

Final Engineering Evaluation/Cost Analysis Fairchild Air Force Base and City of Airway Heights, Washington

Prepared For:



Air Force Civil Engineer Center



U.S. Army Corps of Engineers, Seattle District
Contract Number: W912DW-18-D-1014
Task Order: W912DW18F2100

June 2021

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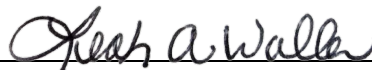
FINAL
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and
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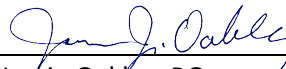
This document has been prepared by Brice-AECOM JV. The material and data in this report were prepared under the supervision and direction of the undersigned.



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EXECUTIVE SUMMARY

This Engineering Evaluation/Cost Analysis (EE/CA) for a Non-Time Critical Removal Action (NTCRA) was prepared to evaluate removal action alternatives for mitigating impacts from perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) in drinking water for City of Airway Heights, Washington, in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). As required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), an EE/CA must be completed for all NTCRAs. Brice Environmental Services Corporation (Brice) and AECOM Technical Services Inc. (AECOM) Joint Venture (JV) 1 (Brice-AECOM JV) has been contracted by the U.S. Army Corps of Engineers (USACE), Seattle District, to complete this EE/CA on behalf of the Fairchild Air Force Base (FAFB), Washington. The project is being performed under Contract Number W912DW-18-D-1014, Task Order W912DW18F2100. Regulatory oversight for this project is provided by the Washington State Department of Ecology (Ecology) and U.S. Environmental Protection Agency (EPA) Region 10.

Alternatives were developed to address PFOS and PFOA in Airway Heights water supply wells – Wells 1 and 4 [a wellfield referred to as Wells 1/4] and Well 9. The alternatives were based on the water use by Airway Heights at the time PFOS and PFOA were detected in drinking water. Defense Environmental Restoration Program (DERP) provides funding to the U.S. Air Force (USAF) for removal actions conducted under CERCLA; and DERP funding can only address the volume of water in use at the time PFOS/PFOA were detected, not future capacity or water rights.

Source, Nature, and Extent of Contamination

PFOS and PFOA were likely released to groundwater at FAFB through fire training and fire response activities. In 2017, site inspections at FAFB detected PFOS and PFOA in groundwater at concentrations above the EPA lifetime health advisory (HA) of 70 parts per trillion (ppt) for PFOS and PFOA in drinking water (individual or combined). The sum of PFOS and PFOA concentrations detected in groundwater at FAFB ranged from 17,690 to 167,000 ppt, above the HA of 70 ppt. Based on these results, sampling of off-base groundwater monitoring wells, private residential wells, and municipal supply wells was subsequently completed.

PFOS and PFOA were detected at concentrations above the HA in water samples from three of the eight Airway Heights municipal supply wells, Wells 1/4 and 9. The sum of PFOS and PFOA was detected at concentrations of 1,400 ppt in Wells 1/4 and 1,520 ppt in Well 9, with individual PFOS and PFOA concentrations up to 1,100 and 300 ppt, respectively, at Wells 1/4 and 1,200 and 320 ppt, respectively, at Well 9.

Removal Action Objectives

The specific removal action objectives (RAOs) for this removal action are as follows:

- Provide a long-term option to eliminate the imminent and substantial danger to human health or the environment posed by PFOS and/or PFOA in groundwater used as drinking water and provide an average supply of 1,014 gallons per minute (gpm) of drinking water (532,752,742 gallons per year)
- Restrict potential exposure to PFOS and PFOA in drinking water at concentrations above the EPA HA of 70 ppt (0.07 micrograms per liter) (individually or combined)

Removal Action Alternatives

With the exception of the No Action alternative, removal action alternatives were developed by assembling treatment technologies or other options to achieve the RAOs. Three alternatives were developed that provide for treatment technologies, and two of the alternatives provide an alternate water supply.

The following alternatives were developed for achieving the RAOs:

- Alternative 1 – No Action
- Alternative 2 – Granular Activated Carbon (GAC) Wellhead Treatment
- Alternative 3 – Ion Exchange Resin (IXR) Wellhead Treatment
- Alternative 4 – Reverse Osmosis Membrane (ROM) Wellhead Treatment
- Alternative 5 – New Water Supply Well with Connection to Airway Heights Water System
- Alternative 6 – Continued Use of Spokane Water Supply

Recommended Alternative

Alternative 2 (GAC Wellhead Treatment) is the recommended removal action alternative. Although it is equally ranked the highest with Alternative 3 (IXR Wellhead Treatment), GAC has the lowest overall cost, as PFOS is better adsorbed by carbon than PFOA. Historical sampling indicates that PFOS is approximately 79 percent of the combined PFOS/PFOA concentrations in each well. Alternative 4 (ROM Wellhead Treatment) has the lowest overall ranking for the wellhead treatment alternatives and has the highest cost. Alternative 5 (New Water Supply Well with Connection to Airway Heights Water System) was equally ranked with Alternative 4; the technical feasibility of acquiring easements, construction, and water rights is not likely to be straightforward and the availability of resources is uncertain. Alternative 6 (Continued Use of Spokane Water Supply) was not ranked higher due to the administrative need for a long-term agreement, and it does not provide for treatment of PFAS-impacted groundwater.

Next Steps

This EE/CA provides information for the USAF and other stakeholders to recommend a preferred removal action alternative. Following consideration of public comments (public notice, comment period, and public meeting), the selected alternative will be documented in an Action Memorandum. FAFB intends to initiate the removal action in 2022, provided all required regulatory documents, plans, and permits are approved.

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ACRONYMS AND ABBREVIATIONS

AECOM	AECOM Technical Services Inc.
AFFF	aqueous film forming foam
AMEC	AMEC Foster Wheeler Environment and Infrastructure, Inc.
ARAR	applicable or relevant and appropriate requirement
ASME	American Society of Mechanical Engineers
Brice	Brice Environmental Services Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	cubic feet
CFR	Code of Federal Regulations
CRBG	Columbia River Basalt Group
DERP	Defense Environmental Restoration Program
Ecology	Washington State Department of Ecology
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
FAFB	Fairchild Air Force Base
GAC	granular activated carbon
gpm	gallons per minute
HA	health advisory
ID	identification
IXR	ion exchange resin
JV	Joint Venture
MTCA	Model Toxics Control Act
NAGPRA	Native American Graves Protection and Repatriation Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NHPA	National Historic Preservation Act
NSF	National Sanitation Foundation
NTCRA	Non-Time Critical Removal Action
O&M	operation and maintenance
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
POTW	publicly owned treatment work
ppt	parts per trillion
psig	pounds per square inch gauge
PVC	polyvinyl chloride
RAO	removal action objective
RCW	Revised Washington Code
RO	reverse osmosis
ROM	reverse osmosis membrane

ACRONYMS AND ABBREVIATIONS (CONTINUED)

SEPA	State Environmental Policy Act
SS	stainless steel
SVRP	Spokane Valley-Rathdrum Prairie
TBC	to be considered
TCRA	Time Critical Removal Action
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USC	United States Code
WAC	Washington Administrative Code

1.0 INTRODUCTION

This Engineering Evaluation/Cost Analysis (EE/CA) for a Non-Time Critical Removal Action (NTCRA) was prepared to evaluate removal action alternatives for mitigating impacts from perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) in drinking water for City of Airway Heights, Washington. PFOS and PFOA have been detected in the City's municipal supply wells. Although temporary actions have been taken, a longer-term supply of clean drinking water to residents and businesses in Airway Heights is required.

Brice Environmental Services Corporation (Brice) and AECOM Technical Services Inc. (AECOM) Joint Venture (JV) 1 (Brice-AECOM JV) has been contracted by the U.S. Army Corps of Engineers (USACE), Seattle District, to complete this EE/CA on behalf of the Fairchild Air Force Base (FAFB), Washington. The project is being performed under Contract Number W912DW-18-D-1014, Task Order W912DW18F2100. Regulatory oversight for this project is provided by the Washington State Department of Ecology (Ecology) and U.S. Environmental Protection Agency (EPA) Region 10.

1.1 Purpose

The purpose of this EE/CA is to develop and evaluate removal action alternatives for mitigating impacts to Airway Heights' drinking water from groundwater contaminated with PFOS and PFOA in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to support a NTCRA. As required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), an EE/CA must be completed for all NTCRAs. This EE/CA was prepared in accordance with *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA 1993). Alternatives were developed to address PFOS and PFOA in water at Airway Heights supply wells – Wells 1 and 4 (a wellfield referred to as Wells 1/4) and Well 9. The alternatives were based on the water use by Airway Heights at the time PFOS and PFOA were detected in drinking water. In accordance with guidance (EPA 1993), the alternatives were evaluated against effectiveness, implementability, and cost criteria, and a removal action alternative was recommended.

1.2 EE/CA Organization

This EE/CA is organized as follows:

- Section 1 – Introduction
- Section 2 – Site characterization
- Section 3 – Removal action scope, goals, and objectives
- Section 4 – Identification and analysis of removal action alternatives
- Section 5 – Comparative analysis of removal action alternatives
- Section 6 – Recommended removal action alternative
- Section 7 – References

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2.0 SITE CHARACTERIZATION

2.1 Site Description and Background

FAFB provides air refueling and wing supporting contingency operations around the world. The base is identified on the National Priorities List under CERCLA (EPA ID WA9571924647). The U.S. Air Force (USAF), State of Washington, and EPA entered into a Federal Facility Agreement under CERCLA Section 120 in 1990.

Airway Heights is located in northeastern Washington, approximately 6 miles west of the City of Spokane, in Spokane County, Washington (see Figure 1). FAFB is located approximately 1 mile southwest, and Spokane International Airport is approximately 0.5 miles to the southeast (see Figure 2). The City's corporate boundaries cover roughly 5.5 square miles of land, with the city center lying at an elevation of approximately 2,390 feet above mean sea level (AMEC Foster Wheeler Environment and Infrastructure, Inc. [AMEC] 2017). Land use in Airway Heights is predominantly residential, commercial, and industrial. Airway Heights has a population of approximately 6,400 residents plus another 2,100 in the Department of Corrections (AMEC 2018).

2.1.1 Airway Heights Current Water Supply Infrastructure

Current water supply infrastructure for the City of Airway Heights includes (see Figures 2 through 6):

- Eight City-owned water supply wells (Century West 2017)
- Two interties to the City of Spokane water system for supplemental water
- An aquifer recharge facility that uses reclaimed water to recharge the paleochannel beneath the city (Century West 2017; Esvelt 2014)

A summary of the current status of the supply wells is provided below:

- Well 1 and Well 4 (S01 and S04): Wells 1 and 4 (1/4) are screened in paleochannel material. Well 1, constructed prior to 1961, has a 10-inch casing installed to 175 feet and a total depth of 192 feet. Well 4, drilled in 1967, has a 12-inch casing installed to 181 feet and a total depth of 200 feet. The wells have a combined yield of 350 gallons per minute (gpm) before routine pumping stopped in May 2017 following detection of PFOS/PFOA.
- Well 3 (S03): Well 3 was removed from potable use in 2012 due to elevated nitrate concentrations (Esvelt 2014; Ecology 2012). It is currently only used for non-potable water uses, such as filling water trucks.
- Well 5 (S05): Well 5 ran dry in 2012 (Ecology 2012) and presumably has not been used since.
- Well 7 (S07): Well 7 has historically had limited production (Ecology 2012), ran dry in 2001 (Century West 2017), and presumably has not been used since.
- Well 8 (S10): Well 8 was installed in 2005 as a replacement for Well 2, then deepened in 2006. Well 8, which experienced declining yields, then a reduced operational pumping rate of 45 gpm, is no longer in service (AMEC 2018a).
- Well 9 (S11): Well 9 is also known as the "Recovery Well" because water withdrawn (recovered) includes recharged reclaimed water. The well was drilled in 2012 to a depth of 255 feet in the paleochannel. A 16-inch casing was installed to a depth of 202 feet. The system operated at

between 1,000 and 1,500 gpm depending on the level of the aquifer each year and ability to produce water at a consistent rate. Pumping stopped in May 2017 following detection of PFOS/PFOA. A temporary granular activated carbon (GAC) water treatment system was constructed in 2018 to treat PFOS and PFOA (AMEC 2019b) and began operating in 2019.

- Well 10/Parkwest Well (S09): Well 10, also known as the Parkwest Well, was originally owned and operated by Parkwest Properties, Inc for continuous industrial use. In around 2001, the City purchased the property hosting the well and acquired the well and associated water right (Permit G3-29249P) for continuous industrial use. The well is capable of producing up to 1,400 gpm, but drawdown interference with other wells in the area led to a 2011 agreement between Ecology and the City (Agreed Order Docket No. 8703) to only use the well for emergency purposes. In 2012, a portion of the right changed to municipal use (Certificate G3-29249(A)), while the rest of the right remained industrial purpose of use (Superseding-Permit G3-29249(B)).
- Well 2 (S02): Well 2 is inactive, has not been used since 1985 (Century West 2017), and was replaced in 2008 by Well 8.
- Well 6 (S06): Well 6 was installed in 1981 but has “long since been decommissioned” (Ecology 2012).

There are approximately 38 miles of distribution piping in the Airway Heights water system. This piping ranges in size from 6 to 12 inches in diameter of various pipe materials throughout the system. The existing water distribution system is in fair to good condition (Century West 2017).

In 1989, an Intertie Agreement was carried out between the City of Airway Heights and the City of Spokane, which allows Airway Heights to receive water from Spokane (Century West 2017). This water is used to supplement City of Airway Heights’ water demands that cannot be met with their other water supply sources. The intertie connection between the two systems is shown on Figure 2. The agreement states that Airway Heights will pay the City of Spokane for the water used, based on rates up to 1,500 gpm.

The City of Spokane is currently providing the City of Airway Heights with municipal water.

2.1.2 Hydrogeology

Aquifers within a 7-mile radius of Airway Heights (Study Area) consist of the basement bedrock, west plains alluvial, the Columbia River Basalt Group (CRBG), and the eastern margin in the alluvium of the Spokane Valley-Rathdrum Prairie (SVRP) aquifer. The southwest portion of the area appears to be a mix of CRBG, basement rock, and a likely continuation of the sand and gravel paleochannel shown at Airway Heights. The most thorough documents to date describing aquifers in the area are Spokane County (Spokane County 2013) and GSI et. al (GSI 2015) for the West Plains, and Kahle and Bartolino (Kahle et al. 2007) and Hsieh et al. (2007) for the SVRP aquifer. Additional documentation for Hangman Creek Watershed (WRIA 56) is provided by NLW (NLW 2011 and 2012).

The basement bedrock unit is present at ground surface along the western and southern margins of the area, and lies beneath the alluvial, basalt, and SVRP aquifers everywhere else. The fine-grained metasediments and crystalline rocks that comprise the basement bedrock unit have a low primary porosity. Groundwater is available in this aquifer where secondary porosity occurs such as fracturing or faults. Wells drilled into basement bedrock aquifer typically produce low yields.

The West Plains Alluvial aquifer in the Study Area consists of a series of discontinuous, unconsolidated sediment deposits lying on top of basalt. These sediment deposits include paleochannels, which have been incised into the basalt and subsequently filled in with sediment, deposits along current drainages, and unconsolidated deposits that overlay the basalt but are not incised like the paleochannels. The lateral extent of the alluvial aquifer is controlled by basalt and basement outcrops. Alluvial aquifer thickness appears to range from a few feet to several tens of feet. Depth to water in the alluvial aquifer varies from near surface on floodplains near streams to several feet or tens of feet distally from streams. In the paleochannels, the depth to water can be several tens of feet or more. Coarse alluvium can be highly transmissive and produce high well yields on a short-term basis, but the limited spatial extent of the material limits the long-term sustainability of those yields.

The CRBG aquifer system in the Study Area consists of three parts: the Wanapum Basalt and the upper and lower Grande Ronde Basalt. Groundwater in the CRBG aquifer system occurs primarily in interflow zones and interbedded Latah Formation sediments, where present. The primary source of recharge for the CRBG in the area is from precipitation. A critical influence on groundwater flow and occurrence in the CRBG is the presence of basement bedrock highs. Basement Bedrock at or near ground surface to the west and south in the area has the effect of creating a groundwater divide that isolates this portion of the CRBG aquifer from the much larger portion of the CRBG that extends into Idaho and Oregon. As a result, the CRBG in the Study Area does not receive any groundwater inflow from the rest of the CRBG.

On the eastern margin of the Study Area is a portion of the SVRP aquifer that extends eastward into Idaho and covers approximately 370 square miles. This aquifer consists largely of outburst flood gravels, cobbles, and boulders and is the sole source of drinking water for over half a million people. Groundwater flow in the SVRP aquifer is generally from east to west. Flow in the Washington State part of the aquifer generally follows the Spokane River with groundwater entering and being recharged by the river over different stretches. The aquifer primarily discharges to the Spokane River and Little Spokane River.

2.1.3 Hydrogeologic Study

A hydrogeologic study was completed in 2020 to identify potential alternate water supply well locations for Airway Heights (NewFields Government Services, LLC [Newfields] 2020). Potential alternate water supply well locations were evaluated within a 7-mile radius of the city. An area to the east in the SVRP aquifer was identified as the best option for potential alternate supply well(s), based on well yields and water rights feasibility.

Well yields in the SVRP aquifer are expected to be high and with good water quality. The SVRP is a highly transmissive aquifer, and it is highly likely that a well or pair of wells would be capable of producing the 1,014-gpm replacement rate. Other supply wells in the general vicinity of the East Area include FAFB wells; the Washington Department of Health website lists well capacities for the FAFB wells ranging from 850 to 1,400 gpm. For a well to draw water from the SVRP, it would need to be located below the bluffs of the West Plains Basalt and west of the Spokane River.

Due to the highly transmissive nature of the SVRP aquifer, groundwater drawdown due to pumping from a new well is expected to be minimal. The drawdown, therefore, would not result in an adverse impact to other wells in the area. However, pumping from a new well in the SVRP aquifer would likely result in stream depletion of the Spokane River. Because the river is the only point of discharge for groundwater in the area, the depletion in the river would be equal to the amount pumped and would be consistent throughout the year because the pumping would be year round.

Although Ecology will not grant a new uninterruptible water right for a new municipal supply well in this area due to the instream flow rights for the Spokane River, this could be offset by using existing Airway Heights water rights. Existing water rights could be transferred to a new well because the potential well location is downgradient from the existing Airway Heights water rights. The transfer process would consist of Airway Heights relinquishing existing water rights and noting that relinquishment in an application for a new water right for the replacement well(s).

2.2 Previous Removal Actions

A Time Critical Removal Action (TCRA) for the treatment of PFOS and PFOA-contaminated water in private residential wells near FAFB was initiated in 2017 (USAF 2017). The TCRA provides for installation and operation of GAC water treatment systems for private residential wells testing above the health advisory (HA).

In 2017, in furtherance of the USAF's CERCLA response action, USAF and City of Airway Heights entered into an Environmental Services Agreement for the purchase of alternative water supplies up to 439.08 million gallons due to the City ceasing the use of supply Wells 1/4 and Well 9.

In 2018, another TCRA was initiated (USAF 2018). A temporary GAC water treatment system for Well 9 was constructed on a gravel pad in 2018 to treat PFOS and PFOA to levels below the HA (AMEC 2019b). The treatment system is intended to be utilized as a temporary water supply for approximately 6 months each year from 1 April through 30 September (summer season). Virgin Bituminous GAC is utilized to remediate the groundwater prior to pumping it into the distribution system. It consists of four duplex GAC systems operating in parallel (each duplex system consists of two 20,000-pound GAC vessels operated in a lead-lag orientation).

2.3 Source, Nature, and Extent of Contamination

Per- and polyfluoroalkyl substances (PFAS) are a large family of compounds, including PFOS and PFOA. PFOS and PFOA were likely released to groundwater at FAFB through fire training and fire response activities (AMEC 2019). The USAF began purchasing and using aqueous film forming foam (AFFF) containing PFAS for extinguishing petroleum fires and during firefighting training activities in 1970. AFFF was primarily used on USAF installations at fire training areas, but may have also been used, stored, or released from hangar fire suppression systems, at firefighting equipment testing and maintenance areas, and during emergency response actions for fuel spills and/or aircraft mishaps.

The mass of PFAS released in AFFF is expected to accumulate at or near the point of release near the ground surface, with the more mobile compounds migrating through the soil column to the water table during precipitation or irrigation events (Interstate Technology & Regulatory Council 2018). PFOS and PFOA are considered more mobile, persistent, and bioaccumulative, and are not known to degrade in the environment. Groundwater at FAFB, generally flowing west to east, is typically encountered at 3 to 12 feet below ground surface in alluvium or within the fractured and weathered portion of the basalt bedrock under unconfined conditions (AMEC 2019).

In 2017, site inspections at FAFB detected PFOS and PFOA in groundwater at concentrations above the EPA's lifetime HA of 70 parts per trillion (ppt) for PFOS and PFOA in drinking water (individual or combined) (EPA 2016). The sum of PFOS and PFOA concentrations detected in groundwater at FAFB ranged from 17,690 to 167,000 ppt (AMEC 2019), above the HA of 70 ppt. Based on these results, sampling of off-base groundwater monitoring wells, private residential wells, and municipal supply wells was subsequently completed.

PFOS and PFOA were detected at concentrations above the HA in water samples from three of the eight Airway Heights' municipal supply wells, Wells 1/4 and Well 9 (see Figure 2 for well locations). The sum of PFOS and PFOA was detected at concentrations of 1,400 ppt in Wells 1/4 and 1,520 ppt in Well 9, with individual PFOS and PFOA concentrations up to 1,100 and 300 ppt, respectively, at Wells 1/4 and 1,200 and 320 ppt, respectively, at Well 9. The current water use by Airway Heights at the time PFOS and PFOA were detected in drinking water, with consideration of water lost to recharge, was an average of 1,014 gpm (532,752,742 gallons per year).

2.4 Streamlined Risk Evaluation

Normally under the NCP and the EPA's guidance, an unacceptable human health risk is present when cumulative human health cancer risk exceeds 10^{-4} or the non-cancer hazard index exceeds 1; or if a drinking water maximum contaminant level is exceeded. Risk-based cleanup levels under CERCLA and the EPA HAs are set at levels below these unacceptable risk levels. Accordingly, if PFOS or PFOA is present in a drinking water supply at concentrations above risk-based response action trigger levels, such levels could present an unacceptable risk, threat, and danger to human health.

Potential exposure pathways—the means by which people, animals, and plants might come into contact with PFOS and PFOA—are based on current and potential future groundwater use. Groundwater is considered a drinking water source, and the groundwater ingestion pathway for current and future commercial/industrial and residential land use scenarios is considered potentially complete. PFOS and PFOA have been detected individually at concentrations above their respective HAs in water samples from three Airway Heights drinking water supply wells (Wells 1/4 and 9) located approximately 1 mile from the Base boundary and downgradient of the AFFF release areas at FAFB (see Figure 2).

Dermal absorption of PFOS and PFOA in water (washing/bathing) is not considered a pathway of concern because it is not well adsorbed through the skin (Agency for Toxic Substances and Disease Registry 2015). Because PFOS and PFOA are not volatile, the indoor and outdoor air inhalation pathways are considered incomplete for current and future commercial/industrial and residential land use scenarios.

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3.0 REMOVAL ACTION SCOPE, GOALS, AND OBJECTIVES

This section identifies the statutory framework for the removal action, removal action objectives (RAOs), and applicable or relevant and appropriate requirements (ARARs).

3.1 Statutory Limits on Removal Actions

This removal action will be performed pursuant to CERCLA and the NCP under the authority delegated by the Office of the President of the United States through Executive Order 12580 as redelegated. This order, as implemented through U.S. 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. The Defense Environmental Restoration Program (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 an EPA 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 removal alternatives for the site and recommends a removal action alternative. This EE/CA complies with the requirements of CERCLA, the Superfund Amendments and Reauthorization Act, NCP, DERP, and Executive Order 12580. This EE/CA is undertaken pursuant to Title 40 of the Code of Federal Regulations (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 Determination of Removal Scope

3.2.1 Removal Action Objectives

The specific RAOs for this removal action are as follows:

- Provide a long-term option to eliminate the imminent and substantial danger to human health or the environment posed by PFOS and/or PFOA in groundwater used as drinking water and provide an average supply of 1,014 gpm of drinking water (532,752,742 gallons per year)
- Restrict potential exposure to PFOS and PFOA in drinking water at concentrations above the EPA HA of 70 ppt (0.07 micrograms per liter) (individually or combined)

3.2.2 Applicable or Relevant and Appropriate Requirements

ARARs are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances found at a CERCLA site. Removal actions under CERCLA must, to the extent practicable attain ARARs (40 CFR 300.415[j]).

Under the NCP, applicable requirements are defined as those cleanup standards, standards of control and other substantive requirements, criteria, or limitations promulgated under federal environmental or state

environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site (40 CFR 300.5).

Relevant and appropriate requirements are promulgated federal or state laws that are not “applicable,” but address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the site.

In addition to ARARs, many federal and state environmental and public health programs also have non-promulgated advisories or guidance that are “to be considered” (TBC) in developing remedies. Although not legally binding, TBCs may provide information that is useful in the evaluation of proposed actions.

Ecology and the Washington State Department of Health released a Draft Chemical Action Plan for PFAS in October 2020 for public comment (Ecology and WSDOH 2020). The Chemical Action Plan addresses PFAS in the environment and resulting human impacts and recommends developing cleanup levels for PFOA and PFOS (and additional PFAS as appropriate). As the Chemical Action Plan has not been finalized and does not provide for promulgated cleanup levels, it is not considered an ARAR. Pursuant to EPA guidance, ARARs are generally divided into three categories: location-specific, action-specific, and chemical-specific items.

3.2.2.1 Potential Location-Specific ARARs

Potential location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because the substances occur or activities are conducted in specified locations. These requirements may limit the type of potential removal action that can be implemented or may impose additional constraints on removal action alternatives. Location-specific ARARs that could affect the removal action at the site are briefly described below, along with the manner in which the applicable alternative(s) presented in this EE/CA intend(s) to meet each ARAR.

Archaeological and Historic Preservation Act, 16 United States Code (USC) 469. This act establishes procedures to provide for the preservation of historical and archaeological data that might be destroyed through alteration of terrain as a result of a federally licensed activity or program. If historic or archaeological artifacts are present in the area where cleanup activity will occur under a federal permit, the remedial activity must be designed to minimize adverse effects on the artifacts. No historic or archaeological data are likely to be present at the site because the area was previously disturbed. However, cleanup action design documents for actions being performed under a federal permit will include a requirement that unavoidable impacts on artifacts be mitigated, in consultation with the State Historic Preservation Officer, through such means as taking photographs and collecting historical records.

Native American Graves Protection and Repatriation Act (NAGPRA) Regulations, 25 USC 3001 et. seq; 43 CFR Part 10.1, 10.4 and 10.5. This act protects Native American burial sites and funerary objects. If Native American graves are discovered within the area where cleanup activity occurs under a federal permit, the U.S. Department of Interior and the tribe with ownership must be notified of the inadvertent discovery; and the activity must cease until a reasonable effort is taken to protect the discovered items. NAGPRA regulations are unlikely to be applicable to cleanup actions at the site because the work area has been previously disturbed. Removal action design documents for actions being performed under a federal permit will include a requirement that if Native American materials are inadvertently discovered during cleanup activities, activity will cease and the affiliated tribes will be notified and consulted.

National Historic Preservation Act (NHPA), 16 USC 470; 36 CFR Parts 60, 65, and 800. The NHPA requires federal agencies to assess the impact of proposed actions on historic or culturally important sites, structures, or objects within the site of the proposed projects. It further requires federal agencies to assess all sites, buildings, and objects on the site to determine if any qualify for inclusion in the National Register of Historic Places or as a National Historic Landmark. Historic sites and structures are unlikely to be present at the site because the area has been previously disturbed. However, removal action design documents for actions being performed under a federal permit will include a requirement that unavoidable impacts on historic sites or structures will be mitigated, in consultation with the State Historic Preservation Officer, through such means as taking photographs and collecting historical records.

3.2.2.2 Potential Action-Specific ARARs

Potential action-specific ARARs are usually technology- or activity-based requirements or restrictions on actions taken with respect to hazardous substances. These potential requirements are triggered by the particular removal alternative and set performance, design, or other standards that will be used to implement the proposed action. These requirements are triggered by the cleanup actions selected. The action-specific requirements do not in themselves determine the selected cleanup action alternative. Rather, they indicate how, or to what level, a selected alternative must be achieved.

Clean Water Act Pretreatment Regulations (40 CFR Part 503.5). These regulations are potentially applicable if construction dewatering water or water from wells is discharged to the City of Airway Heights publicly owned treatment works (POTWs). The federal regulations limit pollutants in wastewater discharges to sanitary sewer systems to protect POTWs from accepting wastewater that would damage their system or cause them to exceed their permit discharge limits. Removal action designs will include pretreatment of construction dewatering water to the standards provided by the POTW. The POTW will have the opportunity to review the treatment approach and goals included in the designs.

Stormwater Permit Program (33 USC 1342, Revised Washington Code [RCW] 90.48.260, 40 CFR 122.26; Chapter 173-220 Washington Administrative Code [WAC]). The Federal Clean Water Act, as delegated to Ecology under RCW 90.48.260, requires that the general stormwater permit be obtained for stormwater discharges associated with construction activities disturbing over 1 acre. The Washington State General Stormwater Permit for Construction Activities is potentially applicable to some of the EE/CA alternatives. Coverage under this permit would be obtained for actions where the permit requirements apply. The conditions of the Washington State Industrial Stormwater General Permit for the facility are also applicable to any work on the property.

State Environmental Policy Act (SEPA) (RCW 43.21.036, WAC 197-11-250 through 268). Under the SEPA rules, Model Toxics Control Act (MTCA) and SEPA processes are to be combined to reduce duplication and improve public participation (WAC 97-11-250). Ecology is the lead agency for implementing the substantive requirements of SEPA as described in WAC 197-11-253. Ecology is likely to determine that it will act as the lead agency for implementing the requirements of SEPA for removal actions at the site. A SEPA checklist will be completed prior to construction and it is expected that a determination of non-significance will be issued, as the alternatives evaluated in this EE/CA are unlikely to have a significant adverse environmental impact.

Washington Solid Waste Management Act and Solid Waste Management Handling Standards Regulations (RCW 70.95 and WAC 173-350). The solid waste regulations are applicable to the offsite disposal of solid non-hazardous wastes and contaminated media that may be generated as part of the cleanup action alternatives. Soils, sediment, dewatering water, and debris generated as the result of the cleanup action alternatives would be characterized, managed, and properly disposed at a licensed and

permitted facility. This requirement is potentially applicable to several alternatives presented in this EE/CA.

3.2.2.3 *Potential Chemical-Specific ARARs*

There are no promulgated chemical-specific ARARs for PFOS and PFOA. In the absence of an ARAR, the HA value is being used to establish protective levels in drinking water. In the absence of ARARs, cleanup levels are based upon "... other reliable information..." (see 40 CFR §300.430(e)(2)(i)). Reliable information is derived from other TBC criteria, advisories, or guidance (40 CFR §300.400(g)(3)). The 2016 HA value issued by the EPA Office of Water for both PFOS and PFOA is based upon the Office of Water's calculated reference dose, which is a Tier 3 toxicity value. Therefore, in the absence of an ARAR, the HA value can be used as a protective level for human health in drinking water.

3.3 Removal Schedule

Subsequent to this EE/CA, a public notice of the availability of the EE/CA will be published. Regulatory agency support/acceptance and community acceptance will be considered as a part of a public comment period and public meeting. Following the public comment period, the selected alternative will be documented in an Action Memorandum. The proposed NTCRA is anticipated to be approved by the USAF, City of Airway Heights, EPA, and Washington Department of Health by 2022. FAFB intends to initiate the removal action in 2022 provided required regulatory documents, plans, and permits are approved.

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

With the exception of the No Action alternative, removal action alternatives were developed by assembling treatment technologies or other options to achieve the RAOs. Three alternatives were developed that provide for treatment technologies, and two of the alternatives provide an alternate water supply. The most common treatment technologies for PFAS include removal using GAC, ion exchange resin (IXR), and reverse osmosis membrane (ROM). Other technologies have generally been inadequate at treating PFOS and PFOA due to their unique stability and surfactant nature.

Section 4.1 describes the CERCLA criteria used to evaluate the alternatives.

Sections 4.2 through 4.7 describe and evaluate the following alternatives for achieving the RAOs:

- Alternative 1 – No Action
- Alternative 2 – GAC Wellhead Treatment
- Alternative 3 – IXR Wellhead Treatment
- Alternative 4 – ROM Wellhead Treatment
- Alternative 5 – New Water Supply Well with Connection to Airway Heights Water System
- Alternative 6 – Continued Use of Spokane Water Supply

A summary of well construction details for Wells 1, 4, 9 and the proposed new water supply well in the SVRP aquifer are provided in Table 1. Table 2 provides a summary of the alternative components and details, and Table 3 provides a summary of costs. Figures 7 through 13 provide a conceptual design for Alternatives 2 through 5. The detailed cost estimates and assumptions are provided in Appendix A.

4.1 Evaluation Criteria

The removal action alternatives were evaluated according to effectiveness, implementability, and cost criteria pursuant to CERCLA guidance (EPA 1993) and assigned a numeric rating of 1 through 4 (poor to excellent).

Effectiveness is evaluated in terms of its ability to meet the RAOs and its protectiveness of human health and the environment, both during the construction/implementation phase (short-term) and after completion (long-term). Influent water parameters can impact the long-term effectiveness and efficiency of a treatment technology. Key factors affecting treatment effectiveness include PFAS characteristics, presence of comingled contaminants and organic matter, and geochemistry. Individual PFAS have diverse physical and chemical properties, different loading capacities and corresponding breakthrough times. For example, a technology may be more effective at removing long-chain PFAS, such as PFOS and PFOA, or PFOS may be better adsorbed than PFOA. In accordance with CERCLA §121(b) (EPA 1988), there is also a preference for remedial actions that employ treatment and technologies that will permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. Sustainability is also considered under this criterion and evaluates each alternatives anticipated general energy usage and resource consumption. Energy usage considers electricity and/or fuel needed for material production, transportation, and equipment used during construction activities and system operations. Resource consumption for this evaluation considers the amount of land impacted by construction and the volume of disposable materials landfilled. Alternatives that use more energy and resources will be rated lower than those which use less.

The implementability of each alternative depends on its technical feasibility, administrative feasibility (including public acceptance), and the availability of necessary resources. Technical feasibility assesses the ability of the technology to be implemented, with proven technologies rated higher. It also considers construction and startup timeframes. Administrative feasibility considers the need for permits, easements, and right-of-way agreements, as well as regulatory agency support/acceptance and community acceptance. Availability of necessary resources considers whether personnel, materials, and services are readily available and whether a promising technology or option requires further development before it can be applied at full scale.

The estimated costs for the alternatives are provided for decision-making purposes only and are consistent with the +50/-30 percent (%) accuracy typically associated with feasibility studies (EPA 1988). The cost of each alternative is evaluated in terms of capital costs and long-term costs, including monitoring and operation and maintenance (O&M). Consistent with EPA guidance, present worth costs are provided for each alternative. Present Worth costs were calculated using a Discount Rate 0.4% (interest rate [2.4%] - inflation [2.0%]) per Office of Management and Budget, Circular A-94, Appendix C, Revised Nov. 2019 (Office of Management and Budget 2020). Costs presented are suitable for comparison purposes; the actual costs to complete the work may be higher or lower than estimated. Detailed cost estimates should be further developed for the remedy after selection.

Table 4 summarizes the evaluation criteria, including the specific parameters for each.

4.2 Alternative 1 – No Action

4.2.1 Description of Alternative

The No Action Alternative is included pursuant to CERCLA guidance as a baseline from which other alternatives may be evaluated. Under this alternative no action would be performed under current or future land use scenarios. This alternative does not include institutional controls, an engineered wellhead treatment, or an alternate water supply.

4.2.2 Effectiveness

The No Action alternative would not reduce or eliminate threats to public health and the environment, and it would not achieve RAOs. Therefore, this alternative was determined to have an effectiveness rating of “poor.”

4.2.3 Implementability

The No Action alternative is readily implementable, as no action is required. No skilled labor, specialty equipment, or materials are needed. However, it is not anticipated to receive regulatory agency support/acceptance or community acceptance. Therefore, it was determined to have a “poor” combined implementability rating.

4.2.4 Cost

There is no cost associated with Alternative 1.

4.3 Alternative 2 – Granular Activated Carbon Wellhead Treatment

4.3.1 Description of Alternative

This alternative involves the construction of two new GAC treatment systems to remove PFOS/PFOA from Wells 1/4 and 9 (see Figures 7 and 8). The design would allow these supply wells to be returned to normal operation by the City of Airway Heights.

The Wells 1/4 GAC system would use two 20,000-pound capacity vessels linked in series and filled with virgin reagglomerated bituminous coal carbon to adsorb the contaminants from the water. The Well 9 GAC system would use four 20,000-pound capacity vessels, also filled with virgin reagglomerated bituminous coal carbon and configured in two parallel series. This system would be similar to a temporary GAC system that has been in place since 2018 to treat water from Well 9 during peak summer demand. The temporary system is located outside without freeze protection and uses eight skid-mounted vessels. The equipment and carbon would meet the American Water Works Association (AWWA) standards for drinking water systems. The two vessels would be American Society of Mechanical Engineers (ASME) rated pressure vessels to 125 pounds per square inch gauge (psig). All new components installed would be disinfected with chlorine prior to providing drinking water to customers, and the necessary equipment would be National Sanitation Foundation (NSF) certified. The water supply from the two systems would not be continually treated by gas chlorination or other disinfection method during normal operations. If disinfection is needed, it would be provided by the City of Airway Heights. Additional details for the two Alternative 2 GAC treatment systems are presented below.

The existing submersible pumps installed in Wells 1/4 and 9 would convey groundwater to ground surface, but instead of going directly into the City water main, it would be piped into new treatment buildings at each well site. It is assumed that the existing pumps would be able to overcome the added back pressure from the treatment system, but booster pumps would be used to increase pressure to the distribution system following treatment. New piping between the existing wellheads, new treatment systems, and the existing water main is assumed to be 10- or 12-inch-diameter polyvinyl chloride (PVC) or stainless steel (SS) pipe at both wells. Existing piping between the wellheads and the adjacent water main would be disconnected or locked out to prevent untreated water from being distributed to customers.

The Wells 1/4 pump would supply its new GAC treatment system with an average flowrate of 350 gpm. The maximum treatment capacity of that treatment system would be 450 gpm, which is believed to be the maximum rated output of the Wells 1/4 pump. The Well 9 pump would supply its new GAC treatment system with an average flowrate of 1,000 gpm. The maximum treatment capacity of this treatment system would be 1,200 gpm, which is believed to be the maximum rated output of the Well 9 pump. This alternative assumes no redundant treatment equipment or additional future capacity beyond the maximum flowrates listed above.

The new Wells 1/4 treatment building would contain all the major system components including SS filter housing for particulate bags, two GAC vessels, piping/valve manifold, backwash pump, two clean water storage tanks, two dirty backwash storage tanks, a transfer pump, a clearwell tank, a booster pump, and associated control and electrical panels. The building would be pre-manufactured offsite for assembly onsite; it would be constructed from steel or use steel trusses and covered with PVC fabric; it would be installed on a secondarily contained concrete foundation immediately east of the existing wellhead building. The building would be approximately 45 feet wide by 50 feet long by 25 feet tall and include insulation and heaters for winter freeze protection and an automated ventilation system for warm weather. The building and all associated equipment would be located within the existing fenced Wells 1/4 perimeter.

The new Well 9 treatment building would contain all the major system components including two SS filter housings with particulate bags, four GAC vessels in two parallel series, piping/valve manifolds, a backwash pump, two clean water storage tanks, two dirty backwash tanks, a transfer pump, a clearwell tank, a booster pump, and associated control and electrical panels. The building would be pre-manufactured offsite; it will be constructed from steel or use steel trusses and covered with PVC fabric. Like for Wells 1/4, the building will be installed on a secondarily contained concrete foundation immediately east of the existing wellhead building. The building will be approximately 45 feet wide by 85 feet long by 25 feet tall and include insulation and heaters for winter freeze protection and an automated ventilation system for warm weather. The building and all associated equipment will be located within the existing fenced Well 9 perimeter.

The carbon vessels and manifolds will come from the manufacturer as a complete system that has been factory tested and certified for use in drinking water systems. Supporting system components will be procured by the construction contractor for installation and integrated together to make a complete carbon treatment system. Each carbon vessel will operate in a lead/lag configuration with an estimated 9-month (Well 9) or 15-month (Well 1/4) operational duration before breakthrough, triggered by 70 ppt of PFOS and PFOA out of the lead vessel (i.e., at the midpoint between vessels). Once analytical testing results of regularly scheduled samples indicate carbon changeout is needed, the carbon in the lead vessel would be removed and transported offsite for regeneration. New virgin carbon would be installed, and that vessel would become the lag vessel; then the original lag vessel with the older carbon would become the lead vessel. The new carbon would be soaked in clean water for 24 hours and backflushed to set the carbon bed before returning the GAC system to service. Two aboveground storage tanks with clean water would be stored onsite for the GAC startup process. After backwash is completed, the dirty water will be slowly transferred through particulate filters back to the system's influent/feed piping for treatment. As the dirty water tanks typically will be empty, they are not located inside the climate-controlled building.

The main components of the two GAC treatment systems include the following, with differences only where specified:

- Buried 10-inch PVC piping from the existing wellhead to the new treatment building; Well 9 would use a minimum 12-inch piping to the new treatment building
- One pre-manufactured treatment building at each site:
 - Wells 1/4: 45 feet wide by 50 feet long by 25 feet high structure on a 12-inch-thick concrete pad that has an 8-inch-tall secondary containment berm
 - Well 9: 45 feet wide by 85 feet long by 25 feet high structure on a 12-inch-thick concrete pad that has an 8-inch-tall secondary containment berm
- Pre-system filtration:
 - Wells 1/4: One 8-bag SS filter housing to prefilter the untreated water prior to GAC treatment
 - Well 9: Two 8-bag SS filter housing to prefilter the untreated water prior to GAC treatment
- GAC vessels and associated manifold:
 - Wells 1/4: One Model 10 system manufactured by Calgon Carbon, which includes two 10-foot diameter, 20,000-pound capacity vessels and piping manifold with numerous control valves. The Model 10 system is rated for 700 gpm, but the maximum flowrate for Well 1/4 is 450 gpm, which is the assumed maximum capability of the existing well pumps.

- Well 9: Two Model 12 systems manufactured by Calgon Carbon. Each of the two Model 12 systems includes two 12-foot diameter, 20,000-pound capacity vessels, for a total capacity of 80,000 lbs. Vessels and piping manifolds with numerous control valves are included. Each Model 12 system is rated for 800 gpm for a total of 1,600 gpm, but the maximum flowrate for Well 9 is 1,200 gpm, which is the assumed maximum capability of the existing well pump.
- One backwash pump with piping to set the new carbon bed in each vessel and perform routine backwashes:
 - Wells 1/4: 700 gpm sustained
 - Well 9: 900 gpm sustained
- One transfer pump at each site with piping from the dirty backwash tanks to the influent bag filters:
 - Wells 1/4: Transfer rate of approximately 50 gpm
 - Well 9: Transfer rate of approximately 100 gpm
- Single-walled water tanks for backwash, testing, equalization, and service water:
 - Wells 1/4: Four 12,000-gallon tanks (11.8 feet diameter by 16.4 feet tall) – two inside for clean water and two outside for temporary dirty backwash storage
 - Well 9: Four 15,500-gallon tanks (11.8 feet diameter by 20.3 feet tall) – two inside for clean water and two outside for temporary dirty backwash storage
- One pressure-rated 5,000-gallon clearwell tank for surge protection (6-foot diameter)
- Booster pump following GAC treatment, pulling water from the clearwell to the drinking water distribution system
- Transfer pump to route water from the outside backwash tanks back to bag filters prior to GAC treatment
- Flowmeters, check valves, isolation valves, air release valves, pressure gauges, an automated controls system, and telemetry for remote monitoring
- Buried 12-inch PVC piping from the new treatment buildings to the existing City of Airway Heights 12-inch PVC water main
- Timeframes:
 - Construction timeframe is assumed to be 5 to 6 months each.
 - System startup and shakedown are assumed to take 1 month.
 - System performance and contaminant monitoring timeframe is assumed to be 30 years.
 - Treatment system O&M is assumed to be 30 years for cost estimating purposes.

4.3.2 Effectiveness

GAC is an established water treatment technology proven to effectively remove PFAS, such as PFOS and PFOA (Interstate Technology & Regulatory Council [ITRC] 2020). PFOS is better adsorbed by carbon than PFOA. Historical sampling indicates that PFOS accounts for approximately 79% of the combined PFOS/PFOA concentrations in each well. Wells 1/4 measured at 1,400 ppt combined PFOS and PFOA, while Well 9 measured at 1,520 ppt. Shorter chain PFAS have faster breakthrough times, but they could be treated effectively if changeout frequency is increased. Current data show that bituminous-based products are more effective for PFAS removal (McNamara et al. 2018; Westreich et al. 2018).

This alternative was determined to have a combined effectiveness of “good +” after rating all the sub-criteria. Its ability to achieve the RAOs was rated “excellent,” if good operating and monitoring practices are conducted to maintain success. GAC long-term effectiveness was rated as “good” because carbon changeouts would be needed approximately every 9 months. Short-term effectiveness was also rated “good” as there would be some risks to construction workers during implementation of this alternative. Sustainability was considered good, as spent GAC media could be reactivated for reuse, and overall energy and resource consumption are similar to other treatment alternatives.

4.3.3 Implementability

Permanent GAC systems can be deployed rapidly, with estimated construction and startup timeframes of 5 to 6 months and 1 month, and several different types of GAC are currently available. Currently, spent GAC media can be reactivated for reuse, or it can be disposed of by landfilling or incineration.

The combined implementability rating was determined to be “excellent” for this alternative. The technical feasibility of installing a GAC system is high as this is a proven technology with multiple vendors and contractors that have implemented it across the country. This alternative also includes offsite regeneration of the spent GAC, which may not be as easily implemented as offsite disposal. No new water rights are needed, and the permit process should be straightforward.

4.3.4 Cost

The total present worth cost to implement Alternative 2 is \$16.5 million. This assumes capital costs associated with construction of a new treatment system for Wells 1/4 and 9, including a treatment building, monitoring, and O&M for 30 years. Long-term O&M costs are sensitive to the assumed changeout frequency, which is based on vendor estimates. Therefore, capital costs also include a water quality assessment/bench-scale testing to confirm changeout frequency and verify assumptions before design is started.

4.4 Alternative 3 – Ion Exchange Resin Wellhead Treatment

4.4.1 Description of Alternative

This alternative involves construction of two new IXR treatment systems to remove PFOS/PFOA from Wells 1/4 and 9 independently (see Figures 9 and 10). The design would allow these water supply wells to be returned to normal operation for the City of Airway Heights.

The IXR system at Wells 1/4 would use two vessels, each with capacity of 200 cubic feet (CF), filled with resin media, linked in series to remove the contaminants from the water. The Well 9 system would consist of two vessels with a capacity of 400 CF each, also linked in series. The equipment and IXR would meet the standards for drinking water systems. The two vessels would be ASME-rated pressure vessels to 125 pounds psig. All new components installed would be disinfected with chlorine prior to providing drinking water to customers and the necessary equipment would be NSF-certified. The water supply from the two systems would not be continually treated by gas chlorination or other disinfection method during normal operations. If continuous disinfection is needed, it would be provided by the City of Airway Heights. Additional details of the Alternative 3 IXR treatment systems are presented below.

The existing submersible pumps already installed in Wells 1/4 and 9 would convey groundwater to ground surface, but instead of going directly into the City water main, it would be piped into a new treatment building at each site. It is assumed that the existing pumps in each well would be capable of overcoming

the added back pressure associated with the new treatment systems. However, a booster pump is included following the resin vessels to increase discharge pressure to the existing water distribution system. New piping between the existing wellheads, new treatment system equipment, and the existing water main is assumed to be 10- or 12-inch-diameter PVC or SS pipe. Existing piping between the wellheads and the adjacent water mains would be disconnected or locked out to prevent untreated water from being distributed to customers.

The IXR vessels selected for use at Wells 1/4 and 9 are rated by the manufacturer for flows up to 900 gpm and 1,400 gpm, respectively, and would operate in a lead/lag configuration. This alternative assumes no redundant treatment equipment or additional future capacity beyond the maximum flowrates presented above.

The new Wells 1/4 treatment building would contain all the major system components including SS filter housing for particulate bags, two IXR vessels, piping/valve manifold, backwash pump, water storage tank, transfer pump, clearwell tank, booster pump, and associated control and electrical panels. The dirty backwash storage tank would be located outside the building as it would not be used often and does not need freeze protection. The building would be pre-manufactured and constructed from steel or use steel trusses and covered with PVC fabric. It would be installed on a secondarily contained concrete foundation immediately east of the existing wellhead building. The building would be approximately 30 feet wide by 40 feet long by 25 feet tall and include insulation and heaters for winter freeze protection and an automated ventilation system for warm weather. The building and all associated equipment would be located within the existing fenced Wells 1/4 perimeter.

The new Well 9 treatment building would contain the same components as the 1/4 building except the vessels would be larger (10 feet diameter for Well 9 versus 8 feet diameter for Wells 1/4), and an extra bag filter housing would be used to manage the higher flowrates. The building would also be prefabricated and constructed from steel or use steel trusses and covered with PVC fabric. It would be installed on a secondarily contained concrete foundation northwest of the existing wellhead building. The Well 9 building would be approximately 40 feet wide by 50 feet long by 25 feet tall and include insulation and heaters for winter freeze protection and automated ventilation system for warm weather. The building and all associated equipment would be located within the existing fenced Well 9 perimeter in approximately the same area as an existing but temporary GAC treatment system.

For each site, the two IXR vessels and manifold would come from the manufacturer as a complete system that has been factory tested and certified for use in drinking water systems. Supporting system components would be procured by the construction contractor for installation and integrated together to make a complete IXR system. The IXR vessels are rated for 900 gpm and 1,400 gpm for Wells 1/4 and 9, respectively, and would operate in a lead/lag configuration. The system at Wells 1/4 has an estimated 1.5-year operational duration before breakthrough, triggered by effluent PFAS concentrations from the lead vessel in excess of 50% of the 70-ppt limit. This resin changeout trigger is slightly more conservative than what was assumed for carbon changeouts in Alternative 2. At Well 9, the operational duration is estimated at 1.3 years between resin changeouts. Once analytical testing results of regularly scheduled samples indicate IXR changeout is needed, the IXR in the lead vessel would be removed and transported offsite for incineration; however, landfill disposal may be an option. New virgin IXR would be installed, and that vessel would become the lag vessel, while the original lag vessel with the older IXR would become the lead vessel. The new IXR would be soaked in clean water for 24 hours and backflushed to set the IXR bed before returning the IXR system to service. Regeneration of IXR was considered but deemed not appropriate for drinking water systems because of the potential for residual solvents left from the regeneration process. After backwash is completed, the dirty water will be slowly transferred through

particulate filters back to the system's influent/feed piping for treatment. As the dirty water tanks typically will be empty, they are not located inside the climate-controlled building.

The main components of each wellhead IXR treatment system includes the following, with differences only where specified:

- Buried 10-inch PVC piping from the existing wellhead to the new treatment building
- One treatment building at each site:
 - Wells 1/4: Approximately 30 feet wide by 40 feet long by 25 feet high on a 12-inch-thick concrete pad that has an 8-inch-tall secondary containment berm
 - Well 9: Approximately 40 feet wide by 50 feet long by 25 feet high on a 12-inch-thick concrete pad that has an 8-inch-tall secondary containment berm
- 8-bag SS filter housings to pre-filter the untreated water prior to IXR treatment:
 - Wells 1/4: Requires one filter housing.
 - Well 9: Requires two filter housings operating in parallel.
- IXR system:
 - Wells 1/4: Sorbix Model 86 system manufactured by ECT2, which includes two vessels with a media capacity of 200 CF each (400 CF total) and SS piping manifold with numerous control valves. The system is rated for 900 gpm, but the maximum recommended flowrate would be limited by the existing well and treatment efficiency, determined by empty-bed contact time.
 - Well 9: Sorbix model 108 system manufactured by ECT2, which includes two 10-foot-diameter vessels with a media capacity of 400 CF each (800 CF total) and SS piping manifold with numerous control valves. The system is rated for 1,400 gpm, but the maximum recommended flowrate would be limited by the existing well and treatment efficiency, determined by empty-bed contact time.
- One backwash pump at each site with piping to set the new IXR bed in each vessel:
 - Wells 1/4: 100 gpm sustained
 - Well 9: 150 gpm sustained
- Water storage tanks for backwash, testing, equalization, and service water:
 - Wells 1/4: Two 2,500-gallon single-walled tanks (8.5 feet diameter by 8.5 feet tall)—one inside for clean water and one outside for temporary dirty backwash storage
 - Well 9: Two 5,000-gallon single-walled tanks (8.5 feet diameter by 13.25 feet tall)—one inside for clean water and one outside for temporary dirty backwash storage
- One transfer pump at each site with piping to transfer water from the dirty backwash tanks to the bag filters:
 - Wells 1/4: Transfer rate of approximately 50 gpm
 - Well 9: Transfer rate of approximately 100 gpm
- One pressure-rated 5,000-gallon clearwell tank (6 feet diameter) at each site following the treatment system to prevent disruption of the resin by pressure surges from the distribution system
- Booster pump following IXR treatment, pulling water from the clearwell to the drinking water distribution system

- Flowmeters, check valves, isolation valves, air release valves, pressure gauges, an automated controls system, and telemetry for remote monitoring.
- Buried 12-inch PVC piping from the new treatment buildings to the existing City of Airway Heights 12-inch PVC water main
- Timeframes:
 - Construction timeframe is assumed to be 5 months each.
 - System startup and shakedown are assumed to take 1 month.
 - System performance and contaminant monitoring timeframe is assumed to be 30 years.
 - Treatment system O&M is assumed to be 30 years for cost estimating purposes.

4.4.2 Effectiveness

Resin is a proven and effective method to remove PFAS from water; and PFOS and especially PFOA are adsorbed effectively by resin (ITRC 2020). The volume of resin needed is generally smaller than carbon and media changeouts are needed less often. Resin is considered by some to be several times more effective than carbon for PFOA, but this is dependent on the total dissolved solids and other constituents in the water that can affect performance.

This alternative was determined to have a combined effectiveness of “good +” after rating all the sub criterion. Alternative 3’s ability to achieve the RAOs was rated “excellent,” if good operating and monitoring practices are conducted to maintain success. IXR long-term effectiveness was rated as “good” because resin changeouts would be needed approximately every 1.5 years. Short-term effectiveness was also rated “good” as there would be some typical construction risks to workers during implementation of this alternative. Sustainability was considered good, although there would be waste from spent resin, overall energy and resource consumption are similar to other treatment alternatives.

4.4.3 Implementability

Permanent IXR systems can be deployed rapidly and are currently available, with estimated construction and startup timeframes of 5 months and 1 month. Spent resin can be disposed of by landfilling or incineration. Resin can also be regenerated onsite using a regenerant solution; however, the process generates a waste that must be managed.

The combined implementability rating was determined to be “excellent” for this alternative. The technical feasibility of installing an IXR system is high as this is a proven technology for PFAS treatment and several vendors manufacture the equipment. Specialty contractors are not needed for construction of an IXR system. This alternative includes disposal of spent resin, which is more easily implemented than regeneration onsite. No new water rights are needed and the permit process should be straightforward.

4.4.4 Cost

The total present worth cost to implement Alternative 3 is \$17.4 million. This assumes capital costs associated with construction of a new treatment system for Wells 1/4 and 9, including a treatment building, monitoring, and O&M for 30 years. Long-term O&M costs are sensitive to the assumed changeout frequency, which is based on vendor estimates. Therefore, capital costs also include a water quality assessment/bench scale testing to confirm changeout frequency and verify assumptions before design is started.

4.5 Alternative 4 – Reverse Osmosis Membrane Wellhead Treatment

4.5.1 Description of Alternative

This alternative involves the construction of a new membrane filtration system to remove PFOS/PFOA from Wells 1/4 and 9 (see Figures 11 and 12). The design would allow these water wells to be returned to normal operation for the City of Airway Heights. ROMs would be combined with GAC secondary treatment for the concentrated waste stream (reject) from the reverse osmosis treatment process. Most of the water would only be treated by reverse osmosis but the reject water, which is approximately 20% of the total flow, would be treated by two GAC vessels connected in series.

The Wells 1/4 treatment system would feature a single skid of 12 ROMs followed by two GAC vessels holding 6,000 pounds of virgin reagglomerated bituminous coal carbon each for the secondary treatment. The Well 9 treatment system would feature a single skid of 36 ROMs followed by two GAC vessels holding 10,000 pounds of virgin reagglomerated bituminous coal carbon each for the secondary treatment. The equipment would have ASME-rated pressure vessels, would be NSF-certified, and would be disinfected with chlorine prior to providing drinking water to customers. The water supply from the two systems would not be continually treated by gas chlorination or other disinfection method during normal operations. If continuous disinfection is needed, it would be provided by City of Airway Heights. Additional details of the Alternative 4 reverse osmosis (RO) treatment systems are presented below.

The existing submersible pumps installed in Wells 1/4 and 9 would convey groundwater to ground surface, but instead of going directly into the City water main, it would be piped into new treatment buildings at each well site. It is assumed that the existing pumps would be able to overcome the added back pressure from the treatment system, but booster pumps would be used to increase pressure to the distribution system following treatment. New piping between the existing wellheads, new treatment systems, and the existing water main is assumed to be 10- or 12-inch-diameter PVC or SS pipe at both wells. Existing piping between the wellheads and the adjacent water main would be disconnected or locked out to prevent untreated water from being distributed to customers.

The Wells 1/4 pump would supply its new RO treatment system with an average flowrate of 350 gpm. The maximum treatment capacity of that treatment system would be 450 gpm, which is believed to be the maximum rated output of the Wells 1/4 pump. With an average flowrate of 350 gpm, the secondary GAC treatment system is expected to treat 90 gpm. The Well 9 pump would supply its new RO treatment system with an average flowrate of 1,000 gpm. The maximum treatment capacity of this treatment system would be 1,200 gpm, which is believed to be the maximum rated output of the Well 9 pump. With an average flowrate of 1,000 gpm, the secondary GAC treatment system is expected to treat 250 gpm. This alternative assumes no redundant treatment equipment or additional future capacity beyond the maximum flowrates listed above.

The new Wells 1/4 treatment building would contain all the major system components including SS filter housing for particulate bags, a skidded 23.5 feet by 5.5 feet RO system, a smaller skidded membrane cleaning system, a smaller skidded anti-scalant system, two GAC vessels, piping/valve manifold, backwash pump, one clean water storage tank, one dirty backwash storage tank, a transfer pump, a clearwell tank, a booster pump, and associated control and electrical panels. The building would be pre-manufactured offsite for assembly onsite, constructed from steel or use steel trusses, and covered with PVC fabric. It would be installed on a secondarily contained concrete foundation immediately east of the existing wellhead building. The building would be approximately 55 feet wide by 45 feet long by 25 feet tall and include insulation and heaters for winter freeze protection and an automated ventilation system for warm

weather. The building and all associated equipment would be located within the existing fenced Well 1/4 perimeter.

The new Well 9 treatment building would contain all the major system components including SS filter housing for particulate bags, a skidded 26 feet by 11 feet RO system, a smaller skidded membrane cleaning system, a smaller skidded anti-scalant system, two GAC vessels, piping/valve manifold, backwash pump, two clean water storage tanks, two dirty backwash storage tanks, a transfer pump, a clearwell tank, a booster pump, and associated control and electrical panels. The building would be premanufactured offsite for assembly onsite, constructed from steel or use steel trusses, and covered with PVC fabric. It would be installed on a secondarily contained concrete foundation immediately east of the existing wellhead building. Building dimensions would be approximately 60 feet wide by 50 feet long by 25 feet tall and include insulation and heaters for winter freeze protection and an automated ventilation system for warm weather. The building and all associated equipment would be located within the existing fenced Well 9 perimeter.

The RO skids, carbon vessels, and manifolds would come from the manufacturer as complete systems that have been factory tested and certified for use in drinking water systems. Supporting system components would be procured by the construction contractor for installation and integrated together to make a complete wellhead treatment system. The RO system is expected to remove 99% of the influent PFAS and recover 75 to 80% of the influent flow with a single-pass design. At Wells 1/4, this translates to an average of 263 gpm of filtered water with 19 ppt PFAS. The Wells 1/4 reject stream to secondary GAC treatment would be 88 gpm with 5,544 ppt PFAS. At Well 9, it translates to an average of 750 gpm of filtered water with 20 ppt PFAS. The Well 9 reject stream to secondary GAC treatment would be 250 gpm with 6,019 ppt PFAS.

The secondary GAC treatment carbon vessels would be rated for a flowrate of 150 gpm at Wells 1/4, and 250 gpm at Well 9, which exceed the estimated treatment rates of 90 and 250 gpm, respectively. Both sites would operate the carbon vessels in a lead/lag configuration with an estimated 6-month operational duration before breakthrough, triggered by 70 ppt out of the lead vessel (i.e., at the midpoint between vessels). Once analytical testing results of regularly scheduled samples indicate carbon changeout is needed, the carbon in the lead vessel would be removed and transported offsite for regeneration. New virgin carbon would be installed, and that vessel would become the lag vessel; then the original lag vessel with the older carbon would become the lead vessel. The new carbon would be soaked in clean water for 24 hours and backflushed to set the carbon bed before returning the GAC system to service. Two aboveground storage tanks with clean water would be stored onsite for the GAC startup process. Routing the concentrate reject water from the RO into an evaporation pond or thermal evaporator/crystallizer unit was also considered but deemed too complicated for permitting and technological reasons. After backwash is completed, the dirty water will be slowly transferred through particulate filters back to the system's influent/feed piping for treatment. As the dirty water tanks typically will be empty, they are not located inside the climate-controlled building.

The main components of the two treatment systems include the following, with differences only where specified:

- Buried 10-inch PVC piping from the existing wellhead to the new treatment building; Well 9 would use a minimum 12-inch piping to the new treatment building
- One pre-manufactured treatment building at each site:
 - Wells 1/4: 55 feet wide by 40 feet long by 25 feet high structure on a 12-inch-thick concrete pad that has an 8-inch-tall secondary containment berm

- Well 9: 60 feet wide by 50 feet long by 25 feet high structure on a 12-inch-thick concrete pad that has an 8-inch-tall secondary containment berm
- Pre-system filtration:
 - Wells 1/4: One 8-bag SS filter housing to pre-filter the untreated water prior to GAC treatment
 - Well 9: Two 8-bag SS filter housing to prefilter the untreated water prior to GAC treatment
- RO treatment systems:
 - Wells 1/4:
 - One Evoqua Vantage RO model M86R072PSAD System, which includes skidded assembly, vertical centrifugal pump, 316 SS cartridge filter housing and 5-micron filters, 316 SS high pressure piping, PVC low pressure piping, fiber-reinforced plastic vessels, 72 thin film composite membranes, 8:4 – 6M array, all valves, instrumentation, and Allen Bradley programmable logic controller with human-machine interface.
 - Additionally, there is a separately skidded anti-scalant chemical feeder with dual dosing pumps, chlorinated PVC piping, calibration column, and isolation valves.
 - Lastly, there is another separately skidded cleaning system with tank, immersion heater, PVC piping, centrifugal pump, and NEMA 4X panel.
 - Well 9: Assumes use of a scaled-up version of the system planned for Wells 1/4. This RO system would likely use a 18:12 – 6M membrane array and have all the other components listed above.
- GAC vessels and associated manifold:
 - Wells 1/4: One Model 6 system manufactured by Calgon Carbon, which includes two 6,000-pound vessels and piping manifold with numerous control valves. The system is rated for 150 gpm but the maximum recommended flowrate would be limited by the existing well and treatment efficiency, determined by empty-bed contact time.
 - Well 9: One Model 8 system manufactured by Calgon Carbon, which includes two 10,000 -pound vessels and piping manifold with numerous control valves. The system is rated for 250 gpm, which is also the anticipated reject flowrate for a Well 9 production rate of 1,000 gpm. Therefore, this system may not be effective at the maximum Well 9 flowrate of 1,200 gpm because the minimum recommended empty-bed contact time would not be achieved.
- One backwash pump with piping to set the new carbon bed in each vessel and perform routine backwashes:
 - Wells 1/4: 300 gpm sustained
 - Well 9: 450 gpm sustained
- One transfer pump at each site with piping from the dirty backwash tanks to the influent bag filters:
 - Wells 1/4: Transfer rate of approximately 50 gpm
 - Well 9: Transfer rate of approximately 100 gpm
- Single-walled water tanks for backwash, testing, equalization, and service water:

- Wells 1/4: Two 8,000-gallon tanks (10 feet diameter by 15.25 feet tall)—one inside for clean water and one outside for temporary dirty backwash storage
- Well 9: Four 8,000-gallon tanks (10 feet diameter by 15.25 feet tall)—two inside for clean water and two outside for temporary dirty backwash storage
- One pressure-rated 5,000-gallon clearwell tank for surge protection (6 feet diameter)
- Booster pump following treatment, pulling water from the clearwell to the drinking water distribution system
- Transfer pump to route water from the outside backwash tanks back to bag filters prior to RO treatment
- Flowmeters, check valves, isolation valves, air release valves, pressure gauges, automated controls system, and telemetry for remote monitoring
- Buried 12-inch PVC piping from the new treatment building to the existing City of Airway Heights 12-inch PVC water main
- Timeframes:
 - Construction timeframe is assumed to be 5 to 7 months each.
 - System startup and shakedown are assumed to take 1 month.
 - System performance and contaminant monitoring timeframe is assumed to be 30 years.
 - Treatment system O&M is assumed to be 30 years for cost estimating purposes.

4.5.2 Effectiveness

ROMs have been highly effective in removing PFOS and PFOA. However, ROMs are susceptible to fouling because of accumulation of material on the membrane surface, and it would generate a waste stream requiring secondary treatment.

This alternative was determined to have a combined effectiveness of “good” after rating all sub-criteria. Its ability to achieve the RAOs was rated “excellent” because ROMs thoroughly remove PFOS and POFA from water. However, ROM long-term effectiveness was rated as “fair” because it requires higher maintenance, including daily checks and membrane upkeep. In addition, this alternative requires secondary carbon and associated changeouts to treat reject water. Short-term effectiveness was also rated “good” as there would be some risks to construction workers during implementation of this alternative. Sustainability was considered good, as spent GAC media could be reactivated for reuse and overall energy and resource consumption are similar to other treatment alternatives.

4.5.3 Implementability

ROM filtration systems are increasingly used by industry and can be deployed rapidly, with estimated construction and startup timeframes of 5 to 7 months and 1 month. However, it requires higher maintenance than other treatment technologies (e.g., GAC, IXR), and secondary treatment of the waste stream.

The combined implementability was determined to be “good +” for this alternative. The technical feasibility of installing the systems is rated lower due to the need for secondary treatment. No new water rights are needed and the permit process should be straightforward.

4.5.4 Cost

The total present worth cost to implement Alternative 4 is \$34.9 million. This assumes capital costs associated with construction of a new treatment system for Wells 1/4 and 9, including a treatment building, monitoring, and O&M for 30 years. Long-term O&M costs are sensitive to the assumed changeout frequency, which is based on vendor estimates. Therefore, capital costs also include a water quality assessment/bench scale testing to confirm changeout frequency and verify assumptions before design is started.

4.6 Alternative 5 – New Water Supply Well with Connection to Airway Heights Water System

4.6.1 Description of Alternative

Alternative 5 consists of construction of new water supply wells (primary and redundant wells) in the SVRP aquifer near the Spokane River, allowing operation of these wells by the City of Airway Heights (see Figure 13). It does not include treatment of PFOS and PFOA in groundwater. Abandonment of Wells 1/4 and 9 to restrict access to contaminated water is also included. Transmission of the water from the new wells to Airway Heights would require installation of approximately 30,000 feet of piping and obtaining right-of-way access along existing roads or through public lands.

Prior to construction of the new wells, water and property rights would be obtained, pre-design and design activities completed (including a more detailed location assessment and evaluation of water quality), and applicable permits acquired. Transfer of existing Airway Heights water rights to the new location would be facilitated prior to starting the detailed design and is assumed to consist of Airway Heights relinquishing existing water rights and noting that relinquishment in an application for a new water right for the replacement well(s). A pre-construction site survey and existing utility drawing evaluation would be completed within the conceptual pipeline alignment. Property right-of-way access, either long-term easements or franchise agreements with the City of Spokane, would be obtained for installation of the new well and pipeline.

The new well(s) would be connected to the existing Airway Heights water system using a buried C-900 PVC pipe using right-of-way access along existing roads or through public lands. It would include the following components:

- General site preparation work and erosion control
- Identification and protection of utilities in the work area
- Drilling and installation of two new 12-inch-diameter wells, each 80 feet deep with 40 feet of SS casing and 40 feet of SS wire-wrap screen with a V-notch spacing of 0.030-inch slot and gravel filter pack
- The new wells would be drilled with air rotary casing hammer (ARCH) methods and have a minimum 18-inch-diameter borehole annulus.
- Installation of two new pump house buildings, each including a submersible well pump, and two booster pumps inside their own buildings
- Electrical service installation to provide power to the new pump house and booster pump station buildings
- Excavation of a 4-foot-deep, 3-foot-wide trench for installation of subsurface piping

- Installation of approximately 30,000 feet of 16-inch-diameter Blue C900 PVC piping with a pressure rating of 305 pounds per square inch and dimension ratio of 14 (DR14)
- Complete hydrostatic pressure testing and disinfecting of the new pipeline system
- Well performance step testing to determine initial specific capacity of the new well
- Disposal of soil cuttings, excavated soil from trenching, purge water, and step-test water
- Construction oversight by third party consultant and operation oversight for first month of system startup
- Timeframes:
 - Construction timeframe is assumed to be 18 months, not including procuring water rights or right-of-way access.
 - System startup and shakedown testing, O&M, and monitoring are assumed for 12 months.

4.6.2 Effectiveness

This alternative provides for protection of human health and the environment by abandoning Wells 1/4 and 9 and restricting use of contaminated water. A new water supply well would provide an alternate source of drinking water, and it may provide long-term protectiveness of human health. However, impacts from pumping and other potential sources of contamination that could impact the water quality of a new water supply are unknown. Pumping from a new well in the SVRP aquifer would likely result in year-round stream depletion of the Spokane River that would be equal to the amount pumped. This alternative does not include treatment of groundwater. There would also be short-term risks to human health and the environment during construction, estimated at approximately 18 months.

This alternative was determined to have a combined effectiveness rating of “good-” after rating all sub-criteria. One water supply well in the SVRP is expected to provide a reliable long-term source of drinking water, and this alternative also includes a redundant well. This alternative is expected to achieve RAOs and maintain long-term effectiveness. However, as long-term water quality is unknown and pumping is expected to impact the Spokane River, it was rated as “good.” Short-term effectiveness was rated “fair” as there would be increased risks to human health and the environment during construction of the new wells, abandonment of existing supply wells, and installation of approximately 30,000 feet of piping. Sustainability was considered good, although land would be impacted by construction in the short-term, over the long-term, energy usage and resource consumption are considered similar to other alternatives.

4.6.3 Implementability

Based on the hydrogeologic study, this alternative is considered technically feasible; however, it would require a more detailed location assessment to support transfer of water rights, more extensive permitting than treatment alternatives, and easements for piping from the new well to the City's water distribution system, which could significantly increase the implementation timeframe beyond the estimated construction timeframe of 18 months. In addition, depletion of the Spokane River could face public opposition.

The combined implementability rating was determined to be “fair” for this alternative. The technical feasibility of acquiring easements, construction, and water rights is not likely to be straightforward, and the availability of resources is uncertain. Although this option is promising, further development would be required before it can be applied at full scale.

4.6.4 Cost

The total present worth cost to implement Alternative 5 is \$16.2 million. This assumes capital costs associated with construction of two water supply wells, including associated piping and buildings, abandonment of Wells 1/4 and 9, and monitoring and O&M for 1 year.

4.7 Alternative 6 – Continued Use of Spokane Water Supply

4.7.1 Description of Alternative

This alternative consists of continued use of municipal water from the City of Spokane under a long-term Agreement with the City of Spokane. It does not include treatment of PFOS and PFOA in groundwater. Wells 1/4 and 9 would be abandoned, Airway Heights' water rights would be transferred to the City of Spokane, and the water service/pipeline between intertie #1 and intertie #3 would be expanded to allow for increased volume of water for peak flow during the summer.

Components of this alternative include the following:

- Continued purchase of alternate water and transmission of water from Spokane to Airway Heights using existing piping and Intertie Agreement, including maintenance of Environmental Services Agreement by USAF
- Transfer of Airway Heights' water rights to the City of Spokane
- Routine sampling of drinking water conducted by the City of Spokane
- Construction/expansion of the water service/pipeline between intertie #1 and intertie #3. Construction specifications described in Section 4.6.1 would apply to this scenario; however, pipeline is estimated at 8,000 feet long, and construction would be performed over a period of 4 months
- Maintenance of the Environmental Services Agreement assumed for 30 years for cost estimating purposes

4.7.2 Effectiveness

This alternative provides for long-term protection of human health and the environment by abandoning Wells 1/4 and 9, restricting use of contaminated water, and providing a continued alternate source of drinking water from the City of Spokane. It does not include treatment of groundwater. There are short-term risks to human health and the environment associated with abandonment of Wells 1/4 and 9.

This alternative was determined to have a combined effectiveness of "good +" after rating all sub-criteria. Alternative 6's ability to achieve RAOs was rated "excellent." The ability to maintain long-term effectiveness was rated "good," but not excellent, as this alternative does not provide for treatment. Short-term effectiveness was rated "good" as there is some construction associated with abandonment of wells. Sustainability was considered good, although land would be impacted by construction in the short-term, over the long-term, energy usage and resource consumption are considered similar to other alternatives.

4.7.3 Implementability

This alternative is technically feasible as the City of Spokane is currently providing Airway Heights with municipal water. However, negotiation of a long-term agreement with the City of Spokane would be

required, and it is unknown if long-term resources would be available from the City of Spokane, providing the water supply necessary to achieve the RAOs and any potential future needs for the City of Airway Heights.

The combined implementability rating was determined to be “good +” for this alternative. It is technically feasible as Airway Heights is currently receiving water from the City of Spokane, and no new water rights or construction of a treatment system would be required. However, due to the administrative need for a long-term agreement, it was not rated higher.

4.7.4 Cost

The total present worth cost to implement Alternative 6 is \$27.8 million. This assumes capital costs associated with abandonment of Wells 1/4 and 9, construction related to the replacement or expansion of the intertie between intertie #1 and intertie #3, and payments to the City of Spokane for water for 30 years. The majority of the costs under this alternative are associated with payments to City of Spokane over 30 years. Payments to the City of Spokane are based on the rate in the current Environmental Services Agreement. There is uncertainty with this cost as a long-term agreement would need to be negotiated.

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5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section compares each alternative developed and evaluated in Section 4 based on effectiveness, implementability, and cost, except Alternative 1, which is discussed briefly below. Table 4 summarizes the comparative analysis of alternatives.

Alternative 1 (No Action) is included pursuant to CERCLA guidance as a baseline from which other alternatives may be evaluated. Under this alternative, no action would be performed under current or future land use scenarios. This alternative does not include institutional controls, an engineered wellhead treatment, or an alternate water supply. Although the No Action alternative is readily implementable and there is no cost, this alternative has an overall ranking of “poor,” because it was determined to have an effectiveness rating of “poor.” Alternative 1 would not reduce or eliminate threats to public health and the environment, would not achieve RAOs, and is not anticipated to receive regulatory agency or community support/acceptance.

Alternative 2 (GAC Wellhead Treatment) and Alternative 3 (IXR Wellhead Treatment) were equally ranked the highest overall with a “good +” rating. Alternative 6 (Continued Use of Spokane Water Supply) received the next highest ranking of “good,” while Alternative 4 (ROM Wellhead Treatment) and 5 (New Water Supply Well with Connection to Airway Heights Water System) were rated “fair +.”

5.1 Effectiveness

Alternatives 2 and 3 had a combined effectiveness of “good +” with an “excellent” rating in the Ability to Meet RAOs category, and “good” rating for the Long- and Short-Term Effectiveness criteria, including for sustainability. Alternatives 2 and 3 earned an “excellent” rating under Ability to Meet RAOs, if good operating and monitoring practices are conducted to maintain effectiveness. The “good” rating for Long-Term Effectiveness is because carbon and resin changeouts would be required approximately every 9 months and 1.5 years, respectively. The “good” rating under Short-Term Effectiveness is due to risks presented to construction workers during implementation of the alternatives.

Alternative 4 was determined to have a combined effectiveness rating of “good.” The ability of Alternative 4 to achieve the RAOs was rated “excellent” because ROMs thoroughly remove PFOS and PFOA from water. However, Long-Term Effectiveness was rated as “fair” because it requires higher maintenance, including daily checks and membrane upkeep. In addition, this alternative requires secondary carbon and associated changeouts to treat reject water. Short-Term Effectiveness was also rated “good” as there would be some risks to construction workers during implementation of this alternative.

Alternative 5 was determined to have a combined effectiveness of “good -.” One water supply well in the SVRP is expected to provide a reliable long-term source of drinking water at a design capacity of 1,014 gpm; this alternative also includes installation of a redundant well. This alternative is expected to achieve RAOs and maintain long-term effectiveness. However, as long-term water quality is unknown and pumping is expected to impact the Spokane River, it was rated as “good.” Short-term effectiveness was rated “fair” as there would be increased risks to human health and the environment during construction of the new wells, abandonment of existing supply wells, and installation of approximately 30,000 feet of piping.

Alternative 6 had a combined effectiveness rating of “good +”. While the ability of this alternative to meet RAOs was rated “excellent,” the ratings for Long- and Short-Term Effectiveness were “good”. The ability to maintain Long-Term Effectiveness under Alternative 6 was rated “good,” but not “excellent,” as this

alternative does not provide for treatment. In accordance with CERCLA §121(b) (EPA 1988), there is a preference for remedial actions that employ treatment and technologies that will permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. Similarly, the “good” rating under Short-Term Effectiveness is due to construction costs associated with abandonment of Wells 1/4 and Well 9 and replacement or expansion of the pipeline between intertie #1 and intertie #3.

Regarding energy and resource consumption, Alternatives 2 through 6 had a sustainability rating of “good.”

5.2 Implementability

Alternatives 2 and 3 had a combined implementability rating of “excellent” as can both be deployed rapidly, with similar estimated construction timeframes of 5 to 6 months and 5 months, respectively, and similar startup timeframes of 1 month; and both are proven technologies offered by multiple vendors. Administratively, obtaining new water rights would not be required under these alternatives and the permit process should be straightforward.

The combined implementability for Alternative 4 is determined to be “good +”. The technical feasibility of installing the systems is rated lower due to the need for secondary treatment. As with Alternatives 2 and 3, obtaining new water rights would not be required under these alternatives and the permit process should be straightforward.

Alternative 5 has a combined implementability rating of “fair,” as the technical feasibility of acquiring easements, construction, and water rights is not likely to be straightforward and the availability of resources is uncertain. Although this option is promising, further development would be required before it can be applied at full scale.

Alternative 6 has a combined implementability rating of “good +” because it is technically feasible. The City of Airway Heights is currently receiving water from the City of Spokane, and no new water rights or construction of a treatment system would be required. However, the need for increased administration over time precludes this alternative from a higher rating.

5.3 Cost

Table 3 provides a summary of costs. The present worth cost for Alternative 1 (No Action) is \$0, and the present worth costs for Alternatives 2 through 6 range from \$16.2 million (Alternative 5) to \$34.9 million (Alternative 4). Alternatives 2 and 3 present worth costs are \$16.5 and \$17.4 million, respectively, making them the lowest cost alternatives that include treatment, buildings/construction, monitoring, and O&M for 30 years. The Alternative 4 present worth cost is \$34.9 million, which includes capital costs associated with construction of a new treatment system, including a treatment building, monitoring, and O&M for 30 years. Alternative 4 has the highest O&M cost, and most of the cost for this alternative is for O&M.

The Alternative 5 present worth cost is \$16.2 million, which includes capital costs associated with construction of two water supply wells, associated piping and buildings, abandonment of Wells 1/4 and 9, and monitoring and O&M for 1 year. Alternative 5 is the lowest cost alternative, but it has the highest capital cost and the highest potential impact to the environment. The Alternative 6 present worth cost is \$27.8 million, which includes capital costs associated with abandonment of Wells 1/4 and 9 and construction/expansion of the pipeline between intertie #1 and intertie #3; the majority of the cost is associated payments to the City of Spokane for water for a 30-year period. Payments to the City of

Spokane are based on the rate in the current Environmental Services Agreement. There is uncertainty with this cost as a long-term agreement would need to be negotiated.

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6.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Alternative 2 (GAC Wellhead Treatment) is the recommended removal action alternative. Although it is equally ranked the highest with Alternative 3 (IXR Wellhead Treatment), GAC has the lowest overall cost, and PFOS is better adsorbed by carbon than PFOA. Historical sampling indicates that PFOS accounts for approximately 79% of the combined PFOS/PFOA concentrations in each well. In comparison, resin is considered to be several times more effective than carbon for PFOA.

Both GAC and IXR are proven to be effective at removing PFAS constituents from groundwater and will have similar construction and O&M costs. Selection of GAC or IXR is highly dependent on long-term operational costs, which are sensitive to changeout frequency. GAC requires more frequent changeouts than IXR, but each changeout is less expensive. This evaluation assumes GAC to have a slightly lower cost to operate over 30 years based on the assumed changeout frequencies used in the cost estimates. However, bench testing of GAC and IXR using groundwater from the site is recommended to fine tune the anticipated changeout frequency of each treatment technology to confirm GAC will be the most cost-effective alternative.

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TABLES

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Table 1 Construction Details for Wells 1, 4, 9, and the Potential New Well

FEATURE	UNITS	EXISTING WELL 1	EXISTING WELL 4	EXISTING WELL 9	PROPOSED NEW WELL
Total Depth	feet	192	200	255	80
Borehole Diameter	inches	Unknown	Unknown	Unknown	18
Casing Diameter	inches	10	12	16	12
Screen Diameter	inches	Unknown	Unknown	14	12
Screen Interval/Length	feet	175-192/ 17	181-200 / 19	200-250 / 50	35-75 / 40
Casing Material	NA	Steel	Steel	Steel	SS
Screen Type	NA	Unknown	Unknown	Unknown	SS wire wrap
Screen Opening	NA	Unknown	Unknown	0.040 (200-220) 0.060 (220-250)	0.030
Filter Pack	NA	Gravel	Gravel	None	Gravel

Notes:

NA – not applicable

SS – stainless steel

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Table 2 Summary of Alternative Components and Details

COMPONENT/ITEM	ALTERNATIVE					
	1	2	3	4	5	6
	NO ACTION	GAC	IXR	ROM	NEW WELL	SPOKANE WATER
ALTERNATIVE COMPONENTS						
General Approach						
Wellhead Treatment	☐	☒	☒	☒	☐	☐
GAC Treatment	☐	☒	☐	☒	☐	☐
IXR Treatment	☐	☐	☒	☐	☐	☐
ROM Treatment	☐	☐	☐	☒	☐	☐
Construction of New Supply Well(s)/Pipeline	☐	☐	☐	☐	☒	☐
Purchase Water from Others	☐	☐	☐	☐	☐	☒
Abandonment of Wells	☐	☐	☐	☐	☒	☒
Specific Components						
Particulate Bag Filter(s)	☐	☒	☒	☒	☐	☐
Clean Water Storage & Backwash System	☐	☒	☒	☒	☐	☐
Temporary Dirty Water Storage/Transfer Pump	☐	☒	☒	☒	☐	☐
Booster Pump(s) and Clearwell	☐	☒	☒	☒	☒	☐
New Building(s) and Concrete Pad	☐	☒	☒	☒	☒	☐
Obtain Right-of-Way Access	☐	☐	☐	☐	☒	☐
Transfer of Water Rights	☐	☐	☐	☐	☒	☒
Other						
Secondary Treatment Required	☐	☐	☐	☒	☐	☐
ROM Anti-Scale System	☐	☐	☐	☒	☐	☐
ALTERNATIVE DETAILS						
Pipeline Length (linear feet)	NA	NA	NA	NA	30,000	NA
New Building Footprint ¹ (square feet)	NA	2,250/3,825	1,200/2,000	2,200/3,000	~400/400	NA
Quantity of Treatment Vessels ¹ (each)	NA	2/4	2/2	2/2 ²	NA	NA
Per Vessel Media Capacity ¹	NA	20,000 lb	200/400 CF	6,000/10,000 lb ²	NA	NA
Total Clean Water Storage ¹ (gal)	NA	24,000/31,000	2,500/5,000	8,000/16,000	NA	NA
Total Temporary Dirty Water Storage ¹ (gal)	NA	24,000/31,000	2,500/5,000	8,000/16,000	NA	NA
PERFORMANCE DETAILS						
Average Flowrate ¹ (gpm)	NA	350/1,000	350/1,000	350/1,000	1,014	Varies
Maximum Flowrate ¹ (gpm)	NA	450/1,200	450/1,200	450/1,000	1,014	Varies
Media Changeout Frequency ¹ (months)	NA	15/9	19.5/15.5	6/6	NA	NA
Construction & Startup Timeframe ¹ (months)	NA	5-6/1	5/1	5-7/1	18/12	NA
OM&M (years)	NA	30	30	30	1	NA

Notes:
¹ Data provided for Wells 1/4 and Well 9 individually.

² Vessel data shown is for secondary GAC treatment.

Key:
☐ – Not Included in Alternative

☒ – Included in Alternative

CF – cubic feet

EA – each

GAC – granular activated carbon

gal – gallons

gpm – gallons per minute

IXR – ion exchange resin

lb – pounds

NA – not applicable

OM&M – operational, maintenance, and monitoring

ROM – reverse osmosis membrane

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Table 3 Summary of Alternative Costs

TASK	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: GAC WELLHEAD TREATMENT	ALTERNATIVE 3: IXR WELLHEAD TREATMENT	ALTERNATIVE 4: ROM WELLHEAD TREATMENT	ALTERNATIVE 5: NEW WATER SUPPLY WELL	ALTERNATIVE 6: CONTINUED USE OF SPOKANE WATER SUPPLY
CAPITAL COSTS						
Remedial Design, Planning, and General (Indirect Costs)	\$0	\$919,600	\$830,800	\$907,700	\$1,394,700	\$383,400
Indirect Contingency and Unlisted Engineering Services Assumed (%)	0	15	15	15	15	15
Remedial Action Construction including Sales Tax (Direct Costs)	\$0	\$5,493,600	\$4,388,100	\$5,345,100	\$13,448,700	\$3,546,000
Direct Contingency and Unlisted Items Assumed (%)	0	25	25	25	25	25
Site Inspection and Overhead	\$0	\$513,100	\$417,600	\$500,300	\$1,187,500	\$314,400
Total Capital Costs	\$0	\$6,926,300	\$5,636,500	\$6,753,100	\$16,030,900	\$4,243,800
OM&M COSTS						
Annualized O&M Costs	\$0	\$247,750	\$323,630	\$909,010	\$303,250	\$834,700
O&M Contingency and Unlisted Items Assumed (%)	0	25	25	25	25	0
O&M Duration (years)	0	30	30	30	1	30
Annualized Monitoring & Reporting Costs	\$0	\$82,560	\$82,560	\$82,560	\$41,280	\$0
Monitoring Contingency and Unlisted Items Assumed (%)	0	20	20	20	20	20
Monitoring Duration (years)	0	30	30	30	1	30
Non-Routine OM&M	\$0	\$325,000	\$325,000	\$247,000	\$0	\$0
Non-Routine Contingency and Unlisted Items Assumed (%)	0	30	30	30	30	30
Total OM&M Costs	\$0	\$10,234,300	\$12,510,700	\$29,995,000	\$345,000	\$25,041,000
TOTALS						
Total Capital and OM&M Costs	\$0	\$17,160,600	\$18,147,200	\$36,748,100	\$16,375,900	\$29,284,800
Estimated Agency Oversight Costs	\$0	\$40,000	\$40,000	\$40,000	\$20,000	\$20,000
Total Escalated Costs ^a	\$0	\$21,269,000	\$22,978,000	\$47,806,000	\$17,377,000	\$38,366,600
Total Present Worth ^b	\$0	\$16,506,000	\$17,373,000	\$34,920,000	\$16,200,000	\$27,770,000

^a Escalated costs were calculated using a 2.0% inflation rate

^b Present worth costs were calculated using a 0.4% discount rate

Notes:

Discount Rate (0.4%) = Interest Rate (2.4%) - Inflation (2.0%)

Remedial Action Construction Costs includes Washington State Sales Tax at 9.1%

GAC – granular activated carbon

IXR – ion exchange resin

O&M – operation and maintenance

OM&M – operational, maintenance, and monitoring

ROM – reverse osmosis membrane

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Table 4 Comparative Analysis of Alternatives

CRITERION	RATINGS					
	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
	NO ACTION	GAC WELLHEAD TREATMENT SYSTEM	IXR WELLHEAD TREATMENT SYSTEM	ROM WELLHEAD TREATMENT SYSTEM	NEW WATER SUPPLY WELL WITH CONNECTION TO EXISTING AIRWAY HEIGHTS WATER SYSTEM	CONTINUED USE OF SPOKANE WATER SUPPLY
Effectiveness¹	Poor	Good +	Good +	Good	Good -	Good +
Ability to meet RAOs	Poor	Excellent	Excellent	Excellent	Good	Excellent
Long-Term Effectiveness (Protect human health and the environment)	Poor	Good	Good	Fair	Good	Good
Short-Term Effectiveness (Protect workers, community, and environment during construction)	Excellent	Good	Good	Good	Fair	Good
Treatment (Yes/No)	No	Yes	Yes	Yes	No	No
Sustainability (Low energy and resource consumption)	Excellent	Good	Good	Good	Good	Good
Implementability¹	Poor	Excellent	Excellent	Good +	Fair	Good +
Technical	Excellent	Excellent	Excellent	Good	Fair	Excellent
Administrative	Poor	Excellent	Excellent	Excellent	Fair	Good
Resource Availability	NA	Yes	Yes	Yes	Uncertain	Yes
Cost^{1,2}	Excellent	Good	Good	Poor	Good	Fair
Present Worth ²	\$0	\$16.5M	\$17.4M	\$34.9M	\$16.2M	\$27.8M
SUMMARY						
Overall³	Poor	Good +	Good +	Fair +	Fair+	Good

Notes:

¹ The combined ranking for this criterion is the average of the individual rating determined for its sub-criterion.

² Costs presented are Feasibility Study-level (+50/-30%) for comparison purposes. Actual costs to complete the work may be higher or lower.

³ The alternative overall ranking is based on the average combined ranking above for Effectiveness, Implementability, and Cost.

Rankings in increasing order of preference are as follows: 1 – Poor, 2 – Fair, 3 – Good, 4 – Excellent.

GAC – granular activated carbon
IXR – ion exchange resin
M – million

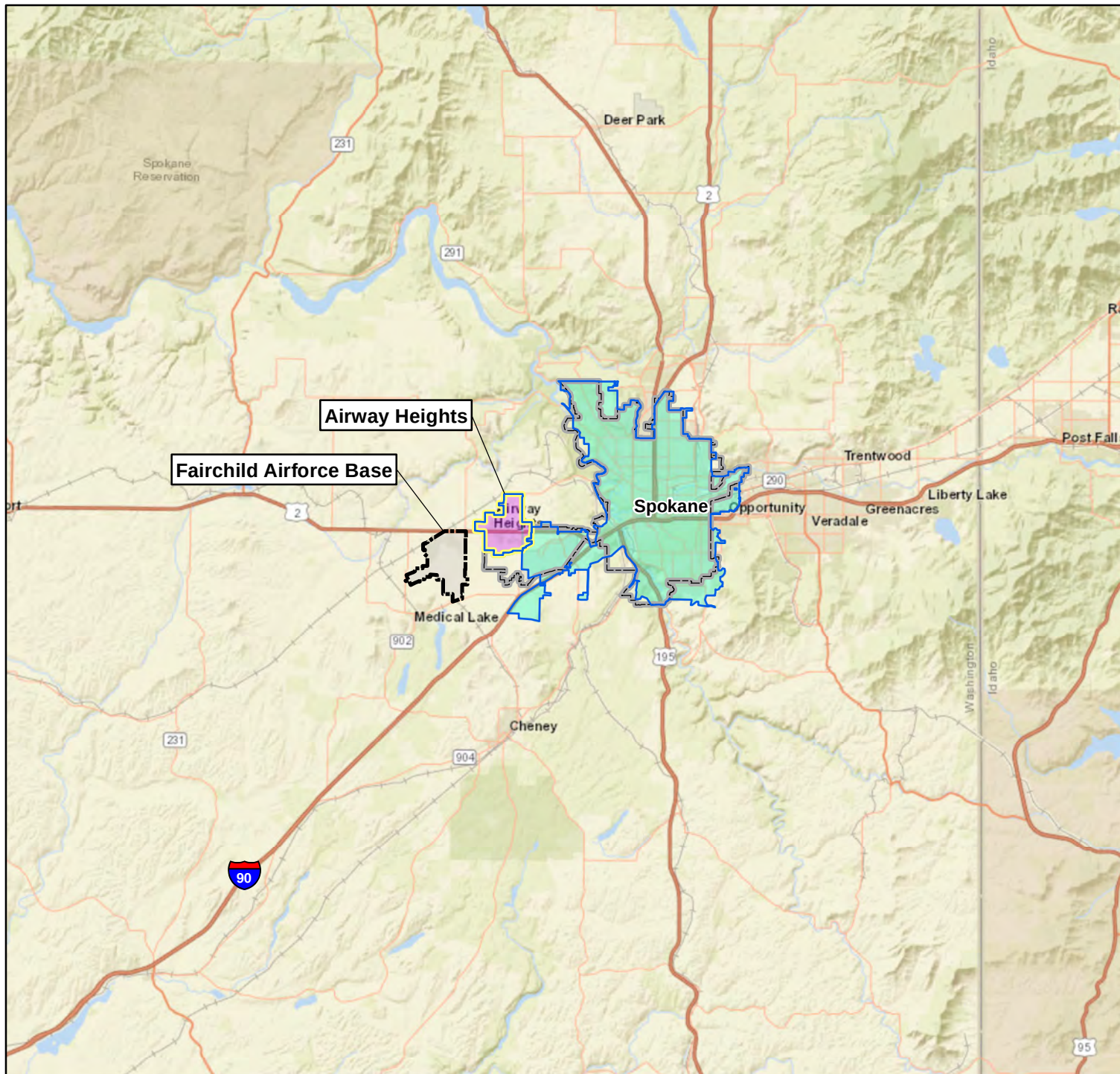
NA – not applicable
ROM – reverse osmosis membrane

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FIGURES

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K:\Fairchild_USA\MXD\Airway_Heights\En1_Site_Location_Map.mxd



Legend

- FAFB Installation Boundary
- City of Airway Heights Water District
- City of Spokane Water District
- Airway Heights City Limits
- Spokane City Limits

Sources:
Basemap: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, ©

Abbreviations:
FAFB = Fairchild Air Force Base

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JOINT VENTURE



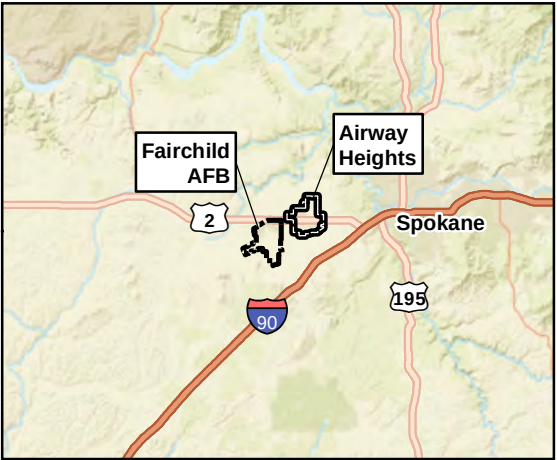
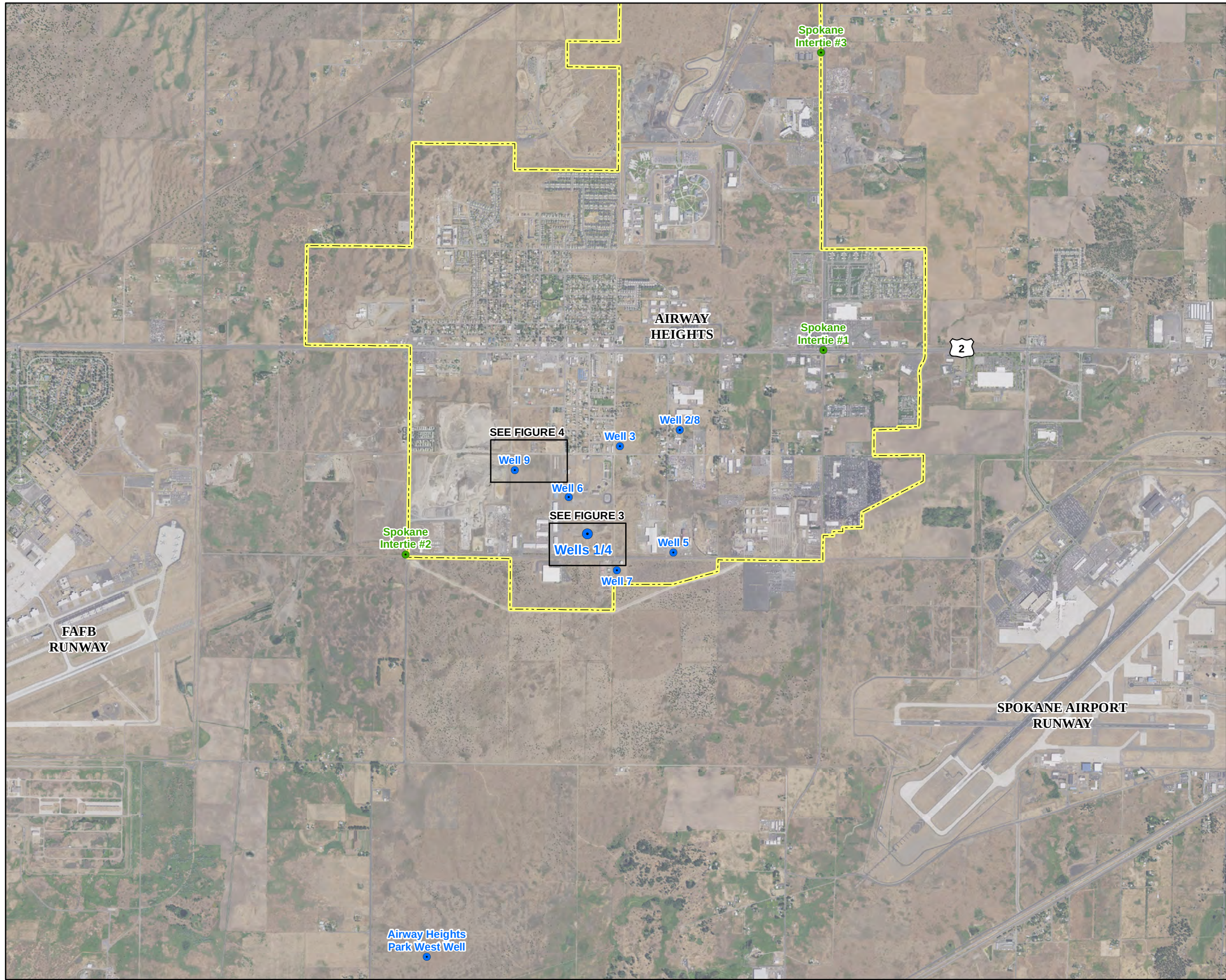
Site Location Map

Drawn By:
SB
Checked By:
GF

Figure 1

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K:\Fairchild USAFMXD\Airway Heights\Fig 2 Well Location Map.mxd



Legend

- Municipal Well
- Spokane Intertie
- City of Airway Heights

Sources:
Imagery: Spokane County NAIP, 2017.

Abbreviations:
FAFB = Fairchild Airforce Base

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JOINT VENTURE



Well Location Map

Drawn By:
SB
Checked By:
GF

Figure 2

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Legend

- Municipal Well
- Gate Valve
- Railroad
- Fence
- Piping

Sources:
Imagery: USGS, 2012.
Water main layout: Century West Engineering Corporation Figure 2-7 from 10/4/04, Airway Heights water piping map from unknown source

Abbreviations
AC = Asbestos cement
IN = Inch
PVC = Polyvinyl chloride

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JOINT VENTURE 1

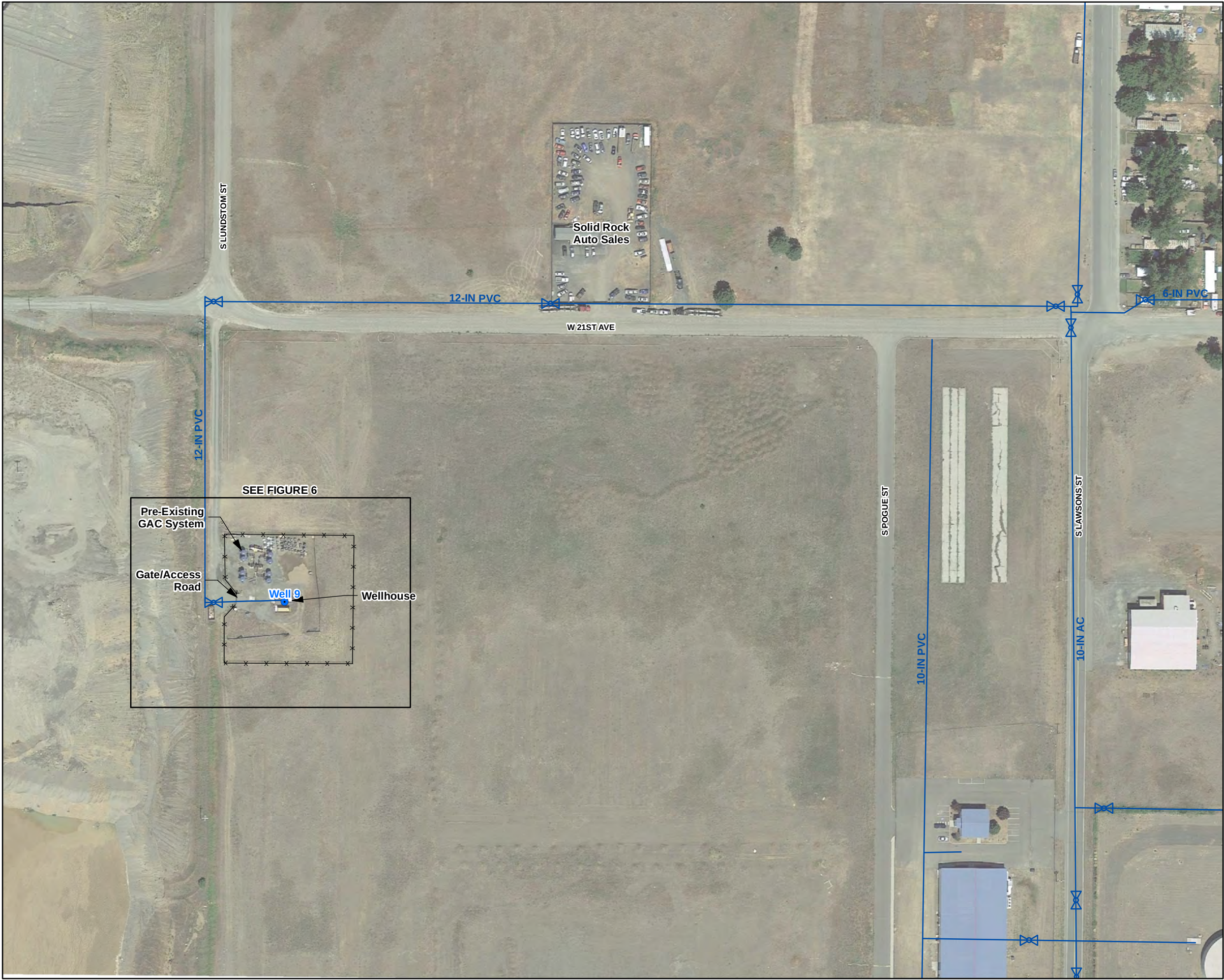


Supply Wells 1/4 Vicinity Map

Drawn By:
SB
Checked By:
GF

Figure 3

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Legend

- Municipal Well
- ⋈ Gate Valve
- ×—× Fence
- Piping

Sources:
Imagery: ©2020 Google.
Water main layout: Century West Engineering Corporation Figure 2-7 from 10/4/04, Airway Heights water piping map from unknown source

Abbreviations
AC = Asbestos cement
GAC = Granular activated carbon
IN = Inch
PVC = Polyvinyl chloride

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Supply Well 9 Vicinity Map

Drawn By:
SB
Checked By:
GF

Figure 4

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Legend

- Municipal Well
- ⋈ Gate Valve
- x—x Fence
- Piping

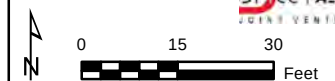
Sources:

Imagery: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Water main layout: Century West Engineering Corporation Figure 2-7 from 10/4/04, Airway Heights water piping map from unknown source

Abbreviations

FT = Foot
 IN = Inch
 PVC = Polyvinyl chloride

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**Existing Wells 1/4 Construction,
 Headworks, and Pump
 House Details**

Drawn By:
 SB
 Checked By:
 GF

Figure 5

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K:\Fairchild_USA\MXD\Airway_Heights\Elm_6_ExistingWell_9_Construction_Headworks_and_Pump_House_Details.mxd



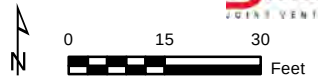
Legend

-  Municipal Well
-  Gate Valve
-  Fence
-  Piping

Sources:
Imagery: ©2020 Google.
Water main layout: Century West Engineering Corporation Figure 2-7 from 10/4/04, Airway Heights water piping map from unknown source

Abbreviations
FT = Foot
GAC = Granular activated carbon
IN = Inch
PVC = Polyvinyl chloride

**Engineering
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Fairchild Air Force Base and
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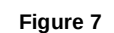
**Existing Well 9 Construction,
Headworks, and Pump
House Details**

Drawn By:
SB
Checked By:
GF

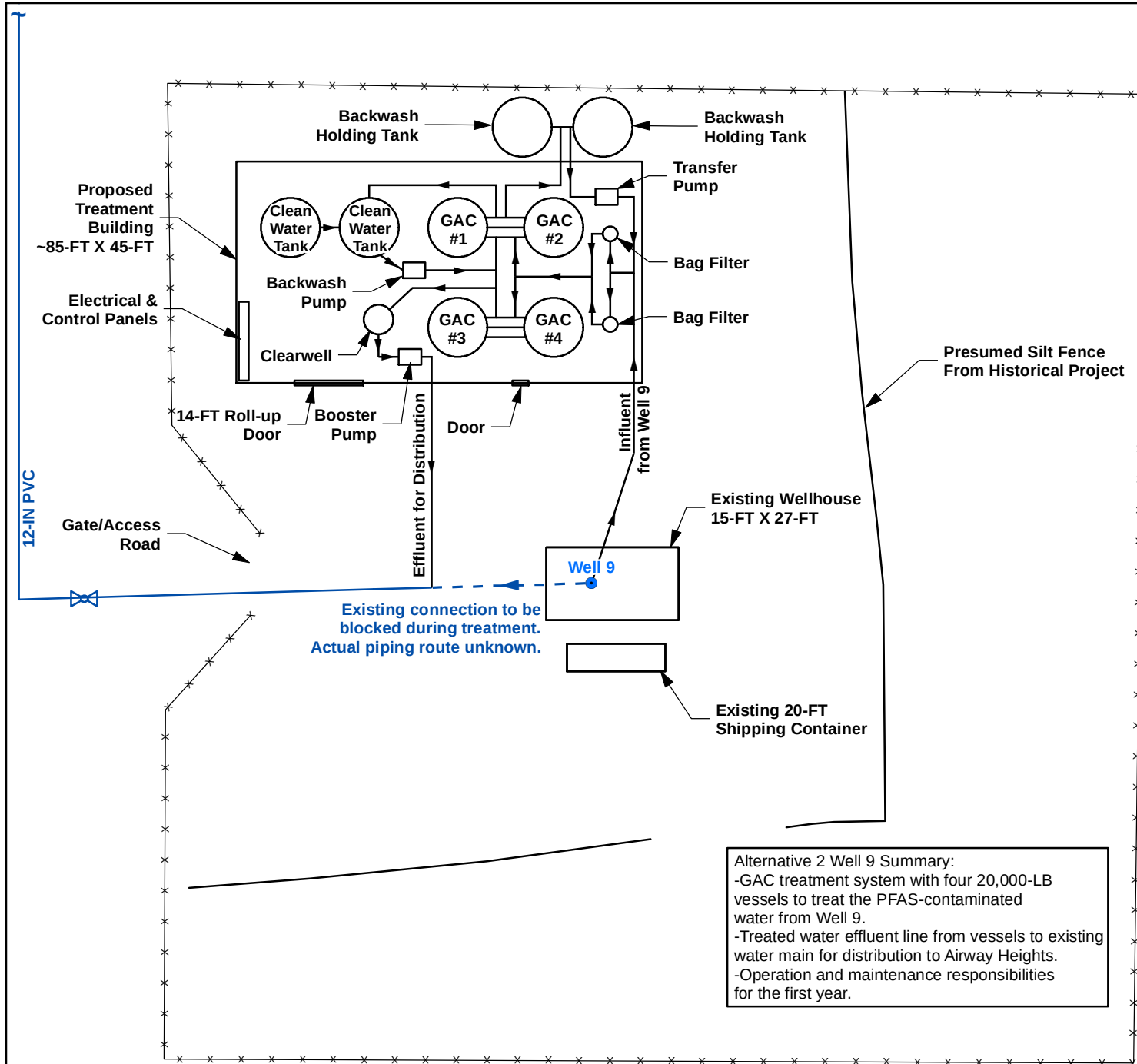
Figure 6

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- Operation and maintenance responsibilities for the first year.



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Alternative 2 Well 9 Summary:

- GAC treatment system with four 20,000-LB vessels to treat the PFAS-contaminated water from Well 9.
- Treated water effluent line from vessels to existing water main for distribution to Airway Heights.
- Operation and maintenance responsibilities for the first year.

Legend

- Municipal Well
- ⋈ Gate Valve
- × × × Fence
- Piping

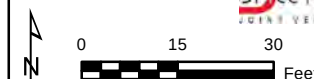
Sources:

Water main layout: Century West Engineering Corporation Figure 2-7 from 10/4/04, Airway Heights water piping map from unknown source

Abbreviations:

FT = Foot
GAC = Granular activated carbon
IN = Inch
LB = Pound
PFAS = Polyfluoroalkyl substances
PVC = Polyvinyl chloride

**Engineering
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The City of Airway Heights



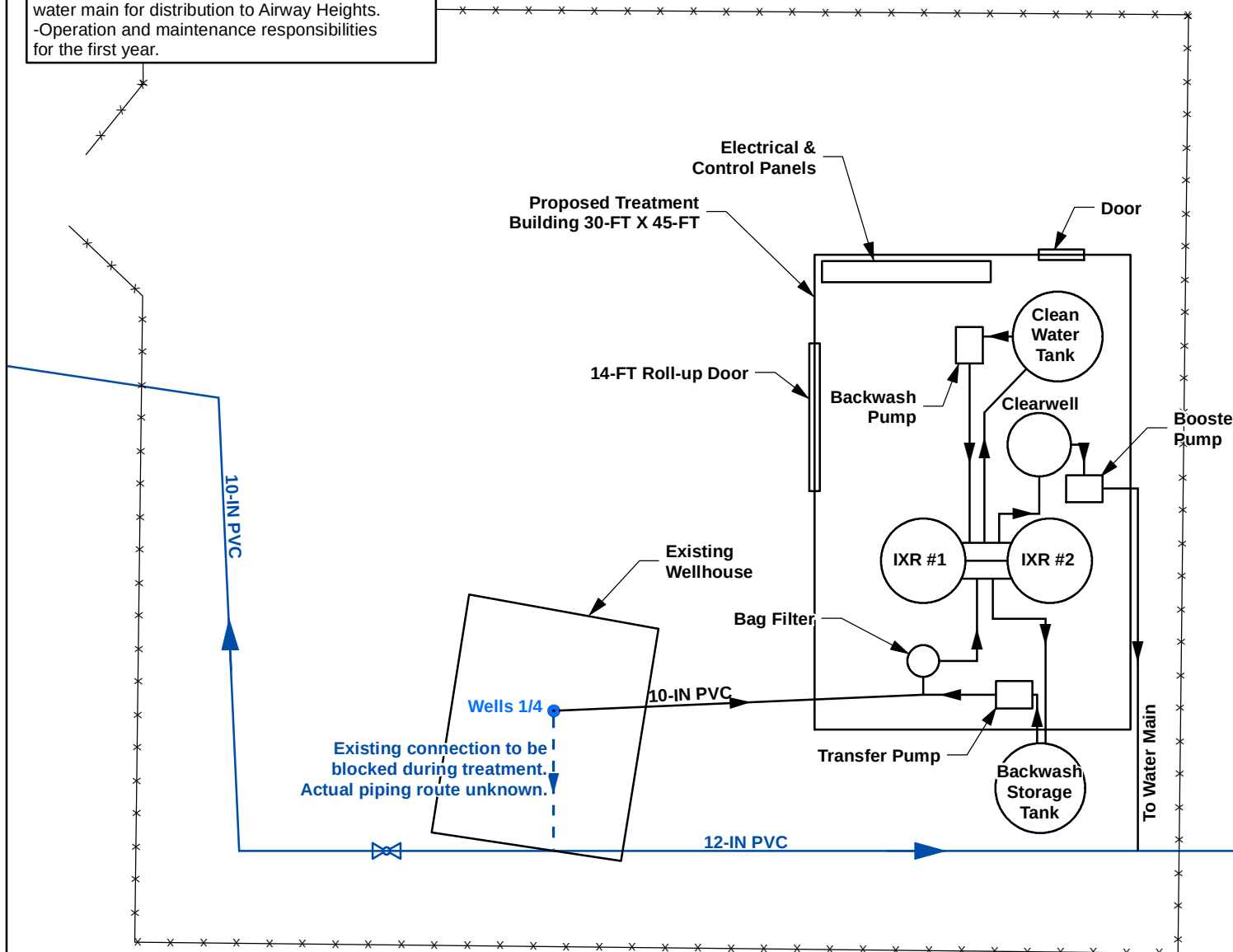
**Alternative 2 - GAC Wellhead
Treatment System for Well 9**

Drawn By:
SB
Checked By:
GF

Figure 8

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Alternative 3 Wells 1/4 Summary:
 -Ion Exchange Resin treatment system with two 200-CF vessels to treat the PFAS-contaminated water from Wells 1/4.
 -Treated water effluent line from vessels to existing water main for distribution to Airway Heights.
 -Operation and maintenance responsibilities for the first year.



Legend

- Municipal Well
- ⋈ Gate Valve
- ××× Fence
- Piping

Sources:

Existing structures: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Water main layout: Century West Engineering Corporation Figure 2-7 from 10/4/04, Airway Heights water piping map from unknown source

Notes:

Existing piping shown in blue.
 New piping shown in black.

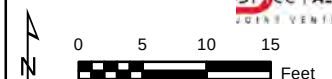
Abbreviations:

CF = Cubic foot
 FT = Foot
 IN = Inch
 IXR = Ion exchange resin
 PFAS = Polyfluoroalkyl substances
 PVC = Polyvinyl chloride

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 The City of Airway Heights



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 JOINT VENTURE

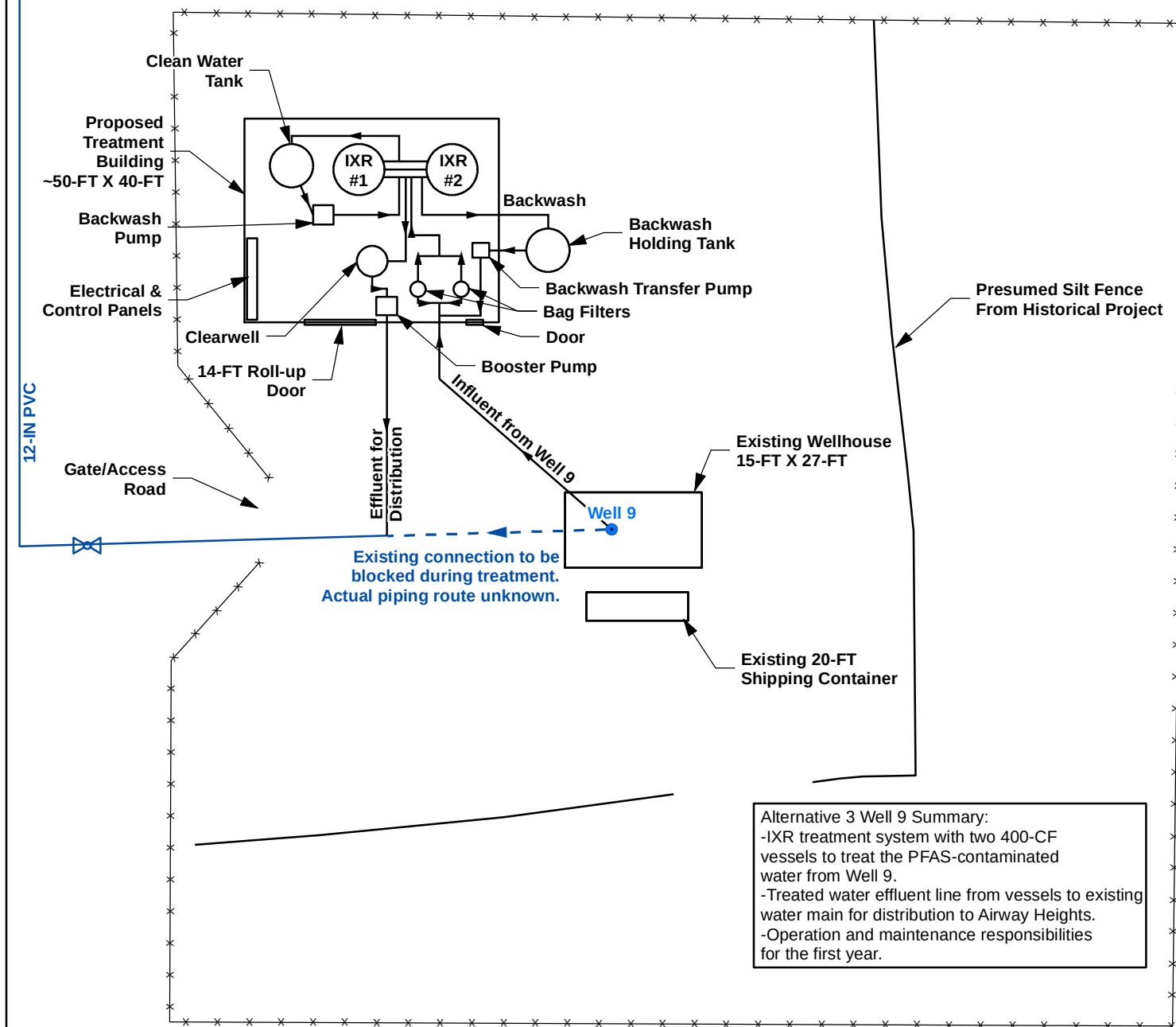


**Alternative 3 - Ion Exchange Resin
 Treatment System for Wells 1/4**

Drawn By:
 SB
 Checked By:
 GF

Figure 9

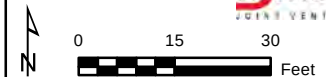
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**Engineering
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 Fairchild Air Force Base and
 The City of Airway Heights



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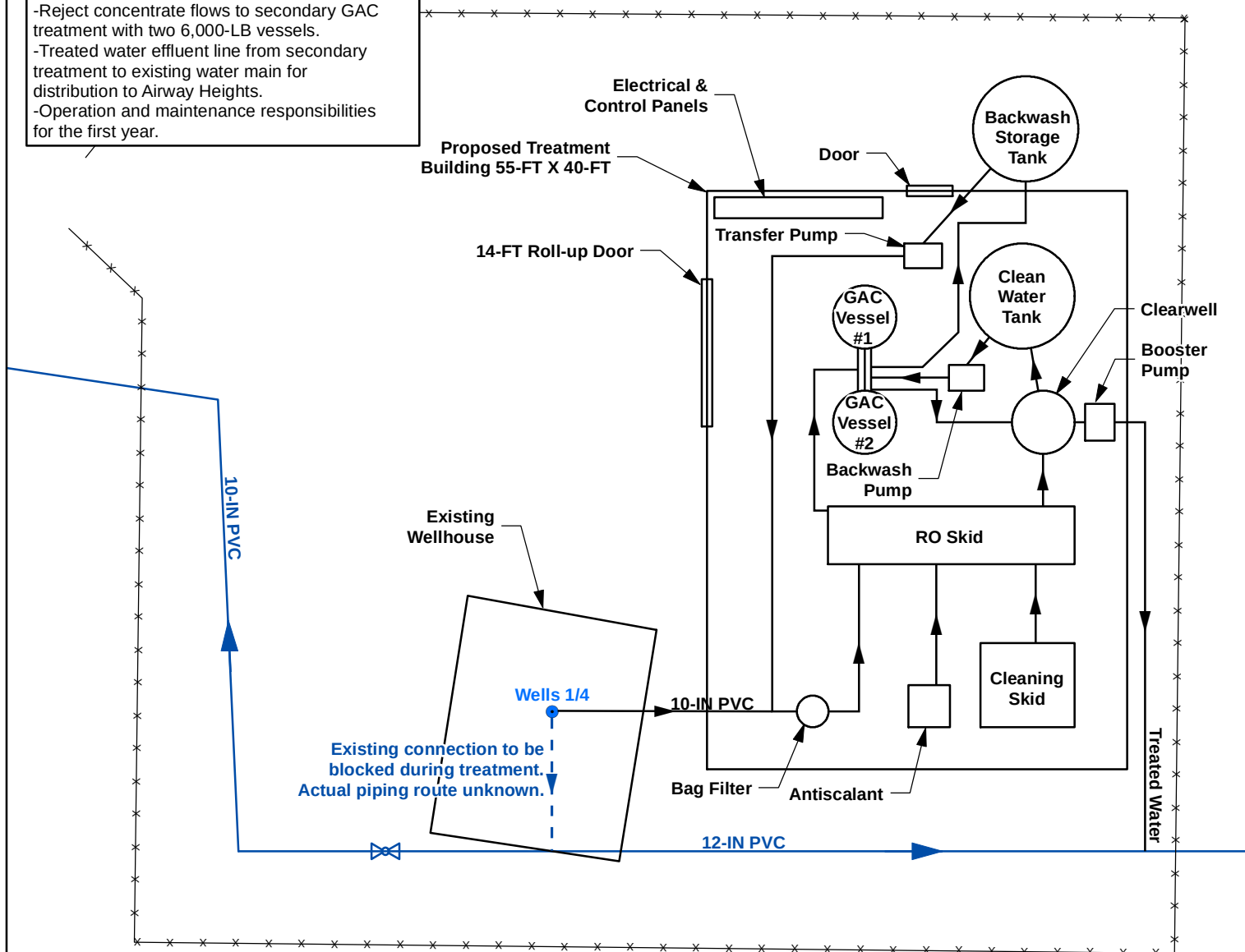
**Alternative 3 - Ion Exchange
 Resin Wellhead Treatment
 System for Well 9**

Drawn By:
 SB
 Checked By:
 GF

Figure 10

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Alternative 4 Wells 1/4 Summary:
 -One skidded RO treatment system to treat PFAS-contaminated water from Wells 1/4.
 -Treated water effluent line from RO to existing water main for distribution to Airway Heights.
 -Reject concentrate flows to secondary GAC treatment with two 6,000-LB vessels.
 -Treated water effluent line from secondary treatment to existing water main for distribution to Airway Heights.
 -Operation and maintenance responsibilities for the first year.



Legend

- Municipal Well
- ⋈ Gate Valve
- × × × Fence
- Piping

Sources:

Existing structures: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Water main layout: Century West Engineering Corporation Figure 2-7 from 10/4/04, Airway Heights water piping map from unknown source

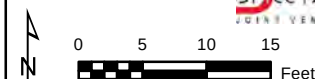
Notes:

Existing piping shown in blue.
 New piping shown in black.

Abbreviations:

CF = Cubic foot
 FT = Foot
 GAC = Granular activated carbon
 IN = Inch
 LB = Pound
 PFAS = Polyfluoroalkyl substances
 PVC = Polyvinyl chloride
 RO = Reverse osmosis

**Engineering
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 Fairchild Air Force Base and
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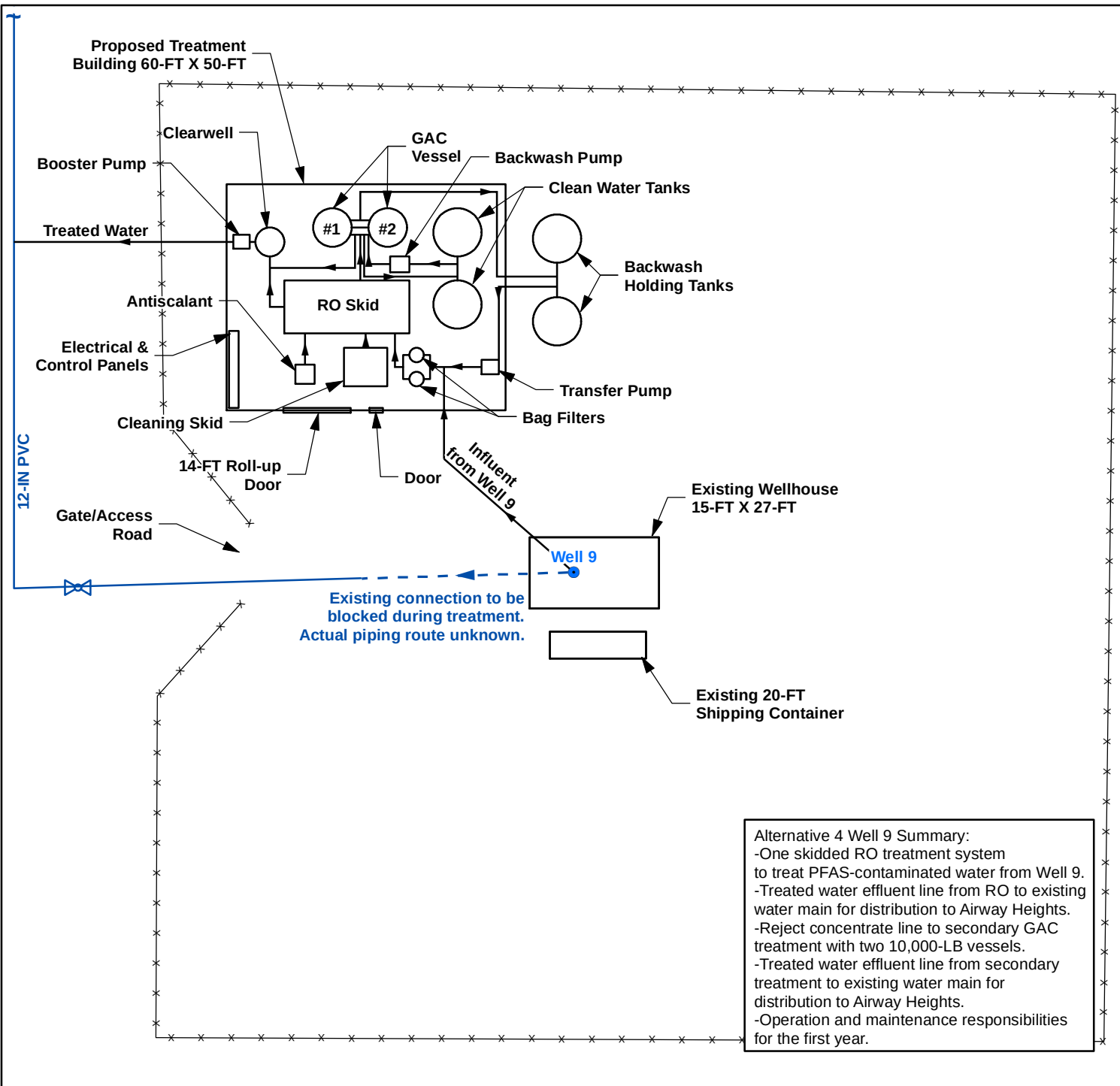
**Alternative 4 - Reverse Osmosis
 Wellhead Treatment System for
 Wells 1/4**

Drawn By:
 SB
 Checked By:
 GF

Figure 11

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K:\Fairchild USA\EMX\Airway Heights\Ein 12 Alternative 4.mxd



Alternative 4 Well 9 Summary:
-One skidded RO treatment system to treat PFAS-contaminated water from Well 9.
-Treated water effluent line from RO to existing water main for distribution to Airway Heights.
-Reject concentrate line to secondary GAC treatment with two 10,000-LB vessels.
-Treated water effluent line from secondary treatment to existing water main for distribution to Airway Heights.
-Operation and maintenance responsibilities for the first year.

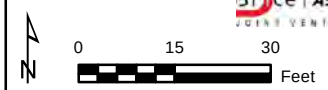
Legend

- Municipal Well
- ⋈ Gate Valve
- ××× Fence
- Piping

Sources:
Water main layout: Century West Engineering Corporation Figure 2-7 from 10/4/04, Airway Heights water piping map from unknown source

Abbreviations:
CF = Cubic foot
FT = Foot
GAC = Granular activated carbon
IN = Inch
LB = Pound
PFAS = Polyfluoroalkyl substances

**Engineering
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Fairchild Air Force Base and
The City of Airway Heights



**Alternative 4 - Reverse Osmosis
Wellhead Treatment System for
Well 9**

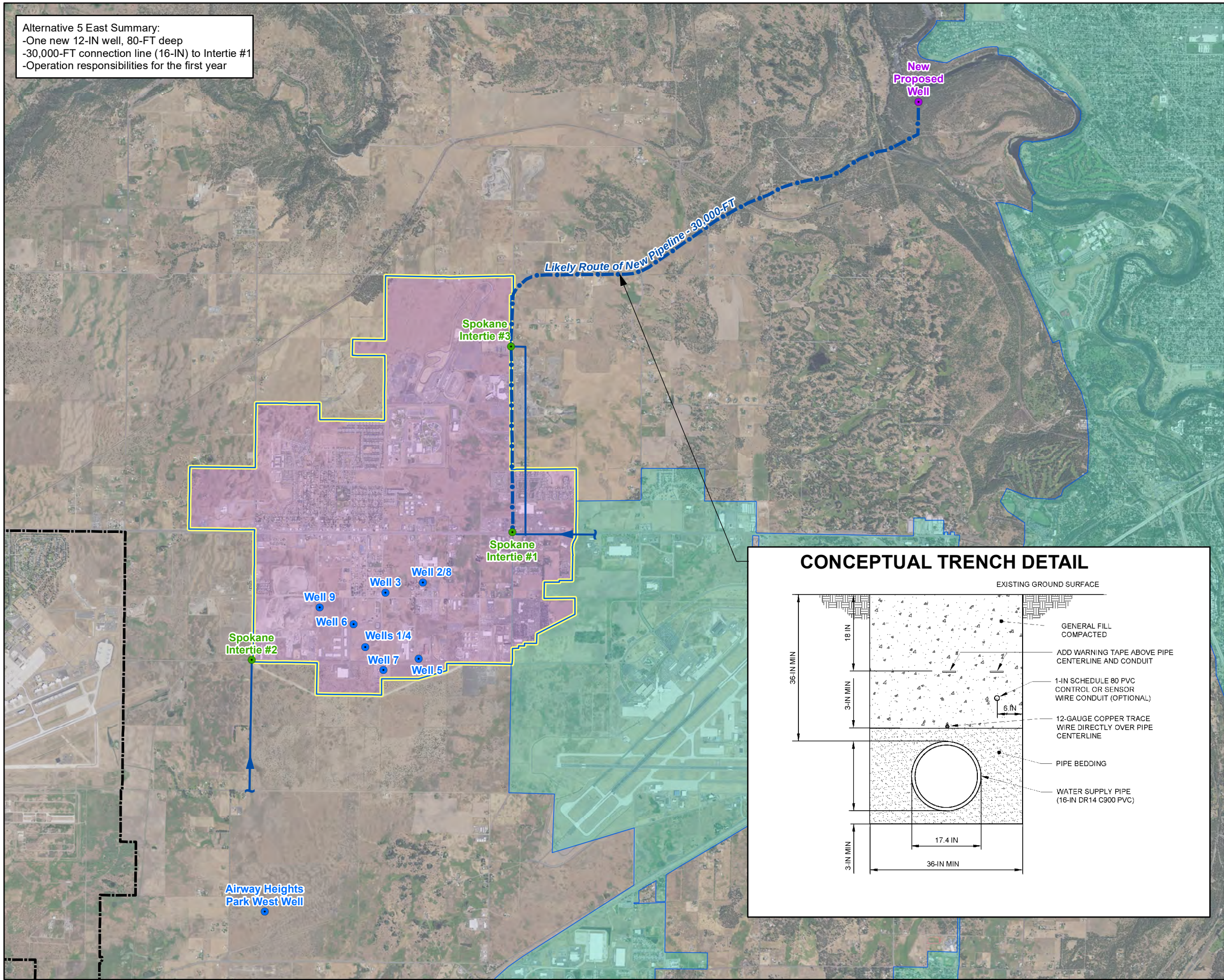
Drawn By:
SB
Checked By:
GF

Figure 12

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K:\Fairchild USAFMXD\Airway Heights\Fig 13 Alternative 5 – New Production Well Option 1.mxd

Alternative 5 East Summary:
-One new 12-IN well, 80-FT deep
-30,000-FT connection line (16-IN) to Intertie #1
-Operation responsibilities for the first year



Legend

- Proposed Well
- Municipal Well
- Spokane Intertie
- Spokane Water Main
- Proposed Water Pipeline
- FAFB Installation Boundary
- City of Airway Heights
- City of Airway Heights Water District
- City of Spokane Water District

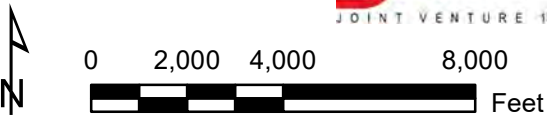
Sources:
Imagery: Spokane County NAIP, 2017.
Water main layout: Century West Engineering Corporation Figure 2-7 from 10/4/04, City of Airway Heights 2018 Water Quality Report

Abbreviations:
FAFB = Fairchild Airforce Base
FT = Foot
IN = Inch
MIN = Minimum
PVC = Polyvinyl Chloride

**Engineering
Evaluation/Cost Analysis**
Fairchild Air Force Base and
The City of Airway Heights



Brice | AECOM
JOINT VENTURE



**Alternative 5 – New Water
Supply Well**

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SB
Checked By:
GF

Figure 13

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APPENDIX A
COST ESTIMATES AND ASSUMPTIONS

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ABBREVIATIONS AND ACRONYMS

Engineering Evaluation/Cost Analysis

Fairchild Air Force Base and City of Airway Heights, Washington

%; percent

AFB: Air Force Base

ASME: American Society of Mechanical Engineers

AST: aboveground storage tank

bgs: below ground surface

CF: cubic feet

CMP/SAP: Construction Management Plan/Sampling and Analysis Plan

CMU: concrete masonry unit

COAH: City of Airway Heights

CY: cubic yards

DC: direct costs

DCC: direct costs including pre-design and pilot testing costs and remedial action construction contractor costs

DR: drum

DY: day

EA: each

EE/CA: Engineering Evaluation / Cost Analysis

EPA: U.S. Environmental Protection Agency

FAFB: Fairchild Air Force Base

FT: feet

GAC: granular activated carbon

GAL: gallons

gpm: gallons per minute

GRO: gasoline range organics

H₂O: water

HP: horsepower

HR: hour

IDW: investigation-derived waste

IN: inch

IXR: Ion Exchange Resin

KW: kilowatt

L: laboratory

LB: pound

LF: linear feet

LS: lump sum

MO: month

NA: not applicable

NR: non-routine

NSF: National Sanitation Foundation

O&M: operation and maintenance

OH: overhead

ABBREVIATIONS AND ACRONYMS (continued)

OHP: overhead and profit
PFAS: per- and polyfluoroalkyl substances
PFOA: perfluorooctanoic acid
PFOS: perfluorooctane sulfonate
PM: project management
ppt: parts per trillion
psi: pounds per square inch
PVC: polyvinyl chloride
QA: quality assurance
QC: quality control
QTR: quarter (3 months)
RA: Remedial Action
RCRA: Resource Conservation and Recovery Act
RO: reverse osmosis
ROM: reverse osmosis membrane
SCADA: Supervisory Control and Data Acquisition
SF: square feet
SIM PAH: selected ion monitoring polynuclear aromatic hydrocarbons
SIOH: Supervision, Inspection, and Overhead
T&D: transportation and disposal
TN: ton
U: utilities
UOM: unit of measure
USACE: U.S. Army Corps of Engineers
VFD: variable frequency drive
VOC: volatile organic compound
WK: week

COST ESTIMATE APPROACH AND GENERAL ASSUMPTIONS

The estimated costs for the alternatives are provided for decision-making purposes only and are consistent with the +50/-30 percent (%) accuracy typically associated with feasibility studies (EPA 1988). Costs presented are suitable for comparison purposes; the actual costs to complete the work may be higher or lower than estimated. Capital and operational, maintenance, and monitoring (OM&M) costs for up to 30 years are presented for each alternative. OM&M costs include operation, maintenance, monitoring, reporting, non-routine, and closure costs anticipated to occur over the life of the alternative. Total cost is the straight addition of the capital cost and the OM&M cost, which are based on 2020 dollars. Present-worth costs are also presented for each alternative.

Present-worth analysis evaluates expenditures that occur over different time periods by discounting all future costs to a common base year. A discount rate of 0.4% was used, which assumes an interest rate of 2.4% minus the inflation rate of 2.0%. The discount rate assumed is based on the Office of Management and Budget, Circular A-94 Appendix C, Revised November 2019. Present-worth costs represent the amount of money that, if invested in the base year (i.e., 2020) and dispersed as needed, would cover all anticipated costs associated with the alternative. Factors are calculated as shown below and multiplied by the applicable future cost to determine its present worth.

The equation used to calculate the present worth factor for reoccurring annual costs is as follows:

$$PW = ((1+i)^{n-1})/(i(1+i)^n)$$

The equation used to calculate the present worth factor for a single future event costs is as follows:

$$PW = ((1+i)^{-n})$$

Where: PW = present worth factor

i = discount interest rate

n = number of reoccurring years or year of future event

The validity of the estimates is subject to the assumptions used in the development of these alternatives, which are included at the beginning of each cost estimate. To improve the accuracy of the estimates, factors were applied to increase costs to account for unforeseen conditions and unlisted incidental items that are unknown at this time. In general, the factors used are applied consistently to each alternative; however, if unique conditions exist, the factors may be adjusted up or down as appropriate. The following baseline factors were used to calculate extra costs for each cost estimate category independently:

- Engineering services (15%)
- Construction (25%)
- O&M (25%)
- Monitoring and reporting (20%)
- Non-routine and closure (30%)

These five cost category factors cover extra costs for unforeseen conditions that may be encountered at the site in the future as well as materials, equipment, and services that are unlisted because they are too detailed for this conceptual level of cost estimating. The factors used are applied as a percentage of the total estimated cost for the category and are based on engineering judgment and experience with similar projects. Lower factors are used when there is a higher degree of confidence, and higher factors are used when there are more unknowns. Washington State sales tax was added to the contractor cost category

at a rate of 9.5% and site inspection and overhead (SIOH) was added to the total implementation cost at 8%. SIOH is intended to represent U.S. Army Corps of Engineers' (USACE) cost to manage the project and 8% is based on what is typically used for government projects. Because of the accuracy level intended, the primary use of these estimates is to allow comparison between alternatives during the selection process, not for establishing project budgets.

References

U.S. Environmental Protection Agency (EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*. EPA/540/G-89/004. October.

COST ESTIMATE

Alternative 2 – Granular Activated Carbon Wellhead Treatment

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ALTERNATIVE 2 COST ESTIMATE ASSUMPTIONS

The cost estimate assumes the following phases and activities:

Pre-Design Activities/Design

1. Confirm the existing submersible pump(s) in Wells 1/4 and 9 are in good working order and can overcome the new back pressure from the treatment system.
2. Collect bulk water samples from each well and submit for bench scale treatability testing to fine tune the anticipated changeout frequency of carbon and use to refine the system design.
3. Determine if a central treatment plant would be more cost effective than two separate systems.
4. Complete pre-construction site evaluation, topographic survey, and utility locate within the work area.
5. Preparation of the design including plans, specifications, and a formal bid package.
6. Procure contractor through formal bid process.
7. Contractor to complete pre-construction work plans.

Implementation

1. Acquire applicable permits.
2. Conduct construction crew and equipment mobilization/demobilization.
3. Conduct general site preparation work and erosion control.
4. Identify and protect utilities/utility in the work area.
5. Complete site earthwork including trenching for influent and effluent piping, preparation of building foundations, and electrical connections.
6. Install new treatment building foundations, buildings, and associated equipment (pumps, water storage tanks, clearwell tanks, filter bag housings, and granular activated carbon [GAC] systems).
7. The GAC systems will consist of the following, which will come pre-packaged:
 - a. Wells 1/4: Calgon Carbon Model 10 carbon adsorber system with 8-inch piping.
 - b. Well 9: Calgon Carbon Model 12 carbon adsorber system with 8-inch piping.
8. The backwash systems will each include polyvinyl chloride (PVC) piping, one centrifugal pump, sight glass, flow meter, isolation and control valves, and a variable frequency drive motor controller.
9. Transfer pumps will be installed at each site to route dirty water from the backwash process back to the GAC system for treatment.
 - a. Wells 1/4: Goulds Model 3656 S, 35 gallons per minute (gpm), 230-foot head
 - b. Well 9: Goulds Model 3656 M, 90 gpm, 230-foot head
10. The inline booster pump at each system will be Goulds Model SSH-22SH stainless steel end suction centrifugal pump with 30-horsepower (hp) motor.
11. The pre-filtration equipment installed at each well will be Cary Company part number SMB-30-30-BF, which is a multi-chamber stainless-steel bag filter housing that holds eight size #2 poly bag filters. It has 8-inch flange connections and is certified NSF 61 listed and American Society of Mechanical Engineers (ASME)-certified pressure vessel. There will be one needed at Wells 1/4 and two needed at Well 9, where the higher flow will be split.
12. Make all piping connections from each existing wellhead piping to the new GAC system and to the existing water main.

13. Complete electrical service installation to provide power to the treatment buildings and associated equipment and control the system including electrical transformers and either buried or overhead service lines.
14. Dispose or spread out on sites unusable excavated soil from trenching and water from system testing.
15. Add lighting, heat, security system, and insulation to the new buildings.
16. Construction oversight for 5 months by third-party consultant and for first month of startup assuming both systems are constructed at the same time.
17. System startup, shakedown, and operation for 12 months by installation contractor assuming both systems are constructed at the same time.

Monitoring

1. Document flowrate and total flow into and out of the GAC treatment systems.
2. Perform weekly performance monitoring of influent groundwater and treated drinking water for per- and polyfluoroalkyl substances (PFAS) for the first month, then monthly for the rest of the first year.
3. After the first year, complete quarterly sampling and analysis of influent and effluent samples for 29 years. Analyze for PFAS including one field duplicate sample every quarter.
4. Routine sampling of existing supply wells for typical drinking water requirements from the Airway Heights monitoring program are not included in this alternative and are assumed to be completed by the City of Airway Heights.
5. Complete ongoing particulate bag filter monitoring for clogging/fouling.

Operation and Maintenance

1. Operation of the treatment system for 30 years – Assumes Airway Heights conducts the work but Fairchild Air Force Base (FAFB) reimburses the City.
2. Maintenance of treatment system for 30 years – Assumes Airway Heights conducts the work but FAFB reimburses the City.
3. Operation and maintenance (O&M) of the water supply well and pump are assumed to be the responsibility of the City of Airway Heights.
4. Provide ongoing transportation and regeneration of spent carbon from the GAC system.
5. Inspection of GAC vessel interior screen and wall coating to be completed every 10 years and repaired if necessary.
6. Utility usage (electrical) for the treatment system components only. The electricity consumption for the water supply wells are assumed to be the responsibility of the City of Airway Heights.

Closeout

1. Conduct Contractor demobilization after construction is complete, including general site restoration work.
2. Provide contractor training of Airway Heights personnel for changeover of O&M activities after initial 12 months of operation.
3. Prepare completion report and closeout submittals (e.g., as-built drawings).

Table A-1
Summary of Alternative Costs
Alternative 2 – GAC Wellhead Treatment for Wells 1/4

Task	Cost
IMPLEMENTATION COSTS	
Remedial Design, Planning, and General (Indirect Costs)	\$404,900
Indirect Contingency and Unlisted Engineering Services Assumed (%)	15
Remedial Action Construction including Sales Tax (Direct Costs)	\$2,063,800
Direct Contingency and Unlisted Items Assumed (%)	25
Site Inspection and Overhead (USACE)	\$197,500
Total Implementation Costs	\$2,666,200
OM&M COSTS	
Annualized O&M Costs	\$84,250
O&M Contingency and Unlisted Items Assumed (%)	25
O&M Duration (years)	30
Annualized Monitoring & Reporting Costs	\$41,280
Monitoring Contingency and Unlisted Items Assumed (%)	20
Monitoring Duration (years)	30
Non-Routine OM&M	\$162,500
Non-Routine Contingency and Unlisted Items Assumed (%)	30
Total OM&M Costs	\$3,928,400
TOTALS	
Total Implementation and OM&M Costs	\$6,594,600
Estimated Agency Oversight Costs	\$20,000
Total Escalated Costs ^a	\$8,181,000
Total Project Present Worth ^b	\$6,347,000

^a Escalated costs were calculated using a 2.0% inflation rate

^b Present worth costs were calculated using a 0.4% discount rate

Notes:

Discount Rate (0.4%) = Interest Rate (2.4%) - Inflation (2.0%)

Remedial Action Construction Costs includes Washington State Sales Tax at 9.1%

OM&M - Operation, Maintenance, and Monitoring

O&M - Operation and Maintenance

Alternative 2 – GAC Wellhead Treatment for Wells 1/4

Client	USACE, Fairchild AFB	Report Date	June 2021
Location	City of Airway Heights		
Project	EE/CA, Fairchild Air Force Base and City of Airway Heights, Washington		
Site Name	Wells 1/4		
Estimator	Gus Friedman, AECOM	Affected Media	Drinking Water
QA Reviewer	Cary Brown, AECOM	COCs	PFOS, PFOA
		Flowrate (Nominal)	350 gpm
		Flowrate (Max)	450 gpm
Site/Problem Description	Groundwater pumped from COAH water supply wells 1/4 has PFAS (PFOA at 300 ppt and PFOS at 1,100 ppt) concentrations above EPA Health Advisory of 70 ppt.		
Proposed Remedial Action	Drinking water from existing COAH Well 1/4 will be rerouted into a newly constructed GAC treatment system at a sustained flow of 350 gpm. Flow will initially pass through bag filters for large particle particulate removal, then through two 20,000 lb GAC vessels for PFOS and PFOA removal. Treated effluent will flow into a clearwell and on into the existing COAH water main for distribution to customers in the city. A booster pump will be used to maintain a minimum 75 psi discharge pressure to the city's water main.		
Alternative Specific Assumptions	- Costs presented have an accuracy of +50% to -30% and are suitable for comparing alternatives. - Washington State Sales Tax is applied to Direct Costs only at 9.1%. - Discount Rate is 0.4% per Office of Management and Budget, Circular A-94 Appendix C, Revised Nov. 2019. - The GAC treatment system will be contained inside a 45 x 50 x 25 ft tall climate controlled building. - The system will have two 20,000-lb vessels filled with virgin coal-based carbon (Calgon FiltraSorb 400 or equal). - The existing submersible pump(s) are in good working order and will be reused. - O&M of the well and submersible pump are not included because it is assumed to be COAH's responsibility. - The system will be designed for a maximum flowrate of 450 gpm, but the nominal flowrate will be 350 gpm. - Empty-bed contact time will be greater than 20 minutes (10 minutes per vessel) at 450 gpm. - Equipment will be NSF-certified for drinking water and the GAC vessels ASME-rated pressure vessels. - No additional water treatment or chlorination equipment is needed and is thus not included. - One 20,000-lb vessel will be changed out every 15 months with fresh virgin carbon or 16,000 lbs annually. - A backwash system rated at maximum flowrate of 700 gpm is included to set new carbon in the vessel. - Assumes dirty backwash water will be stored in outdoor tanks until process is complete. Upon system restart, the backwash will be run through the bag filters at the influent to the GAC treatment system.		

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION	REMEDIAL DESIGN, PLANNING, AND GENERAL (Indirect Costs)						
	\$352,100	1	Project management (5 hrs per week)	6	MO	\$3,250	\$19,500
	With Contingency	2	General coordination, meetings, and planning	1	LS	\$12,500	\$12,500
	\$404,900	3	Regulatory coordination and meetings (% of DC)	1	%	\$2,063,800	\$20,700
		4	Engineering Design/Basis of Design Report	120	HR	\$125	\$15,000
		5	Water Quality Assessment/Bench Testing	1	EA	\$50,000	\$50,000
		6	Design Plans and Specs	6	%	\$2,063,800	\$123,900
		7	Engineers Estimate	80	HR	\$125	\$10,000
		8	Permitting Support	1	LS	\$5,000	\$5,000
		9	Bid and RFI support	40	HR	\$125	\$5,000
		10	Work Plan (CMP/SAP)	150	HR	\$110	\$16,500
		11	Construction oversight and QA (1 person 1/2 time)	6	MO	\$8,667	\$52,000
		12	Reporting (Construction and Record Drawings)	200	HR	\$110	\$22,000
		13	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$352,100
	Indirect Contingency and Unlisted Engineering Services (%)			15	%	\$352,100	\$52,815
	TOTAL INDIRECT COST						\$404,900

Alternative 2 – GAC Wellhead Treatment for Wells 1/4 (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION (Continued)	REMEDIAL ACTION CONSTRUCTION (Direct Costs)						
	\$1,258,100	1	Mobilization/Demobilization	1	LS	\$25,000	\$25,000
	<u>With Contingency</u>	2	Site preparation & erosion control	5,000	SF	\$2	\$10,000
	\$1,572,600	3	Specialty Contractors (Utility locate, Survey)	1	LS	\$10,000	\$10,000
		4	Jobsite trailer, printer/copy machine, generator, tools, portable toilet, and safety supplies	6	MO	\$7,500	\$45,000
		5	GAC vessels, manifold, and 1st load of GAC	1	EA	\$330,000	\$330,000
		6	Treatment building (45x50x25) with roll up door	1	EA	\$207,000	\$207,000
		7	Concrete pad for GAC treatment system building	1	LS	\$76,500	\$76,500
		8	Labor for all GAC system equipment installation and piping connections inside the building	12	WK	\$16,000	\$192,000
		9	Pipe (10-inch PVC)	500	FT	\$33	\$16,300
		10	Pipe installation - above ground (400 ft)	1	LS	\$16,800	\$16,800
		11	Pipe installation - buried (100 ft)	1	LS	\$10,000	\$10,000
		12	Electrical equipment, materials, & install labor	8	WK	\$10,000	\$80,000
		13	Clearwell tank (5,000 gal) and shipping to site	1	EA	\$44,100	\$44,100
		14	Bag filter housing, with first year of bag filters	1	LS	\$30,000	\$30,000
		15	Backwash pump (700 gpm, 60 ft H2O, 20 hp)	1	LS	\$5,700	\$5,700
		16	Backwash tanks (12,000 gal ea) with shipping	4	EA	\$16,000	\$64,000
		17	Backwash transfer pump	1	EA	\$2,300	\$2,300
		18	Booster pump (500 gpm, 200 ft H2O, 20 hp)	1	LS	\$8,500	\$8,500
		19	Meters and control equipment	1	LS	\$20,000	\$20,000
		20	Valves and fittings	1	LS	\$25,000	\$25,000
		21	General site cleanup and misc. restoration	1	LS	\$10,000	\$10,000
		22	Startup and shakedown testing (1 month)	1	LS	\$20,000	\$20,000
		23	Initial O&M and COAH handoff training	3	MO	\$3,000	\$9,000
		24	Initial electricity for equipment inside building	3	MO	\$300	\$900
	CONTAMINATED WASTE DISPOSAL AND TRANSPORTATION (Direct Costs)						
	\$2,900	1	Transportation & Disposal Coordination	8	HR	\$100	\$800
	<u>With Contingency</u>	2	Transportation & Disposal Non-Hazardous Waste	30	TN	\$70	\$2,100
	\$3,600	3	Not Used	0	EA	\$0	\$0
		4	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$1,261,000
	Direct Cost Contingency and Unlisted Items (%)			25	%	\$1,261,000	\$315,300
	Contractor Bond Fee, Overhead, and Profit (%)			20	%	\$1,576,300	\$315,300
	Washington State Sales Tax (%)			9.1	%	\$1,891,600	\$172,200
	TOTAL DIRECT COST						\$2,063,800
	TOTAL DIRECT AND INDIRECT IMPLEMENTATION COSTS						
		1	Total Indirect Costs (see above)	--	--	--	\$404,900
		2	Total Direct Costs (see above)	--	--	--	\$2,063,800
		3	Site Inspection and Overhead Costs (USACE)	8	%	\$2,468,700	\$197,500
	TOTAL IMPLEMENTATION COST			Years until Implementation	3	#	\$2,666,200
	Escalated Implementation Cost			Presumed Inflation Rate	2.00	%	\$2,829,400
	Present-Worth Implementation Cost			Presumed Discount Rate	0.40	%	\$2,634,500

Alternative 2 – GAC Wellhead Treatment for Wells 1/4 (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
OM&M	ANNUAL OPERATION & MAINTENANCE						
	\$67,400	1	Project Management & Coordination (4 hrs/mon)	48	HR	\$150	\$7,200
	<u>With Contingency</u>	2	Annual O&M Reporting	80	HR	\$110	\$8,800
	\$84,250	3	Vehicle Rental & Gas	16	DY	\$70	\$1,200
		4	O&M Labor (3 hr monthly site checks)	12	DY	\$500	\$6,000
		5	O&M Labor (8 hr quarterly maintenance)	4	DY	\$1,000	\$4,000
		6	O&M Supplies and Equipment	12	MO	\$250	\$3,000
		7	Electricity for building and equipment	12	MO	\$500	\$6,000
		8	Carbon Changeout including off site regeneration	1	LS	\$31,200	\$31,200
	Total Routine Annual O&M Cost						\$67,400
	Subtotal Costs			<i>Years of Annual O&M</i>	30		\$2,022,000
	O&M Cost Contingency and Unlisted Items (%)			25	%	\$2,022,000	\$505,500
	TOTAL O&M COST						\$2,527,500
	Escalated O&M Cost			Presumed Inflation Rate	2.00	%	\$3,417,900
	Present-Worth O&M Cost			Presumed Discount Rate	0.40	%	\$2,377,300
	ANNUAL MONITORING & REPORTING						
	\$34,400	1	Project Management & Coord (8 hrs/event)	32	HR	\$150	\$4,800
	<u>With Contingency</u>	2	Quarterly Sampling Reporting	4	EA	\$2,640	\$10,600
	\$41,280	3	Vehicle Rental and Gas	4	DY	\$70	\$300
		4	Monitoring Labor	4	DY	\$1,000	\$4,000
		5	Monitoring Supplies and Equipment	1	LS	\$3,000	\$3,000
		6	Analytical Testing	4	LS	\$2,915	\$11,700
		7	No Used	0	HR	\$0	\$0
		8	Not Used	0	EA	\$0	\$0
	Total Routine Annual Monitoring Cost						\$34,400
	Subtotal Costs			<i>Years of Annual Monitoring</i>	30		\$1,032,000
	Monitoring Cost Contingency and Unlisted Items (%)			20	%	\$1,032,000	\$206,400
	TOTAL MONITORING & REPORTING COST						\$1,238,400
	Escalated Monitoring Cost			Presumed Inflation Rate	2.00	%	\$1,674,700
	Present-Worth Monitoring Cost			Presumed Discount Rate	0.40	%	\$1,164,800
	NON-ROUTINE OM&M						
	\$125,000	1	Minor system repairs and tweaks (Year 5)	1	LS	\$5,000	\$5,000
	<u>With Contingency</u>	2	Non-routine pump replacement/repair (Year 8)	1	LS	\$10,000	\$10,000
		3	Inspect carbon vessel interior screens (Year 10)	1	LS	\$15,000	\$15,000
	\$162,500	4	Major system repairs (Year 15)	1	LS	\$35,000	\$35,000
		5	Inspect carbon vessel interior screens (Year 20)	1	LS	\$15,000	\$15,000
		6	Non-routine pump replacement/repair (Year 23)	1	LS	\$10,000	\$10,000
		7	Major system repair (Year 30)	1	LS	\$35,000	\$35,000
	Subtotal Costs						\$125,000
	Non-Routine Cost Contingency and Unlisted Items (%)			30	%	\$125,000	\$37,500
	TOTAL CLOSURE COST						\$162,500
	Escalated Closure Cost			Presumed Inflation Rate	2.00	%	\$239,400
	Present-Worth Closure Cost			Presumed Discount Rate	0.40	%	\$150,800
	OM&M COSTS				TOTAL	ESCALATED	PRESENT WORTH
		1	Total O&M Costs (see above)		\$2,527,500	\$3,417,900	\$2,377,300
		2	Total Monitoring Costs (see above)		\$1,238,400	\$1,674,700	\$1,164,800
		3	Total Non-Routine OM&M		\$162,500	\$239,400	\$150,800
	TOTAL OM&M COSTS				\$3,928,400	\$5,332,000	\$3,692,900

Alternative 2 – GAC Wellhead Treatment for Wells 1/4 (Continued)

TOTAL	ALTERNATIVE COST SUMMARY		Rounded Total	Cumulative Total
	TOTAL PRESENT-WORTH IMPLEMENTATION COST (DIRECT & INDIRECT)		\$2,634,500	\$2,634,500
	TOTAL PRESENT-WORTH OM&M COST		\$3,692,900	\$6,327,400
	AGENCY OVERSIGHT (EPA and/or ECOLOGY)	LS	\$20,000	\$6,347,400
	TOTAL PRESENT-WORTH COST			\$6,347,000

Table A-2
Summary of Alternative Costs
Alternative 2 - GAC Wellhead Treatment System for Well 9

Task	Cost
IMPLEMENTATION COSTS	
Remedial Design, Planning, and General (Indirect Costs)	\$514,700
Indirect Contingency and Unlisted Engineering Services Assumed (%)	15
Remedial Action Construction including Sales Tax (Direct Costs)	\$3,429,800
Direct Contingency and Unlisted Items Assumed (%)	25
Site Inspection and Overhead (USACE)	\$315,600
Total Implementation Costs	\$4,260,100
OM&M COSTS	
Annualized O&M Costs	\$163,500
O&M Contingency and Unlisted Items Assumed (%)	25
O&M Duration (years)	30
Annualized Monitoring & Reporting Costs	\$41,280
Monitoring Contingency and Unlisted Items Assumed (%)	20
Monitoring Duration (years)	30
Non-Routine OM&M	\$162,500
Non-Routine Contingency and Unlisted Items Assumed (%)	30
Total OM&M Costs	\$6,305,900
TOTALS	
Total Implementation and OM&M Costs	\$10,566,000
Estimated Agency Oversight Costs	\$20,000
Total Escalated Costs ^a	\$13,088,000
Total Project Present Worth ^b	\$10,159,000

^a Escalated costs were calculated using a 2.0% inflation rate

^b Present worth costs were calculated using a 0.4% discount rate

Notes:

Discount Rate (0.4%) = Interest Rate (2.4%) - Inflation (2.0%)

Remedial Action Construction Costs includes Washington State Sales Tax at 9.1%

OM&M - Operation, Maintenance, and Monitoring

O&M - Operation and Maintenance

Alternative 2 - GAC Wellhead Treatment System for Well 9

Client	USACE, Fairchild AFB	Report Date	June 2021
Location	City of Airway Heights		
Project	EE/CA, Fairchild Air Force Base and City of Airway Heights, Washington		
Site Name	Well 9		
Estimator	Gus Friedman, AECOM	Affected Media	Drinking Water
QA Reviewer	Cary Brown, AECOM	COCs	PFOS, PFOA
		Flowrate (Nominal)	1,000 gpm
		Flowrate (Max)	1,200 gpm

Site/Problem Description Groundwater pumped from COAH water supply Well 9 has PFAS (PFOA at 320 ppt and PFOS at 1,200 ppt) concentrations above EPA Health Advisory limit of 70 ppt.

Proposed Remedial Action Drinking water from existing COAH Well 9 will be rerouted into a newly constructed GAC treatment system at a sustained flow of 1,000 gpm. The system will be designed in two parallel series with flow split equally to pass through each. Each series will consist of initial filtration via bag filter manifold for large particle particulate removal, followed by two 20,000 lb GAC vessels in series for PFOS and PFOA removal. Treated effluent will flow into a clearwell and on into the existing COAH water main for distribution to customers in the city. A booster pump will be used to maintain a minimum 75 psi discharge pressure to the city's water main.

Alternative Specific Assumptions	1	Costs presented have an accuracy of +50% to -30% and are suitable for comparing alternatives.
	2	Washington State Sales Tax is applied to Direct Costs only at 9.1%.
	3	Discount Rate is 0.4% per Office of Management and Budget, Circular A-94 Appendix C, Revised Nov. 2019.
	4	The GAC treatment system will be contained inside a 45 x 85 x 25 ft tall climate controlled building.
	5	The system will have four 20,000-lb vessels filled with virgin coal-based carbon (Calgon FiltraSorb 400 or equal).
	6	The existing submersible pump(s) are in good working order and will be reused.
	7	O&M of the well and submersible pump are not included because it is assumed to be COAH's responsibility.
	8	The system will be designed for a maximum flowrate of 1,200 gpm, but the nominal flowrate will be 1,000 gpm.
	9	Empty bed contact time will be greater than 20 minutes (10 minutes per vessel) at 1,200 gpm.
	10	Equipment will be NSF-certified for drinking water and the GAC vessels ASME rated pressure vessels.
	11	No additional water treatment or chlorination equipment is needed and is thus not included.
	12	Each lead 20,000-lb vessel will be changed out every 9 months with fresh virgin carbon or 53,000 lbs per year.
	13	A backwash system rated at maximum flowrate of 900 gpm is included to set new carbon in the vessel.
	14	Assumes dirty backwash water will be stored in outdoor tanks until process is complete. Upon system restart, the backwash water will be run through the bag filters at the influent of the system for treatment.

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION	REMEDIAL DESIGN, PLANNING, AND GENERAL (Indirect Costs)						
	\$447,600	1	Project management (5 hrs per week)	6	MO	\$3,250	\$19,500
	With Contingency	2	General coordination, meetings, and planning	1	LS	\$12,500	\$12,500
	\$514,700	3	Regulatory coordination and meetings (% of DC)	1	%	\$3,429,800	\$34,300
		4	Engineering Design/Basis of Design Report	120	HR	\$125	\$15,000
		5	Water Quality Assessment/Bench Testing	1	EA	\$50,000	\$50,000
		6	Design Plans and Specs	6	%	\$3,429,800	\$205,800
		7	Engineers Estimate	80	HR	\$125	\$10,000
		8	Permitting Support	1	LS	\$5,000	\$5,000
		9	Bid and RFI support	40	HR	\$125	\$5,000
		10	Work Plan (CMP/SAP)	150	HR	\$110	\$16,500
		11	Construction oversight and QA (1 person 1/2 time)	6	MO	\$8,667	\$52,000
		12	Reporting (Construction and Record Drawings)	200	HR	\$110	\$22,000
		13	Not Used	0	LS	\$0	\$0
		14	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$447,600
	Indirect Contingency and Unlisted Engineering Services (%)			15	%	\$447,600	\$67,140
	TOTAL INDIRECT COST						\$514,700

Alternative 2 - GAC Wellhead Treatment System for Well 9 (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION (Continued)	REMEDIAL ACTION CONSTRUCTION (Direct Costs)						
	\$2,092,800	1	Mobilization/Demobilization	1	LS	\$25,000	\$25,000
	<u>With Contingency</u>	2	Site preparation & erosion control	5,000	SF	\$2	\$10,000
	\$2,616,000	3	Specialty Contractors (Utility locate, Survey)	1	LS	\$10,000	\$10,000
		4	Jobsite trailer, printer/copy machine, generator, tools, portable toilet, and safety supplies	6	MO	\$7,500	\$45,000
		5	GAC vessels, manifold, and 1st load of GAC	2	EA	\$350,000	\$700,000
		6	Treatment building (45x85x25) with roll up door	1	EA	\$350,000	\$350,000
		7	Concrete pad for GAC treatment system building	1	LS	\$130,000	\$130,000
		8	Labor for all GAC system equipment installation and piping connections inside the building	20	WK	\$16,000	\$320,000
		9	Pipe (10-inch PVC)	900	FT	\$33	\$29,400
		10	Pipe installation - above ground (800 ft)	1	LS	\$33,600	\$33,600
		11	Pipe installation - buried (100 ft)	1	LS	\$10,000	\$10,000
		12	Electrical equipment, materials, & install labor	10	WK	\$10,000	\$100,000
		13	Clearwell tank (5,000 gal) and shipping to site	1	EA	\$44,100	\$44,100
		14	Bag filter housing, with first year of bag filters	2	LS	\$30,000	\$60,000
		15	Backwash tank (15,500 gal) and shipping to site	4	EA	\$19,500	\$78,000
		16	Backwash pump (900 gpm, 60 ft H2O, 20 hp)	1	LS	\$5,700	\$5,700
		17	Backwash transfer pump	1	EA	\$3,579	\$3,600
		18	Booster pump (500 gpm, 200 ft H2O, 20 hp)	1	LS	\$8,500	\$8,500
		19	Meters and control equipment	2	LS	\$20,000	\$40,000
		20	Valves and fittings	2	LS	\$25,000	\$50,000
		21	General site cleanup and misc. restoration	1	LS	\$10,000	\$10,000
		22	Startup and shakedown testing (1 month)	1	LS	\$20,000	\$20,000
		23	Initial O&M and COAH handoff training	3	MO	\$3,000	\$9,000
		24	Initial electricity for equipment inside building	3	MO	\$300	\$900
	CONTAMINATED WASTE DISPOSAL AND TRANSPORTATION (Direct Costs)						
	\$2,900	1	Transportation & Disposal Coordination	8	HR	\$100	\$800
	<u>With Contingency</u>	2	Transportation & Disposal Non-Hazardous Waste	30	TN	\$70	\$2,100
	\$3,600	3	Not Used	0	EA	\$0	\$0
		4	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$2,095,700
	Direct Cost Contingency and Unlisted Items (%)			25	%	\$2,095,700	\$524,000
	Contractor Bond Fee, Overhead, and Profit (%)			20	%	\$2,619,700	\$524,000
	Washington State Sales Tax (%)			9.1	%	\$3,143,700	\$286,100
	TOTAL DIRECT COST						\$3,429,800
	TOTAL DIRECT AND INDIRECT IMPLEMENTATION COSTS						
		1	Total Indirect Costs (see above)	--	--	--	\$514,700
		2	Total Direct Costs (see above)	--	--	--	\$3,429,800
		3	Site Inspection and Overhead Costs (USACE)	8	%	\$3,944,500	\$315,600
	TOTAL IMPLEMENTATION COST			3	#		\$4,260,100
	Escalated Implementation Cost			Presumed Inflation Rate		2.00	% \$4,520,900
	Present-Worth Implementation Cost			Presumed Discount Rate		0.40	% \$4,209,400

Alternative 2 - GAC Wellhead Treatment System for Well 9 (Continued)

DETAILED COST ESTIMATE								
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs	
OM&M	ANNUAL OPERATION & MAINTENANCE							
	\$130,800 <u>With Contingency</u> \$163,500	1	PM & Coordination (4 hrs/mon)	48	HR	\$150	\$7,200	
		2	Annual O&M Reporting	80	HR	\$110	\$8,800	
		3	Vehicle Rental & Gas	16	DY	\$70	\$1,200	
		4	O&M Labor (3 hr monthly site checks)	12	DY	\$500	\$6,000	
		5	O&M Labor (8 hr quarterly maintenance)	4	DY	\$1,000	\$4,000	
		6	O&M Supplies and Equipment	12	MO	\$250	\$3,000	
		7	Electricity for building and equipment	12	MO	\$600	\$7,200	
		8	Carbon Changeout including offsite regeneration	1	LS	\$93,333	\$93,400	
	Total Routine Annual O&M Cost						\$130,800	
	Subtotal Costs			Years of Annual O&M	30	\$3,924,000		
	O&M Cost Contingency and Unlisted Items (%)				25	%	\$3,924,000	
	TOTAL O&M COST						\$4,905,000	
	Escalated O&M Cost			Presumed Inflation Rate	2.00	%	\$6,632,900	
	Present-Worth O&M Cost			Presumed Discount Rate	0.40	%	\$4,613,500	
	ANNUAL MONITORING & REPORTING							
	\$34,400 <u>With Contingency</u> \$41,280	1	Project Management & Coord (8 hrs/event)	32	HR	\$150	\$4,800	
		2	Quarterly Sampling Reporting	4	EA	\$2,640	\$10,600	
		3	Vehicle Rental and Gas	4	DY	\$70	\$300	
		4	Monitoring Labor	4	DY	\$1,000	\$4,000	
		5	Monitoring Supplies and Equipment	1	LS	\$3,000	\$3,000	
		6	Analytical Testing	4	LS	\$2,915	\$11,700	
		7	No Used	0	HR	\$0	\$0	
		8	Not Used	0	EA	\$0	\$0	
	Total Routine Annual Monitoring Cost						\$34,400	
	Subtotal Costs			Years of Annual Monitoring	30	\$1,032,000		
	Monitoring Cost Contingency and Unlisted Items (%)				20	%	\$1,032,000	
	TOTAL MONITORING & REPORTING COST						\$1,238,400	
	Escalated Monitoring Cost			Presumed Inflation Rate	2.00	%	\$1,674,700	
	Present-Worth Monitoring Cost			Presumed Discount Rate	0.40	%	\$1,164,800	
	NON-ROUTINE OM&M							
	\$125,000 <u>With Contingency</u> \$162,500	1	Minor system repairs and tweaks (Year 5)	1	LS	\$5,000	\$5,000	
		2	Non-routine pump replacement/repair (Year 8)	1	LS	\$10,000	\$10,000	
		3	Inspect carbon vessel interior screens (Year 10)	1	LS	\$15,000	\$15,000	
		4	Major system repairs (Year 15)	1	LS	\$35,000	\$35,000	
		5	Inspect carbon vessel interior screens (Year 20)	1	LS	\$15,000	\$15,000	
		6	Non-routine pump replacement/repair (Year 23)	1	LS	\$10,000	\$10,000	
		7	Major system repair (Year 30)	1	LS	\$35,000	\$35,000	
	Subtotal Costs						\$125,000	
	Non-Routine Cost Contingency and Unlisted Items (%)				30	%	\$125,000	
	TOTAL CLOSURE COST						\$162,500	
	Escalated Closure Cost			Presumed Inflation Rate	2.00	%	\$239,400	
	Present-Worth Closure Cost			Presumed Discount Rate	0.40	%	\$150,800	
	OM&M COSTS					TOTAL	ESCALATED	Present-Worth
		1	Total O&M Costs (see above)			\$4,905,000	\$6,632,900	\$4,613,500
		2	Total Monitoring Costs (see above)			\$1,238,400	\$1,674,700	\$1,164,800
		3	Total Non-Routine OM&M			\$162,500	\$239,400	\$150,800
	TOTAL OM&M COSTS					\$6,305,900	\$8,547,000	\$5,929,100

Alternative 2 - GAC Wellhead Treatment System for Well 9 (Continued)

TOTAL	ALTERNATIVE COST SUMMARY		Rounded Total	Cumulative Total
	TOTAL PRESENT-WORTH IMPLEMENTATION COST (DIRECT & INDIRECT)		\$4,209,400	\$4,209,400
	TOTAL PRESENT-WORTH OM&M COST		\$5,929,100	\$10,138,500
	AGENCY OVERSIGHT (EPA and/or ECOLOGY)	LS	\$20,000	\$10,158,500
	TOTAL PRESENT-WORTH COST			\$10,159,000

COST ESTIMATE

Alternative 3 – Ion Exchange Resin Wellhead Treatment

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ALTERNATIVE 3 COST ESTIMATE ASSUMPTIONS

The cost estimate assumes the following phases and activities:

Pre-Design Activities/Design

1. Confirm the existing submersible pumps in Wells 1/4 and 9 are in good working order.
2. Complete pre-construction site evaluation, topographic survey, and utility locate within the work area.
3. Collect bulk water samples from each well and submit for bench scale treatability testing to fine tune the anticipated changeout frequency of resin and use to refine the system design.
4. Determine if a central treatment plant would be more cost effective than two separate systems.
5. Prepare design including plans, specifications, and a formal bid package.
6. Procure Contractor through formal bid process.
7. Contractor to complete pre-construction work plans.

Implementation

1. Acquire applicable permits.
2. Conduct mobilization/demobilization of construction crew and equipment.
3. Conduct general site preparation work and erosion control.
4. Identify and protect utilities/utility in the work area.
5. Complete site earthwork including trenching for influent and effluent piping, preparation of building foundation, and electrical connection.
6. Install new treatment building foundations, buildings, and associated equipment (one bag filter housing, one booster pump, two water storage tanks, one backwash pump, one transfer pump, and two ion exchange resin [IXR] vessels per site).
7. The IXR systems will consist of the following, which come pre-packaged:
 - a. Wells 1/4: ECT2 Sorbix HDW Model 86 resin system with 8-inch piping.
 - b. Well 9: ECT2 Sorbix HDW Model 108 resin system with 8-inch piping.
8. The backwash systems will each include PVC piping, one centrifugal pump, sight glass, flow meter, isolation and control valves, and a variable frequency drive motor controller.
9. The inline booster pumps will be Goulds Model SSH-22SH stainless-steel end suction centrifugal pump with 30-hp motor.
10. Transfer pumps will be installed at each site to route dirty water from the backwash process back to the IXR system for treatment.
 - a. Wells 1/4: Goulds Model 3656 S, 35 gpm, 230-foot head
 - b. Well 9: Goulds Model 3656 M, 90 gpm, 230-foot head
11. Pre-filtration equipment installed will consist of bag filters in a multi-chamber stainless-steel bag filter housing that holds eight size #2 poly bag filters. Cary Company part number SMB-30-30-BF, which has 8-inch flange connections and is certified NSF 61 listed and ASM-certified pressure vessel. There will be one at the Wells 1/4 system and two at the Well 9 system, where the higher flow will be split.
12. Make all piping connections from the existing wellhead piping to the new IXR systems and to the existing water mains.

13. Complete electrical service installation to provide power to the treatment buildings and associated equipment, and control the systems including electrical transformers and either buried or overhead service lines.
14. Dispose or spread out onsite the unusable excavated soil from trenching and water from system testing.
15. Add lighting, heat, security system, and insulation to the new buildings.
16. Construction oversight for 5 months by third-party consultant and for first month of startup assuming both systems are constructed at the same time.
17. System startup, shakedown, and operation for 12 months by installation Contractor assuming both systems are constructed at the same time.

Monitoring

1. Document flowrate and total flow into and out of the IXR treatment systems.
2. Perform weekly performance monitoring of influent groundwater and treated drinking water for PFAS for the first month, then monthly for the rest of the first year.
3. After the first year, complete quarterly sampling and analysis of influent and effluent samples for 29 years. Analyze for PFAS including one field duplicate sample every quarter.
4. Routine sampling of existing supply well(s) for typical drinking water requirements from the Airway Heights monitoring program is not included in this alternative and is assumed to be completed by the City of Airway Heights.
5. Complete ongoing particulate bag filter monitoring for clogging/fouling.

Operation and Maintenance

1. Operation of the treatment system for 30 years – Assumes Airway Heights conducts the work but FAFB reimburses the City.
2. Maintenance of treatment system for 30 years – Assumes Airway Heights conducts the work but FAFB reimburses the City.
3. O&M of the water supply well and pump is assumed to be the responsibility of the City of Airway Heights.
4. Ongoing transportation and offsite incineration of spent IXR from the IXR systems.
5. Inspection of IXR vessel interior screens and wall coating to be completed every 10 years and repaired if necessary.
6. Utility usage (electrical) for the treatment system components only. The electricity consumption for the water supply well itself is assumed to be the responsibility of the City of Airway Heights.

Closeout

1. Conduct Contractor demobilization after construction is complete, including general site restoration work.
2. Provide contractor training of Airway Heights personnel for changeover of O&M activities after initial 12 months of operation.
3. Prepare completion report and closeout submittals (e.g., as-built drawings).

Table A-3
Summary of Alternative Costs
Alternative 3 - IXR Wellhead Treatment System for Wells 1/4

Task	Cost
IMPLEMENTATION COSTS	
Remedial Design, Planning, and General (Indirect Costs)	\$383,900
Indirect Contingency and Unlisted Engineering Services Assumed (%)	15
Remedial Action Construction including Sales Tax (Direct Costs)	\$1,802,100
Direct Contingency and Unlisted Items Assumed (%)	25
Site Inspection and Overhead (USACE)	\$174,900
Total Implementation Costs	\$2,360,900
OM&M COSTS	
Annualized O&M Costs	\$122,880
O&M Contingency and Unlisted Items Assumed (%)	25
O&M Duration (years)	30
Annualized Monitoring & Reporting Costs	\$41,280
Monitoring Contingency and Unlisted Items Assumed (%)	20
Monitoring Duration (years)	30
Non-Routine OM&M	\$162,500
Non-Routine Contingency and Unlisted Items Assumed (%)	30
Total OM&M Costs	\$5,087,300
TOTALS	
Total Implementation and OM&M Costs	\$7,448,200
Estimated Agency Oversight Costs	\$20,000
Total Escalated Costs ^a	\$9,424,000
Total Project Present Worth ^b	\$7,136,000

^a Escalated costs were calculated using a 2.0% inflation rate

^b Present worth costs were calculated using a 0.4% discount rate

Notes:

Discount Rate (0.4%) = Interest Rate (2.4%) - Inflation (2.0%)

Remedial Action Construction Costs includes Washington State Sales Tax at 9.1%

OM&M - Operation, Maintenance, and Monitoring

O&M - Operation and Maintenance

Alternative 3 - IXR Wellhead Treatment System for Wells 1/4

Client	USACE, Fairchild AFB	Report Date	June 2021
Location	City of Airway Heights		
Project	EE/CA, Fairchild Air Force Base and City of Airway Heights, Washington		
Site Name	Wells 1/4		
Estimator	Gus Friedman, AECOM	Affected Media	Drinking Water
QA Reviewer	Cary Brown, AECOM	COCs	PFOS, PFOA
		Flowrate (Nominal)	350 gpm
		Flowrate (Max)	450 gpm
Site/Problem Description	Groundwater pumped from COAH water supply wells 1/4 has PFAS (PFOA at 300 ppt and PFOS at 1,100 ppt) concentrations above EPA Health Advisory limit of 70 ppt.		
Proposed Remedial Action	Drinking water from existing COAH Wells 1/4 will be rerouted into a newly constructed Ion Exchange Resin (IXR) treatment system at a sustained flow of 350 gpm. Flow will initially pass through bag filters for large particle particulate removal, then through two 200-cf vessels for PFOS and PFOA removal. Treated effluent will flow into a clearwell and on into the existing COAH water main for distribution to customers in the city. A booster pump will be used to maintain a minimum 75 psi discharge pressure into the City's water main.		

Alternative Specific Assumptions	1	Costs presented have an accuracy of +50% to -30% and are suitable for comparing alternatives.
	2	Washington State Sales Tax is applied to Direct Costs only at 9.1%.
	3	Discount Rate is 0.4% per Office of Management and Budget, Circular A-94 Appendix C, Revised Nov. 2019.
	4	The IXR treatment system will be contained inside a 30 x 40 x 25 ft tall climate controlled building.
	5	The system will have two 200-cf vessels (8') filled with virgin ion exchange resin (ECT2 SORBIX PURE or equal).
	6	The existing submersible pump(s) are in good working order and will be reused.
	7	O&M of the well and submersible pump are not included because it is assumed to be COAH's responsibility.
	8	The system will be designed for a maximum flowrate of 450 gpm, but the nominal flowrate will be 350 gpm.
	9	The IXR will last 200,000 bed volumes (1,500 gal/bed x 200,000 / 504,000 gal/day) or 595 days at 350 gpm.
	10	At the maximum flowrate of 450 gpm the IXR would last 463 days (1,500 gal/bed x 200,000 / 648,000 gal/day).
	11	One 200-cf vessel will be changed out every 19.5 months with fresh virgin resin (with PFAS at 1,400 ppt).
	12	Equipment will be NSF-certified for drinking water and the GAC vessels ASME rated pressure vessels.
	13	No additional water treatment or chlorination equipment is needed and is thus not included.
	14	A backwash system rated at maximum flowrate of 100 gpm is included to classify the new resin in the vessel.
	15	Assumes dirty backwash water will be stored in outdoor tanks until process is complete. Upon system restart, the backwash will be run through the bag filters at the beginning of the treatment train.

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION	REMEDIAL DESIGN, PLANNING, AND GENERAL (Indirect Costs)						
	\$333,800	1	Project management (5 hrs per week)	6	MO	\$3,250	\$19,500
	<u>With Contingency</u>	2	General coordination, meetings, and planning	1	LS	\$12,500	\$12,500
	\$383,900	3	Regulatory coordination and meetings (% of DC)	1	%	\$1,802,100	\$18,100
		4	Engineering Design / Basis of Design Report	120	HR	\$125	\$15,000
		5	Water Quality Assessment/Bench Testing	1	EA	\$50,000	\$50,000
		6	Design Plans and Specs	6	%	\$1,802,100	\$108,200
		7	Engineers Estimate	80	HR	\$125	\$10,000
		8	Permitting Support	1	LS	\$5,000	\$5,000
		9	Bid and RFI support	40	HR	\$125	\$5,000
		10	Work Plan (CMP/SAP)	150	HR	\$110	\$16,500
		11	Construction oversight and QA (1 person 1/2 time)	6	MO	\$8,667	\$52,000
		12	Reporting (Construction & Record Drawings)	200	HR	\$110	\$22,000
		13	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$333,800
	Indirect Contingency and Unlisted Engineering Services (%)			15	%	\$333,800	\$50,070
	TOTAL INDIRECT COST						\$383,900

Alternative 3 - IXR Wellhead Treatment System for Wells 1/4 (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION (Continued)	REMEDIAL ACTION CONSTRUCTION (Direct Costs)						
	\$1,098,200	1	Mobilization/Demobilization	1	LS	\$25,000	\$25,000
	<u>With Contingency</u>	2	Site preparation & erosion control	5,000	SF	\$2	\$10,000
	\$1,372,800	3	Specialty Contractors (Utility locate, Survey)	1	LS	\$10,000	\$10,000
		4	Jobsite trailer, printer/copy machine, generator, tools, portable toilet, and safety supplies	6	MO	\$7,500	\$45,000
		5	IXR vessels, manifold, and 1st load of resin	1	EA	\$360,000	\$360,000
		6	Treatment building (30x40x25) with roll up door	1	EA	\$110,000	\$110,000
		7	Concrete pad for IXR treatment system building	1	LS	\$40,000	\$40,000
		8	Labor for all IXR system equipment installation and piping connections inside the building	12	WK	\$16,000	\$192,000
		9	Pipe (10-inch PVC)	500	FT	\$33	\$16,300
		10	Pipe installation - above ground (400 ft)	1	LS	\$16,800	\$16,800
		11	Pipe installation - buried (100 ft)	1	LS	\$10,000	\$10,000
		12	Electrical equipment, materials, & install labor	8	WK	\$10,000	\$80,000
		13	Clearwell tank (5,000 gal) and shipping to site	1	EA	\$44,100	\$44,100
		14	Bag filter housing, with first year of bag filters	1	LS	\$30,000	\$30,000
		15	Backwash pump (100 gpm, 100 ft H2O, 5 hp)	1	LS	\$2,300	\$2,300
		16	Backwash tanks (2,500 gal ea) with shipping	2	EA	\$5,500	\$11,000
		17	Backwash transfer pump	1	EA	\$2,300	\$2,300
		18	Booster pump (500 gpm, 200 ft H2O, 20 hp)	1	LS	\$8,500	\$8,500
		19	Meters and control equipment	1	LS	\$20,000	\$20,000
		20	Valves and fittings	1	LS	\$25,000	\$25,000
		21	General site cleanup and misc. restoration	1	LS	\$10,000	\$10,000
		22	Startup and shakedown testing (1 month)	1	LS	\$20,000	\$20,000
		23	Initial O&M and handoff training	3	MO	\$3,000	\$9,000
		24	Initial electricity for equipment inside building	3	MO	\$300	\$900
	CONTAMINATED WASTE DISPOSAL AND TRANSPORTATION (Direct Costs)						
	\$2,900	1	Transportation & Disposal Coordination	8	HR	\$100	\$800
	<u>With Contingency</u>	2	Transportation & Disposal Non-hazardous Waste	30	TN	\$70	\$2,100
	\$3,600	3	Not Used	0	EA	\$0	\$0
		4	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$1,101,100
	Direct Cost Contingency and Unlisted Items (%)			25	%	\$1,101,100	\$275,300
	Contractor Bond Fee, Overhead, and Profit (%)			20	%	\$1,376,400	\$275,300
	Washington State Sales Tax (%)			9.1	%	\$1,651,700	\$150,400
	TOTAL DIRECT COST						\$1,802,100
	TOTAL DIRECT AND INDIRECT IMPLEMENTATION COSTS						
		1	Total Indirect Costs (see above)	--	--	--	\$383,900
		2	Total Direct Costs (see above)	--	--	--	\$1,802,100
		3	Site Inspection and Overhead Costs (USACE)	8	%	\$2,186,000	\$174,900
	TOTAL IMPLEMENTATION COST			Years until Implementation	3	#	\$2,360,900
	Escalated Implementation Cost			Presumed Inflation Rate	2.00	%	\$2,505,400
	Present-Worth Implementation Cost			Presumed Discount Rate	0.40	%	\$2,332,800

Alternative 3 - IXR Wellhead Treatment System for Wells 1/4 (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
OM&M	ANNUAL OPERATION & MAINTENANCE						
	\$98,300 <u>With Contingency</u> \$122,880	1	Project Management and Coordination (4 hrs/mon)	48	HR	\$150	\$7,200
		2	Annual O&M Reporting	80	HR	\$110	\$8,800
		3	Vehicle Rental & Gas	16	DY	\$70	\$1,200
		4	O&M Labor (3 hr monthly site checks)	12	DY	\$500	\$6,000
		5	O&M Labor (8 hr quarterly maintenance)	4	DY	\$1,000	\$4,000
		6	O&M Supplies and Equipment	12	MO	\$250	\$3,000
		7	Electricity for building and equipment	12	MO	\$300	\$3,600
		8	Resin Changeout (200 cf virgin resin) without disposal. Costs are prorated to account for changeouts every 595 days or the equivalent of 123 cf of resin each year.	123	CF	\$325	\$40,000
		9	Removal, transport, and incineration of 311 cf of spent Ion Exchange Resin every year. Assuming 50 lbs/cf or 6,200 lbs.	1.0	LS	\$24,500	\$24,500
	Total Routine Annual O&M Cost						\$98,300
	Subtotal Costs		Years of Annual O&M	30	\$2,949,000		
	O&M Cost Contingency and Unlisted Items (%)			25	%	\$2,949,000	\$737,250
	TOTAL O&M COST						\$3,686,300
	Escalated O&M Cost		Presumed Inflation Rate	2.00	%	\$4,984,900	
	Present-Worth O&M Cost		Presumed Discount Rate	0.40	%	\$3,467,200	
	ANNUAL MONITORING & REPORTING						
	\$34,400 <u>With Contingency</u> \$41,280	1	Project Management & Coordination (8 hrs/event)	32	HR	\$150	\$4,800
		2	Quarterly Sampling Reporting	4	EA	\$2,640	\$10,600
		3	Vehicle Rental and Gas	4	DY	\$70	\$300
		4	Monitoring Labor	4	DY	\$1,000	\$4,000
		5	Monitoring Supplies and Equipment	1	LS	\$3,000	\$3,000
		6	Analytical Testing	4	LS	\$2,915	\$11,700
		7	No Used	0	HR	\$0	\$0
		8	Not Used	0	EA	\$0	\$0
	Total Routine Annual Monitoring Cost						\$34,400
	Subtotal Costs		Years of Annual Monitoring	30	\$1,032,000		
	Monitoring Cost Contingency and Unlisted Items (%)			20	%	\$1,032,000	\$206,400
	TOTAL MONITORING & REPORTING COST						\$1,238,400
	Escalated Monitoring Cost		Presumed Inflation Rate	2.00	%	\$1,674,700	
	Present-Worth Monitoring Cost		Presumed Discount Rate	0.40	%	\$1,164,800	
	NON-ROUTINE OM&M						
	\$125,000 <u>With Contingency</u> \$162,500	1	Minor system repairs and tweaks (Year 5)	1	LS	\$5,000	\$5,000
		2	Non-routine pump replacement/repair (Year 8)	1	LS	\$10,000	\$10,000
		3	Inspect IXR vessel interior screens (Year 10)	1	LS	\$15,000	\$15,000
		4	Major system repairs (Year 15)	1	LS	\$35,000	\$35,000
		5	Inspect IXR vessel interior screens (Year 20)	1	LS	\$15,000	\$15,000
		6	Non-routine pump replacement/repair (Year 23)	1	LS	\$10,000	\$10,000
		7	Major system repair (Year 30)	1	LS	\$35,000	\$35,000
	Subtotal Costs						\$125,000
	Non-Routine Cost Contingency and Unlisted Items (%)			30	%	\$125,000	\$37,500
	TOTAL CLOSURE COST						\$162,500
	Escalated Closure Cost		Presumed Inflation Rate	2.00	%	\$239,400	
	Present-Worth Closure Cost		Presumed Discount Rate	0.40	%	\$150,800	

Alternative 3 - IXR Wellhead Treatment System for Wells 1/4 (Continued)

TOTAL	OM&M COSTS			TOTAL	ESCALATED	Present-Worth
		1	Total O&M Costs (see above)	\$3,686,300	\$4,984,900	\$3,467,200
		2	Total Monitoring Costs (see above)	\$1,238,400	\$1,674,700	\$1,164,800
		3	Total Non-Routine OM&M	\$162,500	\$239,400	\$150,800
	TOTAL OM&M COSTS			\$5,087,200	\$6,899,000	\$4,782,800
TOTAL	ALTERNATIVE COST SUMMARY				Rounded Total	Cumulative Total
	TOTAL PRESENT-WORTH IMPLEMENTATION COST (DIRECT & INDIRECT)				\$2,332,800	\$2,332,800
	TOTAL PRESENT-WORTH OM&M COST				\$4,782,800	\$7,115,600
	AGENCY OVERSIGHT (EPA and/or ECOLOGY)				LS \$20,000	\$7,135,600
	TOTAL PRESENT-WORTH COST					\$7,136,000

Table A-4
Summary of Alternative Costs
Alternative 3 - IXR Wellhead Treatment System for Well 9

Task	Cost
IMPLEMENTATION COSTS	
Remedial Design, Planning, and General (Indirect Costs)	\$446,900
Indirect Contingency and Unlisted Engineering Services Assumed (%)	15
Remedial Action Construction including Sales Tax (Direct Costs)	\$2,586,000
Direct Contingency and Unlisted Items Assumed (%)	25
Site Inspection and Overhead (USACE)	\$242,700
Total Implementation Costs	\$3,275,600
OM&M COSTS	
Annualized O&M Costs	\$200,750
O&M Contingency and Unlisted Items Assumed (%)	25
O&M Duration (years)	30
Annualized Monitoring & Reporting Costs	\$41,280
Monitoring Contingency and Unlisted Items Assumed (%)	20
Monitoring Duration (years)	30
Non-Routine OM&M	\$162,500
Non-Routine Contingency and Unlisted Items Assumed (%)	30
Total OM&M Costs	\$7,423,400
TOTALS	
Total Implementation and OM&M Costs	\$10,699,000
Estimated Agency Oversight Costs	\$20,000
Total Escalated Costs ^a	\$13,554,000
Total Project Present Worth ^b	\$10,237,000

^a Escalated costs were calculated using a 2.0% inflation rate

^b Present worth costs were calculated using a 0.4% discount rate

Notes:

Discount Rate (0.4%) = Interest Rate (2.4%) - Inflation (2.0%)

Remedial Action Construction Costs includes Washington State Sales Tax at 9.1%

OM&M - Operation, Maintenance, and Monitoring

O&M - Operation and Maintenance

Alternative 3 - IXR Wellhead Treatment System for Well 9

Client	USACE, Fairchild AFB	Report Date	June 2021
Location	City of Airway Heights		
Project	EE/CA, Fairchild Air Force Base and City of Airway Heights, Washington		
Site Name	Well 9		
Estimator	Gus Friedman, AECOM	Affected Media	Drinking Water
QA Reviewer	Cary Brown, AECOM	COCs	PFOS, PFOA
		Flowrate (Nominal)	1,000 gpm
		Flowrate (Max)	1,200 gpm
Site/Problem Description	Groundwater pumped from COAH water supply Well 9 has PFAS (PFOA at 320 ppt and PFOS at 1,200 ppt) concentrations above EPA Health Advisory limit of 70 ppt.		
Proposed Remedial Action	Drinking water from existing COAH Well 9 will be rerouted into a newly constructed Ion Exchange Resin (IXR) treatment system at a sustained flow of 1,000 gpm. Flow will initially pass through bag filters for large particle particulate removal, then through two 400-cf vessels for PFOS and PFOA removal. Treated effluent will flow into a clearwell and on into the existing COAH water main for distribution to customers in the city. A booster pump will be used to maintain a minimum 75 psi discharge pressure into the city's water main.		

Alternative Specific Assumptions	1	Costs presented have an accuracy of +50% to -30% and are suitable for comparing alternatives.
	2	Washington State Sales Tax is applied to Direct Costs only at 9.1%.
	3	Discount Rate is 0.4% per Office of Management and Budget, Circular A-94 Appendix C, Revised Nov. 2019.
	4	The IXR treatment system will be contained inside a 40 x 50 x 25 ft tall climate controlled building.
	5	The system will have two 400-CF vessels filled with virgin ion exchange resin (ECT2 SORBIX PURE or equal).
	6	The existing submersible pump(s) are in good working order and will be reused.
	7	O&M of the well and submersible pump are not included because it is assumed to be COAH's responsibility.
	8	The system will be designed for a maximum flowrate of 1,200 gpm, but the nominal flowrate will be 1,000 gpm.
	9	The IXR will last 230,000 bed volumes or 478 days (2,992 gal/bed x 230,000 BV / 1,440,000 gal/day) at 1,000 gpm.
	10	At the maximum flowrate of 1,200 gpm the IXR would last 398 days (2,992 gal/bed x 230,000 / 1,728,000 gal/day).
	11	One 400-cf vessel will be changed out every 15.5 months with fresh virgin resin (1,000 gpm with PFAS at 1,520 ppt).
	12	Equipment will be NSF-certified for drinking water and the GAC vessels ASME rated pressure vessels.
	13	No additional water treatment or chlorination equipment is needed and is thus not included.
	14	A backwash system rated at maximum flowrate of 150 gpm is included to classify the new resin in the vessel.
	15	Assumes dirty backwash water will be stored in outdoor tanks until process is complete. Upon system restart, the backwash will be run through the bag filters at the beginning of the treatment train.

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION	REMEDIAL DESIGN, PLANNING, AND GENERAL (Indirect Costs)						
	\$388,600	1	Project management (5 hrs per week)	6	MO	\$3,250	\$19,500
	<u>With Contingency</u>	2	General coordination, meetings, and planning	1	LS	\$12,500	\$12,500
	\$446,900	3	Regulatory coordination and meetings (% of DC)	1	%	\$2,586,000	\$25,900
		4	Engineering Design / Basis of Design Report	120	HR	\$125	\$15,000
		5	Water Quality Assessment/Bench Testing	1	EA	\$50,000	\$50,000
		6	Design Plans and Specs	6	%	\$2,586,000	\$155,200
		7	Engineers Estimate	80	HR	\$125	\$10,000
		8	Permitting Support	1	LS	\$5,000	\$5,000
		9	Bid and RFI support	40	HR	\$125	\$5,000
		10	Work Plan (CMP/SAP)	150	HR	\$110	\$16,500
		11	Construction oversight and QA (1 person 1/2 time)	6	MO	\$8,667	\$52,000
		12	Reporting (Construction & Record Drawings)	200	HR	\$110	\$22,000
		13	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$388,600
	Indirect Contingency and Unlisted Engineering Services (%)			15	%	\$388,600	\$58,290
	TOTAL INDIRECT COST						\$446,900

Alternative 3 - IXR Wellhead Treatment System for Well 9 (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION (Continued)	REMEDIAL ACTION CONSTRUCTION (Direct Costs)						
	\$1,577,200	1	Mobilization/Demobilization	1	LS	\$25,000	\$25,000
	<u>With Contingency</u>	2	Site preparation & erosion control	5,000	SF	\$2	\$10,000
	\$1,971,500	3	Specialty Contractors (Utility locate, Survey)	1	LS	\$10,000	\$10,000
		4	Jobsite trailer, printer/copy machine, generator, tools, portable toilet, and safety supplies	6	MO	\$7,500	\$45,000
		5	IXR vessels, manifold, and 1st load of resin	1	EA	\$730,000	\$730,000
		6	Treatment building (40x50x25) with roll up door	1	EA	\$184,000	\$184,000
		7	Concrete pad for IXR treatment system building	1	LS	\$68,000	\$68,000
		8	Labor for all IXR system equipment installation and piping connections inside the building	12	WK	\$16,000	\$192,000
		9	Pipe (10-inch PVC)	500	FT	\$33	\$16,300
		10	Pipe installation - above ground (400 ft)	1	LS	\$16,800	\$16,800
		11	Pipe installation - buried (100 ft)	1	LS	\$10,000	\$10,000
		12	Electrical equipment, materials, & install labor	8	WK	\$10,000	\$80,000
		13	Clearwell tank (5,000 gal) and shipping to site	1	EA	\$44,100	\$44,100
		14	Bag filter housing, with first year of bag filters	1	LS	\$30,000	\$30,000
		15	Backwash pump (150 gpm, 100 ft H2O, 7.5 hp)	1	LS	\$4,000	\$4,000
		16	Backwash tank (5,000 gal) and shipping to site	2	EA	\$7,500	\$15,000
		17	Backwash transfer pump	1	EA	\$3,579	\$3,600
		18	Booster pump (500 gpm, 200 ft H2O, 20 hp)	1	LS	\$8,500	\$8,500
		19	Meters and control equipment	1	LS	\$20,000	\$20,000
		20	Valves and fittings	1	LS	\$25,000	\$25,000
		21	General site cleanup and misc. restoration	1	LS	\$10,000	\$10,000
		22	Startup and shakedown testing (1 month)	1	LS	\$20,000	\$20,000
		23	Initial O&M and handoff training	3	MO	\$3,000	\$9,000
		24	Initial electricity for equipment inside building	3	MO	\$300	\$900
	CONTAMINATED WASTE DISPOSAL AND TRANSPORTATION (Direct Costs)						
	\$2,900	1	Transportation & Disposal Coordination	8	HR	\$100	\$800
	<u>With Contingency</u>	2	Transportation & Disposal Non-Hazardous Waste	30	TN	\$70	\$2,100
	\$3,600	3	Not Used	0	EA	\$0	\$0
		4	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$1,580,100
	Direct Cost Contingency and Unlisted Items (%)			25	%	\$1,580,100	\$395,100
	Contractor Bond Fee, Overhead, and Profit (%)			20	%	\$1,975,200	\$395,100
	Washington State Sales Tax (%)			9.1	%	\$2,370,300	\$215,700
	TOTAL DIRECT COST						\$2,586,000
	TOTAL DIRECT AND INDIRECT IMPLEMENTATION COSTS						
		1	Total Indirect Costs (see above)	--	--	--	\$446,900
		2	Total Direct Costs (see above)	--	--	--	\$2,586,000
		3	Site Inspection and Overhead Costs (USACE)	8	%	\$3,032,900	\$242,700
	TOTAL IMPLEMENTATION COST			Years until Implementation	3	#	\$3,275,600
	Escalated Implementation Cost			Presumed Inflation Rate	2.00	%	\$3,476,100
	Present-Worth Implementation Cost			Presumed Discount Rate	0.40	%	\$3,236,600

Alternative 3 - IXR Wellhead Treatment System for Well 9 (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
OM&M	ANNUAL OPERATION & MAINTENANCE						
	\$160,600 <u>With Contingency</u> \$200,750	1	Project Management and Coordination (4 hrs/mon)	48	HR	\$150	\$7,200
		2	Annual O&M Reporting	80	HR	\$110	\$8,800
		3	Vehicle Rental & Gas	16	DY	\$70	\$1,200
		4	O&M Labor (3 hr monthly site checks)	12	DY	\$500	\$6,000
		5	O&M Labor (8 hr quarterly maintenance)	4	DY	\$1,000	\$4,000
		6	O&M Supplies and Equipment	12	MO	\$250	\$3,000
		7	Electricity for building and equipment	12	MO	\$400	\$4,800
		8	Resin Changeout (400 cf virgin resin) without disposal. Costs are prorated to account for changeouts every 470 days or the equivalent of 311 cf of resin each year.	311	CF	\$325	\$101,100
		9	Removal, transport, and incineration of 311 cf of spent Ion Exchange Resin every year. Assuming 50 lbs/cf or 8,600 lbs.	1.0	LS	\$24,500	\$24,500
	Total Routine Annual O&M Cost						\$160,600
	Subtotal Costs			Years of Annual O&M	30	\$4,818,000	
	O&M Cost Contingency and Unlisted Items (%)			25	%	\$4,818,000	\$1,204,500
	TOTAL O&M COST						\$6,022,500
	Escalated O&M Cost			Presumed Inflation Rate	2.00	%	\$8,144,100
	Present-Worth O&M Cost			Presumed Discount Rate	0.40	%	\$5,664,600
	ANNUAL MONITORING & REPORTING						
	\$34,400 <u>With Contingency</u> \$41,280	1	Project Management & Coordination (8 hrs/event)	32	HR	\$150	\$4,800
		2	Quarterly Sampling Reporting	4	EA	\$2,640	\$10,600
		3	Vehicle Rental and Gas	4	DY	\$70	\$300
		4	Monitoring Labor	4	DY	\$1,000	\$4,000
		5	Monitoring Supplies and Equipment	1	LS	\$3,000	\$3,000
		6	Analytical Testing	4	LS	\$2,915	\$11,700
		7	Not Used	0	EA	\$0	\$0
	Total Routine Annual Monitoring Cost						\$34,400
	Subtotal Costs			Years of Annual Monitoring	30	\$1,032,000	
	Monitoring Cost Contingency and Unlisted Items (%)			20	%	\$1,032,000	\$206,400
	TOTAL MONITORING & REPORTING COST						\$1,238,400
	Escalated Monitoring Cost			Presumed Inflation Rate	2.00	%	\$1,674,700
	Present-Worth Monitoring Cost			Presumed Discount Rate	0.40	%	\$1,164,800
	NON-ROUTINE OM&M						
	\$125,000 <u>With Contingency</u> \$162,500	1	Minor system repairs and tweaks (Year 5)	1	LS	\$5,000	\$5,000
		2	Non-routine pump replacement/repair (Year 8)	1	LS	\$10,000	\$10,000
		3	Inspect IXR vessel interior screens (Year 10)	1	LS	\$15,000	\$15,000
		4	Major system repairs (Year 15)	1	LS	\$35,000	\$35,000
		5	Inspect IXR vessel interior screens (Year 20)	1	LS	\$15,000	\$15,000
		6	Non-routine pump replacement/repair (Year 23)	1	LS	\$10,000	\$10,000
		7	Major system repair (Year 30)	1	LS	\$35,000	\$35,000
	Subtotal Costs						\$125,000
	Non-Routine Cost Contingency and Unlisted Items (%)			30	%	\$125,000	\$37,500
	TOTAL CLOSURE COST						\$162,500
	Escalated Closure Cost			Presumed Inflation Rate	2.00	%	\$239,400
	Present-Worth Closure Cost			Presumed Discount Rate	0.40	%	\$150,800
	OM&M COSTS				TOTAL	ESCALATED	PRESENT WORTH
		1	Total O&M Costs (see above)		\$6,022,500	\$8,144,100	\$5,664,600
		2	Total Monitoring Costs (see above)		\$1,238,400	\$1,674,700	\$1,164,800
		3	Total Non-Routine OM&M		\$162,500	\$239,400	\$150,800
	TOTAL OM&M COSTS				\$7,423,400	\$10,058,200	\$6,980,200

Alternative 3 - IXR Wellhead Treatment System for Well 9 (Continued)

TOTAL	ALTERNATIVE COST SUMMARY		Rounded Total	Cumulative Total
	TOTAL PRESENT-WORTH IMPLEMENTATION COST (DIRECT & INDIRECT)		\$3,236,600	\$3,236,600
	TOTAL PRESENT-WORTH OM&M COST		\$6,980,200	\$10,216,800
	AGENCY OVERSIGHT (EPA and/or ECOLOGY)	LS	\$20,000	\$10,236,800
	TOTAL PRESENT-WORTH COST			\$10,237,000

COST ESTIMATE

Alternative 4 – Reverse Osmosis Membrane Wellhead Treatment

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ALTERNATIVE 4 COST ESTIMATE ASSUMPTIONS

The cost estimate assumes the following phases and activities:

Pre-Design Activities/Design

1. Confirm the existing submersible pump(s) in Wells 1/4 and Well 9 are in good working order and can overcome the new back pressure from the treatment system.
2. Collect bulk water samples from each well and submit for bench scale treatability testing to confirm water quality parameters, anticipated reject water concentrations, and the likely changeout frequency of secondary carbon treatment to refine the system design.
3. Determine if a central treatment plant would be more cost effective than two separate systems.
4. Complete pre-construction site evaluation, topographic survey, and utility locate within the work area.
5. Prepare design including plans, specifications, and a formal bid package.
6. Procure Contractor through formal bid process.
7. Contractor to complete pre-construction work plans.

Implementation

1. Acquire applicable permits.
2. Conduct mobilization/demobilization of construction crew and equipment.
3. Conduct general site preparation work and erosion control.
4. Identify and protect utilities/utility in the work area.
5. Complete site earthwork including trenching for influent and effluent piping, preparation of building foundation, and sanitary sewer connection.
6. Install new treatment building foundation, building, and associated equipment (booster pump, breakout storage tank, and two reverse osmosis [RO] treatment skids).
7. The RO skids will consist of the following pre-packaged systems:
 - a. Wells 1/4: Evoqua Vantage RO M86R072PSAD.
 - b. Well 9: A specific RO system model was not obtained because vendors were not responsive.
8. The GAC secondary treatment systems will consist of the following, which will come pre-packaged:
 - a. Wells 1/4: Calgon Carbon Model 6 carbon adsorber system with 8-inch piping.
 - b. Well 9: Calgon Carbon Model 8 carbon adsorber system with 8-inch piping.
9. The anti-scalant system will be skidded and will include a chemical feeder, dual dosing pumps, chlorinated PVC (CPVC) piping, a calibration column, and isolation valves.
10. The backwash system will be skidded as well, with a tank, immersion heater, PVC piping, centrifugal pump, NEMA 4X panel.
11. The GAC backwash systems will each include PVC piping, one centrifugal pump, sight glass, flow meter, isolation and control valves, and a variable frequency drive motor controller.
12. Transfer pumps will be installed at each site to route dirty water from the backwash process back to the GAC system for treatment.
 - a. Wells 1/4: Goulds Model 3656 S, 35 gpm, 230-foot head
 - b. Well 9: Goulds Model 3656 M, 90 gpm, 230-foot head
13. The inline booster pump at each system will be Goulds Model SSH-22SH stainless-steel end suction centrifugal pump with 30-hp motor.

14. The pre-filtration equipment installed at each well will be Cary Company part number SMB-30-30-BF, which is a multi-chamber stainless-steel bag filter housing that holds eight size #2 poly bag filters. It has 8-inch flange connections and is certified NSF 61 listed and ASME-certified pressure vessel. There will be one filter needed at Wells 1/4 and two for Well 9, where the higher flow will be split.
15. Make all piping connections from the existing wellhead piping to the new RO system and to the existing water main.
16. Complete electrical service installation to provide power the treatment building and associated equipment, and control the system including electrical transformers and either buried or overhead service lines.
17. Dispose offsite or spread out onsite unusable excavated soil from trenching. Water from system testing can be stored for future treatment or allowed to evaporate/infiltrate.
18. Add lighting, heat, security system, and insulation to the new building.
19. Construction oversight for 5 months by third-party consultant and for first month of startup assuming both systems are constructed at the same time.
20. System startup, shakedown, and operation for 12 months by installation Contractor assuming both systems are constructed at the same time.

Monitoring

1. Document flowrate and total flow into and out of the RO treatment system.
2. Perform weekly performance monitoring of influent groundwater and treated drinking water for PFAS for the first month, then monthly for the rest of the first year.
3. After the first year, complete quarterly sampling and analysis of influent and effluent samples for 29 years. Analyze for PFAS including one field duplicate sample every quarter.
4. Routine sampling of existing supply well(s) for typical drinking water requirements from the Airway Heights monitoring program are not included in alternative cost and are assumed to be completed by the City of Airway Heights.
5. Complete ongoing particulate bag filter monitoring for clogging/fouling.
6. Complete manufacturer's recommended membrane equipment monitoring for fouling.

Operation and Maintenance

1. Operation of the treatment system for 30 years – Assumes Airway Heights conducts the work but FAFB reimburses the City.
2. Maintenance of treatment system for 30 years – Assumes Airway Heights conducts the work but FAFB reimburses the City.
3. O&M of the water supply well and pump is assumed to be the responsibility of the City of Airway Heights.
4. Ongoing transportation and regeneration of spent carbon from the GAC system.
5. Inspection of GAC vessel interior screen and wall coating to be completed every 10 years and repaired if necessary.
6. Replacement of membranes assumed to be completed every 5 years.
7. Utility usage (electrical) for the treatment system components only. Electricity consumption for the water supply well itself is assumed to be the responsibility of the City of Airway Heights.

Closeout

1. Conduct Contractor demobilization after construction is complete, including general site restoration work.
2. Provide Contractor training of Airway Heights personnel for changeover of O&M activities after initial 12 months of operation.
3. Prepare completion report and closeout submittals (e.g., as-built drawings).

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Table A-5
Summary of Alternative Costs
Alternative 4 - ROM Wellhead Treatment System for Wells 1/4

Task	Cost
IMPLEMENTATION COSTS	
Remedial Design, Planning, and General (Indirect Costs)	\$416,300
Indirect Contingency and Unlisted Engineering Services Assumed (%)	15
Remedial Action Construction including Sales Tax (Direct Costs)	\$2,206,600
Direct Contingency and Unlisted Items Assumed (%)	25
Site Inspection and Overhead (USACE)	\$209,900
Total Implementation Costs	\$2,832,800
OM&M COSTS	
Annualized O&M Costs	\$335,380
O&M Contingency and Unlisted Items Assumed (%)	25
O&M Duration (years)	30
Annualized Monitoring & Reporting Costs	\$41,280
Monitoring Contingency and Unlisted Items Assumed (%)	20
Monitoring Duration (years)	30
Non-Routine OM&M	\$123,500
Non-Routine Contingency and Unlisted Items Assumed (%)	30
Total OM&M Costs	\$11,424,000
TOTALS	
Total Implementation and OM&M Costs	\$14,256,800
Estimated Agency Oversight Costs	\$20,000
Total Escalated Costs ^a	\$18,493,000
Total Project Present Worth ^b	\$13,560,000

^a Escalated costs were calculated using a 2.0% inflation rate

^b Present worth costs were calculated using a 0.4% discount rate

Notes:

Discount Rate (0.4%) = Interest Rate (2.4%) - Inflation (2.0%)

Remedial Action Construction Costs includes Washington State Sales Tax at 9.1%

OM&M - Operation, Maintenance, and Monitoring

O&M - Operation and Maintenance

Alternative 4 - ROM Wellhead Treatment System for Wells 1/4

Client	USACE, Fairchild AFB	Report Date	June 2021
Location	City of Airway Heights		
Project	EE/CA, Fairchild Air Force Base at		
Site Name	Wells 1/4		
Estimator	Gus Friedman, AECOM	Affected Media	Drinking Water
QA Reviewer	Cary Brown, AECOM	COCs	PFOS, PFOA
		Flowrate (Nominal)	350 gpm
		Flowrate (Max)	450 gpm
Site/Problem Description	Groundwater pumped from COAH water supply well 1/4 has PFAS (PFOA at 300 ppt and PFOS at 1,100 ppt) concentrations above EPA Health Advisory limit of 70 ppt.		
Proposed Remedial Action	Drinking water from existing COAH Well 1/4 will be rerouted into a newly constructed Reverse Osmosis (RO) treatment system at a sustained flow of 350 gpm. Flow will initially pass through bag filters for large particle particulate removal, then through one RO membrane treatment skid for PFOS and PFOA removal. The treated effluent will flow into a clearwell tank. The reject stream will flow into a secondary treatment with two 6,000-lb GAC vessels for secondary PFOS/PFOA removal. The treated water from secondary treatment will flow into the same clearwell, from which a booster pump will maintain a minimum of 75 psi discharge pressure to the COAH water main.		
Alternative Specific Assumptions	- Costs presented have an accuracy of +50% to -30% and are suitable for comparing alternatives. - Washington State Sales Tax is applied to Direct Costs only at 9.1%. - Discount Rate is 0.4% per Office of Management and Budget, Circular A-94 Appendix C, Revised Nov. 2019. - The RO/GAC treatment system will be contained inside a 55 x 40 x 25 ft tall climate-controlled building - The system will have one single pass RO membrane skid for initial PFOS/PFOA treatment. - The RO skids will achieve a maximum 80% recovery (Evoqua Vantage RO M86R072PSAD) and will remove up to 99% of PFAS. - The secondary treatment system for the RO reject stream will be two 6,000-lb GAC vessels (6 ft diameter) filled with virgin GAC (Calgon FiltraSorb 400 or equal). - The existing submersible pump(s) are in good working order and will be reused. - O&M of the well and submersible pump is not included because it is assumed to be COAH's responsibility. - The system will be designed for a maximum flowrate of 450 gpm, but the nominal flowrate will be 350 gpm. - The RO and GAC equipment will be NSF-certified for drinking water. - No additional water treatment or chlorination equipment is needed and is thus not included. - The membranes will be need replacing as they degrade every 5 years. - A backwash system is included to scour the membranes of any fouling and includes a 600-gal storage AST. - An antiscalant chemical feed system is included to limit fouling of the membranes. - The lead vessel of the GAC system will need replacing approximately every 6 months when PFAS concentrations reach 70 ppt at the midpoint. RO reject stream PFAS concentration is an estimated 5,540 ppt, based on Evoqua estimates that 25% of influent flow is rejected and 99% of influent PFAS is rejected. - The GAC system is designed for a maximum flowrate of 115 gpm, but the nominal flowrate will be 90 gpm. - Empty bed contact time will be greater than 20 minutes (10 minutes per vessel) at 450 gpm. - GAC vessels will be ASME rated pressure vessels. - A backwash system rated at maximum flowrate of 300 gpm is included for the secondary GAC system.		

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION	REMEDIAL DESIGN, PLANNING, AND GENERAL (Indirect Costs)						
	\$362,000	1	Project management (5 hrs per week)	6	MO	\$3,250	\$19,500
	<u>With Contingency</u>	2	General coordination, meetings, and planning	1	LS	\$12,500	\$12,500
	\$416,300	3	Regulatory coordination and meetings (% of DC)	1	%	\$2,206,600	\$22,100
		4	Engineering Design/Basis of Design Report	120	HR	\$125	\$15,000
		5	Water Quality Assessment/Bench Testing	1	EA	\$50,000	\$50,000
		6	Design Plans and Specs	6	%	\$2,206,600	\$132,400
		7	Engineers Estimate	80	HR	\$125	\$10,000
		8	Permitting Support	1	LS	\$5,000	\$5,000
		9	Bid and RFI support	40	HR	\$125	\$5,000
		10	Work Plan (CMP/SAP)	150	HR	\$110	\$16,500
		11	Construction oversight & QA (1 person 1/2 time)	6	MO	\$8,667	\$52,000
		12	Reporting	200	HR	\$110	\$22,000
	Subtotal Costs						\$362,000
	Indirect Contingency and Unlisted Engineering Services (%)			15	%	\$362,000	\$54,300
	TOTAL INDIRECT COST						\$416,300

Alternative 4 - ROM Wellhead Treatment System for Wells 1/4 (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION (Continued)	REMEDIAL ACTION CONSTRUCTION (Direct Costs)						
	\$1,345,400	1	Mobilization/Demobilization	1	LS	\$25,000	\$25,000
	<u>With Contingency</u>	2	Site preparation & erosion control	5,000	SF	\$2	\$10,000
	\$1,681,800	3	Specialty Contractors (Utility locate, Survey)	1	LS	\$10,000	\$10,000
		4	Jobsite trailer, printer/copy machine, generator, tools, portable toilet, and safety supplies	6	MO	\$7,500	\$45,000
		5	RO skids, antiscalant feed system, backwash skid	1	EA	\$250,000	\$250,000
		6	Treatment building (55'x40'x25') with roll up door	1	EA	\$202,500	\$202,500
		7	Concrete pad for RO treatment system building	1	LS	\$75,000	\$75,000
		8	Labor for all RO system equipment installation and piping connections inside the building	13	WK	\$16,000	\$208,000
		9	Pipe (10-inch PVC)	500	FT	\$33	\$16,300
		10	Pipe installation - above ground (400 ft)	1	LS	\$16,800	\$16,800
		11	Pipe installation - below ground (100 ft)	1	LS	\$10,000	\$10,000
		12	Electrical equipment, materials, & install labor	8	WK	\$10,000	\$80,000
		13	Bag filter housing, with first year of bag filters	1	LS	\$30,000	\$30,000
		14	GAC secondary treatment system	1	LS	\$200,000	\$200,000
		15	Backwash tanks (8,000 gal) and shipping	2	EA	\$10,000	\$20,000
		16	GAC backwash pump	1	EA	\$2,000	\$2,000
		17	Transfer pump	1	EA	\$2,300	\$2,300
		18	Booster pump (500 gpm, 200 ft H2O, 20 hp)	1	LS	\$8,500	\$8,500
		19	Clearwell tank (5,500 gal) and shipping to site	1	EA	\$44,100	\$44,100
		20	Meters and control equipment	1	LS	\$20,000	\$20,000
		21	Valves and fittings	1	LS	\$30,000	\$30,000
		22	General site cleanup and misc. restoration	1	LS	\$10,000	\$10,000
		23	Startup and shakedown testing (1 month)	1	LS	\$20,000	\$20,000
		24	Initial O&M and handoff training	3	MO	\$3,000	\$9,000
		25	Initial electricity for equipment inside building	3	MO	\$300	\$900
	CONTAMINATED WASTE DISPOSAL AND TRANSPORTATION (Direct Costs)						
	\$2,900	1	Transportation & Disposal Coordination	8	HR	\$100	\$800
	<u>With Contingency</u>	2	Transportation & Disposal Non-Hazardous Waste	30	TN	\$70	\$2,100
	\$3,600	3	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$1,348,300
	Direct Cost Contingency and Unlisted Items (%)			25	%	\$1,348,300	\$337,100
	Contractor Bond Fee, Overhead, and Profit (%)			20	%	\$1,685,400	\$337,100
	Washington State Sales Tax (%)			9.1	%	\$2,022,500	\$184,100
	TOTAL DIRECT COST						\$2,206,600
	TOTAL DIRECT AND INDIRECT IMPLEMENTATION COSTS						
		1	Total Indirect Costs (see above)	--	--	--	\$416,300
		2	Total Direct Costs (see above)	--	--	--	\$2,206,600
		3	Site Inspection and Overhead Costs (USACE)	8	%	\$2,622,900	\$209,900
	TOTAL IMPLEMENTATION COST			Years until Implementation	3	#	\$2,832,800
	Escalated Implementation Cost			Presumed Inflation Rate	2.00	%	\$3,006,200
	Present-Worth Implementation Cost			Presumed Discount Rate	0.40	%	\$2,799,100

Alternative 4 - ROM Wellhead Treatment System for Wells 1/4 (Continued)

DETAILED COST ESTIMATE								
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs	
OM&M	ANNUAL OPERATION & MAINTENANCE							
	\$268,300	1	Project Management and Coordination (4 hrs/mon)	48	HR	\$150	\$7,200	
	With Contingency	2	Annual O&M Reporting	80	HR	\$110	\$8,800	
	\$335,380	3	Vehicle Rental & Gas	16	DY	\$70	\$1,200	
		4	O&M Labor (3 hr monthly site checks)	12	MO	\$500	\$6,000	
		5	O&M Labor (3 hr daily remote checks)	353	DY	\$300	\$105,900	
		6	O&M Labor (16 hr quarterly cleaning)	8	DY	\$1,000	\$8,000	
		7	O&M Supplies and Equipment	12	MO	\$250	\$3,000	
		8	O&M antiscalant chemical feed	12	MO	\$250	\$3,000	
		9	Membrane changeouts	1	LS	\$1,200	\$1,200	
		10	Virgin Carbon including off site regeneration	16,000	LS	\$1.75	\$28,000	
		11	Electricity for building and equipment	12	MO	\$8,000	\$96,000	
	Total Routine Annual O&M Cost							\$268,300
	Subtotal Costs		Years of Annual O&M		30			\$8,049,000
	O&M Cost Contingency and Unlisted Items (%)				25	%	\$8,049,000	\$2,012,250
	TOTAL O&M COST							\$10,061,300
	Escalated O&M Cost			Presumed Inflation Rate	2.00	%	\$13,605,600	
	Present-Worth O&M Cost			Presumed Discount Rate	0.40	%	\$9,463,300	
	ANNUAL MONITORING & REPORTING							
	\$34,400	1	Project Management & Coordination (8 hrs/event)		32	HR	\$150	\$4,800
	With Contingency	2	Quarterly Sampling Reporting		4	EA	\$2,640	\$10,600
	\$41,280	3	Vehicle Rental and Gas		4	DY	\$70	\$300
		4	Monitoring Labor		4	DY	\$1,000	\$4,000
		5	Monitoring Supplies and Equipment		1	LS	\$3,000	\$3,000
		6	Analytical Testing		4	LS	\$2,915	\$11,700
		7	Not Used		0	EA	\$0	\$0
	Total Routine Annual Monitoring Cost							\$34,400
	Subtotal Costs		Years of Annual Monitoring		30			\$1,032,000
	Monitoring Cost Contingency and Unlisted Items (%)				20	%	\$1,032,000	\$206,400
	TOTAL MONITORING & REPORTING COST							\$1,238,400
	Escalated Monitoring Cost			Presumed Inflation Rate	2.00	%	\$1,674,700	
	Present-Worth Monitoring Cost			Presumed Discount Rate	0.40	%	\$1,164,800	
	NON-ROUTINE OM&M							
	\$95,000	1	Minor system repairs and tweaks (Year 5)		1	LS	\$5,000	\$5,000
	With Contingency	2	Non-routine pump replacement/repair (Year 8)		1	LS	\$10,000	\$10,000
	\$123,500	3	Major system repairs (Year 15)		1	LS	\$35,000	\$35,000
		4	Non-routine pump replacement/repair (Year 23)		1	LS	\$10,000	\$10,000
		5	Major system repair (Year 30)		1	LS	\$35,000	\$35,000
		6	Not Used		0			
	Subtotal Costs							\$95,000
	Non-Routine Cost Contingency and Unlisted Items (%)				30	%	\$95,000	\$28,500
	TOTAL CLOSURE COST							\$123,500
	Escalated Closure Cost			Presumed Inflation Rate	2.00	%	\$186,600	
	Present-Worth Closure Cost			Presumed Discount Rate	0.40	%	\$114,100	
	OM&M COSTS					TOTAL	ESCALATED	Present-Worth
		1	Total O&M Costs (see above)			\$10,061,300	\$13,605,600	\$9,463,300
		2	Total Monitoring Costs (see above)			\$1,238,400	\$1,674,700	\$1,164,800
		3	Total Non-Routine OM&M			\$123,500	\$186,600	\$114,100
	TOTAL OM&M COSTS					\$11,424,000	\$15,467,000	\$10,743,000

Alternative 4 - ROM Wellhead Treatment System for Wells 1/4 (Continued)

TOTAL	ALTERNATIVE COST SUMMARY		Rounded	Cumulative
			Total	Total
	TOTAL PRESENT-WORTH IMPLEMENTATION COST (DIRECT & INDIRECT)		\$2,799,100	\$2,799,100
	TOTAL PRESENT-WORTH OM&M COST		\$10,743,000	\$13,542,100
	AGENCY OVERSIGHT (EPA and/or ECOLOGY)		LS \$20,000	\$13,562,100
	TOTAL PRESENT-WORTH COST			\$13,560,000

Table A-6
Summary of Alternative Costs
Alternative 4 - ROM Wellhead Treatment System for Well 9

Task	Cost
IMPLEMENTATION COSTS	
Remedial Design, Planning, and General (Indirect Costs)	\$491,400
Indirect Contingency and Unlisted Engineering Services Assumed (%)	15
Remedial Action Construction including Sales Tax (Direct Costs)	\$3,138,500
Direct Contingency and Unlisted Items Assumed (%)	25
Total Implementation Costs	\$3,920,300
OM&M COSTS	
Annualized O&M Costs	\$573,630
O&M Contingency and Unlisted Items Assumed (%)	25
O&M Duration (years)	30
Annualized Monitoring & Reporting Costs	\$41,280
Monitoring Contingency and Unlisted Items Assumed (%)	20
Monitoring Duration (years)	30
Non-Routine OM&M	\$123,500
Non-Routine Contingency and Unlisted Items Assumed (%)	30
Total OM&M Costs	\$18,571,000
TOTALS	
Total Implementation and OM&M Costs	\$22,491,300
Estimated Agency Oversight Costs	\$20,000
Total Escalated Costs ^a	\$29,313,000
Total Project Present Worth ^b	\$21,360,000

^a Escalated costs were calculated using a 2.0% inflation rate

^b Present worth costs were calculated using a 0.4% discount rate

Notes:

Discount Rate (0.4%) = Interest Rate (2.4%) - Inflation (2.0%)

Remedial Action Construction Costs includes Washington State Sales Tax at 9.1%

OM&M - Operation, Maintenance, and Monitoring

Cost Type

Alternative 4 - ROM Wellhead Treatment System for Well 9

Client	USACE, Fairchild AFB	Report Date	June 2021
Location	City of Airway Heights		
Project	EE/CA, Fairchild Air Force Base and City of Airway Heights, Washington		
Site Name	Well 9		
Estimator	Gus Friedman, AECOM	Affected Media	Drinking Water
QA Reviewer	Cary Brown, AECOM	COCs	PFOS/PFOA
		Flowrate (Nominal)	1,000 gpm
		Flowrate (Max)	1,200 gpm

Site/Problem Description Groundwater pumped from COAH water supply Well 9 has PFAS (PFOA at 320 ppt and PFOS at 1,200 ppt) concentrations above EPA Health Advisory limit of 70 ppt.

Proposed Remedial Action Drinking water from existing COAH Well 9 will be rerouted into a newly constructed Reverse Osmosis (RO) treatment system at a sustained flow of 1,000 gpm. Flow will initially pass through bag filters for large particle particulate removal, then through one RO membrane treatment skid for PFOS and PFOA removal. The treated effluent will flow into a clearwell tank. The reject stream will flow at 250 gpm into secondary treatment with two 10,000 lb-GAC vessels for secondary PFOS/PFOA removal. The treated water from secondary treatment will flow into the same clearwell, from which a booster pump will maintain a minimum of 75 psi discharge pressure to the COAH water main.

Alternative Specific Assumptions	1	Costs presented have an accuracy of +50% to -30% and are suitable for comparing alternatives.
	2	Washington State Sales Tax is applied to Direct Costs only at 9.1%.
	3	Discount Rate is 0.4% per Office of Management and Budget, Circular A-94 Appendix C, Revised Nov. 2019.
	4	The RO/GAC treatment system will be contained inside a 60' x 50' x 25' tall climate controlled building.
	5	The system will have one single pass RO membrane skid for initial PFOS/PFOA treatment.
	6	The RO skids will achieve a maximum 80% recovery (Evoqua Vantage RO M86R072PSAD) and will remove up to 99% of PFAS.
	7	The secondary treatment system for the RO reject stream will be two 10,000 lb GAC vessels (8-ft) filled with virgin GAC (Calgon FiltraSorb 400 or equal).
	8	The existing submersible pump(s) are in good working order and will be reused.
	9	O&M of the well and submersible pump are not included because it is assumed to be COAH's responsibility.
	10	The RO system is designed for a maximum flowrate of 1,200 gpm, but the nominal flowrate will be 1,000 gpm.
	11	The GAC system is designed for a maximum flowrate of 250 gpm so the RO system is limited to 1,000 gpm.
	12	The RO and GAC equipment will be NSF-certified for drinking water.
	13	No additional water treatment or chlorination equipment is needed and is thus not included.
	14	The membranes will be replaced every 5 years, they degrade every 0-10 years, depending on water quality.
	15	A backwash system is included to scour the membranes of any fouling and includes a 600 gallon storage AST.
	16	An antiscalant chemical feed system is included to limit fouling of the membranes.
	17	The lead vessel of the GAC system will need replacing approximately every 6 months when PFAS concentrations reach 70 ppt at the midpoint. RO reject stream PFAS concentration is an estimated 6,019 ppt, based on Evoqua estimates that 25% of influent flow is rejected and 99% of influent PFAS is rejected in the RO filtration.
	18	Empty-bed contact time will be greater than 20 minutes (10 minutes per vessel) at 250 gpm.
	19	GAC vessels will be ASME rated pressure vessels.
	20	A backwash system rated at maximum flowrate of 350 gpm is included for the GAC system.

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION	REMEDIAL DESIGN, PLANNING, AND GENERAL (Indirect Costs)						
	\$427,300	1	Project management (5 hrs per week)	6	MO	\$3,250	\$19,500
	With Contingency	2	General coordination, meetings, and planning	1	LS	\$12,500	\$12,500
	\$491,400	3	Regulatory coordination and meetings (% of DC)	1	%	\$3,138,500	\$31,400
		4	Engineering Design/Basis of Design Report	120	HR	\$125	\$15,000
		5	Water Quality Assessment/Bench Testing	1	EA	\$50,000	\$50,000
		6	Design Plans and Specs	6	%	\$3,138,500	\$188,400
		7	Engineers Estimate	80	HR	\$125	\$10,000
		8	Permitting Support	1	LS	\$5,000	\$5,000
		9	Bid and RFI support	40	HR	\$125	\$5,000
		10	Work Plan (CMP/SAP)	150	HR	\$110	\$16,500
		11	Construction oversight & QA (1 person 1/2 time)	6	MO	\$8,667	\$52,000
		12	Reporting	200	HR	\$110	\$22,000
	Subtotal Costs						\$427,300
	Indirect Contingency and Unlisted Engineering Services (%)			15	%	\$427,300	\$64,095
	TOTAL INDIRECT COST						\$491,400

Alternative 4 - ROM Wellhead Treatment System for Well 9 (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION (Continued)	REMEDIAL ACTION CONSTRUCTION (Direct Costs)						
	\$1,914,800	1	Mobilization/Demobilization	1	LS	\$25,000	\$25,000
	With Contingency	2	Site preparation & erosion control	5,000	SF	\$2	\$10,000
	\$2,393,500	3	Specialty Contractors (Utility locate, Survey)	1	LS	\$10,000	\$10,000
		4	Jobsite trailer, printer/copy machine, generator, tools, portable toilet, and safety supplies	6	MO	\$7,500	\$45,000
		5	RO skid, antiscalant feed system, backwash skid	1	EA	\$666,700	\$666,700
		6	Treatment building (60'x50'x25') with roll up door	1	EA	\$276,000	\$276,000
		7	Concrete pad for RO treatment system building	1	LS	\$102,000	\$102,000
		8	Labor for all RO system equipment installation and piping connections inside the building	13	WK	\$16,000	\$208,000
		9	Pipe (10-inch PVC)	500	FT	\$33	\$16,300
		10	Pipe installation - above ground (400 ft)	1	LS	\$16,800	\$16,800
		11	Pipe installation - below ground (100 ft)	1	LS	\$10,000	\$10,000
		12	Electrical equipment, materials, & install labor	8	WK	\$10,000	\$80,000
		13	Bag filter housing, with first year of bag filters	1	LS	\$30,000	\$30,000
		14	GAC secondary treatment system	1	LS	\$240,000	\$240,000
		15	Backwash tanks (8,000 gal) and shipping	4	EA	\$8,000	\$32,000
		16	GAC backwash pump	1	EA	\$3,900	\$3,900
		17	Transfer pump	1	EA	\$3,600	\$3,600
		18	Booster pump (500 gpm, 200 ft H2O, 20 hp)	1	LS	\$8,500	\$8,500
		19	Clearwell tank (5,000 gal) and shipping to site	1	EA	\$41,100	\$41,100
		20	Meters and control equipment	1	LS	\$20,000	\$20,000
		21	Valves and fittings	1	LS	\$30,000	\$30,000
		22	General site cleanup and misc. restoration	1	LS	\$10,000	\$10,000
		23	Startup and shakedown testing (1 month)	1	LS	\$20,000	\$20,000
		24	Initial O&M and handoff training	3	MO	\$3,000	\$9,000
		25	Initial electricity for equipment inside building	3	MO	\$300	\$900
	CONTAMINATED WASTE DISPOSAL AND TRANSPORTATION (Direct Costs)						
	\$2,900	1	Transportation & Disposal Coordination	8	HR	\$100	\$800
	With Contingency	2	Transportation & Disposal Non-Hazardous Waste	30	TN	\$70	\$2,100
	\$3,600	3	Not Used	0	EA	\$0	\$0
		4	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$1,917,700
	Direct Cost Contingency and Unlisted Items (%)			25	%	\$1,917,700	\$479,500
	Contractor Bond Fee, Overhead, and Profit (%)			20	%	\$2,397,200	\$479,500
	Washington State Sales Tax (%)			9.1	%	\$2,876,700	\$261,800
	TOTAL DIRECT COST						\$3,138,500
	TOTAL DIRECT AND INDIRECT IMPLEMENTATION COSTS						
		1	Total Indirect Costs (see above)	--	--	--	\$491,400
		2	Total Direct Costs (see above)	--	--	--	\$3,138,500
		3	Site Inspection and Overhead Costs (USACE)	8	%	\$3,629,900	\$290,400
	TOTAL IMPLEMENTATION COST			Years until Implementation	3	#	\$3,920,300
	Escalated Implementation Cost			Presumed Inflation Rate	2.00	%	\$4,160,300
	Present-Worth Implementation Cost			Presumed Discount Rate	0.40	%	\$3,873,600

Alternative 4 - ROM Wellhead Treatment System for Well 9 (Continued)

DETAILED COST ESTIMATE								
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs	
OM&M	ANNUAL OPERATION & MAINTENANCE							
	\$458,900	1	PM and Coordination (4 hrs/mon)	48	HR	\$150	\$7,200	
	With Contingency	2	Annual O&M Reporting	80	HR	\$110	\$8,800	
	\$573,630	3	Vehicle Rental & Gas	16	DY	\$70	\$1,200	
		4	O&M Labor (3 hr monthly site checks)	12	MO	\$500	\$6,000	
		5	O&M Labor (3 hr daily remote checks)	353	DY	\$300	\$105,900	
		6	O&M Labor (16 hr quarterly cleaning)	8	DY	\$1,000	\$8,000	
		7	O&M Supplies and Equipment	12	MO	\$250	\$3,000	
		8	O&M antiscalant chemical feed	12	MO	\$250	\$3,000	
		9	Membrane changeouts	1	LS	\$3,600	\$3,600	
		10	Carbon Changeout (10,000 lbs virgin carbon) including off site regeneration (cost prorated to account for 6 months until breakthrough, which is equal to 20,000 lbs per year)	1	LS	\$35,000	\$35,000	
		11	Electricity for building and equipment	12	MO	\$23,100	\$277,200	
	Total Routine Annual O&M Cost							\$458,900
	Subtotal Costs		Years of Annual O&M		30			\$13,767,000
	O&M Cost Contingency and Unlisted Items (%)				25	%	\$13,767,000	\$3,441,750
	TOTAL O&M COST							\$17,208,800
	Escalated O&M Cost		Presumed Inflation Rate		2.00	%	\$23,270,900	
	Present-Worth O&M Cost		Presumed Discount Rate		0.40	%	\$16,185,900	
	ANNUAL MONITORING & REPORTING							
	\$34,400	1	Project Management & Coordination (8 hrs/event)		32	HR	\$150	\$4,800
	With Contingency	2	Quarterly Sampling Reporting		4	EA	\$2,640	\$10,600
	\$41,280	3	Vehicle Rental and Gas		4	DY	\$70	\$300
		4	Monitoring Labor		4	DY	\$1,000	\$4,000
		5	Monitoring Supplies and Equipment		1	LS	\$3,000	\$3,000
		6	Analytical Testing		4	LS	\$2,915	\$11,700
		7	Not Used		0	EA	\$0	\$0
	Total Routine Annual Monitoring Cost							\$34,400
	Subtotal Costs		Years of Annual Monitoring		30			\$1,032,000
	Monitoring Cost Contingency and Unlisted Items (%)				20	%	\$1,032,000	\$206,400
	TOTAL MONITORING & REPORTING COST							\$1,238,400
	Escalated Monitoring Cost		Presumed Inflation Rate		2.00	%	\$1,674,700	
	Present-Worth Monitoring Cost		Presumed Discount Rate		0.40	%	\$1,164,800	
	NON-ROUTINE OM&M							
	\$95,000	1	Minor system repairs and tweaks (Year 5)		1	LS	\$5,000	\$5,000
	With Contingency	2	Non-routine pump replacement/repair (Year 8)		1	LS	\$10,000	\$10,000
		3	Major system repairs (Year 15)		1	LS	\$35,000	\$35,000
	\$123,500	4	Non-routine pump replacement/repair (Year 23)		1	LS	\$10,000	\$10,000
		5	Major system repair (Year 30)		1	LS	\$35,000	\$35,000
		6	Not Used		0			
	Subtotal Costs							\$95,000
	Non-Routine Cost Contingency and Unlisted Items (%)				30	%	\$95,000	\$28,500
	TOTAL CLOSURE COST							\$123,500
	Escalated Closure Cost		Presumed Inflation Rate		2.00	%	\$186,600	
	Present-Worth Closure Cost		Presumed Discount Rate		0.40	%	\$114,100	
	OM&M COSTS					TOTAL	ESCALATED	Present-Worth
		1	Total O&M Costs (see above)			\$17,208,800	\$23,270,900	\$16,185,900
		2	Total Monitoring Costs (see above)			\$1,238,400	\$1,674,700	\$1,164,800
		3	Total Non-Routine OM&M			\$123,500	\$186,600	\$114,100
	TOTAL OM&M COSTS					\$18,571,000	\$25,133,000	\$17,465,000

Alternative 4 - ROM Wellhead Treatment System for Well 9 (Continued)

TOTAL	ALTERNATIVE COST SUMMARY		Rounded Total	Cumulative Total
	TOTAL PRESENT-WORTH IMPLEMENTATION COST (DIRECT & INDIRECT)		\$3,873,600	\$3,873,600
	TOTAL PRESENT-WORTH OM&M COST		\$17,465,000	\$21,338,600
	AGENCY OVERSIGHT (EPA and/or ECOLOGY)	LS	\$20,000	\$21,358,600
	TOTAL PRESENT-WORTH COST			\$21,360,000

COST ESTIMATE

**Alternative 5 – New Water Supply Well with
Connection to Airway Heights Water System**

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Table A-7

Summary of Alternative Costs

Alternative 5 - New Water Supply Well with Connection to Airway Heights Water System

Task	Cost
IMPLEMENTATION COSTS	
Remedial Design, Planning, and General (Indirect Costs)	\$1,394,700
Indirect Contingency and Unlisted Engineering Services Assumed (%)	15
Remedial Action Construction including Sales Tax (Direct Costs)	\$13,448,700
Direct Contingency and Unlisted Items Assumed (%)	25
Site Inspection and Overhead (USACE)	\$1,187,500
Total Implementation Costs	\$16,030,900
OM&M COSTS	
Annualized O&M Costs	\$303,250
O&M Contingency and Unlisted Items Assumed (%)	25
O&M Duration (years)	1
Annualized Monitoring & Reporting Costs	\$41,280
Monitoring Contingency and Unlisted Items Assumed (%)	20
Monitoring Duration (years)	1
Non-Routine OM&M	\$0
Non-Routine Contingency and Unlisted Items Assumed (%)	30
Total OM&M Costs	\$345,000
TOTALS	
Total Implementation and OM&M Costs	\$16,375,900
Estimated Agency Oversight Costs	\$20,000
Total Escalated Costs ^a	\$17,377,000
Total Project Present Worth ^b	\$16,200,000

^a Escalated costs were calculated using a 2.0% inflation rate

^b Present worth costs were calculated using a 0.4% discount rate

Notes:

Discount Rate (0.4%) = Interest Rate (2.4%) - Inflation (2.0%)

Remedial Action Construction Costs includes Washington State Sales Tax at 9.1%

OM&M - Operation, Maintenance, and Monitoring

O&M - Operation and Maintenance

Alternative 5 - New Water Supply Well with Connection to Airway Heights Water System

Client	USACE, Fairchild AFB	Report Date	June 2021
Location	City of Airway Heights		
Project	EE/CA, Fairchild Air Force Base and City of Airway Heights, Washington		
Site Name	New Supply Wells in SVRP Aquifer and Piping, Abandonment of Wells 1/4 and 9		
		Affected Media	Drinking Water
Estimator	Scott Dressler, Brice	COCs	PFOS, PFOA
QA Reviewer	Cary Brown, AECOM	Flowrate (Nominal)	1014 gpm
		Flowrate (Max)	1600 gpm

Site/Problem Description Groundwater pumped from COAH water supply Wells 1/4 has PFAS (PFOA at 320 ppt and PFOS at 1,200 ppt) concentrations above EPA Health Advisory limit of 70 ppt. Groundwater pumped from COAH water supply Well 9 has PFAS (PFOA at 320 ppt and PFOS at 1,200 ppt) concentrations above EPA Health Advisory limit of 70 ppt.

Proposed Remedial Action This alternative involves the abandonment of Wells 1/4 and 9; transfer of COAH water rights; construction of new water supply wells in the SVRP Aquifer (primary and redundant wells), to replace the existing PFAS-contaminated supply from Wells 1/4; and construction of a new pumphouse building, submersible well pump, and two booster pumps in the building. The new well(s) will be designed to provide an average supply of 1,014 gpm. This alternative also includes construction of a 30,000-foot pipeline to the COAH water distribution system.

Alternative Specific Assumptions	1	Costs presented have an accuracy of +50% to -30% and are suitable for comparing alternatives.
	2	Washington State Sales Tax is applied to Direct Costs only at 9.1%.
	3	Discount Rate is 0.4% per Office of Management and Budget, Circular A-94 Appendix C, Revised Nov. 2019.
	4	Drilling of two new 12-inch-diameter water wells to supply at least 1,014 gpm of water. The quantity of wells needed will depend on the capacity of the aquifer in the location selected, but only one primary well, with one redundant well, is assumed for this alternative.
	5	This alternative assumes a redundant/backup well will be installed and have its own dedicated pump.
	6	The new well will be located near the Spokane River and is assumed to be 80 feet deep. The borehole annulus will be 20 to 24 inches in diameter, and the well screen will be 12-inch continuous wire-wrapped stainless steel.
	7	The new well pump is a Goulds 10DXC (~20 HP) with 8-inch drop pipe with Aquivar Variable Frequency Drive.
	8	The construction timeframe is assumed to be 1 year to complete.
	9	The system will be designed for a maximum flowrate of 1,600 gpm, but the nominal flowrate will be 1,014 gpm.
	10	O&M of the well and submersible pump are not included because it is assumed to be COAH's responsibility.
	11	The well equipment will be NSF 61 certified for drinking water.
	12	No additional wellhead water contaminant treatment equipment is needed or included.
	13	The system will include flowmeter, check valves, isolation valves, air release valves, pressure gauges, submersible pump, and two in-line booster pumps every 10,000 feet.
	13	Booster stations will be powered by electricity with natural gas backup generators.
	15	No major creek, river, or road crossings are included
	16	The new well will be connected to the COAH water distribution system at the corner of Sunset Highway (Highway 2) and South Hayford Road using a buried 16-inch diameter PVC pipeline approximately 30,000 feet long.
	17	Well abandonment includes mobilization and demobilization to Spokane, WA; abandonment of Well 1 (10-inch casing and screen to 175 feet bgs, Well 4 (12-inch casing and screen to 175 feet bgs) and Well 9 (16-inch casing and screen to 181 feet bgs). Cost includes all equipment, supplies (cement, bentonite) and disposal of removed equipment.

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION	REMEDIAL DESIGN, PLANNING, AND GENERAL (Indirect Costs)						
	\$1,212,800	1	Project management (5 hrs per week)	12	MO	\$3,250	\$39,000
	<u>With Contingency</u>	2	General coordination, meetings, and planning	1	LS	\$25,000	\$25,000
	\$1,394,700	3	Regulatory coordination and meetings (% of DC)	0.5	%	\$13,448,700	\$67,300
		4	Engineering Design / Basis of Design Report	240	HR	\$125	\$30,000
		5	Design Plans and Specs	6	%	\$13,448,700	\$807,000
		6	Engineers Estimate	160	HR	\$125	\$20,000
		7	Permitting Support	1	LS	\$20,000	\$20,000
		8	Bid and RFI support	100	HR	\$125	\$12,500
		9	Work Plan (CMP/SAP)	300	HR	\$110	\$33,000
		10	Construction oversight & QA (1 person 1/2 time)	12	MO	\$8,667	\$104,000
		11	Reporting	500	HR	\$110	\$55,000
		12	Not Used	0	EA	\$0	\$0
	Subtotal Costs						\$1,212,800
	Indirect Contingency and Unlisted Engineering Services (%)			15	%	\$1,212,800	\$181,920
	TOTAL INDIRECT COST						\$1,394,700

Alternative 5 - New Water Supply Well with Connection to Airway Heights Water System (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION (Continued)	REMEDIATION ACTION CONSTRUCTION (Direct Costs)						
	\$8,091,100	1	Mobilization/Demobilization (Well Install)	1	LS	\$127,000	\$127,000
	<u>With Contingency</u>	2	Borehole Drilling 20" Diameter to 80'	2	LS	\$29,840	\$59,700
	\$10,113,900	3	Well Install, 12.75" Diameter Well & Screen	2	LS	\$32,480	\$65,000
		4	Well Development, Pump Test	2	LS	\$50,311	\$100,700
		5	Permanent Pump, 8" Drop Pipe, Well Seal, Panel, Shed	2	LS	\$46,138	\$92,300
		6	Well Abandonment (Wells 1/4 and 9)	1	LS	\$147,175	\$147,200
		7	Variable Frequency Drive	2	EA	\$5,600	\$11,200
		8	SCADA, Chlorine Injector, & Shed	1	LS	\$25,000	\$25,000
		9	Well Enclosure Landscape, Security Fence, Cameras	1	LS	\$15,000	\$15,000
		10	Site Preparation & Erosion Control	300,000	SF	\$2	\$600,000
		11	Specialty Contractors (Utility locate, Survey)	10	Day	\$1,900	\$19,000
		12	Utility Clearing & Air Knife	1	LS	\$9,794	\$9,800
		13	Trench, Installation, Backfill, Paving Equip	1	LS	\$372,004	\$372,100
		14	Bedding Sand with Delivery	1	LS	\$192,888	\$192,900
		15	Hydro-seeding	1	LS	\$97,944	\$98,000
		16	Water Truck Service	1	LS	\$156,098	\$156,100
		17	Trench spoils disposal	1	LS	\$183,645	\$183,700
		18	Tracer Wire & detector tape	1	LS	\$9,097	\$9,100
		19	FOG, Deliveries, Water	1	LS	\$82,909	\$83,000
		20	Surveying & Staking	1	LS	\$6,122	\$6,200
		21	Professional Labor (Superintendent, QC)	1	LS	\$189,944	\$190,000
		22	Craft Labor	1	LS	\$2,117,066	\$2,117,100
		23	Jobsite trailer, printer/copy machine, generator, tools, portable toilets, conex, and safety supplies	12	MO	\$2,500	\$30,000
		24	C-900 16" dia., DR18, CL235 PVC GJ Blue Pipe	30,000	FT	\$55	\$1,660,200
		25	C-900 16" dia., Misc. Elbows & Flanges	1	LS	\$27,591	\$27,600
		26	500-5500 GPM Flow Meter	1	EA	\$4,866	\$4,900
		27	16" Flanged Check Valves	3	EA	\$18,315	\$55,000
		28	16" Flanged Isolation Valve Sets	6	EA	\$27,707	\$166,300
		29	Isolation Valve Vaults	4	EA	\$12,000	\$48,000
		30	2" CI Combination Air Release Valves	12	EA	\$1,110	\$13,400
		31	Air Release Valve Vault	12	EA	\$250	\$3,000
		32	NP 2.5" Pressure Gauges (0-300 PSI)	12	EA	\$25	\$300
		33	Booster Pumps Stations Powered by Electricity with 125 KW NG Backup Generator	2	LS	\$325,000	\$650,000
		34	Booster Pump CMU Control Building	2	LS	\$80,000	\$160,000
		35	Traffic Control	1	LS	\$397,898	\$397,900
		36	Electrical Equipment, Materials, & Install Labor	8	WK	\$10,000	\$80,000
		37	Install Vaults	20	EA	\$2,500	\$50,000
		38	Install Flow Meter and VFD Control Equipment	1	LS	\$8,000	\$8,000
		39	Install Valves and Fittings	1	LS	\$15,000	\$15,000
		40	General Site Cleanup and Misc. Restoration	1	LS	\$10,000	\$10,000
		41	Startup and Shakedown Testing (1 month)	1	LS	\$20,000	\$20,000
		42	Initial O&M and Handoff Training	3	MO	\$3,000	\$9,000
		43	Initial Electricity for Equipment	3	MO	\$800	\$2,400
	CONTAMINATED WASTE DISPOSAL AND TRANSPORTATION (Direct Costs)						
	\$126,800	1	Demolition Asphalt and Concrete Disposal	1	LS	\$16,528	\$16,600
	<u>With Contingency</u>	2	General Construction Waste Disposal	1	LS	\$110,187	\$110,200
	\$158,500	3	Not Used	0		\$0	\$0
		4	Not Used	0		\$0	\$0
		5	Not Used	0		\$0	\$0
		6	Not Used	0		\$0	\$0
		7	Not Used	0		\$0	\$0
		8	Not Used	0		\$0	\$0
	Subtotal Costs						\$8,217,900
	Direct Cost Contingency and Unlisted Items (%)			25	%	\$8,217,900	\$2,054,500
	Contractor Bond Fee, Overhead, and Profit (%)			20	%	\$10,272,400	\$2,054,500
	Washington State Sales Tax (%)			9.1	%	\$12,326,900	\$1,121,800

Alternative 5 - New Water Supply Well with Connection to Airway Heights Water System (Continued)

	TOTAL DIRECT COST						\$13,448,700
	TOTAL DIRECT AND INDIRECT IMPLEMENTATION COSTS						
		1	Total Indirect Costs (see above)	--	--	--	\$1,394,700
		2	Total Direct Costs (see above)	--	--	--	\$13,448,700
		3	Site Inspection and Overhead Costs (USACE)	8	%	\$14,843,400	\$1,187,500
	TOTAL IMPLEMENTATION COST			Years until Implementation	3	#	\$16,030,900
	Escalated Implementation Cost			Presumed Inflation Rate	2.00	%	\$17,012,100
	Present-Worth Implementation Cost			Presumed Discount Rate	0.40	%	\$15,840,100
	DETAILED COST ESTIMATE						
	Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs
OM&M	ANNUAL OPERATION & MAINTENANCE						
	\$242,600	1	Project Management and Coordination (4 hrs/mon)	48	HR	\$150	\$7,200
	<u>With Contingency</u>	2	Annual O&M Reporting	80	HR	\$110	\$8,800
	\$303,250	3	Vehicle Rental & Gas	16	DY	\$70	\$1,200
		4	O&M Labor (3 hr monthly site checks)	12	MO	\$500	\$6,000
		5	O&M Labor (3 hr daily remote checks)	353	DY	\$300	\$105,900
		6	O&M Labor (16 hr quarterly cleaning)	8	DY	\$1,000	\$8,000
		7	O&M Supplies and Equipment	12	MO	\$250	\$3,000
		8	O&M antiscalant chemical f	12	MO	\$250	\$3,000
		9	Electricity for building and equipment	12	MO	\$8,000	\$96,000
		10	Natural Gas for Booster Stations	0.5	MO	\$7,000	\$3,500
		11	Not Used	0	EA	\$0	\$0
	Total Routine Annual O&M Cost						\$242,600
	Subtotal Costs			Years of Annual O&M		1	\$242,600
	O&M Cost Contingency and Unlisted Items (%)			25	%	\$242,600	\$60,650
	TOTAL O&M COST						\$303,300
	Escalated O&M Cost			Presumed Inflation Rate	2.00	%	\$303,300
	Present-Worth O&M Cost			Presumed Discount Rate	0.40	%	\$302,100
	ANNUAL MONITORING & REPORTING						
	\$34,400	1	Project Management & Coordination (8 hrs/event)	32	HR	\$150	\$4,800
	<u>With Contingency</u>	2	Quarterly Sampling Reporting	4	EA	\$2,640	\$10,600
	\$41,280	3	Vehicle Rental and Gas	4	DY	\$70	\$300
		4	Monitoring Labor	4	DY	\$1,000	\$4,000
		5	Monitoring Supplies and Equipment	1	LS	\$3,000	\$3,000
		6	Analytical Testing	4	LS	\$2,915	\$11,700
		7	Not Used	0	HR	\$0	\$0
		8	Not Used	0	EA	\$0	\$0
	Total Routine Annual Monitoring Cost						\$34,400
	Subtotal Costs			Years of Annual Monitoring		1	\$34,400
	Monitoring Cost Contingency and Unlisted Items (%)			20	%	\$34,400	\$6,880
	TOTAL MONITORING & REPORTING COST						\$41,300
	Escalated Monitoring Cost			Presumed Inflation Rate	2.00	%	\$41,300
	Present-Worth Monitoring Cost			Presumed Discount Rate	0.40	%	\$41,200
	NON-ROUTINE OM&M						
	\$0	1	Not Used				\$0
	<u>With Contingency</u>	2	Not Used				\$0
		3	Not Used			LS	\$0
	\$0	4	Not Used			LS	\$0
		5	Not Used			LS	\$0
		6	Not Used				\$0
		7	Not Used	0			\$0
	Subtotal Costs						\$0
	Non-Routine Cost Contingency and Unlisted Items (%)			30	%	\$0	\$0
	TOTAL CLOSURE COST						\$0
	Escalated Closure Cost			Presumed Inflation Rate	2.00	%	\$0
	Present-Worth Closure Cost			Presumed Discount Rate	0.40	%	\$0
	OM&M COSTS				TOTAL	ESCALATED	PRESENT WORTH
		1	Total O&M Costs (see above)		\$303,300	\$303,300	\$302,100
		2	Total Monitoring Costs (see above)		\$41,300	\$41,300	\$41,200
		3	Total Non-Routine OM&M		\$0	\$0	\$0
	TOTAL OM&M COSTS				\$345,000	\$345,000	\$344,000

Alternative 5 - New Water Supply Well with Connection to Airway Heights Water System (Continued)

TOTAL	ALTERNATIVE COST SUMMARY		Rounded Total	Cumulative Total
	TOTAL PRESENT-WORTH IMPLEMENTATION COST (DIRECT & INDIRECT)		\$15,840,100	\$15,840,100
	TOTAL PRESENT-WORTH OM&M COST		\$344,000	\$16,184,100
	AGENCY OVERSIGHT (EPA and/or ECOLOGY)	LS	\$20,000	\$16,204,100
	TOTAL PRESENT-WORTH COST			\$16,200,000

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COST ESTIMATE

Alternative 6 – Continued Use of Spokane Water Supply

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Table A-8
Summary of Alternative Costs
Alternative 6 - Continued Use of Spokane Water Supply

Task	Cost
IMPLEMENTATION COSTS	
Remedial Design, Planning, and General (Indirect Costs)	\$383,400
Indirect Contingency and Unlisted Engineering Services Assumed (%)	15
Remedial Action Construction including Sales Tax (Direct Costs)	\$3,546,000
Direct Contingency and Unlisted Items Assumed (%)	25
Site Inspection and Overhead (USACE)	\$314,400
Total Implementation Costs	\$4,243,800
OM&M COSTS	
Annualized O&M Costs	\$834,700
O&M Contingency and Unlisted Items Assumed (%)	0
O&M Duration (years)	30
Annualized Monitoring & Reporting Costs	\$0
Monitoring Contingency and Unlisted Items Assumed (%)	20
Monitoring Duration (years)	30
Non-Routine OM&M	\$0
Non-Routine Contingency and Unlisted Items Assumed (%)	30
Total OM&M Costs	\$25,041,000
TOTALS	
Total Implementation and OM&M Costs	\$29,284,800
Estimated Agency Oversight Costs	\$20,000
Total Escalated Costs ^a	\$38,387,000
Total Project Present Worth ^b	\$27,770,000

^a Escalated costs were calculated using a 2.0% inflation rate

^b Present worth costs were calculated using a 0.4% discount rate

Notes:

Discount Rate (0.4%) = Interest Rate (2.4%) - Inflation (2.0%)

Remedial Action Construction Costs includes Washington State Sales Tax at 9.1%

OM&M - Operation, Maintenance, and Monitoring

O&M - Operation and Maintenance

Alternative 6 - Continued Use of Spokane Water Supply

Client	USACE, Fairchild AFB	Report Date	June 2021
Location	City of Airway Heights		
Project	EE/CA, Fairchild Air Force Base ar		
Site Name	Water Supply Reimbursement and New Intertie Piping		
Estimator	Scott Brockway, Brice	Affected Media	Drinking Water
QA Reviewer	Cary Brown	COCs	PFOS, PFOA
		Flowrate (Nominal)	1,104 GPM
		Flowrate (Max)	1,600 GPM

Site/Problem Description Groundwater pumped from COAH water supply wells 1/4 has PFAS (PFOA at 320 ppt and PFOS at 1,200 ppt) concentrations above EPA Health Advisory limit of 70 ppt. Groundwater pumped from COAH water supply Well 9 has PFAS (PFOA at 320 ppt and PFOS at 1,200 ppt) concentrations above EPA Health Advisory limit of 70 ppt.

Proposed Remedial Action This alternative consists of continued use of municipal water from the City of Spokane under the existing intertie agreement. It does not include treatment of PFOS and PFOA in groundwater. Wells 1/4 and 9 would be abandoned and Airway Heights' water rights would be transferred to the City of Spokane. It is assumed that transmission of water to Airway Heights would not require installation of new piping; however, the 8,000-ft section between intertie #1 and #3 would be extended by installation of a 16-inch pipeline between intertie #1 and #3.

- Alternative Specific Assumptions**
- Costs presented have an accuracy of +50% to -30% and are suitable for comparing alternatives.
 - Washington State Sales Tax is applied to Direct Costs only at 9.1%.
 - Discount Rate is 0.4% per Office of Management and Budget, Circular A-94 Appendix C, Revised Nov. 2019.
 - Monthly basis up to 439.08 million gallons (MG) at rate of \$1,566.74/MG.
 - Limited administration of reimbursement account, for water generated and distributed via COAH and/or COS within framework of Environmental Services Agreement between the United States Civil Engineer Center and City of Airway Heights, effective 1 November 2017.
 - No major creek, river, or road crossings are included
 - The system will be designed for a maximum flowrate of 1,600 gpm, but the nominal flowrate will be 1,014 gpm.
 - Construction timeframe is assumed to be 4 months to complete.
 - No major creek, river, or road crossings are included.
 - The system will include flowmeter, check valves, isolation valves, air release valves, pressure gauges, and submersible pumps.
 - Assume buried 16-inch-diameter PVC pipeline approximately 8,000 feet long to expand the intertie.
 - Well abandonment includes mobilization and demobilization to Spokane, WA; abandonment of Well 1 (10-inch casing and screen to 175 ft bgs, Well 4 (12-inch casing and screen to 175 ft bgs) and Well 9 (16-inch casing and screen to 181 ft bgs). Cost includes all equipment, supplies (cement, bentonite) and disposal of removed equipment.

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION	REMEDIAL DESIGN, PLANNING, AND GENERAL (Indirect Costs)						
	\$333,400	1	Project management (5 hrs per week)	4	MO	\$3,900	\$15,600
	With Contingency	2	General coordination, meetings, and planning	1	LS	\$6,250	\$6,300
	\$383,400	3	Regulatory coordination and meetings (% of DC)	0.5	%	\$3,546,000	\$17,800
		4	Engineering Design / Basis of Design Report	100	HR	\$125	\$12,500
		5	Design Plans and Specs	6	%	\$3,546,000	\$212,800
		6	Engineers Estimate	50	HR	\$125	\$6,300
		6	Permitting Support	1	LS	\$5,000	\$5,000
		7	Bid and RFI support	50	HR	\$125	\$6,300
		8	Work Plan (CMP/SAP)	100	HR	\$110	\$11,000
		9	Construction oversight & QA (1 person 1/2 time)	4	MO	\$6,500	\$26,000
		10	Reporting	125	HR	\$110	\$13,800
	Subtotal Costs						\$333,400
	Indirect Contingency and Unlisted Engineering Services (%)			15	%	\$333,400	\$50,010
	TOTAL INDIRECT COST						\$383,400

Alternative 6 - Continued Use of Spokane Water Supply (Continued)

DETAILED COST ESTIMATE							
Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs	Costs
IMPLEMENTATION (Continued)	REMEDIAL ACTION CONSTRUCTION (Direct Costs)						
	\$2,124,400	1	Well Abandonment	1	LS	\$147,175	\$147,200
	<u>With Contingency</u>	2	Site preparation & erosion control	75,000	SF	\$2	\$150,000
	\$2,655,500	3	Specialty Contractors (Utility locate, Survey)	6	Day	\$1,900	\$11,400
		4	Utility Clearing & Air Knife	1	LS	\$2,939	\$3,000
		6	Trench, Installation, Backfill, Paving Equip	1	LS	\$111,601	\$111,700
		7	Bedding Sand with delivery	1	LS	\$57,866	\$57,900
		8	Hydro-seeding	1	LS	\$29,383	\$29,400
		9	Water truck service	1	LS	\$46,829	\$46,900
		10	Trench spoils disposal	1	LS	\$55,094	\$55,100
		11	Tracer Wire & detector tape	1	LS	\$2,729	\$2,800
		12	FOG, Deliveries, Water	1	LS	\$24,873	\$24,900
		13	Surveying & Staking	1	LS	\$1,837	\$1,900
		14	Professional Labor (Superintendent, QC)	1	LS	\$56,983	\$57,000
		15	Craft Labor	1	LS	\$635,120	\$635,200
		16	Jobsite trailer, printer/copy machine, generator, tools, portable toilets, conex, and safety supplies	4	MO	\$2,500	\$10,000
		17	C-900 16" dia., DR18, CL235 PVC GJ Blue Pipe	8,000	FT	\$55	\$442,800
		18	C-900 16" dia., Misc. Elbows & Flanges	1	LS	\$8,277	\$8,300
		19	500-5500 GPM Flow Meter	1	EA	\$4,866	\$4,900
		20	16" Flanged Check Valves	1	EA	\$18,315	\$18,400
		21	16" Flanged Isolation Valve Sets	2	EA	\$27,707	\$55,500
		22	Isolation Valve Vaults	1	EA	\$12,000	\$12,000
		23	2" CI Combination Air Release Valves	4	EA	\$1,110	\$4,500
		24	Air Release Valve Vault	4	EA	\$250	\$1,000
		25	NP 2.5" Pressure Gauges (0-300 PSI)	4	EA	\$25	\$100
		26	Traffic Control	1	LS	\$120,575	\$120,600
		27	Electrical equipment, materials, & install labor	3	WK	\$10,000	\$30,000
		28	Install vaults	7	EA	\$2,500	\$17,500
		29	Install Flow Meter and VFD Control Equipment	1	LS	\$8,000	\$8,000
		30	Install Valves and fittings	1	LS	\$15,000	\$15,000
		31	General site cleanup and misc. restoration	1	LS	\$10,000	\$10,000
		32	Startup and shakedown testing (1 month)	1	LS	\$20,000	\$20,000
		33	Initial O&M and handoff training	3	MO	\$3,000	\$9,000
		34	Initial electricity for equipment	3	MO	\$800	\$2,400
	CONTAMINATED WASTE DISPOSAL AND TRANSPORTATION (Direct Costs)						
	\$42,400	1	Demolition Asphalt and Concrete Disposal	1	LS	\$5,509	\$5,600
	<u>With Contingency</u>	2	General Construction waste Disposal	1	LS	\$36,729	\$36,800
	\$53,000	3	Not Used	0		\$0	\$0
		4	Not Used	0		\$0	\$0
		5	Not Used	0		\$0	\$0
		6	Not Used	0		\$0	\$0
		7	Not Used	0		\$0	\$0
		8	Not Used	0		\$0	\$0
	Subtotal Costs						\$2,166,800
	Direct Cost Contingency and Unlisted Items (%)			25	%	\$2,166,800	\$541,700
	Contractor Bond Fee, Overhead, and Profit (%)			20	%	\$2,708,500	\$541,700
	Washington State Sales Tax (%)			9.1	%	\$3,250,200	\$295,800
	TOTAL DIRECT COST						\$3,546,000

Alternative 6 - Continued Use of Spokane Water Supply (Continued)

	TOTAL DIRECT AND INDIRECT IMPLEMENTATION COSTS						
		1	Total Indirect Costs (see above)	--	--	--	\$383,400
		2	Total Direct Costs (see above)	--	--	--	\$3,546,000
		3	Site Inspection and Overhead Costs (USACE)	8	%	\$3,929,400	\$314,400
	TOTAL IMPLEMENTATION COST			Years until Implementation	3	#	\$4,243,800
	Escalated Implementation Cost			Presumed Inflation Rate	2.00	%	\$4,503,600
	Present-Worth Implementation Cost			Presumed Discount Rate	0.40	%	\$4,193,300
	DETAILED COST ESTIMATE						
	Cost Type	Category	Item #	Description	Qty.	Unit	Unit Costs
	ANNUAL OPERATION & MAINTENANCE						
OM&M		\$834,700	1	Reimbursement Rate per million gallons (MG)	533	MG	\$1,567
	Total Routine Annual O&M Cost						\$834,700
	Subtotal Costs			Years of Annual O&M	30		\$25,041,000
	O&M Cost Contingency and Unlisted Items (%)				0	%	\$25,041,000
	TOTAL O&M COST						\$25,041,000
	Escalated O&M Cost			Presumed Inflation Rate	2.00	%	\$33,862,200
	Present-Worth O&M Cost			Presumed Discount Rate	0.40	%	\$23,552,600
	ANNUAL MONITORING & REPORTING						
		\$0	1	Not Used	0		\$0
		With Contingency	2	Not Used	0		\$0
		\$0	3	Not Used	0		\$0
			4	Not Used	0		\$0
			5	Not Used	0		\$0
			6	Not Used	0		\$0
			7	Not Used	0		\$0
			8	Not Used	0		\$0
	Total Routine Annual Monitoring Cost						\$0
	Subtotal Costs			Years of Annual Reporting	30		\$0
	Monitoring Cost Contingency and Unlisted Items (%)				20	%	\$0
	TOTAL MONITORING & REPORTING COST						\$0
	Escalated Monitoring Cost			Presumed Inflation Rate	2.00	%	\$0
	Present-Worth Monitoring Cost			Presumed Discount Rate	0.40	%	\$0
	NON-ROUTINE OM&M						
		\$0	1	Not Used	0		\$0
		With Contingency	2	Not Used	0		\$0
		\$0	3	Not Used	0		\$0
			4	Not Used	0		\$0
			5	Not Used	0		\$0
			6	Not Used	0		\$0
			7	Not Used	0		\$0
	Subtotal Costs						\$0
	Non-Routine Cost Contingency and Unlisted Items (%)				30	%	\$0
	TOTAL CLOSURE COST						\$0
	Escalated Closure Cost			Presumed Inflation Rate	2.00	%	\$0
	Present-Worth Closure Cost			Presumed Discount Rate	0.40	%	\$0
	OM&M COSTS				TOTAL	ESCALATED	PRESENT WORTH
		1	Total O&M Costs (see above)		\$25,041,000	\$33,862,200	\$23,552,600
		2	Total Monitoring Costs (see above)		\$0	\$0	\$0
		3	Total Non-Routine OM&M		\$0	\$0	\$0
	TOTAL OM&M COSTS				\$25,041,000	\$33,863,000	\$23,553,000

Alternative 6 - Continued Use of Spokane Water Supply (Continued)

TOTAL	ALTERNATIVE COST SUMMARY	Rounded Total	Cumulative Total
	TOTAL PRESENT-WORTH IMPLEMENTATION COST (DIRECT & INDIRECT)	\$4,193,300	\$4,193,300
	TOTAL PRESENT-WORTH OM&M COST	\$23,553,000	\$27,746,300
	AGENCY OVERSIGHT (EPA and/or ECOLOGY) LS	\$20,000	\$27,766,300
	TOTAL PRESENT-WORTH COST		\$27,770,000

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