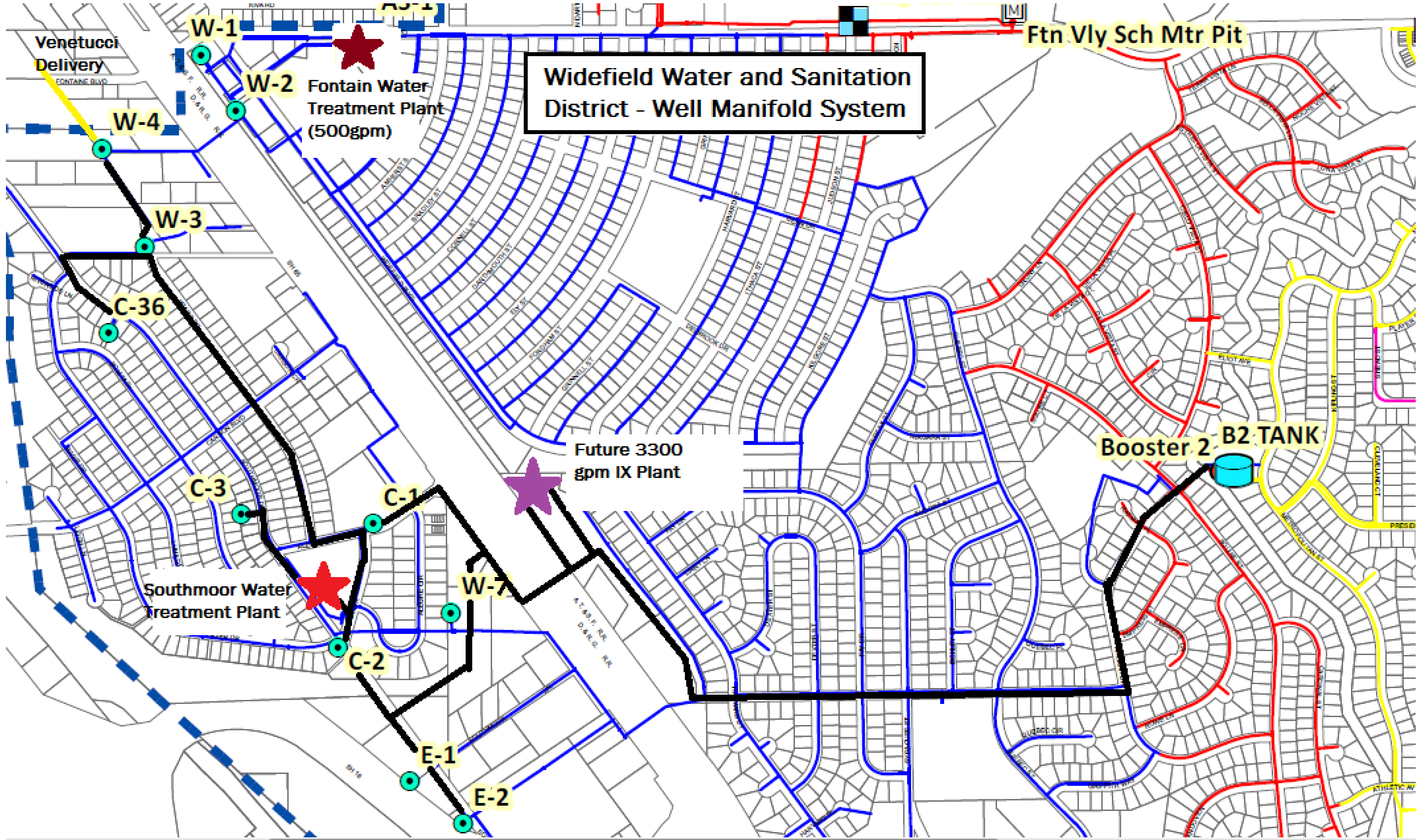



| |
|---|
| Project No.: 102.08 |
| Scale: AS SHOWN |
| Date: 03/06/08 |
| Design: JPM |
| Drawn: RMD |
| Check: JPM |
| Revised: |

WIDEFIELD WATER AND SANITATION DISTRICT
WATER AND SEWER SERVICE BOUNDARIES
W/ GROWTH AREAS

JDS-HYDRO CONSULTANTS, INC.
545 East Pikes Peak Avenue, Suite 300
Colorado Springs, Colorado 80903
(719) 227-0072

1 of 1



Widefield Water and Sanitation District - Well Manifold System
Venetucci Delivery
W-1
W-2
W-3
W-4
Fontain Water Treatment Plant (500gpm)
Ftn Vly Sch Mtr Pit
C-36
C-3
C-1
C-2
W-7
E-1
E-2
Southmoor Water Treatment Plant
Future 3300 gpm IX Plant
Booster 2
B2 TANK

# APPENDIX A

# COST ANALYSIS

Table A.1

Annual Operation and Maintenance Cost Estimate - Alternative 1 (Operation of Existing Ion Exchange System

Engineering Evaluation and Cost Analysis, Widefield Water and Sanitation District, Colorado

| Item | Unit Rate | Units | Quantity | Extended Cost | Notes |
|---|---|---|---|---|---|
| Staffing | $ 104,000.00 | LS | 1 | $ 104,000.00 | From Security Water District cost estimate |
| Sampling | $ 36,000.00 | LS | 1 | $ 36,000.00 | Half of level of effort for Security Water District cost estimate |
| Pumping | $ 14,300.00 | LS | 1 | $ 14,300.00 | Half of level of effort for Security Water District cost estimate |
| Cartridge filters | $ 1,050.00 | LS | 1 | $ 1,050.00 | Half of level of effort for Security Water District cost estimate |
| Building heat and electrical | $ 29,600.00 | LS | 1 | $ 29,600.00 | From Security Water District cost estimate |
| Resin changeout | $ 126,000.00 | LS | 1 | $ 126,000.00 | From Security Water District cost estimate |
| | | | | | |
| Subtotal | | | | $ 310,950.00 | |
| Contingency | | | 15% | $ 46,642.50 | |
| Subtotal with contingency | | | | $ 357,592.50 | |
| | | | | | |
| Project Management | | | 10% | $ 35,759.25 | |
| Technical Support | | | 10% | $ 35,759.25 | |
| | | | | | |
| Total | | | | $ 429,000.00 | |

Table A.2
Capital Cost Estimate - Alternative 2
Engineering Evaluation and Cost Analysis, Widefield Water and Sanitation District, Colorado

| Item | Unit Rate | Units | Quantity | Extended Cost | Notes |
|---|---|---|---|---|---|
| Sitework | $ 116,111.00 | LS | 1 | $ 116,111.00 | Sitework cost for Security District EE/CA, Pinello Plant |
| Protective Structure | $1,991,704.00 | LS | 1 | $ 1,991,704.00 | Building cost for Security District EE/CA, Pinello Plant |
| 12-inch ductile iron pipe | $ 70.00 | LF | 2500 | $ 175,000.00 | unit rate from Security District EE/CA |
| 18-inch ductile iron pipe | $ 102.00 | LF | 4000 | $ 408,000.00 | unit rate from Security District EE/CA |
| Pavement replacement for piping | $ 50.00 | square yard | 7222 | $ 361,111.11 | unit rate from Security District EE/CA |
| 12" valve with valve box | $ 3,600.00 | each | 5 | $ 18,000.00 | unit rate from Security District EE/CA |
| 18" valve with valve box | $ 8,700.00 | each | 2 | $ 17,400.00 | unit rate from Security District EE/CA |
| Feed pump | $ 16,000.00 | each | 3 | $ 48,000.00 | Cost for Security District EE/CA |
| Standby pump | $ 4,000.00 | each | 3 | $ 12,000.00 | Cost for Security District EE/CA |
| Prefilter | $ 20,000.00 | each | 3 | $ 60,000.00 | Cost for Security District EE/CA |
| Treatment train, empty | $ 174,000.00 | each | 3 | $ 522,000.00 | Cost for Security District EE/CA less cost to replace resin |
| Control system and SCADA integration | $ 65,000.00 | LS | 1 | $ 65,000.00 | Cost for Security District EE/CA |
| GAC | $ 2.50 | per pound | 120,000 | $ 300,000.00 | Professional judgment |
| Chlorination system and monitoring | $ 38,000.00 | LS | 1 | $ 38,000.00 | Cost for Security District EE/CA |
| Flow meters | $ 3,500.00 | each | 4 | $ 14,000.00 | Cost for Security District EE/CA |
| Process piping | $ 112,000.00 | LS | 1 | $ 112,000.00 | Cost for Security District EE/CA |
| Electrical systems | $ 20,000.00 | LS | 1 | $ 20,000.00 | Cost for Security District EE/CA |
| 3-phase power | $ 60,000.00 | LS | 1 | $ 60,000.00 | Cost for Security District EE/CA |
| Emergency generator | $ 75,000.00 | LS | 1 | $ 75,000.00 | Cost for Security District EE/CA |
| Sewer line extension | $ 90,000.00 | LS | 1 | $ 90,000.00 | Professional judgment |

Table A.2
Capital Cost Estimate - Alternative 2
Engineering Evaluation and Cost Analysis, Widefield Water and Sanitation District, Colorado

| Item | Unit Rate | Units | Quantity | Extended Cost | Notes |
|---|---|---|---|---|---|
| | | | | | |
| Subtotal | | | | $ 4,503,326.11 | |
| Bid and scope contingency | | | 25% | $ 1,125,831.53 | |
| Subtotal with contingency | | | | $ 5,629,157.64 | |
| | | | | | |
| Project Management | | | 5% | $ 281,457.88 | |
| Construction Management | | | 6% | $ 337,749.46 | |
| | | | | | |
| Total | | | | $ 6,248,364.98 | |

Table A.3
Annual Operation and Maintenance Cost Estimate - Alternative 2
Engineering Evaluation and Cost Analysis, City of Fountain, Colorado

| Item | Unit Rate | Units | Quantity | Extended Cost | Notes |
|---|---|---|---|---|---|
| Staffing | $ 104,000.00 | LS | 2 | $ 208,000.00 | Twice level of effort for operating existing system |
| Sampling | $ 36,000.00 | LS | 2 | $ 72,000.00 | Twice level of effort for operating existing system |
| Pumping | $ 14,300.00 | LS | 2 | $ 28,600.00 | Twice level of effort for operating existing system |
| Cartridge filters | $ 1,050.00 | LS | 2 | $ 2,100.00 | Twice level of effort for operating existing system |
| Building heat and electrical | $ 29,600.00 | LS | 2 | $ 59,200.00 | Twice level of effort for operating existing system |
| Resin changeout | $ 126,000.00 | LS | 1 | $ 126,000.00 | Existing ion exchange system would still be operated |
| GAC changeout | $ 2.50 | per lb | 60,000 | $ 150,000.00 | Assumed each lead vessel is changed out per year |
| | | | | | |
| Subtotal | | | | $ 645,900.00 | |
| Contingency | | | 15% | $ 96,885.00 | |
| Subtotal with contingency | | | | $ 742,785.00 | |
| | | | | | |
| Project Management | | | 6% | $ 44,567.10 | |
| Technical Support | | | 6% | $ 44,567.10 | |
| | | | | | |
| Total | | | | $ 831,919.20 | |

Table A.4
Capital Cost Estimate - Alternative 3
Engineering Evaluation and Cost Analysis, City of Fountain, Colorado

| Item | Unit Rate | Units | Quantity | Extended Cost | Notes |
|---|---|---|---|---|---|
| Sitework | $ 116,111.00 | LS | 1 | $ 116,111.00 | Sitework cost for Security District EE/CA, Pinello Plant |
| Protective Structure | $1,991,704.00 | LS | 1 | $ 1,991,704.00 | Building cost for Security District EE/CA, Pinello Plant |
| 12-inch ductile iron pipe | $ 70.00 | LF | 2500 | $ 175,000.00 | unit rate from Security District EE/CA |
| 18-inch ductile iron pipe | $ 102.00 | LF | 4000 | $ 408,000.00 | unit rate from Security District EE/CA |
| Pavement replacement for piping | $ 50.00 | square yard | 7222 | $ 361,111.11 | unit rate from Security District EE/CA |
| 12" valve with valve box | $ 3,600.00 | each | 5 | $ 18,000.00 | unit rate from Security District EE/CA |
| 18" valve with valve box | $ 8,700.00 | each | 2 | $ 17,400.00 | unit rate from Security District EE/CA |
| Feed pump | $ 16,000.00 | each | 3 | $ 48,000.00 | Cost for Security District EE/CA |
| Standby pump | $ 4,000.00 | each | 3 | $ 12,000.00 | Cost for Security District EE/CA |
| Prefilter | $ 20,000.00 | each | 3 | $ 60,000.00 | Cost for Security District EE/CA |
| Treatment train, filled with resin | $ 300,000.00 | each | 3 | $ 900,000.00 | Cost for Security District EE/CA less cost to replace resin |
| Control system and SCADA integration | $ 65,000.00 | LS | 1 | $ 65,000.00 | Cost for Security District EE/CA |
| Chlorination system and monitoring | $ 38,000.00 | LS | 1 | $ 38,000.00 | Cost for Security District EE/CA |
| Flow meters | $ 3,500.00 | each | 4 | $ 14,000.00 | Cost for Security District EE/CA |
| Process piping | $ 112,000.00 | LS | 1 | $ 112,000.00 | Cost for Security District EE/CA |
| Electrical systems | $ 20,000.00 | LS | 1 | $ 20,000.00 | Cost for Security District EE/CA |
| 3-phase power | $ 60,000.00 | LS | 1 | $ 60,000.00 | Cost for Security District EE/CA |
| Emergency generator | $ 75,000.00 | LS | 1 | $ 75,000.00 | Cost for Security District EE/CA |
| Sewer line extension | $ 90,000.00 | LS | 1 | $ 90,000.00 | Professional judgment |
| | | | | | |

Table A.4
Capital Cost Estimate - Alternative 3
Engineering Evaluation and Cost Analysis, City of Fountain, Colorado

| Item | Unit Rate | Units | Quantity | Extended Cost | Notes |
|---|---|---|---|---|---|
| Subtotal | | | | $ 4,581,326.11 | |
| Bid and scope contingency | | | 25% | $ 1,145,331.53 | |
| Subtotal with contingency | | | | $ 5,726,657.64 | |
| | | | | | |
| Project Management | | | 5% | $ 286,332.88 | |
| Construction Management | | | 6% | $ 343,599.46 | |
| | | | | | |
| Total | | | | $ 6,356,589.98 | |

Table A.5

Annual Operation and Maintenance Cost Estimate - Alternative 3

Engineering Evaluation and Cost Analysis, City of Fountain, Colorado

| Item | Unit Rate | Units | Quantity | Extended Cost | Notes |
|---|---|---|---|---|---|
| Staffing | $ 104,000.00 | LS | 2 | $ 208,000.00 | Twice level of effort for operating existing system |
| Sampling | $ 36,000.00 | LS | 2 | $ 72,000.00 | Twice level of effort for operating existing system |
| Pumping | $ 14,300.00 | LS | 2 | $ 28,600.00 | Twice level of effort for operating existing system |
| Cartridge filters | $ 1,050.00 | LS | 2 | $ 2,100.00 | Twice level of effort for operating existing system |
| Building heat and electrical | $ 29,600.00 | LS | 2 | $ 59,200.00 | Twice level of effort for operating existing system |
| Resin changeout | $ 126,000.00 | LS | 2 | $ 252,000.00 | Twice level of effort for operating existing system |
| | | | | | |
| Subtotal | | | | $ 621,900.00 | |
| Contingency | | | 15% | $ 93,285.00 | |
| Subtotal with contingency | | | | $ 715,185.00 | |
| | | | | | |
| Project Management | | | 6% | $ 42,911.10 | |
| Technical Support | | | 6% | $ 42,911.10 | |
| | | | | | |
| Total | | | | $ 801,007.20 | |