ENGINEERING EVALUATION AND COST ANALYSIS NON-TIME CRITICAL REMOVAL ACTION FOR PERFLUOROOCTANOIC ACID AND PERFLUOROOCTANE SULFONIC ACID IN RESIDENTIAL WELLS ELLSWORTH AIR FORCE BASE, SOUTH DAKOTA

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> > **Prepared for:**



USACE Omaha District 1616 Capitol Ave Omaha, NE 68102-4901

Prepared by:



Tehama 1600 Genessee Street, Suite 754 Kansas City, MO 64102

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# ENGINEERING EVALUATION AND COST ANALYSIS NON-TIME CRITICAL REMOVAL ACTION FOR PERFLUOROOCTANOIC ACID AND PERFLUOROOCTANE SULFONIC ACID IN RESIDENTIAL WELLS

**ELLSWORTH AIR FORCE BASE, SOUTH DAKOTA** 

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EXEC	CUTIVE	SUMN	IARY	ES-1
1.0	INTRO 1.1 1.2 1.3	DDUCT PURP STAT REPO	TON OSE AND OBJECTIVE UTORY FRAMEWORK RT ORGANIZATION	1-1 1-1 1-1 1-2
2.0	SITE 0 2.1 2.2 2.3 2.4 2.5 2.6	CHARA SITE I INVE: PREV SOUR ANAI STRE	ACTERIZATION DESCRIPTION AND BACKGROUND STIGATION OF PFOS AND PFOA IOUS AND ONGOING ACTIONS CE, NATURE, AND EXTENT OF CONTAMINATION YTICAL DATA AMLINED RISK EVALUATION	2-1 2-1 2-1 2-2 2-4 2-5 2-5
3.0	REMO 3.1 3.2 3.3 3.4 3.5	OVAL A STAT SCOP OBJEG REMC REMC PLAN	ACTION OBJECTIVES UTORY FRAMEWORK E OF THE REMOVAL ACTION AND REMOVAL ACTION CTIVE OVAL ACTION CRITERIA OVAL SCHEDULE	3-1 3-1 3-2 3-2 3-2 3-2
4.0	IDEN <sup>7</sup> ALTE 4.1 4.1.2.1 4.1.2.2	TIFICA RNATI POTE 4.1.1 4.1.2	TION AND ANALYSIS OF REMOVAL ACTION VES NTIAL APPROACHES Treatment of Contaminated Groundwater Alternative Drinking Water Supplies Connection to Municipal Water Supply Installation of New Supply Well	4-1 4-2 4-2 4-3 4-3 4-3
	4.2 4.2.1.1	4.1.3 REMO 4.2.1	Purchase Affected Properties DVAL ACTION ALTERNATIVES Alternative 1 – No Further Action Effectiveness	4-4 4-4 4-5 4-5
	4.2.1.2	4.2.2	Implementability Cost Alternative 2 – Box Elder New Water Supply Well	4-6 4-6
	4.2.2.1 4.2.2.2 4.2.2.3		Effectiveness Implementability Cost	4-7 4-8 4-8

#### TABLE OF CONTENTS

Page

# TABLE OF CONTENTS (Continued)

	4.2.	3 Alternative 3 – SDEDA, Rapid City Source, New Transmission Main	4-8
	4.2.3.1	Effectiveness	
	4.2.3.2	Implementability	
	4.2.3.3	Cost	
	4.2.4.1	4 Alternative 4 – SDEDA, New Supply Well Effectiveness	
	4.2.4.2	Implementability	
	4.2.4.3	Cost	
	4.2.5.1	5 Alternative 5 – Purchase Affected Properties Effectiveness	4-11 4-11
	4.2.5.2	Implementability	
	4.2.5.3	Cost	
	4.2. 4.2.6.1	6 Alternative 6 – Connect Area C to Rural Water System Effectiveness	
	4.2.6.2	Implementability	
	4.2.6.3	Cost	
	4.2.7 4.2.7.1	7 Alternative 7 – Drill New Individual Wells Effectiveness	
	4.2.7.2	Implementability	
	4.2.7.3	Cost	
5.0	COMPARA 5.1 EFF 5.2 IMF 5.3 COS	ATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES FECTIVENESS PLEMENTABILITY ST	5-1 5-1 5-1 5-2
6.0	RECOMM	ENDED REMOVAL ACTION ALTERNATIVE	6-1
7.0	REFEREN	CES	7_1
		<b>* / • / • /</b> • • • • • • • • • • • • • •	

7.0

 Table 2.1
 Sample Locations with PFOS/PFOA Concentrations Greater than the LHA Action Levels

 Table 5.1
 Concentration of Concentratin of Concentration of Concentratin of Concentration o

 Table 5.1
 Summary of Comparative Analysis of Removal Action Alternatives

#### LIST OF FIGURES

Figure 2.1Site LocationFigure 4.1EE/CA Response Actions for Drinking Water Wells Above the PFOS/PFOALHA

#### LIST OF APPENDICES

Appendix A Cost Estimate

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#### LIST OF ACRONYMS AND ABBREVIATIONS

AFB AFFF AFI AOC	Air Force Base aqueous film-forming foam Air Force instruction area of concern
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act, 42 USC §§ 9601-9675
CFR	Code of Federal Regulations
DERP DoD DoDI 4715.07	Defense Environmental Restoration Program, 10 USC §§ 2701-2711 (U.S.) Department of Defense Department of Defense Instruction 4715.07, <i>Defense Environmental</i> <i>Restoration Program (DERP)</i> , May 21, 2013 (incorporating Change 2, August 31, 2018)
DoDM 4715.20	Department of Defense Manual 4715.20, <i>Defense Environmental</i> <i>Restoration Program (DERP) Management</i> , March 9, 2012 (incorporating Change 1, August 31, 2018)
EE/CA EO 12580 EPA	engineering evaluation and cost analysis Executive Order 12580, <i>Superfund Implementation</i> , January 23, 1987 (U.S.) Environmental Protection Agency
gpm	gallons per minute
LHA	lifetime health advisory
µg/L	microgram per liter
NCP	National Oil and Hazardous Substances Pollution Contingency Plan, 40 CER Part 300
NTCRA	non-time critical removal action
OU O&M	operable unit operation and maintenance
PA PFOA PFOS ppt	preliminary assessment perfluorooctanoic acid perfluorooctane sulfonic acid parts per trillion
RAO	removal action objective

# LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

SARA	Superfund Amendments and Reauthorization Act, Public Law 99-499 (1986)
SDEDA SI	South Dakota Ellsworth Development Authority site investigation
TBC TCRA	to be considered time critical removal action
U.S.	United States
USAF	U.S. Air Force
USC	U.S. Code

# EXECUTIVE SUMMARY

The U.S. Air Force (USAF) will conduct a non-time critical removal action (NTCRA) to address the releases from the use of aqueous film forming foam (AFFF) during USAF firefighting activities. While AFFF was used in accordance with manufacturer guidelines, it contained perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) that are a likely potential contamination source of groundwater used as a drinking water source for residences near Ellsworth Air Force Base, South Dakota. In 24 privately-owned wells, concentrations of PFOS and PFOA are greater than recently developed U.S. Environmental Protection Agency (EPA) lifetime health advisory (LHA) action levels. These exceedances of the LHA action levels prevent the residents from using their wells for potable water and triggered the need for this NTCRA.

This engineering evaluation and cost analysis (EE/CA) identifies the removal action objective (RAO), identifies and evaluates potential alternatives for completing the NTCRA, and recommends which alternative or combination of alternatives should be implemented to achieve the RAO. These alternatives are:

- Alternative 1, no further action: maintain the status quo through the USAF operating and maintaining point-of-entry or wellhead treatment systems installed as part of the 2017 time critical removal action (TCRA) and alternative water supply actions in the Southwest Waterline area. Alternative 1 provides a baseline against which the other removal action alternatives can be evaluated.
- Alternative 2, Box Elder new water supply well: install new water supply well and connect affected properties to Box Elder's water distribution system.
- Alternative 3, South Dakota Ellsworth Development Authority (SDEDA), Rapid City source, new transmission main: connect the affected properties to a new regional water system that is operated by SDEDA and obtains water from Rapid City. Water would be conveyed through a new transmission main.
- Alternative 4, SDEDA, new supply well: similar to Alternative 3 except SDEDA would obtain water from a new supply well located in or near Box Elder.
- Alternative 5, purchase affected properties: the USAF or another entity, such as SDEDA, would purchase the properties with contaminated wells and the current occupants would relocate.
- Alternative 6, connect Area C to rural water system: connect the Area C properties to the Sunset Ranch rural water system.
- Alternative 7, drill new individual wells: install a new alluvial well to replace each contaminated well.

One or more of the above alternatives, depending on site-specific circumstances, will be used to assure attainment of the RAO. This proposed action will protect human health from exposure to PFOS and PFOA in drinking water at concentrations in excess of the EPA LHA action levels.

# ENGINEERING EVALUATION AND COST ANALYSIS NON-TIME CRITICAL REMOVAL ACTION FOR PERFLUOROOCTANOIC ACID AND PERFLUOROOCTANE SULFONIC ACID IN RESIDENTIAL WELLS ELLSWORTH AIR FORCE BASE, SOUTH DAKOTA

# **1.0 INTRODUCTION**

#### 1.1 PURPOSE AND OBJECTIVE

The U.S. Air Force (USAF) will conduct a non-time critical removal action (NTCRA) to address historical releases by the USAF of pollutants or contaminants into the environment that are a likely potential cause of concentrations of perfluorooctanoic acid (PFOA) and/or perfluorooctane sulfonic acid (PFOS) exceeding U.S. Environmental Protection Agency (EPA) lifetime health advisory (LHA) action levels in 24 wells used to supply drinking water to private residences near Ellsworth Air Force Base (AFB), South Dakota. This engineering evaluation and cost analysis (EE/CA) identifies and evaluates proposed alternatives for completing the NTCRA to protect human health from exposure to these pollutants or contaminants in drinking water. The EE/CA identifies the removal action objective (RAO); identifies and evaluates potential alternatives for conducting the removal action; and recommends the best-suited removal action alternative. This proposed action will protect human health from exposure to PFOS and PFOA in drinking water in excess of the EPA LHA action levels.

The U.S. Department of Defense (DoD) has the authority to undertake this removal action pursuant to Sections 104 and 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S. Code (USC) §§ 9604, 9620; Section 2701 of the Defense Environmental Restoration Program (DERP), 10 USC § 2701; Section 300.415 of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) § 300.415; Executive Order (EO) 12580, as amended; and EPA, DoD, and USAF guidance. This EE/CA was prepared for Ellsworth AFB, the Air Force Civil Engineer Center, and the U.S. Army Corps of Engineers, Omaha District, under Contract Number W9128F-16-D-0044, Delivery Order W9128F19F0178, in accordance with the *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA, 1993).

#### **1.2 STATUTORY FRAMEWORK**

CERCLA and the NCP provide authority for the lead federal agency to take action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release of a pollutant or contaminant the agency determines poses an imminent and substantial danger to public health or welfare, and the lead federal agency determines that such action is appropriate based on consideration of several factors, to include actual or potential exposure to nearby human populations, and actual or potential contamination of potential drinking water supplies. The EPA has categorized removal actions in three ways (emergency, time-critical, and non-time critical) based on the type of situation, the urgency and threat of the release or potential release, and the subsequent time frame in which the action must be initiated. CERCLA and NCP define removal

actions to include such actions as may necessarily be taken in the event of the threat of release of pollutants or contaminants into the environment; and such action as may be necessary to monitor, assess, and evaluate the release or threat of release, the disposal of removal material, or the taking of such other actions as may be necessary to prevent, minimize or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release.

Removal actions are usually interim measures that, to the extent practicable, must contribute to the efficient performance of any anticipated, long-term remedial action. One example of a removal action listed in 40 CFR 300.415(e) is provision of an alternate water supply until a permanent remedy can be implemented. Another potential removal action is treatment of the extracted groundwater before use. This latter action is currently being implemented through point-of-use treatment at residences near Ellsworth AFB as part of the time critical removal action (TCRA) for responding to off-Base drinking water sources with PFOS and PFOA at concentrations above the EPA LHA action levels.

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

# **1.3 REPORT ORGANIZATION**

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

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

# 2.0 SITE CHARACTERIZATION

# 2.1 SITE DESCRIPTION AND BACKGROUND

Ellsworth AFB is located 6 miles northeast of Rapid City, South Dakota and adjacent to the City of Box Elder, South Dakota (Figure 2.1). The Base encompasses 4,858 acres within Meade and Pennington counties. Ellsworth AFB has been in operation since the 1940s and has been the base of operations for several types of aircraft and missile systems. Presently, the 28th Bomb Wing (B-1B bombers) is the host unit of Ellsworth AFB. The installation is composed of one major runway supported by taxiways, airfield operations, industrial areas, housing units, and recreational facilities. Ellsworth AFB is bordered to the north and west by ranch land, and to the east and south by residential and commercial areas as well as ranches. During the 1990s, the USAF installed a waterline southwest of the Base to provide drinking water to properties with residential drinking water wells that had been contaminated with volatile organic compounds from a landfill. This waterline is called the Southwest Waterline.

Environmental investigations began in 1984 and Ellsworth AFB was placed on the National Priorities List in 1990 (EPA identification: SD2571924644). The USAF, State of South Dakota, and EPA Region 8 entered into a Federal Facilities Agreement under CERCLA Section 120 (42 USC § 9620) in 1992. The 1992 Federal Facility Agreement identified 12 operable units (OUs). After two partial deletions in 2006 and 2012, OU-11 (Basewide Groundwater) is all that remains on the National Priorities List requiring further cleanup (URS, 2017). The site for this NTCRA encompasses PFOS and PFOA in off-Base groundwater used as a potable water supply by off-Base, private residences.

# 2.2 INVESTIGATION OF PFOS AND PFOA

Investigation of PFOS and PFOA was initiated in 2011 with soil and groundwater sampling at FT001, also known as OU-1, a former fire training area that had been previously investigated and deleted from the National Priorities List. Because PFOS and PFOA have only recently been identified as potential contaminants, samples collected at FT001 during the historical investigations had not been analyzed for these compounds. FT001 was identified as a potential area of concern (AOC) for PFOS and PFOA contamination because historical fire training activities used aqueous film-forming foam (AFFF) in accordance with manufacturer guidelines to extinguish fires. PFOS and PFOA are ingredients of AFFF. PFOS and PFOA are considered emerging contaminants and the EPA is currently working to promulgate drinking water standards.

The analytical results of the 2011 samples showed PFOS and PFOA contamination in both soil and groundwater at FT001. In 2014 – 2015, a Basewide preliminary assessment (PA) evaluated 18 sites where PFOS and PFOA could have been used and released. The PA reviewed historical records to identify fire training areas, crash sites, and other areas at the installation where AFFF could have been used, stored, handled, or released. FT001 was one of the 18 sites included in the PA. The PA recommended no further action for five sites, completion of a site investigation (SI) for 12 sites, and further investigation of FT001 (CH2M Hill, 2015). In 2014, an SI was performed to assess the presence of PFOS and PFOA at four of the sites recommended for investigation by the Basewide PA. Detections reported for groundwater samples from all four sites were greater than the screening values (SES Construction and Fuel Services LLC, 2015).

A Basewide SI was initiated in 2016. The investigation targeted the 12 sites identified by the PA and included soil, groundwater, surface water, and sediment sampling. The four sites from the 2014 SI were part of the 12 sites evaluated in the Basewide SI. Based on the analytical results, further investigation was recommended for 10 sites and no further action was recommended for two sites. In total, there are 11 sites recommended for investigation of PFOS and PFOA: 10 sites from the Basewide SI and FT001. In 2016 - 2018, additional investigation of the PFOS and PFOA contamination emanating from FT001 showed groundwater contamination migrating off-Base to the south.

The results of the above investigations prompted the initial sampling of drinking water wells for private residences. In 2016, PFOS and PFOA were identified in one off-Base, private drinking water well that supplied two residences. In 2018 – 2019, sampling of private, residential, drinking water wells near the Base identified 22 household wells with PFOS and/or PFOA concentrations greater than the LHA action levels in addition to the contaminated well identified in 2016 (APTIM Federal Services, LLC, 2019a). One of these wells supplies drinking water to the Plainsview Mobile Manor Home Park with, on average, 65 occupied residences and a maximum of 119 occupied residences. The number of occupied residences fluctuates. The other contaminated wells each supply drinking water to one or more residences. Samples with action level exceedances from the 2018-2019 well survey are listed in Table 2.1.

The groundwater data collected to date suggest that PFOS and PFOA are migrating from Ellsworth AFB to and along Box Elder Creek through the surface drainage alluvium. Most private wells in the area are approximately 20 to 50 feet deep and generally located within drainage alluvia (APTIM Federal Service, LLC, 2019b).

In 2016, the Ellsworth AFB drinking water supply was sampled for analysis of PFOS and PFOA. Neither compound was detected. In 2018, the City of Box Elder sampled their supply wells, which are 4,500 feet deep, for analysis of PFOS and PFOA. Neither compound was detected in these deep groundwater samples (USAF, 2019).

# 2.3 PREVIOUS AND ONGOING ACTIONS

The NTCRA being evaluated in this document is a follow-on to actions initiated in September 2018 which continue today in accordance with the TCRA Action Memorandum that was signed on June 5, 2019. All removal actions are part of the USAF's larger, long-term response action to the groundwater contamination.

In 1970, the Air Force began using AFFF, which contains PFOS and PFOA. AFFF is the most efficient extinguishing method for petroleum fires and is widely used across the firefighting industry, including at all commercial airports, to protect people and property. Once PFOS and PFOA were identified as emerging contaminants, the USAF began to investigate Ellsworth AFB for the presence of these compounds. These investigations started in 2011 and are ongoing.

In January 2017, two residential properties south of the Base with PFOS and/or PFOA concentrations exceeding the LHA action levels of 0.07  $\mu$ g/L (70 ppt) for PFOS and PFOA individually, and 0.07  $\mu$ g/L (70 ppt) for the two compounds in combination in the private drinking

water well were connected to an existing, temporary potable water supply line (Southwest Waterline).

In July 2017, a property south (downgradient) of the Base was investigated for PFOS and PFOA in surface water and groundwater. In 2018-2019, a well survey was completed and 112 drinking water wells were sampled for PFOS/PFOA. This survey identified 22 residential drinking water wells with PFOS and/or PFOA concentrations greater than the LHA action levels. These 22 contaminated wells supply water to 91 residences. The USAF purchased bottled water for the affected residences as a temporary solution. To date, three residences have been connected to the Box Elder municipal water supply, four residences are planned for connection, 19 point-of-entry treatment systems have been installed, and installation of one point-of-entry treatment system is planned.

Current PFOS and PFOA actions include the following activities:

- Continued provision of bottled drinking water to residences with PFOS and/or PFOA concentrations above the LHA action levels in drinking water wells until an alternate water source (treatment system, replacement well, or connection to a water system) is available.
- Operation and maintenance (O&M), including semiannual sampling, of the point-of-entry treatment systems that have been installed and the treatment system for the well that supplies drinking water to the Plainsview Mobile Manor Home Park.
- Quarterly resampling of residential wells with PFOS and/or PFOA previously detected at concentrations between 35 parts per trillion (ppt) and 70 ppt to confirm that concentrations in these wells do not increase to greater than the LHA action level.
- Seventeen residences that were connected in the 1990s to the Southwest Waterline as part of an environmental response action to volatile organic compound/trichloroethene contamination and two residences that were connected to this supply line in January 2017 in response to PFOS/PFOA contamination from the installation (see above) will remain on the Southwest Waterline until implementation of the NTCRA that this EE/CA supports.

Reports in the administrative record documenting the investigations and actions taken to date are listed below and are available on the publicly available administrative record website available at https://ar.afcec-cloud.af.mil/search.aspx.

- Final Preliminary Assessment Report for Perfluorinated Compounds at Ellsworth Air Force Base, South Dakota (CH2M Hill, 2015) (AR #8339).
- Final Site Investigation Report for Site Investigations of Fire Fighting Foam Usage at Various Air Force Bases in the United States for Ellsworth Air Force Base, Meade and Pennington Counties, South Dakota (SES Construction and Fuel Services, LLC, 2015) (AR #8343).
- Final Technical Memorandum Residential Well Survey Perfluorinated Compound Delineation at Area of Concern Perfluorinated Compound-1, Ellsworth Air Force Base, South Dakota (Ayuda Partners Joint Venture, 2017) (AR #8492).
- Final Phase I Field Sampling Report, Perfluorinated Compound Sampling, Ellsworth Air Force Base, South Dakota – Farrar Ranch (APTIM Federal Services, LLC, 2018) (AR #8547).

- Draft Remedial Investigation Report Per- and Polyfluoroalkyl Substances Area of Concern Perfluorinated Compounds-1, Ellsworth Air Force Base, South Dakota (Ayuda Partners Joint Venture, 2018) (AR #8588).
- Final Site Inspection Report of Aqueous Film Forming Foam Areas at Ellsworth Air Force Base, Meade and Pennington Counties, South Dakota (Aerostar SES, LLC, 2019) (AR #8596).
- Final Phase II Off-Base Per- and Polyfluoroalkyl Substances in Private Wells Sampling Report, Ellsworth Air Force Base, South Dakota. (APTIM Federal Services, LLC, 2019b) (AR #8650).
- Technical Memorandum: Additional Well Sampling, Implementation of High Resolution Site Characterization and Remediation Techniques at Complex Sites at Ellsworth Air Force Base, South Dakota (OTIE, 2019) (AR #8655).
- Action Memorandum for a Time-Critical Removal Action, Treatment of PFOS- and PFOA-Contaminated Water in Residential Wells Near Ellsworth Air Force Base, South Dakota (USAF, 2019) (AR # 8603).

#### 2.4 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The source of PFOS and PFOA contamination at Ellsworth AFB is historical use of AFFF. AFFF was developed in the 1960s to extinguish petroleum fires. The USAF started using AFFF in 1970. Because of their ability to put out fires and suppress re-ignition, AFFFs were widely used at both military and civilian airports. AFFF, which contains both PFOS and PFOA, would have been used during fire training exercises, during suppression of actual fires, and in fire suppression systems.

As described above, PFOS and PFOA investigations completed to date at Ellsworth AFB have identified 11 sites where historical activities resulted in PFOS and PFOA contamination in groundwater at concentrations exceeding the EPA LHA action levels. Data collected from residential wells indicate that this contamination has migrated in groundwater off-Base to the west, south, and east; and surface water data show that it has discharged into the surface water of Box Elder Creek. The combined PFOS and PFOA concentrations reported for the residential wells have a maximum of 17,370 ppt for a well located due south of the Base boundary. Along Box Elder Creek between New Underwood and Owanka, combined PFOS/PFOA groundwater concentrations of 280.9 ppt and 101.9 ppt were reported. The maximum combined PFOS and PFOA concentration reported for the on-Base samples is 551,000 ppt at FT001.

PFOS/PFOA contamination from releases at Ellsworth AFB is assumed to have migrated in surface water approximately 25 miles east of Ellsworth AFB to Owanka (Figure 4-1), based on the detection of PFOS and PFOA above the EPA LHA in an irrigation well. The furthest affected drinking water well is located 18 miles east of the Base (Area D as discussed further in Section 4). PFOS and PFOA were not detected in two samples collected from wells located between Owanka and the Cheyenne River. The well in Owanka marks the easternmost, or most downgradient, boundary of this NTCRA because PFOS and PFOA were not detected in drinking water wells located east of Owanka. PFOS and PFOA migrate readily with groundwater contamination because they are highly soluble and have little tendency to associate with soil particles, thus these compounds tend to form long plumes of groundwater contamination. Note: surface water will be evaluated in future investigation efforts.

# 2.5 ANALYTICAL DATA

As described above, several PFOS and PFOA investigations have been completed at Ellsworth AFB. The wells with PFOS and/or PFOA concentrations greater than the LHA action levels are listed in Table 2.1. The analytical results for these investigations can be found in the reports listed in Section 2.3, which are available on the Administrative Record website at https://ar.afcec-cloud.af.mil/search.aspx.

#### 2.6 STREAMLINED RISK EVALUATION

In 2016, the EPA published the current LHA action levels of 0.07  $\mu$ g/L (70 ppt) for PFOS and PFOA individually, and 0.07  $\mu$ g/L (70 ppt) for the two compounds in combination (EPA, 2016a; 2016b). The State of South Dakota does not currently have a drinking water standard for PFOS or PFOA. The EPA used a two-step process, explained in the following paragraphs, to calculate the LHA action levels.

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

Historically, PFOS and PFOA were used in many consumer goods, including carpets, stainresistant upholstery, food packaging, non-stick cookware, textiles, and leather goods. Most manufacturing of PFOS in the United States was discontinued in 2002, and the phase-out of PFOA manufacturing began in 2006. The USAF has phased out the use of the former AFFF in favor of the more environmentally friendly C6 AFFF at Ellsworth AFB and nationwide. Because of the historical uses of PFOS and PFOA, these compounds are widespread throughout the environment and are found in many food products such as eggs, meat, milk, fish, and root vegetables. PFOS and PFOA have been measured in indoor dust. The primary routes by which people are exposed to PFOS and PFOA are food and indoor dust (EPA, 2016a; 2016b).

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

As noted above, PFOS and/or PFOA concentration in 24 off-Base residential wells (the initial well identified in 2016, 22 wells identified in 2018 – 2019, and one well identified in 2020) exceed the LHA action levels. For the individuals who use these wells as a potable water supply, their exposure to PFOS and PFOA through use of the well water may pose an unacceptable health risk. As noted in Section 2.4, the extent of the PFOS/PFOA contamination beyond the boundary of Ellsworth AFB is due to the high solubility of these compounds, allowing them to migrate over

long distances in groundwater and surface water. It is also possible that some PFOS/PFOA may be from non-Air Force sources.

# 3.0 REMOVAL ACTION OBJECTIVES

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

# 3.1 STATUTORY FRAMEWORK

This removal action is performed pursuant to CERCLA and the NCP under the authority delegated by the Office of the President of the United States through EO 12580 as re-delegated. This order, as implemented through Department of Defense Instruction (DoDI) 4715.07 and Department of Defense Manual (DoDM) 4715.20 as amended, provides USAF with authorization to conduct removal actions. DERP provides funding to USAF for removal actions conducted under CERCLA. This removal action is non-time critical because the planning period from the time a removal action was determined to be necessary to the time when the removal action will be initiated is greater than 6 months.

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

# 3.2 SCOPE OF THE REMOVAL ACTION AND REMOVAL ACTION OBJECTIVE

The scope of this removal action is to supply drinking water to the residential properties that have private, household wells that cannot be used for drinking water due to the presence of PFOS and/or PFOA at concentrations greater than the LHA action levels. The residences with PFOS- and PFOA-contaminated wells that have been or will be replaced with connections to the Box Elder municipal water supply are not included in the areas and removal action alternatives because these locations will comply with the RAO through implementation of the TCRA that was initiated in 2017. All other household wells described in Table 2.1 and the residences connected to the Southwest Waterline will be addressed as part of the NTCRA. Non-household wells, such as those used for irrigation or livestock, that have PFOS/PFOA concentrations greater than the LHA action levels are not included in the scope of this NTRCA. This NTCRA encompasses only wells that supply drinking water to private, off-Base residences. It is unlikely that a future remedial action to address non-household wells will conflict with or contribute to a future remedial action for the groundwater itself.

The RAO specifies what the proposed removal action is expected to accomplish. In other words, it defines the goals for the removal action. As such, RAOs are site-specific and are influenced by the nature and extent of chemical contamination, current and potentially threatened resources, and the potential for human and environmental exposure. Based on the scope of the removal action, which is to prevent off-Base residents from being exposed to PFOS and PFOA in drinking water, the following RAO was developed:

• Prevent exposure of off-Base residents to drinking water that contains PFOS and/or PFOA at concentrations that, individually or in combination, exceed the EPA LHA action levels of 0.07  $\mu$ g/L (70 ppt).

#### 3.3 **REMOVAL ACTION CRITERIA**

The removal action criteria are the contaminant concentrations that the removal action alternative must achieve. The current EPA LHA action level of 0.07  $\mu$ g/L (70 ppt) for PFOS and PFOA concentrations individually and combined is the removal action criterion.

#### 3.4 REMOVAL SCHEDULE

The removal schedule calls for completing the Action Memorandum and advertising a remedial response contract for the removal action in summer 2020. Proposals will be evaluated and a contract awarded before the end of September 2020. The selected firm will then plan and construct the removal action and begin operations in 2021.

#### 3.5 PLANNED REMEDIAL ACTIVITIES

At this time, specific remedial activities for PFOS and PFOA in soil, groundwater, and surface water are not planned because investigation of the on-Base and off-Base contamination is ongoing. Until there is a more complete understanding of the nature and extent of PFOS and PFOA contamination, as well as risks to human health and the environment via other exposure routes, potential remedial activities for these contaminants cannot be identified. Regardless, because the potential removal action alternatives will not alter groundwater flow and chemical conditions, the alternatives considered for this NTCRA will not interfere with or hinder any future groundwater remedial action.

# 4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

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

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

State and community acceptance will be evaluated as part of the responsiveness summary to be included in the NTCRA Action Memorandum.

# 4.1 POTENTIAL APPROACHES

In developing the removal alternatives, several strategies were considered: treatment of contaminated groundwater prior to use; development of an alternative drinking water supply; and buy-out of the affected properties to eliminate the need for drinking water at those locations. The options associated with each strategy are described in the subsections below. The term "affected property" refers to a residence supplied by a well with PFOS/PFOA concentrations greater than the EPA LHA action levels.

Because of the large area encompassed by the affected properties, the site was divided into Areas A, B, C, and D for developing strategies for the removal alternatives. These areas are shown on Figure 4.1. The sample locations included in each area are identified in Table 2.1. The three residences with PFOS- and PFOA-contaminated wells that have been or will be replaced with connections to the Box Elder municipal water supply are not included in the areas and removal action alternatives because these locations will comply with the RAO through implementation of the TCRA that was initiated in 2017. All other household wells described in Table 2.1 and the residences connected to the Southwest Waterline will be addressed as part of the NTCRA. The three residences that are considering connecting to the Box Elder municipal water supply are included in Table 2.1. Area A consists of the properties southwest of the Base and encompasses nine wells that serve 12 dwellings and one well that supplies drinking water to the mobile home park identified during the rapid response action. Additionally, the 19 residences currently served by the Southwest Waterline are in Area A. Area B and Area C encompass six wells and three wells, respectively, and are southeast of the Base, with Area C located east of Area B. Area D consists of one well east of Area C that serves two properties. This well is evaluated separately because of its distance from the Base and the other contaminated residential wells.

# 4.1.1 Treatment of Contaminated Groundwater

As shown on Figure 4.1, the affected residential wells extend from southwest of the Base boundary to approximately 18 miles east of the Base. Because of the large area spanned by the affected wells, the only practical approach for treatment of the contaminated groundwater is to install a unit at each affected residence to provide point-of-entry treatment or, in the case of the single well which supplies the mobile home park, a well-head treatment system. As part of the TCRA initiated in 2017, the USAF has installed or is in the process of planning/installing point-of-entry or wellhead treatment systems for 20 properties (17 wells). There are three commercially available technologies for point-of-entry treatment systems: reverse osmosis, granular activated carbon, and ion exchange. All three technologies are capable of effectively removing PFOS and PFOA to concentrations less than the LHA action levels. The TCRA Action Memorandum identified all three technologies as options for the point-of-entry treatment systems. Depending on site-specific circumstances, one or more of these technologies will be used to assure the removal action objective is met.

Continued operation of the existing and planned point-of-entry treatment systems is identified as a removal action alternative. Because this alternative maintains the status quo established by the

TCRA, this alternative is identified as the "no action" alternative. Per guidance, the no action alternative should evaluate the situation in which no action is taken at all to prevent exposure to the site contaminants. However, the Action Memorandum for the TCRA already determined that "no action" is not protective of human health and specified an action that is in the process of being implemented. Thus, to define the no action alternative for the current NTCRA as the pre-TCRA situation would be to ignore the site's current conditions. For this reason, the "no action" alternative is defined as no further action beyond that completed by implementation of the TCRA.

#### 4.1.2 Alternative Drinking Water Supplies

This strategy consists of providing a permanent, alternative water supply to the affected properties. There are two general options available for this strategy: connection to a municipal water system and installation of a new supply well(s).

#### 4.1.2.1 <u>Connection to Municipal Water Supply</u>

There are three entities that could provide drinking water to the affected properties: City of Box Elder (Box Elder); City of Rapid City (Rapid City); and South Dakota Ellsworth Development Authority (SDEDA). The latter was established in 2009 as a corporate and political organization of the State of South Dakota, a designation that allows SDEDA to act as a utility provider. In addition, there is a rural water service, Sunset Ranch, that could provide water to the properties in Area C.

Box Elder surrounds Ellsworth AFB on three sides and currently operates a drinking water supply system. Its distribution system is adjacent to several of the affected properties. In fact, three residences (2 wells) with PFOS and PFOA-contaminated drinking water wells have been connected to the Box Elder municipal water supply under the TCRA, and another four residences (one well each) are considering being connected. The city, however, does not have enough water at times to meet current demand and will not accommodate additional new customers outside of their city limits without either the property being annexed into the city or an increase in its water supply. In the recent past, Box Elder has had to obtain water from both Rapid City and Ellsworth AFB to meet peak demand.

Rapid City operates a municipal water system located southwest of Box Elder. Both Box Elder and Ellsworth AFB have connections to the Rapid City distribution system. For cost and operational reasons, however, Rapid City is not interested in expanding its distribution system that far outside of its current boundaries. The closest portion of the Rapid City distribution system is more than 2 miles from Ellsworth AFB.

Some of the affected properties east of Ellsworth AFB are near a rural development, Sunset Ranch, that is served by a privately owned and operated community water system. The Sunset Ranch water system is supplied by a deep well that obtains water from the Inyan Kara aquifer, which is a confined aquifer about 1,900 feet below the contaminated zone and unlikely to be affected by contamination from the alluvial groundwater. The water system operator was contacted, and the initial indication was that the water system would accommodate additional customers. The Sunset Ranch well has not been sampled for PFOS/PFOA; however, one well screened in the Inyan Kara aquifer was inadvertently sampled for PFOS/PFOA in 2019. The well, with a total depth of 2,700

feet, had concentrations of 0.719 ng/l PFOS and 1.79 ng/l PFOA, which are below the LHAs. The Sunset Ranch well will be sampled for PFOS/PFOA before connecting the affected properties.

#### 4.1.2.2 Installation of New Supply Well

The PFOS and PFOA contamination appears to be confined to the shallow alluvial groundwater. The alluvial zone is the unconsolidated material, such as sand or silt, that lies above bedrock. Bedrock aquifers in the contaminated area include the Inyan Kara (uppermost), Minnelusa, and Madison (deepest) aquifers. Because of its water quality and quantity, the Madison aquifer is the preferred water source near Ellsworth AFB. Box Elder's supply wells that extract from the Madison aquifer produce between 275 gallons per minute (gpm) and 440 gpm (KTM Design Solutions, Inc., 2018). This aquifer, however, is 4,500 feet deep. This depth makes it expensive to construct a supply well in the Madison aquifer. The cost of installing a supply well in the Madison aquifer is estimated to be \$2,000,000.

The Madison aquifer is overlain by the Minnelusa aquifer. Box Elder installed a new supply well in 2012. This new well appears to pull water from both the Madison and Minnelusa aquifers. This well yields water that has high concentrations of radionuclides, total dissolved solids, sulfate, iron, and manganese. Although the high sulfate, total dissolved solids, iron, and manganese concentrations are attributed to water from the Minnelusa aquifer, it cannot be determined with certainty if the high radionuclide concentrations come from the Madison aquifer or Minnelusa aquifer (KTM Design Solutions, Inc., 2018).

The Inyan Kara aquifer is 2,600 feet deep, but its water often has high total dissolved solids concentration and its flow rate is typically less than 50 gpm. Because the Inyan Kara aquifer is not as deep as the Madison, it costs less to install a well in the Inyan Kara aquifer as compared to the Madison aquifer. The cost of a supply well installed in the Inyan Kara aquifer is estimated to be \$1,500,000.

#### 4.1.3 Purchase Affected Properties

If the USAF or another entity purchases the affected properties with no intent to occupy the homes, then it will not be necessary to provide an alternative water supply or point-of-entry treatment. The contamination at any properties purchased to prevent exposure to PFOS/PFOA in drinking water will be addressed as part of the final remedy.

# 4.2 **REMOVAL ACTION ALTERNATIVES**

The removal action alternatives are listed below. It is possible for the alternatives to be applied to one or two areas instead of all three. For example, it is possible for the USAF to implement Alternative 5, purchase affected properties, in Area C while using Alternative 2 for Areas A and B. "Affected properties" refers to residences with private drinking water supply wells with PFOS/PFOA concentrations greater than the EPA LHA action levels.

• Alternative 1, no further action: maintain the status quo through the USAF operating and maintaining point-of-entry or wellhead treatment systems installed as part of the 2017

TCRA and alternative water supply actions in the Southwest Waterline area. Alternative 1 provides a baseline against which the other removal action alternatives can be evaluated.

- Alternative 2, Box Elder new water supply well: install new water supply well and connect affected properties to Box Elder's water distribution system.
- Alternative 3, SDEDA, Rapid City source, new transmission main: connect the affected properties to a new regional water system that is operated by SDEDA and obtains water from Rapid City. Water would be conveyed through a new transmission main.
- Alternative 4, SDEDA, new supply well: similar to Alternative 3 except SDEDA would obtain water from a new supply well located in or near Box Elder.
- Alternative 5, purchase affected properties: the USAF or another entity, such as SDEDA, would purchase the affected properties and the current occupants would relocate.
- Alternative 6, connect Area C to rural water system: connect the Area C properties to the Sunset Ranch rural water system.
- Alternative 7, drill new individual wells: install a new alluvial well to replace each contaminated well.

The selected removal alternative will need to be operated until replaced by or incorporated into a remedy for PFOS and PFOA contamination in the groundwater. At this time, it is not known how long it will take to fully investigate and develop a remedy for the PFOS and PFOA contamination. For the purposes of this EE/CA, it is assumed that each alternative would be operated for 30 years. Each alternative is described and evaluated below.

# 4.2.1 Alternative 1 – No Further Action

The no further action alternative consists of maintaining the status quo. The USAF would continue to operate the 20 PFOS/PFOA treatment systems installed or being installed as part of the TCRA initiated in 2017and retain connection of the 19 residences to the Southwest Waterline. Because this alternative relies on existing infrastructure, the alternative does not include construction.

#### 4.2.1.1 <u>Effectiveness</u>

By removing PFOS and PFOA through the point-of-entry or wellhead treatment systems, Alternative 1 prevents people from being exposed to PFOS and PFOA in their drinking water, thereby achieving the RAO. This alternative is protective of human health.

Because the treatment systems are already in place or being installed, Alternative 1 poses no short-term effects on workers or the community.

The point-of-entry systems can effectively remove PFOS and PFOA to concentrations less than the LHA action levels provided that these systems are monitored and maintained. Proper monitoring and maintenance require long-term access to the affected properties. Long-term operation of the treatment systems would decrease PFOS and PFOA mobility and volume through removing the compounds from the extracted groundwater. Given the small volume of groundwater that would be treated by these systems relative to the probable volume of contaminated groundwater, the active PFOS/PFOA treatment provided by this alternative would have negligible effect on the overall remediation of the PFOS/PFOA plume.

Additionally, the USAF may want to explore options for changing how the alternative water supply is provided to the residences connected to the Southwest Waterline once the environmental restoration action the Southwest Waterline supported has achieved its objective and cleanup work is complete..

# 4.2.1.2 Implementability

In the short-term, the no further action alternative is readily implementable because the treatment systems are in place or will be installed soon. In the long-term, however, it may be difficult for the USAF to retain the access needed to properly monitor and maintain the point-of-entry treatment systems, particularly if the affected properties are sold.

There are no permits required for this alternative. The material, equipment, and labor needed to implement this alternative are readily available. This alternative relies on conventional technologies.

#### 4.2.1.3 <u>Cost</u>

The estimated cost for Alternative 1 is provided in Appendix A. Because the point-of-entry treatment systems have been or are being installed as part of the TCRA, Alternative 1 has no capital cost.

The 30-year cost is estimated to be \$10,643,000 and is based on the following assumptions:

- The USAF would pay the operation and maintenance (O&M) costs for each PFOS/PFOA treatment system. The USAF would hire a certified contractor to perform the O&M work or pay an upfront cost and turn the O&M and sampling over to a utility provider.
- Costs include O&M of affected properties in each area and the property east of Area C.

#### 4.2.2 Alternative 2 – Box Elder New Water Supply Well

Alternative 2 consists of connecting all but one of the affected properties to the Box Elder water distribution system. Because of the distance between the easternmost contaminated drinking water well in Area D and Box Elder, approximately 18 miles, it would be prohibitively expensive to connect this household to the Box Elder water supply. Therefore, Alternative 2 does not address the contamination at the Area D and another alternative (i.e., providing an alternate source of water or maintaining a treatment system) is still required.

As described in Section 4.1.2.1, Box Elder does not have the capacity to meet its current peak water demand. It is estimated that Alternative 2 would increase the average demand on the Box Elder system by almost 31,000 gallons per day (21.5 gpm) and the peak demand by 88.5 gpm. To

allow the Box Elder water supply system to accommodate these additional demands, Alternative 2 includes drilling a new supply well into the Madison aquifer and constructing conveyance piping and a booster station.

It is assumed that the new supply well would be installed in or near Area A. The final well location will be determined in subsequent project investigation and design. This area has the highest number of affected properties, and Box Elder currently does not have a Madison aquifer well in this area. Water distribution mains would be built to connect the new well to the existing distribution system. The properties in Areas A and B would be connected to the existing Box Elder distribution system. A new water main would be constructed to connect Area C to the Box Elder distribution system.

Due to limited capacity, Box Elder is currently requiring annexation for connection of new properties to the Box Elder water distribution system. The new well included in this alternative will alleviate the city's current capacity constraints and may allow the city to waive its annexation requirements.

All new construction under this alternative would be limited to those distribution mains and service connections required to address the affected properties. Additional improvements desired by Box Elder, even if they were related to the new supply well or distribution needs, would have to be funded by Box Elder since they would be outside of the scope of this removal action.

# 4.2.2.1 Effectiveness

The provision of municipal water would achieve the RAO and be protective of human health for all but one of the affected properties. A different removal action would be required for the property that is too far from the Box Elder water system to be included in this alternative.

The new supply well and distribution system would be constructed in accordance with the South Dakota regulations.

It is not known if Box Elder would waive its current annexation requirement for properties to be connected to the municipal water distribution system; however, this alternative alleviates the primary concern expressed by Box Elder regarding the limited quantity of water available to non-residents. Some residents have expressed concern about annexation due to increased taxes and limitations on land use, such as raising livestock.

This approach would provide a long-term effective and permanent solution for all but one of the affected properties. During construction of the piping and booster station, there could be short-term effects on the local community with respect to traffic, dust generation, noise, and road closures. These impacts, however, could be readily mitigated through standard practices. Because construction would occur along existing rights-of-way, there would be little impact on the environment.

This alternative would not reduce toxicity, mobility, or volume of PFOS and PFOA contamination released by the Air Force.

#### 4.2.2.2 Implementability

This alternative could be implemented with readily available material, services, and labor. This alternative relies on well-established, conventional technologies.

The 2012 attempt by Box Elder to install a new supply well was not successful due to the poor quality of the groundwater extracted by the new well. To limit the potential for installing a supply well in a zone of poor groundwater quality, design of the new well would consider all available information on lithology and groundwater quality from the existing well network.

The new mains would be constructed along existing rights-of-way. Landowner permission would be needed to install the piping to connect each residence to the municipal water distribution system. It may be moderately difficult to obtain landowner permission for installation of the connection piping for those landowners objecting to being annexed into Box Elder.

This alternative would require appropriating additional or reappropriating previous water rights for Box Elder and obtaining/modifying well construction, distribution system, and operating permits.

# 4.2.2.3 <u>Cost</u>

The 30-year cost is estimated to be \$8,117,000 and is based on the assumptions listed below.

- Capital costs include construction of the new supply well in the Madison aquifer, booster station, transmission mains, and connection piping.
- The existing temporary potable water supply line (Southwest Waterline) for 19 residences in Area A can be connected to the Box Elder distribution system, precluding the need to install connection piping to these 19 locations.
- Additional water storage capacity is not required by Box Elder.
- O&M costs will not be paid for by the USAF but will be paid by the landowners/customers through a monthly water bill with the rates set by Box Elder. Box Elder will directly bill the landowners/customers.

# 4.2.3 Alternative 3 – SDEDA, Rapid City Source, New Transmission Main

Under Alternative 3, SDEDA would create a regional water system to serve the affected properties excluding Area D. Similar to Alternative 2, because of the distance from Area D to the other affected properties, it would be prohibitively expensive to connect Area D to a new, regional water system and another alternative would be required for that well.

Water would be obtained from Rapid City through a new transmission main. The new transmission main would connect Rapid City's system to Areas A, B, and C. Distribution piping would be constructed within each area to connect the affected properties to the new transmission main. SDEDA would own and operate the entire distribution system from the Rapid City connection to the individual properties. A pressure reducing station would be required to serve properties at an elevation less than 3,200 feet above mean sea level.

Permits may be required for SDEDA to construct and operate the new distribution system.

# 4.2.3.1 <u>Effectiveness</u>

This alternative would achieve the RAO and be protective of human health for all but Area D. A different removal alternative would be required for Area D.

Alternative 3 would provide a permanent, long-term solution. Similar to Alternative 2, there could be short-term effects on the local community and workers during construction of the transmission main and connection piping. The potential effects could be managed through standard construction practices. Because construction would occur in existing rights-of-way, there would be minimal impact to the environment.

This alternative would not reduce toxicity, mobility, or volume of PFOS and PFOA contamination released by the Air Force.

#### 4.2.3.2 Implementability

This alternative could be implemented with readily available material, services, and labor. This alternative relies on well-established, conventional technologies.

The new mains would be constructed along existing rights-of-way. Landowner permission would be needed to install the piping to connect each affected property to the SDEDA water distribution system.

This alternative requires SDEDA to negotiate with Rapid City for the purchase of water to supply the affected properties. Rapid City might not agree to supplying water to a new entity located outside of Rapid City.

This alternative may require SDEDA to obtain a distribution system permit(s) and waterline easements. The Air Force would have to enter into an agreement with SDEDA that described how SDEDA would help the Air Force implement this alternative.

#### 4.2.3.3 <u>Cost</u>

The 30-year cost is estimated to be \$14,399,000 and is based on the assumptions listed below.

- Additional water storage or reservoir is not required.
- Rapid City will agree to sell water to SDEDA.
- The existing temporary potable water supply line (Southwest Waterline) for 19 residences in Area A can be connected to the SDEDA distribution system, precluding the need to install connection piping to these 19 locations.
- The property owners will pay a monthly water bill with the rates set by SDEDA. Therefore, the USAF will not pay for O&M of the water supply system.

#### 4.2.4 Alternative 4 – SDEDA, New Supply Well

Alternative 4 consists of SDEDA creating a regional water system and constructing a new supply well for the water system. The well would preferably be located in Area A and screened in the Madison aquifer, and transmission mains would be constructed to serve Areas B and C. Distribution piping would be constructed to connect the affected properties to the new transmission mains.

Again, because of the distance from Area D to the other affected properties, it would be prohibitively expensive to connect Area D to a new, regional water system. Therefore, Alternative 4 excludes Area D.

#### 4.2.4.1 <u>Effectiveness</u>

Alternative 4 would achieve the RAO and be protective of human health for all but Area D. A different removal alternative would be required for Area D.

The new supply well and distribution system would be constructed in accordance with the South Dakota regulations, and SDEDA may be required to obtain permits and licenses to construct and operate the new distribution system.

Alternative 4 would provide a permanent, long-term effective solution. There could be short-term effects on the local community and workers during construction of the distribution system. The potential effects could be managed through standard construction practices. Because construction would occur in existing rights-of-way, there would be minimal impact to the environment.

This alternative would not reduce toxicity, mobility, or volume of PFOS and PFOA contamination.

#### 4.2.4.2 Implementability

This alternative could be implemented with readily available material, services, and labor. This alternative relies on well-established, conventional technologies.

The 2012 attempt by Box Elder to install a new supply well was not successful due to the poor quality of the groundwater extracted by the new well. To limit the potential for installing a supply well in a zone of poor groundwater quality, design of the new well would consider all available information on lithology and groundwater quality from the existing well network.

The new mains would be constructed along existing rights-of-way. Landowner permission would be needed to install the piping to connect each affected property to the SDEDA water distribution system.

This alternative would require SDEDA appropriating water rights and may require them to obtain well construction and distribution system permits.

# 4.2.4.3 <u>Cost</u>

The 30-year cost is estimated to be \$14,832,000 and is based on the assumptions listed below.

- A water reservoir is not required. Capital costs include installation of tanks at the new well to provide storage and maintain system pressure.
- The existing temporary potable water supply line (Southwest Waterline) for 19 residences in Area A can be connected to the SDEDA distribution system, precluding the need to install connection piping to these 19 locations.
- The affected property owners will pay a monthly water bill with the rates set by SDEDA. Therefore, the USAF will not pay for O&M of the water supply system.

# 4.2.5 Alternative 5 – Purchase Affected Properties

Under Alternative 5, the USAF or another entity, such as SDEDA, would purchase the affected properties and the current occupants would relocate. Similar to the other alternatives, this alternative could be combined with another alternative to achieve a more cost-effective solution. The contamination at any property purchased under this alternative would be addressed as part of the final remedy.

# 4.2.5.1 Effectiveness

By eliminating use of wells with PFOS/PFOA concentrations greater than the LHA action levels, this alternative would achieve the RAO.

Purchasing the affected properties would eliminate the need to use the contaminated groundwater, thereby providing a long-term effective and permanent solution for these properties.

Because this alternative would not require any construction, there would be no short-term effects on workers. People who live on the purchased properties would need to find new homes, temporarily increasing the demand for rental or sale properties until the re-location is complete.

This alternative would not reduce toxicity, mobility, or volume of PFOS and PFOA contamination released by the Air Force.

#### 4.2.5.2 Implementability

Alternative 5 would not require any permits. Although some property owners may be willing to move, others might wish to stay in their current homes. Depending on the property owners, it might not be possible to purchase all of the affected properties. If an alternate water supply was still required for residents not willing to sell, purchasing the affected properties may be impractical. However, it may still make sense to purchase isolated, affected properties rather than making a capital expenditure and incurring annual O&M costs. Finally, because other alternatives are available, the government would likely not consider condemnation of properties with owners not willing to sell unless other overriding considerations (e.g., new missions requiring additional property or buffer areas) were to arise in the future.

Alternative 5 would not require any technical expertise, material, or equipment. The legal skills needed to complete the property transactions are readily available. The purchase of any property by the Air Force would need to be completed in accordance with DoDI 4165.71 and AFI 32-9001, which require Department of Defense approval of proposals to purchase 1,000 or more acres of land, or land with an estimated purchase price that exceeds one million dollars (\$1 million). Purchase proposals must be approved early on in the acquisition process. Depending on property cost and the number of properties purchased, the requirement for Department of Defense approval might not be triggered (for example, if this alternative is used on a limited number of properties).

# 4.2.5.3 <u>Cost</u>

The cost is estimated to be \$9,633,000 and is based on the estimated prices for the individual properties and the assumptions listed below.

- There are no O&M costs.
- Purchase prices were based on information in Zillow, an online real estate database.

As mentioned, this alternative does not need to be used for all affected properties but, instead, can be applied to individual properties that are difficult to incorporate into the other alternatives. For example, Alternative 5 could be used for Area D that is too far from the other properties to allow cost-effective connection to a regional water system.

#### 4.2.6 Alternative 6 – Connect Area C to Rural Water System

Alternative 6 consists of connecting three affected properties in Area C to the rural water system operated by Sunset Ranch. This alternative does not address the Area D, Area A, and Area B. Alternative 6 would need to be combined with other alternatives to address all of these areas.

#### 4.2.6.1 <u>Effectiveness</u>

Alternative 6 would achieve the RAO and provide a long-term effective and permanent solution for the three affected properties in Area C.

Construction of the connection piping would cause short-term impacts on the local community and workers that could be readily mitigated through standard practices. Piping would be placed in existing rights-of-way, thereby limiting potential effects on the environment.

Alternative 6 would not reduce toxicity, mobility, or volume of the PFOS and PFOA contamination released by the Air Force.

# 4.2.6.2 <u>Implementability</u>

Alternative 6 can be implemented with readily available material, equipment, and labor. The USAF would need to obtain permission from Sunset Ranch, but initial information indicates that Sunset Ranch would agree to adding the three affected properties to its water system.

# 4.2.6.3 <u>Cost</u>

The cost is estimated to be \$960,000 and is based on the assumptions listed below.

- The distribution system between Sunset Ranch and the three affected properties does not require a water storage structure.
- The residents of the three affected properties would pay a monthly water bill with rates set by Sunset Ranch. The USAF would incur no O&M costs.

#### 4.2.7 Alternative 7 – Drill New Individual Wells

Alternative 7 consists of replacing the well on each affected property with a new well drilled into the shallow alluvial groundwater. Deeper wells for individual residents are cost prohibitive, and a common deep well is already evaluated as a component of municipal water supply alternatives. Although the extent of the PFOS and PFOA contamination in groundwater is not completely defined, the well survey data suggest that it would be difficult to find a location on each affected property in Areas A and B where groundwater concentrations are less than the LHA action levels. Even if an uncontaminated area could be found in Areas A and B, it is not known if future plume migration or well pumping would cause the PFOS and PFOA concentration in the new wells to increase to unacceptable levels with time. Therefore, Alternative 7 was not considered for properties in Areas A and B.

The well survey data suggest that the groundwater plume narrows as it migrates east of the Base (APTIM Federal Services, LLC, 2019b). In Area C, while it may be possible to find an area where the shallow groundwater is unaffected, it is still unlikely and multiple wells may have to be drilled. In Area D, it is more likely that an uncontaminated area can be found for a replacement well. Therefore, Alternative 7 was only retained for the affected property in Area D. Fate and transport modeling could be used to support placement of a future well to limit the potential for PFOS/PFOA contamination in groundwater to migrate towards the replacement well.

#### 4.2.7.1 <u>Effectiveness</u>

If Area D encompasses alluvial groundwater characterized by PFOS/PFOA concentrations less than the LHA action levels, then Alternative 7 could achieve the RAO and provide a long-term effective and permanent solution for this affected property. Because of the potential for the groundwater contamination to continue to migrate, routine sampling of replacement well(s) would be required to confirm that the PFOS/PFOA concentration does not exceed the LHA action levels in the future.

Potential short-term effects associated with installation of an alluvial well in Area D would be minimal. Risks to workers could be mitigated through standard practices. There would be no effect on the local community.

Alternative 7 would not reduce the toxicity, mobility, or volume of PFOS and PFOA contamination released by the Air Force.

#### 4.2.7.2 Implementability

The materials, equipment, and labor needed to implement Alternative 7 are readily available. It may be difficult to obtain landowner permission to obtain access for routine monitoring of the replacement well to confirm that it does not become contaminated with PFOS/PFOA.

# 4.2.7.3 <u>Cost</u>

The cost is estimated to be \$65,000 and is based on the assumptions listed below.

- The cost of installing an alluvial well ranges from \$5,000 to \$20,000.
- This cost does not include the connection piping.
- It might be necessary to install more than one well to find shallow groundwater with PFOS/PFOA concentrations less than the LHA action levels and costs could increase accordingly. Similarly, it might be necessary to install more than one well to meet the water demand of both homes.

# 5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section provides a comparative analysis of the removal action alternatives described and evaluated in Section 4. This analysis is summarized in Table 5.1.

#### 5.1 EFFECTIVENESS

Alternatives 1 through 5 would achieve the RAO and be protective of human health for all or most of the affected properties. Alternative 6 would need to be combined with other alternatives to address the affected properties in Areas A, B and D. Alternatives 2, 3, 4, and 6 would need to be combined with Alternatives 1, 5, or 7 to address Area D.

Alternative 7 would need to be combined with another alternative for the affected properties in Areas A, B, and C, and might not meet the RAO for Area D depending on the extent of groundwater contamination. Even if a clean replacement well can be installed in Area D, pumping of the new well could affect groundwater flow and cause migration of PFOS and PFOA contamination to the well. For these reasons, Alternative 7 has the lowest effectiveness.

Because Alternative 1 requires long-term monitoring and maintenance of the point-of-entry treatment systems, this alternative provides a relatively low degree of long-term effectiveness and permanence.

Alternative 1 has the lowest potential for short-term impacts. Alternatives 2, 3, 4, 6, and 7 involve construction that could affect workers and the local community. The greatest effects would be associated with Alternative 3, which would install the most piping of the alternatives. Short-term effects posed by installation of piping, wells, and other infrastructure could be mitigated with standard practices. Alternative 5 could temporarily affect the local housing market as occupants of the purchased properties find new homes.

Only Alternative 1 includes treatment that would decrease contaminant toxicity, mobility or volume. The potential treatment provided by continued operation of the point-of-entry systems, however, would have negligible effect on the long-term groundwater remediation.

#### 5.2 IMPLEMENTABILITY

All alternatives rely on conventional technologies or strategies (property purchase) that can be implemented with readily available materials, equipment, and labor.

Alternative 1 would not require any permits but would need long-term access to the point-of-entry treatment systems for monitoring and maintenance. It may be difficult for the USAF to ensure continued access in the long-term, particularly if the property is sold. Additionally, USAF would have to continue providing water for the Southwest Waterline or implement a different way to provide an alternative water supply to the 19 residences.

Alternative 5 also would not require permits, but the USAF would need to obtain landowner concurrence to purchase the affected properties at a fair market price. Some landowners might not

wish to move. In addition, purchase of these properties may require prior approval from the Office of the Secretary of Defense pursuant to AFI 32-9001.

Alternative 7 would require long-term access to confirm that PFOS/PFOA contamination has not migrated to the replacement well. It may be difficult to retain long-term access to the property, particularly if the property is sold.

Alternative 3 may be difficult to implement because Rapid City might not agree to supplying a new entity outside of the city limits. In addition, use of SDEDA to build and operate a utility would require implementation of a binding agreement between SDEDA and the USAF to specify how SDEDA will conduct these activities.

Alternative 6 could be readily implemented if Sunset Ranch is willing to add customers to their system, but Alternative 6 would need to be combined with other alternatives.

Alternatives 2 and 4 are the most implementable. Both alternatives would require water appropriation and permits for well construction and the distribution systems. The appropriation and permits, however, should be readily obtainable by Box Elder or SDEDA. Both alternatives also provide solutions for all but one of the affected properties.

# 5.3 COST

The estimated costs for Alternatives 1 through 6 range from \$960,000 for the three properties in Area C to \$14,832,000 for Alternative 4. The uncertainties described below need to be considered in evaluating the relative costs. Also, evaluation of the cost for Alternative 6 must consider that this alternative would need to be combined with one or more of the other alternatives to achieve the RAO at all affected properties.

Because of the uncertainty associated with finding uncontaminated shallow groundwater in Area D, it is difficult to estimate the cost of Alternative 7 with certainty. Although each alluvial well would cost between \$5,000 and \$20,000, it is not known how many wells would need to be installed and sampled before clean groundwater is found. The 30-year life-cycle sampling and O&M costs result in an estimated total cost of just over \$65,000 for Area D provided that the first well drilled encounters uncontaminated groundwater.

Alternatives 2 and 4 both require construction of a new well in the Madison aquifer. As demonstrated by Box Elder's recent installation of a supply well, there is no guarantee that a new well will provide water of a quality that can be used for drinking water. The cost estimates for Alternatives 2 and 4 do not account for the possibility of drilling a well that cannot be used as a supply well because of poor water quality.

For Alternative 2, Box Elder may identify additional requirements before connecting the affected properties to the city's distribution system. These requirements could add costs or deter landowners from connecting to their system.

For all alternatives that include new piping, the costs were based on installing the piping in city or county rights-of-way. Easements and permitting may require alternate routing at additional cost.

In addition, if the existing temporary potable water supply line (Southwest Waterline) for 19 residences in Area A cannot be re-used, then costs will increase to account for installation of new connections to these residences.

The cost for Alternative 5 is based on pricing information listed on Zillow. The landowners might request higher pricing for their properties.

The most cost-effective approach is likely a combination of different alternatives for Areas A, B, C, and D.

The cost estimates do not include USAF staff time to prepare and implement agreements with the local governments or SDEDA, to review plans or specifications, or to procure properties or services. These costs are similar across most of the alternatives and will depend on the extent contract assistance is required and how the alternative is implemented.

# 6.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Because of the infrastructure required to connect all of the affected properties to a centralized water supply system, the most cost-effective approach is a combination of a centralized system for the properties that are close together and a decentralized approach for the properties several miles away from the Base. Therefore, the following combination of removal action alternatives is recommended:

- Area A and Area B: Alternative 2, Box Elder water supply, is recommended for the affected properties that are close together. This alternative achieves all RAOs for these properties. If an agreement with Box Elder cannot be reached, then Alternative 4, a new supply well and water distribution system operated by SDEDA, could be implemented with similar benefits and should be retained as a contingency.
- Three properties in Area C: Alternative 6, connect to the private rural water system at Sunset Ranch. If an agreement with the rural water system cannot be reached, then these properties could be connected to the new water supply operated by Box Elder (Alternative 2) or the USAF could continue to maintain the existing point-of-entry treatment systems (Alternative 1) at these locations as an interim measure until other alternatives are evaluated in the feasibility study.
- Area D: Alternative 7, drill a replacement well in an uncontaminated portion of the shallow aquifer. If uncontaminated, shallow groundwater is not available on this property, then the USAF could continue to maintain the existing point-of-entry treatment systems (Alternative 1) as an interim measure until other alternatives are evaluated in the feasibility study.

The estimated cost for the above combination of alternatives is \$6,980,000. The cost estimate for the recommended approach is presented in Appendix A.

In summary, it is recommended that the removal action alternative consist of a combination of Alternatives 2, 6, and 7, with Alternative 4 as a contingency. Alternative 1 is also a contingency for Areas C and D. As plans and the alternatives are developed, other combinations of alternatives may become more favorable.

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TABLES

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# Table 2.1 Private Wells With PFOS/PFOA Concentrations Greater than LHA Action Levels Ellsworth Air Force Base, South Dakota

Type of Well	Number of Wells	Location	
Household	1	South of Base (connected to Southwest Waterline)	
Household	9	Southwest of Base (Area A)	
Not household	t household 1 Southwest of Base		
Not household 8 South of Base			
Household 1 West of Base (Area A)		West of Base (Area A)	
Household	3	East of Base (connected to or planned for connection to municipal	
		water supply; not part of NTCRA)	
Not household	2	South-southeast of Base	
Not household	5	Southeast of Base	
Household 6 Southeast of Base (Area B)		Southeast of Base (Area B)	
Household 3 Southeast of Base (Area C)		Southeast of Base (Area C)	
Household	1	Southeast of Base (Area D)	

Note: household refers to a well that supplies drinking water; not household refers to a well that supplies water for non-drinking uses

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# Table 5.1Summary of Comparative Analysis of Removal Action Alternatives<br/>Ellsworth Air Force Base, South Dakota

Alternative	Effectiveness	Implementability	Cost		
1. No further action	Requires long-term O&M of	Readily implemented but	\$10,643,000		
(maintain status quo)	treatment systems.	access for treatment system			
		monitoring and			
		maintenance may be			
		difficult to retain for 30			
		years.			
2. Connect to Box	Would achieve objectives for	Readily implemented;	\$8,117,000		
Elder water supply	all but Area D. High	requires water			
	effectiveness.	appropriation permit.	<u> </u>		
3. SDEDA, Rapid City	Effective but would incur the	Rapid City might not be	\$14,399,000		
source, new	most short-term impacts	willing to provide water to			
transmission main	during piping installation.	new users outside of the			
4. CDED 4	We have here the strength of the	City limits.	¢14.922.000		
4. SDEDA, new well	would achieve objectives for	Readily implemented;	\$14,832,000		
	all but Area D. High	requires water			
5 Durahasa affaatad	High dagraa of offactiveness.	Homeowners might not	\$0,622,000		
properties	through permanently	wish to sell their	\$9,055,000		
properties	eliminating water use at	residences Requires			
	affected properties	approval from the Office of			
	uncetted properties.	the Secretary of Defense if			
		purchase price is greater			
		than \$1,000,000.			
6. Connect Area C to	Effective for Area C but	Requires concurrence from	\$960,000 (addresses		
rural water system	would need to be combined	Sunset Ranch rural water	only Area C)		
	with other alternatives for	system.			
	Areas A, B, and D.				
7. Drill new wells	Least effective due to	May require multiple wells.	\$65,225 (per well)		
	potential inability to find	Access to monitor water			
	uncontaminated groundwater	quality may be difficult to			
	and potential future	retain for 30 years.			
	migration of contamination				
D 11	to replacement well.		¢ < 000 000		
Recommended	Would achieve objectives for	Readily implemented;	\$6,980,000		
2 for Areas A and D.	all properties. High degree of	requires water			
2 Ior Areas A and B; Alternative 6 for Area	effectiveness.	appropriation permit.			
C: and Alternative 7		Supset Ranch rural water			
for Area D		system May require			
		multiple wells to find			
		"clean" water on Area D			
		Need to maintain access to			
		monitor water quality at			
		Area D.			

**FIGURES** 



EE/CA, PFOS/PFOA NTRCA—Ellsworth AFB, SD Figure 2.1 Site Location **Ellsworth Air Force Base** Legend Site Location  $\star$ Ellsworth Air Force Base Notes: EE/CA=Engineering Evaluation/Cost Analysis NTCRA=Non-Time Critical Removal Action PFOA=perfluorooctanoic acid PFOS=perfluorooctanesulfonic acid

\\Srv-gst-01\HGLGIS\Ellsworth\_AFB\_TH1009\\_MSIW\EECA\_NTCRA\ (2-01)Site\_Location.mxd 5/20/2020 JG Source: HGL, USACE ArcGIS Online World Street Map



EE/CA, PFOS/PFOA NTRCA—Ellsworth AFB, SD

# Figure 4.1

# EE/CA Response Actions for Drinking Water Wells Above the PFOS/PFOA LHA Ellsworth Air Force Base

#### Legend

- Property Connected to Southwest Waterline
- Area Boundary
  - Ellsworth Air Force Base

Notes: EE/CA=Engineering Evaluation/Cost Analysis LHA=Lifetime Health Advisory NTCRA=Non-Time Critical Removal Action PFOA=perfluorooctanoic acid PFOS=perfluorooctanesulfonic acid

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# APPENDIX A

# **COST ANALYSIS**

Alternativ	e 1: No Further Action				
ITEM NO.	DESCRIPTION OF ITEM	UNIT	QTY	UNIT COST	TOTAL COST
A-1	Area A (Excluding Plainsview Mobile Manor)				
1	Individual Ion Exchange/GAC Annual O&M (from APTIM report)	EA	12	2,096	25,152
2	Total Individual Ion Exchange/GAC 30 Year O&M	YR	30	25,152	754,560
A-2	Area A (Plainsview Mobile Manor only)				
3	Mobil Home Ion Exchange/GAC Annual O&M (from APTIM report)	YR	30	215,750	6,472,500
4	Mobil Home Ion Exchange Media Change (Annual)	YR	30	95,000	2,850,000
	30 Year O&M Total				9,322,500
в	Area B (Central)				
1	Individual Ion Exchange/GAC Annual O&M (from APTIM report)	EA	5	2,096	10,480
2	Total Individual Ion Exchange/GAC 30 Year O&M	YR	30	10,480	314,400
с	Areas C and D				
1	Individual Ion Exchange/GAC Annual O&M (from APTIM report)	EA	4	2,096	8,384
2	Total Individual Ion Exchange/GAC 30 Year O&M	YR	30	8,384	251,520
		Subtotal Excluding	g Plainsview M	obile Manor (PMM)	1,320,480
		Total including PMM			10,643,000

Alternative	2: City of Box Elder, New Water Supply Well						
ITEM NO.	DESCRIPTION OF ITEM	UNIT	QTY		UNIT COST		TOTAL COST
Source	Water Source						
1	Madison Aquifer Well	LS	1	\$	1,350,000	\$	1,350,000
2	Well House - Pump, Aeration, Chemical Feed	LS	1	\$	650,000	\$	650,000
					Subtotal	\$	2,000,000
Α	Area A						
1	Water Distribution Mains, 8" PVC	LF	4,800	\$	65	\$	312,000
2	Service Lines, 1"	LF	1,400	\$	40	\$	56,000
3	8" Gate Valves	EA	5	\$	2,500	\$	12,500
4	Fire Hydrants	EA	5	\$	5,000	\$	25,000
5	8" Pipe Fittings	EA	19	\$	1,000	\$	19,200
6	Connect to Service Line	EA	12	\$	2,500	\$	30,000
7	Erosion & Sediment Control	LF	4,800	\$	2.00	\$	9,600
8	Surface Restoration	LF	4,800	\$	10.00	\$	48,000
9	Booster Station	LS	1	\$	200,000	\$	200,000
					Subtotal	\$	712,300
В	Area B						
1	Water Distribution Mains, 8" PVC	LF	2,500	\$	65	\$	162,500
2	Service Lines, 1"	LF	2,500	\$	40	\$	100,000
3	8" Gate Valves	EA	3	\$	2,500	\$	7,500
4	Fire Hydrants	EA	3	\$	5,000	\$	15,000
5	8" Pipe Fittings	EA	10	\$	1,000	\$	10,000
6	Connect to Service Line	EA	3	\$	2,500	\$	7,500
7	Erosion & Sediment Control	LF	2,500	\$	2.00	\$	5,000
8	Surface Restoration	LF	2,500	Ş	10.00	\$	25,000
	1 m 2				Subtotal	Ş	332,500
	Area C		17 500	ć	45.00	ć	797 500
1 2	Somice Lines 1"		17,500	ې د	45.00	ې د	68,000
2	Service Lines, 1	LF	1,700	ې د	2 500 00	ې د	10 000
1	Fire Hydrants	EA EA	4	¢ ¢	5,000,00	ې خ	20,000
5	Pine Fittings	FΔ	- 18	ç ç	1 000 00	ې د	17 500
6	Connect to Service Line	FA	3	Ś	2 500 00	Ś	7 500
8 7	Erosion & Sediment Control	LF	17.500	Ś	2.00	Ś	35.000
8	Surface Restoration	LF	17.500	Ś	10.00	Ś	175.000
-				Ŧ	Subtotal	\$	1,120,500
							, ,
					Summary		Cost
					Water Source	\$	2,000,000
					Area A	\$	712,300
					Area B	\$	332,500
					Area C	\$	1,120,500
					Subtotal	\$	4,165,300
				Mo	bilization (8%)	\$	333,000
			General	Requ	irements (8%)	\$	333,000
					Subtotal	\$	4,831,300
			Scope	Cont	ingency (25%)	\$	1,207,825
			Construction	Cont	ingency (15%)	\$	724,695
					Subtotal	\$	6,763,820
		Engineering and Co	nstruction A	dmini	stration (20%)	\$	1,353,000
			Total Esti	mate	d Project Cost	\$	8,117,000

Alternative 3: SDEDA, Rapid City Source, New Transmission Main ITEM NO. DESCRIPTION OF ITEM UNIT QTY UNIT COST TOTAL COST Source Water Source 1 LF 13,400 75.00 \$ 1,005,000 Transmission Main From Rapid City, 8" PVC \$ Subtotal \$ 1,005,000 Area A Α 1 Water Distribution Mains, 8" PVC LF 5,600 \$ 65.00 \$ 364,000 2 40.00 \$ 100,000 Service Lines, 1" LF 2,500 \$ 3 8" Gate Valves \$ 2,500.00 \$ 15,000 FΑ 6 4 \$ \$ 30,000 Fire Hydrants 6 5,000.00 EΑ 5 Connect to Service Line ΕA 12 \$ 2,500.00 \$ 30,000 6 **Erosion & Sediment Control** LF 5,600 \$ 2.00 \$ 11,200 7 Surface Restoration LF 5,600 \$ 10.00 \$ 56,000 8 **PRV/Booster Station** LS 1 \$ 150,000.00 \$ 150,000 Subtotal \$ 778,600 В Area B \$ 1 Water Transmission Main, 8" PVC LF 37,800 65.00 \$ 2,457,000 \$ 2 Water Distribution Mains, 8" PVC LF 3,100 \$ 65.00 201,500 \$ 3 Service Lines, 1" LF 1,400 \$ 40.00 56,000 4 8" Gate Valves 41 \$ 2,500.00 \$ 102,500 ΕA 5 Fire Hydrants ΕA 17 \$ 5,000.00 \$ 85,000 6 **Pipe Fittings** 82 \$ 1,000.00 \$ 81,800 FA 7 Connect to Service Line 3 \$ 2,500.00 \$ 7,500 EΑ 8 LF 40,900 \$ \$ 81,800 **Erosion & Sediment Control** 2.00 409,000 9 Surface Restoration LF 40,900 \$ 10.00 \$ Subtotal \$ 3,482,100 С Area C 1 Water Transmission Main, 6" PVC LF 34,400 \$ 45.00 \$ 1,548,000 2 Service Lines, 1" LF 1,700 \$ 40.00 \$ 68,000 3 8" Gate Valves 7 \$ 2,500.00 17,500 EΑ \$ 4 Fire Hydrants 7 \$ 5,000.00 \$ 35,000 ΕA 5 **Pipe Fittings** ΕA 34 \$ 1,000.00 \$ 34,400 Connect to Service Line 6 EΑ 3 \$ 2,500.00 \$ 7,500 7 **Erosion & Sediment Control** LF 34,400 \$ 2.00 \$ 68,800 34,400 8 Surface Restoration 10.00 \$ 344,000 LF \$ Subtotal \$ 2,123,200

Summary	Cost
Water Source	\$ 1,005,000
Area A	\$ 778,600
Area B	\$ 3,482,100
Area C	\$ 2,123,200
Subtotal	\$ 7,388,900
Mobilization (8%)	\$ 591,000
General Requirements (8%)	\$ 591,000
Subtotal	\$ 8,570,900
Scope Contingency (25%)	\$ 2,142,725
Construction Contingency (15%)	\$ 1,285,635
Subtotal	\$ 11,999,260
Engineering and Construction Administration (20%)	\$ 2,400,000
Total Estimated Project Cost	\$ 14,399,000

Alternative 4	4: SDEDA, New Supply Well						
ITEM NO.	DESCRIPTION OF ITEM	UNIT	QTY	UNI	T COST		TOTAL COST
Source	Water Source						
1	Madison Aguifer Well	LS	1	\$	1,350,000	\$	1,350,000
2	Well House - Pump, Aeration, Chemical Feed, & Pressure T	anks LS	1	\$	850,000	\$	850,000
				•	Subtotal	\$	2,200,000
Α	Area A						
1	Water Distribution Mains, 8" PVC	LF	6,000	\$	65	\$	390,000
2	Service Lines, 1"	LF	2,500	\$	40	\$	100,000
3	8" Gate Valves	EA	6	\$	2,500	\$	15,000
4	Fire Hydrants	EA	6	\$	5,000	\$	30,000
5	8" Pipe Fittings	EA	24	\$	1,000	\$	24,000
6	Connect to Service Line	EA	12	\$	2,500	\$	30,000
7	Erosion & Sediment Control	LF	6,000	\$	2.00	\$	12,000
8	Surface Restoration	LF	6,000	\$	10.00	\$	60,000
9	Booster Station	LS	1	\$	200,000	\$	200,000
					Subtotal	\$	887,400
В	Area B						
1	Water Transmission Main, 8" PVC	LF	22,000	\$	65.00	\$	1,430,000
2	Water Distribution Mains, 8" PVC	LF	5,930	\$	65.00	\$	385,450
3	Service Lines, 1"	LF	1,400	\$	40.00	\$	56,000
4	8" Gate Valves	EA	28	\$	2,500.00	\$	70,000
5	Fire Hydrants	EA	12	\$	5,000.00	\$	60,000
6	Pipe Fittings	EA	56	\$	1,000.00	\$	55,860
7	Connect to Service Line	EA	3	\$	2,500.00	\$	7,500
8	Erosion & Sediment Control	LF	27,930	\$	2.00	\$	55,860
9	Surface Restoration	LF	27,930	\$	10.00	\$	279,300
	Amer C				Subtotal	Ş	2,399,970
1	Area C	15	24 400	ć	45.00	÷	1 5 4 8 0 0 0
1	Service Lines 1"		34,400	ې د	45.00	ې د	1,548,000
2	Service Lines, 1		1,700	ې د	2 500 00	ې د	17 500
5 1	o Gale Valves	EA	7	ې د	2,300.00	၃ င်	25,000
4 5		EA EA	31	ې خ	1,000,00	ې د	34,400
5	Connect to Service Line	EA EA	2	ې د	2 500 00	ې خ	7 500
7	Erosion & Sediment Control		31 100	ې خ	2,500.00	ې د	68 800
8	Surface Restoration	LI	34,400	ې خ	10.00	ې خ	344 000
0	Surface Restoration	Li	54,400	Ļ	Subtotal	\$	2.123.200
					Summary		Cost
					Water Source	\$	2,200,000
					Area A	\$	887,400
					Area B	\$	2,399,970
					Area C	\$	2,123,200
					Subtotal	\$	7,610,570
				M	obilization (8%)	\$	609,000
			Genera	Req	uirements (8%)	\$	609,000
					Subtotal	\$	8,828,570
			Scope	e Con	tingency (25%)	\$	2,207,143
			Construction	n Con	tingency (15%)	\$	1,324,286
					Subtotal	\$	12,359,998
	Engi	neering and Co	nstruction A	dmir	istration (20%)	\$	2,472,000
			Total Est	imat	ed Project Cost	\$	14,832,000

Alternative 5: Purchase Affected Properties							
Location	Estimated Property value	Assumed Taxes and Fees (13%)	Total				
Area A	\$5,884,306	\$764,960	\$6,649,266				
Area B	\$602,684	\$78,349	\$681,033				
Areas C and D	\$2,037,646	\$264,894	\$2,302,540				
Total			\$9,632,839				

Alternative 6	5: Connect Area C to Rural Water System					
ITEM NO.	DESCRIPTION OF ITEM	UNIT	QTY	UNIT	COST	TOTAL COST
С	Area C					
1	Water Main, 4" PVC	LF	11,300	\$	25.00	\$ 282,500
2	Service Lines, 1"	LF	1,700	\$	40.00	\$ 68,000
3	Connect to Service Line	EA	3	\$	2,500.00	\$ 7,500
4	Erosion & Sediment Control	LF	11,300	\$	2.00	\$ 22,600
5	Surface Restoration	LF	11,300	\$	10.00	\$ 113,000
					Subtotal	\$ 493,600
					Summary	Cost
					Area C	\$ 493,600
					Subtotal	\$ 493,600
				Mob	ilization (8%)	\$ 39,000
			General	Requir	ements (8%)	\$ 39,000
					Subtotal	\$ 571,600
			Scope	Contir	ngency (25%)	\$ 142,900
		Con	struction	Contir	ngency (15%)	\$ 85,740
					Subtotal	\$ 800,240
		Engineering and Constr	uction A	dminist	ration (20%)	\$ 160,000
		1	Total Esti	mated	Project Cost	\$ 960,000

Alternative 7: Drill New Individual Wells (per well)							
ITEM NO.	DESCRIPTION OF ITEM	UNIT	QTY	UNIT	COST		TOTAL COST
1	Alluvial Well	EA	1	\$	20,000	\$	20,000
					Capital Cost	\$	20,000
	Annual O&M (costs taken from APTIM report)						
1	PFOS/PFOA Sampling, analytical + field labor, travel	EA	2	\$	434	\$	868
2	PFOS/PFOA Reporting, data validation & reporting labor hours	Hr	2	\$	160	\$	320
3	Admin, planning, coordination	Hr	2	\$	160	\$	320
			Tot	al Ann	ual O&M Cost	\$	1,508
	30 Year Life-Cycle Cost						
1	Capital Cost	EA	1	\$	20,000	\$	20,000
2	O&M Cost	Yrs	30	\$	1,508	\$	45,225
			Total 30	Total 30 Year Life-Cycle Cost			

Recommended Alternative Cost Estimate										
ITEM										
NO.	DESCRIPTION OF ITEM	UNIT	QTY	UN	IT COST	T	OTAL COST			
Capital Costs										
Area A Water Distribution - Alternative 2 (install new well, connect to municipal water supply)										
1	Water Distribution Mains, 8" PVC	LF	4,800	\$	65	\$	312,000			
2	Service Lines, 1"	LF	1,400	\$	40	\$	56,000			
3	8" Gate Valves	EA	5	\$	2,500	\$	12,500			
4	Fire Hydrants	EA	5	\$	5,000	\$	25,000			
5	8" Pipe Fittings	EA	19	\$	1,000	\$	19,200			
6	Connect to Service Line	EA	12	\$	2,500	\$	30,000			
7	Erosion & Sediment Control	LF	4,800	\$	2.00	\$	9,600			
8	Surface Restoration	LF	4,800	\$	10.00	\$	48,000			
9	Booster Station	LS	1	\$	200,000	\$	200,000			
					Subtotal	\$	712,300			
Area B	Water Distribution - Alternative 2 (install new w	ell, conn	ect to muni	cipa	l water sup	ply)				
1	Water Distribution Mains, 8" PVC	LF	2,500	\$	65	\$	162,500			
2	Service Lines, 1"	LF	2,500	\$	40	\$	100,000			
3	8" Gate Valves	EA	3	\$	2,500	\$	7,500			
4	Fire Hydrants	EA	3	\$	5,000	\$	15,000			
5	8" Pipe Fittings	EA	10	\$	1,000	\$	10,000			
6	Connect to Service Line	EA	3	\$	2,500	\$	7,500			
7	Erosion & Sediment Control	LF	2,500	\$	2.00	\$	5,000			
8	Surface Restoration	LF	2,500	\$	10.00	\$	25,000			
					Subtotal	\$	332,500			
Area A	& B Water Source - Alternative 2									
1	Madison Aquifer Well	LS	1	\$	1,350,000	\$1	.,350,000			
2	Well House - Pump, Aeration, Chemical Feed	LS	1	\$	650,000	\$	650,000			
					Subtotal	\$ 2	,000,000			
Area C	<ul> <li>Alternative 6 (connect to rural water system)</li> </ul>									
1	Water Main, 4" PVC	LF	11,300	\$	25.00	\$	282,500			
2	Service Lines, 1"	LF	1,700	\$	40.00	\$	68,000			
3	Connect to Service Line	EA	3	\$	2,500.00	\$	7,500			
4	Erosion & Sediment Control	LF	11,300	\$	2.00	\$	22,600			
5	Surface Restoration	LF	11,300	\$	10.00	\$	113,000			
					Subtotal	\$	493,600			
Area D - Alternative 7 (install individual well)										
1	Alluvial well	EA	1	\$	20,000.00	\$	20,000			
					Subtotal	\$	20,000			

Summary	Cost						
Water Source	\$ 2,000,000						
Area A							
Area B							
Area C							
Area D							
Subtotal							
Mobilization (8%)							
General Requirements (8%)							
Subtotal							
Scope Contingency (25%)							
Construction Contingency (15%)							
Subtotal							
Engineering and Construction Administration (20%)							
Total Estimated Project Capital Cost							
Operation and Maintenance Costs							
Area D - Alternative 7 O&M Cost							
1 PFOS/PFOA sampling and reporting Annual 30 \$ 1,508	\$ 45,225						
Total Estimated Capital and O&M Costs, 30 Year Present Worth							