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Appendix C –Alternatives Analysis Technical Memorandum

Englewood Water District Utility Plan – Supply and Treatment System Capacity Evaluation and Improvement Alternatives Technical Memorandum

Englewood Water District

District Contract No. 2022-129

Englewood, FL
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1 Introduction

The Englewood Water District (District) has retained HDR Engineering, Inc. (HDR) to provide professional services to develop a Potable Water Master Plan for the Englewood Water Treatment Plant (WTP). The Master Plan will assess the District's water service and facility needs for the next 20-year planning period from 2023 through 2043 and the next 50-year period from 2023 to 2073. Included in these services is an evaluation of the water supply and treatment system capacities of both the District's Lime Softening (LS) Plant and Reverse Osmosis (RO) Plant.

The District's water supply consists of multiple sources including shallow potable groundwater and deeper brackish supply wells. The LS plant treats raw fresh groundwater supplied by Wellfields 1, 2, 3, and 5 whereas the RO plant treats raw brackish groundwater supplied by Wellfield 4 and Wellfield 2, referred to herein as RO WF2 and RO WF4. Note that Wellfield 2 contains both types of wells. The wellfields are permitted for a combined average annual withdrawal of 5.36 MGD and peak month withdrawal of 6.59 MGD under Water Use Permit (WUP) No. 4866.010. Wellfield 1 is located immediately west and north of the plant., Wellfield 2 and RO WF2 are approximately 2 miles north of the plant. Wellfield 3 is located in the north-central part of the District's service area, approximately 4 miles north of the plant, which is currently under development. RO WF4 is located on the plant property to the north of plant infrastructure and bordered by Wellfield 1. Wellfield 5 is the newest constructed wellfield located along the east side of Indiana Avenue and over 1 mile north of the plant. Both plants are co-located at the District's main site at 201 Selma Avenue, Englewood, Florida, and the finished water from each plant is blended before distribution. The LS plant was built in 1961 with 3 MGD treatment capacity; however, the District has not historically treated more than 2 MGD with the plant. The RO plant was placed into service in 1982 and continues to treat its designed capacity of 3 MGD.

The purpose of this Technical Memorandum, as one component of the Master Plan, is to evaluate the hydraulic design and treatment capacity of the unit processes at the utility plant across both the LS and RO treatment trains and to identify any infrastructure or capacity deficiencies. This Memorandum will also include the assessment of three different facility improvement alternatives based on the future demand projections and water treatment performance needs. Environmental impacts, including wetlands and threatened and endangered species, will be evaluated within the impact of the water plant expansion limits.

1.1 Background

Created in 1959, the District classifies as a political sub-division of the State of Florida under Chapter 2004-439. The District owns and operates a public utility that provides water services within the unincorporated areas of Sarasota and Charlotte Counties generally known as Englewood, Grove City, and Manasota Key. The District's current service area boundary encompasses approximately 44.5 square miles. In addition, the District currently has an interlocal agreements for the delivery of potable water to Bocilla Utilities for the residents of Don Pedro and Knight/Palm Island in Charlotte County.

The District's water supply, treatment, and distribution facilities include:

- Five (5) groundwater wellfields

   - Four (4) freshwater well systems with aggregated permitted withdrawal capacities of up to 3.54 MGD (annual average) and up to 4.35 MGD (peak month) within Wellfields 1, 2, 3, and 5 provided the current total WUP allocation is not exceeded.
   - Two (2) brackish water well systems with aggregated permitted withdrawal capacities of up to 4.25 MGD (annual average) and up to 5.44 MGD (peak month) within Wellfields 2 and 4 provided the current total WUP allocation is not exceeded.
- Two (2) water treatment plants
   - One (1) lime softening plant built in 1961 at 3.0 MGD design capacity for treatment of the freshwater wellfield supply; however, the District can only reliably treat 2 MGD of this capacity.
   - One (1) reverse osmosis (RO) Plant built in 1981 at 3.0 MGD design capacity for treatment of the brackish water wellfield supply
- Four (4) finished water storage tanks with a combined capacity of 7.5 million gallons, and one (1) elevated storage tank with 100,000-gallon capacity used to dampen the amplitude of distribution system pressures
- Two (2) deep injection wells
   - One (1) 1.58-MGD deep injection well (DIW-1) onsite for RO concentrate disposal
   - One (1) 2.94-MGD deep injection well (DIW-2) offsite at the Holiday Ventures Lift Station for reclaimed water disposal and backup RO concentrate disposal. Backup capacity is limited due to existing use by the South Water Reclamation Facility (WRF) and future use by the North WRF that is being currently planned.
- Over 3,571 miles of water transmission and distribution pipelines and appurtenances, with emergency interconnections with Sarasota and Charlotte Counties.

The LS Plant treats raw water through a series of unit processes including aeration, lime feed system, treaters, and dual media filters. The RO plant treats brackish water using cartridge filters, semi-permeable membranes, and chemical feed pumps, and degasifiers. Effluent from both plants is blended and treated to finished water quality through chemical feed for chloramination, and clearwells prior to finished water storage and high service pumping. A more detailed list of the processes utilized by each plant and their functions is shown in Table 1-1, and a process flow diagram is shown in Figure 1-1.

Table 1-1: Existing Facility Processes

Process	No. Units	Purpose / Notes
Lime Softening Plant		
Wells	54	Wellfields 1, 2, 3, and 5. Wells provide raw fresh surficial groundwater to the plant
Aerator	1	3 MGD, removes hydrogen sulfide and carbon dioxide, and adds oxygen
Lime Slaker	1	Forms lime slurry to soften the water with lime
Treater/Filter	3	Provides turbidity and suspended solids removal.
Reverse Osmosis Plant		
Wells	17	Wellfields 2 and 4. Wells provide brackish groundwater to the plant
Antiscalant Storage and Dosing System	1	Increases solubility of soluble salts, protecting membranes from scaling
Sulfuric Acid Storage and Dosing System	1	Decreases pH to reduce precipitation of soluble salts on membranes, protecting them from scaling
Feed Pumps	7	Provides feedwater to RO units, one per skid, and one backup to provide flow to any skid
Cartridge Filters	6	Provides pretreatment filtration upstream of RO membranes
RO Skids	6	Provides removal of dissolved constituents
Degasifier	1	Removes carbon dioxide and dissolved sulfide gases
CIP System	1	Can provide chemical cleaning of RO membranes, not currently in use
Deep Injection Well	2	Class I- Receives the concentrate from the RO plant and injects it into a saline aquifer (DIW-1). An inline booster pump to DIW-2 serves as a backup.
Post-Treatment		
Chlorine Storage and Dosing System	1	Provides disinfection upstream of filters and at blending clearwell
Ammonia Storage and Dosing System	1	Provides disinfection at blending clearwell
Clearwell	2	Water from both plants is blended together
Ground Storage Tanks	4	Combined capacity of 7.5 MGD- provides finished water storage
Elevated Storage Tank	1	Controls pumping and pressure fluctuations at the high service pumping system
Old High Service Pumps	4	Four pumps rated at 800 gpm (4.5 MGD) each - maintains a constant pressure in the potable water distribution system
New High Service Pumps	3	Three pumps rated at 3,000 gpm (12.9 MGD) each - maintains a constant pressure in the potable water distribution system

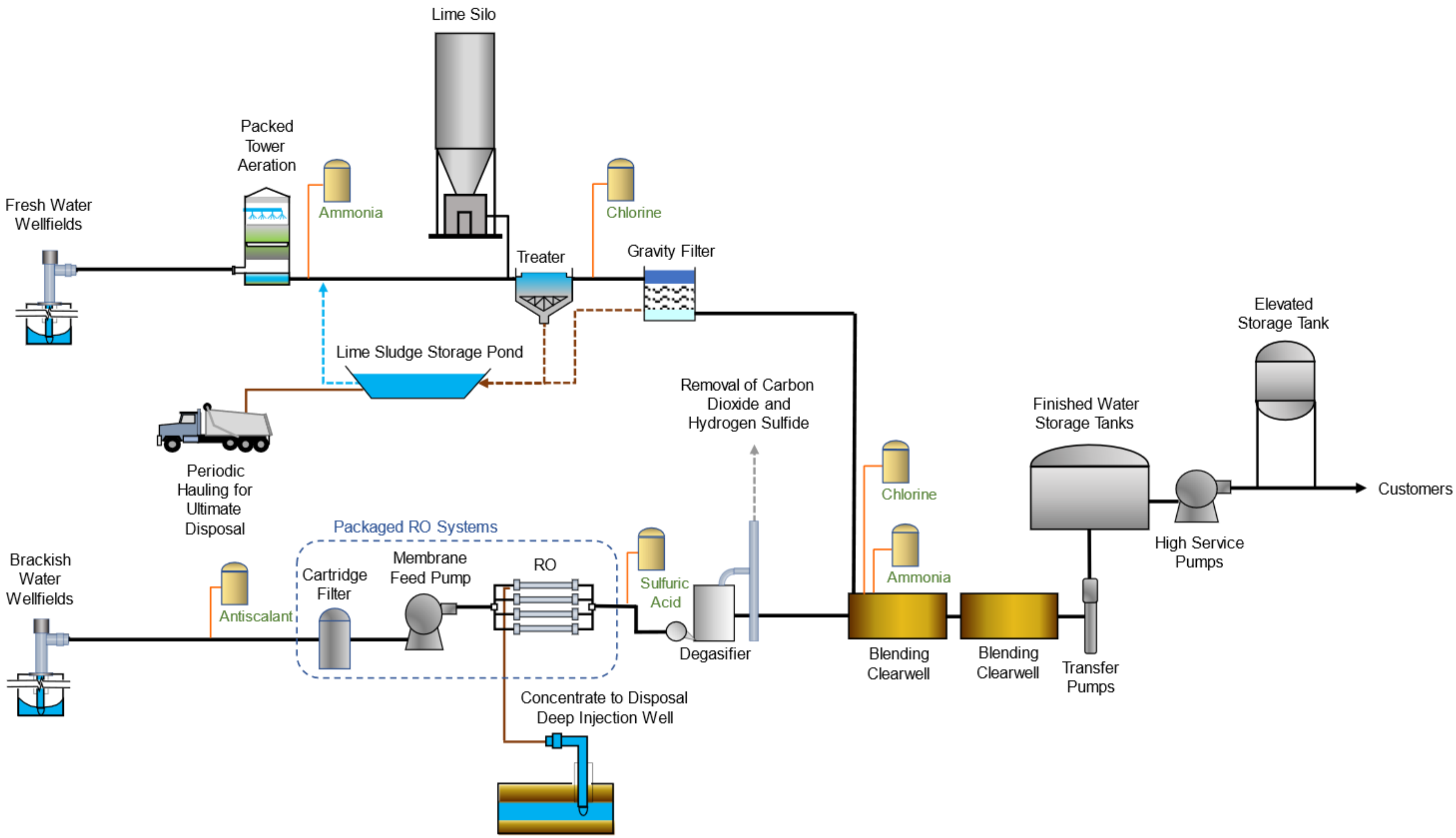

Figure 1-1. Englewood WTP Process Flow Diagram

1.2 Demand Projections

For the District's Utility Master Plan, the Per Capita Model for forecasting water supply demands was used. The Per Capita Model calculates the total production or consumption per capita for a historical period and applies the current year per capita consumption to the population projections for future periods. This is the simplest forecasting method and requires only historical production or consumption data, historical population, and forecast of population through the demand forecasting horizon.

Utilizing the District's historical (2018-2022) records of production data as well as the Historical Population Served reported on the District's Public Supply Annual Reports (PSAR's) to the Southwest Florida Water Management District, a determination of per capita usage was calculated. Based on the Districts demographic data taken from the 2014 to 2021 U.S. Census Bureau Data, it was determined that the average household size is 2.19 persons for both Charlotte and Sarasota counties. This household size is assumed to be typical of the region and the service area of the District. The District's PSARs show an average per capita demand of 77 gallons per capita per day (gpcd) with a maximum of 79 gpcd in 2020. Given low population growth expectations in the region and taking a conservative approach given the expected developments to be constructed in the area, the maximum value of 79 gpcd was rounded up to 80 gpcd and used to estimate the future water demands. Water supply demands are calculated and projected from 2023 to 2073. For water treatment capacity, an expected equipment service life correlates to approximately 20 years. Thus, the projected annual average water supply demands for the Englewood Water District within its current service boundary ranges from 3.827 MGD in 2023 to 4.996 MGD in 2043. The projected peak month water supply demands ranges from 5.320 MGD in 2023 to 6.944 MGD in 2043. Therefore, it is recommended to expand the water treatment plant to provide a finished water capacity of 7 MGD.

A more detailed evaluation of the water demand projections can be found in the Population and Demand Projections Technical Memorandum (HDR, 2023).

1.3 Water Quality Analysis

Table 1-2 presents water quality results from sampling the LS Plant raw water and Table 1-3 presents water quality results from the RO Plant raw water. These values include recent wellfield sampling from March to May 2023 and several sampling events conducted in December of 2022. The minimum, average, 90th percentile, and maximum values from each data parameter were calculated and flow weighting was applied. The flow weighting calculations took into consideration the daily well production of each wellfield in March to May 2023 and December of 2022 accordingly. For the LS plant, wellfields 1, 2, 3, and 5 productions fell within the range of 0.3 MG to 0.5 MG for March to May of 2023 and 12.3 MG to 16.6 MG for December 2022. For the RO plant, RO wellfields 2 and 4 production fell within the range of 0.7 MG to 1.9 MG for March to May of 2023 and 35.0 MG to 43.0 MG for December 2022. Applying flow weighting allows for a more accurate representation of the sample results from wellfield to wellfield on different sampling dates.

Primary Drinking Water Standards are standards that have been set by the U.S. Environmental Protection Agency (EPA) as part of establishing National Primary Drinking Water Regulations (NPDWR). These standards are also known as Maximum Contaminant Levels (MCLs) which are put in place to control the level of contaminants in drinking water. The data presented in Tables 1-2 and 1-3 below was compared against these standards to assess the quality of the water for each treatment process. The water quality data results showcase some notable differences between the two raw water sources. The total dissolved solids (TDS), salinity, and total organic carbon for both water sources earn some attention. The freshwater source shows normal salinity values but, the brackish water source has high salinity values. This is expected since brackish water is a mixture of fresh and salt water. It is recommended that total dissolved solids follow the secondary MCL of 500 mg/L. In both the fresh and brackish water sources, higher values of total dissolved solids were recorded. The total organic carbon is very high for the freshwater source. These factors are enough to warrant a concern for color issues. Color may be indicative of dissolved organic material and therefore should be monitored.

In the WY 2021 EWD Annual Wellfield Report, trend analysis of the monthly TDS concentrations collected from the RO WF 2 and RO WF 4 production wells were conducted using the Seasonal Kendall Tau test. Kendall Tau and the Seasonal Kendall Tau tests are nonparametric statistical tests used to analyze data for trends. The results of the Seasonal Kendall Tau tests show statistical increases in TDS concentrations at RO WF 2 and RO WF 4. The Report projects RO WF2 to have 2051 TDS concentrations of 7,579 mg/L up from the current 4,957 mg/L and RO WF4 to have 2051 TDS concentrations of 14,491 mg/L up from the current 4,827 mg/L. The RO plant will need further assessments to determine if the existing membranes could handle these projected TDS concentrations with reasonable performance efficiency long term.

Both water sources are showing low levels of iron and manganese. The secondary MCLs for iron and manganese are 0.3 mg/L and 0.05 mg/L accordingly. There is a significant difference in the nitrate levels of each water source. With the MCL for nitrate being 10 mg/L the freshwater source has low levels of nitrate, and the brackish water source has fairly elevated levels of nitrate. Elevated levels of nitrate might indicate runoff from fertilized soil, urban drainage, or industrial discharges. The total phosphorous levels between the two water sources are similar and not of concern.

Table 1-2. Surficial Aquifer Water Quality Data

Parameter	Units	Minimum	Average	90th Percentile	Maximum
Field Parameters					
Salinity	ppt	0.4	0.45	0.49	0.5
Temperature	°C	25	25	25	25
pH	SU	7.5	7.8	8.2	8.3
Color	CU	22	52	85	131
Alkalinity	mg/L as CaCO3	179	265	309	330
Hardness	mg/L as CaCO3	176	287	341	365
Turbidity	NTU	0.41	4.7	10	16
Other Water Quality Parameters					
Total Dissolved Solids	mg/L	270	459	565	680
Total Suspended Solids	mg/L	1.0	2.1	3.4	4.0
Total Organic Carbon	mg/L	9.9	11	11.7	12
Total Carbon Dioxide	mg/L	226	245	253	254
Metals					
Ammonium	mg/L	0.39	0.45	0.52	0.52
Barium	mg/L	0.0092	0.010	0.011	0.011
Calcium	mg/L	60	100	120	127
Iron	mg/L	0.03	0.053	0.066	0.069
Magnesium	mg/L	5.1	8.6	11.4	13.1
Manganese	mg/L	0.0050	0.0051	0.0053	0.0054
Potassium	mg/L	1.12	1.35	1.47	1.5
Sodium	mg/L	16	37	49	81
Strontium	mg/L	0.86	0.88	0.89	0.89
Anions					
Bromide	mg/L	0.32	0.34	0.36	0.36
Chloride	mg/L	24	81	127	162
Fluoride	mg/L	0.18	0.28	0.39	0.40
Nitrate (as N)	mg/L	0.12	0.34	0.70	0.90
Sulfate	mg/L	20	38	59	73
Total Phosphorus	mg/L	0.15	1.23	2.3	2.3
Neutrals					
Boron	mg/L	0.046	0.063	0.09	0.1
Silicon Dioxide	mg/L	8.4	9.3	9.9	10

Table 1-3. Brackish Aquifer Water Quality Data

Parameter	Units	Minimum	Average	90th Percentile	Maximum
Field Parameters					
Salinity	ppt	7.4	8.03	8.42	8.51
Temperature	°C	25	25	25	25
pH	SU	7.4	7.4	7.5	7.6
Alkalinity	mg/L as CaCO3	135	146	152	155
Hardness	mg/L as CaCO3	1,448	2,068	2,405	2,559
Other Water Quality Parameters					
Conductivity	umhos/cm	12,674	13,350	13,918	14,000
Total Dissolved Solids	mg/L	5,954	8,531	10,330	11,064
Total Suspended Solids	mg/L	1.0	3.5	5.4	6.2
Total Organic Carbon	mg/L	2.0	2.2	2.5	2.6
Total Carbon Dioxide	mg/L	120	128	132	133
Metals					
Ammonium	mg/L	0.72	0.81	0.93	1
Barium	mg/L	0.075	0.079	0.083	0.084
Calcium	mg/L	291	366	404	428
Iron	mg/L	0.0067	0.012	0.016	0.017
Magnesium	mg/L	225	293	340	362
Manganese	mg/L	0.005	0.005	0.005	0.005
Potassium	mg/L	62	62	63	64
Sodium	mg/L	1,420	2,068	2,514	2,746
Strontium	mg/L	40	42	43	43
Anions					
Bromide	mg/L	15	18	20	21
Chloride	mg/L	3,267	4,608	5,628	6,046
Fluoride	mg/L	1.8	6.4	14.5	20
Nitrate (as N)	mg/L	1.2	12.2	31.9	45
Sulfate	mg/L	516	731	938	967
Total Phosphorus	mg/L	0.15	1.23	2.3	2.3
Neutrals					
Boron	mg/L	0.30	0.32	0.33	0.34
Silicon Dioxide	mg/L	10	11	12	13

1.4 Raw Water Source Reliance

The District obtains source water from a combination of freshwater wells which draw from surficial aquifers and brackish water wells which draw from a deeper, higher salinity aquifer. To meet projected demands, the District will need to increase withdrawals from one or both sources to supply a peak flow of 7 MGD of finished drinking water to its customers. Discussions with the District have led to the conclusion that expansion into the brackish water aquifer as opposed to surficial aquifer will be better for optimal long-term operation. The reasons for this preference include:

- Ongoing concerns with continually drawing from the surficial aquifer as more frequent periods of drought occur and more water is being drawn than what can be replenished from rainfall and other surficial influences. The surficial aquifer is also under a dry season minimum flow requirement, which can significantly reduce the availability of this water supply when potable water demands are usually highest. The brackish water source is understood to have a confining interval between it and the surficial aquifer source, which lead the brackish water source to be more reliable and abundant long-term.
- The brackish water aquifer interval yields higher capacities per well, allowing for fewer wells for each expansion alternative.
- The deeper, confined depths of the brackish water aquifer will allow for further dissociation from current water quality impediments including intermittent color spikes and chloride concentration variations that limit the use of the surficial aquifer as well as watershed issues such as nutrients and emerging contaminants, which includes PFAS.
- Freshwater WF2 and WF3 wellfields have strong influences on the local wetlands.
- Wellfield WF3 taps where a community development is being constructed. This development aims to source groundwater from the surficial aquifer for irrigation purposes, which would compete with the WF3 flows for potable water supply.

2 Environmental Assessment

A desktop environmental analysis was performed for the areas at the Englewood Water Treatment Plant that were assessed for plant expansion. The intent of the desktop assessment is to determine the potential for wetland impacts, endangered species impacts, and the resulting permitting required for the Englewood Water District Utility Plan project.

An analysis for the presence or absence of wetlands and other surface waters for each water reclamation site was conducted based on a review of aerial imagery from Google Earth and on information obtained on the U.S. Fish & Wildlife Service National Wetlands Inventory (NWI). It was found that no wetlands exist on site. Although the plant is geographically located between a creek and Lemon Bay, it is not anticipated that any construction will be completed near the water's edge, and these bodies of water will not be affected.

To obtain baseline information on threatened and endangered species that may be present on or utilize the project sites, an Information for Planning and Consultation (IPaC) Resource List was downloaded from the U.S. Fish and Wildlife Service (USFWS) website. It was found that no critical habitats for threatened or endangered species are located on the property or within areas of influence near the property.

Although no longer a listed species, the bald eagle is protected under the Bald and Golden Eagle Protection Act (BGEPA). This act protects eagle nest sites by establishing a 660- foot protection buffer around the nest tree that limits activity within the buffer zone. The nearest known bald eagle nest to the plant is located over a mile away from the project site. The proposed construction activities for the plant will not have any effect on this eagle nest based on the BGEPA guidelines.

Additionally, the District has noted the presence of sand pines on the water treatment plant property. The 2023 Sarasota County Comprehensive Plan requires that all sand pine scrub be preserved (Chapter 1, Paragraph X(2)(a)). It is recommended that additional survey be performed to protect sand pines prior to any development of wooded areas on the plant site.

3 Alternatives Analysis

Five alternatives were evaluated to meet future demand projections and water treatment plant performance needs. These alternatives reflect a completed set of projects to upgrade and expand supply and treatment.

- Alternative 1a – Rehabilitate the Existing LS Plant and Rehabilitate and Expand the RO Plant
- Alternative 1b – Convert the LS Plant to Pellet Softening and Rehabilitate and Expand the RO Plant
- Alternative 2 – Replace the LS Plant with a Nanofiltration (NF) Plant and Rehabilitate and Expand the RO Plant
- Alternative 3a – Decommission LS Plant and Rehabilitate and Expand the RO Plant in Place
- Alternative 3b – Decommission LS Plant and Completely Replace Existing RO Plant at Expanded Capacity with a New RO Plant

These alternatives were evaluated after conducting a site visit at the WTP and by utilizing engineering best practices to evaluate design hydraulic and treatment capacity relative to current unit process performance. Alternatives were considered on non-cost factors such as water quality, energy efficiency, operational complexity, and concentrate/residuals disposal. Planning-level cost estimates were developed for each alternative.

A projected peak finished water capacity of 7.0 MGD was used to evaluate each alternative for rehabilitation and expansion.

4 Alternative 1 – Rehabilitate LS Plant and Rehabilitate and Expand RO Plant

4.1 Alternative Description

Alternative 1 involves upgrading the existing WTP infrastructure and maintaining parallel treatment trains of non-membrane softening and RO. This alternative contains two options that are broken down further into alternative 1a and 1b. The optimal alternative is dependent on the results of the softening upgrades study. Alternative 1a includes rehabilitating the LS plant to maintain the lime softening process. Alternative 1b includes converting the LS plant to pellet softening. Both alternatives include simultaneously rehabilitating and expanding the existing RO plant to produce a combined total of up to 7.0 MGD of finished water. This purpose of this alternative is to prolong the life of existing facilities. The LS plant will continue to produce up to 2.0 MGD (current reliable capacity), and the RO plant production will increase from the current production of 3.0 MGD up to 5.0 MGD.

Major projects required of this alternative are:

Studies and Evaluations:

- LS Plant Filter Evaluation.
- LS Plant Softening Upgrades Study.
- RO Plant Membrane Management Study.

Capital Projects:

- LS Plant rehabilitation (1a) or pellet softening conversion (1b).
- LS Plant Filter rehabilitation.
- Increasing brackish water well capacity.
- RO system rehabilitation.
- RO plant expansion.
- Degasifier Expansion
- Additional Deep Injection Well
- Post treatment chemical upgrades.
    - Corrosion control and post-treatment.
    - Conversion of chlorine gas to liquid sodium hypochlorite.

4.2 Modifications and Recommendations

A site visit and condition assessment were performed on March 31, 2023. Recommendations from this assessment are documented in the *Potable Water Master Plan – Condition Assessment Technical Memorandum* (HDR, 2023). Table 4-1 presents a list of equipment evaluated during this assessment and whether the equipment needs rehabilitation or replacement for this alternative to be implemented.

Table 4-1: Water Treatment Plant Equipment

Equipment Name	Total Quantity		Recommendation / Notes
	Current	Expanded	
Lime Softening Plant			
Packed Tower Aerator	1	1	No attention needed; blower was rebuilt in August of 2023
Lime Slaker	1	1	No attention needed; Lime slaker skirt is replaced as needed
Treater 1	1	1	No attention needed. Drive recently replaced.
Treater 2	1	1	No attention needed; Rehabilitated about four years ago
Treater 3	1	1	No attention needed; Rehabilitated about three years ago
Filters	3	3	Needs rehabilitation, including filter evaluation study, possible air scour addition, structural improvements; Media is currently replaced every 3 to 5 years
Filter Backwash Pump	1	1	No attention needed
Old High Service Pumps	4	4	No attention needed
New High Service Pumps	3	3	Repairs needed, including check valve replacement for pumps 7 and 9; Severe vibrations from pumps 7 and 9
Backwash Storage Pond	1	1	Needs routine cleaning. Stored lime needs hauling.
RO Plant			
Antiscalant System	1	1	Upsize to serve increased capacity
Cartridge Filters	6	10	Current cartridge filters could be rehabilitated or replaced. Add new cartridge filters to accompany new RO skids
Membrane Feed Pumps	7	11	Replace motors. Add new feed pumps to accompany new RO skids. Motors in some pumps are undersized and do not provide adequate capacity to the skids
RO Skids	6	10	Rehabilitate components as needed. Conduct membrane management study to improve performance. Add new skids to treat a total of 5 MGD.
Sulfuric Acid System	1	1	Repair damage to the sump located beneath the storage tank and upsize to serve increased capacity
CIP System	1	1	Has not been operated recently. Test system to evaluate status
Degasifiers	1	2	Add new 5 MGD degasifier. Replace existing 3 MGD unit with new 5 MGD unit.
Deep Injection Well	2	3	Additional deep injection well capacity will likely be needed to accommodate higher concentrate flow. As mentioned previously the plant uses DIW-2 as its second well (a backup well)
Blending Clearwell	2	2	Pitting noted during site visit. Repair areas with corrosion damage
Common Plant Infrastructure			
Ground Storage Tanks	4	4	No attention needed
Elevated Storage Tank	1	1	Cross members have been repaired. May be replaced with hydropneumatic tank.
Chlorine Gas System	1	1	Convert to liquid sodium hypochlorite and upsize during expansion to treat 7 MGD
Ammonia System	1	1	No attention needed to current system. Upsize during expansion to treat 7 MGD

4.3 Lime Softening Plant

This section describes modifications and upgrades to the LS Plant.

4.3.1 Filter Evaluation

Based on the condition assessment and analysis to date, a comprehensive filter evaluation is recommended. The goal of this filter evaluation is to provide valuable information on current filter operation, cleaning effectiveness, operational improvements, and future capital improvements. A filter evaluation involves the following:

- Collecting samples and testing media (offsite) to determine how effective size, specific gravity, and uniformity coefficient compares to design specifications.
- Collecting samples and testing media (offsite) for calcium carbonate calcification.
- Evaluating backwashing performance (onsite) such as turbidity reduction over time, floc retention analyses, and media expansion.
- Analyzing performance data (desktop analysis) including filter effluent turbidity, filter run times, head loss, unit filter run volume (UFRV), etc.

Potential recommendations could include operational changes such as modifying filter influent pH, decreasing lime dose, operating at a different loading rate, or changing backwash strategy (e.g., rates, frequency, duration). Recommendations could also include design modifications including adding air scour, elevating troughs, changing media type/size, etc. These changes could improve filter effluent water quality and/or prolong media life.

For three filters, field work would be completed over the course of several days. The typical field investigations could be scheduled over the course of several weeks to minimize downtime. In total, this task would require about 2 to 3 months, and this includes offsite media testing, drafting a report, providing recommendations, etc.

Potential capital improvements to filters include:

- Raising backwash water collection troughs to avoid media loss
- Installing air scour to improve backwashing performance
- Replacing existing local control panels
- Replacing missing and deteriorating guardrails

4.3.2 Softening Upgrades Study

A study is recommended to identify the preferred upgrades to maintain non-membrane softening in the plant. Keeping the existing lime softening process, converting to pellet softening, or converting to nanofiltration all have potential value. The study would have four components: 1) desktop analysis for lime softening process optimization; 2) pellet softening investigation and pilot; 3) nanofiltration investigation and pilot; and 4) conceptual development of the chosen upgrades.

The lime softening optimization study would involve a desktop analysis evaluating the use of additional / alternative chemicals at the WTP, including carbon dioxide to decrease pH upstream of filters, soda ash to maintain alkalinity, and caustic to increase pH at the clearwells.

The pellet softening investigation and pilot would compare pellet softening to conventional lime softening with regard to water quality, chemical usage, maintenance, and residuals management. Pellet softening offers a process that can utilize caustic for pH adjustment, eliminating the need for lime, and will greatly reduce the residuals volume as no lime sludge is produced. A pilot is recommended due to the relatively few full-scale municipal installations of pellet softening in our region. Because this technology is offered by a single vendor (Veolia), it is suggested that the District and their engineer coordinate with Veolia on a pilot to gather the data necessary to make the decision.

The conclusion of this study will be to select either maintaining the existing lime softening plant or converting to pellet softening and to develop a conceptual design.

This study would be performed in parallel with the RO Plant expansion, as both softening upgrades and RO Plant expansion will alter the finished water quality. Expected LS Plant and RO Plant blended water quality with the expansion of RO (without LS Plant changes) is discussed in greater detail in Section 4.5.

4.4 RO Plant

This section describes upgrades to the RO Plant included in this Alternative.

4.4.1 Brackish Well Capacity Increase

There are currently 17 brackish wells (Wellfields 2 and 4) with a permitted combined peak month withdrawal of 5.44 MGD. To achieve an RO permeate production rate of 5.0 MGD and assuming operation at 70% recovery, the RO feed flow will need to be 7.14 MGD. This means the brackish well capacity will need to increase by a minimum of 1.70 MGD. A study evaluating ideal brackish well locations and depths is recommended. Based on an assumed well capacity of 0.4 MGD, it is preliminarily estimated that 5 new brackish water supply wells will need to be installed to provide the necessary RO feed flow. It would be preferable that the new wells could be added to the RO WF2 or RO WF4 system for minimal piping upgrade requirements to convey the needed flow to the RO Plant.

4.4.2 RO Rehabilitation and Membrane Management Evaluation

The RO skids are aging, and a condition assessment showed there are areas within the system that could be rehabilitated to extend system life. Rehabilitation could be performed on the following components:

- Replace cartridge filter vessels and corroded valves. These vessels could be replaced with horizontal units to provide easier access.
- Replace field instruments and instrument panels.
- Replace corroded grooved end couplings.
- Replace corroded pressure vessels.
- Replace skid valves.
- Install new variable frequency drives (VFDs).

The RO skids were designed to operate at 70% recovery, but often operate at lower recoveries (60%). Membranes are replaced every 5 to 7 years. This low recovery and frequent replacement could be due to non-optimal pretreatment (e.g., antiscalant chemical/dose or cartridge filter selection), reusing membranes that have lost production capabilities after they have been removed and dried from other skids, or lack of clean-in-place (CIP) events. Brackish water RO plants typically operate at 70% to 85% recovery when adequate pretreatment and cleaning strategies are employed, and can have 10 year lifespans (03-AMTA-Fact-Sheet-NF-and-RO-Rev1.pdf (amtaorg.com)). A holistic evaluation could be performed for the WTP to assess available operating data, operating procedures, and management practices to evaluate the system's performance. This evaluation could include the following components:

- A site visit and interviews with WTP staff to understand current operations and management of the RO Plant.
- Evaluating historical water quality, cleaning procedures, and operating data trends to provide pretreatment, post-treatment, and cleaning recommendations.
- Having a third-party perform a membrane autopsy to determine impacts of fouling/scaling, which could impact pretreatment and cleaning recommendations.
- A full-scale membrane cleaning study based on membrane autopsy results to identify the optimal cleaning strategy.

The outcome of this evaluation would include recommendations to improve membrane operations (efficiency), prolong membrane life, and help plan for future membrane replacement/rotation.

4.4.3 RO Expansion

Expanding the RO Plant from 3.0 MGD to 5.0 MGD will require the following:

- Additional equipment – Chemical feed system expansion, cartridge filters, feed pumps, skids, pressure vessels, membranes, instrumentation, etc.
    - Four, 0.5 MGD skids (same size/capacity as existing skids) operating at 70% to 75% recovery
- Corrosion control and post-treatment modifications (see Section 4.5.1 below).
- Engineering services for the design of the new system.
- Construction activities within the building adjacent to the existing building.
- Increased monitoring due to installation/operation of additional skids.

4.4.4 RO Modeling

Modeling was performed to estimate operating parameters, permeate water quality, and concentrate water quality from the new RO skids. Modeling was performed with RO feed water data provided by the WTP. Table 4-2 presents expected design and operation of a new RO system at both skid size options.

Table 4-2: New Reverse Osmosis System Design and Operational Modeling Results

Design / Operation Parameter	Units	Four, 0.5 MGD Skids
No. Skids	No.	4
Capacity per Skid	MGD	0.5
Array	N/A	8:4 per skid
No. Pressure Vessels per Skid	No.	12
No. Elements per Pressure Vessel	No.	7
Total No. Elements per Skid	No.	84
Feed Flow Rate	gpm	495
Permeate Flow Rate	gpm	347
Concentrate Flow Rate	gpm	148
Feed TDS	ppm	12,000
Average Flux	gfd	13.5
System Recovery	%	70-75
Feed Pressure	psi	376
Concentrate Pressure	psi	316

Table 4-3 presents RO system water quality results from modeling. In the modeling software, metals, anions, and neutrals must be balanced with respect to ion charge. Therefore, feed water quality in the table were slightly modified as needed from the data presented previously in Table 1-3 for the ions to balance.

Table 4-3. Reverse Osmosis Modeling Results

Parameter	Units	Feed	Permeate	Concentrate
Field Parameters				
Temperature	°C	25	25	25
pH	SU	7.5	6.5	7.6
Alkalinity	mg/L as CaCO3	158	12.3	484
Hardness	mg/L as CaCO3	982	34	3,408
Other Water Quality Parameters				
Conductivity	umhos/cm	8,288	558	23,564
Total Dissolved Solids	mg/L	4,722	278	15,089
Total Carbon Dioxide	mg/L	6.05	6.88	10.2
Metals				
Ammonium	mg/L	0.69	0.07	2.1
Barium	mg/L	0.07	0.0	0.23
Calcium	mg/L	173	6.18	562
Magnesium	mg/L	256	9.4	832
Potassium	mg/L	49	3.7	155
Sodium	mg/L	1,122	79	3,557
Strontium	mg/L	35	1.25	114
Anions				
Bromide	mg/L	12	1.1	38
Chloride	mg/L	2,375	146	7,578
Fluoride	mg/L	1.8	0.15	5.7
Nitrate (as N)	mg/L	1.2	0.4	3.1
Sulfate	mg/L	488	12.5	1,598
Neutrals				
Boron	mg/L	0.48	0.33	0.82
Silicon Dioxide	mg/L	11.3	0.52	36

4.4.5 Degasifier Expansion

With the expansion of the RO system, the existing 3.0 MGD degasifier system will also need expansion. A new, 5.0 MGD degasifier would be added adjacent to the existing system, which is shown in Photo 4-1. This larger unit could handle the full flow of the RO system, allowing some flexibility to be added to the degasification process by allowing for the existing unit to be taken offline. The new degasifier would be constructed on top of the second clearwell, located north of the first clearwell and existing degasifier. It is also recommended that the existing 3.0 MGD degasifier be replaced with a 5.0 MGD degasifier to provide adequate redundancy in case one unit needs to be taken offline.

Photo 4-1: Existing RO Degasifier

4.4.6 Concentrate Disposal

With the expansion of the RO Plant and assuming a 70% recovery efficiency, there will be approximately 2.14 MGD of l RO concentrate produced, which will require disposal. Relying only on DIW-1 with a maximum capacity of 1.85 MGD, a new deep injection well onsite will likely be needed to accommodate this higher flow rate. The current deep injection well is aging (Photo 4-2).

Alternatively, a portion of the concentrate flow could be sent to DIW-2 at the Holiday Ventures Lift Station. This would require coordination with the WRF to ensure flows and water quality are acceptable. It should be noted a new North WRF will begin using DIW-2 as well, and an additional deep injection well onsite would provide more system reliability potentially without the need of pumping that occurs to convey concentrate to DIW-2.

Photo 4-2: Existing Deep Injection Well

4.5 Blended Water Analysis

The current finished water blend operationally consists of around 44% LS Plant effluent (up to 2.0 MGD) and 56% RO Plant permeate (up to 3.0 MGD). Table 4-4 presents typical LS Plant effluent and RO Plant permeate prior to blending in the clearwell based on daily data collected in September 2023.

Table 4-4: Current LS Plant Effluent and RO Permeate Water Quality

Water Quality Parameter	LS Plant Effluent			RO Plant Permeate		
	Min	Avg	Max	Min	Avg	Max
pH	10.1	10.8	11.2	7.1	7.4	8.2
Alkalinity	60	87	124	4.0	8.5	12
Hardness	152	175	208	4.0	12	24

With the LS Plant capacity remaining at 2.0 MGD and capacity expansion of only the RO Plant to reach a total facility production rate of 7.0 MGD, this will result in 5.0 MGD produced by RO and minorly change the design finished water composition to about 29% LS Plant effluent and 71% RO Plant permeate. Operating more in favor of utilizing RO treatment could change finished water quality, which would trigger needing changes to post-treatment and likely a corrosion control study to maintain compliance with the Lead and Copper Rule Revisions (LCRR).

Table 4-5 presents current and expected finished water quality that impacts corrosion (without post-treatment modifications) with the addition of RO Plant capacity. With the new LS/RO blend, the finished water pH, alkalinity, and hardness should be like the current finished water quality.

Table 4-5: Alternative 1 Current Finished Water Quality and Expected Changes

Water Quality Parameter	Current (4.5 MGD)		Current (4.5 MGD)		Future (7.0 MGD)	
	LS: 1.5 MGD 33%	RO: 3.0 MGD 66%	LS: 2.0 MGD 44%	RO: 2.5 MGD 56%	LS: 2.0 MGD 29%	RO: 5.0 MGD 71%
pH	8.5		8.9		8.4	
Alkalinity	35		43		31	
Hardness	66		84		59	

4.5.1 Corrosion Control and Potential Post-Treatment

Currently, LS Plant effluent and RO Plant permeate are blended in a clearwell below the RO degasifier. Since the blend ratio of LS effluent to RO permeate will change, a corrosion control study will be needed to determine new post-treatment requirements and ensure Lead and Copper Rule (LCR) compliance. Potential post-treatment options include any or all of the below strategies:

1. pH adjustment at the clearwell using caustic.
2. Corrosion inhibitor addition at the clearwell or storage tanks.
3. Blending with surficial groundwater (if well withdrawal capacity allows).

These strategies would be evaluated at the pilot scale prior to RO expansion and would follow guidelines established in the EPA *Optimal Corrosion Control Treatment Evaluation Technical Recommendations* document and in the Lead and Copper Rule (40 CFR 141(I)).

4.6 RO Expansion Location

The new RO skids would be located in the metal building adjacent to the existing RO skids (see Photo 4-3). This building was designed to accommodate four additional 0.5 MGD skids. New electrical components could either be located within this building or in an existing outdoor space adjacent to the building, which would need to be enclosed. Figure 4-1 shows the location of existing components and where new systems could be located.

Photo 4-3: RO Expansion Building

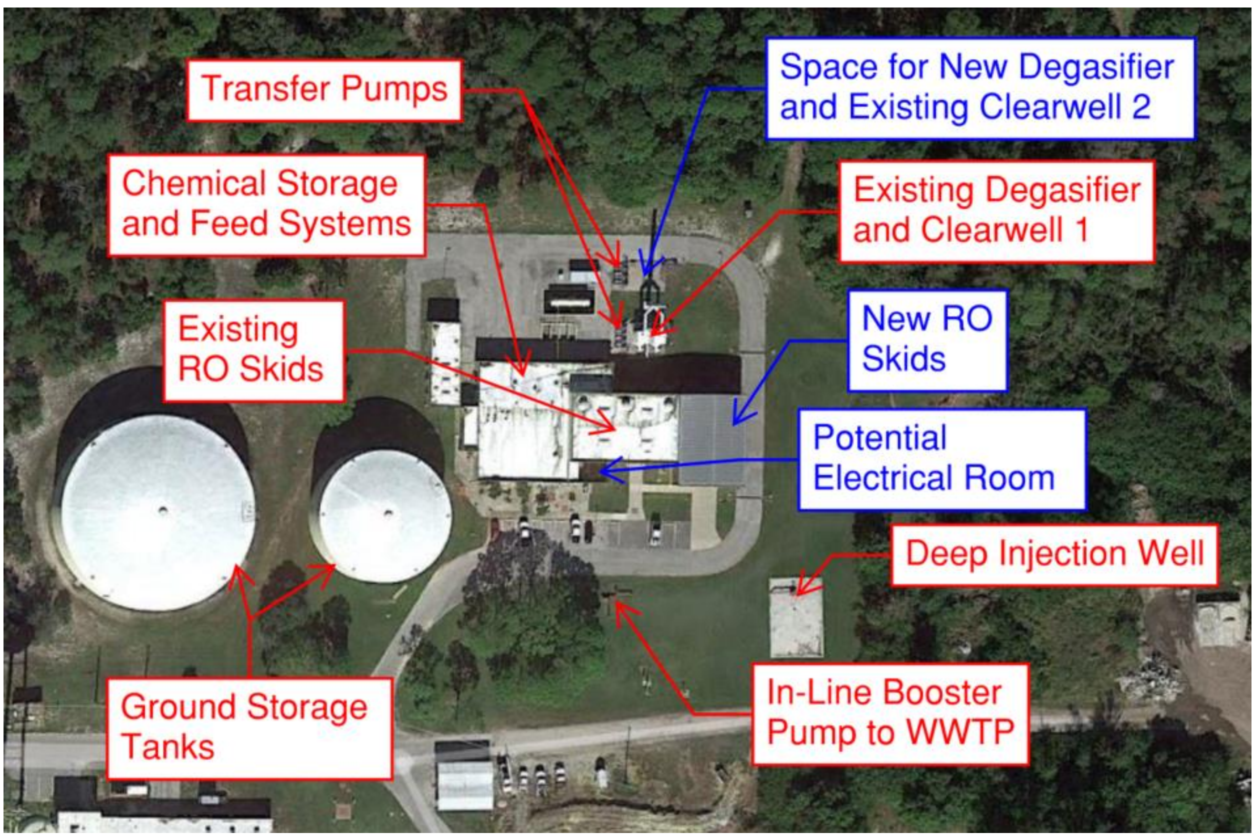

Figure 4-1. Existing and Future RO Plant System Locations

4.7 Cost Estimate

Table 4-6 presents a planning-level cost estimate developed for Alternative 1A and 1B. Cost estimates are in 2023 dollars and include applicable demolition, sitework, electrical components, and instrumentation. Future refinements to this estimate may be presented in the final Master Plan. Opinions of probable cost provided by HDR are based on information available to HDR and on the basis of HDR's experience and qualifications and represents the professional judgment of HDR's engineers. However, since HDR has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor(s') methods of determining prices, or over competitive bidding or market conditions, HDR does not guarantee that proposals, bids or actual project or construction cost will not vary from opinions of probable cost that HDR prepares.

Table 4-6: Alternative 1 High-Level Cost Estimate (2023 Dollars)

Plant Area	Total Estimated Cost (2023 Dollars)	
	Option 1A: Lime System Rehab	**Option 1B: Pellet Softening System**
Lime Softening	$3,860,000	-
Pellet Softening System	-	$4,320,000
RO Expansion	$4,180,000	$4,180,000
RO Rehabilitation	$5,400,000	$5,400,000
Non-Membrane RO System Components	$930,000	$930,000
Deep Injection Well	$8,660,000	$8,660,000
Supply Wells	$14,010,000	$14,010,000
Supply Well Piping	$340,000	$340,000
General Plant	$2,840,000	$2,840,000
Studies/Evaluations	$300,000	$270,000
Total	**$40,520,000**	**$40,950,000**

5 Alternative 2 – Replace the LS Plant with a Nanofiltration Plant and Rehabilitate and Expand the RO Plant

5.1 Alternative Description

Alternative 2 considers replacing the existing LS plant with nanofiltration (NF) membranes (2 MGD finished water capacity) and along with rehabilitating and expanding the existing RO plant (5 MGD finished water capacity) to produce a total of 7.0 MGD.

The purpose of this alternative would be to move away from LS and granular media filtration and rely on membranes for treatment. This would change the finished water quality of the facility.

Major projects required of this alternative are:

Studies and Evaluations:

- Membrane (RO) Management Study.

- Softening Upgrades Study (as mentioned in section 4). If the NF pilot done as part of this study indicated NF is a preferred process for softening, the following capital projects would apply.

Capital Projects:

- Increasing the brackish water well capacity.
- LS Plant demolition.
- Media filter rehabilitation (optional)
- NF Plant construction.
- RO system rehabilitation.
- RO system expansion.
- Degasifier Expansion
- Additional Deep Injection Well
- Post Treatment Chemical Upgrades
  - Corrosion control and post-treatment.
  - Conversion of chlorine gas to liquid sodium hypochlorite.

NF membranes operate similar to RO but use less pressure, operate at higher recoveries, and are often used in softening applications to treat fresh groundwater. The same components used for RO would also be used for NF, including the following:

- Chemicals including sulfuric acid and antiscalant.
- Cartridge filters
- Feed pumps
- Membrane skids
- Degasification
- CIP system

5.2 Modifications and Recommendations

A site visit and condition assessment were performed on March 31, 2023. Recommendations from this assessment are documented in the *Potable Water Master Plan – Condition Assessment Technical Memorandum* (HDR, 2023). Table 5-1 presents a list of new components for the NF Plant and RO equipment evaluated during this assessment and whether the equipment needs rehabilitation or expansion for this alternative to be implemented.

Table 5-1: New and Rehabilitated WTP Equipment for Alternative 2

Equipment Name	Total Quantity		Recommendation / Notes
	Current	Expanded	
NF Plant			
Sulfuric Acid System	None	1	Install one system (including redundancy) for the NF Plant
Antiscalant System	None	1	Install one system (including redundancy) for the NF Plant
Cartridge Filters	None	4	One cartridge filter per skid
Membrane Feed Pumps	None	4+1	One dedicated feed pump per skid with one swing pump that can serve any skid
NF Skids	None	4	0.66 MGD capacity per skid
CIP System	None	1	Install one CIP system for the NF Plant
RO Plant			
Antiscalant System	1	1	Upsize to serve increased capacity
Cartridge Filters	6	10	Current cartridge filters could be rehabilitated or replaced. Add new cartridge filters to accompany new RO skids
Membrane Feed Pumps	7	11	Replace motors. Add new feed pumps to accompany new RO skids. Motors in some pumps are undersized and do not provide adequate capacity to the skids
RO Skids	6	10	Rehabilitate components as needed. Conduct membrane management study to improve performance. Add new skids to treat a firm total of 5 MGD. Membrane replacement is staggered; oldest membranes were installed in 2020.
Sulfuric Acid System	1	1	Repair damage to the sump located beneath the storage tank and upsize to serve increased capacity
CIP System	1	1	Has not been operated recently. Test system to evaluate status
Degasifiers	1	2	Add new 5 MGD degasifier. Replace existing 3 MGD unit with new 5 MGD unit.
Deep Injection Well	2	3	A new well will likely be needed to accommodate higher concentrate flow from NF and RO processes. As mentioned previously the plant uses DIW-2 as its second well (a backup well)
Blending Clearwell	2	2	Pitting noted during site visit. Repair areas with corrosion damage
Common Plant Infrastructure			
Ground Storage Tanks	4	4	No attention needed
Elevated Storage Tank	1	1	Cross members have been repaired. May be replaced with hydropneumatic tank.
Chlorine Gas System	1	1	Convert to liquid sodium hypochlorite.
Ammonia System	1	1	No attention needed to current system. Upsize during expansion to treat 7 MGD

5.3 NF Plant

Due to the surficial aquifer turbidity levels up to 29 NTU, pretreatment upstream of NF skids is recommended to prolong the life of cartridge filters and NF membranes. This could include:

- Utilizing the existing granular media filters. This is a low-cost option that would only require decommissioning of lime and clarifier systems.
- Construction of an ultrafiltration (UF) system. This is a higher cost option that would involve decommissioning the lime, clarifier, and filter systems, and then designing and constructing the UF system. The UF requires additional building space, electrical, pumps, backwash system, chemicals, and compressor.

The NF Plant would be sized to produce up to approximately 2 MGD of permeate with one skid offline for maintenance or cleaning. It is recommended to install four, 0.66 MGD NF skids.

Assuming an 80% recovery for NF treatment systems, a surficial aquifer supply of 3.3 MGD is required.

5.3.1 NF Modeling

Modeling was performed to estimate operating parameters and water quality. Table 5-2 presents expected operational parameters for NF system, including flow rates, flux, recovery, and pressures. The NF Plant could operate at a higher recovery and lower pressures compared to the RO Plant since fresh surficial groundwater is utilized. An NF membrane that allows more passage of divalent ions (e.g., calcium and magnesium) was selected to allow more hardness and alkalinity in the NF/RO blend. This type of membrane also allows for operation at higher recovery and lower feed pressures.

Table 5-2. Nanofiltration Design and Operational Modeling Results

Design / Operation Parameter	Units	Result
No. Skids	No.	4
Capacity per Skid	MGD	0.66
Array	N/A	10:5
No. Pressure Vessels	No.	15
No. Elements per Pressure Vessel	No.	7
Total No. Elements per Skid	No.	105
Feed Flow Rate	gpm	573
Permeate Flow Rate	gpm	458
Concentrate Flow Rate	gpm	115
Feed TDS	ppm	836
Average Flux	gfd	14.3
System Recovery	%	80
Feed Pressure	psi	63
Concentrate Pressure	psi	34

Table 5-3 presents NF system water quality results from modeling. In the modeling software, metals, anions, and neutrals must be balanced with respect to ion charge. Therefore, feed water quality in the table were slightly modified as needed from the data presented previously in Table 1-2 for the ions to balance. Similar to LS Plant effluent, NF permeate would be blended with RO permeate prior to post-treatment and distribution.

Table 5-3. Nanofiltration Water Quality Modeling Results

Parameter	Units	Feed	Permeate	Concentrate
Field Parameters				
Temperature	°C	25	25	25
pH	SU	7.6	7.5	7.9
Alkalinity	mg/L as CaCO3	165	107	394
Hardness	mg/L as CaCO3 [1]	145	80	400
Other Water Quality Parameters				
Conductivity	umhos/cm	430	269	1,040
Total Dissolved Solids	mg/L	339	214	837
Total Carbon Dioxide	mg/L	6.1	6.2	7.0
Metals				
Ammonium	mg/L	0.03	0.02	0.06
Barium	mg/L	0.01	0.0	0.02
Calcium	mg/L	55	31	150
Magnesium	mg/L	3.8	1.4	13
Potassium	mg/L	0.88	0.69	1.7
Sodium	mg/L	28	22	49
Strontium	mg/L	0.71	0.36	2.1
Anions				
Bromide	mg/L	0.20	0.20	0.18
Chloride	mg/L	18	16	25
Fluoride	mg/L	0.18	0.17	0.21
Nitrate (as N)	mg/L	0.12	0.15	0.01
Sulfate	mg/L	20	1.2	95
Neutrals				
Boron	mg/L	0.07	0.08	0.06
Silicon Dioxide	mg/L	7.1	6.0	12

[1] Estimated Using Calcium and Magnesium Results.

5.3.2 NF Concentrate Management

NF concentrate will need disposal, which can be accomplished using multiple techniques. Assuming 80% recovery efficiency, a 2 MGD finished water NF capacity would require approximately 0.66 MGD of concentrate disposal. Potential techniques for the WTP include:

1. Deep well injection – Deep well injection would require the construction of a new well onsite and supply pipeline. This concentrate could be combined with the RO Plant concentrate through a single new deep injection well needed.
2. Conveyance to DIW-2 – Conveyance to DIW-2 would need to be discussed with District staff to determine acceptable flow rates and water quality. A new in-line booster pump or expansion of the existing in-line booster pump station would be required.

3. Recycling to the head of the RO Plant – Recycling to the head of the RO Plant would warrant pilot testing to ensure NF concentrate will not adversely impact RO operations.
4. Any combination of the above – Depending on restrictions of the above options, a combination of these options could be utilized.

5.4 RO Plant

5.4.1 Brackish Well Capacity Increase

There are currently 17 brackish wells (Wellfields 2 and 4) with a peak month permitted withdrawal of 5.44 MGD based on withdrawal data from April and May of 2023. To achieve an RO permeate production rate of 5 MGD, the RO feed flow will need to be 7.14 MGD. This means the brackish well capacity will need to increase. A study evaluating ideal brackish well locations and depths is recommended. Based on an assumed well capacity of 0.4 MGD, it is preliminarily estimated that 5 new brackish water supply wells will need to be installed to provide the necessary RO feed flow.

5.4.2 RO Rehabilitation and Membrane Management Evaluation

This recommendation is the same as what was presented previously in Section 4.4.2. Rehabilitation of existing components can prolong their lifespan without needing to replace the entire existing RO system. The RO skids were designed to operate at 70% recovery, but often operate at lower recoveries (60%). A holistic evaluation could be performed for the WTP to improve performance.

5.4.3 RO Expansion

This recommendation is the same as what was presented previously in Section 4.4.3. Four 0.5 MGD RO skids designed to match the existing RO skids would be installed to bring the total RO Plant capacity from 3.0 to 5.0 MGD. Associated equipment, post-treatment modifications, engineering and construction services, and monitoring would be required.

5.4.4 RO Modeling

RO modeling results were discussed previously in Table 4-3. Permeate water quality would be the same as Alternative 1, but blended water quality would differ since RO permeate would be blended with NF permeate instead of LS effluent.

5.4.5 Degasifier Expansion

This recommendation is the same as what was presented previously in Section 4.4.5 above.

5.4.6 Concentrate Disposal

This recommendation is the same as what was presented previously in Section 4.4.6 above. With the combined concentrate disposal of 2.64 MGD from NF and RO systems, a single onsite new deep injection well of similar capacity to DIW-1 would be required. Alternatively, a larger deep injection well to handle all concentrate disposal could be beneficial to allow DIW-1 to be taken offline and maintained.

5.5 Blended Water Analysis

The current finished water blend consists of around 44% NF Plant permeate (up to 2.0 MGD) and 56% RO Plant permeate (up to 3.0 MGD). This water quality was provided previously in Table 4-4.

With the installation of NF membranes and the expansion of the RO Plant to reach a total facility production rate of 7.0 MGD, this will result in 5.0 MGD produced by RO and change the finished water composition to about 25% to 31% NF Plant permeate and 69% to 75% RO Plant permeate, whereas the current LS/RO blend ratio is closer to 40% to 60%. This will change finished water quality, requiring changes to post-treatment and likely a corrosion control study to maintain compliance with the LCRR.

Table 5-4 presents the possible NF/RO operating scenarios using 0.66 MGD NF and 0.5 MGD RO skids.

Table 5-4: Possible NF/RO Operating Scenarios (NF Skids 0.66 MGD, New RO Skids 0.5 MGD)

Scenario	NF Skids Online	RO Skids Online	NF Production (MGD)	RO Production (MGD)	Total WTP Production (MGD)	NF/RO Percent Contribution to Total Capacity (%)
1	4	9	2.64	4.36	7.00	38 / 62
2	3	10	1.98	5.00	6.98	28 / 72
3	2	8	1.32	4.00	5.32	25 / 75
4	1	3	0.66	1.50	2.16	31 / 69

Table 5-5 presents current and expected finished water quality that impacts corrosion (without post-treatment modifications) with the addition of RO Plant capacity.

Table 5-5: Alternative 2 Current Finished Water Quality and Expected Changes

Water Quality Parameter	Current (4.5 MGD)		Current (4.5 MGD)		Future (7.0 MGD)	
	LS: 1.5 MGD 33%	RO: 3.0 MGD 66%	LS: 2.0 MGD 44%	RO: 2.5 MGD 56%	NF: 2.0 MGD 28%	RO: 5.0 MGD 72%
pH	8.75		8.66		6.79	
Alkalinity	40		38		39	
Hardness	77		73		47	

5.5.1 Post-Treatment Requirements

Similar to Alternative 1, post-treatment and a corrosion control study would be required with the construction of a NF Plant. The options presented previously in Section 4.5.1 would also be explored with this alternative.

5.6 Potential Site Layout

The NF plant could be located in the open space south of the existing RO Plant, as shown in Figure 5-1. This new building would include the four, 0.66-MGD NF skids with components integral to the system (pumps, cartridge filters), pretreatment chemical storage and feed systems, an electrical room, and CIP system.

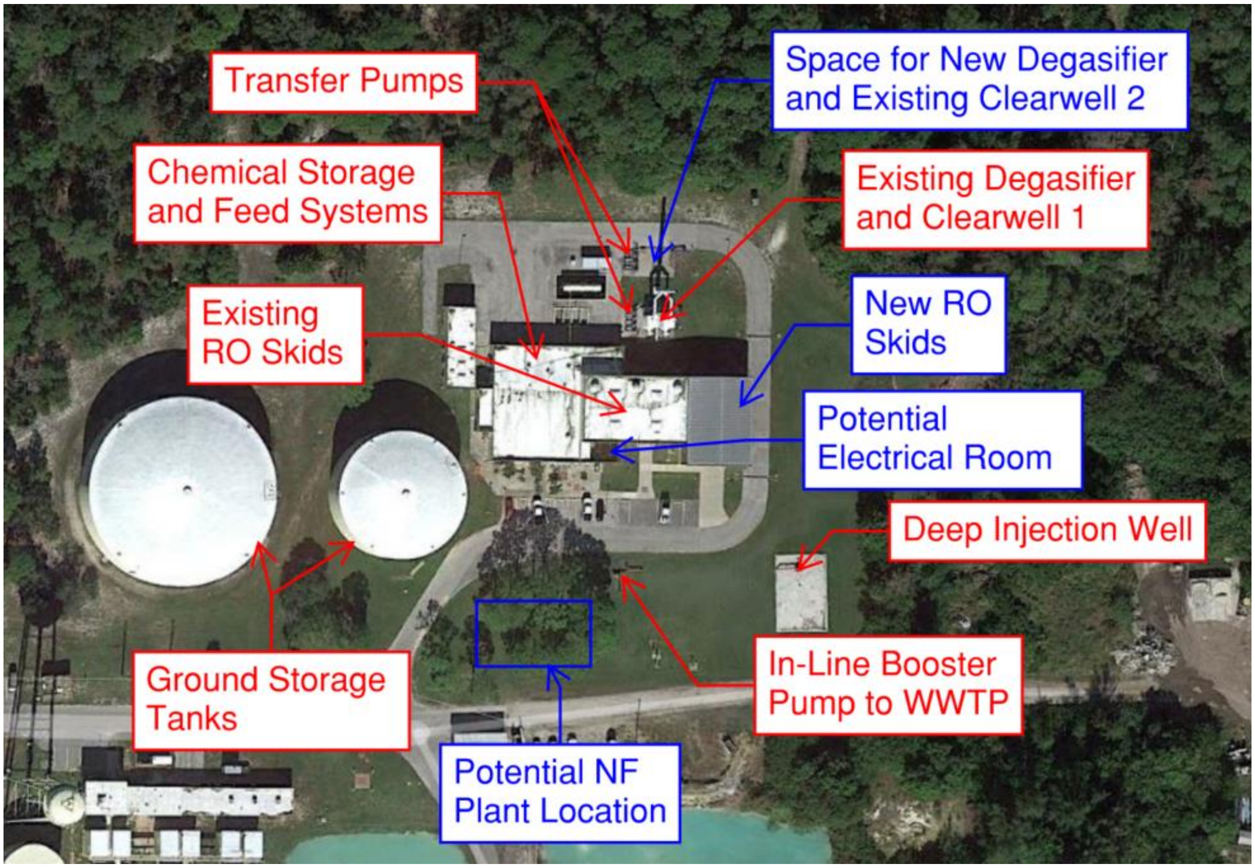

Figure 5-1. Existing and Future RO Plant and Future NF Plant Locations

5.7 Cost Estimate

Table 5-6 presents a planning-level cost estimate developed for Alternative 2. Cost estimates are in 2023 dollars and include applicable demolition, sitework, electrical components, and instrumentation. Refinements to this estimate may be presented in the final Master Plan. Opinions of probable cost provided by HDR are based on information available to HDR and on the basis of HDR's experience and qualifications and represents the professional judgment of HDR's engineers. However, since HDR has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor(s') methods of determining prices, or over competitive bidding or market conditions, HDR does not guarantee that proposals, bids or actual project or construction cost will not vary from opinions of probable cost that HDR prepares.

Table 5-6: Alternative 2 High-Level Cost Estimate (2023 Dollars)

Plant Area	Total Estimated Cost (2023 Dollars)
RO Expansion	$4,180,000
RO Rehabilitation	$5,400,000
Nanofiltration	$8,640,000
Media Filter Rehabilitation	$3,510,000
Non-Membrane System Components	$2,690,000
Deep Injection Well	$8,660,000
Supply Wells	$14,010,000
Supply Well Piping	$340,000
General Plant	$2,840,000
Studies/Evaluations	$250,000
Total	**$50,520,000**

6 Alternative 3 – Decommission LS Plant and Expand to All RO Treatment

6.1 Alternative Description

Alternative 3 evaluated decommissioning the LS plant and utilizing an all-RO system. This alternative contains two options, alternative 3a and 3b. These options include (3a) expanding the existing RO plant to 7 MGD in the existing structure as best as possible or (3b) replacing the existing RO Plant with a new hurricane-hardened 7 MGD RO facility, including a new laboratory and housing quarters for staff during severe weather events. Option 3b would entail demolishing the existing LS Plant and RO Plant and constructing a new 7.0 MGD RO Plant north of the existing RO facility.

Since RO membranes reject many ions, blending with untreated groundwater from the freshwater wells is a possibility. This alternative is only preferred if the previously discussed Softening Upgrades Study, Nanofiltration Pilot, and Membrane Management Study indicate that an all-RO option is advantageous.

Major scope items involved in Alternative 3a – Decommission LS Plant and Expand Existing RO Plant:

- Increasing the brackish water well capacity.
- LS Plant demolition.
- Existing RO system rehabilitation.
- RO system expansion in existing building.
- Degasifier Expansion

- Additional Deep Injection Well
- Post Treatment Chemical Upgrades
  - Corrosion control evaluation.
  - Conversion of chlorine gas to liquid sodium hypochlorite.

Major scope items involved in Alternative 3b – Decommission LS Plant and Construct New RO Facility:

- Increasing brackish water well capacity.
- LS Plant demolition.
- RO Plant demolition.
- New RO facility construction, including laboratory and staff housing
- RO system replacement and expansion.
- Degasifier Expansion
- Additional Deep Injection Well
- Post Treatment Chemical Upgrades
  - Corrosion control evaluation.
  - Conversion of chlorine gas to liquid sodium hypochlorite.

A phased approach would be required to continue providing water while construction occurs. The new RO Plant would be constructed in the wooded area located north of the existing RO Plant. This phased approach is discussed in Section 6.3.2.

6.2 Modifications and Recommendations

A site visit and condition assessment were performed on March 31, 2023. Recommendations from this assessment are documented in the *Potable Water Master Plan – Condition Assessment Technical Memorandum* (HDR, 2023). Table 6-1 below lists all the proposed equipment needs for Alternative 3a. It should be noted that Alternative 3a involves a two-phase expansion of the RO system. In Phase 1, three (3) new, larger RO skids (1.40 MGD) will be installed alongside the existing six (6) 0.5-MGD skids. Between Phases 1 and 2, there will be one (1) standby feed pump for the 0.5-MGD skids and one (1) standby feed pump for the 1.40-MGD skids, resulting in eleven (11) total feed pumps. In Phase 2, the existing six (6) RO skids will be removed and replaced with three (3) more 1.40-MGD skids. It should be noted that the replacement of the existing RO skids with larger skids within the existing footprint may not be constructible without major modifications to the system structural mounting pads, piping and conduit, and electrical and instrumentation feed systems.

Table 6-1: New WTP Equipment for Alternative 3a

Equipment Name	Total Quantity			Recommendation
	Current	Phase 1	Phase 2	
RO Plant				
Antiscalant System	1	1	1	Upsize during Phase 1 and 2 expansions
Cartridge Filters	6	9	6	One per membrane skid and one spare. The 6 current cartridge filter vessels will be demolished during Phase 2 and replaced with fewer, larger cartridge filter vessels
Membrane Feed Pumps	7	11	7	One per membrane skid and one spare. The 7 current feed pumps will be demolished during Phase 2 and replaced with larger feed pumps.
RO Skids	6	9	6	Phase 1 – add 3, 1.40 MGD skids; Phase 2 – demolish existing 0.5 MGD skids and replace with 3, 1.40 MGD skids
Sulfuric Acid System	1	1	1	Upsize during Phase 1 and 2 expansions
CIP System	1	1	1	One CIP system for the RO Plant, upsized to clean one 1.40 MGD skid during Phase 1
Degasifier	1	2	2	Add new 5 MGD degasifier. Replace existing 3 MGD unit with new 5 MGD unit.
Deep Injection Well	2	3	3	A new well will likely be needed to accommodate higher concentrate flow. As mentioned previously the plant uses DIW-2 as its second well (a backup well)
Blending Clearwell	2	2	2	Pitting noted during site visit. Repair areas with corrosion damage.
Common Plant Infrastructure				
Ground Storage Tanks	4	4	4	No attention needed
Elevated Storage Tank	1	1	1	Cross members have been repaired. May be replaced with hydropneumatic tank.
Chlorine Gas System	1	1	1	Convert to liquid sodium hypochlorite, upsize with Phase 1 and 2 expansions
Ammonia System	1	1	1	No attention needed, upsize with Phase 1 and 2 expansions.

If an all-new RO facility is constructed, the phasing plan proposed for Alternative 3a will not be applicable. Both the lime softening and existing RO plants will need to remain online while the new facility is constructed. Table 6-2 below lists all the proposed equipment needs for Alternative 3a.

Table 6-2: New WTP Equipment for Alternative 3b

Equipment Name	Recommendation		
	Current	Proposed	
Antiscalant System	1	1	Upsize to accommodate increased capacity.
Membrane Feed Pumps	7	7	One per membrane skid and one spare.
RO Skids	6	6	Construct 6 new 1.40-MGD skids
Sulfuric Acid System	1	1	Upsize to accommodate increased capacity.
CIP System	1	1	Upsize to accommodate increased capacity.
Degasifier	1	2	Add new 5 MGD degasifier. Replace existing 3 MGD unit with new 5 MGD unit.
Deep Injection Well	2	3	A new well will likely be needed to accommodate higher concentrate flow. As mentioned previously the plant uses DIW-2 as its second well (a backup well)
Blending Clearwell	2	2	Pitting noted during site visit. Repair areas with corrosion damage.
Ground Storage Tanks	4	4	No attention needed.
Elevated Storage Tank	1	1	No attention needed. May be replaced with hydropneumatic tank.
Chlorine Gas System	1	1	Convert to liquid sodium hypochlorite and upsize to accommodate increased capacity.
Ammonia System	1	1	Upsize to accommodate increased capacity.
New Building	1	1	New facility to include RO system, all associated electrical and I&C, a new laboratory, and housing accommodations for staff during severe weather events.

6.3 RO Plant

6.3.1 Brackish Well Capacity Increase

There are currently 17 brackish wells (Wellfields 2 and 4) with a peak month permitted capacity of 5.44 MGD based on withdrawal data from April and May of 2023. To achieve an RO permeate production rate of 7.0 MGD without the use of other processes, the RO feed flow will need to be 10 MGD which will require 12 new brackish supply wells. This means the brackish well capacity will need to significantly increase. A study evaluating ideal brackish well locations and depths is recommended.

6.3.2 RO Expansion Phases

To expand the existing RO Plant to 7.0 MGD of finished water (Alternative 3a), adding 1.4 MGD skids is recommended. Adding fewer, larger skids saves on capital cost due to fewer skids, pumps, cartridge filters, valves, etc. However, for operational flexibility and maintenance, it is recommended that the District install no fewer than four skids. Modifications to the new RO building would be required since this building was designed with the intent of adding 0.50 MGD skids. Adding the intended four, 0.50 MGD skids would only provide 5.0 MGD of RO permeate. The phased approach of construction is shown in Table 6-3.

Table 6-3: Proposed New RO Plant Construction Phases for Alternative 3a

Phase	No. New Skids / Capacity	New Added Capacity (MGD)	Total Capacity with All Units Online (MGD)	Capacity with Largest Unit Offline (MGD)
Current	N/A	N/A	3	2.5
Phase 1	3 / 1.4 MGD per skid	4.2	7.2	5.8
Phase 2	3 / 1.4 MGD per skid[1]	4.2	8.4	7.0

[1]Replace existing 0.5-MGD skids with three (3) 1.4-MGD skids

For Alternative 3b, the lime softening and existing RO plants will need to remain online while the new facility is constructed. Once the new facility is commissioned and brought online, the existing lime softening and RO plants may be demolished at the District's discretion.

6.3.3 RO Modeling

Modeling was performed to estimate operating parameters, permeate water quality, and concentrate water quality from the new RO skids. Modeling was performed with RO feed water data provided by the WTP. Table 6-4 presents expected design and operation of a new RO system at both skid size options.

Table 6-4. New Reverse Osmosis System Design and Operational Modeling Results

Design / Operation Parameter	Units	Result
No. Skids	No.	6 (3 skids per phase)
Capacity per Skid	MGD	1.4
Array	N/A	24:12
No. Pressure Vessels per Skid	No.	36
No. Elements per Pressure Vessel	No.	7
Total No. Elements per Skid	No.	252
Feed Flow Rate	gpm	1,389
Permeate Flow Rate	gpm	972
Concentrate Flow Rate	gpm	416
Feed TDS	ppm	12,000
Average Flux	gfd	12.9
System Recovery	%	70-75
Feed Pressure	psi	366
Concentrate Pressure	psi	311

Table 6-5 presents RO system water quality results from modeling. In the modeling software, metals, anions, and neutrals must be balanced with respect to ion charge. Therefore, feed water quality in the table were slightly modified as needed from the data presented previously in Table 1-3 for the ions to balance.

Table 6-5. Reverse Osmosis Modeling Results

Parameter	Units	Feed	Permeate	Concentrate
Field Parameters				
Temperature	°C	25	25	25
pH	SU	7.5	6.6	7.4
Alkalinity	mg/L as CaCO3	130	10.7	398
Hardness	mg/L as CaCO3	982	36	3,042
Other Water Quality Parameters				
Conductivity	umhos/cm	8,249	588	23,396
Total Dissolved Solids	mg/L	4,675	291	14,899
Total Carbon Dioxide	mg/L	4.99	5.66	8.40
Metals				
Ammonium	mg/L	0.69	0.07	2.13
Barium	mg/L	0.070	0.00	0.23
Calcium	mg/L	173	6.57	561
Magnesium	mg/L	256	9.9	830
Potassium	mg/L	49	3.9	154
Sodium	mg/L	1,109	83	3,504
Strontium	mg/L	35	1.3	114
Anions				
Bromide	mg/L	12	1.1	37
Chloride	mg/L	2,375	156	7,555
Fluoride	mg/L	1.80	0.16	5.6
Nitrate (as N)	mg/L	1.2	0.41	3.0
Sulfate	mg/L	488	13.3	1,596
Neutrals				
Boron	mg/L	0.48	0.34	0.81
Silicon Dioxide	mg/L	11.3	0.58	36

6.3.4 Degasifier Expansion

This recommendation is the same as what was presented previously in Section 4.4.5 above. However, with up to 7 MGD required to be processed through degasification, a new 5 MGD degasifier would not allow the current degasifier to be redundant. It is recommended that the existing 3.0 MGD degasifier be replaced with a 5.0 MGD degasifier to provide adequate redundancy in case one unit needs to be taken offline.

6.3.5 Concentrate Disposal

This recommendation is the same as what was presented previously in Section 4.4.6 above. With the concentrate disposal need of approximately 3.0 MGD, a single onsite new deep injection well of similar capacity to DIW-1 would be required. Alternatively, a larger deep injection well to handle all concentrate disposal could be beneficial to allow DIW-1 to be taken offline and maintained.

6.4 Finished Water Analysis

The current finished water consists of LS Plant effluent and RO Plant permeate. With the decommissioning of the LS Plant and reliance solely on the brackish aquifer wells and RO treatment, this will significantly change the WTP finished water quality. There are multiple options for operating the new RO Plant, none of which are expected to change finished water quality since the same technology is used. The only difference in options is the capacity produced.

Table 6-6 presents current and expected finished water quality that impacts corrosion (without post-treatment modifications) with the addition of RO Plant capacity.

Table 6-6: Alternative 3 Current Finished Water Quality and Expected Changes

Water Quality Parameter	Current (4.5 MGD)		Current (4.5 MGD)		Future (7.0 MGD)
	LS: 1.5 MGD 33%	RO: 3.0 MGD 66%	LS: 2.0 MGD 44%	RO: 2.5 MGD 56%	RO: 7.0 MGD 100%
pH	8.75		8.66		6.6
Alkalinity	40		38		10.7
Hardness	77		73		36

6.4.1 Post-Treatment Requirements

Similar to Alternatives 1 and 2, post-treatment and a corrosion control study would be required with the demolition of the LS Plant and construction of new RO facilities. The options presented previously in Section 4.5.1 would also be explored with this alternative.

6.5 Potential Site Layout

For Alternative 3a, the RO expansion would be located within the existing RO buildings as shown in Figure 6-1. Phase 1 would involve the construction of three, 1.4 MGD RO skids in the metal building adjacent to the existing RO skids. Phase 2 would involve demolishing the existing 0.5 MGD skids and constructing three new 1.4 MGD RO skids. It is assumed that a new 1.4 MGD CIP system will be constructed in the metal building, electrical expansion will be in the metal building or the space located south of the existing RO skids, and there is enough space in the chemical rooms to accommodate additional antiscalant and acid storage and feed pumps during Phase 1.

For Alternative 3b, the new RO facility would be constructed in the currently wooded area just north of the existing RO facility (see Figure 6-2). The boundaries of the proposed site are the drainage ditch north of the existing RO facility, the existing RO facility to the south of the site which will need to remain online during construction, the existing raw water supply piping buried along the east boundary of the site, and the wooded areas to the east and west of the site. These wooded areas have been identified as containing sand pines (see Section 2).

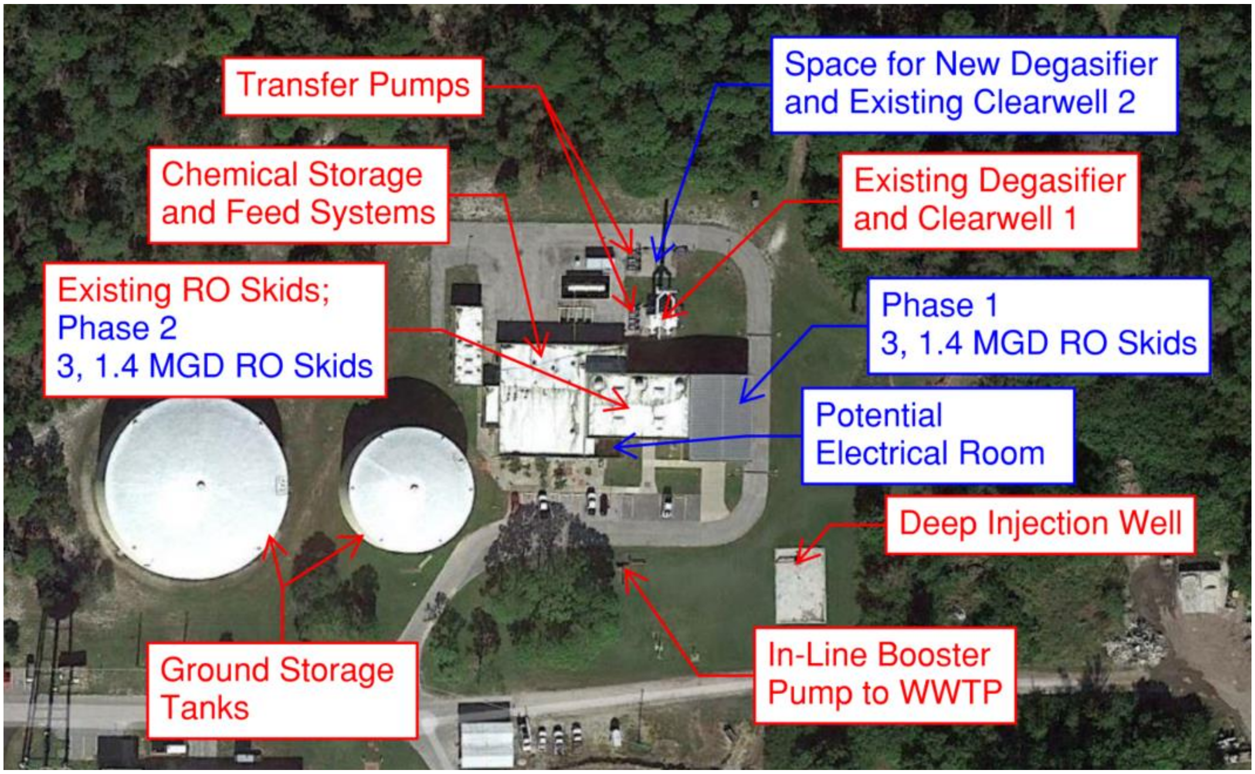

Figure 6-1. Alternative 3a Existing and Future RO Plant Locations (Phase 1 and 2)

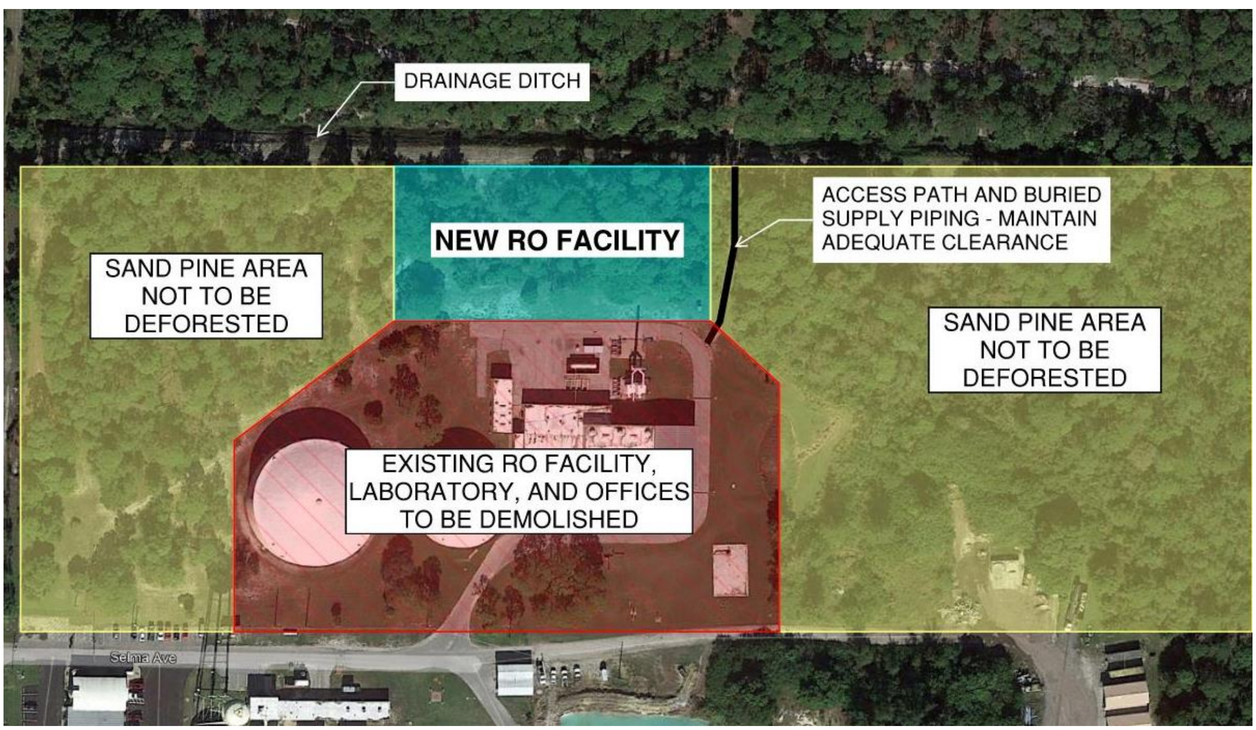

Figure 6-2: Alternative 3b Future RO Plant Location

6.6 Cost Estimate

Table 6-7 presents a planning-level cost estimate developed for Alternatives 3a and 3b. Cost estimates are in 2023 dollars and include applicable demolition, sitework, electrical components, and instrumentation. Refinements to this estimate may be presented in the final Master Plan. Opinions of probable cost provided by HDR are based on information available to HDR and on the basis of HDR's experience and qualifications and represents the professional judgment of HDR's engineers. However, since HDR has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor(s') methods of determining prices, or over competitive bidding or market conditions, HDR does not guarantee that proposals, bids or actual project or construction cost will not vary from opinions of probable cost that HDR prepares.

Table 6-7: Alternative 3 High-Level Cost Estimate (2023 Dollars)

Plant Area	Total Estimated Cost (2023 Dollars)	
	Alternative 3a	Alternative 3b
New 1.4-MGD RO Skids	$26,140,000	-
O&M for 0.5-MG Skids Until Replacement	$1,000,000	-
New RO Facility (Includes all membrane components & chemical systems)	-	$81,580,000
Non-Membrane System Components	$1,810,000	-
Deep Injection Well	$8,660,000	$8,660,000
Supply Wells	$33,610,000	$33,610,000
Supply Well Piping	$13,450,000	$13,450,000
Abandon Freshwater Wells	$810,000	$810,000
General Plant	$2,840,000	$2,840,000
Studies/Evaluations	$50,000	$50,000
Total	**$88,370,000**	**$141,000,000**

7 Common Plant Infrastructure

Common plant infrastructure includes the disinfection systems (chlorine and ammonia) and storage tanks (ground and elevated). These components will need a detailed evaluation during plant expansion design. Disinfection systems will likely need an expansion when the new RO skids are brought online, but a detailed evaluation will be needed including a review of historical chemical use for the last several years. For rehabilitation, conversion from chlorine gas to sodium hypochlorite is recommended.

There are currently four storage tanks with a combined capacity of 7.5 million gallons (MG) and one elevated storage tank with a capacity of 100,000 gallons. The elevated storage tank is used to dampen the amplitude of distribution system pressures. A distribution system modeling analysis is needed to confirm if additional finished storage is warranted; however, for purposes of this study, it is assumed that existing storage is sufficient.

7.1 Conversion from Chlorine Gas to Liquid Sodium Hypochlorite

The WTP currently uses chlorine gas for disinfection. Switching to liquid sodium hypochlorite could be beneficial as there is only one local supplier of chlorine gas. Additionally, transport and on-site storage of chlorine gas poses an undesirable safety risk to plant staff.

To construct a sodium hypochlorite system, the following would be needed:

- Chemical delivery access and a fill station.
- An emergency eyewash and shower station.
- Storage tanks to provide a minimum 30 days of storage of the diluted storage concentration at maximum design treatment flow rate.
- A chemical feed system including redundant pumps.
- Transfer / recirculation pumps for onsite dilution.
- Secondary containment.

Should the District choose to switch to liquid sodium hypochlorite at 12.5 wt% Cl_2, onsite dilution with RO permeate to 6 wt% Cl_2 could allow for a more stable solution and increase protection of assets from chlorine vapors. This strategy could be considered more if this option is chosen. It is assumed that with 6 wt% Cl_2 sodium hypochlorite solution, the facility will require two storage tanks with a storage capacity of about 15,000 gallons each to accommodate a future flow of 7 MGD. A minimum of two feed pumps per injection point is also required.

8 Summary

Projected water demands for the Englewood Water District service area show that the District will need to increase total finished water to 7 MGD. The Englewood Water Treatment Plant is comprised of a 2-MGD LS plant which treats freshwater drawn from surficial aquifer wells and a 3-MGD RO plant which treats brackish water drawn from deeper wells.

After evaluating the hydraulic design and treatment capacity of the unit processes at the LS and RO plants, four separate alternatives have been developed for consideration by the District. These four alternatives are as follows:

- Alternative 1a – Rehabilitate the LS Plant and Rehabilitate and Expand the RO Plant
- Alternative 1b – Convert the LS Plant to Pellet Softening and Rehabilitation and Expand the RO Plant
- Alternative 2 – Replace the LS Plant with a NF Plant and Rehabilitate and Expand the RO Plant
- Alternative 3a – Decommission LS Plant and Expand Existing RO Plant
- Alternative 3b - Decommission LS Plant and Construct New RO Facility

Alternative 1 involves rehabilitating or modifying the existing lime softening system and improving RO membrane operations, prolonging the membrane life, and planning for future membrane replacement/rotation at the RO plant. Alternative 1a includes rehabilitation of the existing lime softening system. Alternative 1b replaces the existing LS system with a pellet softening system. This is only slightly more expensive than 1a but will require some piloting to ensure that it will work well with the source water and existing infrastructure at the WTP. Expanding the RO system would require additional brackish water capacity, additional equipment (i.e., chemical feed system expansion, cartridge filters, feed pumps, skids, pressure vessels, membranes, instrumentation, etc.), corrosion control and post-treatment modifications, and increased monitoring.

Alternative 2 involves demolishing the existing LS plant, adding NF in a new building, and expanding RO capacity. NF membranes operate like RO but use less pressure, operate at higher recoveries, and are often used in softening applications to treat fresh groundwater. The same components used for RO would also be used for NF, including chemicals, cartridge filters, feed pumps, membrane skids, degasification, and a CIP system.

Alternative 3 evaluated a complete replacement of infrastructure with a new RO treatment system. Alternative 3a includes demolishing the existing LS plant and upsizing all RO trains to produce 7.0 MGD within the current RO Building. Alternative 3b includes constructing an entirely new RO facility to provide 7.0 MGD, as well as a new laboratory and new staff housing for severe weather events. This alternative would provide treatment with a single process train utilizing six RO skids. One major benefit of this alternative is the use of fewer, larger skids than the 10 skids needed in Alternatives 1 and 2. This may be a higher capital cost than other alternatives, but fewer, larger skids would save footprint, reduce instrumentation and controls, allow upgrades to modern components, materials of construction, and more efficient pumps. Adding fewer, larger skids saves on capital cost due to fewer skids, pumps, cartridge filters, valves, etc.

The advantages, disadvantages, and high-level costs of each alternative are summarized in Table 8-1.

Table 8-1: Alternative Comparison

Alternative	Estimated Total Capital Cost (2023 Dollars)	Key Advantages	Key Disadvantages
Alternative 1a – Rehabilitate the LS Plant and Rehabilitate and Expand the RO Plant	$40,520,000	• Less disruption to the current process • Shorter construction durations	• Lime sludge waste generation remains • Continued vulnerability of surficial aquifer to water supply stresses and wetland influence
Alternative 1b - Convert the LS Plant to Pellet Softening and Rehabilitation and Expand the RO Plant	$40,950,000	• Less waste generated • Uses caustic instead of lime	• Not in widespread use, emerging technology • Disruptive to the current site, longer construction • Continued vulnerability of surficial aquifer to water supply stresses and wetland influence

Alternative 2 – Replace the LS Plant with A Nanofiltration (NF) Plant and Rehabilitate and Expand the RO Plant	$50,520,000	• Compared to RO option:
		  ○ Lower feed pressure
		  ○ Operate at higher recoveries
		• Similar components used between the RO plant and NF plant
		• Enhanced TOC removal
			• More costly than other softening options
			• Disruptive to the current site, longer construction
			• Increased membrane cleaning and replacement

Alternative 3a – Decommission LS Plant and Rehabilitate and Expand Existing RO Plant	$88,370,000	• Smaller footprint than current plant • Single treatment process • Allows upgrades to modern components and materials of construction	• Costly • Increased membrane cleaning and replacement • Significant brackish water supply expansion required • Risk of unforeseen site space and facility retrofit challenges
Alternative 3b – Decommission LS Plant and Rehabilitate and Construct New, Expanded RO Facility	$141,000,000	• Smaller footprint than current plant • Single treatment process • Allows upgrades to modern components and materials of construction • Hurricane hardened facility • New laboratory and emergency housing for employees • Least complicated construction • Can repurpose existing buildings for alternative uses to save cost	• Most costly • Increased membrane cleaning and replacement • Significant brackish water supply expansion required

9 Recommendations

While each alternative is reasonable to create the water treatment capacity expansion to 7 MGD, Alternative 3b is recommended. Providing the District with a new single treatment process with modernizations for process energy and operational efficiencies would allow for a more reliable facility for the community. A new RO Facility and hardened building with new laboratory, modern operations control room, staff breakroom and restrooms, and emergency operations center could attract new workers. Construction would have the least impact to current operations. During construction, District staff can learn about modern processes installed, and the system can be placed online when all staff are comfortable with doing so. This alternative may require the least amount of piloting with any upgrade and lessen the complexity of blending two water types. Using solely RO treatment has the added benefit of potentially lessening system disinfection costs overall by having the highest probability of allowing the District to convert their disinfection strategy from chloramination to free chlorine, thereby eliminating the need for ammonia dosing systems. Furthermore, RO treatment is the only process considered for reasonable plant upgrades that inherently removes contaminants of emerging concern, creating a safer drinking water for Distrist customers.