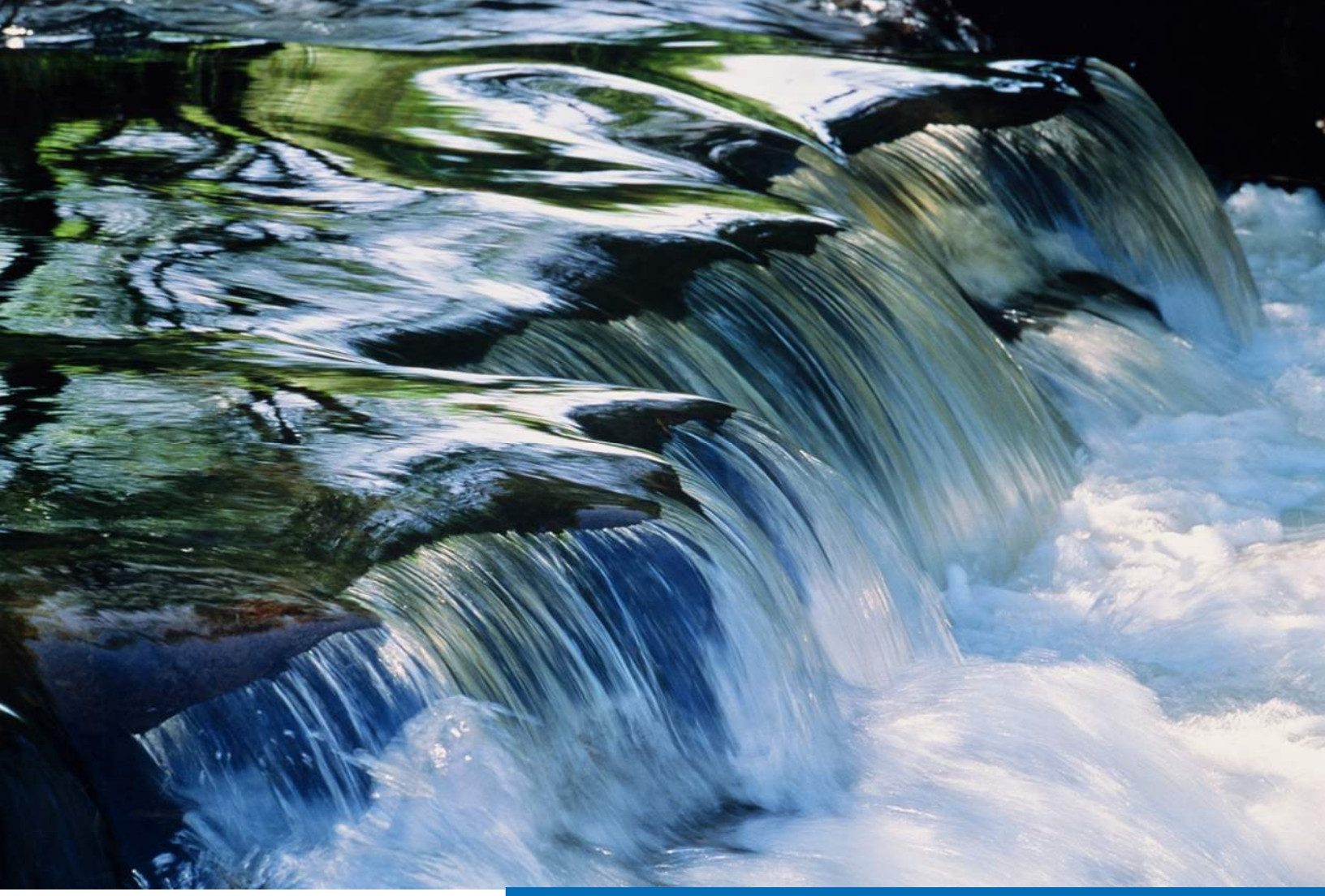

Zone 7 Water Agency
PFAS Treatment Feasibility Study

Technical Memorandum 1
PFAS AND HEXAVALENT CHROMIUM TREATMENT FEASIBILITY STUDY

DRAFT | June 2020

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Abbreviations

AFY	acre-feet per year
AF	acre-feet
CA	California
Carollo	Carollo Engineers, Inc.
COL1	Chain of Lakes Well Number 1
COL2	Chain of Lakes Well Number 2
COL5	Chain of Lakes Well Number 5
Cr3	trivalent chromium
Cr6	hexavalent chromium
DDW	State Water Board's Division of Drinking Water
deg	degrees
EBCT	empty bed contact time
EPA	United States Environmental Protection Agency
ft	feet
ft^3	cubic feet
GAC	granular activated carbon
gpm	gallons per minute
gpm/sf	gallons per minute per square foot
IX	ion exchange
kWh	kilowatt hour
lb(s)	pound(s)
µm	micrometers
µg/L	parts per billion
MCLs	maximum contaminant levels
ppm	milligrams per liter
MGDP	Mocho Groundwater Demineralization Plant
Mocho 1	Mocho Well Number 1
Mocho 2	Mocho Well Number 2
Mocho 3	Mocho Well Number 3
Mocho 4	Mocho Well Number 4
n.a.	not applicable
ND	non-detect
NF	nanofiltration
ppt	nanograms per liter
NLs	notification levels
NTU	nephelometric turbidity unit
O&M	operations and maintenance

PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutane sulfonic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexane sulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PHA	provisional health advisory
ppt	parts per trillion
psig	pounds per square inch gauge
Q4	fourth quarter
RAA	running annual average
RLs	response levels
RO	reverse osmosis
SMCL	secondary maximum contaminant level
Study	PFAS Treatment Planning Study
TDS	total dissolved solids
TOC	total organic carbon
UCMR3	Unregulated Contaminant Monitoring Rule 3
VT	Vermont
Zone 7	Zone 7 Water Agency

EXECUTIVE SUMMARY

Zone 7 Water Agency (Zone 7) has been monitoring its groundwater production wells for per- and polyfluoroalkyl substances (PFAS). Data indicate that eight out of the ten production wells have been impacted by these compounds. Based on the 2019 fourth quarter running annual average concentrations of these chemicals two of the wells have concentrations of perfluorooctanesulfonic acid (PFOS) in excess of the current California Division of Drinking Water response level (RL) of 40 parts per trillion (ppt). Water sources that have test results exceeding the respective RLs are required to be taken out of service or provide treatment.

- **Evolving Regulations.** The U.S. Environmental Protection Agency (EPA) has indicated that a federal maximum contaminant level (MCL) will be established for PFOS and perfluorooctanoic acid (PFOA). This study has evaluated four PFAS treatment goals, between the current RL down to below reporting limits for PFAS, to evaluate the potential impacts of the evolving regulatory and identify an implementation strategy to address these changes. Additionally, DDW has issued a notification to open comment on the economic feasibility analysis in consideration of a hexavalent chromium (Cr6) MCL. This was previously established at 10 parts per billion (ppb) but later invalidated, and if reinstated would impact the Chain of Lakes Wellfield.
- **California DDW RL Compliant.** Zone 7 has utilized reverse osmosis (RO) membrane treatment at the Mocho Groundwater Demineralization Plant (MGDP) and blending to produce water from the Mocho Wellfield compliant with the DDW PFOS RL. Through progressively more restrictive operating conditions, this approach may be used to the most stringent of likely regulatory limits. Water produced by the other wellfields (Chain of Lakes, Stoneridge, and Hopyard) are already in compliance with the current PFAS RLs.
- **Chain of Lakes Wellfield is Next**. As the regulatory limit decreases, Chain of Lakes is the next wellfield to require treatment. Given site constraints of the individual wells, providing a centralized treatment and blending facility at the Chain of Lakes No. 1 Well site (COL1) is recommended. Assuming that additional salt does not have to be removed from the basin and based on the estimated costs of multiple treatment options, a "hybrid-media" treatment system is recommended. This hybrid media system could utilize either proven ion exchange (IX) or granular activated carbon (GAC) media. It may also accept some of the new and innovative PFAS treatment media being developed, once they become commercially viable, economically attractive, and supported by regulators. An AACE International Class 5 opinion of probable construction cost developed for relative treatment comparison purposes indicated the facility total capital cost is approximately $26.3m (-30%/+50%). This value includes Zone 7's selected treatment approach to managing Cr6 (reductive coagulation without filtration using stannous chloride).
- **Continue Monitoring**. Continue tracking the water quality in all of the production wells and characterize the PFAS distribution across the basin. Also continue to monitor regulatory developments. Together the water quality and regulation can be used to determine if changes to the recommended strategy are necessary.

Section 1

INTRODUCTION

Zone 7 Water Agency (Zone 7) contracted with Carollo to conduct a PFAS Treatment Feasibility Study to evaluate treatment options for eight of its ten groundwater wells that are impacted by PFAS and develop an approach to implementation.

Under California law (Assembly Bill 756; published August 1, 2019), public water systems may be ordered to test for per- and polyfluoroalkyl substances (PFAS). On February 6, 2020, the Division of Drinking Water (DDW) issued revised drinking water response levels (RLs) of 10 parts per trillion (ppt or ng/L) for perfluorooctanoic acid (PFOA) and and 40 ppt for perfluorooctanesulfonic acid (PFOS). Water sources that have test results exceeding the respective RLs are required to be taken out of service, provide treatment, or notify customers.

Based on the 2019 fourth quarter (Q4) running annual average (RAA) values, two of Zone 7's production wells exceed the PFOS RL. None of the ten groundwater wells reported a PFOA RAA in excess of its RL. Zone 7 has utilized reverse osmosis (RO) membrane treatment at the Mocho Groundwater Demineralization Plant (MGDP) and blending to distribute water that is compliant (i.e. does not exceed) the RLs.

In addition to PFAS, on March 6, 2020, DDW issued a notification to open comment on the economic feasibility analysis in consideration of a hexavalent chromium (Cr6) maximum contaminant level (MCL). Zone 7 has one production well with a hexavalent chromium RAA in excess of 10 ppb, the MCL established in 2014 and later invalidated in 2017.

This Study evaluates blending and treatment alternatives to meet four different PFAS goals for three wellfields impacted by PFAS, as well as managing hexavalent chromium to one treatment goal. Based upon discussions with Zone 7 staff, a conceptual implementation strategy was developed.

1.1 Service Area

Zone 7 service area highlighted in Figure 1, encompasses an area of approximately 425 square miles, providing drinking water to four retail water entities, combined serving over 260,000 residents. The retailers include:

- California Water Service Company- Livermore District (Cal Water).
- Dublin San Ramon Services District (DSRSD).
- City of Livermore (Livermore).
- City of Pleasanton (Pleasanton).

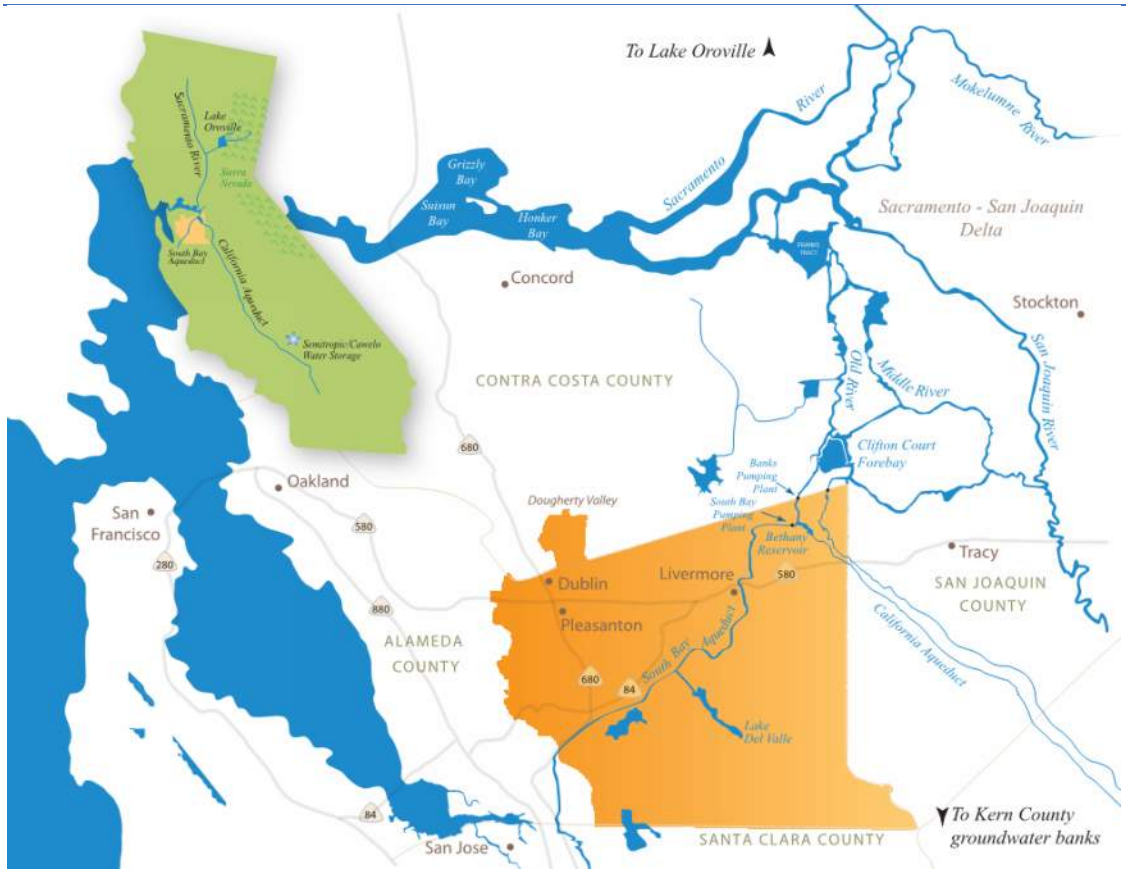

Figure 1 Zone 7 Service Area

1.2 Existing Groundwater Supply

In addition to local and imported surface water, Zone 7's existing water sources include four groundwater wellfields. To prevent over-pumping, the main groundwater basin is cooperatively managed by Zone 7 and its four retailers. The management strategy is to maintain groundwater levels above the historic low level of 130,000 acre-feet (52 percent of the estimated 250,000 acre-feet capacity), even during a multiyear drought.

The total capacity of all the production wells is 42.3-million gallons per day (mgd); of this, 10.8-mgd is intended for emergency flows. Table 1 summarizes the capacity of the eight production wells included in this evaluation.[1] Figure 2 presents the general location of the wells. The actual production from each well can vary significantly from year to year. For the purposes of this evaluation, it was agreed with Zone 7 staff during the project Kick-off Meeting (March 5, 2020), that 25 percent of the well capacity could be used as a basis for estimating average annual operation.

[1] At the request of Zone 7, this evaluation was limited to: Chain of Lakes Wells 1, 2, and 5; Mocho Wells 1, 2, 3, and 4; and Stoneridge Well 1. The Hopyard wellfield was not included.

Table 1 Zone 7 Groundwater Wells

Well[1]	Capacity (gpm)	Assumed Annual Production [2] (MG)
Chain of Lakes 1	2,500	330
Chain of Lakes 2	3,500	450
Chain of Lakes 5	2500	330
Stoneridge 1	4,600	605
Mocho 1	2,500	330
Mocho 2	2,750	350
Mocho 3	4,200	550
Mocho 4	3,700	475

Notes:
(1) Wells included in this evaluations scope of work.
(2) Established for the purposes of developing operational costs. Value is based on 25 percent of an annual production at well capacity.

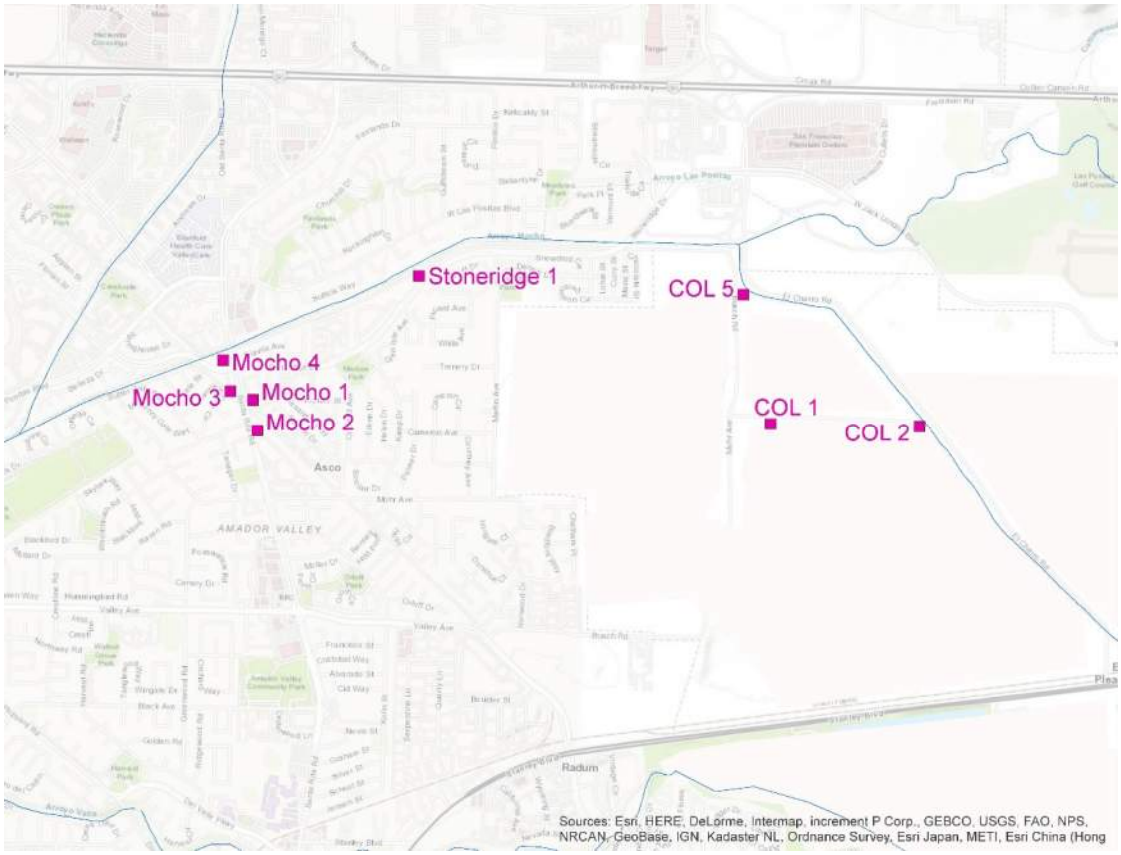

Figure 2 Zone 7 Geographic Distribution of Wells

Table 2 summarizes general water quality parameters for these wells. These values are averages of all data sourced from the US EPA database Safe Drinking Water Information System (SDWIS v3.21).

Table 3 summarizes the 2019 fourth quarter RAAs for selected PFAS and Cr6. While there is additional historical data and variability within these data sets, Zone 7 indicated that it is the data presented in this table that should be used for this evaluation, identify the wells that require treatment to meet the various goals as well as to establish blending scenarios. This was chosen over utilizing historical maximums or other values that would be considered a more conservative approach.

These data indicate that all wells have PFAS above one or both notification levels, and two wells (Mocho 1 and Mocho 2) have PFOS above the response level. In addition to these two compounds, multiple other PFAS were detected in each well including some of the seven additional PFAS for which DDW has initiated NL development. Only one well (Chain of Lakes 5) has Cr6 above the previously invalidated California 10 ppb MCL.

Additional wells may be impacted in the future depending on migration of these contaminants within the basin, regulatory development, or revised Zone 7 policies.

Table 2 Wells Average Water Quality

Parameter[1]	Units	MCL[2]	Chain of Lakes 1	Chain of Lakes 2	Chain of Lakes 5	Stoneridge 1	Mocho 1	Mocho 2	Mocho 3	Mocho 4
Sulfate	ppm	500	45.6	39.2	40.6	43.4	68.1	62.8	99.5	95.4
Nitrate	ppm as NO_3	45	18.6	15.7	19.3	18.6	19.8	15.5	19.1	16.3
Alkalinity	ppm as $CaCO_3$		263.6	225.5	245.9	252.9	312.1	290.6	367.1	364.7
Chloride	ppm	500	80.9	59.3	53.6	65.3	107.5	95.6	146.9	134.0
Uranium	pCi/L	20	0.5	0.1	0.1	0.9	1.6	1.5	2.3	2.2
Perchlorate	ppb	6	3.0	3.0	2.0	2.4	2.9	2.9	2.4	2.4
Arsenic	ppb	10	0.1	0.1	0.1	0.1	0.8	0.7	0.1	0.4
Iron	ppb	300	9.2	2.9	4.8	0.0	36.7	41.0	5.4	16.0
Manganese	ppb	50	0.6	0.7	3.7	0.0	9.3	9.2	1.2	1.3
Sodium	ppm		36.0	29.8	35.8	48.6	70.0	50.9	103.1	88.5
Potassium	ppm		1.7	1.5	1.7	1.8	1.9	1.8	2.5	2.9
Calcium	ppm as $CaCO_3$		157.6	132.2	131.6	136.0	186.1	218.5	218.4	243.6
Magnesium	ppm as $CaCO_3$		202.5	167.0	170.4	164.1	213.5	194.4	244.5	227.9
pH	-		7.4	7.3	7.4	7.6	7.5	7.4	7.4	7.5
TDS	ppm	1000	483.5	401.0	417.9	449.4	612.5	561.1	780.1	753.7
TOC	ppm		0.0	0.0	0.0	0.0	0.3	0.2	0.3	0.3

Notes:
(1) Values are averages of all data sourced from the US EPA database Safe Drinking Water Information System (SDWIS v3.21).
(2) Primary or secondary maximum contaminant level.

Abbreviations
$CaCO_3$ = Calcium carbonate
ppb = parts per billion
ppm = milligrams per liter
N = Nitrogen
NO_3 = Nitrate
pCi/L = picocuries per liter
TDS = total dissolved solids
TOC = total organic carbon

Table 3 PFAS and Hexavalent Chromium Running Annual Averages (4th Quarter 2019)

Parameter[1]	Units	Chain of Lakes 1	Chain of Lakes 2	Chain of Lakes 5	Stoneridge 1	Mocho 1	Mocho 2	Mocho 3	Mocho 4
PFOS[2,3]	ppt	34	14	37	8	94	41	34	11
PFOA[2,3]	ppt	4	2	1	1	9	6	6	3
ADONA	ppt	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]
PFBS	ppt	5.2	3.0	2.8	3.2	13.3	8.3	6.8	5.3
PFHpA	ppt	2.1	<2[4]	<2[4]	<2[4]	3.7	2.4	2.5	<2[4]
PFHxS	ppt	26.8	12.8	21.8	10.7	76.5	42.5	30.0	16.3
PFHxA	ppt	5.2	2.6	2.8	2.1	11.8	7.0	6.0	3.8
PFNA	ppt	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]
PFDA	ppt	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]	<2[4]	2.1	<2[4]
Cr6[5]	ppb	7	9	13	6	3	5	n.a.	5

Notes:
(1) All values are 2019 Q4 running annual averages.
(2) California Notification Levels for PFOS and PFOA are 6.5 ppt and 5.1 ppt, respectively.
(3) California Response Levels for PFOS and PFOA are 40 ppt and 10 ppt, respectively.
(4) Detection is below the Method Reporting Limit (MRL).
(5) Previously invalidated DDW MCL of 10 ppb.

Abbreviations
ADONA = 4,8-dioxa-3H-perfluorononanoic Acid
Cr6 = hexavalent chromium
n.a. = not analyzed
ppt = parts per trillion
PFHxS = Perfluorohexanesulfonic Acid
PFDA = Perfluorodecanoic Acid
PFBS = Perfluorobutanesulfonic Acid
PFHxA = Perfluorohexanoic Acid
PFOS = Perfluorooctanesulfonic Acid
PFHpA = Perfluoroheptanoic Acid
PFNA = Perfluorononanoic Acid
PFOA = Perfluorooctanoic Acid
ppb = microgram per liter

Section 2

REGULATIONS AND TREATMENT OBJECTIVES

This section provides an overview of the PFAS and hexavalent chromium regulations as of June 2020, the selected treatment objectives, and the treatment options considered.

2.1 Regulatory Overview – PFAS

PFAS, which includes PFOA and PFOS, are a large group of synthetic fluorinated organic chemicals that have been used in many industries since the 1940s. The unique chemical structure of PFAS make them exceptional surface-active agents for municipal, consumer, and industrial products, with over 3,000 compounds produced globally. Examples of products containing PFAS are depicted on Figure 3.

Figure 3 Products Containing PFAS

The chemical properties of PFAS make them highly soluble, mobile, and difficult to remove through chemical and biological processes employed in conventional water and wastewater

treatment. Based on these properties, PFAS have been detected around the globe in groundwater and drinking water sources.

When released into the environment, PFAS can lead to groundwater contamination and subsequent public health concerns. The chemical structure of long-chain PFAS causes bioaccumulation in both humans and wildlife and is persistent once it enters the environment. At this time, there is evidence that exposure to PFAS can lead to adverse human health effects.

In 2009, the United States Environmental Protection Agency (EPA) established a provisional health advisory (PHA) of 400 ppt for PFOA and 200 ppt for PFOS to assess the potential risk from short-term exposure through drinking water. The EPA later released a non-regulatory health advisory level (HAL) for PFOA and PFOS as a combined concentration of 70 ppt in 2016.

As a result of the social and institutional concerns over chronic exposure to PFAS as well as the established provisional EPA health advisories, several states have implemented drinking water regulations or guidelines on PFOA and PFOS. In 2018 California matched the EPA's combined RL for PFOA and PFA, and added notification levels of 14 and 13, respectively. In 2019 DDW lowered the NLs to 5.1 ppt and 6.5 ppt, respectively. Earlier this year (February 2020), DDW replaced the combined PFOA and PFOS RL, with separate response levels of 10 ppt PFOA and 40 ppt PFOS. At the same time, the State initiated the notification level development process for seven additional PFAS based on its on-going state-wide PFAS investigation. The seven additional chemicals are:

- perfluorohexane sulfonic acid (PFHxS)
- perfluorobutane sulfonic acid (PFBS)
- perfluorohexanoic acid (PFHxA)
- perfluoroheptanoic acid (PFHpA)
- perfluorononanoic acid (PFNA)
- perfluorodecanoic acid (PFDA)
- 4,8-dioxia-3H-perflourononanoic acid (ADONA)

On February 20, 2020, the EPA announced its proposed decision to develop MCLs for PFOA and PFOS. Specific concentrations were not identified.

EPA has also initiated the process for listing PFOA and PFOS as regulated hazardous substances under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). While this does not directly impact the drinking water treatment goals, this has the potential to significantly impact the management of residuals. Through CERCLA, EPA identifies individuals or entities responsible for hazardous waste contamination of a listed site and negotiates or orders the responsible party(ies) to clean up the site or pay others for that effort. If classified as a hazardous waste, any direct or indirect connection to the compounds at a listed site, Zone 7 could be identified as a Potentially Responsible Party (PRP). A single PRP can be held responsible for the entire cost of cleaning up the site. Even manifesting the residuals to a third-party prior to the disposal of the hazardous waste would not relieve Zone 7 of this potential responsibility. As such, the certified destruction of PFAS from any treatment residuals is the preferred approach to residual management.

As both the EPA and the State of California work to establish enforceable standards (i.e., maximum contaminant levels and waste classification), Zone 7 has proceeded with evaluating treatment options for the production wells, identifying potential PFAS sources in the

groundwater basin, and evaluating the extent of groundwater contamination. Treatment options for removing PFAS from the production wells are discussed in further detail in the following sections.

2.2 Treatment Considerations and Goals for the Removal of PFAS

As PFAS began emerging as a constituent of concern, a variety of treatment technologies have been evaluated for PFAS removal with consideration to both cost and efficacy. As shown on Figure 4, the treatment processes commonly used in drinking water plants, including filtration and chlorination, are unable to remove PFAS. However, phase-transfer processes, such as granular activated carbon (GAC), ion exchange (IX) resins, and membrane-based separation (e.g., reverse osmosis (RO)) have emerged as the leading PFAS treatment options based on their high efficacy. These treatment options were considered for this Study and are discussed in additional detail below.

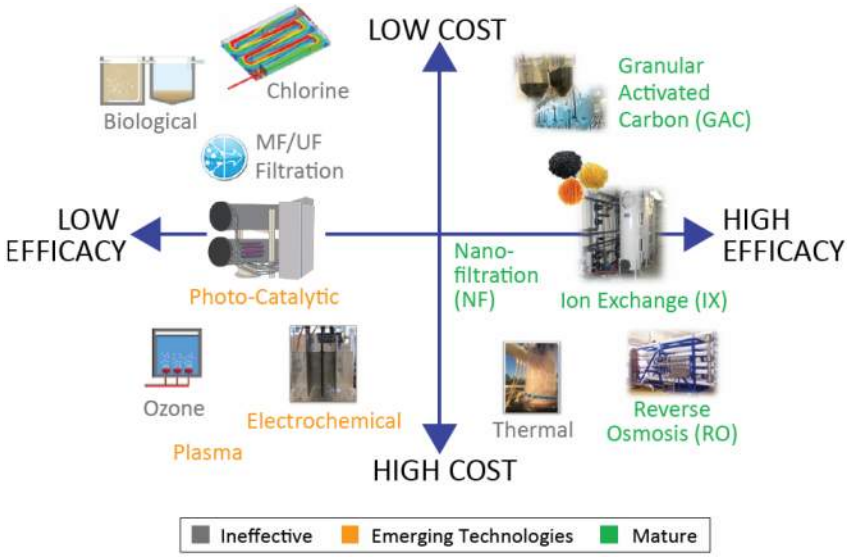

Figure 4 PFAS Treatment Technologies

With a focus on readily implementable solutions to address wells already in excess of the PFOS response level, emerging technologies, those with limited application, or systems requiring extensive demonstration to DDW prior to implementation were not included this Study. Some examples of these include novel media (e.g. FLUORO-SORB®, cyclodextrins, FPG – few layered porous graphite, carbon nanotubes, molecularly imprinted polymers), advanced oxidation systems (Colorado School of Mines UV-Sulfite reactor), plasma destruction (Clarkson Plasma Reactor), electrocoagulation, etc. It is expected that this will be an area of continued development with the potential for new technically feasible, economically competitive, and commercially ready treatment options in the future.

A total of four treatment goals were agreed upon to be evaluated.

- **Current CA DDW PFOA and PFOS Response Levels**. Using the 2019 fourth quarter running annual average PFOA and PFOS concentrations, compared to the 10 ppt PFOA and 40 ppt PFOS response levels, identify the well(s) requiring treatment or removal from service. For those wells that require action, operational costs should be based on a treatment target of 80 percent of the RL.

- **80 Percent of CA DDW Response Levels.** Given potential variability in water quality results, use the 2019 fourth quarter running annual average PFOA and PFOS concentrations with 8 ppt PFOA and 32 ppt PFOS concentrations, to identify the well(s) requiring treatment. For those wells that require action, operational costs should be based on a treatment target of the same concentration. This level of service treatment is consistent with Zone 7's current goal for water delivered to its retailers' turnouts to be less than 80 percent of the applicable primary MCL.
- **Lowest Current National PFAS Regulatory Limit**. As a possible basis for future regulations, treat to a level that matches the lowest current enforceable limit in the nation. The lowest set of PFOA and PFOS maximum contaminant concentration is in the state of New York (10 ppt for each compound). Vermont (VT), however, established an actionable 20 ppt advisory level (interim MCL) for a combined total of five PFAS: PFOA, PFOS, PFHxS, PFHpA, and PFNA. If a VT public water system's sum of five is in excess of 20 ppt, the system shall issue a "do not drink" notice until treatment is implemented to reduce the levels to below the advisory level. As the sum of these five PFAS cannot exceed 20 ppt, and a suite of PFAS compounds are typically detected, this is operationally more restrictive than individual PFOA and PFOS RLs of 10 ppt.
- **Below PFAS Reporting Limits**. This treatment goal is to produce water that has had any PFAS reduced to below the reporting limits, as determined by EPA Method 537 and EPA Method 537.1.

2.2.1 Granular Activated Carbon

GAC is comprised of carbon-based media commonly placed in a pressure vessel, and has historically been used to treat of a wide variety of organic contaminants. Fundamentally, GAC is used to remove contaminants through physical adsorption and has demonstrated that it can be effectively used to treat long-chain PFAS contamination. GAC has been shown to be less effective in removing shorter-chain PFAS (e.g., PFBS, PFHxA, and PFHxS). A typical process flow diagram for a lead-lag GAC treatment system is presented in Figure 5. When PFAS breaks through the lead vessel, the system configuration is adjusted so that the lag vessel becomes the lead position, and treatment continues. The media in the exhausted vessel is then changed out, and is put back into service as the lag vessel.

The efficiency of GAC adsorption is influenced by factors such as target effluent contaminant concentration, pH, water temperature, contact time, the properties of the selected carbon, concentration of inorganic, natural organic matter in the water, and the presence or absence of chlorine.

The exhausted GAC that has been removed can then be thermally regenerated (reactivated) to be returned to service or incinerated. Either approach could be used to end a "cradle to grave" PRP chain of custody, should the reclassification of PFAS as a hazardous waste be finalized. While other methods of regenerating activated carbon exist, these methods have generally do not destroy PFAS, and as such were not considered as a part of this study and are not recommended for Zone 7.

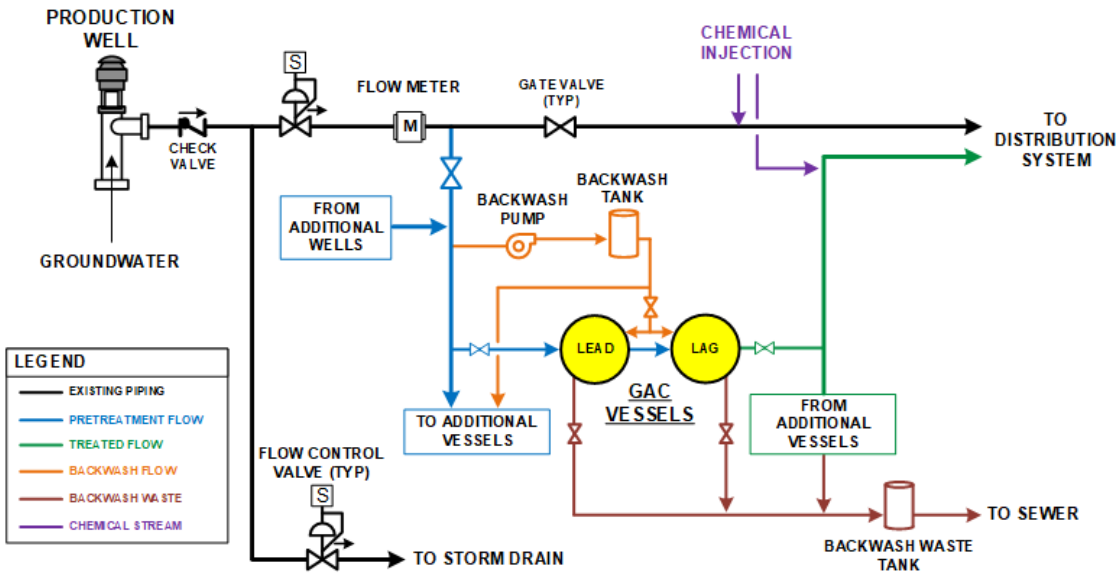

Figure 5 Process Flow Diagram – Activated Carbon

2.2.2 Ion Exchange

IX treatment is commonly used for the removal of groundwater contaminants, such as nitrate and perchlorate, and typically consists of pressurized treatment vessels filled with a polymer-based IX resin that removes contaminants as water passes over it. Contaminant removal occurs when a counter ion is exchanged for the charged contaminant ion. The rate of removal is dependent on initial concentration of the contaminant, the concentration of competing inorganic and organic ions, loading rate, size and types of resin beads, and general water chemistry.

PFAS removal by IX resins occur through classic "exchange" mechanism, but is also influenced by sorptive effects that are dependent on PFAS chain length and configuration. Depending on the presence of co-contaminants (i.e., sulfate, nitrate, and perchlorate), significant competition for IX sites can be observed, lowering the PFAS removal efficiency. Choosing a single-use resin with a high selectivity for the contaminant of interest can significantly extend its effective capacity and eliminate the need to manage a concentrated PFAS-laden liquid residual stream. Removal efficiencies can vary based on the resin selected and the feed water quality. The removal of multiple PFAS to below reporting limits has been demonstrated. The typical process flow for IX treatment is presented on Figure 6.

Like GAC, IX would be applied in a lead-lag configuration. The IX resin, however, is generally more sensitive to solids than GAC and unless sufficient data is available to characterize the concentration and frequency of turbidity events , pretreatment to protect the media would be recommended.

Following exhaustion, the single use resin would be removed and incinerated to destroy the accumulated PFAS. This would be used to complete the cradle-to-grave management of the potential future hazardous waste.

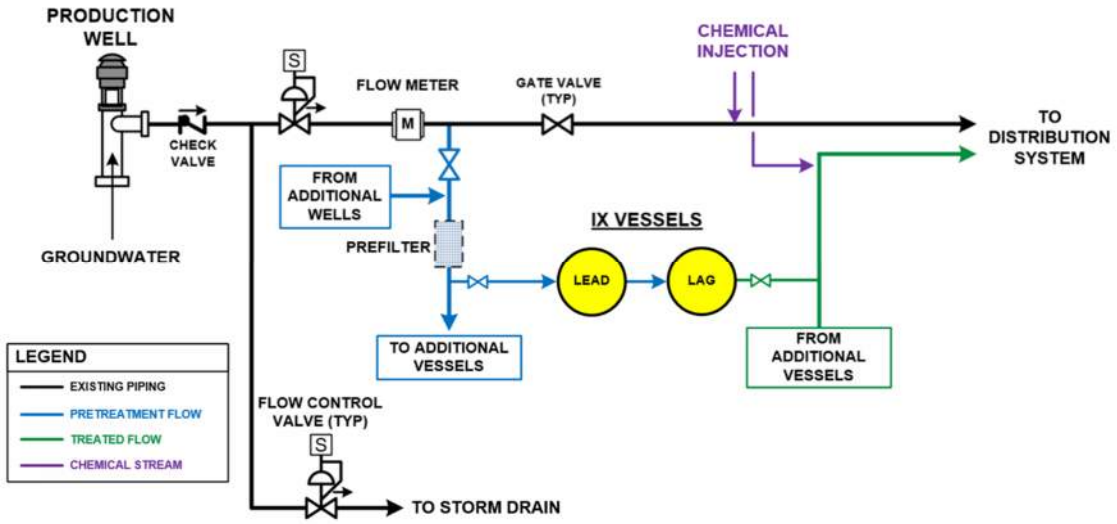

Figure 6 Process Flow Diagram – Ion Exchange

2.2.3 Reverse Osmosis and Nanofiltration

RO and NF are advanced water treatment processes that employ semi-permeable polymeric membranes that physically separate dissolved constituents from water. Although these treatment processes were initially developed for desalination, they have been demonstrated to effectively remove a wide variety of organic constituents, including PFAS.

In RO and NF, the feed flow is pumped under high pressure through the membrane elements. The product water (or permeate) can range from 50 percent to approximately 90 percent of the total flow, depending on the feed water chemistry, and the remainder (or concentrate) that contains the bulk of the dissolved constituents must be managed as a waste product. RO and NF removal efficiencies depend on the membrane selected and removal of PFOA and PFOS to 2 ppt or less have been demonstrated. The typical process flow for RO and NF treatment is presented on Figure 7.

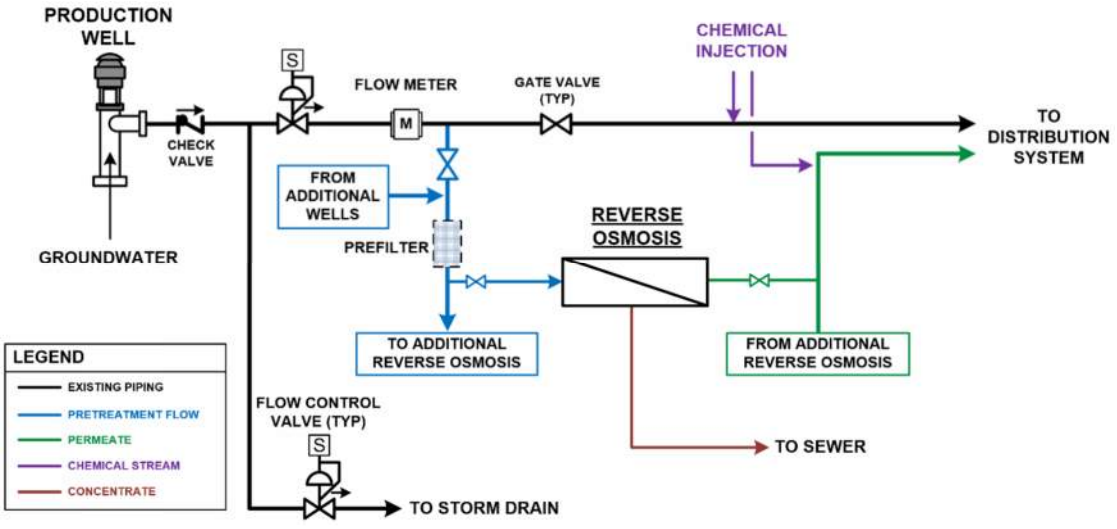

Figure 7 Process Flow Diagram – Reverse Osmosis and Nanofiltration

Zone 7's MGDP was initially installed to facilitate salt removal from the basin. Currently, it is also effectively rejecting PFAS so that the permeate is below reporting levels. Under normal operation of the MGDP, a portion of the production well water is by-passed around the RO membranes. The specific percent by-pass varies based on the specific wells in operation. The bypass has generally ranged from 15 to 60 percent of the total finished water.

This RO concentrate is discharged via the DSRSD system and, ultimately, the Livermore Amador Valley Water Management Agency (LAVWMA) export pipeline. As the PFAS are not destroyed, the future is uncertain with regards to the potential impacts should these chemicals be reclassified as a hazardous waste.

2.2.4 Blending

In addition to the PFAS removal technologies described above, the finished water PFAS concentration may also be managed through blending of specific wells with waters from production wells lower in PFAS concentration. The efficacy of this approach depends on the blending water's quality and the desired finished water PFAS concentration.

2.2.5 Summary of PFAS Treatment Technologies

The advantages and disadvantages for each of the potential treatment technologies considered are summarized in Table 4. The selected treatment options for each site for the City are discussed in further detail in the following sections.

Table 4 Alternative PFAS Treatment Technologies

	Advantages	Disadvantages
GAC	• Effective at removing PFOA and PFOS. • Good option if the source water also contains other organic contaminants that could be removed simultaneously. • Least energy intensive and easier to implement compared to RO/NF. • No additional chemicals.	• Not very effective at removing short-chain PFAS compounds. • GAC must be backwashed after each media change out, at a minimum. • Spent media should be thermally regenerated or incinerated.
IX	• Effective at selectively removing both long- and short- chain compounds. • Has higher PFAS removal capacity per volume. • More suitable for treating groundwater with higher PFAS concentrations. • Handles higher surface loading rates at lower empty bed contact time (EBCT), as compared to GAC, resulting in a smaller treatment footprint than GAC. • More suitable for wellhead treatment when space is limited, or height restrictions apply. • Less energy intensive and easier to implement compared to RO/NF. • No additional chemicals.	• Less flexible to operate than GAC due to poor chlorine resistance of the IX media and the negative impact of backwash or fluffing on the IX mass transfer zone. • Higher headloss across than GAC system. • DDW would prefer to have pilot data to support permit review. • May require more pretreatment than GAC, to protect the resin from abrasion. • Spent resin should be incinerated.
RO/NF	• Removes PFAS at high efficiency, including shorter chain PFAS. • RO removes a wide range of other contaminants, including salinity, improving overall water quality.	• PFAS is move into the RO concentrate and must be disposed. Without additional treatment, the PFAS is ultimately reintroduced to the environment. • RO is energy intensive and more complex than GAC or IX. • Multiple chemicals are used. • High life-cycle costs due to high capital costs and high operating pressure.

2.3 Regulatory Overview – Hexavalent Chromium

In 1977 both California and U.S. EPA established a total chromium drinking water MCL of 0.050 ppm. This includes all forms of chromium, including Cr6. In 1991, the federal level was raised to 0.1 ppm, but the California standard remained unchanged. A 0.010 ppm MCL was later established specific for Cr6 in California. This hexavalent chromium MCL was then invalidated in 2017. As such, the 0.050 ppm total chromium serves as the current basis for chromium regulation in California.

Earlier this year, the State Water Resources Control Board requested public comments on the White Paper Discussion on Economic Feasibility Analysis in Consideration of a Hexavalent Chromium Maximum Contaminant Level (MCL). The public comment period closed May 15, 2020. The input and comments received will be considered by the State Water Board in the future development of the MCL for hexavalent chromium.

2.4 Treatment Considerations and Goals for the Removal of Hexavalent Chromium

Multiple technologies exist to treat hexavalent chromium. These include ion exchange, reverse osmosis, and reduction coagulation filtration. The treatment options selected by Zone 7 to be included in this study included those treatment processes that may already be implemented for PFAS or reduction coagulation without filtration (by stannous chloride).

Both regenerable and single-use ion exchange processes can be used to remove hexavalent chromium, however, only single-use IX was considered here. Regenerable systems were not considered due to the production of a brine containing concentrated chromium, the treatment or disposal of this brine, and increased operational complexity of these systems. The process flow diagram of a single-use IX system looks identical to that shown in Figure 6. It should be noted, however, that the resins used for hexavalent chromium removal and PFAS removal are different. If both contaminants are to be removed by ion exchange, separate systems would generally need to be installed.

As with IX, the process flow to separate hexavalent chromium using reverse osmosis is the same as shown in Figure 7.

The process of removing Cr6 by reduction to trivalent chromium (Cr3) and subsequent coagulation and precipitation has been utilized in industrial systems. While multiple reducing agents have been empoyed, Zone 7 selected stannous chloride (SnCl2) without filtration as the base technology for Cr6 removal (Figure 8). It is understood that this process does not lower the total chromium concentration. Hexavalent chromium reduced to trivalent chromium enters the distribution system to either continue through to the points of distribution, settle out and accumulate in the distribution system, or re-oxidized to Cr6.

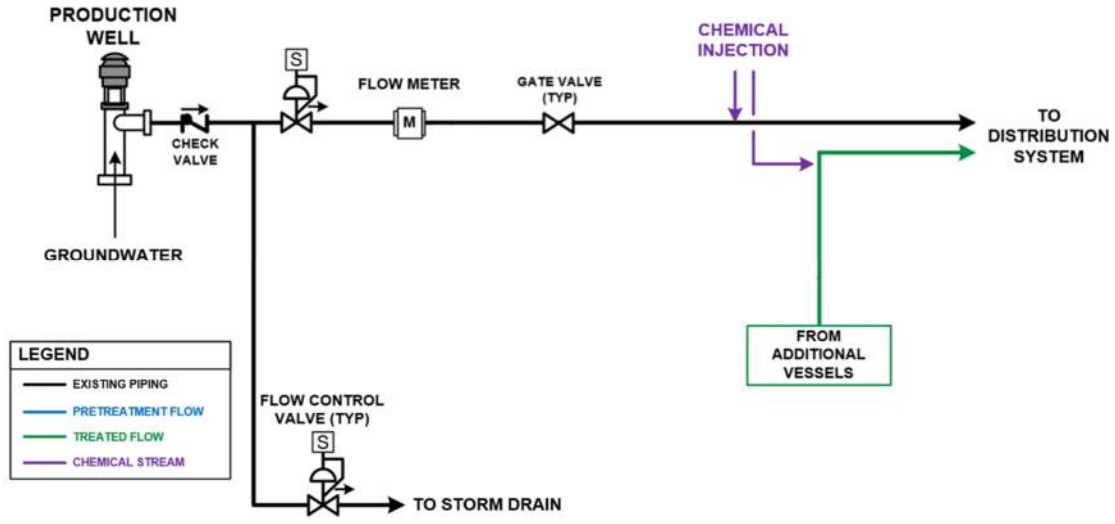

Figure 8 Process Flow Diagram – Stannous Chloride Reduction (without filtration)

A single treatment goal for Cr6 was selected by Zone 7 for evaluation:

- **8 ppb Cr6.** Given former 10 ppb MCL, potential variability in water quality results, and the 2019 fourth quarter running annual average concentrations, use 8 ppb to identify the well(s) requiring treatment. For those wells that are above this trigger, operational costs should be based on a treatment target of 8 ppb.

Section 3

TREATMENT ALTERNATIVES SCREENING

Each of the processes described above were considered where concentrations of PFAS and/or hexavalent chromium exceed the treatment goals for each identified production well. The locations requiring treatment to achieve the various goals are summarized in Table 7. Due to the limited space available at many of the sites, the footprint of each technology was considered to determine if onsite treatment of each technology was reasonably feasible or considered a fatal flaw. Centralized treatment and/or blending was also considered at a single site for each wellfield. Costs and aesthetic impacts were not considered for this initial screening.

Due to the constraints with most of the sites, this footprint screening of the treatment alternatives assumed either no setbacks or the requirements could be waived. Depending on the ultimate treatment strategy selected by Zone 7, the setback requirements or their waivers, the preliminary design should document the appropriate basis for detailed design.

3.1 Pretreatment Requirements

A preliminary evaluation of water quality was performed to determine if pretreatment was required ahead of the GAC and IX systems. Pretreatment limits were coordinated with media vendors and are summarized in Table 5. The limits shown are based on general rules of thumb for considering pretreatment. Water quality data in exceedance of the limit does not necessarily suggest pretreatment is required, but indicates where pilot testing could be utilized to determine if pretreatment could benefit the life-cycle cost of the treatment process.

Table 5 Pre-treatment Water Quality Conditions

Parameter	Units	Limit
Iron(1)	ppb	1,000
Manganese(1)	ppb	1,000
pH(2)	-	9
Turbidity(3)	NTU	1
TOC(4)	ppm	1

Notes:
Abbreviations: NTU – nephelometric turbidity unit; ppb – parts per billion.
(1) Iron and Manganese are problematic at >1 ppm, which is in excess of the secondary MCLs. Above 1 ppm will require pretreatment to prevent colloidal fouling.
(2) Optimal pH is <9. As the pH of zero-point charge for activated carbons is between 7.2 (Calgon F400) and 6.4 (Norit GAC400). Waters with significantly higher pH exhibit lower PFAS removal from electrostatic repulsion with negatively charged polar headgroups on PFAS.
(3) Turbidity higher than 1 NTU can cause colloidal fouling.
(4) Both TOC concentration and character influence the extent to which TOC directly competes with contaminants for adsorption sites or indirectly blocks pores via steric hindrance. Higher than 1 ppm will indicate waters that may need more frequent media replacement.

As shown in Table 2, the average water quality data for the potentially impacted wells is within the range acceptable range for GAC and IX treatment. The maximum reported values are also

within the limits for each parameter, except turbidity. All of these wells had reports of quarterly turbidity values in excess of 0.5 NTU. Mocho 1, Mocho 2, and Mocho 3 all had turbidities ≥1 NTU. Given a range of estimated bed life, it is recommended that at a minimum, space for pre-treatment be included in the site layouts as a means to help protect the treatment system from these solids.

Additional evaluation of the individual wells turbidities and each well's pump-to-waste protocols, is recommended during preliminary design to determine which systems should receive pretreatment.

3.2 Design Criteria

The design criteria used to develop the treatment plant site layouts for GAC and IX systems are summarized in Table 6. Specific design criteria for the recommended alternative are listed in Section 5.

Table 6 General Site Layout Design Criteria

Description	Units	GAC	IX
Flow per System (2 vessels, Lead-Lag)(1)	gpm	900	1,250
Vessel Configuration	-	Lead-Lag	Lead-Lag
EBCT per Vessel	min	10	3
Vessel Diameter	ft	12	12

Notes:
(1) Only 12-foot diameter vessels were considered for the site layout development.

3.3 Site Layouts

The following sections provide preliminary layouts for the selected treatment alternatives at each well site. The layouts include vessel locations, large buried pipeline routes, and major system components. The layouts also show potential equipment needed to support these systems. For space considerations, pretreatment (desanders and bag filters) before GAC and IX has been shown. The need for pretreatment should be verified through preliminary and detailed design.

Zone 7 has stated that treatment facilities are to be enclosed within a building to both protect the equipment and serve as a "good neighbor" to the surrounding community. This was identified after conceptual site layouts had been developed, and as such, have not been included. Site layouts of the facilities selected by Zone 7 to be developed for preliminary and detailed design should be updated to enclose the treatment processes.

For the purposes of the layouts, it was assumed that the kinetics of stannous chloride reduction are sufficiently fast such that additional contact time within the pipe is not necessary prior to chlorination and distribution. It is recommended that during the preliminary design phase, tests be performed to establish the necessary contact time for Zone 7 wells' water quality.

Table 7 Treatment Alternatives Locations

Location	PFAS				Cr(VI)
	California Response Levels[1]	80% of California Response Levels[2]	Vermont Advisory Level [3]	Below Method Reporting Limit[4]	8 ppb
Chain of Lakes 5		✓	✓	✓	✓
Chain of Lakes 2			✓	✓	✓
Chain of Lakes 1		✓	✓	✓	
Centralized Chain of Lakes			✓	✓	✓
Mocho 1	✓	✓	✓	✓	
Mocho 2	✓	✓	✓	✓	
Centralized Mocho	✓	✓	✓	✓	
Stoneridge 1			✓	✓	

Notes:
(1) California Response Levels for PFOS and PFOA are 40 ppt and 10 ppt, respectively.
(2) 80% of California Response Levels for PFOS and PFOA are 32 ppt and 8 ppt, respectively.
(3) Vermont advisory level of 20 ppt for the combined sum of PFOS, PFOA, PFHxS, PFHpA, and PFNA.
(4) Method Reporting Limit (MRL) of <2 ppt for all EPA Method 537 and EPA Method 537.1 PFAS.

Abbreviations
PFHxS = Perfluorohexanesulfonic Acid
PFOS = Perfluorooctanesulfonic Acid
PFHpA = Perfluoroheptanoic Acid
PFNA = Perfluorononanoic Acid
PFOA = Perfluorooctanoic Acid
ppb = parts per billion
ppt = parts per trillion

3.4 Chain of Lakes Wellfield

The screening of each of the alternatives for the Chain of Lakes Wellfield is presented below. For these alternatives, it was assumed that maintenance fluffing or backwashing of media could be either returned to the head of the treatment process or discharged to the adjacent lakes as the ability to connect to a sewer is not in close proximity. This would need to be verified through preliminary and detailed design.

Confirmations of vertical limitations and other requirements should be confirmed through the preliminary and detailed design process due the wellfield's proximity to the Livermore Municipal Airport and its flight paths.

3.4.1 Chain of Lakes 5

The smallest of the Chain of Lakes sites, Chain of Lakes 5 (COL5) has detectable concentrations of both PFAS and Cr6. Given their 2019 Q4 RAAs and the selected treatment goals, hexavalent chromium treatment is required for this water. Treatment for all but the highest PFAS goal (Response Levels) would also be required for this water. Due to the size of the property, not all of the treatment scenarios could be sited here due to footprint constraints.

The treatment train with the smallest footprint utilizes ion exchange to remove PFAS and stannous chloride to reduce hexavalent chromium (without filtration) does fit, but would eliminate vehicular circulation around the wellhouse if pretreatment is necessary (Figure 9).

Figure 10 shows that granular activated carbon for PFAS removal combined with a single-use ion exchange for hexavalent chromium removal may fit, but would reduce access for maintenance around the facilities. Similarly, GAC for PFAS with stannous chloride for Cr6 reduction would also fit.

The small site, however, does not support a separate reverse osmosis building (approximately 5,000 SF) in its current configuration.

3.4.2 Chain of Lakes 2

Given the selected treatment targets, Chain of Lakes 2 (COL2) requires treatment for hexavalent chromium. The PFAS concentrations indicate treatment would only be required to meet the two most stringent treatment goals (Vermont advisory level and Below Reporting Limits). Due to the size of the property, not all of the treatment scenarios could be sited here due to footprint constraints.

The treatment train with the smallest footprint would utilize stannous chloride for Cr6 reduction (or larger IX for Cr6) and no treatment for the higher PFAS treatment goals. This would easily fit within the site. The largest footprint treatment train (reverse osmosis) does not fit.

Providing GAC for the full capacity of the production well to meet the more stringent PFAS treatment goals and split-stream ion exchange treatment for Cr6 removal can be physically arranged on the site (Figure 11). However, it is believed that this would provide insufficient space for routine maintenance activities.

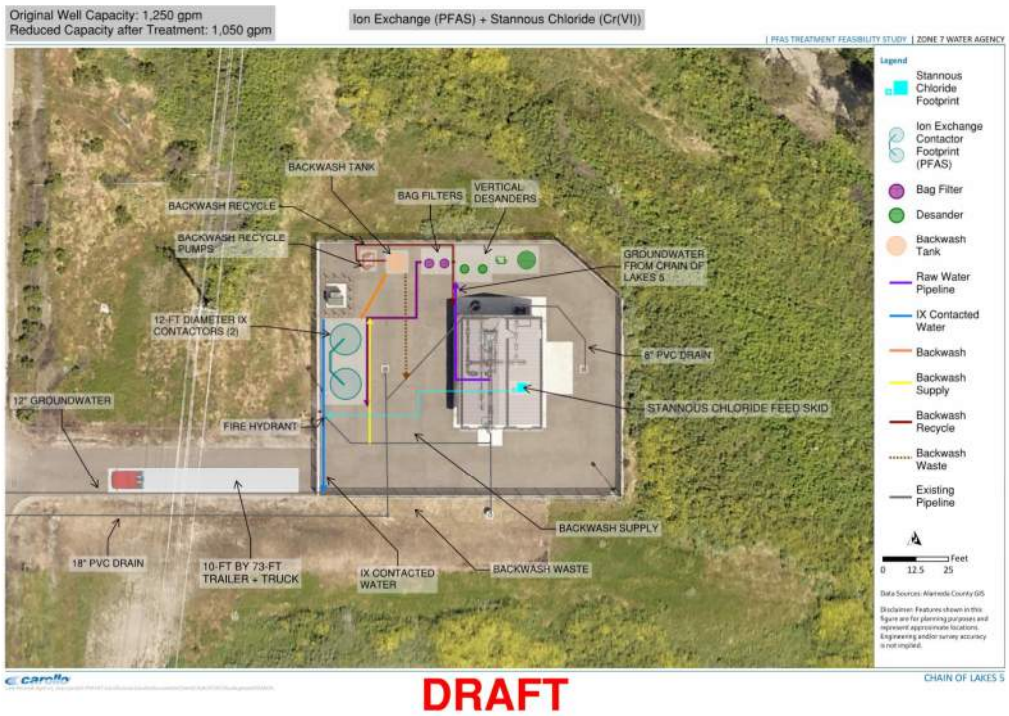

Figure 9 COL5 – IX for PFAS & SnCl2 for Cr6

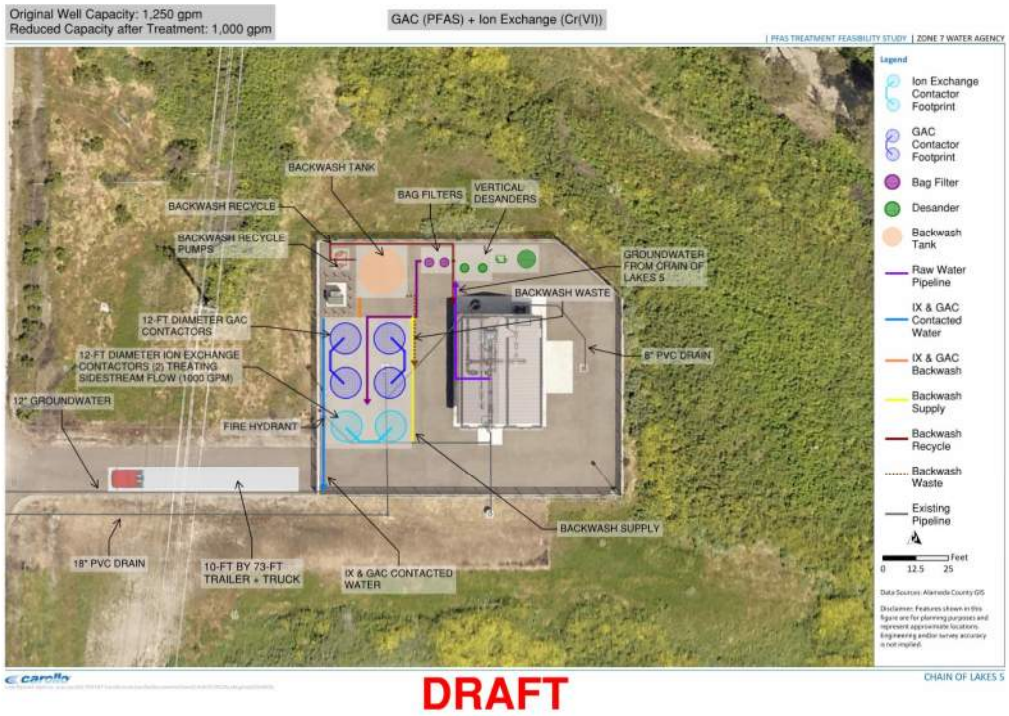

Figure 10 COL5 – GAC for PFAS & IX for Cr6

Figure 11 COL2 – GAC for PFAS & XI for Cr6

Figure 12 COL2 – IX for PFAS & SnCl2 for Cr6

Adjusting treatment to rely upon IX for the full capacity of the well to removal PFAS and stannous chlorine to reduce Cr6, reduces the treatment footprint, but still results in a constrained site with reduced access to facilities (Figure 12). If no other options were available, refining this alternative might result in a suitable facility. However, treatment can be centralized at Chain of Lakes 1 (COL1), providing additional accessibility and centralized operations and maintenance activities.

3.4.3 Chain of Lakes 1

The largest of the Chain of Lakes production wells, COL1 does not need hexavalent chromium treatment. The 2019 Q4 RAA concentrations, however, indicates that PFAS treatment is required to meet three of the four goals.

Either IX or GAC systems for PFAS removal for the full capacity of this production well, easily fit within this site. Figure 13 shows IX with pretreatment.

This is the only Chain of Lakes production well site large enough to support RO treatment. To meet the 80 percent of the Response Level goal, a building approximately 4,000 SF would be required. As the PFAS treatment goal is lowered, more of the water must be treated through the membrane system, increasing the membrane area and building footprint. It is estimated that a building approximately 8,500 SF in size would be required to meet the two lowest PFAS treatment goals (VT advisory level and Below Reporting Limits). Figure 14 shows there is enough space for buildings of these sizes.

For any reverse osmosis treatment option, the disposal of the RO concentrate must be addressed. At a raw water flow rate of 2,500 gpm and the 2019 Q4 PFAS RAA concentrations the RO concentrate flow rate would range from approximately 20- to 500-gpm depending on the treatment goal. The Livermore Interceptor Pipeline and Clean Water Revival Pipeline are approximately 3,500 LF away from COL1. Should this option be considered further, additional investigation into the feasibility and costs of disposing the RO concentrate is necessary.

Independent of the treatment option selection, attention to the geotechnical conditions should be provided during preliminary and detailed design. A structural improvement project (Chain of Lakes 1 Facilities Stabilization Project) was completed earlier this year to help protect the existing facilities from on-going settlement and horizontal migration.

3.4.4 Centralized Treatment at Chain of Lakes 1

In lieu of providing three independent facilities, a centralized treatment facility at COL1 that could treat the full capacity of the three wells was evaluated. Depending on the wells in operation, the centralized facility would need to provide PFAS treatment for three of the treatment goals. Based on the 2019 Q4 RAAs, only a portion of the flow would need to be treated to manage the hexavalent chromium concentration.

A centralized RO facility treating 7,250 gpm of raw water would be between approximately 5,000 and 13,500 SF in area with the building size increasing as the PFAS goal is lowered. The RO system, could simultaneously address hexavalent chromium. As previously shown in Figure 14, facilities of this size could fit within the existing fence lines. The resulting RO concentrate flow generated by these facilities would range from approximately 200 to 1,400 gpm depending on the selected PFAS treatment goal.

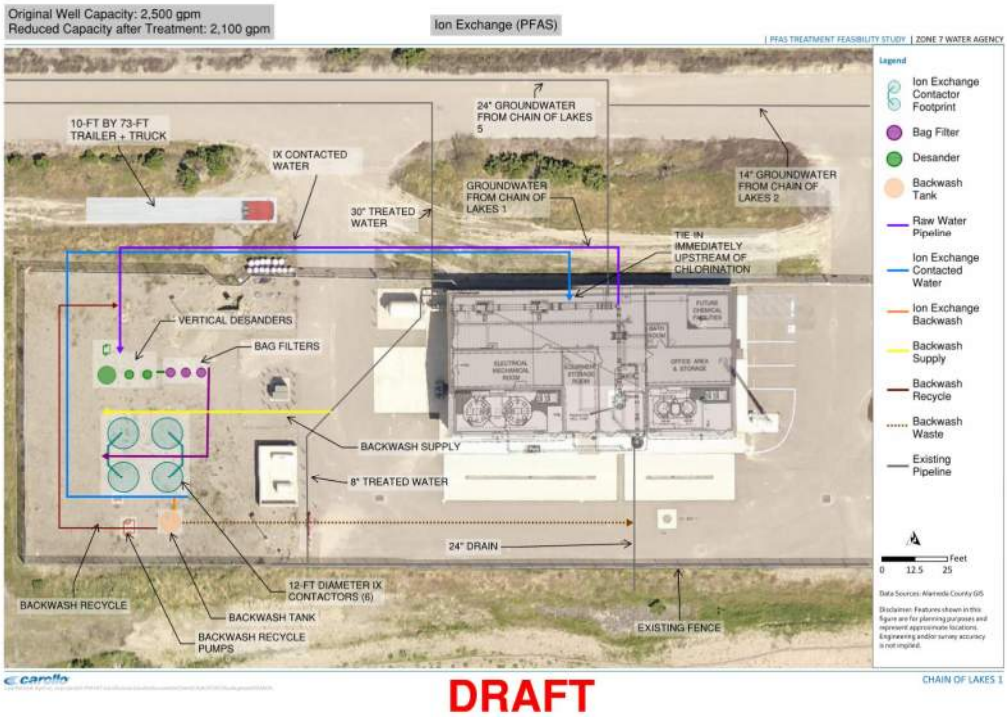

Figure 13 COL1 – IX for PFAS

Figure 14 COL1 – Space available for an RO system to treat PFAS

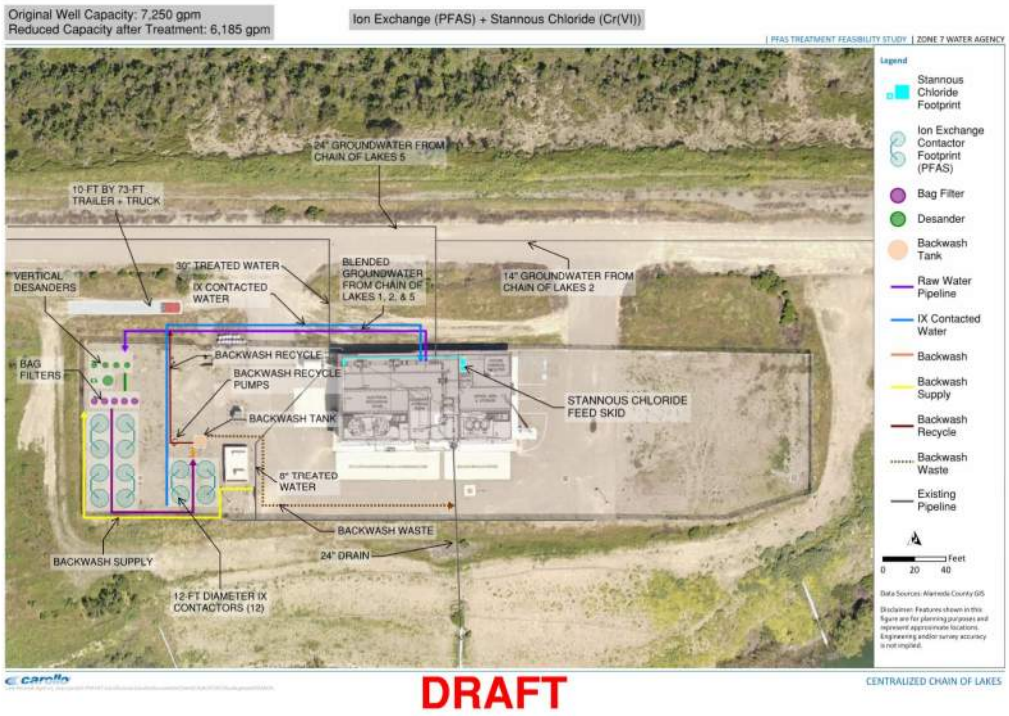

Figure 15 COL Centralized Treatment – IX for PFAS & Stannous Chloride for Cr6

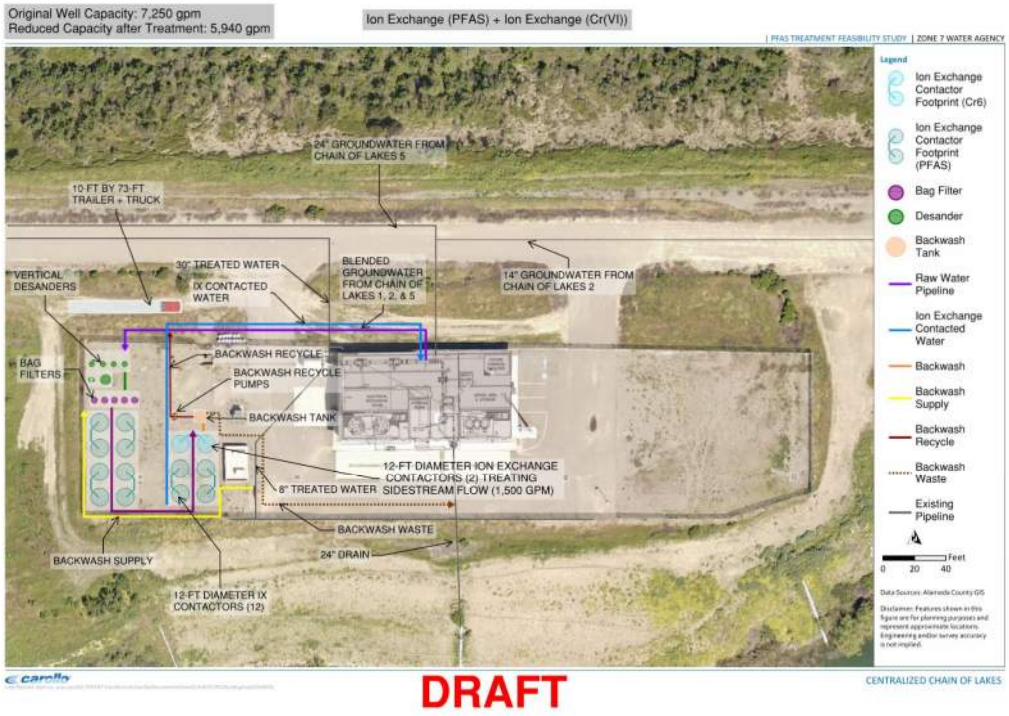

Figure 16 COL Centralized Treatment – IX for PFAS & Cr6

The Livermore Interceptor Pipeline and Clean Water Revival Pipeline are approximately 3,500 LF away from COL1. Should this option be considered further, additional investigation into the feasibility and costs of disposing the RO concentrate is necessary.

Figure 15 shows the smallest footprint for centralized treatment (IX for PFAS and SnCl2 for Cr6) fitting within the property limits. Incremental increases in the size of the treatment train footprints (Figure 16 through Figure 18) show that this site supports any of the alternatives given the assumptions previously discussed.

Independent of the treatment option selection, attention to the geotechnical conditions should be provided during preliminary and detailed design. A structural improvement project (Chain of Lakes 1 Facilities Stabilization Project) was completed earlier this year to protecting the existing facilities from on-going settlement and horizontal migration.

3.5 Mocho Wellfield

The screening of each of the alternatives for the Mocho Wellfield is presented below. In contrast to the Chain of Lakes Wellfield, it was assumed that for these alternatives maintenance fluffing or backwashing of media could be discharged to sewer or returned to the head of the treatment process. This would need to be verified through preliminary and detailed design.

3.5.1 Mocho 1

Mocho 1 produces water with PFAS concentrations in excess of the CA DDW Response Level, requiring treatment to meet all four PFAS goals. The Cr6 concentration is below the 8 ppb goal so additional treatment for this contaminant is not necessary. Operation staff have indicated this well produces enough turbidity that its water is not directed to MDGP as it significantly reduces the operational life of the cartridge filters.

The production well site for Mocho 1 is a small site, but appears to have available space. There are, however, several pipelines (i.e. Santa Rita-Doherty Pipeline, Vineyard Pipeline, 12" from Mocho 2) that transect the site. A previously used ammonia fee building is no longer in use and could be demolished to make space for treatment facilities. Similarly, the southern portion of the existing Mocho 1 Well Pump Building is a former chemical storage area that could be repurposed or demolished. At the same time, the generator, generator power disconnect, and main power disconnect would need to be relocated if these other site modifications were to be considered.

To avoid siting the treatment facilities on top of the buried assets, the treatment was conceptually arranged in the southeast corner of the site. As shown in Figure 19, it would be challenging to fit ion exchange treatment on this site. If these facilities were enclosed within a building, the new construction would consume even more space, further limiting operations and maintenance access. Looking at the larger GAC system (Figure 20), there is insufficient space for the treatment process and provide adequate access for the facilities. The space needed for a reverse osmosis membrane treatment system would exceed the available site.

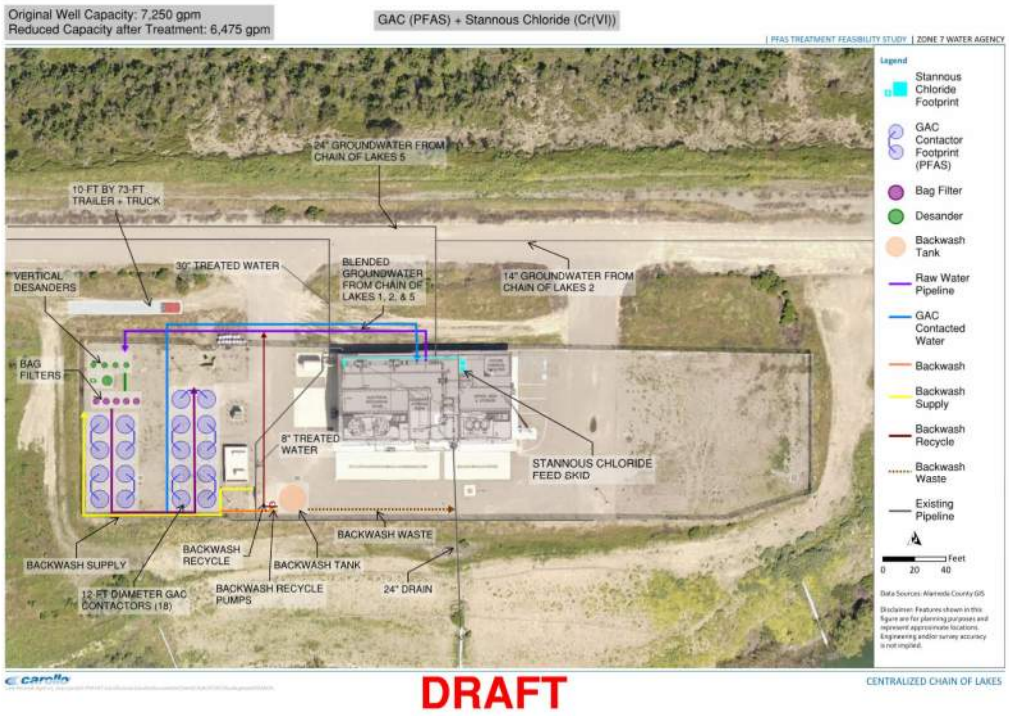

Figure 17 COL Centralized Treatment – GAC for PFAS & Stannous Chloride for Cr6

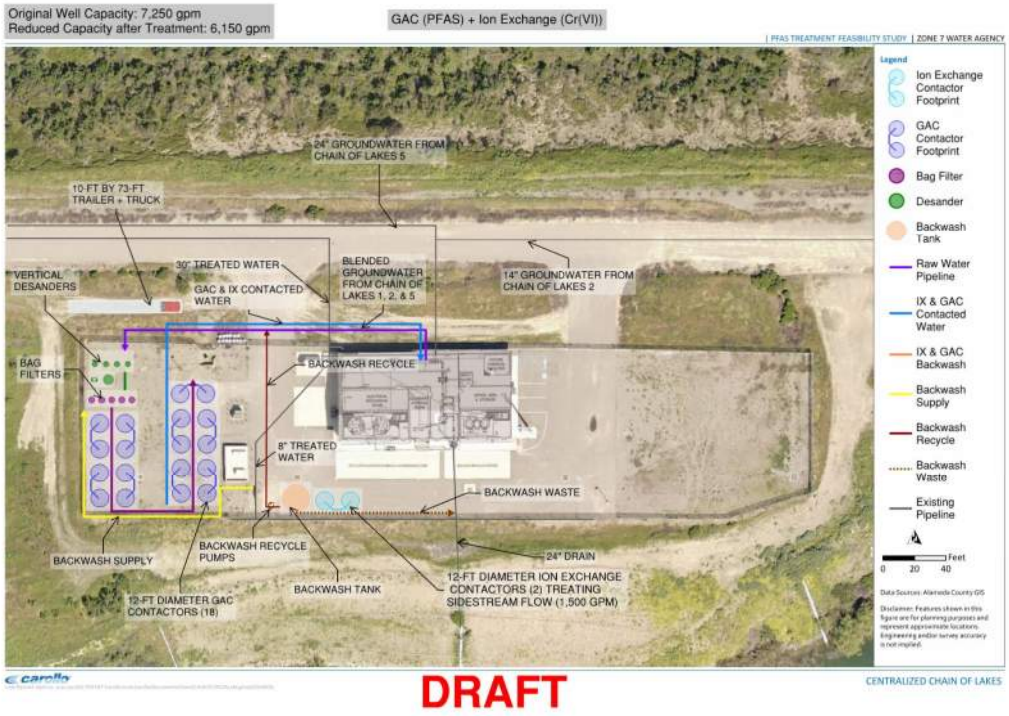

Figure 18 COL Centralized Treatment – GAC for PFAS & IX for Cr6

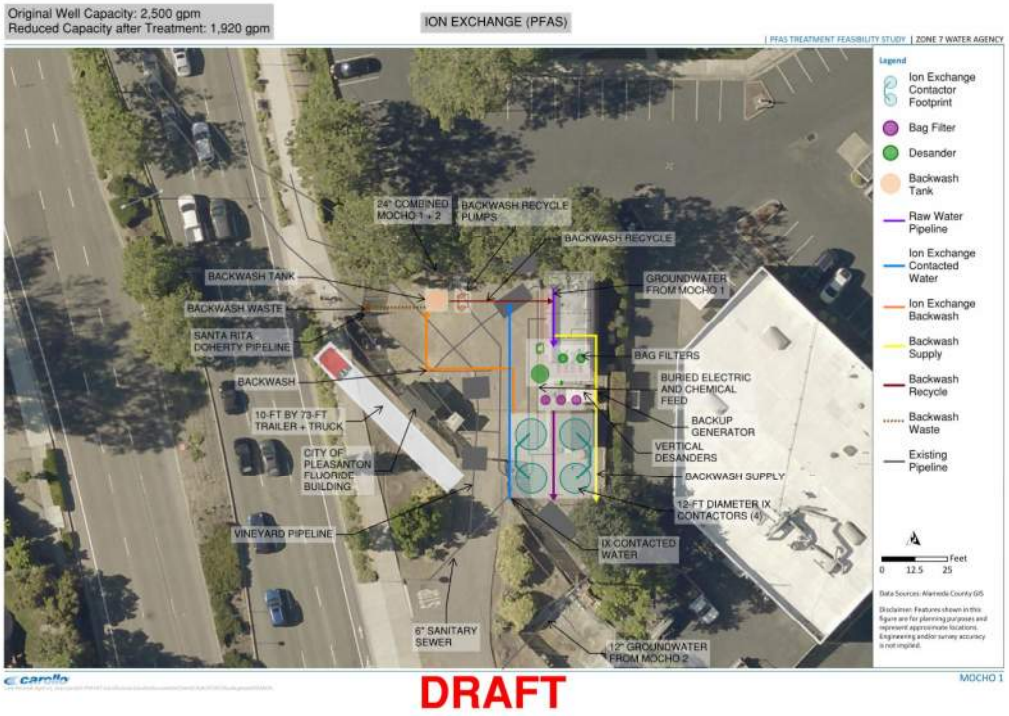

Figure 19 Mocho 1 – IX for PFAS

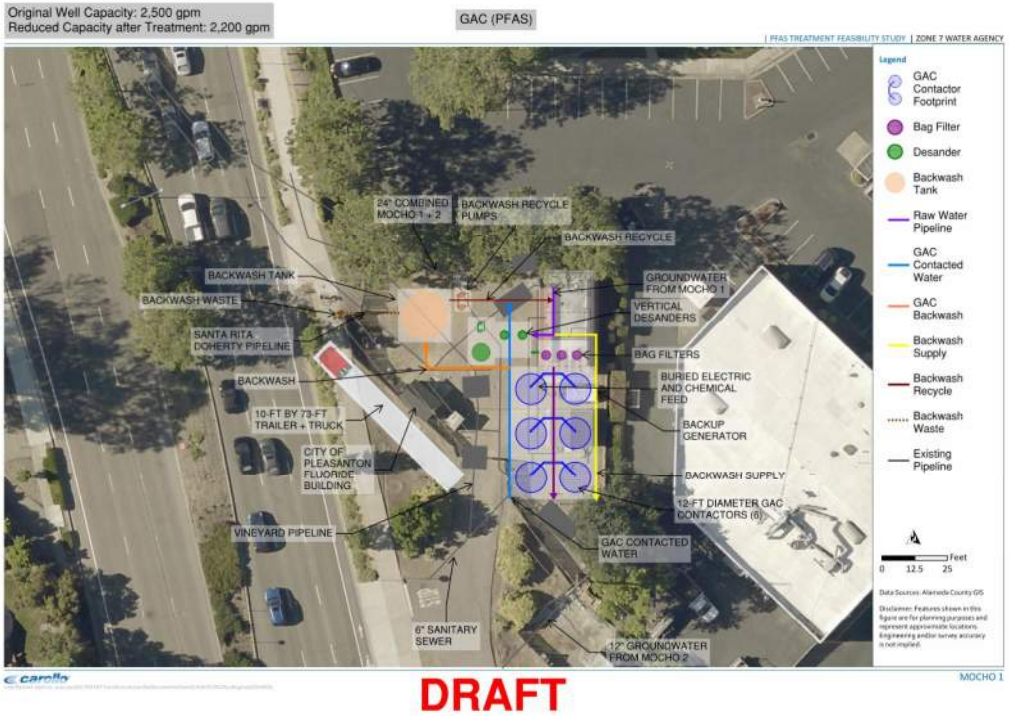

Figure 20 Mocho 1 – GAC for PFAS

3.5.2 Mocho 2

Mocho 2 2019 Q4 RAA results indicate that treatment is required to address all four of the PFAS treatment goals, but no additional Cr6 treatment is required.

Siting treatment at the narrow Mocho 2 has limited options. It appears that an ion exchange system may fit within the property limits, but could reduce access to the existing facilities (Figure 21). The larger treatment footprint of GAC further restrict site access for routine operation and maintenance. If pretreatment for GAC were required, the site would generally be inaccessible by vehicle (Figure 22). There is insufficient space for RO treatment within the property limits.

3.5.3 Mocho 3 & Centralized Treatment

The concentration of PFAS in Mocho 3 requires treatment to meet three of the four goals. Hexavalent chromium treatment is not required for this well.

As the property is owned by the City of Pleasanton, Zone 7 did not wish to consider utilizing this site solely for the treatment of an individual well. However, given the available space could support centralized treatment for the wellfield it was included in the evaluation for this purpose. Should this option be considered further, discussions would need to be initiated between the City of Pleasanton and Zone 7.

Given the flows for Mocho 1 and Mocho 2 pass though the site on their way MDGP, centralized treatment was considered for the full capacity of Mocho 1, 2, and 3. This centralized treatment could be used to reduce PFAS from these wells to the desired treatment goals, reducing the need to operate the MDGP facility for PFAS compliance and reducing the concentration of PFAS in the RO concentrate. MDGP operation would still be required to meet Zone 7's salt removal goals. Including Mocho 4 flows into this facility would require at least one additional pipe crossing Stoneridge Drive to convey the water to the new treatment system.

Space supports any of the treatment technologies (IX, GAC, RO). A centralized GAC treatment system is shown as an example in Figure 23. The IX system would take less space, clearly fitting. The space requirements for the RO treatment alternative (Figure 24) depends on the level of treatment. The smallest RO building footprint is estimated to be approximately 7,000 SF to reduce PFOS to its response level. The building size increases to approximately 13,500 SF when rejecting all EPA Method 537/537.1 PFAS to below reporting limits.

3.5.4 Mocho 4, MDGP, and Centralized Treatment

The concentration of PFAS in the groundwater produced from Mocho 4 is below the higher two treatment goals. Treatment is only required to meet the VT advisory level and to reduce all of the EPA Method 537/537.1 PFAS to below reporting limits. Chromium is sufficiently low so that additional treatment is not necessary for this contaminant.

Figure 21 Mocho 2 – IX for PFAS

Figure 22 Mocho 2 – GAC for PFAS

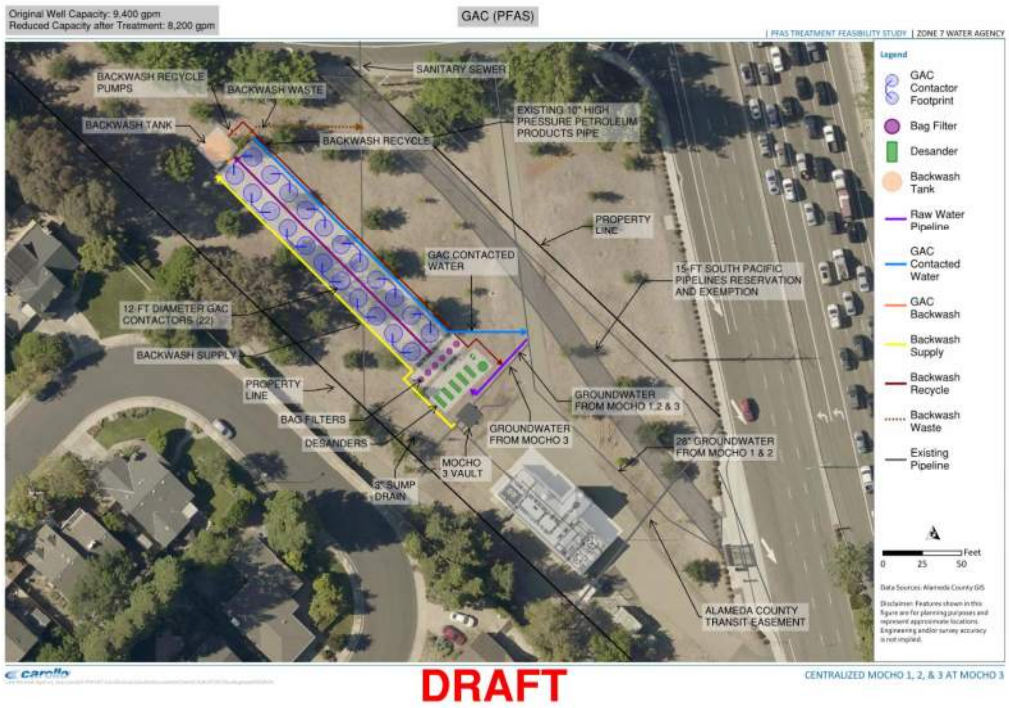

Figure 23 Centralized Mocho Wellfield Treatment at Mocho 3 – GAC for Mocho 1, 2, and 3 PFAS

Figure 24 Centralized Mocho Wellfield Treatment at Mocho 3 – RO for Mocho 1, 2, and 3 PFAS

The MGDP site was considered for centralized treatment. To minimize expenses the capacity of the centralized treatment facility was limited to the wellfield capacity in excess of MGDP's treatment capacity. Utilizing this capacity to size the treatment systems, revealed that there is insufficient space to expand the membranes. Furthermore, the space that might be utilized for either ion exchange or GAC vessels have significant utilities and/or infrastructure that would need to be relocated (Figure 25). Due the complexity, costs, and availability of other options, this was not considered further.

Figure 25 Mocho 4 – MGDP site limitations

3.6 Stoneridge

The screening of each alternative for the Stoneridge well is presented below.

3.6.1 Stoneridge 1

A review of the 2019 Q4 RAA data indicated that the PFAS concentrations are almost exactly the VT advisory level. As such, no PFAS treatment would be required to meet the CA DDW response levels or 80% of these values. However, treatment would be required to consistently maintain concentrations below either the VT advisory level or below the PFAS reporting limits. No hexavalent chromium treatment is necessary to meet the established goal.

Figure 26 shows that a GAC treatment system, or a smaller IX treatment system, could fit within the existing fence line.

RO would require a building approximately 9,500 SF. While this does not currently fit well within the current fence line, Zone 7 owns the parcel contiguous to the north-eastern fence line. Expanding into this area could provide sufficient space if RO treatment was selected.

Figure 26 Stoneridge 1 – GAC for PFAS

3.7 Treatment Technologies Alternatives Summary

The alternatives screening of each technology at the identified wells is summarized in Table 8. This indicates the treatment technologies and the locations at which they may be installed to reach the various treatment goals for PFAS and Cr6. These systems, coupled with blending at centralized locations, are used in describing the various scenarios that may be used to meet the project goals in the following section.

Table 8 Screened Alternatives

Location	PFAS			Cr6	
	IX	GAC	RO	SnCl2	IX
Chain of Lakes 5	✓	Limited access	Insufficient space	✓	Limited access
Chain of Lakes 2	✓	Limited access	Insufficient space	✓	Limited access
Chain of Lakes 1	✓	✓	Brine Disposal	n.a.(1)	n.a.
Centralized Chain of Lakes	✓	✓	Brine Disposal	✓	✓
Mocho 1	Limited access	Insufficient space	Insufficient space	n.a.	n.a.
Mocho 2	Limited access	Insufficient space	Insufficient space	n.a.	n.a.
Centralized Mocho (at Mocho 3)	✓	✓	✓	n.a.	n.a.
Centralized Mocho (at MGDP)	Insufficient space	Insufficient space	Insufficient space	n.a.	n.a.
Stoneridge 1	✓	✓	✓	n.a.	n.a.

Notes:
(1) n.a. = not applicable

Section 4

TREATMENT STRATEGIES

Based on the conceptual physical site layout alternatives identified as feasible in Section 3, strategies for the four targeted PFAS treatment goals and one hexavalent chromium goal are provided in this section.

4.1 Response Levels & 80 Percent of Response Levels

Based on the average values of the four quarterly monitoring results in 2019, Mocho 1 and Mocho 2 would exceed the 40 ppt PFOS response level. All other wells are compliant with this level. All wells would also meet the 10 ppt PFOA response level.

The four wells in the Mocho wellfield may be treated at the Mocho Groundwater Demineralization Plant, a reverse osmosis membrane treatment system. The capacity of the RO system allows for three of the four Mocho wells to be treated at the same time. When the plant is running, both Mocho 1 and Mocho 2 may be treated, lowering PFAS to below detection levels in the RO permeate (filtered water). As previously indicated, elevated turbidities negatively impact the MGDP O&M requirements. Consequently Mocho 1 has not been utilized due to turbidity historically exceeded 0.5 NTU.

When the treatment plant is not running, the PFOS Response Level can be met by blending the water from Mocho 1 and/or Mocho 2 with water from Mocho 3 and Mocho 4 at the MGDP. When the RO trains are not in operation the water that enters the plant is blended in the groundwater bypass pipeline. Mocho 1 and Mocho 2 must be run through MGDP (with treatment or through the groundwater bypass line) for chloramination due to piping configuration. Mocho 3 and Mocho 4 may be run to MGDP or directly to the distribution system as each well has its own chemical feed system for chloramination. When Mocho 3 is run directly to distribution, it enters the Santa Rita-Dougherty Pipeline south of MGDP. When Mocho 4 is run directly to distribution, it is routed through the same pipeline as the MGDP effluent. Therefore, when Mocho 4 is run directly to distribution, it is still blended with water being run through MGDP (treated or through the bypass) prior to entering the distribution system (Santa Rita-Dougherty and/or Mocho pipelines). Zone 7 has prioritized operation of the Mocho wells in the following order, Mocho 4, Mocho 3, Mocho 2, and lowest in priority Mocho 1.

Multiple blending scenarios were evaluated for both the Chain of Lakes and Mocho Wellfields. Based on the results of this evaluation (Table 9), the following operating restrictions apply when RO treatment is not used:

1. Mocho 3 and Mocho 4 must be running to run Mocho 1.
2. All four wells may be run at the same time. Due to capacity limits in the piping at MGDP, Mocho 1, 2, and 3 would be treated at MGDP with Mocho 4 bypassing MGDP to blend prior to distribution.
3. Mocho 2 may be run with Mocho 3, with Mocho 4, or with Mocho 3 and 4.

Table 9 Estimated PFOS and PFOA Concentrations for Various Blending Scenarios without RO Treatment

Blending Scenarios without RO Treatment[(1)]	Estimated PFOS (ppt)	Estimated PFOA (ppt)
Chain of Lakes Wellfield		
COL 1 & 2:	22	3
COL 1 & 5:	35	3
COL 2 & 5:	21	2
COL 1, 2 & 5:	25	2
Mocho Wellfield		
Mocho 1 & 2	**64**	7
Mocho 1 & 3	**52**	7
Mocho 1 & 4	**41**	5
Mocho 1, 2, 3 & 4	39	6
Mocho 1, 2 & 3	**49**	7
Mocho 1, 3 & 4	38	6
Mocho 1, 2 & 4	**41**	5
Mocho 2 & 3	36	6
Mocho 2 & 4	24	5
Mocho 3 & 4	24	5
Mocho 2, 3 & 4	28	6

Notes:
(1) Concentration > Response Level is in bold Red color.
Concentration > Water Quality Goal (80% Response Level) is in Orange color.
Concentration < Response Level is in Green color.
These data are based on the 2019 Q4 RAA values.

To address the 80 percent of PFAS RL treatment goal and the 8 ppb Cr6 goal the following production wells were identified as requiring action:

- PFOS: COL 1, COL 5, Mocho 1, Mocho 2, and Mocho 3.
- PFOA: Mocho 1.
- Cr6: COL5

Within the Chain of Lakes Wellfield, all three wells are routed to COL 1 building for chloramination prior to entering the distribution system at the El Charro Pipeline. Zone 7 currently blends COL 5 with either COL 1 or COL 2 to meet the hexavalent chromium goal and the following operating restriction applies to meet the water quality goal of 80 percent of the PFAS RLs:

- COL 2 must be running to run COL 1 and/or COL 5
  (COL 1 & 2, COL 2 & 5, or COL 1, 2, & 5 are acceptable configurations).

Within the Mocho Wellfield, the 80 percent goal may be achieved when Mocho 1, 2, and 3 are treated with RO. When RO treatment is not available, the following operating restrictions apply:

- Mocho 1 may not be run (without RO treatment).

- Mocho 4 must be running to run Mocho 2 and/or Mocho 3 (Mocho 2 & 4, Mocho 3 & 4, and Mocho 2, 3, & 4 are acceptable configurations).

It is not possible to meet the other treatment goals with blending (no RO) alone.

Table 10 summarizes the operational conditions necessary to support blending as the approach to achieve the stated treatment goals. Through these PFAS operational restrictions, the treatment goal for hexavalent chromium is simultaneously met.

Table 10 Blending Operational Conditions Summary

PFAS Goal	Operational Restrictions	
Chain of Lakes		
Response Level	No restrictions	
80% of RL	• COL2 first on	
VT Advisory Level	Not possible	
Below MRL	Not possible	
Mocho	**RO on**	**RO off**
Response Level	• Mocho 1 and/or 2 to RO.	• Mocho 3 and 4 must be running to run Mocho 1. • All 4 wells may be run at the same time. Due to capacity limits in the piping at MGDP, Mocho 1, 2, and 3 are run to MGDP and Mocho 4 bypass. • Mocho 2 may be run with Mocho 3, Mocho 4, or Mocho 3 and 4.
80% of RL	• Mocho 1, 2, or 3 run to RO.	• Mocho 1 may not run. • Mocho 4 must be running to run Mocho 2 and/or 3.
VT Advisory Level	• Mocho 1 may not run. • Mocho 2, 3, and/or 4 to RO.	Not possible
Below MRL	• Only Mocho 4 to RO.	Not possible
Stoneridge		
Response Level	No restrictions	
80% of RL	No restrictions	
VT Advisory Level	No restrictions	
Below MRL	Not possible	

4.2 VT Advisory Level

The blending options summarized in Table 10 reveal the existing facilities provide operational strategies to simultaneously address two of the four PFAS treatment goals (RLs and 80 percent of RLs) along with the hexavalent chromium treatment goal. To increase the level of service and

meet the VT Advisory Level at all wellfields, treatment would need to be provided for the Chain of Lakes Wells. At this level of service, water from all three COL production wells would require additional treatment. Table 8 shows that while ion exchange can be used either to treat individual wells or at a centralized facility, site limitations practically restrict GAC to treatment at COL1.

To provide a treatment system that could support either GAC or IX, enable future developments in media technology to be utilized, and maximize wellfield operational flexibility, it is recommended that PFAS treatment for the Chain of Lakes Wellfield would need to be:

- Located at COL1
- Media vessels should be sized to support the larger GAC bed volume
- External piping should be sized to support higher hydraulic loading rates of ion exchange.
- Internal elements should support the physical characteristics of either media.
- General arrangement should be developed to support a phased installation of treatment media pressure vessels, if desired, by Zone 7.
- General arrangement should include space planning for pretreatment of the waters to manage turbidity. This may be eliminated if additional analysis during preliminary design demonstrates that it is not needed.

Zone 7 also desires that all treatment system be enclosed within a building.

Based on performance information provided by the media suppliers, it is estimated approximately 170,000 bed volumes (BVs) of water could be treated by GAC before replacement to meet this treatment goal. This bed life is anticipated to increase to approximately 330,000 BV with the use of a PFAS-selective ion exchange resin. These bed volumes will vary depending on the actual operation of the wells. The estimated throughput to reach the treatment goal for each media at each site is presented in Appendix A.

During preliminary design, bench- and or pilot-scale testing can be used to evaluate commercially available GAC and IX media, refine operational and maintenance costs, provide supporting data to DDW as a part of the permit amendment process, support an approved procurement strategy, and finalize the number of media pressure vessels to be initially installed (i.e. 12 for IX, 18 for GAC).

As two of the three wells would also require treatment for hexavalent chromium, it is recommended that treatment be consolidated to the same centralized COL1 site. The alternatives analysis indicated that COL would support the use of either IX or $SnCl_2$ addition to manage the Cr6 concentration.

It is recommended that bench- or pilot-scale testing of $SnCl_2$ be performed during preliminary design to determine the rate of reaction and establish site specific design criteria, characterize the potential for accumulation of Cr3 in the distribution system, and estimate the magnitude of distribution system Cr3 oxidation. The results of this testing may drive a recommendation to one treatment strategy, or drive a decision to consider an alternative approach.

4.3 Below Method Reporting Limits

The treatment goal to reduce the concentration of PFAS to below the EPA Methods 537 and 573.1 analytical reporting limits is the most challenging level of service evaluated. Based on the

blending options summarized in Table 10, additional treatment is required for both the Chain of Lakes and Stoneridge Wellfields. Additional treatment may not be required for the Mocho Wellfield as long as Zone 7 continues to accept the operational restrictions outlined in Table 10.

The recommended system to provide this additional treatment for the Chain of Lakes Wellfield is the same as described in Section 4.2. The primary difference between these systems is with the media replacement frequency. For this treatment goal, the GAC throughput was estimated to be reduced by approximately 93 percent to 12,500 BV. A reduction of 66% to 110,000 BV was also estimated for the IX throughput. With the uneven decrease in media capacity, the economics shift towards IX for this highest level of service (lowest finished treated water concentrations) for PFAS. However, given the uncertainty associated with the regulations, it is recommended that a system be designed to accept either media. This way, an MCL-appropriate media can be selected once the regulation is in place. To minimize operational and maintenance complexity for PFAS treatment, it is recommended that a consistent approach to the treatment equipment be applied across the impacted wellfields were possible. Some variation in the installed media based on individual well water quality would not be unexpected.

Section 5

COSTS TO IMPLEMENTATION

Given the treatment strategies described in Section 4, the recommended implementation approach has three phases:

1. **Continue Existing Practices for Mocho Wellfield Compliance**. Given Zone 7's willingness to accept operational limitations, continue to utilize MGDP and blending to manage the Mocho Wellfield PFAS concentrations to compliance concentrations.
2. **Prepare Chain of Lakes Wellfield for Lower Compliance Levels**. If regulatory PFAS compliance concentrations continue to decrease or a hexavalent chromium MCL is established, the Chain of Lakes is likely to be the next wellfield required to provide treatment based the current water quality conditions. Initiating a preliminary and detailed design of the treatment system will establish the design criteria for this system. Based on the opinions of relative probable construction costs to compare the estimated incremental costs of treatment described below, and opportunities for future operational flexibility described above, a hybrid media pressure vessel treatment system is recommended.
3. **Track Water Quality and Regulatory Changes**. Continue to monitor the PFAS and Cr6 concentrations in the production wells and track the development of the corresponding regulations. These will determine if refinements to the COL treatment facility are necessary, or if treatment at Stoneridge should be considered further.

To support the development of the Chain of Lakes facility and evaluate the costs of other selected alternatives, preliminary Class 5 level cost estimates were developed to evaluate the relative cost-effectiveness of the treatment systems. AACE International defines an Order-of-Magnitude Estimate, deemed appropriate for master plan studies, as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within plus 50 percent to minus 30 percent. As projects proceed into the preliminary design and design stages, estimates are refined when conditions become known. The life-cycle was based on 30 years and included the treatment and infrastructure required.

In addition to the above, it has been assumed that:

- These represent relative to the other treatment alternatives the incremental cost of treatment. The costs do not include the base operational and maintenance costs of operating and maintaining the production wells.
- Reduction of individual well production capacity as the result of increased headloss through the new treatment process(es) has not been included in the costs. It is assumed that the reduced instantaneous capacity would be recovered by additional operational run time to achieve the individual annual well production identified in Table 1.The estimated reduction of well production capacity is identified on the corresponding site layouts in Section 3. Hydraulically, pretreatment is included for both IX and GAC, and represents a conservative condition if the pretreatment is deemed unnecessary during

preliminary design. Financially, as a part of the Class 5 opinion, pretreatment was included in the IX costs, but not the GAC costs.

- Utilities upgrades of the sites are not included.
- Geotechnical considerations have not been included. This may be significant at Chain of Lakes.
- Building will enclose treatment to protect the processes and serve as a 'good neighbor' to the surrounding community.

5.1 Design Criteria

Criteria specific for a centralized hybrid media treatment at COL1 is summarized in Table 11. Criteria for other selected alternatives are presented in Appendix B.

Table 11 Recommended Centralized COL Design Criteria and Estimated Bed Life

Parameter	Single Use IX Resin	GAC	Hybrid
Flow (gpm)	7,250	7,250	7,250
Number of Trains	6	9	9 (6+3)
Vessels per Train	2 (lead-lag)	2 (lead-lag)	2 (lead-lag)
Vessel Diameter (ft)	12	12	12
Working Pressure (psig)	125 at 150 deg F	125 at 150 deg F	125 at 150 deg F
Media	IX Resin	GAC	Based on Selected Media
Media/Vessel (ft^3 or lbs)	500	40,000	
EBCT per Train (min)	6	20	
EBCT per Vessel (min)	3	10	
Hydraulic Loading (gpm/sf)	10.7	7.1	
Desander	4 (3 duty, 1 standby)	4 (3 duty, 1 standby)	4 (3 duty, 1 standby)
Pre-filter	5 (4 duty, 1 standby)	5 (4 duty, 1 standby)	5 (4 duty, 1 standby)
Treatment Goal (Treatment BVs)			
CA DDW RL	n.a.	n.a.	Based on Selected Media
80% of RL	n.a.	n.a.	
VT Advisory Level	330,000	170,000	
Below MRL	110,000	12,500	

5.2 Permitting

Because DDW approves the permits for drinking water systems, DDW will be a vital partner on this (these) projects. It is recommended that Zone 7 engage with DDW early in the project to gain permit approval for the PFAS treatment facilities. Because the project progress will hinge on DDW input, timely meetings, are important to maintaining the project schedule. The application submittal will consist primarily of California Environmental Quality Act documents, design plans and specifications, and the Operations Plan. Most likely, the permit issued for the treatment facilities will be an amendment to the current water supply permit. The following three items should be considered by Zone 7 and the design team:

1. The pilot test data will facilitate DDW review and approval of some media. An IX media may require additional review or testing.

2. An initial meeting with DDW would be useful for walking through the design documents and answering any questions they might have.
3. The Operations Plan would need to address the treatment facility and any proposed blending and would be used to establish permit conditions.

5.3 Construction Duration

A preliminary project schedule was developed for the recommended preferred alternative and is presented on Figure 27**Error! Reference source not found.**. Long lead items may have a significant impact to the construction schedule and should be identified during Preliminary and Final Design. The equipment with the most significant lead time is the pressure vessels. Depending on the supplier, times of up to 34 weeks after submittal approval have been communicated. To reduce the overall schedule, the pressure vessels could be pre-purchased.

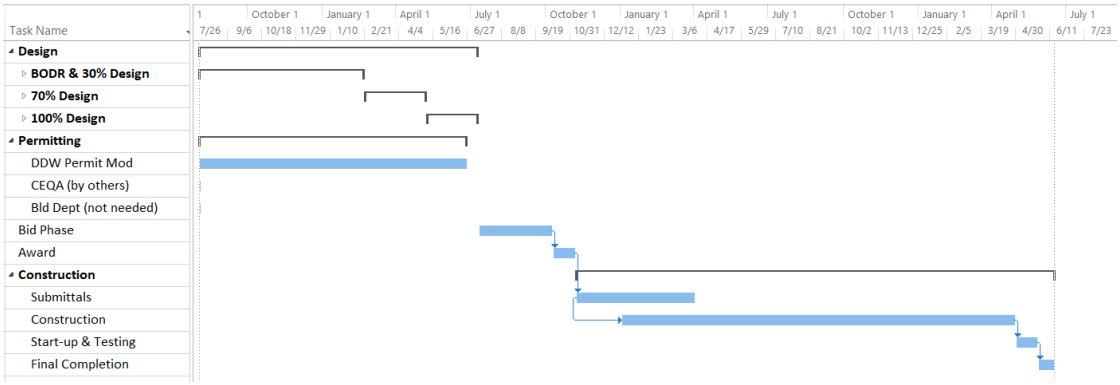

Figure 27 Preliminary Project Schedule

5.4 O&M Activities

The operation and maintenance of GAC and IX systems is fairly straightforward. It consists mainly of monitoring pressure and flow and taking samples to determine the progression of the mass transfer zone through the media bed. The following sections discuss the general operation of these systems including labor, monitoring, and shutdowns; general maintenance requirements; and residual management. This section is not intended to be an O&M manual. Operators should refer to the systems O&M manual to perform any work on the full-scale system.

5.4.1 General Operational Activities

The general operational activities include labor, system monitoring, and shutdown procedures.

5.4.1.1 Operational Certification Requirements

The new treatment facilities will require a certified operator with a treatment operator certificate. An operator with only Distribution Operator certification is not allowed to operate a GAC or IX system. Each treatment facility will be individually classified based on a calculation of total points for the entire facility. The required certificate is based on the total points and shown in Table 12.

Table 12 Water Treatment Facility Class

Total Points	Class
Less than 20	T1
20 through 39(1)	T2
40 through 59	T3
60 through 79	T4
80 or more	T5

Notes:
(1) Class is currently estimated to be T2.

DDW does not look at the treatment itself to determine the Treatment Facility Class, but looks at the source type (groundwater or surface water), the contaminant to be treated, the level of the contaminant, flow rate, and type of disinfectant used. So for example, if treating a groundwater source, PFAS only, and downstream chlorination, the required operator class would be T2. It is recommended to coordinate with DDW to determine actual class for each of the recommended facilities.

5.4.1.2 System Monitoring

Monitoring of GAC and IX systems is established and straightforward. The following is a list of suggested information for an operating log. This information should be recorded each day for each individual GAC or IX system.

1. Record the date and time when each item is logged.
2. Record all maintenance, calibration, cleaning, repairs, and replacement of parts.
3. Record any unusual occurrences such as shutdowns and leaks.
4. Record the flow to and pressure drop across each system to indicate if any foreign objects have entered the system.

5.4.1.3 Media Change Out

The media change out is the most important aspect of GAC and IX system operation. For lead-lag systems a media change out is initiated when a predetermined concentration of a contaminant of concern (in this case PFOS) is detected between the lead and lag vessels. At that point the system is switched so that the lag vessel becomes the lead vessel. When the media change out is initiated, the media service provider is contacted and they will deliver the new media, remove the exhausted media, fill the new media, inspect the empty vessel, and make any necessary repairs. The vessel with the replaced media is then placed into service in the lag position.

This report has estimated bed volumes treated for GAC and IX systems as shown in Table 11 and Appendix B. DDW may request some confirmation of these values through testing.

5.4.2 Maintenance

Maintenance of GAC and IX systems can be divided into two categories: minor and major. Minor maintenance can be performed by operations to provide continuous and effective operation. This maintenance includes visual check of pressure gauges and rupture disks, adjustments to valves and regulators, and tightening flanges and connections to eliminate leakage. During scheduled change-out services vessel internal parts should be inspected (underdrain screens, vessel lining, nozzles, etc.) to ensure they are in good working condition. Major maintenance includes equipment repair or replacement for continued system operation. The need for major maintenance would result from a major malfunction causing the system to be inoperative.

5.4.3 Residual Management

Residual management is an important aspect for both GAC and IX treatment systems. For GAC and IX systems the main residual is the spent media generated through the life of the system.

5.4.3.1 GAC Systems

The GAC vessels may be backwashed periodically to remove fines and other particulate that may accumulate, ideally with non-chlorinated water. The backwash waste water may be sent directly to sewer. A backwash waste tank may be required to equalize the flow to the sewer. The need for a backwash system, waste tank, and potential methods for minimizing biological growth on the media should be evaluated further during detailed design. At COL1 it was assumed that these periodic backwashes could either be sent to the existing 24-in line going to the adjacent lake or to the head of the plant, depending on the nature of the backwash. The ability to discharge to the lake should be confirmed during preliminary design.

Spent GAC would be hauled offsite. The regeneration process heats the GAC to burn off the adsorbed contaminants. There has been some discussion whether the temperatures used for regeneration are consistently sufficient for PFAS destruction. At this time, full incineration of the spent media would ensure the PFAS compounds are destroyed and limit end-of-life liability.

5.4.3.2 IX Systems

The most significant residual produced by IX systems is the spent resin. The resin will have to be replaced on a periodic basis depending on the target water quality and actual well flowrates. The spent resin would be hauled to a waste disposal facility for incineration to destroy the PFAS and limiting end-of-life concerns.

5.5 Cost (Capital, O&M, and Life Cycle)

The opinion of probable construction cost presented in this report represents a Class 5 budgetary estimate as defined by the AACE International. Bids would be expected to fall within a range of 50 percent over the estimate to 30 percent under the estimate. The opinion of probable construction costs is based on preliminary quantity take-offs for GAC and IX systems. The capital and O&M costs were developed using:

- Equipment quotes for major components.
- Percentage multipliers for electrical, instrumentation, and mechanical portions of the project based on recently bid projects of similar scope.

A summary of capital and O&M cost assumptions for centralized COL1is shown in Table 13.

Table 13 Capital and O&M Cost Assumptions

AACE International Class 5 Estimate (Expected Accuracy Range of -30% to +50%)	*Factor*	Vermont Advisory Level		Below MRL	
		IX (PFAS) + $SnCl_2$	GAC + SnCl2	IX (PFAS) + $SnCl_2$	GAC + SnCl2
CAPITAL COST[1]					
DIRECT COST					
Site Work[2]	15%	$403,000	$514,000	$403,000	$514,000
Yard Piping and Valves[2]	25%	$671,000	$857,000	$671,000	$857,000
Major Process Piping[3,4]					
Site Complexity	15%	$403,000	$514,000	$403,000	$514,000
Foundation		$155,000	$213,000	$155,000	$213,000
Process Equipment					
GAC Contactors			$3,330,000		$3,330,000
Anion Exchange (PFAS)		$2,160,000		$2,160,000	
Anion Exchange (Cr-6)					
Backwash Tank		$10,028	$80,649	$10,028	$80,649
Backwash Return Pump		$6,225	$6,225	$6,225	$6,225
Stannous Chloride Feed System		$12,628	$12,628	$12,628	$12,628
Desanders		$199,387		$199,387	
Bag Filters		$295,829		$295,829	
Building		$1,224,500	$1,550,000	$1,224,500	$1,550,000
Installation[2]	20%	$997,000	$1,270,000	$997,000	$1,270,000
Electrical[5]	20%	$981,000	$1,250,000	$981,000	$1,250,000
I&C[5]	20%	$782,000	$996,000	$782,000	$996,000
Site Stabilization		$1,200,000	$1,200,000	$1,200,000	$1,200,000
SUBTOTAL DIRECT COST		**$9,500,000**	**$11,790,000**	**$9,500,000**	**$11,790,000**
Contingency[6]	30%	$2,850,000	$3,537,000	$2,850,000	$3,537,000
TOTAL DIRECT COST		**$12,350,000**	**$15,330,000**	**$12,350,000**	**$15,330,000**

INDIRECT COST					
General Conditions, Overhead, Profit & Risk[7]	15%	$1,853,000	$2,300,000	$1,853,000	$2,300,000
Bonds and Insurance[7]	3%	$371,000	$460,000	$371,000	$460,000
Tax (9.25%)7	9.25%	$1,142,000	$1,418,000	$1,142,000	$1,418,000
TOTAL INDIRECT COST		**$3,370,000**	**$4,180,000**	**$3,370,000**	**$4,180,000**
TOTAL CONSTRUCTION COST		**$15,720,000**	**$19,510,000**	**$15,720,000**	**$19,510,000**
Engineering, Administration, and Legal[8]	25%	$3,930,000	$4,878,000	$3,930,000	$4,878,000
CMAR Pre-construction Services	0%				
Owner's Reserve for Change Orders	10%	$1,572,000	$1,951,000	$1,572,000	$1,951,000
TOTAL CAPITAL COST		**$21,220,000**	**$26,340,000**	**$21,220,000**	**$26,340,000**
ANNUAL OPERATION & MAINTENANCE COST					
Water Quality Monitoring (PFAS)		$18,333	$18,333	$18,333	$18,333
GAC Changeout (including spent media management)[9]			$186,000		$532,000
IX Changeout PFAS (including spent media management)[9]		$230,000		$507,000	
Stannous Chloride Feed		$131,596	$131,596	$131,596	$131,596
General[7]	10.0%	$1,235,000	$1,533,000	$1,235,000	$1,533,000
Labor[10]	$ 140.00	$116,000	$116,000	$116,000	$116,000
TOTAL ANNUAL O&M COST		**$1,730,000**	**$1,980,000**	**$2,010,000**	**$2,330,000**
ECONOMIC ANALYSIS					
Present Worth of Annual O&M[10]		$31,818,000	$36,416,000	$36,968,000	$42,853,000
TOTAL PRESENT WORTH		**$53,040,000**	**$62,760,000**	**$58,190,000**	**$69,190,000**
Annualized Capital Cost[10]		$1,150,000	$1,430,000	$1,150,000	$1,430,000
TOTAL EQUIVALENT ANNUAL COST		**$2,880,000**	**$3,410,000**	**$3,160,000**	**$3,760,000**
CUSTOMER BILL IMPACT ANALYSIS					
TOTAL EQUIVALENT ANNUAL COST		**$2,880,000**	**$3,410,000**	**$3,160,000**	**$3,760,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**	**36,170**	**36,170**
Cost per Acre Foot		**$79.62**	**$94.28**	**$87.37**	**$103.95**
Annual Cost per Household @ 120 CCF		**$21.96**	**$26.04**	**$24.12**	**$28.68**
Monthly Cost per Household @ 10 CCF		**$1.83**	**$2.17**	**$2.01**	**$2.39**

Notes:
(1) Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).
(2) Applied to equipment costs.
(3) Assumed connection of backwash waste pipeline to waste.
(4) Applied to equipment costs and installation.
(5) Applied to direct costs.
(6) Applied to direct costs with contingency.
(7) Applied to total construction cost.
(8) Media changeout frequencies and the corresponding costs are representative of operational targets.
(9) Assumed 80 hours per week.
(10) Assumes discount rate of 3.5% per year and term of 30 years.
(11) Costs for other alternatives are presented in Appendix C.

The recommendations above are based on the premise that treatment would be provided to achieve the water quality goal selected by Zone 7. If the cost and schedule impacts are not desirable or other challenges arise, the impacted wells could be shut down and their production replaced with other groundwater sources, a new well could be drilled to replace the lost production, or excess surface water treatment capacity could be utilized. These options could be considered on a temporary or permanent basis.

Appendix A

ESTIMATED MEDIA THROUGHPUT

Table A-1 IX Bed Volume Throughput to Target Treatment Level

Wellfield	Chain of Lakes				Stoneridge	Mocho		
	1	2	5	Centralized		1	2	Centralized
California RLs	-	-	-	-	-	285,000	500,000	500,000
80% of CA RLs	500,000	-	500,000	-	-	230,000	500,000	400,000
Vermont Advisory Level	270,000	320,000	330,000	330,000	340,000	175,000	250,000	180,000
Below MRL	110,000	110,000	110,000	110,000	115,000	110,000	110,000	109,000

Table A-2 GAC Bed Volume Throughput to Target Treatment Level

Wellfield	Chain of Lakes				Stoneridge	Mocho		
	1	2	5	Centralized		1	2	Centralized
California RLs	-	-	-	-	-	150,000	250,000	250,000
80% of CA RLs	200,000	-	200,000	-	-	125,000	200,000	210,000
Vermont Advisory Level	145,000	250,000	160,000	170,000	250,000	80,000	130,000	125,000
Below MRL	9,500	18,000	14,000	12,500	20,000	6,200	9,200	8,400

Appendix B

DESIGN CRITERIA

Table B-1 GAC Design Criteria For PFAS Adsorption

Parameter	Units	Value								
Well		**COL1**	**COL2**	**COL5**	**COL Blend**	**Stoneridge 1**	**Mocho 1**	**Mocho 2**	**Mocho 1 & 2**	**Mocho Blend**
General		Lead-Lag Operation								
Design Flow	gpm	2,500	3,500	1,250	7,250	4,600	2,500	2,700	5,200	9,400
Design Flow	mgd	3.60	5.04	1.80	10.44	6.62	3.60	3.89	7.49	13.54
GAC Contactors										
Flow Treated	gpm	2,500	3,500	1,250	7,250	4,600	2,500	2,700	5,200	9,400
No. of Trains	No.	3	4	2	9	6	3	3	6	11
No. of Contactors/Train	No.	2	2	2	2	2	2	2	2	2
No. of Contactors Installed	No.	6	8	4	18	12	6	6	12	22
Design Flow/Train	gpm	833	875	625	806	767	833	900	867	855
Contactor Diameter	ft	12	12	12	12	12	12	12	12	12
Carbon Depth	ft	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Dry Weight of GAC/Contactor	lb	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
Liquid Loading Rate	gpm/sf	7.4	7.7	5.5	7.12	6.8	7.4	8.0	7.7	7.6
Liquid Loading Rate with One Train Out of Service	gpm/sf	11.1	10.3	11.1	8.0	8.1	11.1	11.9	9.2	8.3
Empty Bed Contact Time at Design Flow										
Lead Contactor	min	10.7	10.1	14.2	11.0	11.6	10.7	9.9	10.2	10.4
Lag Contactor	min	10.7	10.1	14.2	11.0	11.6	10.7	9.9	10.2	10.4
Backwash										
Backwash Flow Rate/Contactor	gpm	1244	1244	1244	1244	1244	1244	1244	1244	1244
Backwash Liquid Loading Rate	gpm/sf	11	11	11	11	11	11	11	11	11
Bed Expansion during Backwash	%	30	30	30	30	30	30	30	30	30
Backwash Duration	min	15	15	15	15	15	15	15	15	15
Backwash Volume (Active)	gal	18,661	18,661	18,661	18,661	18,661	18,661	18,661	18,661	18,661
Backwash Tank Size	gal	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
Prefilter (+ 1 standby)	Ea	3	3	2	5	3	3	3	4	6
Desanders (+ 1 Standby)	Ea	2	3	2	4	3	2	3	3	5

Table B-2 IX Design Criteria for PFAS Exchange

Parameter	Units	Value								
Well		**COL1**	**COL2**	**COL5**	**COL Blend**	**Stoneridge 1**	**Mocho 1**	**Mocho 2**	**Mocho 1 & 2**	**Mocho Blend**
General		Lead-Lag Operation								
Design Flow	gpm	2,500	3,500	1,250	7,250	4,600	2,500	2,700	5,200	9,400
Design Flow	mgd	3.60	5.04	1.80	10.44	6.62	3.60	3.89	7.49	13.54
GAC Contactors										
Flow Treated	gpm	2,500	3,500	1,250	7,250	4,600	2,500	2,700	5,200	9,400
No. of Trains	No.	2	3	1	6	4	2	2	4	7
No. of Contactors/Train	No.	2	2	2	2	2	2	2	2	2
No. of Contactors Installed	No.	4	6	2	12	8	4	4	8	14
Design Flow/Train	gpm	1250	1167	1250	1208	1150	1250	1350	1300	1343
Contactor Diameter	ft	12	12	12	12	12	12	12	12	12
Carbon Depth	ft	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Dry Weight of GAC/Contactor	lb	500	500	500	500	500	500	500	500	500
Liquid Loading Rate	gpm/sf	11.1	10.3	11.1	10.7	10.2	11.1	11.9	11.5	11.9
Liquid Loading Rate with One Train Out of Service	gpm/sf	22.1	15.5	N/A	12.8	13.6	22.1	23.9	15.3	13.9
Empty Bed Contact Time at Design Flow										
Lead Contactor	min	3.0	3.2	3.0	3.1	3.3	3.0	2.8	2.9	2.8
Lag Contactor	min	3.0	3.2	3.0	3.1	3.3	3.0	2.8	2.9	2.8
Backwash										
Backwash Flow Rate/Contactor	gpm	226	226	226	226	226	226	226	226	226
Backwash Liquid Loading Rate	gpm/sf	2	2	2	2	2	2	2	2	2
Bed Expansion during Backwash	%	60	60	60	60	60	60	60	60	60
Backwash Duration	min	15	15	15	15	15	15	15	15	15
Backwash Volume (Active)	gal	3,393	3,393	3,393	3,393	3,393	3,393	3,393	3,393	3,393
Backwash Tank Size	gal	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
Prefilter (+ 1 standby)	Ea	3	3	2	5	3	3	3	4	6
Desanders (+ 1 Standby)	Ea	2	3	2	4	3	2	3	3	5

Table B-3 IX Design Criteria for Cr6 Exchange

Parameter	Unit	Value	
Well		COL5	COL Blended
General		Lead-Lag Operation	Lead-Lag Operation
Design Flow	gpm	1,250	7,250
Design Flow	mgd	1.80	10.44
Flow Treated	gpm	1,000	1,500
Flow Bypass	gpm	250	5,750
No. of Trains	No.	1	1
No. of Contactors/Train	No.	2	2
No. of Contactors Installed	No.	2	2
Straight Wall Contactor Height	ft	20	20
Media Depth	ft	4.4	4.4
Volume of Media/Contactor	cu. ft	500	500
Liquid Loading Rate	gpm/sf	8.8	13.3
Liquid Loading Rate with One Train Out of Service	gpm/sf	N/A	N/A
Empty Bed Contact Time at Design Flow			
Lead Contactor	min	3.7	2.5
Lag Contactor	min	3.7	2.5
Backwash			
Backwash Flow Rate/Contactor	gpm	226	226
Backwash Liquid Loading Rate	gpm/sf	2	2
Bed Expansion during Backwash	%	60	60
Backwash Duration	min	15	15
Backwash Volume (Active)	gal	3,393	3,393
Backwash Tank Size	gal	4,000	4,000
Desanders (+ 1 Standby)	Ea	2	2
Desanders	Ea	2	2

Parameter	Unit	Value	
Media Replacement Frequency	BVs @ RL	261123	342361
Replacement Frequency	days	678	593
Replacement Frequency	years	2	2
Volume Treated	MG	977	1,280
Resin Volume	cu. ft	500	500
Cost of Resin	$/cu. Ft	850	850
Chemicals			
Sulfuric Acid	$/gal	1.9	1.9
	gal/yr	54,000.0	60,000.0
Caustic Soda	$/gal	3.8	3.8
	gal/yr	89,000.0	74,000.0

Appendix C

OPINIONS OF PROBABLE COST (AACE CLASS 5)

Chain of Lakes 1 *AACE International Class 5 Estimate* *(Expected Accuracy Range of -30% to +50%)*	Factor	1	2	3	4	5	6	7	8
		40/10 ppt		32/8 ppt		Vermont's MCL		Non-detect	
		$SnCl_2$	IX (Cr-6)	IX (PFAS)	GAC	IX (PFAS)	GAC	IX (PFAS)	GAC
CAPITAL COST[1]									
DIRECT COST									
Site Work[2]	15%	$0	$90,000	$150,000	$180,000	$150,000	$180,000	$150,000	$180,000
Yard Piping and Valves[2]	25%	$0	$151,000	$249,000	$301,000	$249,000	$301,000	$249,000	$301,000
Major Process Piping[3]									
Site Complexity	5%	$0	$30,000	$50,000	$60,000	$50,000	$60,000	$50,000	$60,000
Foundation		$9,000	$73,000	$74,000	$93,000	$74,000	$93,000	$74,000	$93,000
Process Equipment									
GAC Contactors					$1,110,000		$1,110,000		$1,110,000
Anion Exchange (PFAS)				$720,000		$720,000		$720,000	
Anion Exchange (Cr-6)			$325,000						
Backwash Tank					$81,000		$81,000		$81,000
Backwash Return Pump					$12,000		$12,000		$12,000
Desanders			$99,694	$99,694		$99,694		$99,694	
Bag Filters			$177,498	$177,498		$177,498		$177,498	
Installation[2]	20%	$0	$169,000	$279,000	$337,000	$279,000	$337,000	$279,000	$337,000
Electrical[4]	20%	$0	$154,000	$255,000	$308,000	$255,000	$308,000	$255,000	$308,000
I&C[4]	20%	$0	$120,000	$199,000	$241,000	$199,000	$241,000	$199,000	$241,000
Building - not included									
Site Stabilization - not included									
SUBTOTAL DIRECT COST		**$10,000**	**$1,390,000**	**$2,250,000**	**$2,720,000**	**$2,250,000**	**$2,720,000**	**$2,250,000**	**$2,720,000**
Contingency[5]	30%	$3,000	$417,000	$675,000	$816,000	$675,000	$816,000	$675,000	$816,000
TOTAL DIRECT COST		**$10,000**	**$1,810,000**	**$2,930,000**	**$3,540,000**	**$2,930,000**	**$3,540,000**	**$2,930,000**	**$3,540,000**
INDIRECT COST									
General Conditions, Overhead, Profit & Risk[6]	15%	$2,000	$272,000	$440,000	$531,000	$440,000	$531,000	$440,000	$531,000
Bonds and Insurance[6]	3%	$0	$54,000	$88,000	$106,000	$88,000	$106,000	$88,000	$106,000
Tax (9.25%)[6]	9.25%	$1,000	$167,000	$271,000	$327,000	$271,000	$327,000	$271,000	$327,000
TOTAL INDIRECT COST		**$0**	**$490,000**	**$800,000**	**$960,000**	**$800,000**	**$960,000**	**$800,000**	**$960,000**
TOTAL CONSTRUCTION COST		**$10,000**	**$2,300,000**	**$3,730,000**	**$4,500,000**	**$3,730,000**	**$4,500,000**	**$3,730,000**	**$4,500,000**
Engineering and Contract Administration[7]	25%	$3,000	$575,000	$933,000	$1,125,000	$933,000	$1,125,000	$933,000	$1,125,000
TOTAL CAPITAL COST		**$10,000**	**$2,880,000**	**$4,660,000**	**$5,630,000**	**$4,660,000**	**$5,630,000**	**$4,660,000**	**$5,630,000**
ANNUAL OPERATION & MAINTENANCE COST									
Water Quality Monitoring (PFAS)				$18,333	$18,333	$18,333	$18,333	$18,333	$18,333
GAC Changeout (including spent media management)[8]					$46,000		$62,000		$241,000
Anion Exchange Resin Changeout PFAS (including spent media management)[8]				$57,000		$77,000		$175,000	
General[6]	10.0%	$1,000	$181,000	$293,000	$354,000	$293,000	$354,000	$293,000	$354,000
Labor[9]	$ 140.00	$582,000	$582,000	$29,000	$29,000	$29,000	$29,000	$29,000	$29,000
TOTAL ANNUAL O&M COST		**$580,000**	**$760,000**	**$400,000**	**$450,000**	**$420,000**	**$460,000**	**$520,000**	**$640,000**
ECONOMIC ANALYSIS									
Present Worth of Annual O&M[10]		$10,667,000	$13,978,000	$7,357,000	$8,276,000	$7,725,000	$8,460,000	$9,564,000	$11,771,000
TOTAL PRESENT WORTH		**$10,680,000**	**$16,860,000**	**$12,020,000**	**$13,910,000**	**$12,390,000**	**$14,090,000**	**$14,220,000**	**$17,400,000**
Annualized Capital Cost[10]		$0	$160,000	$250,000	$310,000	$250,000	$310,000	$250,000	$310,000
TOTAL EQUIVALENT ANNUAL COST		**$580,000**	**$920,000**	**$650,000**	**$760,000**	**$670,000**	**$770,000**	**$770,000**	**$950,000**
CUSTOMER BILL IMPACT ANALYSIS									
TOTAL EQUIVALENT ANNUAL COST		**$580,000**	**$920,000**	**$650,000**	**$760,000**	**$670,000**	**$770,000**	**$770,000**	**$950,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**
Cost per Acre Foot		**$16.04**	**$25.44**	**$17.97**	**$21.01**	**$18.52**	**$21.29**	**$21.29**	**$26.26**
Annual Cost per Household @ 120 CCF		**$4.44**	**$7.08**	**$5.04**	**$5.88**	**$5.16**	**$5.88**	**$5.88**	**$7.32**
Monthly Cost per Household @ 10 CCF		**$0.37**	**$0.59**	**$0.42**	**$0.49**	**$0.43**	**$0.49**	**$0.49**	**$0.61**

[1]Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).
[2]Applied to equipment costs.
[3]Assumed connection of backwash waste pipeline to waste.
[4]Applied to equipment costs and installation.
[5]Applied to direct costs.
[6]Applied to direct costs with contingency.
[7]Applied to total construction cost.
[8]Media changeout frequencies and the corresponding costs are representative of operational targets.
[9]Assumed 80 hours per week.
[10]Assumes discount rate of 3.5% per year and term of 30 years.

Chain of Lake 2 *AACE International Class 5 Estimate* *(Expected Accuracy Range of* *-30% to +50%)*	*Factor*	6	7	8	9
		Vermont's MCL		Non-detect	
		IX (PFAS)	GAC	IX (PFAS)	GAC
CAPITAL COST[1]					
DIRECT COST					
Site Work[2]	15%	$211,000	$235,000	$211,000	$235,000
Yard Piping and Valves[2]	25%	$352,000	$392,000	$352,000	$392,000
Major Process Piping[3,4]					
Site Complexity	10%	$141,000	$157,000	$141,000	$157,000
Foundation		$94,000	$114,000	$94,000	$114,000
Process Equipment					
GAC Contactors			$1,480,000		$1,480,000
Anion Exchange (PFAS)		$1,080,000		$1,080,000	
Anion Exchange (Cr-6)					
Backwash Tank			$80,423		$80,423
Backwash Return Pump			$6,225		$6,225
Desanders		$149,541		$149,541	
Bag Filters		$177,498		$177,498	
Installation[2]	20%	$394,000	$439,000	$394,000	$439,000
Electrical[5]	20%	$360,000	$401,000	$360,000	$401,000
I&C[5]	20%	$281,000	$313,000	$281,000	$313,000
Building - not included					
Site Stabilization - not included					
SUBTOTAL DIRECT COST		**$3,240,000**	**$3,620,000**	**$3,240,000**	**$3,620,000**
Contingency[6]	30%	$972,000	$1,086,000	$972,000	$1,086,000
TOTAL DIRECT COST		**$4,210,000**	**$4,710,000**	**$4,210,000**	**$4,710,000**
INDIRECT COST					
General Conditions, Overhead, Profit & Risk[7]	15%	$632,000	$707,000	$632,000	$707,000
Bonds and Insurance[7]	3%	$126,000	$141,000	$126,000	$141,000
Tax (9.25%)[7]	9.25%	$389,000	$436,000	$389,000	$436,000
TOTAL INDIRECT COST		**$1,150,000**	**$1,280,000**	**$1,150,000**	**$1,280,000**
TOTAL CONSTRUCTION COST		**$5,360,000**	**$5,990,000**	**$5,360,000**	**$5,990,000**
Engineering, Administration, and Legal[8]	25%	$1,340,000	$1,498,000	$1,340,000	$1,498,000
TOTAL CAPITAL COST		**$6,700,000**	**$7,490,000**	**$6,700,000**	**$7,490,000**
ANNUAL OPERATION & MAINTENANCE COST					
Water Quality Monitoring (PFAS)		$18,333	$18,333	$18,333	$18,333
GAC Changeout (including spent media management)[9]			$83,000		$178,000
Anion Exchange Resin Changeout PFAS (including spent media management)[9]		$115,000		$245,000	
General[7]	10.0%	$421,000	$471,000	$421,000	$471,000
Labor[10]	$ 140.00	$29,000	$29,000	$29,000	$29,000
TOTAL ANNUAL O&M COST		**$580,000**	**$600,000**	**$710,000**	**$700,000**
ECONOMIC ANALYSIS					
Present Worth of Annual O&M[10]		$10,667,000	$11,035,000	$13,058,000	$12,874,000
TOTAL PRESENT WORTH		**$17,370,000**	**$18,530,000**	**$19,760,000**	**$20,360,000**
Annualized Capital Cost[10]		$360,000	$410,000	$360,000	$410,000
TOTAL EQUIVALENT ANNUAL COST		**$940,000**	**$1,010,000**	**$1,070,000**	**$1,110,000**
CUSTOMER BILL IMPACT ANALYSIS					
TOTAL EQUIVALENT ANNUAL COST		**$940,000**	**$1,010,000**	**$1,070,000**	**$1,110,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**	**36,170**	**36,170**
Cost per Acre Foot		**$25.99**	**$27.92**	**$29.58**	**$30.69**
Annual Cost per Household @ 120 CCF		**$7.20**	**$7.80**	**$8.16**	**$8.52**
Monthly Cost per Household @ 10 CCF		**$0.60**	**$0.65**	**$0.68**	**$0.71**

[1]Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).
[2]Applied to equipment costs.
[3]Assumed connection of backwash waste pipeline to waste.
[4]Applied to equipment costs and installation.
[5]Applied to direct costs.
[6]Applied to direct costs with contingency.
[7]Applied to total construction cost.
[8]Media changeout frequencies and the corresponding costs are representative of operational targets.
[9]Assumed 80 hours per week.
[10]Assumes discount rate of 3.5% per year and term of 30 years.

Chain of Lakes 5 *AACE International Class 5 Estimate* *(Expected Accuracy Range of* *-30% to +50%)*	*Factor*	3	2	4	5	6	7	8	9	10	11	12	13	14	15
		40/10 ppt		32/8 ppt				Vermont's MCL				Non-detect			
		IX (Cr-6)	$SnCl_2$	IX (PFAS) + IX (Cr-6)	IX (PFAS) + $SnCl_2$	GAC + IX (Cr-6)	GAC + SnCl2	IX (PFAS) + IX (Cr-6)	IX (PFAS) + $SnCl_2$	GAC + IX (Cr-6)	GAC + SnCl2	IX (PFAS) + IX (Cr-6)	IX (PFAS) + $SnCl_2$	GAC + IX (Cr-6)	GAC + SnCl2
CAPITAL COST[1]															
DIRECT COST															
Site Work[2]	15%	$72,000	$2,000	$133,000	$81,000	$203,000	$126,000	$133,000	$81,000	$178,000	$151,000	$133,000	$81,000	$203,000	$126,000
Yard Piping and Valves[2]	25%	$120,000	$3,000	$222,000	$135,000	$339,000	$210,000	$222,000	$135,000	$297,000	$252,000	$222,000	$135,000	$339,000	$210,000
Major Process Piping[3,4]															
Site Complexity	15%	$72,000		$133,000	$81,000	$203,000	$126,000	$133,000	$81,000	$178,000	$151,000	$133,000	$81,000	$203,000	$126,000
Foundation		$53,000		$73,000	$54,000	$92,000	$74,000	$73,000	$54,000	$92,000	$74,000	$73,000	$54,000	$92,000	$74,000
Process Equipment															
GAC Contactors						$740,000	$740,000			$740,000	$740,000			$740,000	$740,000
Anion Exchange (PFAS)				$360,000	$360,000			$360,000	$360,000			$360,000	$360,000		
Anion Exchange (Cr-6)		$360,000		$360,000		$360,000		$360,000		$360,000		$360,000		$360,000	
Backwash Tank						$80,649	$80,649			$80,649	$80,649			$80,649	$80,649
Backwash Return Pump						$6,225	$6,225			$6,225	$6,225			$6,225	$6,225
Stannous Chloride Feed System			$12,628		$12,628		$12,628		$12,628		$12,628		$12,628		$12,628
Desanders				$49,847	$49,847	$49,847		$49,847	$49,847		$49,847	$49,847	$49,847	$49,847	
Bag Filters		$118,332		$118,332	$118,332	$118,332		$118,332	$118,332		$118,332	$118,332	$118,332	$118,332	
Installation[2]	20%	$134,000	$4,000	$249,000	$151,000	$379,000	$235,000	$249,000	$151,000	$332,000	$282,000	$249,000	$151,000	$379,000	$235,000
Electrical[5]	20%	$122,000	$3,000	$227,000	$138,000	$347,000	$215,000	$227,000	$138,000	$304,000	$258,000	$227,000	$138,000	$347,000	$215,000
I&C[5]	20%	$96,000	$3,000	$178,000	$108,000	$271,000	$168,000	$178,000	$108,000	$237,000	$202,000	$178,000	$108,000	$271,000	$168,000
Building - not included															
Site Stabilization - not included															
SUBTOTAL DIRECT COST		**$1,150,000**	**$30,000**	**$2,100,000**	**$1,290,000**	**$3,190,000**	**$1,990,000**	**$2,100,000**	**$1,290,000**	**$2,800,000**	**$2,380,000**	**$2,100,000**	**$1,290,000**	**$3,190,000**	**$1,990,000**
Contingency[6]	30%	$345,000	$9,000	$630,000	$387,000	$957,000	$597,000	$630,000	$387,000	$840,000	$714,000	$630,000	$387,000	$957,000	$597,000
TOTAL DIRECT COST		**$1,500,000**	**$40,000**	**$2,730,000**	**$1,680,000**	**$4,150,000**	**$2,590,000**	**$2,730,000**	**$1,680,000**	**$3,640,000**	**$3,090,000**	**$2,730,000**	**$1,680,000**	**$4,150,000**	**$2,590,000**
INDIRECT COST															
General Conditions, Overhead, Profit & Risk[7]	15%	$225,000	$6,000	$410,000	$252,000	$623,000	$389,000	$410,000	$252,000	$546,000	$464,000	$410,000	$252,000	$623,000	$389,000
Bonds and Insurance[7]	3%	$45,000	$1,000	$82,000	$50,000	$125,000	$78,000	$82,000	$50,000	$109,000	$93,000	$82,000	$50,000	$125,000	$78,000
Tax (9.25%)7	9.25%	$139,000	$4,000	$253,000	$155,000	$384,000	$240,000	$253,000	$155,000	$337,000	$286,000	$253,000	$155,000	$384,000	$240,000
TOTAL INDIRECT COST		**$410,000**	**$10,000**	**$750,000**	**$460,000**	**$1,130,000**	**$710,000**	**$750,000**	**$460,000**	**$990,000**	**$840,000**	**$750,000**	**$460,000**	**$1,130,000**	**$710,000**
TOTAL CONSTRUCTION COST		**$1,910,000**	**$50,000**	**$3,480,000**	**$2,140,000**	**$5,280,000**	**$3,300,000**	**$3,480,000**	**$2,140,000**	**$4,630,000**	**$3,930,000**	**$3,480,000**	**$2,140,000**	**$5,280,000**	**$3,300,000**
Engineering, Administration, and Legal[8]	25%	$478,000	$13,000	$870,000	$535,000	$1,320,000	$825,000	$870,000	$535,000	$1,158,000	$983,000	$870,000	$535,000	$1,320,000	$825,000
TOTAL CAPITAL COST		**$2,390,000**	**$60,000**	**$4,350,000**	**$2,680,000**	**$6,600,000**	**$4,130,000**	**$4,350,000**	**$2,680,000**	**$5,790,000**	**$4,910,000**	**$4,350,000**	**$2,680,000**	**$6,600,000**	**$4,130,000**
ANNUAL OPERATION & MAINTENANCE COST															
Water Quality Monitoring (PFAS)				$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333
GAC Changeout (including spent media management)[9]						$31,000	$31,000			$41,000	$41,000			$82,000	$82,000
Anion Exchange Resin Changeout PFAS (including spent media management)[9]				$29,000	$29,000			$38,000	$38,000			$57,000	$57,000		
Anion Exchange Resin Changeout Cr-6 (including spent media management)[9]		$195,470		$195,470		$195,470		$195,470		$195,470		$195,470		$195,470	
Stannous Chloride Feed			$26,030		$26,030		$26,030		$26,030		$26,030		$26,030		$26,030
General[7]	10.0%	$150,000	$4,000	$273,000	$168,000	$415,000	$259,000	$273,000	$168,000	$364,000	$309,000	$273,000	$168,000	$415,000	$259,000
Labor[10]	$ 140.00	$29,000	$116,000	$58,000	$116,000	$58,000	$116,000	$58,000	$116,000	$58,000	$116,000	$58,000	$116,000	$58,000	$116,000
TOTAL ANNUAL O&M COST		**$370,000**	**$150,000**	**$570,000**	**$360,000**	**$720,000**	**$450,000**	**$580,000**	**$370,000**	**$680,000**	**$510,000**	**$600,000**	**$390,000**	**$770,000**	**$500,000**
ECONOMIC ANALYSIS															
Present Worth of Annual O&M[10]		$6,805,000	$2,759,000	$10,483,000	$6,621,000	$13,242,000	$8,276,000	$10,667,000	$6,805,000	$12,507,000	$9,380,000	$11,035,000	$7,173,000	$14,162,000	$9,196,000
TOTAL PRESENT WORTH		**$9,200,000**	**$2,820,000**	**$14,830,000**	**$9,300,000**	**$19,840,000**	**$12,410,000**	**$15,020,000**	**$9,490,000**	**$18,300,000**	**$14,290,000**	**$15,390,000**	**$9,850,000**	**$20,760,000**	**$13,330,000**
Annualized Capital Cost[10]		$130,000	$0	$240,000	$150,000	$360,000	$220,000	$240,000	$150,000	$310,000	$270,000	$240,000	$150,000	$360,000	$220,000
TOTAL EQUIVALENT ANNUAL COST		**$500,000**	**$150,000**	**$810,000**	**$510,000**	**$1,080,000**	**$670,000**	**$820,000**	**$520,000**	**$990,000**	**$780,000**	**$840,000**	**$540,000**	**$1,130,000**	**$720,000**
CUSTOMER BILL IMPACT ANALYSIS															
TOTAL EQUIVALENT ANNUAL COST		**$500,000**	**$150,000**	**$810,000**	**$510,000**	**$1,080,000**	**$670,000**	**$820,000**	**$520,000**	**$990,000**	**$780,000**	**$840,000**	**$540,000**	**$1,130,000**	**$720,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**
Cost per Acre Foot		**$13.82**	**$4.15**	**$22.39**	**$14.10**	**$29.86**	**$18.52**	**$22.67**	**$14.38**	**$27.37**	**$21.56**	**$23.22**	**$14.93**	**$31.24**	**$19.91**
Annual Cost per Household @ 120 CCF		**$3.84**	**$1.20**	**$6.24**	**$3.96**	**$8.28**	**$5.16**	**$6.36**	**$4.08**	**$7.56**	**$6.00**	**$6.48**	**$4.20**	**$8.64**	**$5.52**
Monthly Cost per Household @ 10 CCF		**$0.32**	**$0.10**	**$0.52**	**$0.33**	**$0.69**	**$0.43**	**$0.53**	**$0.34**	**$0.63**	**$0.50**	**$0.54**	**$0.35**	**$0.72**	**$0.46**

[1]Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).
[2]Applied to equipment costs.
[3]Assumed connection of backwash waste pipeline to waste.
[4]Applied to equipment costs and installation.
[5]Applied to direct costs.
[6]Applied to direct costs with contingency.
[7]Applied to total construction cost.
[8]Media changeout frequencies and the corresponding costs are representative of operational targets.
[9]Assumed 80 hours per week.
[10]Assumes discount rate of 3.5% per year and term of 30 years.

Chain of Lakes Combined AACE International Class 5 Estimate (Expected Accuracy Range of -30% to +50%)	*Factor*	1	3	2	4	5	6	7	8	9	10	11	12	13	14	15
		40/10 ppt			32/8 ppt				Vermont's MCL				Non-detect			
		Blending	IX (Cr-6)	$SnCl_2$	IX (Cr-6)	$SnCl_2$	GAC + IX (Cr-6)	GAC + SnCl2	IX (PFAS) + IX (Cr-6)	IX (PFAS) + $SnCl_2$	GAC + IX (Cr-6)	GAC + SnCl2	IX (PFAS) + IX (Cr-6)	IX (PFAS) + $SnCl_2$	GAC + IX (Cr-6)	GAC + SnCl2
CAPITAL COST[1]																
DIRECT COST																
Site Work[2]	15%	$30,000	$131,000	$2,000	$131,000	$2,000	$641,000	$589,000	$455,000	$403,000	$641,000	$514,000	$455,000	$403,000	$641,000	$514,000
Yard Piping and Valves[2]	25%	$50,000	$218,000	$3,000	$218,000	$3,000	$978,000	$981,000	$758,000	$671,000	$1,068,000	$857,000	$758,000	$671,000	$1,068,000	$857,000
Major Process Piping[3,4]																
Site Complexity	15%		$131,000		$131,000		$131,000	$589,000	$455,000	$403,000	$641,000	$514,000	$455,000	$403,000	$641,000	$514,000
Foundation		$8,000	$154,000		$271,000		$329,000	$213,000	$271,000	$155,000	$329,000	$213,000	$271,000	$155,000	$329,000	$213,000
Process Equipment																
GAC Contactors							$3,330,000	$3,330,000			$3,330,000	$3,330,000			$3,330,000	$3,330,000
Anion Exchange (PFAS)									$2,160,000	$2,160,000			$2,160,000	$2,160,000		
Anion Exchange (Cr-6)			$360,000		$360,000		$360,000		$360,000		$360,000		$360,000		$360,000	
Backwash Tank			$10,028		$10,028		$80,649	$80,649	$10,028	$10,028	$80,649	$80,649	$10,028	$10,028	$80,649	$80,649
Backwash Return Pump			$6,225		$6,225		$6,225	$6,225	$6,225	$6,225	$6,225	$6,225	$6,225	$6,225	$6,225	$6,225
Stannous Chloride Feed System				$12,628		$12,628		$12,628		$12,628		$12,628		$12,628		$12,628
Desanders		$199,387	$199,387		$199,387		$199,387	$199,387	$199,387	$199,387	$199,387		$199,387	$199,387	$199,387	
Bag Filters			$295,829		$295,829		$295,829	$295,829	$295,829	$295,829	$295,829		$295,829	$295,829	$295,829	
Building										$1,224,500		$1,550,000		$1,224,500		$1,550,000
Installation[2]	20%	$56,000	$244,000	$4,000	$244,000	$4,000	$1,178,000	$1,099,000	$849,000	$997,000	$1,196,000	$1,270,000	$849,000	$997,000	$1,196,000	$1,270,000
Electrical[5]	20%	$51,000	$223,000	$3,000	$223,000	$3,000	$1,090,000	$1,005,000	$776,000	$981,000	$1,094,000	$1,250,000	$776,000	$981,000	$1,094,000	$1,250,000
I&C[5]	20%	$40,000	$174,000	$3,000	$174,000	$3,000	$854,000	$785,000	$606,000	$782,000	$854,000	$996,000	$606,000	$782,000	$854,000	$996,000
Site Stabilization		$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000
SUBTOTAL DIRECT COST		**$1,630,000**	**$3,350,000**	**$1,230,000**	**$3,460,000**	**$1,230,000**	**$10,670,000**	**$10,390,000**	**$8,400,000**	**$9,500,000**	**$11,300,000**	**$11,790,000**	**$8,400,000**	**$9,500,000**	**$11,300,000**	**$11,790,000**
Contingency[6]	30%	$489,000	$1,005,000	$369,000	$1,038,000	$369,000	$3,201,000	$3,117,000	$2,520,000	$2,850,000	$3,390,000	$3,537,000	$2,520,000	$2,850,000	$3,390,000	$3,537,000
TOTAL DIRECT COST		**$2,120,000**	**$4,360,000**	**$1,600,000**	**$4,500,000**	**$1,600,000**	**$13,870,000**	**$13,510,000**	**$10,920,000**	**$12,350,000**	**$14,690,000**	**$15,330,000**	**$10,920,000**	**$12,350,000**	**$14,690,000**	**$15,330,000**
INDIRECT COST																
General Conditions, Overhead, Profit & Risk[7]	15%	$318,000	$654,000	$240,000	$675,000	$240,000	$2,081,000	$2,027,000	$1,638,000	$1,853,000	$2,204,000	$2,300,000	$1,638,000	$1,853,000	$2,204,000	$2,300,000
Bonds and Insurance[7]	3%	$64,000	$131,000	$48,000	$135,000	$48,000	$416,000	$405,000	$328,000	$371,000	$441,000	$460,000	$328,000	$371,000	$441,000	$460,000
Tax (9.25%)7	9.25%	$196,000	$403,000	$148,000	$416,000	$148,000	$1,283,000	$1,250,000	$1,010,000	$1,142,000	$1,359,000	$1,418,000	$1,010,000	$1,142,000	$1,359,000	$1,418,000
TOTAL INDIRECT COST		**$580,000**	**$1,190,000**	**$440,000**	**$1,230,000**	**$440,000**	**$3,780,000**	**$3,680,000**	**$2,980,000**	**$3,370,000**	**$4,000,000**	**$4,180,000**	**$2,980,000**	**$3,370,000**	**$4,000,000**	**$4,180,000**
TOTAL CONSTRUCTION COST		**$2,700,000**	**$5,550,000**	**$2,040,000**	**$5,730,000**	**$2,040,000**	**$17,650,000**	**$17,190,000**	**$13,900,000**	**$15,720,000**	**$18,690,000**	**$19,510,000**	**$13,900,000**	**$15,720,000**	**$18,690,000**	**$19,510,000**
Engineering, Administration, and Legal[8]	25%	$675,000	$1,388,000	$510,000	$1,433,000	$510,000	$4,413,000	$4,298,000	$3,475,000	$3,930,000	$4,673,000	$4,878,000	$3,475,000	$3,930,000	$4,673,000	$4,878,000
Owner's Reserve for Change Orders	10%	$270,000	$555,000	$204,000	$573,000	$204,000	$1,765,000	$1,719,000	$1,390,000	$1,572,000	$1,869,000	$1,951,000	$1,390,000	$1,572,000	$1,869,000	$1,951,000
TOTAL CAPITAL COST		**$3,650,000**	**$7,490,000**	**$2,750,000**	**$7,740,000**	**$2,750,000**	**$23,830,000**	**$23,210,000**	**$18,770,000**	**$21,220,000**	**$25,230,000**	**$26,340,000**	**$18,770,000**	**$21,220,000**	**$25,230,000**	**$26,340,000**
ANNUAL OPERATION & MAINTENANCE COST																
Water Quality Monitoring (PFAS)		$18,333					$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333	$18,333
GAC Changeout (including spent media management)[9]							#DIV/0!	#DIV/0!			$186,000	$186,000			$532,000	$532,000
Anion Exchange Resin Changeout PFAS (including spent media management)[9]									$230,000	$230,000			$507,000	$507,000		
Anion Exchange Resin Changeout Cr-6 (including spent media management)[9]			$184,100		$184,100		$184,100		$184,100		$184,100		$184,100		$184,100	
Stannous Chloride Feed				$131,596		$131,596		$131,596		$131,596		$131,596		$131,596		$131,596
General[7]	10.0%	$212,000	$436,000	$160,000	$450,000	$160,000	$1,387,000	$1,351,000	$1,092,000	$1,235,000	$1,469,000	$1,533,000	$1,092,000	$1,235,000	$1,469,000	$1,533,000
Labor[10]	$ 140.00	$582,000	$582,000	$582,000	$582,000	$582,000	$582,000	$582,000	$58,000	$116,000	$58,000	$116,000	$58,000	$116,000	$58,000	$116,000
TOTAL ANNUAL O&M COST		**$810,000**	**$1,200,000**	**$870,000**	**$1,220,000**	**$870,000**	**#DIV/0!**	**#DIV/0!**	**$1,580,000**	**$1,730,000**	**$1,920,000**	**$1,980,000**	**$1,860,000**	**$2,010,000**	**$2,260,000**	**$2,330,000**
ECONOMIC ANALYSIS																
Present Worth of Annual O&M[10]		$14,898,000	$22,070,000	$16,001,000	$22,438,000	$16,001,000	#DIV/0!	#DIV/0!	$29,059,000	$31,818,000	$35,313,000	$36,416,000	$34,209,000	$36,968,000	$41,566,000	$42,853,000
TOTAL PRESENT WORTH		**$18,550,000**	**$29,560,000**	**$18,750,000**	**$30,180,000**	**$18,750,000**	**#DIV/0!**	**#DIV/0!**	**$47,830,000**	**$53,040,000**	**$60,540,000**	**$62,760,000**	**$52,980,000**	**$58,190,000**	**$66,800,000**	**$69,190,000**
Annualized Capital Cost[10]		$200,000	$410,000	$150,000	$420,000	$150,000	$1,300,000	$1,260,000	$1,020,000	$1,150,000	$1,370,000	$1,430,000	$1,020,000	$1,150,000	$1,370,000	$1,430,000
TOTAL EQUIVALENT ANNUAL COST		**$1,010,000**	**$1,610,000**	**$1,020,000**	**$1,640,000**	**$1,020,000**	**#DIV/0!**	**#DIV/0!**	**$2,600,000**	**$2,880,000**	**$3,290,000**	**$3,410,000**	**$2,880,000**	**$3,160,000**	**$3,630,000**	**$3,760,000**
CUSTOMER BILL IMPACT ANALYSIS																
TOTAL EQUIVALENT ANNUAL COST		**$1,010,000**	**$1,610,000**	**$1,020,000**	**$1,640,000**	**$1,020,000**	**#DIV/0!**	**#DIV/0!**	**$2,600,000**	**$2,880,000**	**$3,290,000**	**$3,410,000**	**$2,880,000**	**$3,160,000**	**$3,630,000**	**$3,760,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**	**36,170**
Cost per Acre Foot		**$27.92**	**$44.51**	**$28.20**	**$45.34**	**$28.20**	**#DIV/0!**	**#DIV/0!**	**$71.88**	**$79.62**	**$90.96**	**$94.28**	**$79.62**	**$87.37**	**$100.36**	**$103.95**
Annual Cost per Household @ 120 CCF		**$7.80**	**$12.36**	**$7.80**	**$12.60**	**$7.80**	**$0.00**	**$0.00**	**$19.92**	**$21.96**	**$25.08**	**$26.04**	**$21.96**	**$24.12**	**$27.72**	**$28.68**
Monthly Cost per Household @ 10 CCF		**$0.65**	**$1.03**	**$0.65**	**$1.05**	**$0.65**	**$0.00**	**$0.00**	**$1.66**	**$1.83**	**$2.09**	**$2.17**	**$1.83**	**$2.01**	**$2.31**	**$2.39**

[1]Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).
[2]Applied to equipment costs.
[3]Assumed connection of backwash waste pipeline to waste.
[4]Applied to equipment costs and installation.
[5]Applied to direct costs.
[6]Applied to direct costs with contingency.
[7]Applied to total construction cost.
[8]Media changeout frequencies and the corresponding costs are representative of operational targets.
[9]Assumed 80 hours per week.
[10]Assumes discount rate of 3.5% per year and term of 30 years.

Stoneridge AACE International Class 5 Estimate (Expected Accuracy Range of -30% to +50%)	*Factor*	6	7	8	9
		Vermont's MCL		Non-detect	
		IX (PFAS)	GAC	IX (PFAS)	GAC
CAPITAL COST[1]					
DIRECT COST					
Site Work[2]	15%	$373,000	$346,000	$211,000	$346,000
Yard Piping and Valves[2]	25%	$622,000	$577,000	$352,000	$577,000
Major Process Piping[3,4]					
Site Complexity	5%	$124,000	$115,000	$70,000	$115,000
Foundation		$114,000	$153,000	$114,000	$153,000
Process Equipment					
GAC Contactors			$2,220,000		$2,220,000
Anion Exchange (PFAS)		$2,160,000		$1,080,000	
Anion Exchange (Cr-6)					
Backwash Tank			$80,649		$80,649
Backwash Return Pump			$6,225		$6,225
Stannous Chloride Feed System					
Desanders		$149,541		$149,541	
Bag Filters		$177,498		$177,498	
Installation[2]	20%	$696,000	$646,000	$394,000	$646,000
Electrical[5]	20%	$637,000	$591,000	$360,000	$591,000
I&C[5]	20%	$497,000	$461,000	$281,000	$461,000
Building - not included					
Site Stabilization - not included					
SUBTOTAL DIRECT COST		**$5,550,000**	**$5,200,000**	**$3,190,000**	**$5,200,000**
Contingency[6]	30%	$1,665,000	$1,560,000	$957,000	$1,560,000
TOTAL DIRECT COST		**$7,220,000**	**$6,760,000**	**$4,150,000**	**$6,760,000**
INDIRECT COST					
General Conditions, Overhead, Profit & Risk[7]	15%	$1,083,000	$1,014,000	$623,000	$1,014,000
Bonds and Insurance[7]	3%	$217,000	$203,000	$125,000	$203,000
Tax (9.25%)7	9.25%	$668,000	$625,000	$384,000	$625,000
TOTAL INDIRECT COST		**$1,970,000**	**$1,840,000**	**$1,130,000**	**$1,840,000**
TOTAL CONSTRUCTION COST		**$9,190,000**	**$8,600,000**	**$5,280,000**	**$8,600,000**
Engineering, Administration, and Legal[8]	25%	$2,298,000	$2,150,000	$1,320,000	$2,150,000
TOTAL CAPITAL COST		**$11,490,000**	**$10,750,000**	**$6,600,000**	**$10,750,000**
ANNUAL OPERATION & MAINTENANCE COST					
Water Quality Monitoring (PFAS)		$18,333	$18,333	$18,333	$18,333
GAC Changeout (including spent media management)[9]			$124,000		$211,000
Anion Exchange Resin Changeout PFAS (including spent media management)[9]		$153,000		$307,000	
General[7]	10.0%	$722,000	$676,000	$415,000	$676,000
Labor[10]	$ 140.00	$29,000	$29,000	$29,000	$29,000
TOTAL ANNUAL O&M COST		**$920,000**	**$850,000**	**$770,000**	**$930,000**
ECONOMIC ANALYSIS					
Present Worth of Annual O&M[10]		$16,921,000	$15,633,000	$14,162,000	$17,105,000
TOTAL PRESENT WORTH		**$28,410,000**	**$26,380,000**	**$20,760,000**	**$27,860,000**
Annualized Capital Cost[10]		$620,000	$580,000	$360,000	$580,000
TOTAL EQUIVALENT ANNUAL COST		**$1,540,000**	**$1,430,000**	**$1,130,000**	**$1,510,000**
CUSTOMER BILL IMPACT ANALYSIS					
TOTAL EQUIVALENT ANNUAL COST		**$1,540,000**	**$1,430,000**	**$1,130,000**	**$1,510,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**	**36,170**	**36,170**
Cost per Acre Foot		**$42.58**	**$39.54**	**$31.24**	**$41.75**
Annual Cost per Household @ 120 CCF		**$11.76**	**$10.92**	**$8.64**	**$11.52**
Monthly Cost per Household @ 10 CCF		**$0.98**	**$0.91**	**$0.72**	**$0.96**

[1]Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).
[2]Applied to equipment costs.
[3]Assumed connection of backwash waste pipeline to waste.
[4]Applied to equipment costs and installation.
[5]Applied to direct costs.
[6]Applied to direct costs with contingency.
[7]Applied to total construction cost.
[8]Media changeout frequencies and the corresponding costs are representative of operational targets.
[9]Assumed 80 hours per week.
[10]Assumes discount rate of 3.5% per year and term of 30 years.

Mocho 1 *AACE International Class 5 Estimate* *(Expected Accuracy Range of* *-30% to +50%)*	*Factor*	2	3
		40/10 ppt	
		IX (PFAS)	GAC
CAPITAL COST[1]			
DIRECT COST			
Site Work[2]	15%	$150,000	$180,000
Yard Piping and Valves[2]	25%	$249,000	$299,000
Major Process Piping[3,4]			
Site Complexity	35%	$349,000	$419,000
Foundation		$73,000	$92,000
Process Equipment			
GAC Contactors			$1,110,000
Anion Exchange (PFAS)		$720,000	
Anion Exchange (Cr-6)			
Backwash Tank			$80,649
Backwash Return Pump			$6,225
Stannous Chloride Feed System			
Desanders		$99,694	
Bag Filters		$177,498	
Installation[2]	20%	$279,000	$335,000
Electrical[5]	20%	$255,000	$306,000
I&C[5]	20%	$199,000	$239,000
Building - not included			
Site Stabilization - not included			
SUBTOTAL DIRECT COST		**$2,550,000**	**$3,070,000**
Contingency[6]	30%	$765,000	$921,000
TOTAL DIRECT COST		**$3,320,000**	**$3,990,000**
INDIRECT COST			
General Conditions, Overhead, Profit & Risk[7]	15%	$498,000	$599,000
Bonds and Insurance[7]	3%	$100,000	$120,000
Tax (9.25%)7	9.25%	$307,000	$369,000
TOTAL INDIRECT COST		**$910,000**	**$1,090,000**
TOTAL CONSTRUCTION COST		**$4,230,000**	**$5,080,000**
Engineering, Administration, and Legal[8]	25%	$1,058,000	$1,270,000
TOTAL CAPITAL COST		**$5,290,000**	**$6,350,000**
ANNUAL OPERATION & MAINTENANCE COST			
Water Quality Monitoring (PFAS)		$18,333	$18,333
GAC Changeout (including spent media management)[9]			$37,000
Anion Exchange Resin Changeout PFAS (including spent media management)[9]		$46,000	
General[7]	10.0%	$332,000	$399,000
Labor[10]	$ 140.00	$29,000	$29,000
TOTAL ANNUAL O&M COST		**$430,000**	**$480,000**
ECONOMIC ANALYSIS			
Present Worth of Annual O&M[10]		$7,909,000	$8,828,000
TOTAL PRESENT WORTH		**$13,200,000**	**$15,180,000**
Annualized Capital Cost[10]		$290,000	$350,000
TOTAL EQUIVALENT ANNUAL COST		**$720,000**	**$830,000**
CUSTOMER BILL IMPACT ANALYSIS			
TOTAL EQUIVALENT ANNUAL COST		**$720,000**	**$830,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**
Cost per Acre Foot		**$19.91**	**$22.95**
Annual Cost per Household @ 120 CCF		**$5.52**	**$6.36**
Monthly Cost per Household @ 10 CCF		**$0.46**	**$0.53**

[1]Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).

[2]Applied to equipment costs.

[3]Assumed connection of backwash waste pipeline to waste.

[4]Applied to equipment costs and installation.

[5]Applied to direct costs.

[6]Applied to direct costs with contingency.

[7]Applied to total construction cost.

[8]Media changeout frequencies and the corresponding costs are representative of operational targets.

[9]Assumed 80 hours per week.

[10]Assumes discount rate of 3.5% per year and term of 30 years.

Mocho 2 *AACE International Class 5 Estimate* *(Expected Accuracy Range of* *-30% to +50%)*	*Factor*	2	3
		40/10 ppt	
		IX (PFAS)	GAC
CAPITAL COST[1]			
DIRECT COST			
Site Work[2]	15%	$150,000	$180,000
Yard Piping and Valves[2]	25%	$249,000	$299,000
Major Process Piping[3,4]			
Site Complexity	25%	$249,000	$299,000
Foundation		$73,000	$92,000
Process Equipment			
GAC Contactors			$1,110,000
Anion Exchange (PFAS)		$720,000	
Anion Exchange (Cr-6)			
Backwash Tank			$80,649
Backwash Return Pump			$6,225
Stannous Chloride Feed System			
Desanders		$99,694	
Bag Filters		$177,498	
Installation[2]	20%	$279,000	$335,000
Electrical[5]	20%	$255,000	$306,000
I&C[5]	20%	$199,000	$239,000
Building - not included			
Site Stabilization - not included			
SUBTOTAL DIRECT COST		**$2,450,000**	**$2,950,000**
Contingency[6]	30%	$735,000	$885,000
TOTAL DIRECT COST		**$3,190,000**	**$3,840,000**
INDIRECT COST			
General Conditions, Overhead, Profit & Risk[7]	15%	$479,000	$576,000
Bonds and Insurance[7]	3%	$96,000	$115,000
Tax (9.25%)7	9.25%	$295,000	$355,000
TOTAL INDIRECT COST		**$870,000**	**$1,050,000**
TOTAL CONSTRUCTION COST		**$4,060,000**	**$4,890,000**
Engineering, Administration, and Legal[8]	25%	$1,015,000	$1,223,000
TOTAL CAPITAL COST		**$5,080,000**	**$6,110,000**
ANNUAL OPERATION & MAINTENANCE COST			
Water Quality Monitoring (PFAS)		$18,333	$18,333
GAC Changeout (including spent media management)[9]			$37,000
Anion Exchange Resin Changeout PFAS (including spent media management)[9]		$46,000	
General[7]	10.0%	$319,000	$384,000
Labor[10]	$ 140.00	$29,000	$29,000
TOTAL ANNUAL O&M COST		**$410,000**	**$470,000**
ECONOMIC ANALYSIS			
Present Worth of Annual O&M[10]		$7,541,000	$8,644,000
TOTAL PRESENT WORTH		**$12,620,000**	**$14,750,000**
Annualized Capital Cost[10]		$280,000	$330,000
TOTAL EQUIVALENT ANNUAL COST		**$690,000**	**$800,000**
CUSTOMER BILL IMPACT ANALYSIS			
TOTAL EQUIVALENT ANNUAL COST		**$690,000**	**$800,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**
Cost per Acre Foot		**$19.08**	**$22.12**
Annual Cost per Household @ 120 CCF		**$5.28**	**$6.12**
Monthly Cost per Household @ 10 CCF		**$0.44**	**$0.51**

[1]Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).
[2]Applied to equipment costs.
[3]Assumed connection of backwash waste pipeline to waste.
[4]Applied to equipment costs and installation.
[5]Applied to direct costs.
[6]Applied to direct costs with contingency.
[7]Applied to total construction cost.
[8]Media changeout frequencies and the corresponding costs are representative of operational targets.
[9]Assumed 80 hours per week.
[10]Assumes discount rate of 3.5% per year and term of 30 years.

Mocho 1+2 *AACE International Class 5 Estimate* *(Expected Accuracy Range of* *-30% to +50%)*	*Factor*	2	3
		40/10 ppt	
		IX (PFAS)	GAC
CAPITAL COST[1]			
DIRECT COST			
Site Work[2]	15%	$274,000	$346,000
Yard Piping and Valves[2]	25%	$457,000	$577,000
Major Process Piping[3,4]			
Site Complexity	5%	$91,000	$115,000
Foundation		$114,000	$92,000
Process Equipment			
GAC Contactors			$2,220,000
Anion Exchange (PFAS)		$1,440,000	
Anion Exchange (Cr-6)			
Backwash Tank			$80,649
Backwash Return Pump			$6,225
Stannous Chloride Feed System			
Desanders		$149,541	
Bag Filters		$236,664	
Installation[2]	20%	$511,000	$646,000
Electrical[5]	20%	$467,000	$591,000
I&C[5]	20%	$365,000	$461,000
Building - not included			
Site Stabilization - not included			
SUBTOTAL DIRECT COST		**$4,110,000**	**$5,130,000**
Contingency[6]	30%	$1,233,000	$1,539,000
TOTAL DIRECT COST		**$5,340,000**	**$6,670,000**
INDIRECT COST			
General Conditions, Overhead, Profit & Risk[7]	15%	$801,000	$1,001,000
Bonds and Insurance[7]	3%	$160,000	$200,000
Tax (9.25%)7	9.25%	$494,000	$617,000
TOTAL INDIRECT COST		**$1,460,000**	**$1,820,000**
TOTAL CONSTRUCTION COST		**$6,800,000**	**$8,490,000**
Engineering, Administration, and Legal[8]	25%	$1,700,000	$2,123,000
TOTAL CAPITAL COST		**$8,500,000**	**$10,610,000**
ANNUAL OPERATION & MAINTENANCE COST			
Water Quality Monitoring (PFAS)		$18,333	$18,333
GAC Changeout (including spent media management)[9]			$74,000
Anion Exchange Resin Changeout PFAS (including spent media management)[9]		$92,000	
General[7]	10.0%	$534,000	$667,000
Labor[10]	$ 140.00	$29,000	$29,000
TOTAL ANNUAL O&M COST		**$670,000**	**$790,000**
ECONOMIC ANALYSIS			
Present Worth of Annual O&M[10]		$12,323,000	$14,530,000
TOTAL PRESENT WORTH		**$20,820,000**	**$25,140,000**
Annualized Capital Cost[10]		$460,000	$580,000
TOTAL EQUIVALENT ANNUAL COST		**$1,130,000**	**$1,370,000**
CUSTOMER BILL IMPACT ANALYSIS			
TOTAL EQUIVALENT ANNUAL COST		**$1,130,000**	**$1,370,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**
Cost per Acre Foot		**$31.24**	**$37.88**
Annual Cost per Household @ 120 CCF		**$8.64**	**$10.44**
Monthly Cost per Household @ 10 CCF		**$0.72**	**$0.87**

[1]Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).
[2]Applied to equipment costs.
[3]Assumed connection of backwash waste pipeline to waste.
[4]Applied to equipment costs and installation.
[5]Applied to direct costs.
[6]Applied to direct costs with contingency.
[7]Applied to total construction cost.
[8]Media changeout frequencies and the corresponding costs are representative of operational targets.
[9]Assumed 80 hours per week.
[10]Assumes discount rate of 3.5% per year and term of 30 years.

Mocho Combined AACE International Class 5 Estimate (Expected Accuracy Range of -30% to +50%)	*Factor*	2	3
		40/10 ppt	
		IX (PFAS)	GAC
CAPITAL COST[1]			
DIRECT COST			
Site Work[2]	15%	$453,000	$624,000
Yard Piping and Valves[2]	25%	$755,000	$1,039,000
Major Process Piping[3,4]			
Site Complexity	5%	$151,000	$208,000
Foundation		$176,000	$254,000
Process Equipment			
GAC Contactors			$4,070,000
Anion Exchange (PFAS)		$2,520,000	
Anion Exchange (Cr-6)			
Backwash Tank			$80,649
Backwash Return Pump			$6,225
Stannous Chloride Feed System			
Desanders		$249,234	
Bag Filters		$249,234	
Installation[2]	20%	$845,000	$1,164,000
Electrical[5]	20%	$773,000	$1,064,000
I&C[5]	20%	$604,000	$831,000
Building - not included			
Site Stabilization - not included			
SUBTOTAL DIRECT COST		**$6,780,000**	**$9,340,000**
Contingency[6]	30%	$2,034,000	$2,802,000
TOTAL DIRECT COST		**$8,810,000**	**$12,140,000**
INDIRECT COST		$354,995	$354,995
General Conditions, Overhead, Profit & Risk[7]	15%	$1,322,000	$1,821,000
Bonds and Insurance[7]	3%	$264,000	$364,000
Tax (9.25%)7	9.25%	$815,000	$1,123,000
TOTAL INDIRECT COST		**$2,400,000**	**$3,310,000**
Building ($420/SF)			
TOTAL CONSTRUCTION COST		**$11,210,000**	**$15,450,000**
Engineering, Administration, and Legal[8]	25%	$2,803,000	$3,863,000
TOTAL CAPITAL COST		**$14,010,000**	**$19,310,000**
ANNUAL OPERATION & MAINTENANCE COST			
Water Quality Monitoring (PFAS)		$18,333	$18,333
GAC Changeout (including spent media management)[9]			$136,000
Anion Exchange Resin Changeout PFAS (including spent media management)[9]		$161,000	
General[7]	10.0%	$881,000	$1,214,000
Labor[10]	$ 140.00	$29,000	$29,000
TOTAL ANNUAL O&M COST		**$1,090,000**	**$1,400,000**
ECONOMIC ANALYSIS			
Present Worth of Annual O&M[10]		$20,047,000	$25,749,000
TOTAL PRESENT WORTH		**$34,060,000**	**$45,060,000**
Annualized Capital Cost[10]		$760,000	$1,050,000
TOTAL EQUIVALENT ANNUAL COST		**$1,850,000**	**$2,450,000**
CUSTOMER BILL IMPACT ANALYSIS			
TOTAL EQUIVALENT ANNUAL COST		**$1,850,000**	**$2,450,000**
Acre Feet per Year (2019 Treated Water Data)		**36,170**	**36,170**
Cost per Acre Foot		**$51.15**	**$67.74**
Annual Cost per Household @ 120 CCF		**$14.16**	**$18.72**
Monthly Cost per Household @ 10 CCF		**$1.18**	**$1.56**

[1]Cost opinions correspond to November 2019 dollars (ENR 20-Cities Average Construction Cost Index = 11,381).
[2]Applied to equipment costs.
[3]Assumed connection of backwash waste pipeline to waste.
[4]Applied to equipment costs and installation.
[5]Applied to direct costs.
[6]Applied to direct costs with contingency.
[7]Applied to total construction cost.
[8]Media changeout frequencies and the corresponding costs are representative of operational targets.
[9]Assumed 80 hours per week.
[10]Assumes discount rate of 3.5% per year and term of 30 years.

PROJECT:	Scenario 1: COL 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 1: 40/10 ppt PFOs/PFOA	**Treatment 2: 32/8 ppt PFOs/PFOA**
CAPITAL COSTS	**No Treatment Needed**	
RO Water Treatment Plant		**$21,300,000**
Engineering & Contingencies (20%)		4,260,000
Total Project Cost		**$25,560,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]		1,798,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost		215,000
Chemicals		11,090
Indirect Costs		351,990
Total Annual Cost		**$2,376,080**
Available Project Yield, MGD		3.6
Available Project Yield, AF/yr		4,002
Actual Project Yield, AF/yr [2]		1,001
Unit Capital Cost ($/gpd)		**$7.15**
Unit Cost of Water ($ per 1,000 gallons) [2]		**$7.29**
Unit Cost of Water ($ per acft) [2]		**$2,375**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 1: COL 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatement 3: PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	**Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L**
CAPITAL COSTS		
RO Water Treatment Plant	**$30,930,000**	**$31,850,000**
Engineering & Contingencies (20%)	6,186,000	6,370,000
Total Project Cost	**$37,116,000**	**$38,220,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	2,612,000	2,689,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	255,000	267,000
Chemicals	41,930	66,880
Indirect Costs	522,960	557,320
Total Annual Cost	**$3,431,890**	**$3,580,200**
Available Project Yield, MGD	3.1	2.9
Available Project Yield, AF/yr	3,433	3,248
Actual Project Yield, AF/yr [2]	858	812
Unit Capital Cost ($/gpd)	**$12.11**	**$13.18**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$12.27**	**$13.53**
Unit Cost of Water ($ per acft) [2]	**$3,999**	**$4,410**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 1: COL 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 1: 40/10 ppt PFOs/PFOA

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Land				
Raw Water Pipeline [1]				
Desanders				
Building [2]				
RO Equipment [3]				
Chemical Storage/Feed System				
Scale Inhibitor				
Caustic Soda				
Calcium Chloride				
Ammonia				
Sodium Hypochlorite				
Degasifiers				
High Service Pump Station				
High Service Pump Reservoir [4]				
Yard Piping				
Concentrate Pipeline [1]				
Process Electrical				
Standby Power for RO WTP				
Process Instrumentation				
Site Work [5]				
Subtotal				
Contingency (30%)				
TOTAL CONSTRUCTION COSTS [6]				
Engineering and Contract Administration (20%)				
TOTAL PROJECT COST [7]				**No Treatment Needed**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 1: COL 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 2: 32/8 ppt PFOs/PFOA

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Land [1]	1	LS	$ 11,300	$ 11,300
Raw Water Pipeline [2]	300	LF	$ 269	$ 80,769
Desanders	1	LS	$ 150,000	$ 150,000
Building [3]	4,000	SF	$ 450	$ 1,800,000
RO Equipment [4]	0.1	MGD	$ 1,000,000	$ 109,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 35,000	$ 35,000
Caustic Soda	1	LS	$ 40,000	$ 40,000
Calcium Chloride	1	LS	$ 40,000	$ 40,000
Ammonia	1	LS	$ 35,000	$ 35,000
Sodium Hypochlorite	1	LS	$ 40,000	$ 40,000
Degasifiers	1	LS	$ 100,000	$ 100,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [5]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [2]	24,900	LF	$ 192	$ 4,788,462
Process Electrical	1	LS	$ 2,500,000	$ 2,500,000
Standby Power for RO WTP	1	LS	$ 850,000	$ 850,000
Process Instrumentation	1	LS	$ 1,400,000	$ 1,400,000
Site Work [6]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 16,380,000
Contingency (30%)				$ 4,920,000
TOTAL CONSTRUCTION COSTS [7]				**$ 21,300,000**
Engineering and Contract Administration (20%)				**$ 4,260,000**
TOTAL PROJECT COST [8]				**$ 25,560,000**

1. Assessed value of parcel 946-1350-3-10
2. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
3. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
4. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
5. Includes bypass flow rate pumping.
6. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
7. ENR Construction Cost Index (20-City average, January 2020): 11,392
8. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 1: COL 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatement 3: PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Land[1]	1	LS	$ 11,300	$ 11,300
Raw Water Pipeline [2]	300	LF	$ 269	$ 80,769
Desanders	1	LS	$ 400,000	$ 400,000
Building [3]	8,500	SF	$ 450	$ 3,825,000
RO Equipment [4]	2.1	MGD	$ 950,000	$ 2,036,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [5]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [2]	24,900	LF	$ 192	$ 4,788,462
Process Electrical	1	LS	$ 4,200,000	$ 4,200,000
Standby Power for RO WTP	1	LS	$ 850,000	$ 850,000
Process Instrumentation	1	LS	$ 2,400,000	$ 2,400,000
Site Work [6]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 23,790,000
Contingency (30%)				$ 7,140,000
TOTAL CONSTRUCTION COSTS [7]				**$ 30,930,000**
Engineering and Contract Administration (20%)				**$ 6,186,000**
TOTAL PROJECT COST [8]				**$ 37,116,000**

1. Assessed value of parcel 946-1350-3-10
2. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
3. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
4. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
5. Includes bypass flow rate pumping.
6. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
7. ENR Construction Cost Index (20-City average, January 2020): 11,392
8. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 1: COL 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Land [1]	1	LS	$ 11,300	$ 11,300
Raw Water Pipeline [2]	300	LF	$ 269	$ 80,769
Desanders	1	LS	$ 280,000	$ 280,000
Building [3]	8,500	SF	$ 450	$ 3,825,000
RO Equipment [4]	2.8	MGD	$ 950,000	$ 2,665,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [5]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [2]	24,900	LF	$ 192	$ 4,788,462
Process Electrical	1	LS	$ 4,300,000	$ 4,300,000
Standby Power for RO WTP	1	LS	$ 850,000	$ 850,000
Process Instrumentation	1	LS	$ 2,500,000	$ 2,500,000
Site Work [6]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 24,500,000
Contingency (30%)				$ 7,350,000
TOTAL CONSTRUCTION COSTS [7]				**$ 31,850,000**
Engineering and Contract Administration (20%)				**$ 6,370,000**
TOTAL PROJECT COST [8]				**$ 38,220,000**

1. Assessed value of parcel 946-1350-3-10
2. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
3. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
4. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
5. Includes bypass flow rate pumping.
6. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
7. ENR Construction Cost Index (20-City average, January 2020): 11,392
8. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 1: COL 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 1: 40/10 ppt PFOs/PFOA	Treatment 2: 32/8 ppt PFOs/PFOA
Well Pumping	No Treatment Needed	102,000
RO Feed Pumping		2,000
Interstage Pumping		1,000
Decarbonation Tower Blowers		11,000
High Service Pumping		99,000
Electrical Pumping Costs		*215,000*
Cost per 1,000 gallons		*0.66*
Cartridge Filters		1,000
Sulfuric Acid		-
Scale Inhibitor		-
Calcium Chloride		-
Sodium Hydroxide		-
Lime		-
Carbon Dioxide		-
Aqua Ammonia		1,090
Chlorine Gas		-
Sodium Hypochlorite (12%)		8,000
Membrane Cleaning Chemicals		1,000
Chemical Operating Costs		*11,090*
Cost per 1,000 gallons		*0.03*
Membrane Replacement		3,990
Labor		
Laboratory Testing		100,000
General Building Utilities		35,000
Equipment Replacement Parts and Consumables		213,000
Indirect (Fixed) Operating Costs		*351,990*
Cost per 1,000 gallons		*1.08*
TOTAL COST		***578,080***
COST PER 1,000 GALLONS		***1.77***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 1: COL 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatement 3: PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L
Well Pumping	102,000	102,000
RO Feed Pumping	43,000	56,000
Interstage Pumping	14,000	18,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	85,000	80,000
Electrical Pumping Costs	*255,000*	*267,000*
Cost per 1,000 gallons	*0.91*	*1.01*
Cartridge Filters	10,000	13,000
Sulfuric Acid	-	-
Scale Inhibitor	6,000	8,000
Calcium Chloride	6,000	23,000
Sodium Hydroxide	11,000	15,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	930	880
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	7,000	6,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*41,930*	*66,880*
Cost per 1,000 gallons	*0.15*	*0.25*
Membrane Replacement	78,960	103,320
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	309,000	319,000
Indirect (Fixed) Operating Costs	*522,960*	*557,320*
Cost per 1,000 gallons	*1.87*	*2.11*
TOTAL COST	***819,890***	***891,200***
COST PER 1,000 GALLONS	***2.93***	***3.37***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 2: COL 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 1: PFOs/PFOA - 40/10 ng/L	**Treatment 2: PFOs/PFOA - 32/8 ng/L**
CAPITAL COSTS	**No treatment Needed**	**No treatment Needed**
RO Water Treatment Plant		
Engineering & Contingencies (20%)		
Total Project Cost		
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]		
Operation and Maintenance:		
Water Treatment Plant Energy Cost		
Chemicals		
Indirect Costs		
Total Annual Cost		
Available Project Yield, MGD		
Available Project Yield, AF/yr		
Actual Project Yield, AF/yr [2]		
Unit Capital Cost ($/gpd)		
Unit Cost of Water ($ per 1,000 gallons) [2]		
Unit Cost of Water ($ per acft) [2]		

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 2: COL 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	**Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L**
CAPITAL COSTS		
RO Water Treatment Plant	**$26,260,000**	**$34,260,000**
Engineering & Contingencies (20%)	5,252,000	6,852,000
Total Project Cost	**$31,512,000**	**$41,112,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	2,217,000	2,893,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	323,000	368,000
Chemicals	27,420	87,240
Indirect Costs	453,650	617,230
Total Annual Cost	**$3,021,070**	**$3,965,470**
Available Project Yield, MGD	4.7	4.1
Available Project Yield, AF/yr	5,223	4,588
Actual Project Yield, AF/yr [2]	1,306	1,147
Unit Capital Cost ($/gpd)	**$6.76**	**$10.04**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$7.10**	**$10.61**
Unit Cost of Water ($ per acft) [2]	**$2,314**	**$3,458**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 2: COL 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 1: PFOs/PFOA - 40/10 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells				
Raw Water Pipeline [1]				
Desanders				
Building [2]				
RO Equipment [3]				
Chemical Storage/Feed System				
Scale Inhibitor				
Caustic Soda				
Calcium Chloride				
Ammonia				
Sodium Hypochlorite				
Degasifiers				
High Service Pump Station				
High Service Pump Reservoir [4]				
Yard Piping				
Concentrate Pipeline [1]				
Process Electrical				
Standby Power for RO WTP				
Process Instrumentation				
Site Work [5]				
Subtotal				
Contingency (30%)				
TOTAL CONSTRUCTION COSTS [6]				
Engineering and Contract Administration (20%)				
TOTAL PROJECT COST [7]				**No Treatment Needed**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 2: COL 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 2: PFOs/PFOA - 32/8 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost
Groundwater Wells			
Raw Water Pipeline [1]			
Desanders			
Building [2]			
RO Equipment [3]			
Chemical Storage/Feed System			
Scale Inhibitor			
Caustic Soda			
Calcium Chloride			
Ammonia			
Sodium Hypochlorite			
Degasifiers			
High Service Pump Station			
High Service Pump Reservoir [4]			
Yard Piping			
Concentrate Pipeline [1]			
Process Electrical			
Standby Power for RO WTP			
Process Instrumentation			
Site Work [5]			
Subtotal			
Contingency (30%)			
TOTAL CONSTRUCTION COSTS [6]			
Engineering and Contract Administration (20%)			
TOTAL PROJECT COST [7]			

1. Open trench construction, assumes public right of way, and does not include trenchless intersection cro
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expe range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of cu in the project area and is subject to change as variances in the cost of labor, materials, equipment, ser by others or economic conditions occur. Since the Engineer has no control over these factors, he cann guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, professional opinion of accurate costs at this time.

Extended Cost

No Treatment Needed

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PROJECT:	Scenario 2: COL 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]			$ -	$ -
Desanders	1	LS	$ 250,000	$ 250,000
Building [2]	5,000	SF	$ 450	$ 2,250,000
RO Equipment [3]	1.5	MGD	$ 1,000,000	$ 1,511,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 45,000	$ 45,000
Caustic Soda	1	LS	$ 160,000	$ 160,000
Calcium Chloride	1	LS	$ 90,000	$ 90,000
Ammonia	1	LS	$ 75,000	$ 75,000
Sodium Hypochlorite	1	LS	$ 90,000	$ 90,000
Degasifiers	1	LS	$ 180,000	$ 180,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	27,900	LF	$ 192	$ 5,365,385
Process Electrical	1	LS	$ 3,200,000	$ 3,200,000
Standby Power for RO WTP	1	LS	$ 780,000	$ 780,000
Process Instrumentation	1	LS	$ 1,800,000	$ 1,800,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 20,200,000
Contingency (30%)				$ 6,060,000
TOTAL CONSTRUCTION COSTS [6]				**$ 26,260,000**
Engineering and Contract Administration (20%)				**$ 5,252,000**
TOTAL PROJECT COST [7]				**$ 31,512,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 2: COL 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]			$ -	$ -
Desanders	1	LS	$ 350,000	$ 350,000
Building [2]	8,000	SF	$ 450	$ 3,600,000
RO Equipment [3]	3.8	MGD	$ 950,000	$ 3,592,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Caustic Soda	1	LS	$ 250,000	$ 250,000
Calcium Chloride	1	LS	$ 160,000	$ 160,000
Ammonia	1	LS	$ 135,000	$ 135,000
Sodium Hypochlorite	1	LS	$ 160,000	$ 160,000
Degasifiers	1	LS	$ 250,000	$ 250,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	27,900	LF	$ 192	$ 5,365,385
Process Electrical	1	LS	$ 4,500,000	$ 4,500,000
Standby Power for RO WTP	1	LS	$ 1,000,000	$ 1,000,000
Process Instrumentation	1	LS	$ 2,500,000	$ 2,500,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 26,350,000
Contingency (30%)				$ 7,910,000
TOTAL CONSTRUCTION COSTS [6]				**$ 34,260,000**
Engineering and Contract Administration (20%)				**$ 6,852,000**
TOTAL PROJECT COST [7]				**$ 41,112,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 2: COL 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 1: PFOs/PFOA - 40/10 ng/L	Treatment 2: PFOs/PFOA - 32/8 ng/L
Well Pumping RO Feed Pumping Interstage Pumping Decarbonation Tower Blowers High Service Pumping	No Treatment Needed	No Treatment Needed
Electrical Pumping Costs *Cost per 1,000 gallons*		
Cartridge Filters Sulfuric Acid Scale Inhibitor Calcium Chloride Sodium Hydroxide Lime Carbon Dioxide Aqua Ammonia Chlorine Gas Sodium Hypochlorite (12%) Membrane Cleaning Chemicals		
Chemical Operating Costs *Cost per 1,000 gallons*		
Membrane Replacement Labor Laboratory Testing General Building Utilities Equipment Replacement Parts and Consumables		
Indirect (Fixed) Operating Costs *Cost per 1,000 gallons*		
TOTAL COST **COST PER 1,000 GALLONS**		

1. Based upon 91 days of operation per year

PROJECT:	Scenario 2: COL 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L
Well Pumping	143,000	143,000
RO Feed Pumping	30,000	76,000
Interstage Pumping	10,000	24,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	129,000	114,000
Electrical Pumping Costs	*323,000*	*368,000*
Cost per 1,000 gallons	*0.76*	*0.98*
Cartridge Filters	7,000	18,000
Sulfuric Acid	-	-
Scale Inhibitor	4,000	10,000
Calcium Chloride	4,000	27,000
Sodium Hydroxide	-	21,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	1,420	1,240
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	10,000	9,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*27,420*	*87,240*
Cost per 1,000 gallons	*0.06*	*0.23*
Membrane Replacement	55,650	139,230
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	263,000	343,000
Indirect (Fixed) Operating Costs	*453,650*	*617,230*
Cost per 1,000 gallons	*1.07*	*1.65*
TOTAL COST	***804,070***	***1,072,470***
COST PER 1,000 GALLONS	***1.89***	***2.87***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 3: COL 5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	These two treatments are governed by the Cr(6) concentration in the water

SUMMARY OF COSTS		
	Treatment 1: PFOs/PFOA - 40/10 ng/L, and Cr(6) 8 ppb	**Treatment 2: PFOs/PFOA - 32/8 ng/L, and Cr(6) 8 ppb**
CAPITAL COSTS		
RO Water Treatment Plant	**$21,950,000**	**$21,950,000**
Engineering & Contingencies (20%)	4,390,000	4,390,000
Total Project Cost	**$26,340,000**	**$26,340,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	1,853,000	1,853,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	122,000	122,000
Chemicals	9,510	9,510
Indirect Costs	374,740	374,740
Total Annual Cost	**$2,359,250**	**$2,359,250**
Available Project Yield, MGD	1.7	1.7
Available Project Yield, AF/yr	1,866	1,866
Actual Project Yield, AF/yr [2]	467	467
Unit Capital Cost ($/gpd)	**$15.81**	**$15.81**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$15.52**	**$15.52**
Unit Cost of Water ($ per acft) [2]	**$5,057**	**$5,057**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 3: COL 5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt and Cr(6) 8ppb	**Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L and Cr(6) 8 ppb**
CAPITAL COSTS		
RO Water Treatment Plant	**$24,220,000**	**$24,940,000**
Engineering & Contingencies (20%)	4,844,000	4,988,000
Total Project Cost	**$29,064,000**	**$29,928,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	2,045,000	2,106,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	133,000	139,000
Chemicals	26,470	32,440
Indirect Costs	415,430	435,870
Total Annual Cost	**$2,619,900**	**$2,713,310**
Available Project Yield, MGD	1.5	1.4
Available Project Yield, AF/yr	1,724	1,622
Actual Project Yield, AF/yr [2]	431	406
Unit Capital Cost ($/gpd)	**$18.89**	**$20.66**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$18.66**	**$20.53**
Unit Cost of Water ($ per acft) [2]	**$6,079**	**$6,690**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 3: COL 5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	These two treatments are governed by the Cr(6) concentration in the water
OPTION A:	Treatment 1: PFOs/PFOA - 40/10 ng/L, and Cr(6) 8 ppb

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	1200	LF	$ 215	$ 258,462
Desanders	1	LS	$ 150,000	$ 150,000
Building [2]	4,000	SF	$ 450	$ 1,800,000
RO Equipment [3]	0.5	MGD	$ 1,000,000	$ 537,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 35,000	$ 35,000
Caustic Soda	1	LS	$ 100,000	$ 100,000
Calcium Chloride	1	LS	$ 70,000	$ 70,000
Ammonia	1	LS	$ 35,000	$ 35,000
Sodium Hypochlorite	1	LS	$ 70,000	$ 70,000
Degasifiers	1	LS	$ 180,000	$ 180,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	21,100	LF	$ 192	$ 4,057,692
Process Electrical	1	LS	$ 2,800,000	$ 2,800,000
Standby Power for RO WTP	1	LS	$ 780,000	$ 780,000
Process Instrumentation	1	LS	$ 1,600,000	$ 1,600,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 16,880,000
Contingency (30%)				$ 5,070,000
TOTAL CONSTRUCTION COSTS [6]				**$ 21,950,000**
Engineering and Contract Administration (20%)				**$ 4,390,000**
TOTAL PROJECT COST [7]				**$ 26,340,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 3: COL 5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	These two treatments are governed by the Cr(6) concentration in the water
OPTION B:	Treatment 2: PFOs/PFOA - 32/8 ng/L, and Cr(6) 8 ppb

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	1200	LF	$ 215	$ 258,462
Desanders	1	LS	$ 150,000	$ 150,000
Building [2]	4,000	SF	$ 450	$ 1,800,000
RO Equipment [3]	0.5	MGD	$ 1,000,000	$ 537,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 35,000	$ 35,000
Caustic Soda	1	LS	$ 100,000	$ 100,000
Calcium Chloride	1	LS	$ 70,000	$ 70,000
Ammonia	1	LS	$ 35,000	$ 35,000
Sodium Hypochlorite	1	LS	$ 70,000	$ 70,000
Degasifiers	1	LS	$ 180,000	$ 180,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	21,100	LF	$ 192	$ 4,057,692
Process Electrical	1	LS	$ 2,800,000	$ 2,800,000
Standby Power for RO WTP	1	LS	$ 780,000	$ 780,000
Process Instrumentation	1	LS	$ 1,600,000	$ 1,600,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 16,880,000
Contingency (30%)				$ 5,070,000
TOTAL CONSTRUCTION COSTS [6]				**$ 21,950,000**
Engineering and Contract Administration (20%)				**$ 4,390,000**
TOTAL PROJECT COST [7]				**$ 26,340,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 3: COL 5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt and Cr(6) 8ppb

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	1200	LF	$ 215	$ 258,462
Desanders	1	LS	$ 250,000	$ 250,000
Building [2]	5,000	SF	$ 450	$ 2,250,000
RO Equipment [3]	1.0	MGD	$ 950,000	$ 993,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 45,000	$ 45,000
Caustic Soda	1	LS	$ 160,000	$ 160,000
Calcium Chloride	1	LS	$ 90,000	$ 90,000
Ammonia	1	LS	$ 75,000	$ 75,000
Sodium Hypochlorite	1	LS	$ 90,000	$ 90,000
Degasifiers	1	LS	$ 180,000	$ 180,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	21,100	LF	$ 192	$ 4,057,692
Process Electrical	1	LS	$ 3,200,000	$ 3,200,000
Standby Power for RO WTP	1	LS	$ 780,000	$ 780,000
Process Instrumentation	1	LS	$ 1,800,000	$ 1,800,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 18,630,000
Contingency (30%)				$ 5,590,000
TOTAL CONSTRUCTION COSTS [6]				**$ 24,220,000**
Engineering and Contract Administration (20%)				**$ 4,844,000**
TOTAL PROJECT COST [7]				**$ 29,064,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 3: COL 5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L and Cr(6) 8 ppb

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	1200	LF	$ 215	$ 258,462
Desanders	1	LS	$ 250,000	$ 250,000
Building [2]	5,000	SF	$ 450	$ 2,250,000
RO Equipment [3]	1.4	MGD	$ 950,000	$ 1,338,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 45,000	$ 45,000
Caustic Soda	1	LS	$ 160,000	$ 160,000
Calcium Chloride	1	LS	$ 90,000	$ 90,000
Ammonia	1	LS	$ 75,000	$ 75,000
Sodium Hypochlorite	1	LS	$ 90,000	$ 90,000
Degasifiers	1	LS	$ 180,000	$ 180,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	21,100	LF	$ 192	$ 4,057,692
Process Electrical	1	LS	$ 3,300,000	$ 3,300,000
Standby Power for RO WTP	1	LS	$ 780,000	$ 780,000
Process Instrumentation	1	LS	$ 1,900,000	$ 1,900,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 19,180,000
Contingency (30%)				$ 5,760,000
TOTAL CONSTRUCTION COSTS [6]				**$ 24,940,000**
Engineering and Contract Administration (20%)				**$ 4,988,000**
TOTAL PROJECT COST [7]				**$ 29,928,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 3: COL 5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	These two treatments are governed by the Cr(6) concentration in the water

Annual Operation & Maintenance Costs [1]

	Treatment 1: PFOs/PFOA - 40/10 ng/L, and Cr(6) 8 ppb	Treatment 2: PFOs/PFOA - 32/8 ng/L, and Cr(6) 8 ppb
Well Pumping	51,000	51,000
RO Feed Pumping	11,000	11,000
Interstage Pumping	3,000	3,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	46,000	46,000
Electrical Pumping Costs	*122,000*	*122,000*
Cost per 1,000 gallons	*0.80*	*0.80*
Cartridge Filters	3,000	3,000
Sulfuric Acid	-	-
Scale Inhibitor	1,000	1,000
Calcium Chloride	-	-
Sodium Hydroxide	-	-
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	510	510
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	4,000	4,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*9,510*	*9,510*
Cost per 1,000 gallons	*0.06*	*0.06*
Membrane Replacement	19,740	19,740
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	220,000	220,000
Indirect (Fixed) Operating Costs	*374,740*	*374,740*
Cost per 1,000 gallons	*2.47*	*2.47*
TOTAL COST	***506,250***	***506,250***
COST PER 1,000 GALLONS	***3.33***	***3.33***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 3: COL 5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt and Cr(6) 8ppb	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L and Cr(6) 8 ppb
Well Pumping	51,000	51,000
RO Feed Pumping	21,000	28,000
Interstage Pumping	7,000	9,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	43,000	40,000
Electrical Pumping Costs	*133,000*	*139,000*
Cost per 1,000 gallons	*0.95*	*1.05*
Cartridge Filters	5,000	7,000
Sulfuric Acid	-	-
Scale Inhibitor	3,000	4,000
Calcium Chloride	9,000	10,000
Sodium Hydroxide	5,000	7,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	470	440
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	3,000	3,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*26,470*	*32,440*
Cost per 1,000 gallons	*0.19*	*0.25*
Membrane Replacement	38,430	51,870
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	242,000	249,000
Indirect (Fixed) Operating Costs	*415,430*	*435,870*
Cost per 1,000 gallons	*2.96*	*3.30*
TOTAL COST	***574,900***	***607,310***
COST PER 1,000 GALLONS	***4.09***	***4.60***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 4: COL 1,2,5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	These two treatments are governed by the Cr(6) concentration in the water

SUMMARY OF COSTS		
	Treatment 1: PFOs/PFOA - 40/10 ng/L, and Cr(6) 8 ppb	**Treatment 2: PFOs/PFOA - 32/8 ng/L and Cr(6) 8 ppb**
CAPITAL COSTS		
RO Water Treatment Plant	**$30,460,000**	**$30,460,000**
Engineering & Contingencies (20%)	6,092,000	6,092,000
Total Project Cost	**$36,552,000**	**$36,552,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	2,572,000	2,572,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	619,000	619,000
Chemicals	34,090	34,090
Indirect Costs	481,580	481,580
Total Annual Cost	**$3,706,670**	**$3,706,670**
Available Project Yield, MGD	10.2	10.2
Available Project Yield, AF/yr	11,378	11,378
Actual Project Yield, AF/yr [2]	2,845	2,845
Unit Capital Cost ($/gpd)	**$3.60**	**$3.60**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$4.00**	**$4.00**
Unit Cost of Water ($ per acft) [2]	**$1,303**	**$1,303**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 4: COL 1,2,5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt and Cr(6) 8 ppb	**Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L and Cr(6) 8 ppb**
CAPITAL COSTS		
RO Water Treatment Plant	**$44,750,000**	**$56,070,000**
Engineering & Contingencies (20%)	8,950,000	11,214,000
Total Project Cost	**$53,700,000**	**$67,284,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	3,778,000	4,734,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	703,000	755,000
Chemicals	117,760	183,560
Indirect Costs	782,290	993,570
Total Annual Cost	**$5,381,050**	**$6,666,130**
Available Project Yield, MGD	9.1	8.4
Available Project Yield, AF/yr	10,180	9,433
Actual Project Yield, AF/yr [2]	2,545	2,358
Unit Capital Cost ($/gpd)	**$5.91**	**$7.99**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$6.49**	**$8.67**
Unit Cost of Water ($ per acft) [2]	**$2,114**	**$2,827**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 4: COL 1,2,5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	These two treatments are governed by the Cr(6) concentration in the water
OPTION A:	Treatment 1: PFOs/PFOA - 40/10 ng/L, and Cr(6) 8 ppb

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	6500	LF	$ 308	$ 2,000,000
Desanders	1	LS	$ 250,000	$ 250,000
Building [2]	5,000	SF	$ 450	$ 2,250,000
RO Equipment [3]	1.1	MGD	$ 950,000	$ 1,073,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 45,000	$ 45,000
Caustic Soda	1	LS	$ 160,000	$ 160,000
Calcium Chloride	1	LS	$ 90,000	$ 90,000
Ammonia	1	LS	$ 75,000	$ 75,000
Sodium Hypochlorite	1	LS	$ 90,000	$ 90,000
Degasifiers	1	LS	$ 180,000	$ 180,000
High Service Pump Station	1	LS	$ 3,000,000	$ 3,000,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 450,000	$ 450,000
Concentrate Pipeline [1]	21,100	LF	$ 192	$ 4,057,692
Process Electrical	1	LS	$ 4,200,000	$ 4,200,000
Standby Power for RO WTP	1	LS	$ 800,000	$ 800,000
Process Instrumentation	1	LS	$ 2,400,000	$ 2,400,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 23,430,000
Contingency (30%)				$ 7,030,000
TOTAL CONSTRUCTION COSTS [6]				**$ 30,460,000**
Engineering and Contract Administration (20%)				**$ 6,092,000**
TOTAL PROJECT COST [7]				**$ 36,552,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 4: COL 1,2,5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	These two treatments are governed by the Cr(6) concentration in the water
OPTION B:	Treatment 2: PFOs/PFOA - 32/8 ng/L and Cr(6) 8 ppb

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	6500	LF	$ 308	$ 2,000,000
Desanders	1	LS	$ 250,000	$ 250,000
Building [2]	5,000	SF	$ 450	$ 2,250,000
RO Equipment [3]	1.1	MGD	$ 950,000	$ 1,073,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 45,000	$ 45,000
Caustic Soda	1	LS	$ 160,000	$ 160,000
Calcium Chloride	1	LS	$ 90,000	$ 90,000
Ammonia	1	LS	$ 75,000	$ 75,000
Sodium Hypochlorite	1	LS	$ 90,000	$ 90,000
Degasifiers	1	LS	$ 180,000	$ 180,000
High Service Pump Station	1	LS	$ 3,000,000	$ 3,000,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 450,000	$ 450,000
Concentrate Pipeline [1]	21,100	LF	$ 192	$ 4,057,692
Process Electrical	1	LS	$ 4,200,000	$ 4,200,000
Standby Power for RO WTP	1	LS	$ 800,000	$ 800,000
Process Instrumentation	1	LS	$ 2,400,000	$ 2,400,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 23,430,000
Contingency (30%)				$ 7,030,000
TOTAL CONSTRUCTION COSTS [6]				**$ 30,460,000**
Engineering and Contract Administration (20%)				**$ 6,092,000**
TOTAL PROJECT COST [7]				**$ 36,552,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 4: COL 1,2,5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt and Cr(6) 8 ppb

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	6500	LF	$ 308	$ 2,000,000
Desanders	1	LS	$ 350,000	$ 350,000
Building [2]	9,500	SF	$ 450	$ 4,275,000
RO Equipment [3]	5.4	MGD	$ 950,000	$ 5,142,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Caustic Soda	1	LS	$ 280,000	$ 280,000
Calcium Chloride	1	LS	$ 180,000	$ 180,000
Ammonia	1	LS	$ 140,000	$ 140,000
Sodium Hypochlorite	1	LS	$ 180,000	$ 180,000
Degasifiers	1	LS	$ 280,000	$ 280,000
High Service Pump Station	1	LS	$ 3,000,000	$ 3,000,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 450,000	$ 450,000
Concentrate Pipeline [1]	21,100	LF	$ 192	$ 4,057,692
Process Electrical	1	LS	$ 6,700,000	$ 6,700,000
Standby Power for RO WTP	1	LS	$ 1,200,000	$ 1,200,000
Process Instrumentation	1	LS	$ 3,800,000	$ 3,800,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 34,420,000
Contingency (30%)				$ 10,330,000
TOTAL CONSTRUCTION COSTS [6]				**$ 44,750,000**
Engineering and Contract Administration (20%)				**$ 8,950,000**
TOTAL PROJECT COST [7]				**$ 53,700,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 4: COL 1,2,5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L and Cr(6) 8 ppb

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	6500	LF	$ 308	$ 2,000,000
Desanders	1	LS	$ 650,000	$ 650,000
Building [2]	13,500	SF	$ 450	$ 6,075,000
RO Equipment [3]	8.1	MGD	$ 950,000	$ 7,676,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Caustic Soda	1	LS	$ 300,000	$ 300,000
Calcium Chloride	1	LS	$ 200,000	$ 200,000
Ammonia	1	LS	$ 200,000	$ 200,000
Sodium Hypochlorite	1	LS	$ 200,000	$ 200,000
Degasifiers	1	LS	$ 350,000	$ 350,000
High Service Pump Station	1	LS	$ 3,000,000	$ 3,000,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 450,000	$ 450,000
Concentrate Pipeline [1]	21,100	LF	$ 215	$ 4,544,615
Process Electrical	1	LS	$ 8,500,000	$ 8,500,000
Standby Power for RO WTP	1	LS	$ 1,800,000	$ 1,800,000
Process Instrumentation	1	LS	$ 4,800,000	$ 4,800,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 43,130,000
Contingency (30%)				$ 12,940,000
TOTAL CONSTRUCTION COSTS [6]				**$ 56,070,000**
Engineering and Contract Administration (20%)				**$ 11,214,000**
TOTAL PROJECT COST [7]				**$ 67,284,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 4: COL 1,2,5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	These two treatments are governed by the Cr(6) concentration in the water

Annual Operation & Maintenance Costs [1]

	40/10 ng/L, and Cr(6) 8 ppb	Treatment 2: PFOs/PFOA - 32/8 ng/L and Cr(6) 8 ppb
Well Pumping	296,000	296,000
RO Feed Pumping	23,000	23,000
Interstage Pumping	7,000	7,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	282,000	282,000
Electrical Pumping Costs	*619,000*	*619,000*
Cost per 1,000 gallons	*0.67*	*0.67*
Cartridge Filters	5,000	5,000
Sulfuric Acid	-	-
Scale Inhibitor	3,000	3,000
Calcium Chloride	-	-
Sodium Hydroxide	-	-
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	3,090	3,090
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	22,000	22,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*34,090*	*34,090*
Cost per 1,000 gallons	*0.04*	*0.04*
Membrane Replacement	41,580	41,580
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	305,000	305,000
Indirect (Fixed) Operating Costs	*481,580*	*481,580*
Cost per 1,000 gallons	*0.52*	*0.52*
TOTAL COST	***1,134,670***	***1,134,670***
COST PER 1,000 GALLONS	***1.22***	***1.22***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 4: COL 1,2,5
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt and Cr(6) 8 ppb	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L and Cr(6) 8 ppb
Well Pumping	296,000	296,000
RO Feed Pumping	109,000	162,000
Interstage Pumping	35,000	52,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	252,000	234,000
Electrical Pumping Costs	*703,000*	*755,000*
Cost per 1,000 gallons	*0.85*	*0.98*
Cartridge Filters	26,000	38,000
Sulfuric Acid	-	-
Scale Inhibitor	15,000	22,000
Calcium Chloride	21,000	58,000
Sodium Hydroxide	33,000	44,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	2,760	2,560
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	19,000	18,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*117,760*	*183,560*
Cost per 1,000 gallons	*0.14*	*0.24*
Membrane Replacement	199,290	297,570
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	448,000	561,000
Indirect (Fixed) Operating Costs	*782,290*	*993,570*
Cost per 1,000 gallons	*0.94*	*1.29*
TOTAL COST	***1,603,050***	***1,932,130***
COST PER 1,000 GALLONS	***1.93***	***2.51***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 5: Stoneridge
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 1: PFOs/PFOA - 40/10 ng/L	**Treatment 2: PFOs/PFOA - 32/8 ng/L**
CAPITAL COSTS	**No Treatment Needed**	**No Treatment Needed**
RO Water Treatment Plant		
Engineering & Contingencies (20%)		
Total Project Cost		
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]		
Operation and Maintenance:		
Water Treatment Plant Energy Cost		
Chemicals		
Indirect Costs		
Total Annual Cost		
Available Project Yield, MGD		
Available Project Yield, AF/yr		
Actual Project Yield, AF/yr [2]		
Unit Capital Cost ($/gpd)		
Unit Cost of Water ($ per 1,000 gallons) [2]		
Unit Cost of Water ($ per acft) [2]		

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 5: Stoneridge
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	**Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L**
CAPITAL COSTS	**No Treatment Needed**	
RO Water Treatment Plant		**$36,050,000**
Engineering & Contingencies (20%)		7,210,000
Total Project Cost		**$43,260,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]		3,044,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost		476,000
Chemicals		112,650
Indirect Costs		670,510
Total Annual Cost		**$4,303,160**
Available Project Yield, MGD		5.4
Available Project Yield, AF/yr		6,094
Actual Project Yield, AF/yr [2]		1,523
Unit Capital Cost ($/gpd)		**$7.95**
Unit Cost of Water ($ per 1,000 gallons) [2]		**$8.67**
Unit Cost of Water ($ per acft) [2]		**$2,825**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 5: Stoneridge
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 1: PFOs/PFOA - 40/10 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells				
Raw Water Pipeline [1]				
Desanders				
Building [2]				
RO Equipment [3]				
Chemical Storage/Feed System				
Scale Inhibitor				
Caustic Soda				
Calcium Chloride				
Ammonia				
Sodium Hypochlorite				
Degasifiers				
High Service Pump Station				
High Service Pump Reservoir [4]				
Yard Piping				
Concentrate Pipeline [1]				
Process Electrical				
Standby Power for RO WTP				
Process Instrumentation				
Site Work [5]				
Subtotal				
Contingency (30%)				
TOTAL CONSTRUCTION COSTS 6				
Engineering and Contract Administration (20%)				
TOTAL PROJECT COST [7]				**No Treatment Needed**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 5: Stoneridge
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 2: PFOs/PFOA - 32/8 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Land [1]				
Raw Water Pipeline [2]				
Desanders				
Building [3]				
RO Equipment [4]				
Chemical Storage/Feed System				
Scale Inhibitor				
Caustic Soda				
Calcium Chloride				
Ammonia				
Sodium Hypochlorite				
Degasifiers				
High Service Pump Station				
High Service Pump Reservoir [5]				
Yard Piping				
Concentrate Pipeline [2]				
Process Electrical				
Standby Power for RO WTP				
Process Instrumentation				
Site Work [6]				
Subtotal				
Contingency (30%)				
TOTAL CONSTRUCTION COSTS [7]				
Engineering and Contract Administration (20%)				
TOTAL PROJECT COST [8]				**No Treatment Needed**

1. Land would need to be purchased from parcel 946-1144-2
2. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
3. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
4. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
5. Includes bypass flow rate pumping.
6. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
7. ENR Construction Cost Index (20-City average, January 2020): 11,392
8. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 5: Stoneridge
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells				
Raw Water Pipeline [1]				
Desanders				
Building [2]				
RO Equipment [3]				
Chemical Storage/Feed System				
Scale Inhibitor				
Caustic Soda				
Calcium Chloride				
Ammonia				
Sodium Hypochlorite				
Degasifiers				
High Service Pump Station				
High Service Pump Reservoir [4]				
Yard Piping				
Concentrate Pipeline [1]				
Process Electrical				
Standby Power for RO WTP				
Process Instrumentation				
Site Work [5]				
Subtotal				
Contingency (30%)				
TOTAL CONSTRUCTION COSTS [6]				
Engineering and Contract Administration (20%)				
TOTAL PROJECT COST [7]				**No Treatment Needed**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 5: Stoneridge
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Land [1]	1	LS	$ 500,000	$ 500,000
Raw Water Pipeline [2]			$ -	$ -
Desanders	1	LS	$ 350,000	$ 350,000
Building [3]	9,500	SF	$ 450	$ 4,275,000
RO Equipment [4]	4.7	MGD	$ 950,000	$ 4,503,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Caustic Soda	1	LS	$ 280,000	$ 280,000
Calcium Chloride	1	LS	$ 180,000	$ 180,000
Ammonia	1	LS	$ 140,000	$ 140,000
Sodium Hypochlorite	1	LS	$ 180,000	$ 180,000
Degasifiers	1	LS	$ 280,000	$ 280,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [5]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [2]	16,400	LF	$ 192	$ 3,153,846
Process Electrical	1	LS	$ 5,200,000	$ 5,200,000
Standby Power for RO WTP	1	LS	$ 1,200,000	$ 1,200,000
Process Instrumentation	1	LS	$ 3,000,000	$ 3,000,000
Site Work [6]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 27,730,000
Contingency (30%)				$ 8,320,000
TOTAL CONSTRUCTION COSTS [7]				**$ 36,050,000**
Engineering and Contract Administration (20%)				**$ 7,210,000**
TOTAL PROJECT COST [8]				**$ 43,260,000**

1. Land would need to be purchased from parcel 946-1144-2
2. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
3. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
4. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
5. Includes bypass flow rate pumping.
6. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
7. ENR Construction Cost Index (20-City average, January 2020): 11,392
8. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 5: Stoneridge
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 1: PFOs/PFOA - 40/10 ng/L	Treatment 2: PFOs/PFOA - 32/8 ng/L
Well Pumping RO Feed Pumping Interstage Pumping Decarbonation Tower Blowers High Service Pumping	No Treatement Needed	No Treatment Needed
Electrical Pumping Costs *Cost per 1,000 gallons*		
Cartridge Filters Sulfuric Acid Scale Inhibitor Calcium Chloride Sodium Hydroxide Lime Carbon Dioxide Aqua Ammonia Chlorine Gas Sodium Hypochlorite (12%) Membrane Cleaning Chemicals		
Chemical Operating Costs *Cost per 1,000 gallons*		
Membrane Replacement Labor Laboratory Testing General Building Utilities Equipment Replacement Parts and Consumables		
Indirect (Fixed) Operating Costs *Cost per 1,000 gallons*		
TOTAL COST **COST PER 1,000 GALLONS**		

1. Based upon 91 days of operation per year

PROJECT:	Scenario 5: Stoneridge
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L
Well Pumping	No Treatement Needed	188,000
RO Feed Pumping		95,000
Interstage Pumping		31,000
Decarbonation Tower Blowers		11,000
High Service Pumping		151,000
Electrical Pumping Costs		*476,000*
Cost per 1,000 gallons		*0.96*
Cartridge Filters		22,000
Sulfuric Acid		-
Scale Inhibitor		13,000
Calcium Chloride		37,000
Sodium Hydroxide		26,000
Lime		-
Carbon Dioxide		-
Aqua Ammonia		1,650
Chlorine Gas		-
Sodium Hypochlorite (12%)		12,000
Membrane Cleaning Chemicals		1,000
Chemical Operating Costs		*112,650*
Cost per 1,000 gallons		*0.23*
Membrane Replacement		174,510
Labor		
Laboratory Testing		100,000
General Building Utilities		35,000
Equipment Replacement Parts and Consumables		361,000
Indirect (Fixed) Operating Costs		*670,510*
Cost per 1,000 gallons		*1.35*
TOTAL COST		***1,259,160***
COST PER 1,000 GALLONS		***2.54***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 6: Mocho 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 1: PFOs/PFOA - 40/10 ng/L	**Treatment 2: PFOs/PFOA - 32/8 ng/L**
CAPITAL COSTS		
RO Water Treatment Plant	**$23,590,000**	**$25,930,000**
Engineering & Contingencies (20%)	4,718,000	5,186,000
Total Project Cost	**$28,308,000**	**$31,116,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	1,992,000	2,189,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	247,000	252,000
Chemicals	32,960	39,940
Indirect Costs	434,630	466,870
Total Annual Cost	**$2,706,590**	**$2,947,810**
Available Project Yield, MGD	3.2	3.1
Available Project Yield, AF/yr	3,549	3,479
Actual Project Yield, AF/yr [2]	887	870
Unit Capital Cost ($/gpd)	**$8.94**	**$10.02**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$9.36**	**$10.40**
Unit Cost of Water ($ per acft) [2]	**$3,051**	**$3,389**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 6: Mocho 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	**Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L Cr(6) 8 ppb**
CAPITAL COSTS		
RO Water Treatment Plant	**$26,930,000**	**$27,530,000**
Engineering & Contingencies (20%)	5,386,000	5,506,000
Total Project Cost	**$32,316,000**	**$33,036,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	2,274,000	2,324,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	265,000	268,000
Chemicals	49,900	68,880
Indirect Costs	500,180	515,000
Total Annual Cost	**$3,089,080**	**$3,175,880**
Available Project Yield, MGD	2.9	2.9
Available Project Yield, AF/yr	3,301	3,234
Actual Project Yield, AF/yr [2]	825	809
Unit Capital Cost ($/gpd)	**$10.97**	**$11.44**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$11.49**	**$12.05**
Unit Cost of Water ($ per acft) [2]	**$3,743**	**$3,928**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 6: Mocho 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 1: PFOs/PFOA - 40/10 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	600	LF	$ 269	$ 161,538
Desanders	1	LS	$ 250,000	$ 250,000
Building [2]	5,000	SF	$ 450	$ 2,250,000
RO Equipment [3]	1.7	MGD	$ 950,000	$ 1,643,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 45,000	$ 45,000
Caustic Soda	1	LS	$ 180,000	$ 180,000
Calcium Chloride	1	LS	$ 100,000	$ 100,000
Ammonia	1	LS	$ 85,000	$ 85,000
Sodium Hypochlorite	1	LS	$ 100,000	$ 100,000
Degasifiers	1	LS	$ 200,000	$ 200,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 3,500,000	$ 3,500,000
Standby Power for RO WTP	1	LS	$ 800,000	$ 800,000
Process Instrumentation	1	LS	$ 2,000,000	$ 2,000,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 18,140,000
Contingency (30%)				$ 5,450,000
TOTAL CONSTRUCTION COSTS [6]				**$ 23,590,000**
Engineering and Contract Administration (20%)				**$ 4,718,000**
TOTAL PROJECT COST [7]				**$ 28,308,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 6: Mocho 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 2: PFOs/PFOA - 32/8 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	600	LF	$ 269	$ 161,538
Desanders	1	LS	$ 280,000	$ 280,000
Building [2]	7,000	SF	$ 450	$ 3,150,000
RO Equipment [3]	2.0	MGD	$ 950,000	$ 1,879,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 3,800,000	$ 3,800,000
Standby Power for RO WTP	1	LS	$ 850,000	$ 850,000
Process Instrumentation	1	LS	$ 2,200,000	$ 2,200,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 19,940,000
Contingency (30%)				$ 5,990,000
TOTAL CONSTRUCTION COSTS [6]				**$ 25,930,000**
Engineering and Contract Administration (20%)				**$ 5,186,000**
TOTAL PROJECT COST [7]				**$ 31,116,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 6: Mocho 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	600	LF	$ 269	$ 161,538
Desanders	1	LS	$ 250,000	$ 250,000
Building [2]	7,000	SF	$ 450	$ 3,150,000
RO Equipment [3]	2.6	MGD	$ 950,000	$ 2,484,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 4,000,000	$ 4,000,000
Standby Power for RO WTP	1	LS	$ 850,000	$ 850,000
Process Instrumentation	1	LS	$ 2,200,000	$ 2,200,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 20,710,000
Contingency (30%)				$ 6,220,000
TOTAL CONSTRUCTION COSTS [6]				**$ 26,930,000**
Engineering and Contract Administration (20%)				**$ 5,386,000**
TOTAL PROJECT COST [7]				**$ 32,316,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 6: Mocho 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L Cr(6) 8 ppb

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	600	LF	$ 269	$ 161,538
Desanders	1	LS	$ 280,000	$ 280,000
Building [2]	7,000	SF	$ 450	$ 3,150,000
RO Equipment [3]	2.9	MGD	$ 950,000	$ 2,711,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 4,100,000	$ 4,100,000
Standby Power for RO WTP	1	LS	$ 850,000	$ 850,000
Process Instrumentation	1	LS	$ 2,300,000	$ 2,300,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 21,170,000
Contingency (30%)				$ 6,360,000
TOTAL CONSTRUCTION COSTS [6]				**$ 27,530,000**
Engineering and Contract Administration (20%)				**$ 5,506,000**
TOTAL PROJECT COST [7]				**$ 33,036,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 6: Mocho 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 1: PFOs/PFOA - 40/10 ng/L	Treatment 2: PFOs/PFOA - 32/8 ng/L
Well Pumping	102,000	102,000
RO Feed Pumping	35,000	40,000
Interstage Pumping	11,000	13,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	88,000	86,000
Electrical Pumping Costs	*247,000*	*252,000*
Cost per 1,000 gallons	*0.85*	*0.89*
Cartridge Filters	8,000	9,000
Sulfuric Acid	-	-
Scale Inhibitor	5,000	5,000
Calcium Chloride	6,000	9,000
Sodium Hydroxide	5,000	8,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	960	940
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	7,000	7,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*32,960*	*39,940*
Cost per 1,000 gallons	*0.11*	*0.14*
Membrane Replacement	63,630	72,870
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	236,000	259,000
Indirect (Fixed) Operating Costs	*434,630*	*466,870*
Cost per 1,000 gallons	*1.50*	*1.65*
TOTAL COST	***714,590***	***758,810***
COST PER 1,000 GALLONS	***2.47***	***2.68***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 6: Mocho 1
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L Cr(6) 8 ppb
Well Pumping	102,000	102,000
RO Feed Pumping	53,000	57,000
Interstage Pumping	17,000	18,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	82,000	80,000
Electrical Pumping Costs	*265,000*	*268,000*
Cost per 1,000 gallons	*0.99*	*1.02*
Cartridge Filters	12,000	13,000
Sulfuric Acid	-	-
Scale Inhibitor	7,000	8,000
Calcium Chloride	9,000	25,000
Sodium Hydroxide	14,000	15,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	900	880
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	6,000	6,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*49,900*	*68,880*
Cost per 1,000 gallons	*0.19*	*0.26*
Membrane Replacement	96,180	105,000
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	269,000	275,000
Indirect (Fixed) Operating Costs	*500,180*	*515,000*
Cost per 1,000 gallons	*1.86*	*1.95*
TOTAL COST	***815,080***	***851,880***
COST PER 1,000 GALLONS	***3.03***	***3.23***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 7: Mocho 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 1: PFOs/PFOA - 40/10 ng/L	**Treatment 2: PFOs/PFOA - 32/8 ng/L**
CAPITAL COSTS		
RO Water Treatment Plant		
Engineering & Contingencies (20%)		
Total Project Cost		
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]		
Operation and Maintenance:		
Water Treatment Plant Energy Cost		
Chemicals		
Indirect Costs		
Total Annual Cost		
Available Project Yield, MGD		
Available Project Yield, AF/yr		
Actual Project Yield, AF/yr [2]		
Unit Capital Cost ($/gpd)		
Unit Cost of Water ($ per 1,000 gallons) [2]		
Unit Cost of Water ($ per acft) [2]	**No Treatment Needed**	**No Treatment Needed**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 7: Mocho 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	**Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L**
CAPITAL COSTS		
RO Water Treatment Plant	**$26,110,000**	**$27,970,000**
Engineering & Contingencies (20%)	5,222,000	5,594,000
Total Project Cost	**$31,332,000**	**$33,564,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	2,205,000	2,362,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	268,000	287,000
Chemicals	58,030	67,950
Indirect Costs	469,710	525,250
Total Annual Cost	**$3,000,740**	**$3,242,200**
Available Project Yield, MGD	3.4	3.1
Available Project Yield, AF/yr	3,795	3,518
Actual Project Yield, AF/yr [2]	949	879
Unit Capital Cost ($/gpd)	**$9.25**	**$10.69**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$9.71**	**$11.31**
Unit Cost of Water ($ per acft) [2]	**$3,163**	**$3,687**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 7: Mocho 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 1: PFOs/PFOA - 40/10 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells				
Raw Water Pipeline [1]				
Desanders				
Building [2]				
RO Equipment [3]				
Chemical Storage/Feed System				
Scale Inhibitor				
Caustic Soda				
Calcium Chloride				
Ammonia				
Sodium Hypochlorite				
Degasifiers				
High Service Pump Station				
High Service Pump Reservoir [4]				
Yard Piping				
Concentrate Pipeline [1]				
Process Electrical				
Standby Power for RO WTP				
Process Instrumentation				
Site Work [5]				
Subtotal				
Contingency (30%)				
TOTAL CONSTRUCTION COSTS [6]				
Engineering and Contract Administration (20%)				
TOTAL PROJECT COST [7]				**No Treatment Needed**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 7: Mocho 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 2: PFOs/PFOA - 32/8 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells				
Raw Water Pipeline [1]				
Desanders				
Building [2]				
RO Equipment [3]				
Chemical Storage/Feed System				
Scale Inhibitor				
Caustic Soda				
Calcium Chloride				
Ammonia				
Sodium Hypochlorite				
Degasifiers				
High Service Pump Station				
High Service Pump Reservoir [4]				
Yard Piping				
Concentrate Pipeline [1]				
Process Electrical				
Standby Power for RO WTP				
Process Instrumentation				
Site Work [5]				
Subtotal				
Contingency (30%)				
TOTAL CONSTRUCTION COSTS [6]				
Engineering and Contract Administration (20%)				
TOTAL PROJECT COST [7]				**No Treatment Needed**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 7: Mocho 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 269	$ 215,385
Desanders	1	LS	$ 250,000	$ 250,000
Building [2]	7,000	SF	$ 450	$ 3,150,000
RO Equipment [3]	2.0	MGD	$ 950,000	$ 1,901,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 3,900,000	$ 3,900,000
Standby Power for RO WTP	1	LS	$ 850,000	$ 850,000
Process Instrumentation	1	LS	$ 2,200,000	$ 2,200,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 20,080,000
Contingency (30%)				$ 6,030,000
TOTAL CONSTRUCTION COSTS [6]				**$ 26,110,000**
Engineering and Contract Administration (20%)				**$ 5,222,000**
TOTAL PROJECT COST [7]				**$ 31,332,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 7: Mocho 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 269	$ 215,385
Desanders	1	LS	$ 280,000	$ 280,000
Building [2]	7,000	SF	$ 450	$ 3,150,000
RO Equipment [3]	3.0	MGD	$ 950,000	$ 2,843,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 350,000	$ 350,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 4,200,000	$ 4,200,000
Standby Power for RO WTP	1	LS	$ 900,000	$ 900,000
Process Instrumentation	1	LS	$ 2,300,000	$ 2,300,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 21,510,000
Contingency (30%)				$ 6,460,000
TOTAL CONSTRUCTION COSTS [6]				**$ 27,970,000**
Engineering and Contract Administration (20%)				**$ 5,594,000**
TOTAL PROJECT COST [7]				**$ 33,564,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 7: Mocho 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 1: PFOs/PFOA - 40/10 ng/L	Treatment 2: PFOs/PFOA - 32/8 ng/L
Well Pumping RO Feed Pumping Interstage Pumping Decarbonation Tower Blowers High Service Pumping	No Treatment Needed	No Treatment Needed
Electrical Pumping Costs *Cost per 1,000 gallons*		
Cartridge Filters Sulfuric Acid Scale Inhibitor Calcium Chloride Sodium Hydroxide Lime Carbon Dioxide Aqua Ammonia Chlorine Gas Sodium Hypochlorite (12%) Membrane Cleaning Chemicals		
Chemical Operating Costs *Cost per 1,000 gallons*		
Membrane Replacement Labor Laboratory Testing General Building Utilities Equipment Replacement Parts and Consumables		
Indirect (Fixed) Operating Costs *Cost per 1,000 gallons*		
TOTAL COST **COST PER 1,000 GALLONS**		

1. Based upon 91 days of operation per year

PROJECT:	Scenario 7: Mocho 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L
Well Pumping	110,000	110,000
RO Feed Pumping	40,000	60,000
Interstage Pumping	13,000	19,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	94,000	87,000
Electrical Pumping Costs	*268,000*	*287,000*
Cost per 1,000 gallons	*0.87*	*1.00*
Cartridge Filters	9,000	14,000
Sulfuric Acid	-	-
Scale Inhibitor	6,000	8,000
Calcium Chloride	26,000	21,000
Sodium Hydroxide	8,000	16,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	1,030	950
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	7,000	7,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*58,030*	*67,950*
Cost per 1,000 gallons	*0.19*	*0.24*
Membrane Replacement	73,710	110,250
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	261,000	280,000
Indirect (Fixed) Operating Costs	*469,710*	*525,250*
Cost per 1,000 gallons	*1.52*	*1.83*
TOTAL COST	***795,740***	***880,200***
COST PER 1,000 GALLONS	***2.57***	***3.07***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 8: Mocho 1 + 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 1: PFOs/PFOA - 40/10 ng/L	**Treatment 2: PFOs/PFOA - 32/8 ng/L**
CAPITAL COSTS		
RO Water Treatment Plant	**$27,980,000**	**$29,700,000**
Engineering & Contingencies (20%)	5,596,000	5,940,000
Total Project Cost	**$33,576,000**	**$35,640,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	2,362,000	2,508,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	485,000	498,000
Chemicals	47,070	77,010
Indirect Costs	514,960	558,630
Total Annual Cost	**$3,409,030**	**$3,641,640**
Available Project Yield, MGD	6.8	6.6
Available Project Yield, AF/yr	7,628	7,425
Actual Project Yield, AF/yr [2]	1,907	1,856
Unit Capital Cost ($/gpd)	**$4.93**	**$5.38**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$5.49**	**$6.02**
Unit Cost of Water ($ per acft) [2]	**$1,788**	**$1,962**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 8: Mocho 1+2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	**Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L**
CAPITAL COSTS		
RO Water Treatment Plant	**$36,400,000**	**$37,740,000**
Engineering & Contingencies (20%)	7,280,000	7,548,000
Total Project Cost	**$43,680,000**	**$45,288,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	3,073,000	3,187,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	533,000	547,000
Chemicals	117,880	141,830
Indirect Costs	692,200	729,770
Total Annual Cost	**$4,416,080**	**$4,605,600**
Available Project Yield, MGD	6.2	6.0
Available Project Yield, AF/yr	6,919	6,732
Actual Project Yield, AF/yr [2]	1,730	1,683
Unit Capital Cost ($/gpd)	**$7.07**	**$7.54**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$7.84**	**$8.40**
Unit Cost of Water ($ per acft) [2]	**$2,553**	**$2,736**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 8: Mocho 1 + 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 1: PFOs/PFOA - 40/10 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 308	$ 246,154
Desanders	1	LS	$ 250,000	$ 250,000
Building [2]	7,000	SF	$ 450	$ 3,150,000
RO Equipment [3]	2.7	MGD	$ 950,000	$ 2,580,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 2,000,000	$ 2,000,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 375,000	$ 375,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 4,200,000	$ 4,200,000
Standby Power for RO WTP	1	LS	$ 900,000	$ 900,000
Process Instrumentation	1	LS	$ 2,300,000	$ 2,300,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 21,520,000
Contingency (30%)				$ 6,460,000
TOTAL CONSTRUCTION COSTS [6]				**$ 27,980,000**
Engineering and Contract Administration (20%)				**$ 5,596,000**
TOTAL PROJECT COST [7]				**$ 33,576,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 8: Mocho 1 + 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 2: PFOs/PFOA - 32/8 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 308	$ 246,154
Desanders	1	LS	$ 280,000	$ 280,000
Building [2]	7,000	SF	$ 450	$ 3,150,000
RO Equipment [3]	3.4	MGD	$ 950,000	$ 3,269,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 2,000,000	$ 2,000,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 375,000	$ 375,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 4,500,000	$ 4,500,000
Standby Power for RO WTP	1	LS	$ 900,000	$ 900,000
Process Instrumentation	1	LS	$ 2,600,000	$ 2,600,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 22,840,000
Contingency (30%)				$ 6,860,000
TOTAL CONSTRUCTION COSTS [6]				**$ 29,700,000**
Engineering and Contract Administration (20%)				**$ 5,940,000**
TOTAL PROJECT COST [7]				**$ 35,640,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 8: Mocho 1+2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 308	$ 246,154
Desanders	1	LS	$ 350,000	$ 350,000
Building [2]	9,500	SF	$ 450	$ 4,275,000
RO Equipment [3]	5.2	MGD	$ 950,000	$ 4,987,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Caustic Soda	1	LS	$ 280,000	$ 280,000
Calcium Chloride	1	LS	$ 180,000	$ 180,000
Ammonia	1	LS	$ 140,000	$ 140,000
Sodium Hypochlorite	1	LS	$ 180,000	$ 180,000
Degasifiers	1	LS	$ 280,000	$ 280,000
High Service Pump Station	1	LS	$ 2,000,000	$ 2,000,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 375,000	$ 375,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 5,500,000	$ 5,500,000
Standby Power for RO WTP	1	LS	$ 1,200,000	$ 1,200,000
Process Instrumentation	1	LS	$ 3,200,000	$ 3,200,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 28,000,000
Contingency (30%)				$ 8,400,000
TOTAL CONSTRUCTION COSTS [6]				**$ 36,400,000**
Engineering and Contract Administration (20%)				**$ 7,280,000**
TOTAL PROJECT COST [7]				**$ 43,680,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 8: Mocho 1+2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 308	$ 246,154
Desanders	1	LS	$ 350,000	$ 350,000
Building [2]	9,500	SF	$ 450	$ 4,275,000
RO Equipment [3]	5.9	MGD	$ 950,000	$ 5,619,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Caustic Soda	1	LS	$ 280,000	$ 280,000
Calcium Chloride	1	LS	$ 180,000	$ 180,000
Ammonia	1	LS	$ 140,000	$ 140,000
Sodium Hypochlorite	1	LS	$ 180,000	$ 180,000
Degasifiers	1	LS	$ 280,000	$ 280,000
High Service Pump Station	1	LS	$ 2,000,000	$ 2,000,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 375,000	$ 375,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 5,800,000	$ 5,800,000
Standby Power for RO WTP	1	LS	$ 1,200,000	$ 1,200,000
Process Instrumentation	1	LS	$ 3,300,000	$ 3,300,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 29,030,000
Contingency (30%)				$ 8,710,000
TOTAL CONSTRUCTION COSTS [6]				**$ 37,740,000**
Engineering and Contract Administration (20%)				**$ 7,548,000**
TOTAL PROJECT COST [7]				**$ 45,288,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 8: Mocho 1 + 2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 1: PFOs/PFOA - 40/10 ng/L	Treatment 2: PFOs/PFOA - 32/8 ng/L
Well Pumping	212,000	212,000
RO Feed Pumping	55,000	69,000
Interstage Pumping	18,000	22,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	189,000	184,000
Electrical Pumping Costs	*485,000*	*498,000*
Cost per 1,000 gallons	*0.78*	*0.82*
Cartridge Filters	13,000	16,000
Sulfuric Acid	-	-
Scale Inhibitor	7,000	9,000
Calcium Chloride	-	19,000
Sodium Hydroxide	10,000	16,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	2,070	2,010
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	14,000	14,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*47,070*	*77,010*
Cost per 1,000 gallons	*0.08*	*0.13*
Membrane Replacement	99,960	126,630
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	280,000	297,000
Indirect (Fixed) Operating Costs	*514,960*	*558,630*
Cost per 1,000 gallons	*0.83*	*0.92*
TOTAL COST	***1,047,030***	***1,133,640***
COST PER 1,000 GALLONS	***1.69***	***1.87***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 8: Mocho 1+2
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L
Well Pumping	212,000	212,000
RO Feed Pumping	105,000	119,000
Interstage Pumping	34,000	38,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	171,000	167,000
Electrical Pumping Costs	*533,000*	*547,000*
Cost per 1,000 gallons	*0.95*	*1.00*
Cartridge Filters	25,000	28,000
Sulfuric Acid	-	-
Scale Inhibitor	14,000	16,000
Calcium Chloride	35,000	51,000
Sodium Hydroxide	28,000	31,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	1,880	1,830
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	13,000	13,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*117,880*	*141,830*
Cost per 1,000 gallons	*0.21*	*0.26*
Membrane Replacement	193,200	217,770
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	364,000	377,000
Indirect (Fixed) Operating Costs	*692,200*	*729,770*
Cost per 1,000 gallons	*1.23*	*1.33*
TOTAL COST	***1,343,080***	***1,418,600***
COST PER 1,000 GALLONS	***2.38***	***2.59***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 9: Mocho 1 + 2 + 3
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 1: PFOs/PFOA - 40/10 ng/L	**Treatment 2: PFOs/PFOA - 32/8 ng/L**
CAPITAL COSTS		
RO Water Treatment Plant	**$30,050,000**	**$40,550,000**
Engineering & Contingencies (20%)	6,010,000	8,110,000
Total Project Cost	**$36,060,000**	**$48,660,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	2,537,000	3,424,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	828,000	863,000
Chemicals	53,890	76,750
Indirect Costs	544,780	715,930
Total Annual Cost	**$3,963,670**	**$5,079,680**
Available Project Yield, MGD	12.8	12.3
Available Project Yield, AF/yr	14,335	13,832
Actual Project Yield, AF/yr [2]	3,584	3,458
Unit Capital Cost ($/gpd)	**$2.82**	**$3.94**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$3.39**	**$4.51**
Unit Cost of Water ($ per acft) [2]	**$1,106**	**$1,469**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 9: Mocho 1+2+3
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

SUMMARY OF COSTS		
	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	**Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L**
CAPITAL COSTS		
RO Water Treatment Plant	**$52,560,000**	**$54,930,000**
Engineering & Contingencies (20%)	10,512,000	10,986,000
Total Project Cost	**$63,072,000**	**$65,916,000**
ANNUAL COSTS		
Ammortized Annual Cost (3.5% for 20 Years) [1]	4,438,000	4,638,000
Operation and Maintenance:		
Water Treatment Plant Energy Cost	950,000	980,000
Chemicals	219,420	255,310
Indirect Costs	998,260	1,076,280
Total Annual Cost	**$6,605,680**	**$6,949,590**
Available Project Yield, MGD	11.2	10.9
Available Project Yield, AF/yr	12,600	12,181
Actual Project Yield, AF/yr [2]	3,150	3,045
Unit Capital Cost ($/gpd)	**$5.61**	**$6.06**
Unit Cost of Water ($ per 1,000 gallons) [2]	**$6.44**	**$7.00**
Unit Cost of Water ($ per acft) [2]	**$2,097**	**$2,282**

1. Interest rate based upon FY2006 State Revolving Loan Interest Rates
2. Based upon 91 days of operation per year.

PROJECT:	Scenario 9: Mocho 1 + 2 + 3
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 1: PFOs/PFOA - 40/10 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 385	$ 307,692
Desanders	1	LS	$ 280,000	$ 280,000
Building [2]	7,000	SF	$ 450	$ 3,150,000
RO Equipment [3]	3.0	MGD	$ 950,000	$ 2,808,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 50,000	$ 50,000
Caustic Soda	1	LS	$ 200,000	$ 200,000
Calcium Chloride	1	LS	$ 110,000	$ 110,000
Ammonia	1	LS	$ 100,000	$ 100,000
Sodium Hypochlorite	1	LS	$ 110,000	$ 110,000
Degasifiers	1	LS	$ 220,000	$ 220,000
High Service Pump Station	1	LS	$ 2,500,000	$ 2,500,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 400,000	$ 400,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 4,600,000	$ 4,600,000
Standby Power for RO WTP	1	LS	$ 950,000	$ 950,000
Process Instrumentation	1	LS	$ 2,600,000	$ 2,600,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 23,110,000
Contingency (30%)				$ 6,940,000
TOTAL CONSTRUCTION COSTS [6]				**$ 30,050,000**
Engineering and Contract Administration (20%)				**$ 6,010,000**
TOTAL PROJECT COST [7]				**$ 36,060,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 9: Mocho 1 + 2 + 3
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 2: PFOs/PFOA - 32/8 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 385	$ 307,692
Desanders	1	LS	$ 350,000	$ 350,000
Building [2]	9,500	SF	$ 450	$ 4,275,000
RO Equipment [3]	4.8	MGD	$ 950,000	$ 4,515,000
Chemical Storage/Feed System			$ 80,000	
Scale Inhibitor	1	LS	$ 280,000	$ 280,000
Caustic Soda	1	LS	$ 180,000	$ 180,000
Calcium Chloride	1	LS	$ 140,000	$ 140,000
Ammonia	1	LS	$ 180,000	$ 180,000
Sodium Hypochlorite	1	LS	$ 280,000	$ 280,000
Degasifiers	1	LS	$ 2,500,000	$ 2,500,000
High Service Pump Station	1	LS	$ 1,750,000	$ 1,750,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 400,000	$ 400,000
Concentrate Pipeline [1]	12,600	LF	$ 192	$ 2,423,077
Process Electrical	1	LS	$ 6,400,000	$ 6,400,000
Standby Power for RO WTP	1	LS	$ 1,200,000	$ 1,200,000
Process Instrumentation	1	LS	$ 3,700,000	$ 3,700,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 31,190,000
Contingency (30%)				$ 9,360,000
TOTAL CONSTRUCTION COSTS [6]				**$ 40,550,000**
Engineering and Contract Administration (20%)				**$ 8,110,000**
TOTAL PROJECT COST [7]				**$ 48,660,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 9: Mocho 1+2+3
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION A:	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 385	$ 307,692
Desanders	1	LS	$ 650,000	$ 650,000
Building [2]	13,500	SF	$ 450	$ 6,075,000
RO Equipment [3]	9.2	MGD	$ 950,000	$ 8,700,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Caustic Soda	1	LS	$ 300,000	$ 300,000
Calcium Chloride	1	LS	$ 200,000	$ 200,000
Ammonia	1	LS	$ 200,000	$ 200,000
Sodium Hypochlorite	1	LS	$ 200,000	$ 200,000
Degasifiers	1	LS	$ 350,000	$ 350,000
High Service Pump Station	1	LS	$ 2,800,000	$ 2,800,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 450,000	$ 450,000
Concentrate Pipeline [1]	12,600	LF	$ 231	$ 2,907,692
Process Electrical	1	LS	$ 8,300,000	$ 8,300,000
Standby Power for RO WTP	1	LS	$ 1,800,000	$ 1,800,000
Process Instrumentation	1	LS	$ 4,800,000	$ 4,800,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 40,430,000
Contingency (30%)				$ 12,130,000
TOTAL CONSTRUCTION COSTS [6]				**$ 52,560,000**
Engineering and Contract Administration (20%)				**$ 10,512,000**
TOTAL PROJECT COST [7]				**$ 63,072,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 9: Mocho 1+2+3
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	
OPTION B:	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L

CAPITAL COST ESTIMATE

Classification	Quantity	Units	Unit Cost	Extended Cost
Groundwater Wells			$ -	$ -
Raw Water Pipeline [1]	800	LF	$ 385	$ 307,692
Desanders	1	LS	$ 650,000	$ 650,000
Building [2]	13,500	SF	$ 450	$ 6,075,000
RO Equipment [3]	10.7	MGD	$ 950,000	$ 10,120,000
Chemical Storage/Feed System				
Scale Inhibitor	1	LS	$ 80,000	$ 80,000
Caustic Soda	1	LS	$ 300,000	$ 300,000
Calcium Chloride	1	LS	$ 200,000	$ 200,000
Ammonia	1	LS	$ 200,000	$ 200,000
Sodium Hypochlorite	1	LS	$ 200,000	$ 200,000
Degasifiers	1	LS	$ 350,000	$ 350,000
High Service Pump Station	1	LS	$ 2,800,000	$ 2,800,000
High Service Pump Reservoir [4]	1,000,000	GALLON	$ 2.00	$ 2,000,000
Yard Piping	1	LS	$ 450,000	$ 450,000
Concentrate Pipeline [1]	12,600	LF	$ 231	$ 2,907,692
Process Electrical	1	LS	$ 8,500,000	$ 8,500,000
Standby Power for RO WTP	1	LS	$ 1,800,000	$ 1,800,000
Process Instrumentation	1	LS	$ 5,000,000	$ 5,000,000
Site Work [5]	1	LS	$ 300,000	$ 300,000
Subtotal				$ 42,250,000
Contingency (30%)				$ 12,680,000
TOTAL CONSTRUCTION COSTS [6]				**$ 54,930,000**
Engineering and Contract Administration (20%)				**$ 10,986,000**
TOTAL PROJECT COST [7]				**$ 65,916,000**

1. Open trench construction, assumes public right of way, and does not include trenchless intersection crossings.
2. Includes general building HVAC, plumbing, and electrical. Unit price based on pre-engineered metal building type construction. Unit price based on usable square footage.
3. Includes membrane skids, piping, pressure vessels, membranes, CIP system, cartridge filters and on-skid instrumentation & control.
4. Includes bypass flow rate pumping.
5. Includes demolition, excavation, paving, sidewalks, landscaping and general site improvements.
6. ENR Construction Cost Index (20-City average, January 2020): 11,392
7. This is a class 4 Budget Estimate as defined by the AACEI's Revised Classification (1999) with an expected accuracy range of + 30 percent or - 15 percent. This cost estimate is based upon the Engineer's perception of current conditions in the project area and is subject to change as variances in the cost of labor, materials, equipment, services provided by others or economic conditions occur. Since the Engineer has no control over these factors, he cannot warrant or guarantee that actual bids will not vary from the costs presented herein. This estimate does, however, reflect the Engineer's professional opinion of accurate costs at this time.

PROJECT:	Scenario 9: Mocho 1 + 2 + 3
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 1: PFOs/PFOA - 40/10 ng/L	Treatment 2: PFOs/PFOA - 32/8 ng/L
Well Pumping	384,000	384,000
RO Feed Pumping	59,000	95,000
Interstage Pumping	19,000	31,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	355,000	342,000
Electrical Pumping Costs	*828,000*	*863,000*
Cost per 1,000 gallons	*0.71*	*0.77*
Cartridge Filters	14,000	22,000
Sulfuric Acid	-	-
Scale Inhibitor	8,000	13,000
Calcium Chloride	-	7,000
Sodium Hydroxide	-	4,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	3,890	3,750
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	27,000	26,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*53,890*	*76,750*
Cost per 1,000 gallons	*0.05*	*0.07*
Membrane Replacement	108,780	174,930
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	301,000	406,000
Indirect (Fixed) Operating Costs	*544,780*	*715,930*
Cost per 1,000 gallons	*0.47*	*0.64*
TOTAL COST	***1,426,670***	***1,655,680***
COST PER 1,000 GALLONS	***1.22***	***1.47***

1. Based upon 91 days of operation per year

PROJECT:	Scenario 9: Mocho 1+2+3
JOB NO.:	Zone 7
DATE:	3/4/2020
BY:	E.Hull
COMMENTS:	

Annual Operation & Maintenance Costs [1]

	Treatment 3: Vermont's standard of PFOS + PFOA + PFHxS + PFHpA + PFNA < 20 ppt	Treatment 4: PFOs/PFOA - 1.1/0.53 ng/L
Well Pumping	384,000	384,000
RO Feed Pumping	184,000	214,000
Interstage Pumping	59,000	69,000
Decarbonation Tower Blowers	11,000	11,000
High Service Pumping	312,000	302,000
Electrical Pumping Costs	*950,000*	*980,000*
Cost per 1,000 gallons	*0.93*	*0.99*
Cartridge Filters	43,000	50,000
Sulfuric Acid	-	-
Scale Inhibitor	25,000	29,000
Calcium Chloride	75,000	93,000
Sodium Hydroxide	48,000	56,000
Lime	-	-
Carbon Dioxide	-	-
Aqua Ammonia	3,420	3,310
Chlorine Gas	-	-
Sodium Hypochlorite (12%)	24,000	23,000
Membrane Cleaning Chemicals	1,000	1,000
Chemical Operating Costs	*219,420*	*255,310*
Cost per 1,000 gallons	*0.21*	*0.26*
Membrane Replacement	337,260	392,280
Labor		
Laboratory Testing	100,000	100,000
General Building Utilities	35,000	35,000
Equipment Replacement Parts and Consumables	526,000	549,000
Indirect (Fixed) Operating Costs	*998,260*	*1,076,280*
Cost per 1,000 gallons	*0.97*	*1.08*
TOTAL COST	***2,167,680***	***2,311,590***
COST PER 1,000 GALLONS	***2.11***	***2.33***

1. Based upon 91 days of operation per year