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Master Plan Report

FINAL
JEA Innovative Wastewater Treatment Program

June 2, 2021

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List of Acronyms

Abbreviation	Definition
AADF	Annual average daily flow
AGS	Aerobic granular sludge
ATO	Advanced thermal oxidation
AWT	Advanced wastewater treatment
BNR	Biological nutrient removal
BOD	Biochemical oxygen demand
CFR	Code of Federal Regulations
CMAR	Construction management at-risk
DB	Design-build
DBB	Design-bid-build
DBFO	Design-build-finance-operate
DO	Dissolved oxygen

Abbreviation	Definition
EDR	Electrodialysis reversal
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FMAS	Fixed media activated sludge
GP	Grinder pump
HRT	Hydraulic retention time
IFAS	Integrated fixed film activated sludge
IWTP	Innovative Wastewater Treatment Program
IP	Inline pumping
MABR	Membrane aerated biofilm reactor
MBBR	Moving bed bioreactor
MBR	Membrane bioreactor
OSTDS	Onsite sewage treatment and disposal system
P3	Public private partnerships
P/C	Physical/chemical
PVC	Polyvinyl chloride
RBC	Rotating biological contactor
RI	Rapid infiltration
SBR	Sequencing batch reactor
SDGS	Small diameter gravity sewer
SJWMD	St. Johns River Water Management District
SR	Slow rate
SRT	Solids retention time
STEG	Septic tank effluent gravity
STEP	Septic tank effluent pump
STPO	Septic Tank Phase Out

Abbreviation	Definition
STU	Soil treatment unit
TDS	Total dissolved solids
TN	Total nitrogen
TP	Total phosphorus
TSS	Total suspended solids
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
WRF	Water reclamation facility
WWTF	Wastewater treatment facility

Executive Summary

ES.1 Introduction

ES.1.1 Project Background

Approximately 65,000 septic systems and 35,000 private water wells remain in the JEA service areas of Duval, St. Johns, and Nassau counties. Over time, the City of Jacksonville (City), with technical support from JEA, has led multiple septic tank phase out programs in areas without central water and sewer infrastructure. These infrastructure projects were accomplished through City capital project initiatives with contributions by JEA. The work continues today with the current JEA septic tank phase out (STPO) program.

In 2003, the Water and Sewer Infrastructure Task Force was formed by the City and JEA. The Task Force caused the development of a prioritization system for the phase out of remaining septic systems. The prioritization system was created by the City of Jacksonville Regulatory and Environmental Services Department in consultation with the Duval County Health Department. The 2003 prioritization system focused on environmental, public health and welfare considerations including the number of septic tank system repair permits issued, average lot size, soil potential, seasonal high-water table, sanitary conditions, proximity to any surface water body and potential for flooding in the areas. In 2016, the City and JEA collaborated to modify the STPO program approach to prioritization and allocation of funding to include certain additional community considerations.

To that end, a STPO project area matrix was jointly developed by the City and JEA. It has been updated annually. The matrix included data in two distinct sections. The first section contained environmental, health and welfare parameters with a maximum of 70 points possible towards an overall total score for prioritization. The second section contained community consideration parameters with a maximum of 30 points possible towards the overall total score.

The most recent 2020 matrix update resulted in the prioritization of approximately 22,000 residential parcels with existing septic systems (out of the total 65,000) into 35 STPO project areas. The top tier in the matrix (meaning the most important to implement) included three areas with septic conversion projects already underway at various stages at the time of this report, including: Biltmore C and Beverly Hills (under construction) and Cristobel (initiation of preliminary design engineering services). Historically the STPO program projects have replaced existing septic systems with conventional gravity collection systems.

This project, the *JEA Innovative Wastewater Treatment Program (IWTP)*, was intended to assess and recommend the most appropriate technologies and approaches (including centralized sewer, decentralized sewer and treatment, and/ or improved onsite treatment) that could be applied to the remaining 32 prioritized STPO project areas. The planning documents developed as part of this project identified approaches that may also be used in the future for the approximately 43,000 additional septic systems that remain in Duval County.

ES.1.2 Goal of Task 8

The purpose of this Task 8 Master Plan Report was to formulate recommended solutions for implementation for each STPO priority area.

ES.1.3 Project Objectives

The main objectives of the overall project were:

- Identification of available wastewater technologies and management strategies.
- Evaluation of identified technologies, wastewater management strategies and institutional frameworks.
- Characterization of the remaining STPO priority areas (meaning the 22,000 parcels recommended in the most recent matrix evaluation) and evaluation of potential solutions.
- Determination of the best value method of implementing a conversion program.
- Development of a Master Plan recommending a wastewater management solution for each of the STPO priority areas.

ES.1.4 Project Scope

The overall IWTP program included four phases for development of a Master Plan:

- Phase 1: Literature & Industry Best Practices Review and Screening
- Phase 2: Geographic Conceptual Master Plan
- Phase 3: Potential Pilot
- Phase 4: Public Education Program

In accordance with Contract No. 184401, JEA authorized Hazen and Sawyer to complete Phase 1 and Phase 2 of the IWTP program. Exhibit B of the Contract provides the Scope of Work. The contract included the option to proceed with Phases 3 and 4 at JEA’s discretion. The overall scope of the current contract encompassed eight tasks:

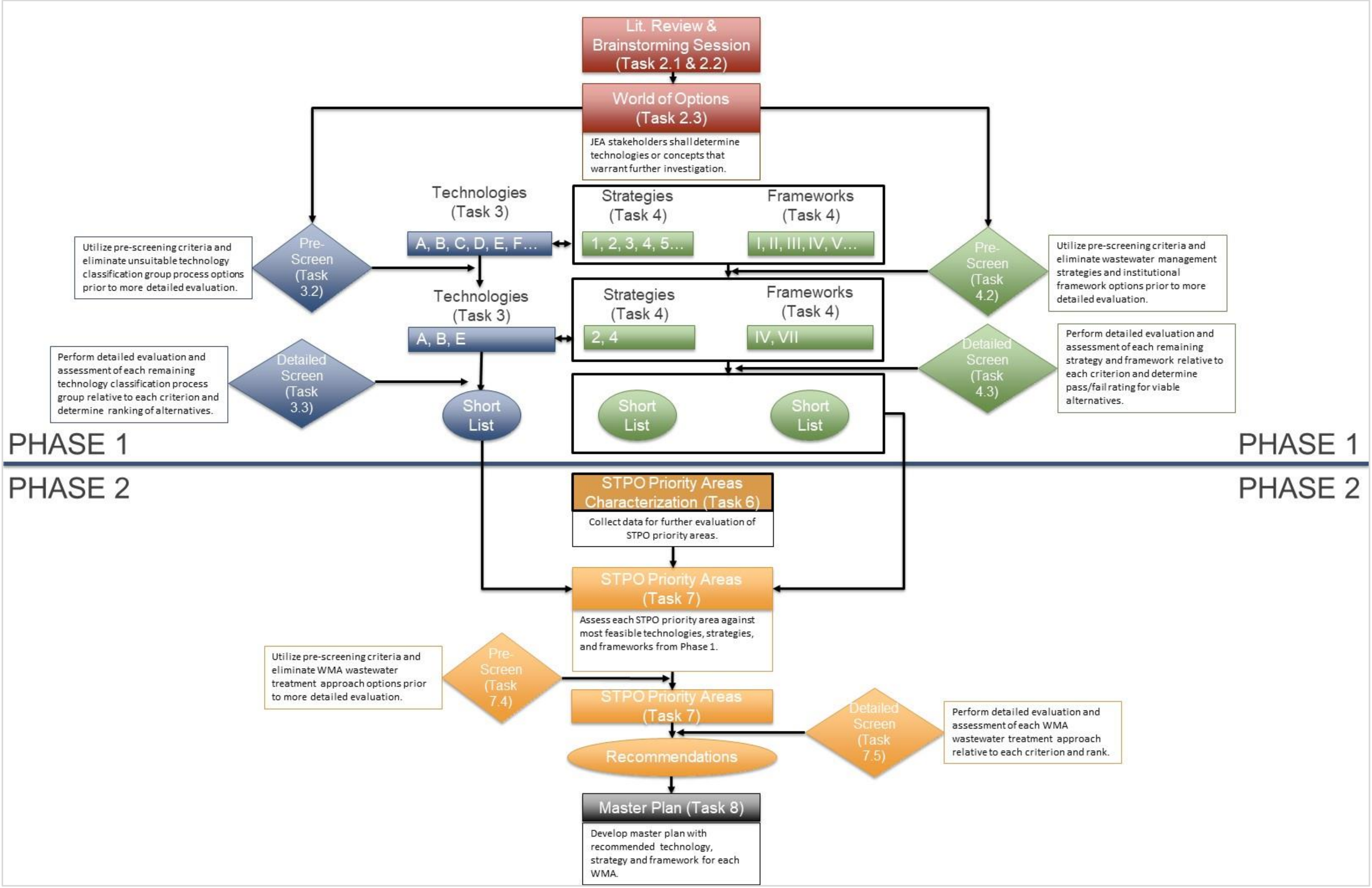
- Task 1: Program Initiation & Management
- Task 2: Literature & Industry Best Practices Review (reported in separate memorandum)
- Task 3: Technology Evaluation (reported in separate memorandum)
- Task 4: WW Management Strategies & Institutional Frameworks Evaluation (reported in separate memorandum)
- Task 5: Phase 1 Reporting (consolidates Tasks 2, 3 and 4)
- Task 6: Characterization of STPO Priority Areas
- Task 7: Application of Strategies & Technologies to STPO Priority Areas
- Task 8: Master Plan Report

ES.1.5 Overall Project Approach

The overall project approach is depicted in Figure ES-1. The following define the major components of the Phase 1 assessment:

- Technologies: equipment developed for wastewater collection, treatment, and/or effluent disposal (such as vacuum sewer system, biological treatment, and engineered wetlands).
- Wastewater management strategies: strategies for managing STPO priority area wastewater in lieu of existing septic systems (such as advanced onsite, decentralized, centralized, integrated, and source separation).
- Institutional frameworks: methods used to own, operate, finance, and implement wastewater management strategies (such as public, private, and design/build/operate/finance).

Phase 2 specifically evaluated 32 STPO priority areas utilizing the results of the Phase 1 assessments, with results detailed in this Master Plan (Task 8 of the scope of work).



JEA stakeholders shall determine technologies or concepts that warrant further investigation.

Utilize pre-screening criteria and eliminate unsuitable technology classification group process options prior to more detailed evaluation.

Utilize pre-screening criteria and eliminate wastewater management strategies and institutional framework options prior to more detailed evaluation.

Perform detailed evaluation and assessment of each remaining technology classification process group relative to each criterion and determine ranking of alternatives.

Perform detailed evaluation and assessment of each remaining strategy and framework relative to each criterion and determine pass/fail rating for viable alternatives.

Collect data for further evaluation of STPO priority areas.

Assess each STPO priority area against most feasible technologies, strategies, and frameworks from Phase 1.

Utilize pre-screening criteria and eliminate WMA wastewater treatment approach options prior to more detailed evaluation.

Perform detailed evaluation and assessment of each WMA wastewater treatment approach relative to each criterion and rank.

Develop master plan with recommended technology, strategy and framework for each WMA.

Figure ES-1: Overall Project Approach Framework

ES.2 Literature and Industry Best Practices Review

The literature review identified conventional and innovative wastewater treatment technologies for onsite and decentralized wastewater treatment facilities, wastewater collection technologies, wastewater management strategies, and institutional frameworks for septic system conversion that warranted further investigation. Peer-reviewed journal articles, conference proceedings, case studies, reports, and technical information from manufacturers in the US and internationally were synthesized to identify limitations, challenges, and lessons learned.

ES.2.1 Identified Wastewater Treatment Technologies

The literature review identified wastewater treatment technologies for both decentralized and onsite management strategies (Section 2.2). Centralized collection system alternatives were assumed to utilize JEA’s existing municipal wastewater treatment facilities.

Decentralized treatment processes were defined as a multi-source collection, community or clustered treatment system used to collect, treat and disperse and/or reclaim wastewater from a small community or service area. For the purpose of this project, decentralized treatment was considered for wastewater flows between 5,000 gpd annual average daily flow (AADF) and up to approximately 1 million gallons per day (mgd) AADF, which covered the range of flow projected for the STPO priority project areas. Onsite treatment systems were defined as systems to collect, treat and disperse or reclaim wastewater from a single dwelling or building at the site where wastewater is generated. For this project, onsite treatment was considered for properties with wastewater flows less than 5,000 gpd AADF. It should be noted that future permitting and management of onsite wastewater treatment systems were scheduled to be transferred to the Florida Dept. of Environmental Protection (FDEP) at the time of this report (Chapter 2020-150), however new regulations have not been promulgated.

The literature review identified fundamental processes used in each wastewater treatment system to achieve the effluent quality likely required for various end uses. These included physical, chemical and/or biological unit processes in various combinations, including natural systems.

The physical, chemical and/or biological unit processes were broken down further based on distinct process variations within a group for both onsite treatment and decentralized treatment systems. A scheme for classifying identified alternatives was created to allow comparisons between the many options available for onsite treatment (Figure ES-2) and decentralized treatment (Figure ES-3).

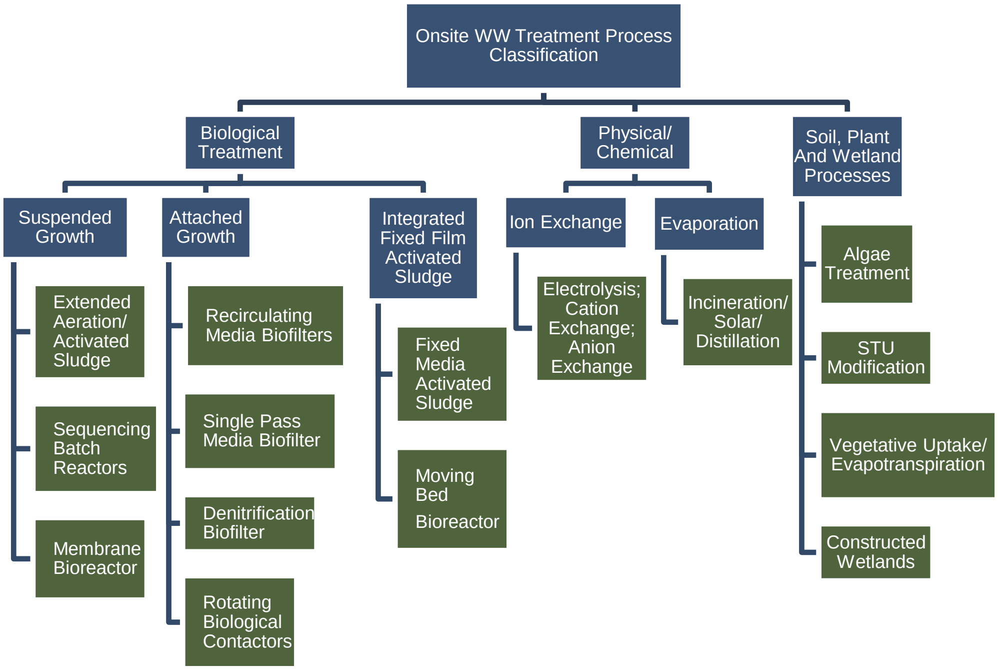


Figure ES-2: Classification of Onsite Treatment Technologies

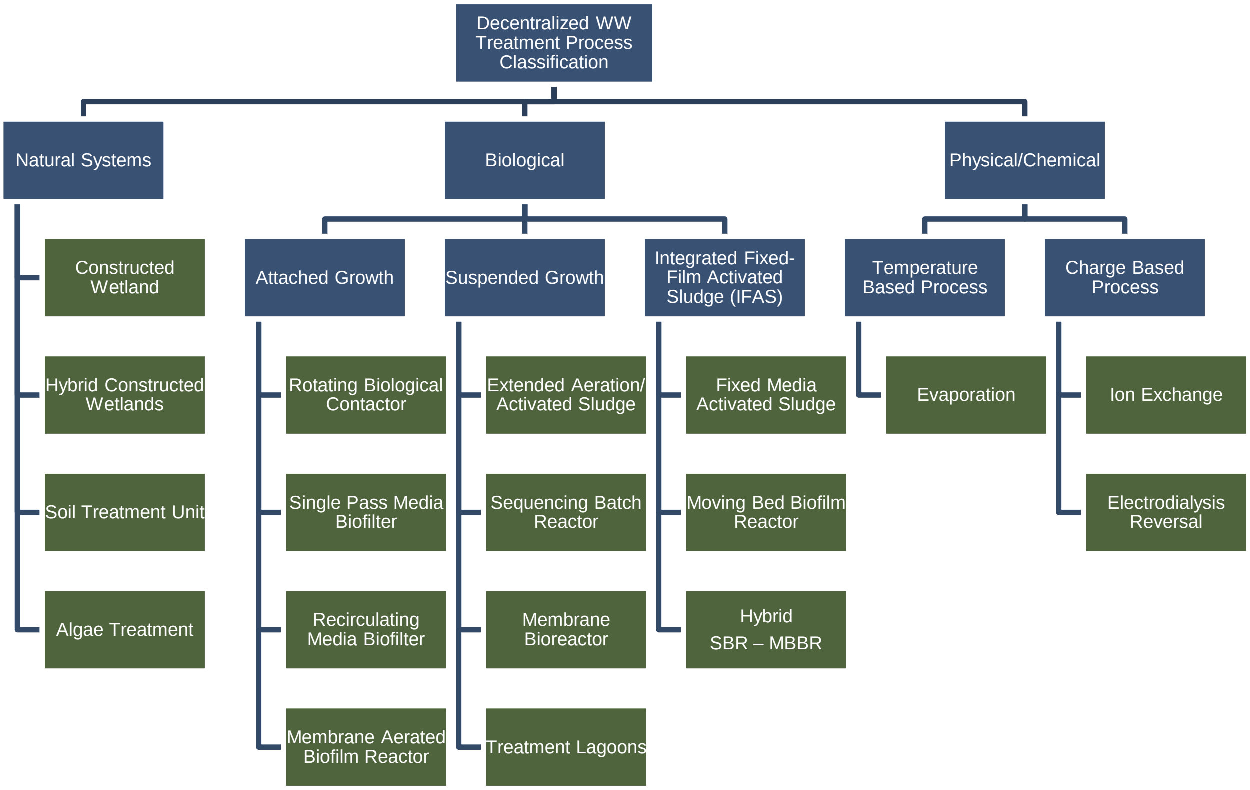


Figure ES-3: Classification of Decentralized Treatment Technologies

ES.2.2 Identified Wastewater Collection Technologies

The literature review found that conventional gravity flow sewer collection systems are the most widely used method for residential wastewater collection in the US. However, conventional gravity is not always the best suited solution for site-specific conditions primarily due to cost, especially for retrofitting into existing residential development. The literature review identified five wastewater sewer collection system types typically used for septic to sewer conversion: gravity, low pressure, vacuum, hybrid and holding tank as shown in Figure ES-4.

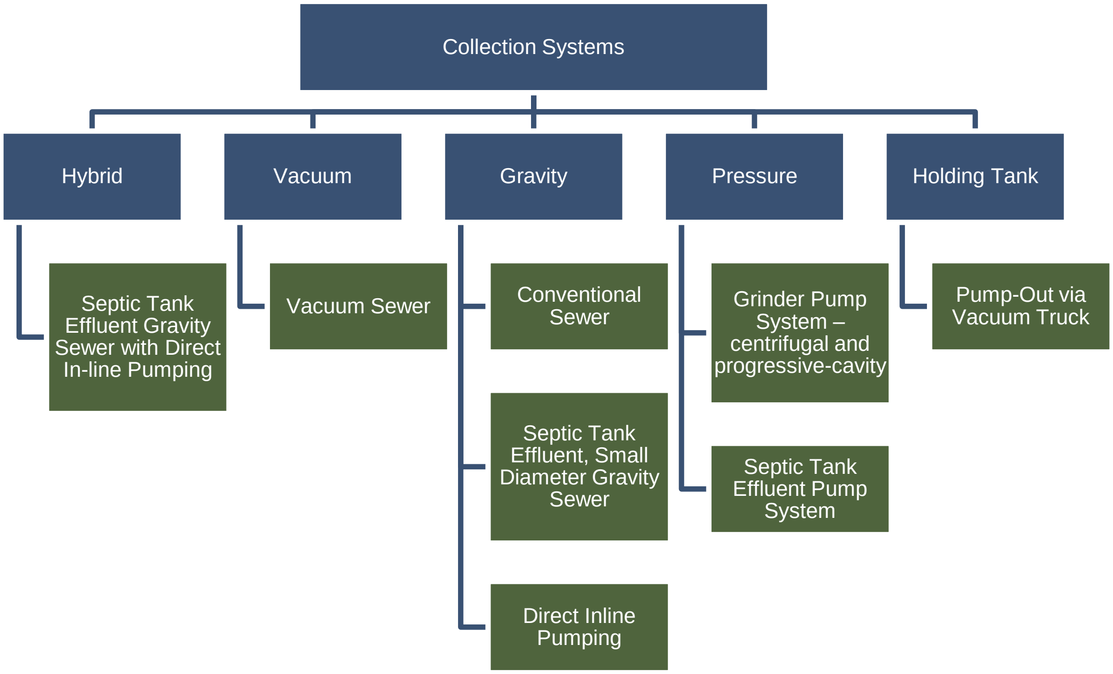


Figure ES-4: Wastewater Collection System Alternatives Summary

ES.2.3 Identified Wastewater Management Strategies

Wastewater management strategies for this project were defined as methods for managing wastewater generated in the STPO priority areas in lieu of the existing septic systems. The literature review identified two main groups of wastewater management strategies (Section 2.4): traditional wastewater management strategies and innovative component wastewater management strategies. Figure ES-5 shows the four identified traditional wastewater management strategies (i.e., onsite, decentralized, centralized, and integrated) and their subgroups (e.g., collection methods and level of treatment).

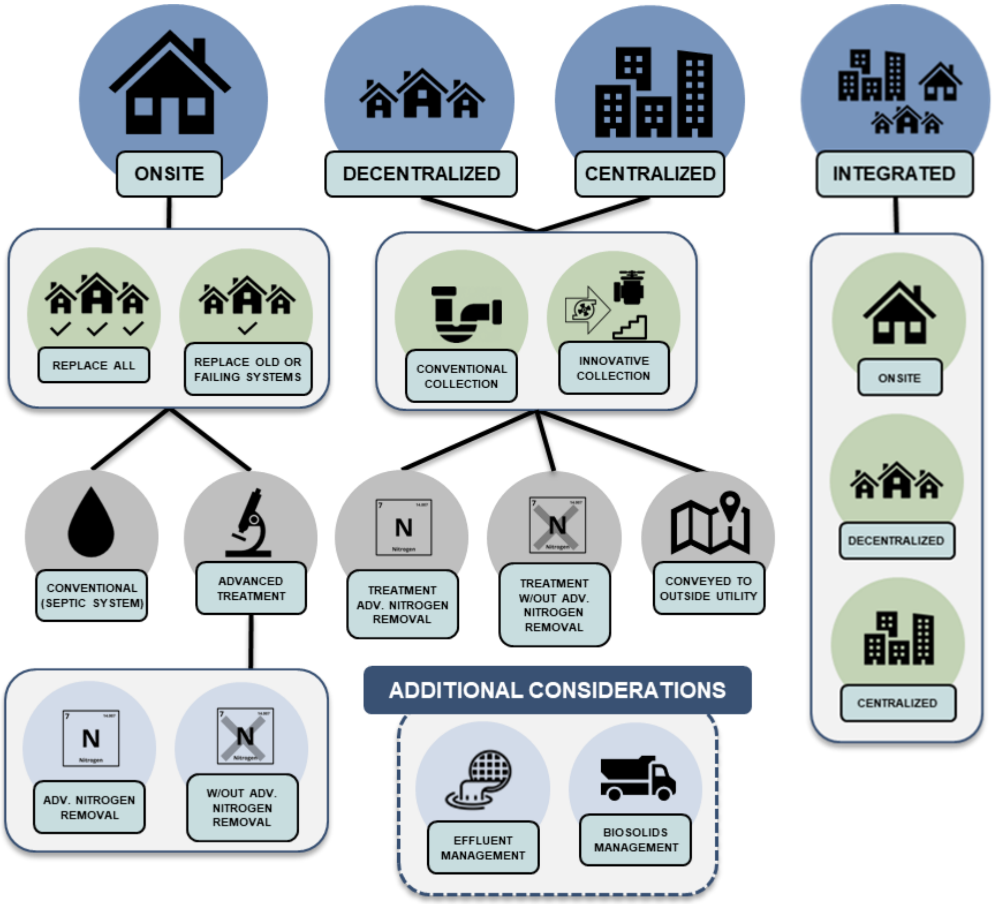


Figure ES-5: Identified Traditional Wastewater Management Strategies Alternatives

In addition, innovative component management strategies could be coupled with overall strategies such as: community redevelopment, source separation, and groundwater remediation with permeable reactive barriers as summarized in Figure ES-6.

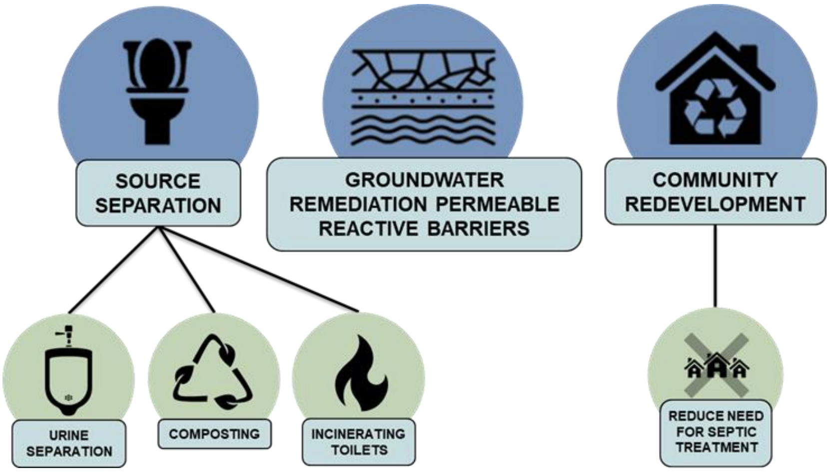


Figure ES-6: Innovative Component Wastewater Management Strategies

ES.2.4 Identified Institutional Frameworks

Institutional frameworks for this project were defined as methods used to finance, build, and operate the various wastewater management strategies and included public, private and hybrid solutions. Various approaches were identified (Section 2.5) including ownership frameworks (Figure ES-7), project delivery frameworks (Figure ES-8), and funding opportunities (Figure ES-9).

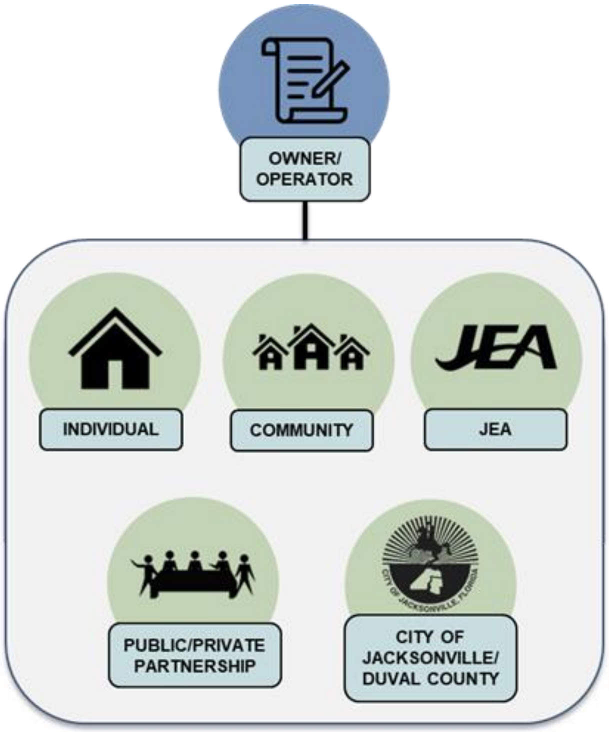


Figure ES-7: Ownership Frameworks

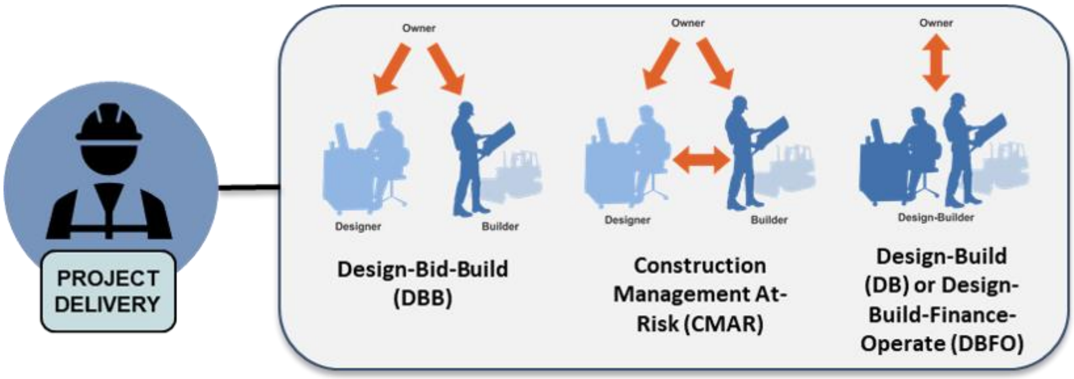


Figure ES-8: Project Delivery Frameworks

The components required for each individual funding source were unique due to source-specific rules, procedures, and activities. Pursuing each of the identified funding sources will increase the probability of obtaining financial assistance.

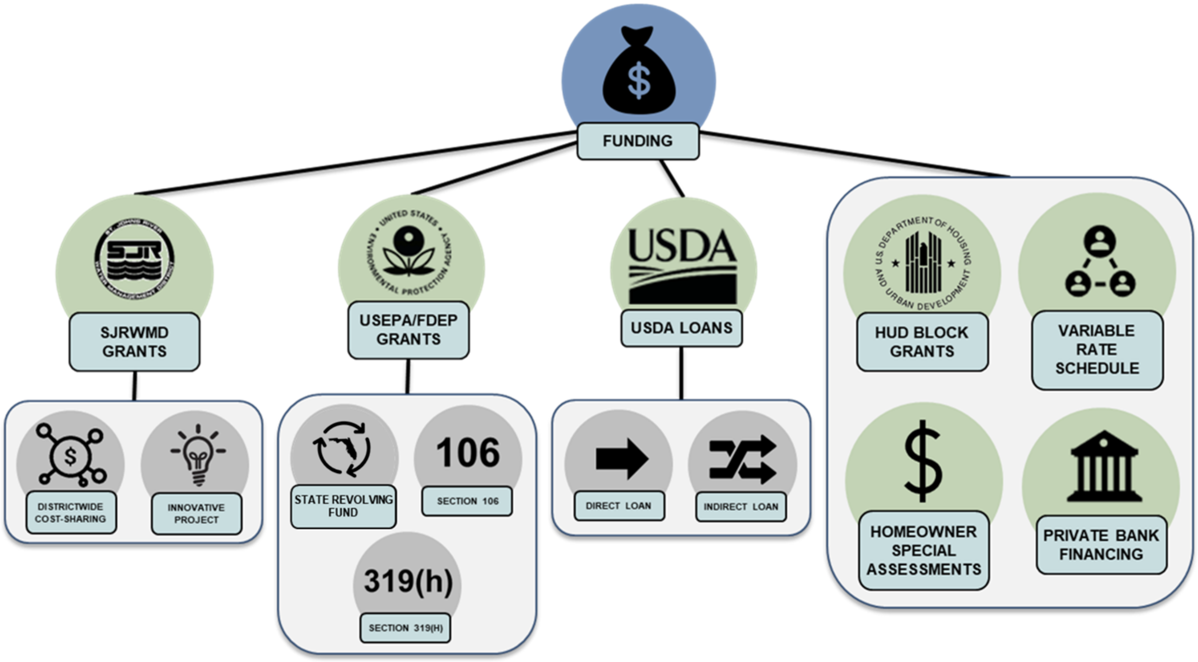


Figure ES-9: Funding Opportunities

ES.3 Assessment of Technologies, Strategies and Institutional Frameworks

The identified wastewater treatment and collection technologies, wastewater management strategies and institutional frameworks were classified, evaluated, screened and prioritized for consideration by JEA in Phase 1 of the project.

ES.3.1 Technology Evaluation

For this project, technologies were defined as equipment developed for wastewater collection, treatment, and/or effluent disposal. The wastewater treatment technologies identified were evaluated in two steps (see Section 3): first a preliminary screening (pre-screening) followed by a detailed screening analysis.

ES.3.1.1 Assessment of Wastewater Treatment Technologies

Traditional and innovative wastewater treatment technologies were evaluated for applicability to the JEA IWTP program. Three criteria were used to judge viability of treatment technologies for further consideration:

1. **Meets Programmatic Goals:** The first criterion considered whether the alternative met JEA's programmatic goals of meeting certain effluent water quality standards. In addition, the feasibility of using the technology in an urban environment was considered.
2. **Technology Maturity and Experience:** The second criterion considered whether the technology was proven with full-scale applications to clearly demonstrate viability in the marketplace.
3. **Regulatory Considerations:** The third criterion considered whether the technology had precedence of approval in Florida (FDEP/FDOH) or reasonable assurance that it could be permitted in the current regulatory environment.

The treatment system alternatives that moved forward to detailed evaluation are summarized in Figure ES-10 (decentralized) and Figure ES-11 (onsite).

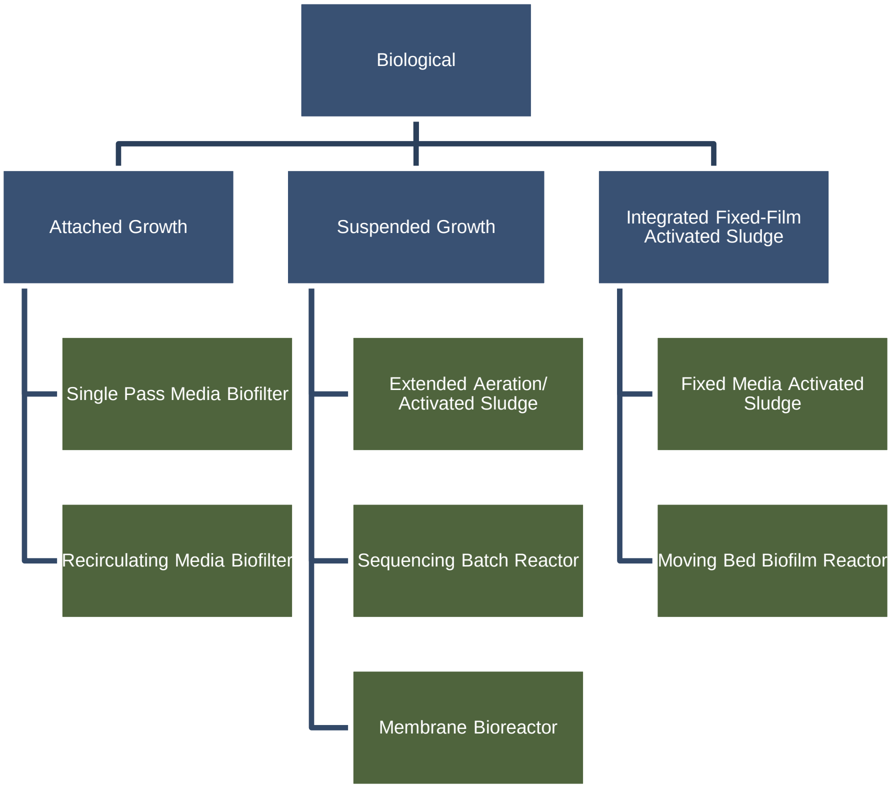


Figure ES-10: Decentralized Treatment Technologies Screening Results

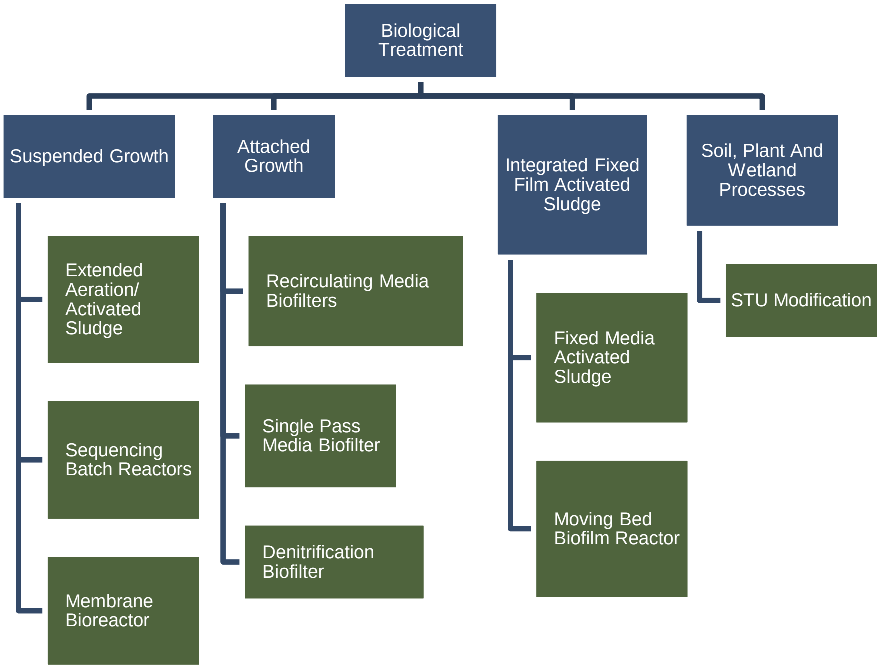


Figure ES-11: Onsite Treatment Technologies Screening Results

ES.3.1.2 Assessment of Wastewater Collection Technologies

Traditional and innovative wastewater collection systems were evaluated (Section 3.5) for applicability to the JEA IWTP program. Three criteria were used to judge viability of sewer collection system technologies for further consideration: met programmatic goals, regulatory considerations and technology maturity and experience. The remaining collection system alternatives included: conventional gravity, pressure grinder pumps systems, and vacuum sewer.

ES.3.2 Assessment of Wastewater Management Strategies

The identified wastewater management strategies were screened using decision support criteria and input from JEA. Four criteria were used to judge the viability of innovative and traditional wastewater management strategies: proven strategy, physical implementation feasible, secondary impacts, and environmental benefits. The remaining alternatives for traditional and innovative wastewater management strategies are depicted in Figure ES-12.

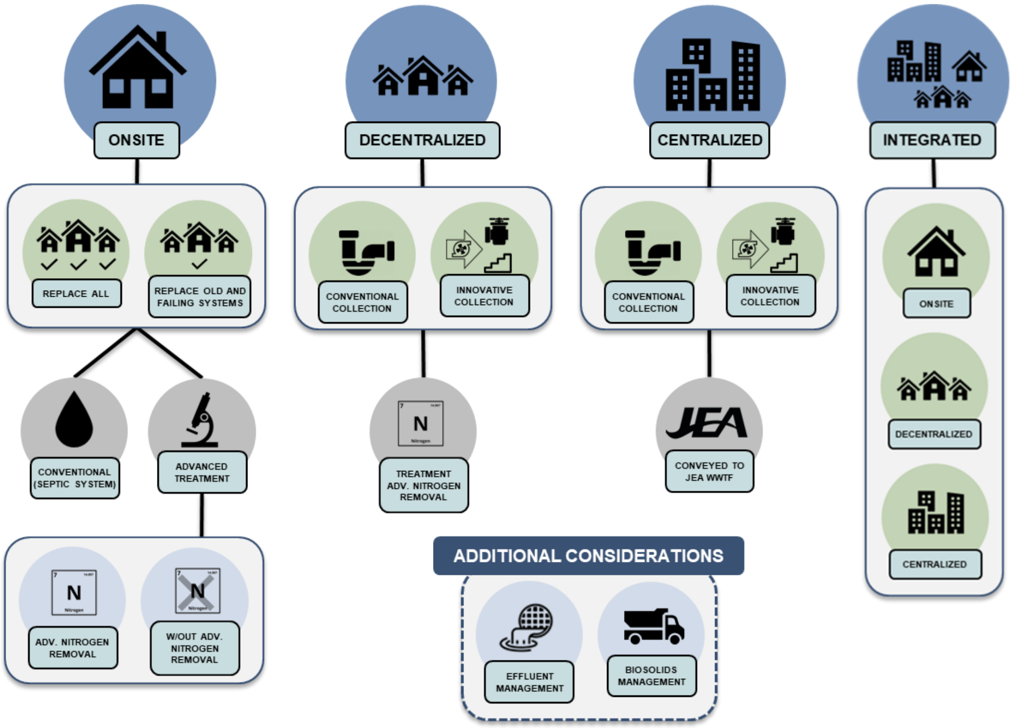


Figure ES-12: Traditional Wastewater Management Strategies Screening Results

ES.3.4 Assessment of Institutional Frameworks

The results from the literature review led to the development of a scheme for examining institutional frameworks. Similar to the process used to evaluate wastewater technologies and management strategies, institutional frameworks and funding mechanisms underwent a screening analysis (Section 4.3). The criteria for institutional frameworks differed from the wastewater management strategies because it focused on two criteria: feasibility and met programmatic goals. The Ownership and Project Delivery Frameworks screening results are shown in Figure ES-13. All identified project delivery methods were defined as feasible and met the programmatic goals. Results of the analysis for funding opportunities are shown in Figure ES-14.

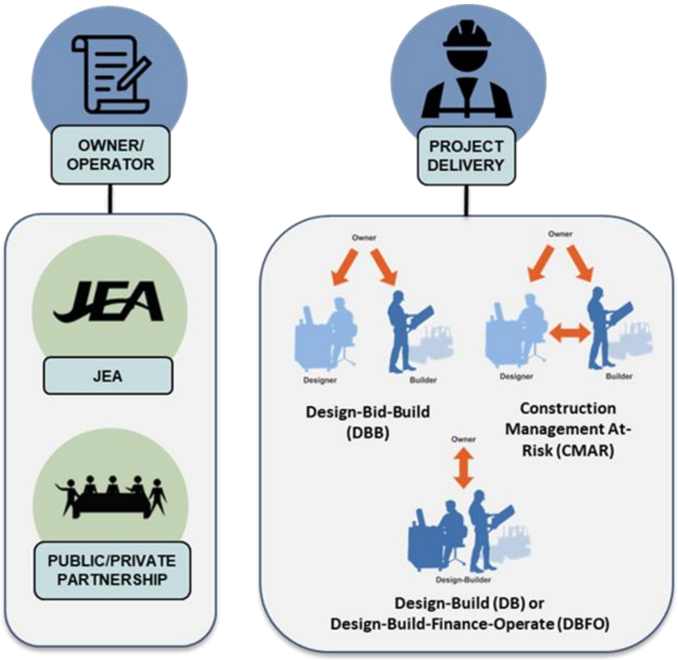


Figure ES-13: Ownership and Project Delivery Frameworks Screening Results

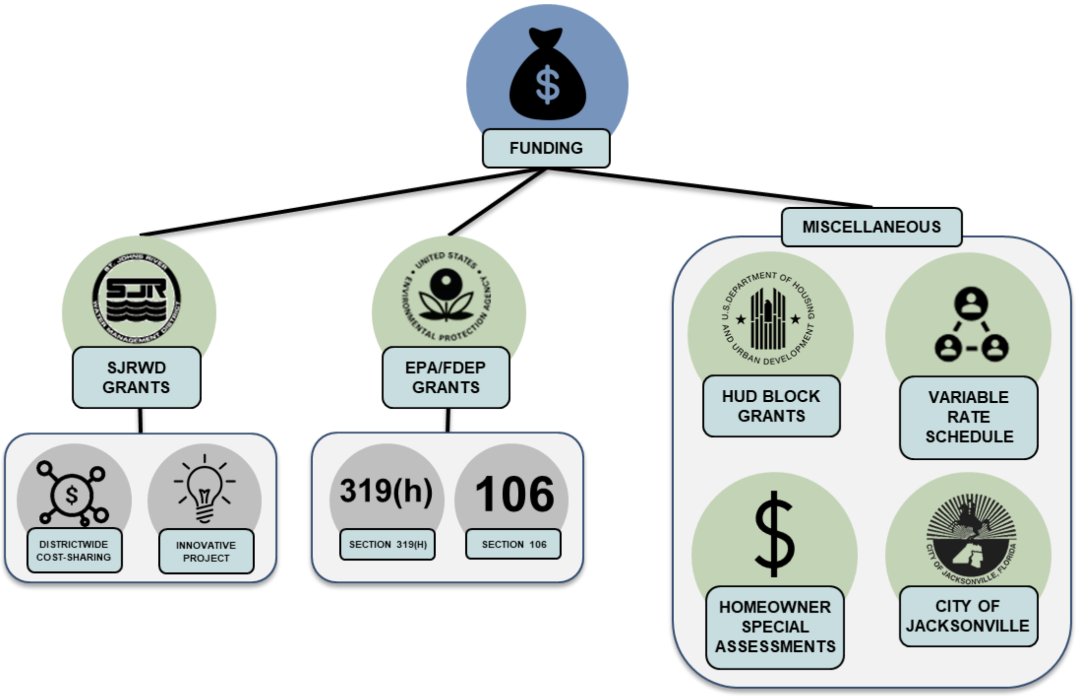


Figure ES-14: Funding Alternatives Screening Results

ES.4 Characterization of STPO Priority Areas Review

The remaining 32 STPO priority project areas were grouped according to existing JEA wastewater treatment facility (WWTF) service areas. The STPO priority areas were located within six WWTF service areas: Arlington East, Buckman, Cedar Bay (District 2), Mandarin, Monterey, and Southwest. Currently no STPO priority project areas are within the Blacks Ford, Julington Creek Plantation (JCP), Ponte Vedra, Ponce de Leon or Nassau Regional WWTF service areas. The STPO priority area characterization, which was used when assessing alternative wastewater capital improvements in Task 7, included an analysis of existing customers, septic system density, land use, existing utilities, topography, other existing infrastructure and environmental factors (including sea level rise). Table ES-1 summarizes certain metrics for the aggregated 32 remaining STPO priority areas considered.

Table ES-1: General Overall Characterization of 32 Remaining STPO Priority Areas

Description	Units	Minimum	Maximum	Average	Total
Total Parcels	#	35	4,802	896	28,669
Septic Parcels	#	34	3,714	719	22,998
Vacant Parcels	#	0	324	46	1,475
Proportion Septic Parcels	%	49	100	83	
Proportion Residential Parcels	%	80	100	95	
Eq. Res. Units	#	32	4,239	693	22,165
Avg Res. Parcel Acreage	acres	0.19	1.82	0.43	
Vacant Acreage	acres	0	157	27	864
Vacant Government Owned Acreage	acres	0	28	4	133

ES.4.1 Wastewater Flow Generation Projections

The existing and future land use designations of the septic parcels were considered to enable estimation of wastewater flow rates for each STPO priority project area. The combined residential, commercial, industrial and institutional wastewater flow projection for the STPO priority areas ranged from approximately 5.3 to 7.3 million gallons per day as summarized in Table ES-2 using two different methodologies.

Table ES-2: Wastewater Flow Generation Projections for STPO Priority Areas

Description	Units	Minimum	Maximum	Average	Total
Water Meter AADF	gpd	6,650	790,300	164,900	5,275,600
Planning AADF	gpd	9,650	1,133,200	230,000	7,357,700

Figure ES-15 presents the JEA WWTF service areas which included the 32 remaining STPO priority areas. The JEA Annual Water Resource Master Plan (2019), included wastewater flow projections for the WWTF service areas through the year 2040 (see Table ES-3). However, JEA noted that recent changes to planned improvements at the wastewater treatment facilities altered the year 2040 projections. Based on these projections and the referenced improvements, the Arlington East,Monterey and Southwest WWTFs may not have available capacity to accommodate the estimated additional STPO priority areas flow by 2040. However, JEA noted that there is time to make appropriate changes at JEA’s WWTFs to accommodate additional flow if needed.

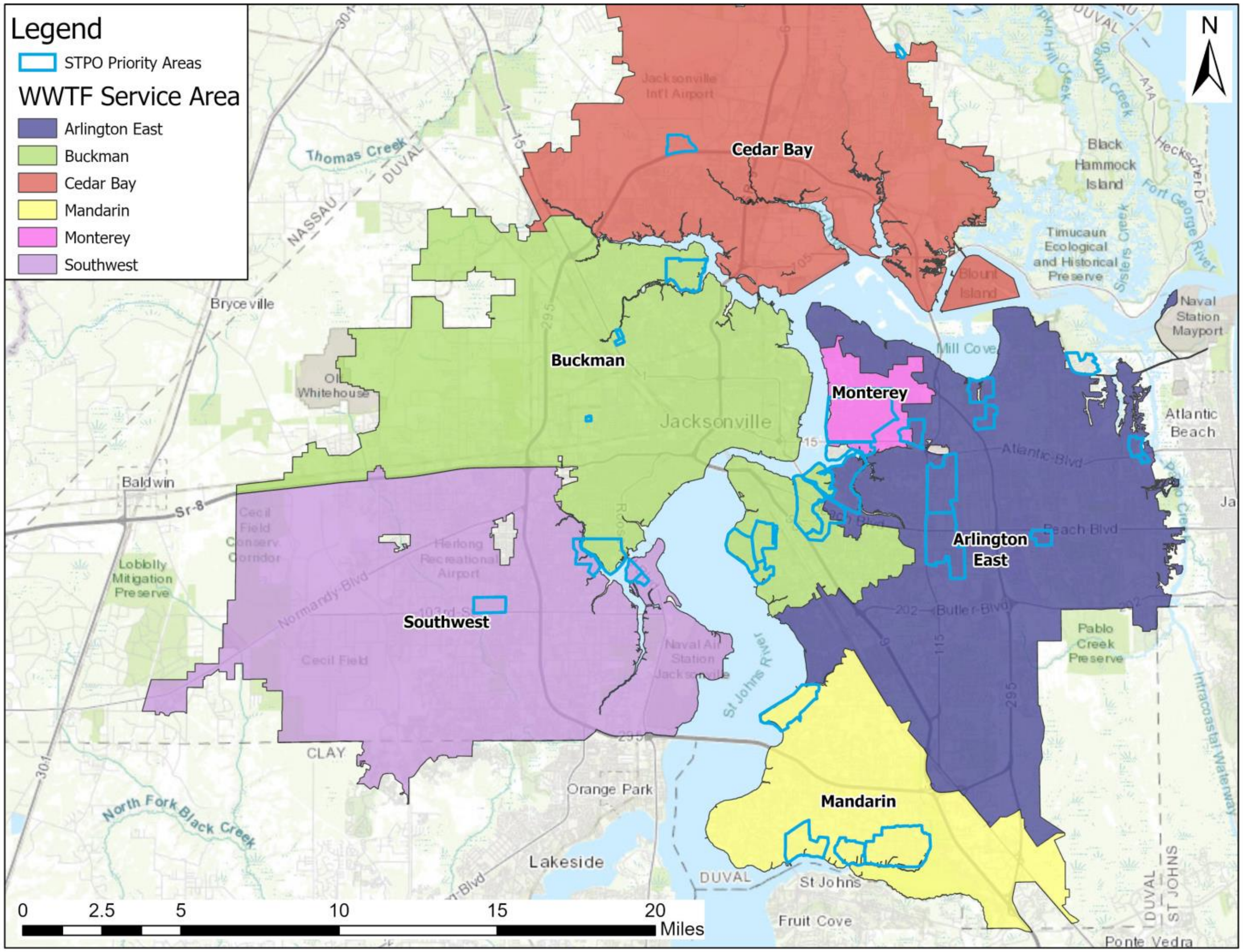


Figure ES-15: Impacted JEA WWTF Service Areas

Table ES-3: WWTF Available Capacity and Estimated Additional STPO Priority Areas Wastewater Flow

JEA Annual Water Resources Master Plan[1]					Estimated Additional AADF Flow from STPO Priority Areas[3], MGD	Received 8/10/2020		Including Additional STPO Flow, Projected Available Capacity in 2040, MGD (%)
JEA WWTF Service Area	**AADF as of May 2018, MGD**	**AADF Projections for 2040[1], MGD**	**Permitted Capacity, MGD**	**Projected Available Capacity in 2040, MGD (%)**		***Revised AADF Projections for 2040[2], MGD***	***Projected Available Capacity in 2040, MGD (%)***	
A	B	C	D	E= D-C	F	G	H= D-G	I= D-(F+G)
Arlington East	22.40	20.97	25.00	4.03 (16%)	1.94	*24.14*	*0.86 (3%)*	-1.08 (- 4%)
Buckman	28.33	39.47	52.50	13.03 (25%)	1.81	*30.17*	*22.33 (43%)*	20.52 (39%)
Cedar Bay (District 2)	5.66	8.67	10.00	1.33 (13%)	0.09	*8.10*	*1.9 (19%)*	1.81 (18%)
Mandarin	8.03	7.49	8.75	1.26 (14%)	1.24	*6.59*	*2.16 (25%)*	0.92 (10%)
Monterey	1.32	1.84	3.60	1.76 (49%)	1.30	*2.13*	*1.47 (41%)*	0.17 (5%)
Southwest	11.95	14.16	14.00 [18.00[2]]	[18.00[2]] 3.84 (21%)	0.97	*14.27*	*[16.00[2]]* *1.73 (11%)*	0.76 (5%)
Total					**7.36**			

[1] Source: JEA Annual Water Resource Master Plan, September 2019

[2] Design was planned for expanding the Southwest WWTF treatment capacity to 18 MGD from 14 MGD but was revised to 16 MGD.

[3] Planning level wastewater flow projection estimate of 280 gpd per ERC which was compared to water meter data.

ES.4.2 Representative STPO Priority Areas

The 32 remaining STPO priority areas were categorized based on similar septic system density (i.e. lot size) characteristics, and nine representative STPO priority areas were chosen for more detailed planning level cost analysis for various strategies and technologies. In addition, some STPO priority areas had a mixture of waterfront parcels which were typically long, narrow, large lots and smaller inland parcels. The use of several different wastewater management strategies (hybrid) may be most cost effective for these areas thus were categorized as hybrid. The resulting representative areas by density type are outlined in Table ES-4.

Table ES-4: Representative STPO priority areas for IWTP Wastewater Improvements Cost Analysis

Housing Density			
High (<0.25 acre avg. lot size)	**Medium (0.25 – 0.5 acre avg. lot size)**	**Low (>0.5 acre avg. lot size)**	**Hybrid (highly variable lot sizes)**
Westfield	Pablo Point	Northlake	Mt. Pleasant
Lakeshore	Cedar River	Holly Oaks	Cedar River
Riverview	Mill Creek	Mt. Pleasant	Riverview

Conceptual wastewater improvement layouts and associated costs for these representative areas were used in screening of wastewater capital improvements.

ES.5 Development of Recommended STPO Priority Areas Wastewater Improvements

Recommended wastewater improvements for each STPO priority area were formulated by combining the characterization of each STPO priority area with the top ranked wastewater management strategies, institutional frameworks and technologies identified in Phase 1. This analysis resulted in recommended wastewater capital improvements for each STPO. The representative area planning level cost estimates were used to estimate costs for the remaining priority areas. These costs, along with an additional eight criteria, were used to further evaluate wastewater capital improvement alternatives for each STPO priority area. The detailed evaluation resulted in a top ranked wastewater capital improvement recommendation for each STPO priority area.

ES.5.1 Pre-Screening of STPO Priority Areas Wastewater Improvements

Using the results of the Task 6 STPO priority areas assessment, onsite, decentralized and centralized hybrid collection system wastewater improvement alternatives were pre-screened. Vacuum and low pressure collection systems were assumed to be feasible for all of the STPO priority areas. The Task 6 STPO priority area characterization indicated that parcels with a topographic elevation below 6-ft could be significantly impacted by future sea level rise, with expected groundwater rise limiting the unsaturated thickness of the soil which would hinder operation and treatment efficacy of some onsite wastewater treatment systems and other technologies. Therefore, only the STPO priority areas not expected to be impacted by sea level rise and an average parcel acreage greater than 0.25 acres included onsite wastewater improvements as a solution alternative in the detailed evaluation.

For STPO priority areas either located far away from existing JEA infrastructure or within an area of the JEA service area with limited available capacity, a low-cost approach to wastewater treatment could be a new decentralized wastewater treatment facility. A preliminary cost analysis for new infrastructure to the JEA existing wastewater infrastructure point of connection (POC) indicated that only the areas with a POC greater than 4,000 linear feet from the boundary have the potential to offset the additional cost of decentralized treatment. Hence, only two STPO priority areas (Riverview and Northlake) were deemed suitable for consideration of decentralized wastewater improvements in the detailed evaluation.

Using the results of the Task 6 sea level rise estimations, the STPO priority areas impacted by both sea level rise and consisting of a mixture of long, narrow parcels at the riverfront with smaller lots inland included a hybrid collection system for decentralized and/or centralized wastewater improvements. Therefore, seventeen STPO priority areas included hybrid collection system wastewater improvements in the detailed evaluation.

Table ES-5 presents a summary of the results of the pre-screening of wastewater capital improvements. These wastewater capital improvements were considered for the STPO priority areas along with gravity, vacuum and low pressure collection systems for decentralized and centralized (as applicable).

Table ES-5: Results of the STPO Priority Area Pre-Screening of Wastewater Capital Improvements

Onsite	Decentralized	Decentralized or Centralized – Hybrid Sewer Collection
Champion Forest Lone Star Park Mill Creek Northlake Odessa Southside Estates	Northlake Riverview	Beauclerc Gardens Cedar River Clifton Empire Point Holly Oaks Hood Landing II Julington Creek Julington Hills Lakeshore Mt. Pleasant Oak Lawn Oakhaven Ortega Point La Vista Riverview Spring Glen St Nicholas

ES.5.2 Detailed Evaluation of STPO Priority Areas Wastewater Capital Improvements

Pre-screening was followed by a detailed evaluation including multiple selection criteria and weighting factors which were combined for a total score and resulted in one wastewater capital improvement recommendation per STPO priority area. The STPO priority area wastewater improvement criteria were individually discussed with JEA and edited accordingly. A final consensus list of nine criteria was agreed to with JEA (Table ES-6). A simple numerical ranking system was developed to prioritize the STPO priority area wastewater improvement recommendations based on the criteria.

Table ES-6: Detailed Evaluation Criteria for Wastewater Capital Improvements

	Category	Criterion
Technology Specific Criteria	Regulatory Uncertainty	Regulatory Uncertainty
	Management of Operation	Ease of Management
	Maximize Reliability	Sensitivity to Flooding
		Power Outages, Emergency Storage, Reliability of Equipment
	Maximize Public Acceptance	Odor
		Aesthetics (noise, visual)
		Construction Impacts
		Ease Private and Neighborhood Property Restrictions
STPO Priority Area Specific Criteria	Cost Effectiveness	Net Present Value of Costs (NPC)

The project team recognized that the criteria have differing levels of importance in the decision-making process, thus requiring the assignment of weighting factors to criteria that reflect JEA’s valuation structure. Criteria scores were normalized and weighted to determine a total score for each wastewater capital improvement alternative for a given STPO priority area. Table ES-7 presents the top ranked wastewater capital improvement for each STPO priority area based on the results of the detailed evaluation.

Table ES-7: Top Ranked Wastewater Capital Improvements

STPO Priority Area	Gravity	Vacuum	Low Pressure	Onsite
Atlantic Highlands	X			
Beauclerc Gardens		X		
Cedar River		X		
Champion Forest		X		
Clifton		X		
Eggleston Heights		X		
Emerson		X		
Empire Point		X		
Freeman	X			
Holly Oaks		X		
Hood Landing II		X		
Julington Creek		X		
Julington Hills		X		
Kinard			X	
Lakeshore		X		
Lone Star Park		X		
Mill Creek		X		
Mt Pleasant		X		
Northlake				X
Oak Lawn		X		
Oakhaven		X		
Odessa				X
Ortega			X	
Pablo Point		X		
Point La Vista		X		
Riverview		X (Decentralized)		
Sans Pareil		X		
Southside Estates		X		
Spring Glen		X		
St Nicholas		X		
The Cape	X			
Westfield		X		
TOTAL	**3**	**25**	**2**	**2**

ES.6 Development of Recommended Wastewater Capital Improvement Plan

The conclusions and recommendations presented in this Master Plan result from a comprehensive 1.5-year study effort, which included evaluations of multiple technologies, wastewater management strategies and institutional frameworks. An overarching goal of the study was to identify best value methods for accomplishing the large-scale septic to sewer conversion program. Figure 6-4 through Figure 6-9 in the previous Section illustrated the recommended wastewater capital improvement for each STPO priority area. The septic tank conversions contemplated herein were evaluated (using weighted criteria) without consideration of other major construction within the public right-of-way. It is possible that certain conversion project areas may ultimately include investments in water service, stormwater drainage, or other infrastructure which, if considered, could affect the weighted criteria analysis conclusions. For example, if a project area were to include major water and drainage improvements, the entire right-of-way may require roadway reconstruction. In such an instance, it is possible that a different sewer approach (e.g. gravity instead of vacuum) may ultimately represent a better value to JEA. Moreover, the technology evaluation presented herein could be affected by changes to legislation, available funding, etc. Hence, review of all such factors during detailed design is recommended to validate the approaches identified within this Master Plan.

ES.6.1 Wastewater Capital Improvement Planning Level Estimates

A total of approximately 22,998 prioritized unsewered parcels in the JEA service area were evaluated for potential wastewater capital improvements. Of the total parcels, 22,395 (97%) parcels were recommended to be served by a vacuum collection system, 207 connections were recommended to be served by a gravity collection system, and 223 connections by a low pressure collection system. The remaining 173 connections were recommended to be served by an advanced onsite treatment system. Planning level cost estimates were prepared for each STPO priority project area for the purpose of defining the total wastewater capital improvement costs for the JEA STPO Program. A summary of the estimated capital costs for the STPO priority project areas are summarized in Table ES-13.

Table ES-13: STPO Priority Areas Program Cost[1] Summary

Description	Phase-Out Cost 32 STPO Priority Areas	Phase-Out Cost Per Connection (Average)
Estimated Total Capital Construction Costs	$743M	$37K
Estimated 20-year O&M NPC[2]	$79M	$4K
Estimated Total NPC	$822M	$41K

[1] Preliminary engineer's opinion of probable construction costs (EOPCC) have been prepared based upon Master Plan level information. Because of the level of scope development at this stage the estimate is an "Order of Magnitude" estimate as defined by the Association for the Advancement of Cost Engineering International (AACE) Class 5. The expected range of accuracy for this type of estimate is - 50% to +100%. These costs have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material cost, competitive market conditions, final project scope, implementation schedule, and other variable conditions. As a result, the final project costs will vary from the estimate presented herein. The capital construction costs do not include new water services nor new stormwater drainage aspects to the project areas.
[2] The presented 20-year O&M net present costs (NPC) were determined based on 2.5% discount rate, the current rate for Federal Water Projects.

Total capital wastewater improvements construction costs were estimated to equal $743 million with costs ranging from $1.2 million to over $103 million for the project areas. Costs include estimated costs for constructing collection systems, vacuum pump stations, lift stations, major transmission systems, low pressure collection systems, and advanced onsite systems. The capital construction costs do not include new water services nor new stormwater drainage aspects to the project areas. Costs associated with expanded treatment plant capacity necessary to accommodate additional flows from each service area were not evaluated as part of this study. Based on the wastewater flow projections and the referenced wastewater improvements, the Arlington East, Monterey and Southwest WWTFs may not have available capacity to accommodate the estimated additional STPO priority areas flow by Year 2040. However, JEA noted that there is time to make appropriate changes at JEA's WWTFs to accommodate additional flow if needed. These costs will still need to be accounted for in the Utility's budget cycle when any one of the service areas within the JEA study area is included as a capital improvement project.

ES.6.1 Next Steps

This Section provides guidance on the future direction of the STPO Program and those efforts which are needed to support that direction. Based on the results of this project, various efforts and programs are recommended to facilitate meeting goals and objectives of the STPO Program. Such efforts and programs include the following:

1. **Development of an Implementation Plan**. The Implementation Plan would identify methods and strategies to finance the wastewater capital improvements in coordination with the City and provide conceptual plans for the top ranked recommended wastewater capital improvements. A benefits and cost allocation evaluation of the Program would assist in the development of financing program policies and procedures. In addition, the Implementation Plan could include development of narrative and graphics as needed to seek grant funding for the program.

2. **Purchasing Review.** JEA should consider early implementation of a purchasing strategy designed to ensure adequate pricing protection recognizing the potential for large scale implementation of vacuum technology and the limited quantity of qualified suppliers.

3. **Design Standards**. As JEA proceeds with the design and construction of wastewater improvements, update the current Water & Wastewater Standards Manual as it pertains to the use of advanced onsite, low pressure and vacuum sewer technologies as needed.

4. **Interdepartmental Coordination**. JEA should continue its interdepartmental coordination with the City as the Program moves forward. These efforts become particularly critical when other capital improvement projects (e.g., stormwater) geographically intersect with the STPO program. This will result in a cost savings to Jacksonville residents and keep construction disturbance to a minimum.

5. **Funding**. JEA should continue to aggressively pursue the securing of outside agency grants and other forms of "cost free" capital to minimize the financial effects of the Program.

6. **Phase 3: Potential Pilot Projects.** JEA should consider potential pilot projects to determine technical feasibility and as a tool to inform homeowners. Potential pilot projects to facilitate the evaluation of benefits include innovative wastewater management strategies and/or technologies such as advanced onsite treatment and management, remote/web based monitoring for onsite treatment, vacuum and low pressure sewer collection systems.

7. **Phase 4: Public Education Program**. Most importantly, the development of a Public Education Program regarding the wastewater improvements selected and scheduled for implementation will

increase citizen awareness and help to address citizen's concerns regarding the ongoing STPO wastewater improvements program. Various program elements could include:

- Stakeholder analysis
- Media releases
- Web page updates
- Surveys
- Public information materials
- Public presentations

1. Introduction

1.1 Project Background

Approximately 65,000 septic systems and 35,000 private water wells remain in JEA service areas of Duval, St. Johns and Nassau counties. Over time, the City of Jacksonville (City), with technical support from JEA, has led multiple septic tank phase out programs in areas without central water and sewer infrastructure. These infrastructure projects were accomplished through City capital project initiatives with contributions by JEA. The work continues today with the current JEA septic tank phase out (STPO) program.

In 2003, the Water and Sewer Infrastructure Task Force was formed by the City and JEA. The Task Force caused the development of a prioritization system for the phase out of remaining septic systems. The prioritization system was created by the City of Jacksonville Regulatory and Environmental Services Department in consultation with the Duval County Health Department. The 2003 system focused on environmental, public health and welfare considerations including the number of septic tank system repair permits issued, average lot size, soil potential, seasonal high water table, sanitary conditions, proximity to any surface water body and potential for flooding in the areas. In 2016, the City and JEA collaborated to modify the STPO program approach to prioritization and allocation of funding to include certain community considerations.

To that end, a STPO project area matrix was jointly developed by the City and JEA. It is updated annually. The matrix includes data in two distinct sections. The first section considers environmental, health and welfare parameters with a maximum of 70 points possible towards the overall total score. Parameters include:

- Annual Duval County Health Department (DCHD) scoring which considers the number of septic tank system repair permits issued, average lot size, soil potential, seasonal high water table, threat to potable water, sanitary conditions, proximity to any surface water body, and potential for flooding in the area.

- Impaired tributary exceedance factor which is a measure of the percentage of samples exceeding State standards for fecal coliform in the area as determined by the City of Jacksonville Environmental Quality Division.

- Percentage of lots in the area within a 150 meter buffer of water bodies.

The second section considers community consideration parameters with a maximum of 30 points possible towards the overall total score. Parameters include:

- Whether developed prior to 1968, the year in which the City was consolidated. Priority is given to those areas developed prior to 1968.

- Median home value, and priority is given to economically challenged areas.

- Central water distribution coverage in the area, and priority is given to areas with no existing water distribution.

- Elimination of future proliferation which considers the percent of undeveloped lots within the area.

- Offsite economic development opportunities to recognize potential secondary economic development benefits that may result from the offsite infrastructure construction.

The most recent 2020 matrix update resulted in the prioritization of approximately 22,000 residential parcels with existing septic systems (out of the total 65,000) into 35 STPO project areas. The top tier in the matrix (meaning the most important to implement) includes three areas with septic conversion projects already underway at various stages including: Biltmore C and Beverly Hills (under construction) and Cristobel (preliminary design underway). Historically the STPO program projects have replaced existing septic systems with conventional gravity collection systems.

This project, the *JEA Innovative Wastewater Treatment Program (IWTP)*, is intended to assess and recommend the most appropriate technologies and approaches (including centralized sewer, decentralized sewer and treatment, and/ or improved onsite treatment) that can be applied to these prioritized STPO areas. The planning documents developed as part of this project will identify approaches that may also be used in the future for the approximately 43,000 additional septic systems that remain in Duval County.

1.2 Goal of Task 8

The purpose of this Task 8 Master Plan Report is to formulate recommended solutions for implementation for each STPO priority area. The Master Plan couples the wastewater management strategies, institutional frameworks and technologies from the Phase 1 assessment and the STPO priority area characterization.

1.3 Overall Project Objectives

The main objectives of the overall project are to:

- Identify available wastewater technologies and management strategies that can be applied to STPO priority areas.
- Evaluate identified technologies, wastewater management strategies and institutional frameworks for consideration by JEA.
- Characterize the 32 remaining STPO priority areas (meaning the 22,000 parcels recommended in the recent matrix evaluation) and evaluate potential solutions.
- Develop a Master Plan recommending a wastewater management solution for each of the STPO priority areas.

1.4 Project Scope

The overall IWTP program includes four phases for development of a Master Plan:

- Phase 1: Literature & Industry Best Practices Review and Screening
- Phase 2: Geographic Conceptual Master Plan
- Phase 3: Potential Pilot Projects
- Phase 4: Public Education Program

In accordance with Contract No. 184401, JEA retained Hazen and Sawyer to complete Phase 1 and Phase 2 of the IWTP program. Exhibit B of the Contract provides the Scope of Work. The contract includes the option to proceed with Phases 3 and 4 at JEA's discretion. The overall scope/deliverables of the current contract are summarized in Table 1-1.

Table 1-1: Overall Project Tasks, Activities and Goals

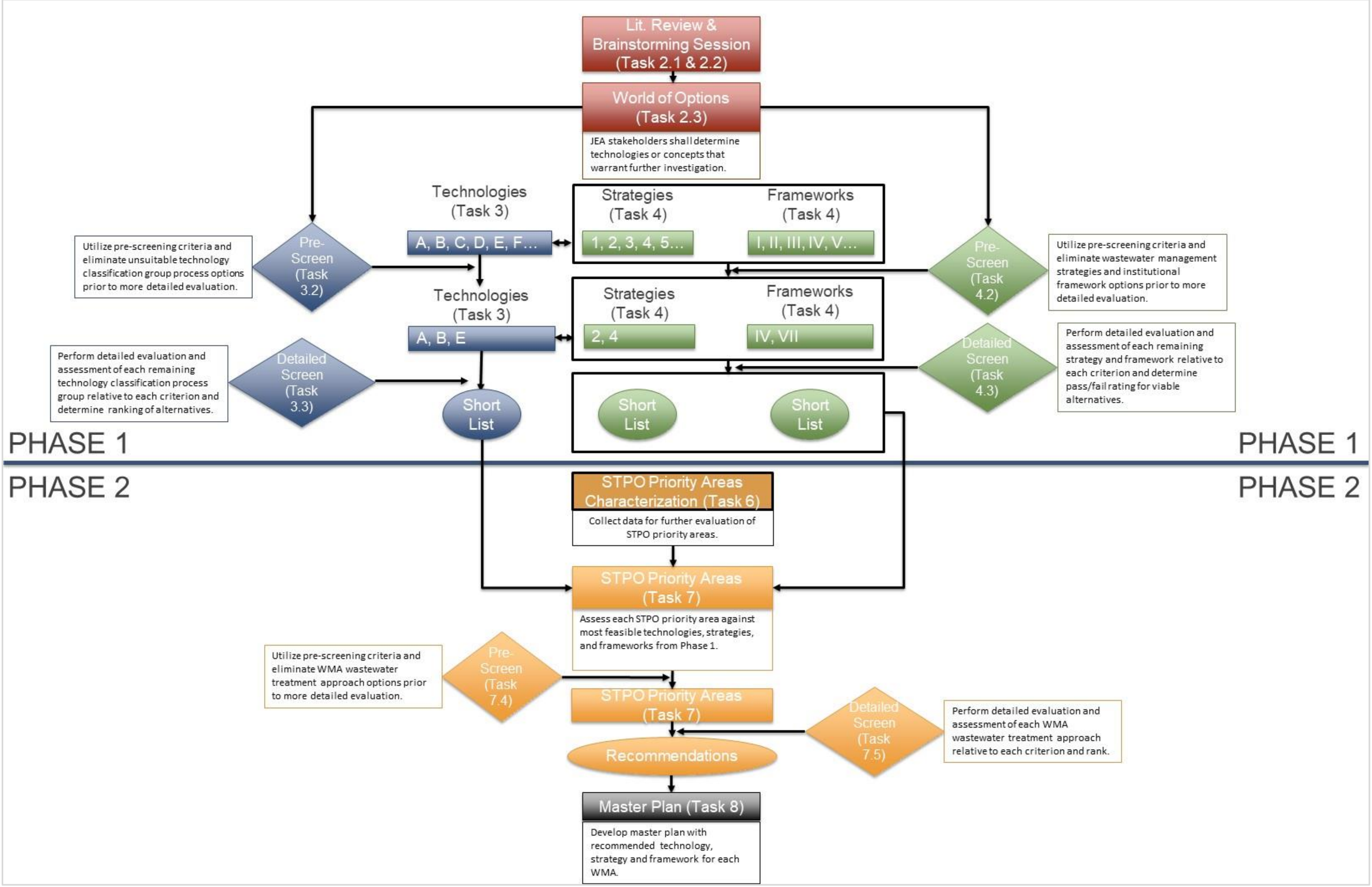
Task	Main Activities and Goals
Task 1: Program Initiation & Management	Initiate the project with a kick-off meeting, program coordination with JEA's project manager and initial data review.
Task 2: Literature & Industry Best Practices Review	Perform a literature & industry best practices review of regional, national and international research regarding innovative technologies, strategies and frameworks for septic system conversion documented in a searchable literature reference database, technology database in tabular format and Technical Memorandum.
Task 3: Technology Evaluation	Classify, prioritize and rank technologies from Task 2 available for consideration by JEA for collection systems, decentralized treatment, and onsite treatment utilizing a multi-step decision process.
Task 4: WW Management Strategies & Institutional Frameworks	Identify viable wastewater management strategies and institutional frameworks from Task 2 for consideration by JEA utilizing a multi-step decision process.
Task 5: Phase 1 Reporting	Preparation of a final report documenting the results from Tasks 1 through 4.
Task 6: Characterization of STPO Priority Areas	Collection of data related to the STPO priority areas to aid in the detailed evaluation of recommended approaches for each area.
Task 7: Application of Strategies & Technologies to STPO priority areas	Assessment of each of the STPO priority areas based on the top ranked wastewater management strategies, institutional frameworks, and technologies. Geographic maps using GIS will be developed indicating the recommended approach (strategy and technology) for each STPO priority area.
Task 8: Master Plan Report	Master Plan Report with Geographic Maps will summarize the recommended improvements for implementation.

1.5 Overall Project Approach

The overall project approach is depicted in Figure 1-1. The Phase 1 literature & industry best practices review, and screening process were developed in Tasks 2 through 5. Task 2 identified the world of options that warranted further investigation in Task 3 (technologies) and Task 4 (wastewater management strategies and institutional frameworks). The following define the major components of the Phase 1 assessment:

- Technologies: equipment developed for wastewater collection, treatment, and/or effluent management (such as vacuum sewer system, biological treatment, engineered wetlands, etc.)
- Wastewater Management Strategies: strategies for managing STPO priority area wastewater in lieu of septic systems (such as advanced onsite, decentralized, centralized, integrated, source separation, etc.)
- Institutional Frameworks: methods used to own, operate, finance, and implement wastewater management strategies (such as public, private, design/build/operate/finance, etc.).

The priority STPO project areas were characterized (Task 6) and the priority areas were assessed against the most feasible wastewater management strategies, institutional frameworks and technologies from Phase 1 with the goal of identifying the most feasible, planning-level approaches for implementation for each area (Task 7).



JEA stakeholders shall determine technologies or concepts that warrant further investigation.

Utilize pre-screening criteria and eliminate unsuitable technology classification group process options prior to more detailed evaluation.

Utilize pre-screening criteria and eliminate wastewater management strategies and institutional framework options prior to more detailed evaluation.

Perform detailed evaluation and assessment of each remaining technology classification process group relative to each criterion and determine ranking of alternatives.

Perform detailed evaluation and assessment of each remaining strategy and framework relative to each criterion and determine pass/fail rating for viable alternatives.

Collect data for further evaluation of STPO priority areas.

Assess each STPO priority area against most feasible technologies, strategies, and frameworks from Phase 1.

Utilize pre-screening criteria and eliminate WMA wastewater treatment approach options prior to more detailed evaluation.

Perform detailed evaluation and assessment of each WMA wastewater treatment approach relative to each criterion and rank.

Develop master plan with recommended technology, strategy and framework for each WMA.

Figure 1-1: **Overall Project Approach Framework**

2. Literature and Industry Best Practices Review (Task 2)

The purpose of this section was to document the findings of the literature and industry best practices review performed of regional, national, and international research regarding innovative technologies, strategies and frameworks for septic system replacement. This assessment identified various manufacturers, viability, limitations, costs, challenges, lessons learned and other aspects of these technologies, strategies and frameworks through synthesis of peer-reviewed journal articles, conference proceedings, case studies, reports and manufacturers technical materials both in the US and internationally.

Two attachments accompany this assessment:

- Attachment 1: a searchable literature reference database, compatible with Endnote^{TM} software format
- Attachment 2: a technology database, in tabular format.

Both databases incorporated organizational categories for summary and comparison.

2.1 Overview of Wastewater Treatment

2.1.1 Wastewater Treatment System Sizing

The wastewater treatment technology assessment was organized by three sizing classifications based on anticipated annual average daily flow (AADF):

- Onsite Treatment (<5,000 gpd AADF)
- Decentralized Treatment (5,000 – ~1,000,000 gpd AADF)
- Centralized Treatment (> 1,000,000 gpd AADF)

Onsite Treatment**:** Defined as a treatment system relying on natural processes and/or mechanical components to collect, treat and disperse or reclaim wastewater from a single dwelling or buildings at the site where wastewater is generated. Currently, the Florida Department of Health (FDOH) issues permits for onsite treatment systems for a residence or establishment with an estimated domestic sewage AADF flow of 10,000 gallons per day (gpd) or less, or an estimated commercial sewage AADF flow of 5,000 gpd or less, which is not currently regulated under Chapter 403.

Decentralized Treatment**:** Defined as multi-source collection and community or clustered treatment system used to collect, treat and disperse and/or reclaim wastewater from a small community or service area. In addition, for the purpose of this project, decentralized treatment was defined as wastewater flows between 5,000 gpd AADF and up to approximately 1 million gallons per day (mgd) AADF.

Decentralized treatment facilities could use land treatment technologies and natural systems approaches for the smaller flows. Decentralized treatment systems that use mechanical treatment approaches were sometimes referred to as “package plants” and were marketed in multiple ways as follows:

1. Off-the-shelf package – A completely turn-key treatment system (e.g., “plug and play”) provided by the vendor.
2. Customized treatment package – A customized design (process and equipment) provided by the vendor to treat a specific influent quality and meet a specific effluent quality.
3. Equipment package – Design criteria are provided by the engineer with the equipment provided by one or more vendors.
4. Hybrid approach – The hybrid approach provides a combination of a custom-built design in conjunction with one or more package type approaches.

<u>Centralized Treatment</u>**:** For the purpose of this project a centralized treatment facility was defined as an existing JEA wastewater treatment facility (WWTF), traditionally called a publicly owned treatment works as defined in Title 40 of the CFR Section 122.2.

2.1.2 Pollutant Quantities in Residential Wastewater

Wastewater discharged from single family homes is composed of flows from various water using activities including toilet flushing, bathing, clothes and dish washing, cleaning activities, and in some instances garbage disposal and water conditioning brines. The characteristics of the wastewater are influenced by many factors such as family size, age group, socioeconomic status, and family mobility and occupation. Large variations in wastewater quantity and quality may exist between homes in the same community. Commercial establishments will have different wastewater pollutant loadings based on their water use. Measured average per capita daily indoor residential water use (a surrogate for wastewater flows) showed that it typically ranged from 40 to 70 gpd per person (Brown and Caldwell 1984, Anderson and Siegrist 1989, Anderson, Mulville-Friel et al. 1993, Mayer, DeOreo et al. 1999, Water Research Foundation 2014), with lower values in more recent years attributed to water conserving plumbing fixtures.

Ranges of typical residential wastewater pollutant mass loadings and observed concentrations are presented in Table 2-1. Both the typical per capita mass loadings of pollutants and the concentration of the pollutants in raw wastewater are presented. The wastewater was typical of residential dwellings equipped with water-using fixtures and appliances that collectively generate approximately 45 gallons per capita per day (gpcd) (USEPA, 2002), however JEA typically sees a higher range from approximately 44 to 142 gpcd. It should be noted that raw wastewater from individual homes often contains higher concentrations of these pollutants than municipal domestic wastewater, because infiltration/inflow (I/I) was typically not present in individual home wastewater. For comparison, the typical Arlington East Water Reclamation Facility (WRF) influent concentrations is also provided.

Table 2-1: Typical Pollutant Concentrations in Residential Wastewater

Constituent	Mass Loading (grams/person/day) ((USEPA 2002),(Lowe 2009))	Typical Concentration, mg/L ((USEPA 2002),(Lowe 2009))	Projected Influent Concentration, mg/L at Arlington East WRF (Hazen, 2018)
5 day Biochemical Oxygen Demand (BOD_5)	35 - 65	155 - 286	244
Total Suspended Solids (TSS)	35 - 75	155 - 330	226
Total Nitrogen (TN)	6 - 17	26 - 75	48

2.1.3 Level of Treatment

When discussing wastewater treatment processes, various levels of treatment were typically defined. These were classified as primary, secondary, advanced secondary and advanced wastewater treatment. The method of effluent management to be employed and the effluent quality standards pertaining to the method should be considered when assessing the degree of treatment required for wastewater collected in the STPO priority project areas.

Table 2-2 summarizes the Florida Administrative Code (FAC) Chapter 64E-6 which defined treatment levels for onsite treatment systems established by the FDOH. Secondary and advanced secondary effluent water quality allowed for a reduction in the drainfield size requirements, 25% and 40% respectively. Florida Department of Environmental Protection (FDEP) level of treatment requirements were based on the method of effluent management as summarized in Section 2.4.6

Table 2-2: FDOH Defined Level of Treatment Effluent Water Quality Requirements[1] for Onsite Sewage Treatment and Disposal Systems (OSTDS)

Level of Treatment	BOD_5/TSS (mg/L)	TN (mg/L)	TP (mg/L)	Fecal Coliform (#/100 mL)	Max. Drainfield Reduction
Primary (Baseline)	240/176	45	10	-	-
Baseline – to Groundwater from compliant drainfield	5	25	5	-	-
Secondary	20	No Requirement	No Requirement	200[2]	25%
Advanced Secondary	10	20	10	200[2]	40%
Advanced Wastewater Treatment (AWT)	5	3	1	Below detection 75% of samples[3]	

[1] The arithmetic mean for the effluent samples collected (whether grab or composite technique is used) during an annual period shall not exceed.

[2] Where chlorine is used for disinfection, the design shall include provisions for rapid and uniform missing and total chloride residual of at least 0.5 mg/L shall be maintained after at least 15 minutes of contact time at the peak hourly flow.

[3] Where chlorine is used for disinfection, the design shall include provisions for rapid and uniform missing and total chloride residual of at least 1.0 mg/L shall be maintained after at least 15 minutes of contact time at the peak hourly flow.

2.1.3.1 Primary Treatment

Generally, primary treatment is used to remove settleable solids, greases, oils and other floatable solids from the waste stream. Primary treatment provides a partially clarified effluent, but does not remove all suspended solids, dissolved organic materials, or other soluble pollutants from the wastewater stream.

Onsite Treatment: A septic tank (Figure 2-1) is commonly used as the first treatment step in an onsite system providing primary treatment. Its principal function is to remove, store, and digest settable and floatable suspended solids in the raw wastewater. These solids collect as sludge and scum within the tank. The form of nitrogen in domestic septic tank effluent varied but was approximately 70 percent ammonium and 30 percent organic nitrogen. As much as 10 to 15 percent of the influent nitrogen was retained in the tank within the sludge and scum.

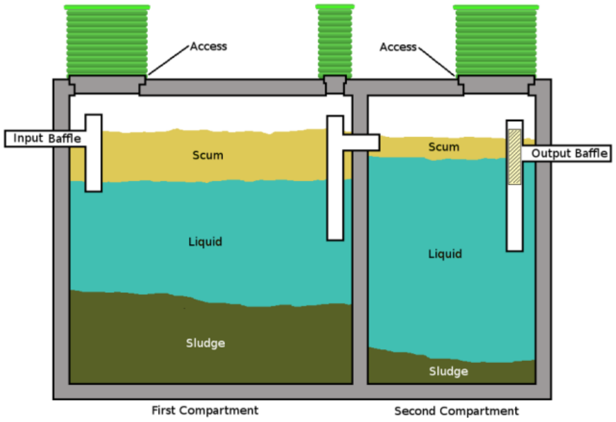


Figure 2-1: Primary Tank (Septic Tank) (Express Septic Service 2016)

Decentralized Treatment: In a similar fashion, the role of primary treatment in decentralized systems is to remove rags, sticks, floatables, grit, grease, and a portion of suspended solids and organic matter. Typically, the first primary unit operation incorporated into decentralized treatment process trains are coarse and/or fine screens. The specific type of screen selected is based on influent wastewater quality and the downstream processes. Although not always utilized, decentralized systems sometimes also incorporated a settling tank into the primary treatment train. The main purpose of this tank is to reduce the inorganic and organic suspended solid content of the influent.

2.1.3.2 Secondary Treatment

Generally, secondary treatment provides further removal of dissolved organic materials and suspended solids. Secondary treatment processes generally remove greater than 85% of the biochemical oxygen demand (BOD) and the suspended solids (TSS) from the wastewater stream, but only provide limited removal of nutrients nitrogen and phosphorus.

2.1.3.3 Advanced Secondary Treatment

Generally, advanced secondary treatment provides further removal of dissolved organic materials and suspended solids and included additional removal of nutrients (nitrogen and phosphorus) which may be required to meet more stringent levels of treatment due to the disposal option and/or setback requirements.

2.1.3.4 Advanced Wastewater Treatment

Advanced wastewater treatment (AWT) provides further removal of nutrients, BOD, and suspended solids. Generally, AWT processes provide removals of greater than 95% for BOD and suspended solids and greater than 90% for nitrogen and phosphorus.

Whether onsite or decentralized, the level of treatment needed will determine the treatment approach required for the removal of constituents of concern. Examples utilizing mechanical treatment approaches are shown in Figure 2-2 for onsite treatment and in Figure 2-3 for decentralized treatment. Primary treatment is followed by secondary treatment which typically involves biological processes for the treatment of wastewater. The inclusion of advanced treatment in decentralized wastewater systems is typically dependent on regulations and the treated effluent disposal method.

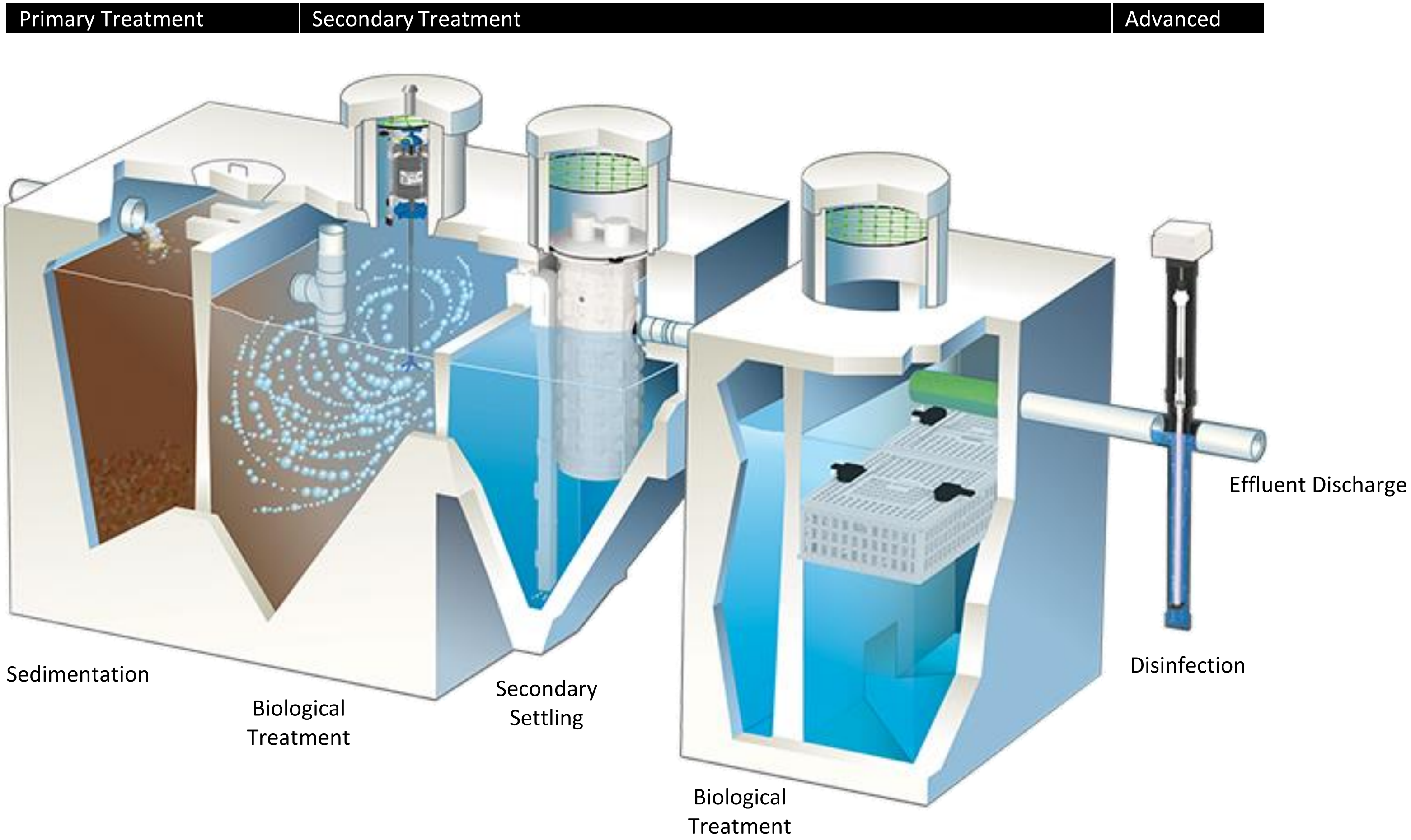


Figure 2-2: Example Onsite Wastewater Advanced Treatment Train

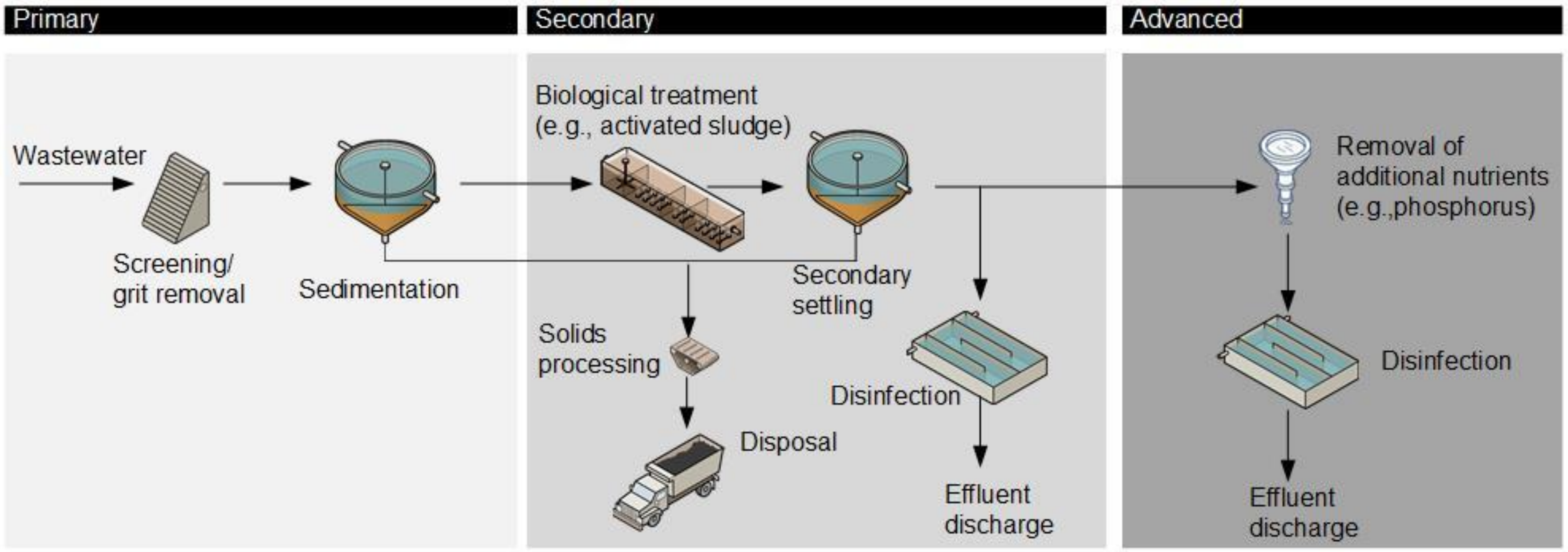


Figure 2-3: Example Decentralized Wastewater Treatment Train

2.1.4 Wastewater Treatment Processes

The fundamental processes used in all wastewater treatment systems to achieve these levels of treatment consisted of physical, chemical and/or biological unit processes in various combinations.

- **Physical treatment processes:** The most typical physical treatment processes includes sedimentation (gravitational settling of solids), screening (remove particles larger than internal diameter of the screen openings) and filtration (uses filtration medium to remove suspended materials by straining).

- **Chemical treatment processes:** Typically, chemical treatment processes utilize a chemical reaction to alter the state of the wastewater constituents, so they are more easily removed from the wastewater stream, often by using a physical treatment process. Examples identified of physical/chemical treatment processes include precipitation, ion exchange, adsorption, and reverse osmosis.

- **Biological treatment processes:** Typically, these treatment processes utilize microbes to alter the state of wastewater constituents. Microbes utilize organic materials and nutrients in wastewater as a food source and break down these materials to harmless end products or incorporate them into cell tissue.

- **Natural systems consisting of soil, plant and wetland processes:** Natural systems such as soil, plant and wetland systems are included as a separate classification because they utilize a combination of physical, chemical and biological processes that occur naturally in the soil and/or plant. An example is the soil treatment unit (STU), often referred to as a drainfield in conventional onsite systems, which is typically the last step in the process sequence for final treatment.

An approach to classify and group identified traditional and innovative treatment system categories by process type is presented in Figure 2-4.

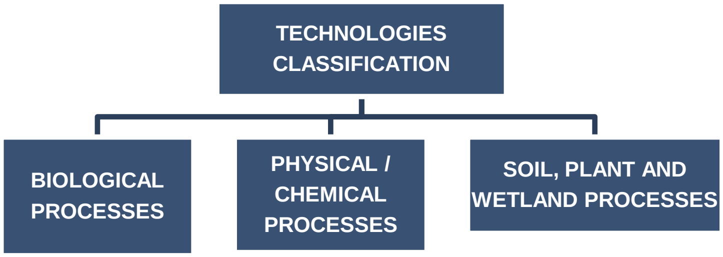


Figure 2-4: Wastewater Treatment Technology Classifications

2.2 Wastewater Treatment Technologies Assessment

This section summarizes identified alternatives for the treatment of wastewater for both onsite and decentralized wastewater treatment facilities. Centralized wastewater treatment systems were not evaluated at all since it was assumed that the existing JEA treatment processes would be utilized. Additional details on related research by process type is provided in Appendix A.

Accompanying this assessment is a technology database which can be used to assess analysis of trends and differences among systems. Equipment suppliers were contacted to obtain process and equipment information. The suppliers were identified primarily through the technical literature, internet searches, and conference proceedings. In addition, regulatory database queries were performed to identify small-flow treatment systems used in the State of Florida.

A scheme for classifying technologies to allow comparisons between the many options that were available for onsite treatment is provided in Figure 2-5. A scheme for classifying technologies to allow comparisons between the many options that were available for decentralized treatment is provided in Figure 2-6.

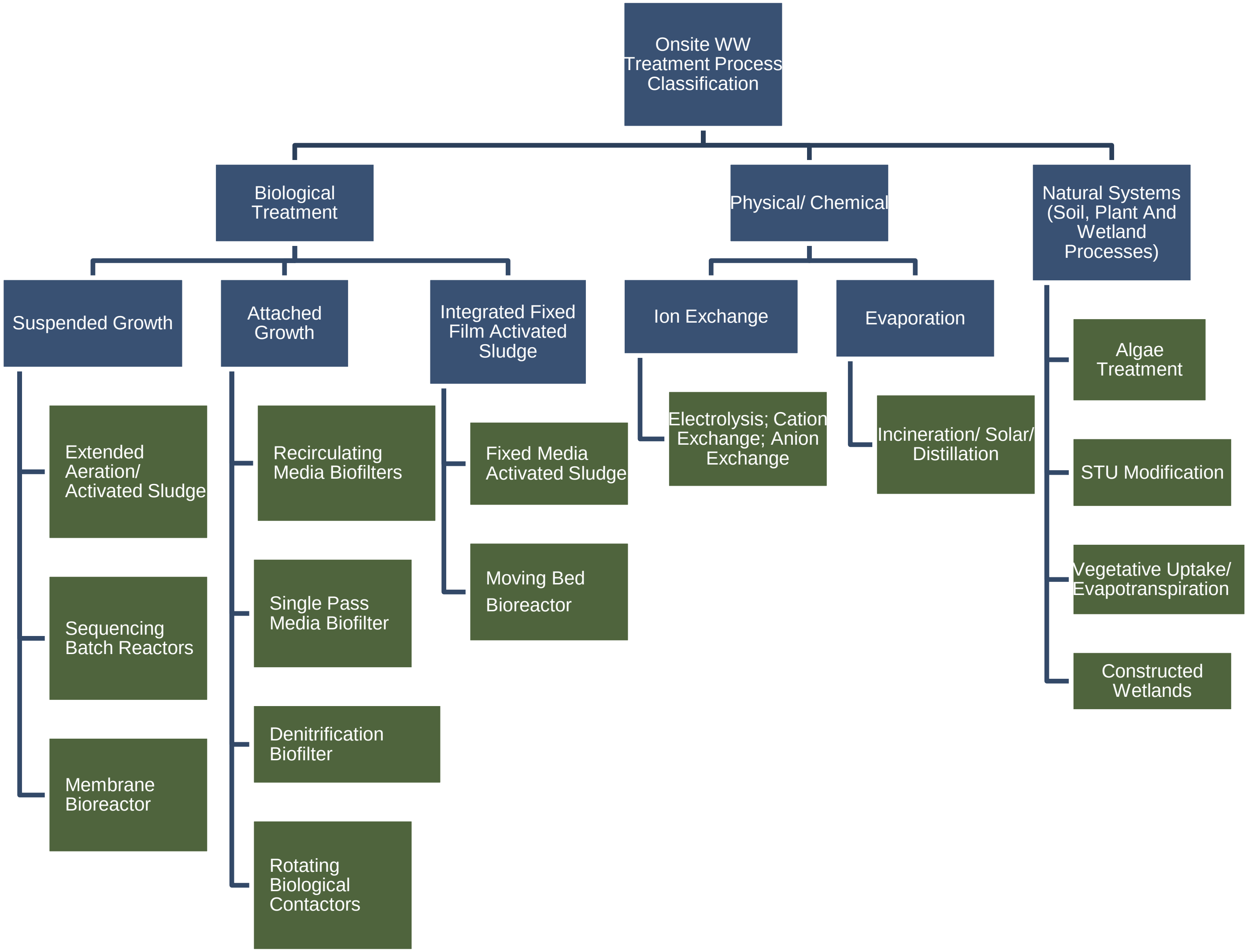


Figure 2-5: Classification of Onsite Treatment Processes

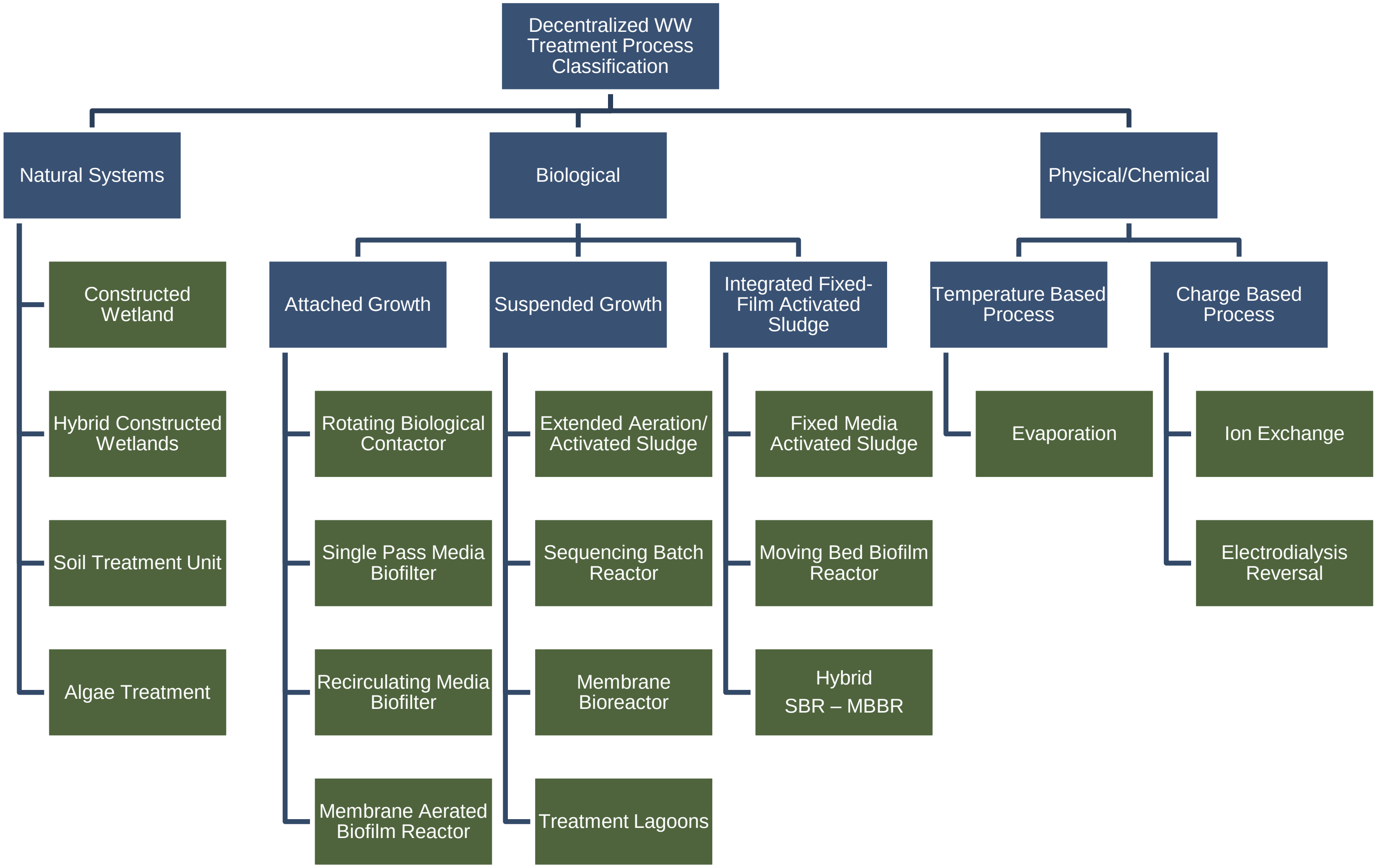


Figure 2-6: Classification of Decentralized Treatment Processes

2.2.1 Biological Treatment Processes

The overall objectives of the biological treatment of domestic wastewater are to 1) biologically transform dissolved and particulate biodegradable constituents into acceptable end products, 2) capture and incorporate suspended and non-settleable colloidal solids into a biological floc or biofilm, 3) transform or remove nutrients, such as nitrogen and phosphorus, and 4) in some cases, remove specific trace organic constituents and compounds. The removal of dissolved and particulate carbonaceous BOD and the stabilization of organic matter found in wastewater is accomplished biologically using a variety of microorganisms, principally bacteria. Microorganisms are used to oxidize (i.e., convert) the dissolved and particulate carbonaceous organic matter into simple end products and additional biomass. The principal biological processes typically used for general wastewater treatment can be classified as suspended growth and attached growth (or fixed film) processes. Integrated fixed film activated sludge (IFAS) is a group of technologies that combine both fixed film and suspended growth microbial communities.

2.2.1.1 Suspended Growth

In suspended growth processes, the microorganisms responsible for treatment are maintained in liquid suspension by appropriate mixing methods. Many suspended growth processes used in wastewater treatment for biodegradation of organic substances are operated with dissolved oxygen (aerobic) or nitrate/nitrite (anoxic) utilization. Several manufacturers offer suspended growth treatment units for both onsite and decentralized systems. For onsite systems, most were developed to provide better treatment than conventional onsite alone, and to reduce clogging of the infiltrative surface in the soil treatment unit (i.e., drainfield) by removing BOD_5.

2.2.1.1.1 Extended Aeration/ Activated Sludge

The most common suspended growth process used for municipal wastewater treatment is the activated sludge process. The activated sludge process is named as such because it involves the production of an activated mass of microorganisms, generally referred to as mixed liquor suspended solids (MLSS), capable of stabilizing a waste under aerobic, anoxic and/or anaerobic conditions. Mechanical equipment is used to provide the mixing and transfer of oxygen into the process. The MLSS then flows to a clarifier where a fraction of the microbial suspension is settled and thickened. The settled biomass (activated sludge) is returned to the aeration tank to continue biodegradation of the influent organic material. Extended aeration is similar to conventional activated sludge except the hydraulic and mean cell residence times are significantly longer than conventional systems, thus reducing waste sludge. Figure 2-7 presents a process flow diagram for a typical conventional activated sludge or extended aeration treatment process.

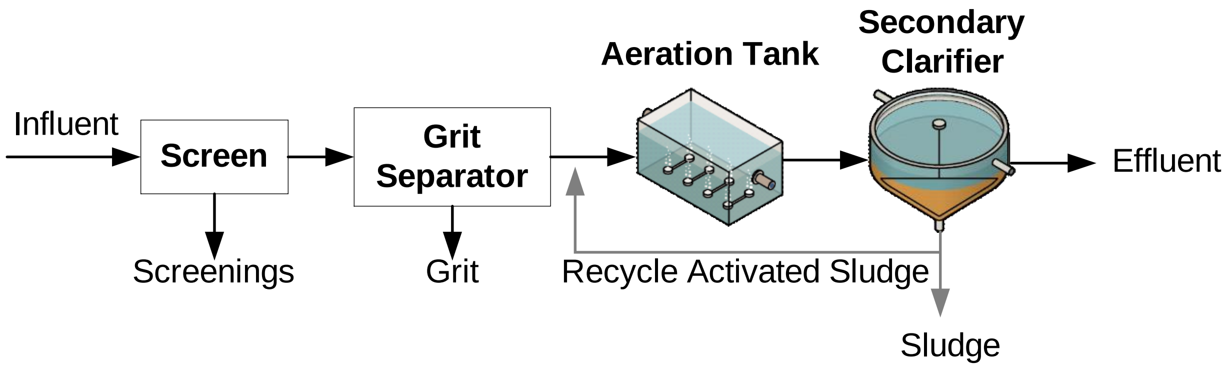


Figure 2-7: Extended Aeration Process Flow Diagram

Generally activated sludge processes are well developed with proven capabilities to remove total nitrogen (TN) from wastewater to very low concentrations via various biological nitrification/denitrification configurations.

The treatment processes described above can be applied to both onsite and decentralized wastewater management approaches, however there were differences in application that should be noted between the two.

Onsite Wastewater Treatment:

- Need to be simpler in operation, since homeowners often manage them
- Mechanical treatment systems are more energy intensive as compared to conventional septic systems
- Mechanical treatment systems tend to produce more sludge as compared to conventional septic tanks
- Typical TN removal ranges from 40 to 75 percent
- Pulse or intermittent aeration could be an effective way to reduce the loss of organic carbon during nitrification (Ayres Associates 1998, Habermeyer and Sánchez 2005).

Decentralized Wastewater Treatment:

There were many decentralized treatment units identified that incorporate variations on the activated sludge process which are further described in Appendix A. The type of activated sludge process selected was often based on the desired treated effluent water quality.

2.2.1.1.2 Membrane Bioreactor (MBR)

Membrane bioreactors (MBR), also referred to as submerged or immersed membrane bioreactors, have gained widespread application in wastewater treatment. Ultrafiltration membranes tend to be used in activated sludge processes as a substitute separation process in lieu of the final clarifier. The membranes retain the volatile suspended solids in the biological treatment vessel through filtration rather than sedimentation, which allowed the process to maintain significantly higher biomass concentrations that facilitate both nitrification and denitrification at a smaller footprint. Figure 2-8 presents a MBR module configuration diagram.

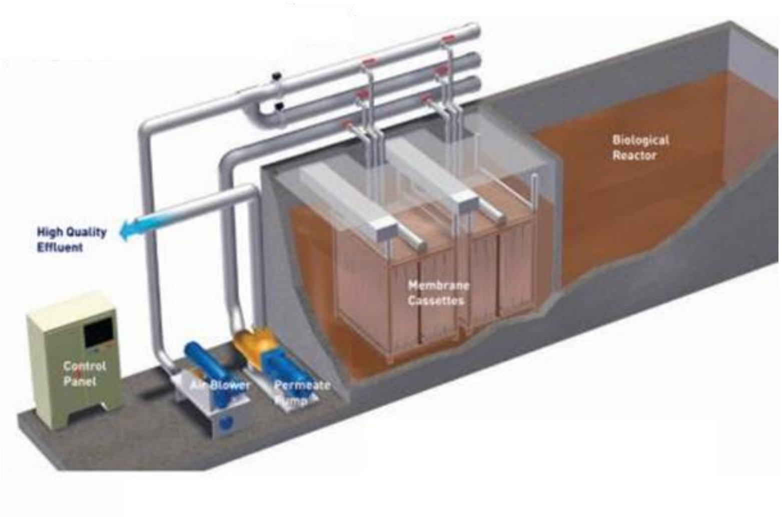


Figure 2-8: Example MBR Configuration Replacing Final Clarifier Diagram (Suez, 2020)

Onsite Wastewater Treatment:

- MBR technologies have not been widely applied for onsite treatment. As of 2018, Suffolk County, NY had two onsite MBR pilot scale installations; the systems were seeing acceptable BOD and TSS removal but poor TN removal and effluent pH, so they were taken offline (Sohngen 2019).
- There were more installations in Europe, and they were often in areas with space constraints or high groundwater tables and often housed inside a basement, garage or shed.

Decentralized Wastewater Treatment:

- There were several types of membrane systems and configurations identified as available for decentralized treatment.
- MBR systems not only reduce the footprint of wastewater treatment plants by replacing final clarifiers, but also provide the necessary filtration step required for achieving reclaimed water quality effluent.
- The main drawback to MBR systems is the occurrence and control of fouling on membrane surfaces via sparging (gas) or chemical cleans.
- Most, if not all, of the decentralized activated sludge processes described in Appendix A could be modified to replace the final clarifier with an MBR.
- Current commercial decentralized MBR systems were modular which facilitated phased expansions to the treatment capacity of a decentralized system.

2.2.1.1.3 Sequencing Batch Reactor (SBR)

A sequencing batch reactor (SBR) process provides secondary treatment and clarification within the same reactor during a period of approximately 4 to 7 hours. Generally, SBRs operate in treatment phases, which typically consist of fill, react, settling, decant, and idle as shown in Figure 2-9. The react cycle could be subdivided to allow for nitrification and denitrification.

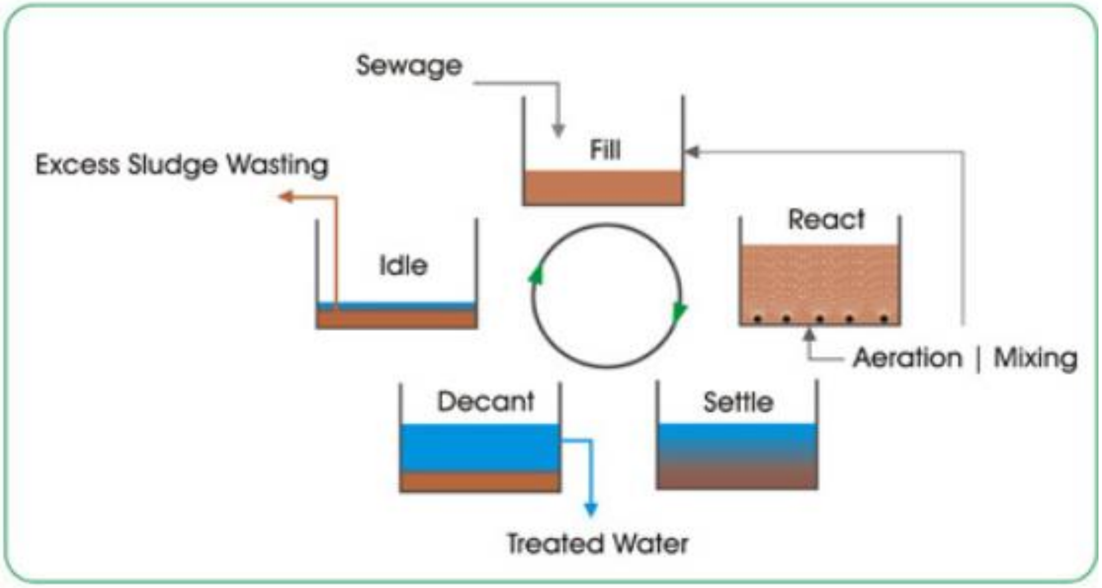


Figure 2-9: Sequencing Batch Reactor (SBR) Operating Principle (Rogers 2016)

Onsite Wastewater Treatment:

- SBRs are more complex in operation but can be easily automated
- Achieve complete nitrification with extended aeration durations
- Denitrification requires careful management of the organic carbon during treatment
- Can produce effluent quality with low BOD, TSS, TN and total phosphorus (TP) with proper operation and management, but are susceptible to process upset
- Small footprint (one tank operation)

Decentralized Wastewater Treatment:

- SBR systems require oversight and maintenance and are susceptible to process upset
- Produce effluent quality with low BOD, TSS, TN and TP
- SBR systems could be beneficial in areas with limited footprint

2.2.1.1.4 Treatment Lagoons

Another suspended growth process type identified is aerobic treatment lagoons. There are three types of lagoon systems: (1) anaerobic, (2) facultative, and (3) aerobic. Aerobic lagoons typically utilize mechanical aerators to introduce oxygen into the wastewater (see Figure 2-10) and provide mixing to facilitate the biological degradation of BOD from wastewater and the conversion of ammonia to nitrates with sufficient hydraulic retention times (HRTs) (typically approximately 30 days) (Massoud, Tarhini et al. 2009). Aerated lagoons tended to be followed by holding ponds for settling prior to discharging the treated wastewater.

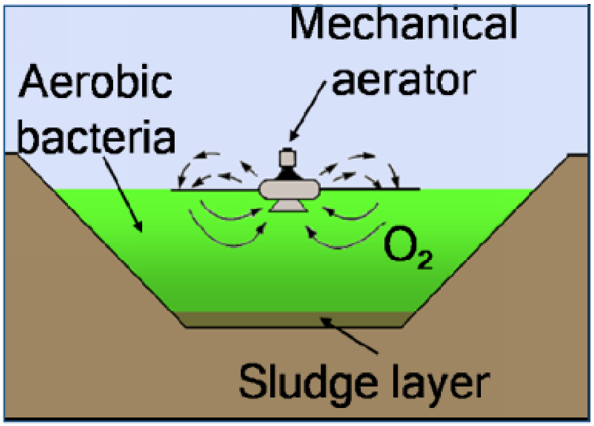


Figure 2-10: Typical Configuration of an Aerated Lagoon (Buchanan 2010)

Onsite Technologies: Treatment lagoons are not generally used for onsite treatment.

Decentralized Technologies:

- Land availability required for large footprint, suitable for rural areas
- Not often incorporated into urban environments due to footprint, odor, secondary nuisances

2.2.1.2 Attached Growth (Fixed Film)

In attached growth (or fixed film) processes, the microorganisms responsible for the conversion of organic material or nutrients grow on an inert packing material. The organic material and nutrients are removed from the wastewater flowing past the attached growth, also known as biofilm. The media could be submerged completely in liquid or partially submerged, with air or gas space above the biofilm liquid layer. Biofilms from the growth of microorganisms develop on the porous media and retain/accumulate the biology needed to carry out biological treatment. Air circulation in the void space, by either natural draft or blowers, provides oxygen for the microorganisms growing as an attached biofilm. Biochemical transformations and physical filtration are the dominant treatment mechanisms within attached growth processes, but chemical sorption also could be significant depending on the media selected.

Materials used in attached growth processes include rock, gravel, slag, sand, redwood, and a wide range of plastic and other synthetic materials. Three of the more innovative media materials currently available today identified are (1) zeolites, (2) porous granular or (3) plastic media and peat which are explained in further detail in Appendix A. There were various types of attached growth processes identified, with the most common being single pass media biofilters, recirculating media biofilters, denitrification biofilters, and rotating biological contactors (RBCs). These types of attached growth processes, along with an innovative process called membrane aerated biofilm reactor (MABR), are described in more detail in the following subsections.

2.2.1.2.1 Single Pass Media Biofilters

In single pass processes, wastewater passes through the filter media only once before being discharged for further treatment or dispersal (see Figure 2-11). The microorganisms in the biofilm absorb soluble and colloidal waste materials in the wastewater as it percolates over the surfaces of the media. The absorbed materials are incorporated into new cell mass or degraded under aerobic conditions to carbon dioxide and water. This generally results in good nitrification but may not provide sufficient overall nitrogen reduction to meet treatment goals. Low hydraulic loading rates and deeper media depths could increase denitrification in single pass biofilters by allowing the formation of an anoxic zone. Single pass media biofilters for onsite treatment typically consist of covered or uncovered lined excavations or containers filled with a bed of porous media that is placed over an underdrain system. The porous media is typically inert with sand and fine gravel being the most common materials, but peat, textile, plastic, and open cell foam re also prevalent. Other media materials that are used are crushed glass, slag, tire chips, polystyrene, expanded shale, expanded clay, natural zeolites (hydrous aluminum silicates) and coir (fibrous material from coconut husks).

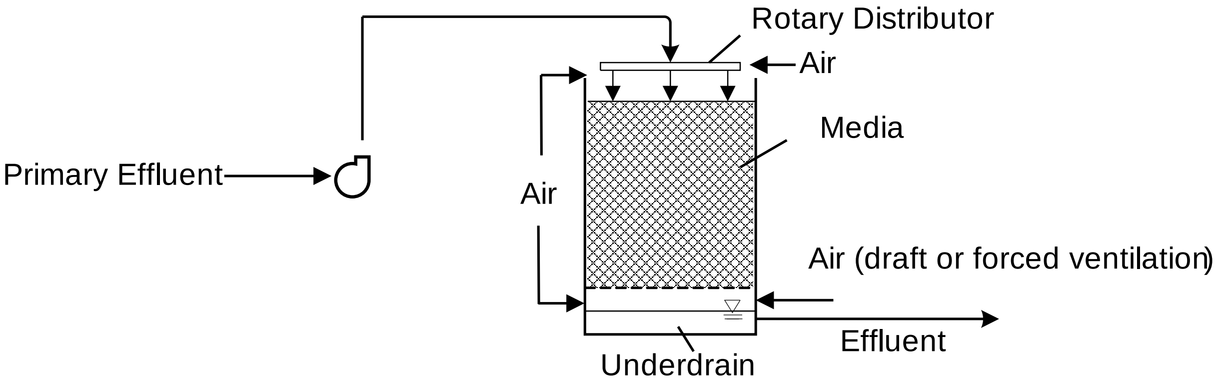


Figure 2-11: Single Pass Media Biofilter Process Flow Diagram

Onsite Wastewater Treatment:

- Simple in operation and maintenance
- Results in good nitrification but sometimes does not provide sufficient overall nitrogen reduction to meet treatment goals.
- Sand filters require maintenance visits to keep the surface of the beds clean and prevent clogging of the surface layer of the reactor.

- Some porous media (expanded clay, clinoptilolite) show capability to accept higher hydraulic loading rates without compromising nitrification, which allowed for smaller footprint requirements as compared to traditional sand media filters.

Decentralized Wastewater Treatment:

- For decentralized treatment units, rock-based media was utilized until the early 1950s
- The introduction of plastic medias increases the surface area available for biofilm growth while reducing the incidence of clogging common in rock-based systems.
- Rarely employed in decentralized treatment today, except for smaller facilities (< 10,000 gpd) due to the large footprint required and limited nitrogen removal even with simple operation and long history of use.

2.2.1.2.2 Recirculating Media Biofilters

Recirculating media biofilters typically recycle the nitrified filtrate back to a recirculation tank (Figure 2-12), which allows the wastewater to pass through the filter several times. The recirculation provides the needed wastewater residence times in the media to achieve greater treatment performance including nitrification. Recirculation provides more control of the treatment process by adjustments that can be made to recirculation ratios and dosing frequencies. The hydraulic, organic and nitrogen loading rates are critical operating parameters for recirculating porous media filters, particularly as they related to the functioning of the physical and biological processes within the media. The mixing of the return filtrate with fresh influent in the recirculation tank (the “recirculation” part) results in significant nitrogen removal via denitrification with wastewater carbon. Media filter applications, design, operation and performance can be found elsewhere such as Crites and Tchobanoglous 1998, Leverenz, Tchobanoglous et al. 2002, USEPA 2002, Jantrania and Gross 2006.

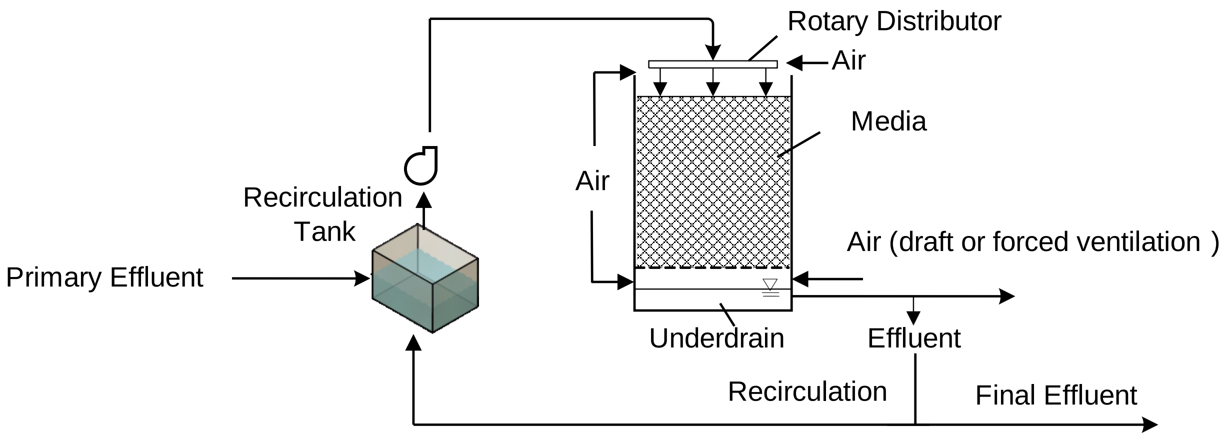


Figure 2-12: Recirculating Media Biofilter Process Flow Diagram

Onsite Wastewater Treatment:

- More complex in operation as compared to single pass operation

- Requires oversight and monitoring of treatment process recirculation ratios and dosing frequencies
- Typical biofilter effluent concentrations treating domestic wastewater are <10/10 mg/L for BOD and TSS, respectively, and approximately 50 percent TN removal
- When the effluent is recycled back to the septic tank, TN removal up to 75 percent occurs
- Organic overloading to porous media biofilters led to development of excessive biomass near the application surface, reduction in reaeration rates and media clogging that reduced treatment capacity (USEPA 2002, Kang, Mancl et al. 2007)

Decentralized Wastewater Treatment:

- Decentralized treatment units that were commercially available included both recirculating sand and textile biofilters, as well as several other media types
- Generally used to treat flows in the range of 5,000 gpd to 50,000 gpd
- Consistently produce effluent with 10 mg/L BOD, 10 mg/L TSS, and 12 mg/L nitrogen

2.2.1.2.3 Denitrification Media Biofilters

Denitrification biofilters are attached growth processes that operate in anoxic conditions to facilitate the biological conversion of nitrates to elemental (gaseous) nitrogen typically following a nitrification step (Figure 2-13). Two groups of processes were identified as being used for denitrification. Heterotrophic denitrification uses organic carbon as the electron donor, which may be added as a liquid or as a solid reactive medium. Autotrophic denitrification uses chemical compounds for electron donors, which are added as solid reactive media such as elemental sulfur, ferrous iron or pyrite, as electron donors (Le et al., 2016; Lv et al., 2017). Design factors for denitrification biofilters include filter size, water residence time, media size and shape, and the fraction of media for alkalinity supply. A two sludge, two-stage biological nutrient removal (BNR) system for household use consists of a septic tank, porous media biofilter (nitrification), anoxic denitrification biofilter, followed by a soil treatment unit for final treatment and dispersal. An example of such a system is shown in Figure 2-13.

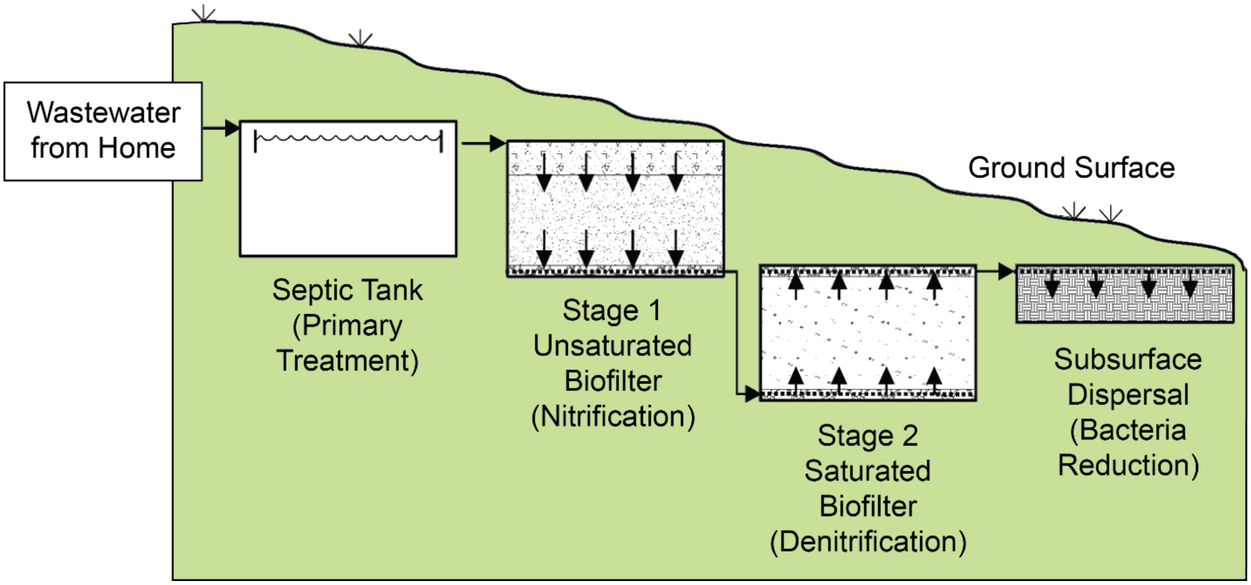


Figure 2-13: Onsite Treatment Biofilter Process Flow Diagram with Denitrification Media Biofilter

Onsite and Decentralized Technologies:

- Outperform most other onsite wastewater treatment system for nitrogen removal.
- Requires an initial nitrification step which adds overall system footprint either as tankage or soil treatment unit area.
- The more promising innovative dentification media materials currently available are lignocellulose and elemental sulfur.
- Sulfur denitrification achieves high NO_3^- removal rates and lowered excess sludge production when compared with heterotrophic denitrification but consumes more alkalinity and generates sulfate as a byproduct.
- The timescales of media replacement, maintenance and supplementation and the practical aspects of these activities should be considered.
- Simple operation and maintenance.

2.2.1.2.4 Rotating Biological Contactors (RBC)

Rotating biological contactor (RBC) is an older technology that was first installed in West Germany in 1960 but had hundreds of installations by the 1970’s. RBCs consist of a reactor containing a series of rotating plastic discs, which serve as the biological growth medium (Figure 2-14). The discs are mounted and allowed to turn with the rotation, wetting the discs and then exposing it to air before re-exposing to wastewater. The biofilm population is well oxygenated and thus removes organic matter from the wastewater. RBCs are primarily used for BOD removal though could be used for nitrification. RBCs are more efficient when several stages are used, and recirculation is sometimes used. The process typically consists of a number of units operating in series, requiring up to 6 stages for proper nitrification.

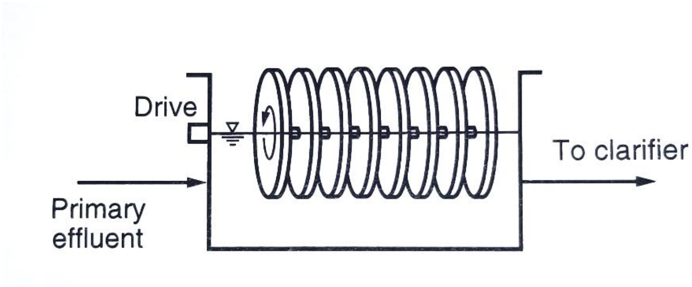


Figure 2-14: RBC Process Flow Diagram

Onsite and Decentralized Wastewater Treatment:

- Prone to several operational issues which includes excess biomass accumulation on the rotating discs, media deterioration, and lower performance at design loadings.
- Few new RBC installations have been commissioned in the last 20 years both for onsite and decentralized treatment.
- There were proprietary RBC systems identified on the market for onsite and decentralized treatment with installations globally (see Technology Database).

2.2.1.2.5 Membrane Aerated Biofilm Reactor (MABR)

Also known as membrane biofilm reactors (MBR), membrane aerated biofilm reactor (MABR) systems use membranes to both deliver oxygen (or hydrogen) gas to the biofilm on one end while providing a surface area for the growth and accumulation of biofilm on the other. MABR systems are typically constructed to maximize surface area with the most common type of membranes utilized being microporous hollow-fiber membranes. In this configuration, the membranes are not used to filter out the MLSS but provide the biofilm with oxygen (or hydrogen) directly rather than through the bulk liquid layer (wastewater). This allows MABR systems to operate at higher fluxes but requires careful monitoring of the thickness of the biofilm layer to maintain optimum treatment efficiencies. A cross section of a typical process flow diagram for a MABR system is presented in Figure 2-15.

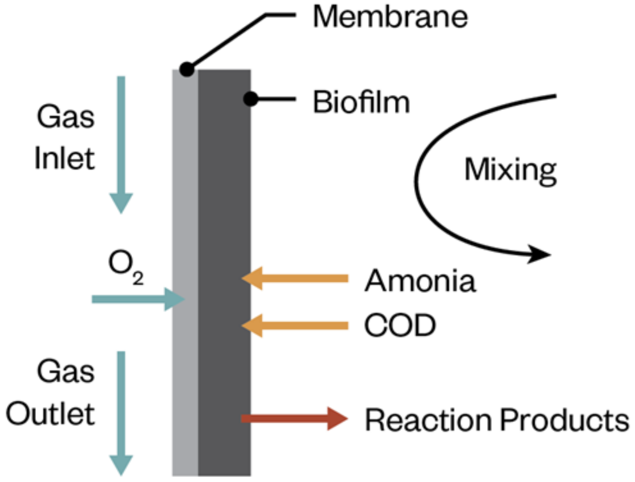


Figure 2-15: MABR Cross Section

Onsite Wastewater Treatment: MABR applications have not been demonstrated for onsite treatment.

Decentralized Wastewater Treatment:

- Demonstrate the ability for simultaneous carbon and nitrogen removal
- Complex operation which requires operator oversight
- Process control related challenges reported for full scale implementation
- Few manufacturers offered modular MABR systems
- Installations of this technology have only been reported outside of the US

2.2.1.3 Integrated Fixed-Film Activated Sludge (IFAS)

Integrated fixed film activated sludge (IFAS) processes combine both fixed film and suspended growth microbial communities. The combination of these two communities yields very stable treatment processes that can achieve more reliable and consistent performance than other single sludge processes. Many of the medias used in IFAS processes tend to be proprietary.

2.2.1.3.1 Fixed Media Activated Sludge (FMAS)

The fixed media activated sludge (FMAS) process was one of the earliest types of IFAS systems and utilizes media to grow an attached biofilm in a suspended growth reactor (Figure 2-16). This process is typically paired with dedicated coarse-bubble systems underneath the media providing good mixing, oxygen transfer, and media agitation for biofilm thickness control.

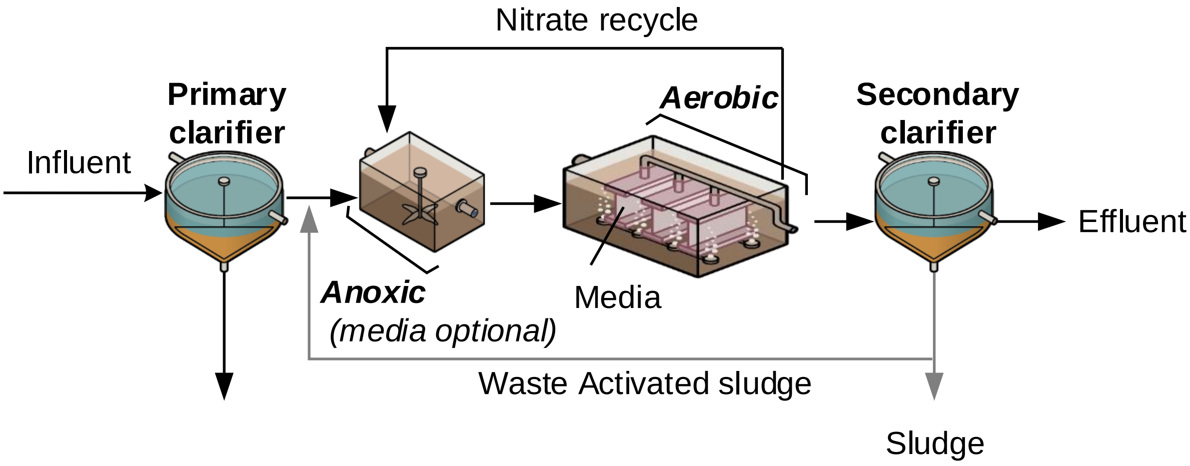


Figure 2-16: FMAS Process Flow Diagram

Onsite Wastewater Treatment:

- Small footprint
- Somewhat complex operation as compared to conventional onsite systems
- Rely heavily on proper dissolved oxygen (DO) levels within the reactor for treatment performance
- Consistently reduces BOD, TSS and TN

Decentralized Wastewater Treatment:

- Commonly used to convert conventional aerobic activated sludge treatment processes to nitrifying-denitrifying systems
- Small footprint
- Typical treatment flow ranged from 5,000 gpd to 50,000 gpd

2.2.1.3.2 Moving Bed Bioreactor (MBBR)

Moving bed bioreactors (MBBR) are made up of two or three anoxic/aerobic regions and use small buoyant plastic media that are uniformly distributed throughout the reactor through the use of mechanical mixing or aeration. The media is typically held in the reactor, but water and sloughed solids pass through. MBBR systems remove BOD and nitrogen from wastewater but require chemical addition for phosphorus removal. Figure 2-17 presents a typical process flow diagram for an MBBR treatment system.

The most common process design immerses low density bio support media in a portion of the reactor tank through which the reactor contents are recirculated vertically down through the media. The recycle operation also mixes the contents of the reactor to keep the unattached biomass in suspension.

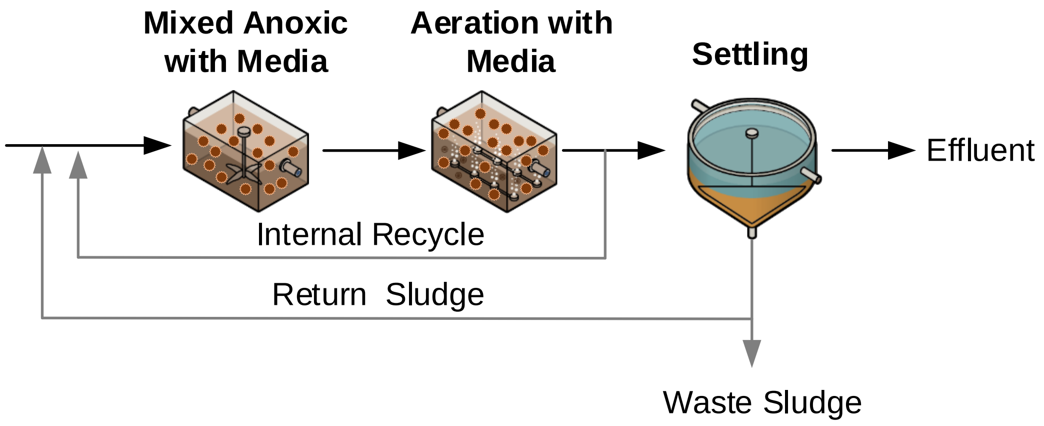


Figure 2-17: MBBR Process Flow Diagram

Onsite Wastewater Treatment:

- Small footprint
- Somewhat complex operation as compared to conventional onsite systems
- Consistently reduces BOD, TSS and TN.

Decentralized Wastewater Treatment:

- Small footprint
- Simple operation which does not require manual sludge wasting, solids retention time (SRT) control, or sludge recycle.
- There were several commercially available MBBR systems identified for small communities.

2.2.1.3.3 Hybrid SBR- MBBR

A relatively new concept by one vendor for a decentralized treatment unit identified is a hybrid SBR-MBBR system. The system retains the mixing of both attached and suspended growth processes in an SBR operational configuration (EarthTek Wastewater Treatment Solutions). This reduces the number of tanks required as the entire treatment process occurs in one tank. Similar to MBBR systems, this hybrid process also relies on adequate primary treatment to minimize influent TSS into the reactor tank (EarthTek Wastewater Treatment Solutions). Another study explored the combination of SBR with MBR technology and showed that the hybrid system was flexible, robust, and resilient to changes in operating conditions (Vuono, Henkel et al. 2013)

2.2.1.4 Aerobic Granular Sludge (AGS)

The aerobic granular sludge (AGS) process utilizes operating strategies and equipment to cultivate and retain AGS granules for the purpose of achieving biological nutrient removal. AGS granules provide differing layers of microbiological growth and activity, whereas the presence of oxygen and electron acceptors decrease towards the center of each granule. AGS granules also display excellent settling characteristics that require less area and time to perform solids separation by gravity. Rapid settling facilitates operation with a high solids inventory and nutrient removal within a more compact footprint relative to activated sludge systems. As a result, AGS has emerged as a cost-effective alternative to activated sludge processes for meeting nutrient limits. Aqua Aerobics Systems, Inc. (Aqua-Aerobic) was identified as an AGS process provider in North America. Aqua-Aerobic licenses the AquaNereda® technology, an AGS process that utilizes proprietary equipment and operating strategies within sequential batch reactors (SBRs) to retain AGS granules (see Figure 2-18). The use of SBRs consolidates the infrastructure by performing secondary biological nutrient removal and solids separation in the same tankage. Considerations for the process included instrumentation reliance to successfully perform BNR in SBRs as well as upstream screening requirements.

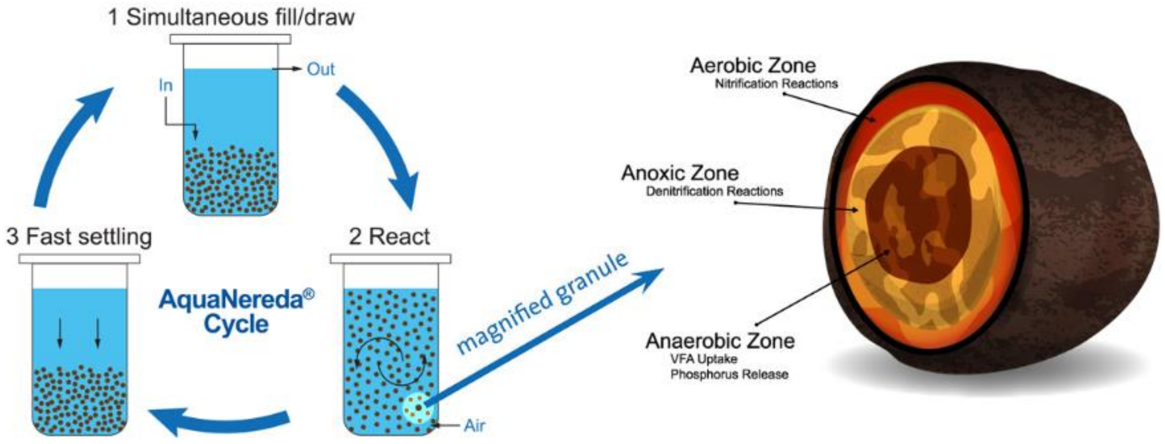


Figure 2-18: AquaNereda® Process Flow Diagram

Onsite Wastewater Treatment: AGS applications have not been tested for onsite treatment.

Decentralized Wastewater Treatment:

- Small footprint
- Relatively complex operation, with several process controls required
- Consistently reduces BOD, TSS and TN
- Applicable to larger decentralized treatment systems (>0.5 mgd).

2.2.1.5 Deammonification

An alternative approach for biological nitrogen removal identified is the use of the deammonification process (Figure 2-19). This process is mostly used for high strength (ammonia) wastewaters such as the liquid stream of the centrifugation dewatering process (“centrate”) at municipal wastewater treatment plants as a sidestream treatment. The deammonification process requires conversion of approximately

50% of the influent ammonia into nitrite by ammonia oxidizing bacteria (AOB) using nitritation, followed by the simultaneous removal of ammonia and nitrite by anammox bacteria. Anammox bacteria, short for anaerobic ammonia oxidizing bacteria, are the catalyst behind the deammonification process. Under anoxic conditions, anammox bacteria have the ability to simultaneously reduce nitrite and ammonia to nitrogen gas.

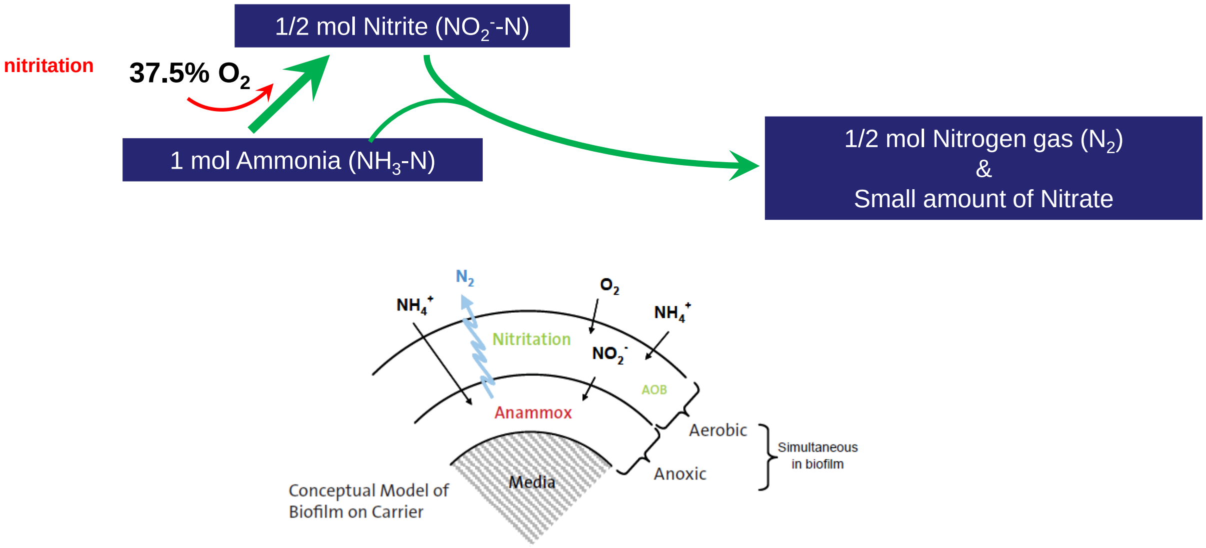


Figure 2-19: Deammonification Process

Onsite and Decentralized Wastewater Treatment:

The deammonification process has not yet been considered for development of an onsite or decentralized treatment unit. However, the resultant energy and chemical savings associated with incorporating this treatment technology and research directed toward the role and mechanisms of the specialized media could lead to lower cost, scalable installations. Constraints to this process include operational oversight requirements, low temperature sensitivity, pH sensitivity, and slow growth rate of anammox bacteria.

2.2.2 Physical/Chemical Treatment Processes

Physical/chemical (P/C) processes use non-biochemical approaches for wastewater treatment. Though P/C processes were initially equally acceptable compared to biological processes, they have been found to be more expensive and more problematic when treating dilute waste streams. Thus, there were limited municipal applications identified. The more suitable P/C options for community/household/on-site use identified were 1) membrane separation, 2) ion exchange, and 3) evaporation. P/C processes are not typically used for onsite treatment; however, are occasionally used in decentralized systems primarily as tertiary treatment processes, side stream treatment or sludge processing. Membrane separation requires substantial and costly pretreatment, and therefore is generally used for drinking water treatment. A summary of potential P/C process options for onsite or decentralized wastewater treatment are summarized in Figure 2-20.

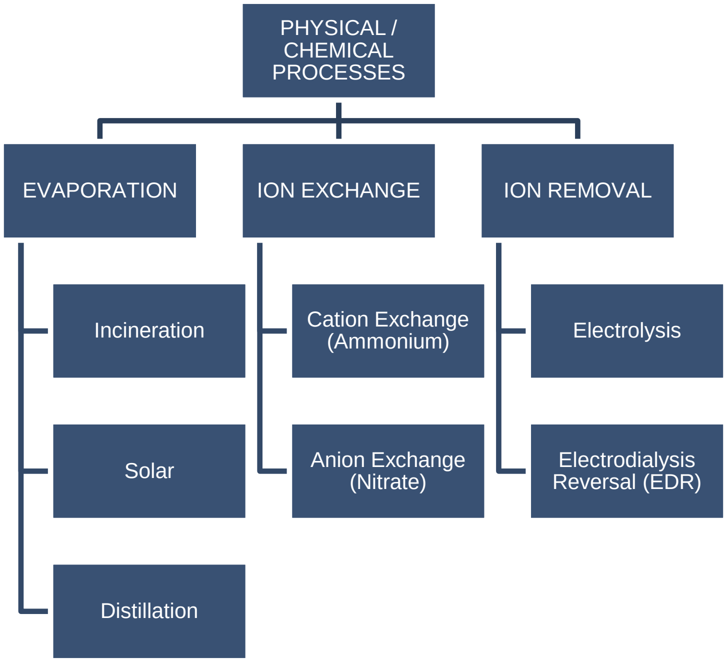


Figure 2-20: Treatment Technology Categories for Physical/Chemical Processes

2.2.2.1 Evaporation

Solar evaporation and distillation were identified as emerging options for households. Incineration is also referred to as advanced thermal oxidation (ATO) process and was mostly used for the treatment of sludge and biosolids.

2.2.2.2 Ion Exchange

Ion exchange for removal of either NH^+_4 or NO^-_3 nitrogen from wastewater has been studied by several investigators using various media. However, without prior treatment, the media is easily fouled. The added cost of the pretreatment would likely make ion exchange impractical for onsite applications. Due to the extensive pretreatment required, resin integrity, and the complexity of regeneration systems, ion exchange systems are not commonly used for decentralized treatment.

2.2.2.3 Electrolysis

Electrolysis is an electro-chemical process that can be used to remove ionic compounds from solution. At least two inventors have developed electrolysis processes to remove ammonium (and/or nitrate) from wastewaters (Jeon, Kim et al. 2012, Spielman and Summers 2012). The systems are successful at reducing nitrogen and phosphorus but not TSS. Electrolysis is still in development stages of technology, but provides promise for nutrient removal, specifically phosphorus.

2.2.2.4 Electrodialysis Reversal (EDR)

The electrodialysis reversal (EDR) was identified as a relatively common membrane desalination technology used for water reuse. While EDR effectively removes charged constituents from wastewater, various operating issues such as membrane fouling and clogging have limited the use of this technology for decentralized treatment. The expected total nitrogen removal rate for an EDR system is approximately 75 percent.

2.2.3 Natural System Processes

Natural systems such as soil, plant and wetland systems are included as a separate classification because they utilize a combination of physical, chemical and biological processes that occur naturally in the soil and/or plant. Natural treatment systems rely heavily on the assimilative capacity of the receiving environment to yield the required treatment. These systems tend to be passive, relatively simple in operation and mechanics, but typically have larger land area requirements. Natural systems tend to absorb fluctuations in influent flows with little operator attention or loss of performance. Categories of technologies that are practical for onsite and decentralized wastewater treatment are presented in Figure 2-21.

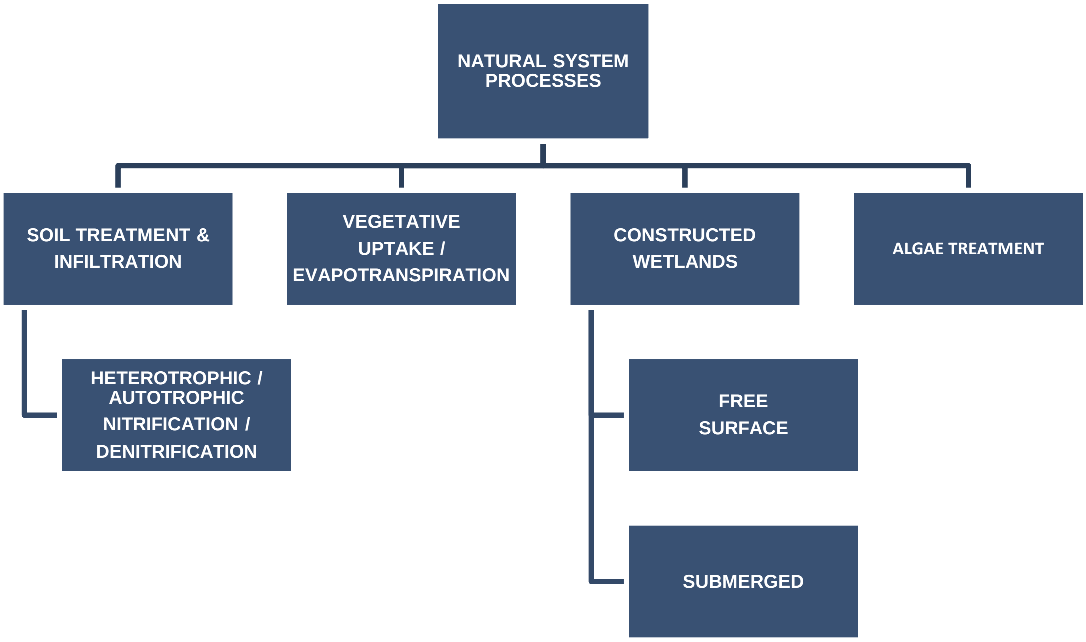


Figure 2-21: Categories of Natural Systems for Nitrogen Reduction

2.2.3.1 Soil Treatment Unit (STU)

Soil Treatment Unit (STU) systems are typically the last step in the process sequence of conventional onsite systems for final treatment and dispersal of effluent (see Figure 2-22) (Briggs, Roeder et al. 2007, Otis 2007). In conventional onsite systems, the STU process is responsible for the myriad of physical, chemical, and biological processes that provide most of the treatment. The level of treatment varies with soil characteristics, climate, and method of wastewater application.

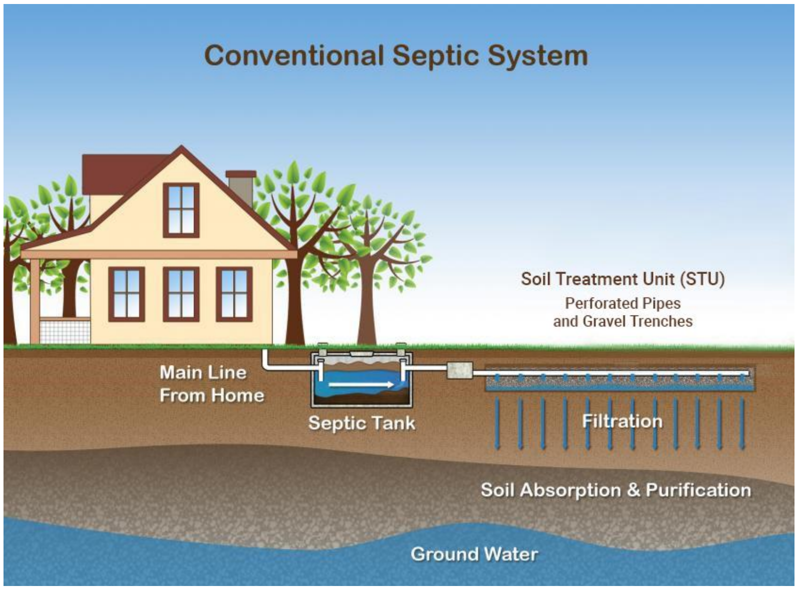


Figure 2-22: Conventional Septic System showing the Soil Treatment Unit (Minnesota Pollution Control Agency 2020)

Onsite Wastewater Treatment:

- Complete nitrification generally occurs in the first 30 cm of depth for unsaturated, aerobic soils with adequate permeability.
- The capacity of the soil to denitrify varies depending on the specific environmental conditions at the particular site, as well as the design and operation of the STU.

Decentralized Wastewater Treatment: Three major applicable land treatment processes were identified for decentralized treatment, generally used up to 250,000 gpd.

- **Slow rate (SR)**: The SR process is the application of wastewater to a vegetated land surface with the applied wastewater being treated as it flows through the plant-soil matrix. A portion of the flow percolates to the groundwater and some is used by the vegetation. The SR process is capable of producing the highest degree of wastewater treatment and was similar to rapid infiltration except wastewater application rates were typically much lower.
- **Rapid infiltration (RI)**: With RI most of the applied wastewater percolates through the soil, and the treated effluent drains naturally to surface waters or joins the ground water. The wastewater is applied to moderately and highly permeable soils by spreading in Rapid Infiltration Basins (RIBs) or by sprinkling and is treated as it travels through the soil matrix. Removals of wastewater constituents by the filtering and straining action of the soil are

excellent. Suspended solids, BOD and fecal coliforms are almost completely removed. The extent of nitrification of the applied wastewater was dependent on the hydraulic loading rate used. More recent RIB designs incorporated the addition of media for enhanced nitrogen and phosphorus removal.

- **Overland flow**: With overland flow, the wastewater is applied at the upper reaches of grass covered slopes and allowed to flow over the vegetated surface to runoff collection ditches. Overland flow is best suited for sites having relatively impermeable soils. The wastewater is renovated by physical, chemical and biological processes as it flows in a thin film down the length of the slope. Biological oxidation, sedimentation, and filtration are the primary removal mechanisms for organics and suspended soils. Nitrogen removals are a combination of plant uptake, denitrification and volatilization of ammonia nitrogen.

2.2.3.2 Soil Treatment Unit Modification for Nutrient Removal

Modifications to conventional STUs can entail the addition of a reactive media that supports denitrification through the release of a carbon or electron donor. Primary treated wastewater initially passes through an unsaturated layer or zone (of sand or other porous media for example) where nitrification occurs. Following passage through the unsaturated zone, the wastewater passes through a denitrification layer or zone which consists of a mixed denitrification media (Robertson and Cherry 1995, Robertson, Blowes et al. 2000).

Figure 2-23 presents a typical process flow diagram for a STU that has been enhanced with denitrification media for nutrient removal (Robertson, Blowes et al. 2000).

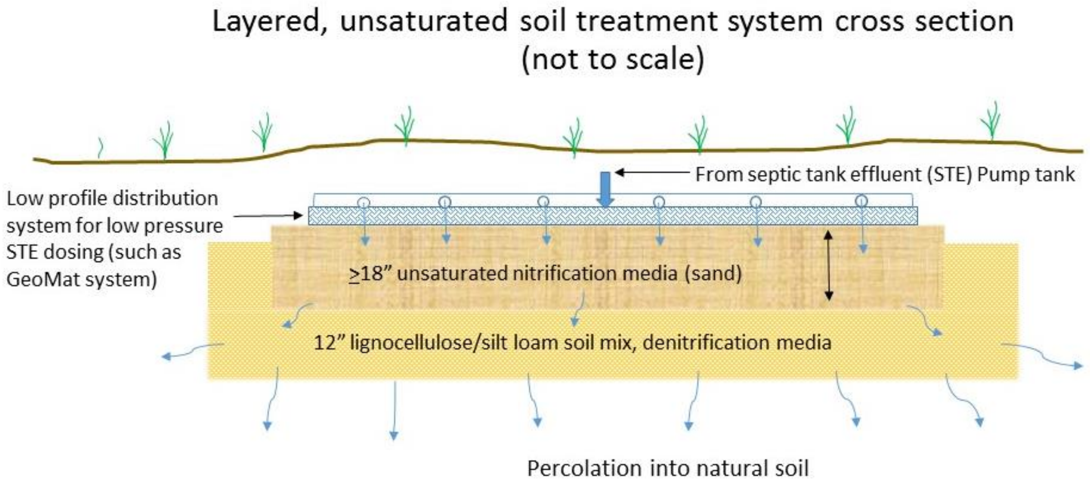


Figure 2-23: Enhanced STU Process with Denitrification Media (Hazen 2015)

Onsite Wastewater Treatment:

- Simple operation and maintenance, similar to conventional septic systems

- Nitrogen reduction resulted in TN below 10 mg/L
- Issues of concern include media longevity, replacement intervals, and hydraulic issues related to preferential flow paths.

Decentralized Wastewater Treatment: Similar modified STU applications could be applied to smaller decentralized treatment facilities.

2.2.3.3 Evapotranspiration and Vegetative Uptake

Lined evapotranspiration beds and vegetative uptake are two other methods that have been promoted for nitrogen removal. Both rely on plants to either transpire the water or uptake nitrogen for incorporation into the plant materials. However, the loss of water through evapotranspiration leaves a nutrient and salts rich liquid that has to be removed periodically to prevent toxic conditions for the plants. Also, the plants are continually harvested to remove the nutrients taken up from the system. Studies have found that nitrogen removal was achieved by these systems, but that other systems perform as well or better in removing nitrogen from the wastewater (Atkins and Christensen 2001, Barton, Schipper et al. 2005, Taylor 2006). While promoted heavily in the 1970's and early 1980's as an option for areas with slowly permeable soils or shallow water tables, evapotranspiration beds were infrequently used more recently and seem to have been replaced by constructed wetlands.

2.2.3.4 Constructed Wetlands

Constructed wetlands are wastewater treatment systems consisting of shallow ponds or channels that are usually less than a meter deep; are planted with aquatic plants; and rely upon natural biological, physical, and chemical processes to treat wastewater. Wetlands are defined as free water surface wetlands (i.e., water surface that is exposed to the atmosphere) or subsurface flow wetlands (i.e., constructed bed or channel containing appropriate media) shown in Figure 2-24. They typically have impervious clay or synthetic liners, as well as engineered structures to control the flow direction, liquid detention time, and water level.

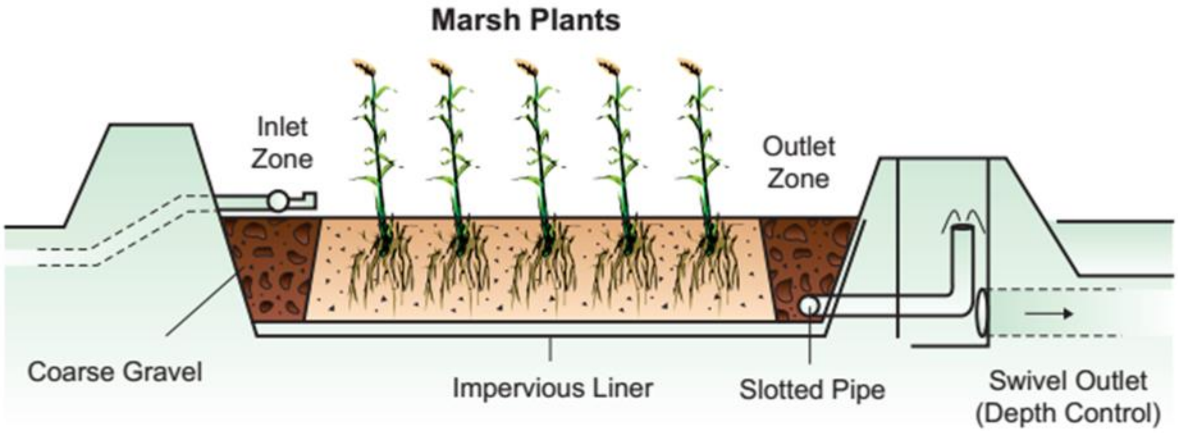


Figure 2-24: Typical Configuration of a sub-surface wetland system (Kadlec and Knight 1996)

Onsite Wastewater Treatment:

- Subsurface flow constructed wetlands have been used for single family and commercial applications for several years.
- Nitrification seldom exceeded 50 percent, which limits denitrification.
- Denitrification reduced nearly all the nitrate available if adequate electron donors were present.

Decentralized Wastewater Treatment:

- Free Surface wetlands are typically used as a tertiary process in decentralized treatment installations for polishing secondary effluent.
- Free Surface wetlands have the potential for vector attraction and public health concerns because of the readily accessible standing water.
- Hyacinths have been used in pilot and small-scale constructed wetland systems as tertiary treatment for further removal of nutrients which achieved reclaimed water quality (Wang and Calderon 2012).

2.2.3.5 Hybrid Constructed Wetlands

Hybrid systems such as recirculating wetlands and systems combining anaerobic treatment with constructed wetlands have been explored with relative success for decentralized treatment. While most of these were engineered systems, there were a few vendors identified that provided packaged hybrid constructed wetlands. Figure 2-25 presents a process flow diagram for a proprietary hybrid constructed wetland system capable of removing TSS, BOD, nitrogen, and phosphorus.

Figure 2-25: Proprietary Hybrid Constructed Wetlands System Process Flow Diagram (Organica)

Onsite Wastewater Treatment: Hybrid applications have not been tested for onsite treatment.

Decentralized Wastewater Treatment:

- Systems like the Organica Food Chain Reactor combine IFAS processes with constructed wetlands which provides full treatment of domestic wastewater within package plants

- Shows capability of blending into urban environments
- Produces reuse quality effluent (Organica)
- Have not been widely commercialized in the United States
- Proprietary systems typical flow ranges between 50,000 gpd and 125,000 gpd

2.2.3.6 Algae Treatment

Algae has also been proven to remove nitrogen and phosphorous from both water and wastewater while providing the benefit of producing oxygen. Originally patented in 1982 by Dr. Walter Adey, the Algal Turf Scrubber® (ATS) was developed based on natural algal mats over coral reefs. Algae is considered an emerging technology which could be considered more as a wastewater polishing process with sustainable, energy recovery features. Shallow raceway mixed ponds were developed in the 1960's and have since been improved by including paddle wheels. The paddle wheels are used to keep the microalgae suspended for sunlight exposure and the shallow depths allow for light penetration. Figure 2-26 presents a proprietary process illustration for an algae system treating wastewater effluent or natural water.

Figure 2-26: Algae Treatment System Process Flow Diagram (Water Environment Federation 2016)

Onsite Wastewater Treatment:

- The application of algae treatment for onsite treatment has been explored at the lab-scale, but not demonstrated in the field.

Decentralized Wastewater Treatment:

Algae decentralized treatment systems provides:

- low cost solution

- energy efficiency
- the algae nutrient removal was typically seasonal
- systems require large land area requirements
- efficiency of treatment was largely dependent on the sun and temperature

2.2.4 Disinfection

The organisms of concern in domestic wastewater include enteric bacteria, viruses, and protozoan cysts. Disinfection is considered a primary mechanism for inactivating/destroying pathogenic organisms and preventing the spread of waterborne diseases to downstream users and the environment. Some of the commonly used disinfectants for wastewater applications included chlorine, iodine and ultraviolet radiation (UV).

2.2.4.1 STU Fecal Reduction

The drainfield (STU) and underlying soils are the most critical components of conventional septic systems for the treatment of wastewater. Conventional onsite systems that meet current regulatory requirements are generally not significant sources of bacteria to water bodies because the soil is an excellent removal mechanism when the wastewater is allowed to percolate through a sufficient depth of unsaturated soil (> 2 feet) before reaching the groundwater. Many studies confirm the high and nearly complete removal of fecal coliform bacteria in a properly functioning drainfield. A failing septic system does not function in a sanitary manner and may result in the transport of untreated or partially treated wastewater to surface waters. The Jacksonville area has a relatively high ground water table, which could potentially transport fecal coliforms through shallow ground water into the creeks.

Aging septic systems have been identified as contributing to fecal coliform loading, in addition to nitrogen loading, to the St. Johns River and tributaries as documented in Basin Management Action Plans (FDEP). Many of the aging septic systems did not meet current code requirements. In the Lower St. Johns River Basins (LSJR) and its tributaries watersheds, special concern exists because of the high number of septic systems and the fact that the water table was often high, sometimes resulting in a very thin unsaturated zone (< 2 ft). Generally, the water table in most of Duval County was within 5 ft. of land surface and could be less than the 2 ft. in areas adjacent to water bodies. These concerns led to the FDEP study *Evaluation of Septic Tank Influences on Nutrient Loading to the Lower St. Johns River Basin and Its Tributaries* (Belanger, et al., 2011), which concluded that clear evidence of septic system nutrient and bacterial impact downgradient from drainfields was lacking. Furthermore, nutrient and bacterial plumes were not documented as reaching the adjacent surface water. In most cases, bacteria did not increase downgradient from the drainfield, rather, bacteria were greatly reduced within short distances of the drainfield (< 10 ft.). In the study, no significant relationships were found between the nutrient or bacterial plume migration distances and particle size, hydraulic conductivity, or hydraulic gradients.

2.2.4.2 Onsite Treatment Disinfection

Disinfection systems for onsite systems were regulated per FAC 64E.6.0181(3)(a)2.h. where “effluent shall be disinfected by chlorination or other disinfection method approved by the State Health Office”. A minimum disinfection level equivalent to a free chlorine residual of 0.5 mg/L measured at the point of discharge after a minimum chlorine contact time of 15 minutes is required for injection well disposal. Ultraviolet (UV) light disinfection is the second most common wastewater disinfection process in the United States. The effectiveness of a UV system depends on the characteristics of the wastewater, the intensity of UV radiation, the amount of time the microorganisms are exposed to the radiation, and the reactor configuration (UV LEDs are coming into the market soon).

2.2.4.3 Decentralized Treatment

Disinfection success in any decentralized system is directly related to the concentration of colloidal and particulate constituents in the wastewater. Alternative compounds/techniques to chlorine and UV disinfection include:

- Ozone – ozone gas (O3) is generated by imposing a high voltage alternating current (6 to 20 kV) across a dielectric discharge gap that contains an oxygen-bearing gas. Ozone is typically generated onsite because it was unstable and decomposed to elemental oxygen in a short amount of time after generation.
- Peracetic Acid (PAA) – an equilibrium mixture of acetic acid and hydrogen peroxide and water. Commercially available, PAA has a stabilizer to increase its storage life. Typically, a pump is used to transfer the PAA from the storage vessel into the secondary effluent. First commercial use of PAA for wastewater disinfection was in 1980.
- Chlorine Dioxide – generated by mixing and reacting a chlorine solution in water with a solution of sodium chlorite ($NaClO_2$). Chlorine dioxide is also generated on site because it is unstable and decomposes rapidly.
- Pasteurization – the process of heating water at a specified temperature and time for the purpose of killing microorganisms. Three different operational methods are typically used: batch, high-temperature short time, and ultra-high temperature.

2.2.5 Wastewater Treatment Technologies Summary

A summary of identified alternatives for the treatment of wastewater for both onsite and decentralized sized wastewater treatment facilities is provided in Table 2-3.

Table 2-3: Wastewater Treatment Alternatives

Category	Wastewater Treatment Process	Onsite Treatment	Decentralized Treatment
Biological, Suspended Growth	Extended Aeration/ Activated Sludge	• Small footprint • More energy intensive as compared to conventional • Mechanical treatment systems could produce more sludge as compared to conventional septic tanks • Effluent quality good, low BOD & TSS. Typical TN removal ranged from 40 to 75%	• Many options for varying flows • Designed to meet desired treatment effluent water quality
	Membrane Bioreactor (MBR)	• Not applicable	• Small footprint • Potential for membrane fouling • Modular design for phased implementation • Effluent quality good, low BOD, TSS, TN
	Sequencing Batch Reactor (SBR)	• Complex operation • Energy intensive • Require oversight • Small footprint • Effluent quality good, low BOD, TSS, TN	
	Treatment Lagoons	• Not applicable	• Large footprint • Secondary nuisances including odor
Biological, Attached Growth	Single Pass Media Biofilters	• Simple operation • Low energy use • Effluent quality good, low BOD & TSS. Limited TN removal • Maintenance of media surface req.	• Rarely used except for smaller systems • Large footprint • Limited TN removal
	Recirculating Media Biofilters	• More complex in operation than single pass • Required oversight and monitoring • Effluent quality good, low BOD & TSS. TN removal ~50%	• Typically designed for 5,000 to 50,000 gpd • Effluent quality good, low BOD, TSS, TN
	Denitrification Media Biofilters	• Required nitrification step prior which adds to footprint • Simple O&M • Low energy use • Effluent quality good, low BOD, TSS, TN	
Biological, Attached Growth	Rotating Biological Contactors (RBC)	• Small footprint • Prone to operational issues • Few new installations	

Table 2-3: Wastewater Treatment Alternatives

Category	Wastewater Treatment Process	Onsite Treatment	Decentralized Treatment
	Membrane Aerated Biofilm Reactor (MABR)	• Not applicable	• Complex operation • Operator oversight req. • Process control challenges • No US installations
Biological, Integrated Fixed-Film Activated Sludge (IFAS)	Fixed Media Activated Sludge (FMAS)	• Numerous installations • Small footprint • Complex operation • Effluent quality good, low BOD, TSS, TN	• Typically designed for 5,000 to 50,000 gpd • Small footprint • Effluent quality good, low BOD, TSS, TN
	Moving Bed Bioreactor (MBBR)	• Small footprint • Energy intensive • Consistent effluent quality with low BOD, TSS, TN	• Typically designed for 5,000 to 75,000 gpd • Small footprint • Consistent effluent quality with low BOD, TSS, TN
	Hybrid SBR-MBBR	• Not applicable	• New concept- pilot testing
Biological, AGS	Aerobic Granular Sludge (AGS)	• Not applicable	• Applicable for >0.5 mgd • Small footprint • Effluent quality good, low BOD, TSS, TN
Natural Systems	Soil Treatment Unit (STU)	• Large footprint • Simple operation • Effluent quality good, low BOD & TSS	• Applicable for <250,000 gpd • Slow rate effluent quality good, low BOD & TSS
	STU Modification for Nutrient Removal	• Simple O&M • Effluent quality good, low BOD, TSS, TN	• Not applicable
	Evapotranspiration and Vegetative Uptake	• Infrequently used	
	Constructed Wetlands	• Complex operation to optimize performance • Large footprint • Secondary nuisances • Effluent quality good, low BOD & TSS	• Large footprint • Secondary nuisances including vector attraction
	Hybrid Constructed Wetlands	• Not applicable	• Applicable for 50,000 – 125,000 gpd • Few US installations
	Algae Treatment	• Not applicable	• Large footprint • Low energy • Nutrient removal is inconsistent (seasonal)

*Listed advantages and disadvantages are not all inclusive

2.3 Wastewater Collection Technologies Assessment

Applicable collection and transmission technologies for the conveyance of wastewater to decentralized or centralized wastewater treatment facilities were evaluated. Three main categories of wastewater collection systems were identified: gravity, low pressure and vacuum systems (see Figure 2-27). Hybrid alternatives and a no-sewer alternative consisting of holding tanks at individual points of connection with pump out via vacuum truck and transport to a treatment facility were also included.

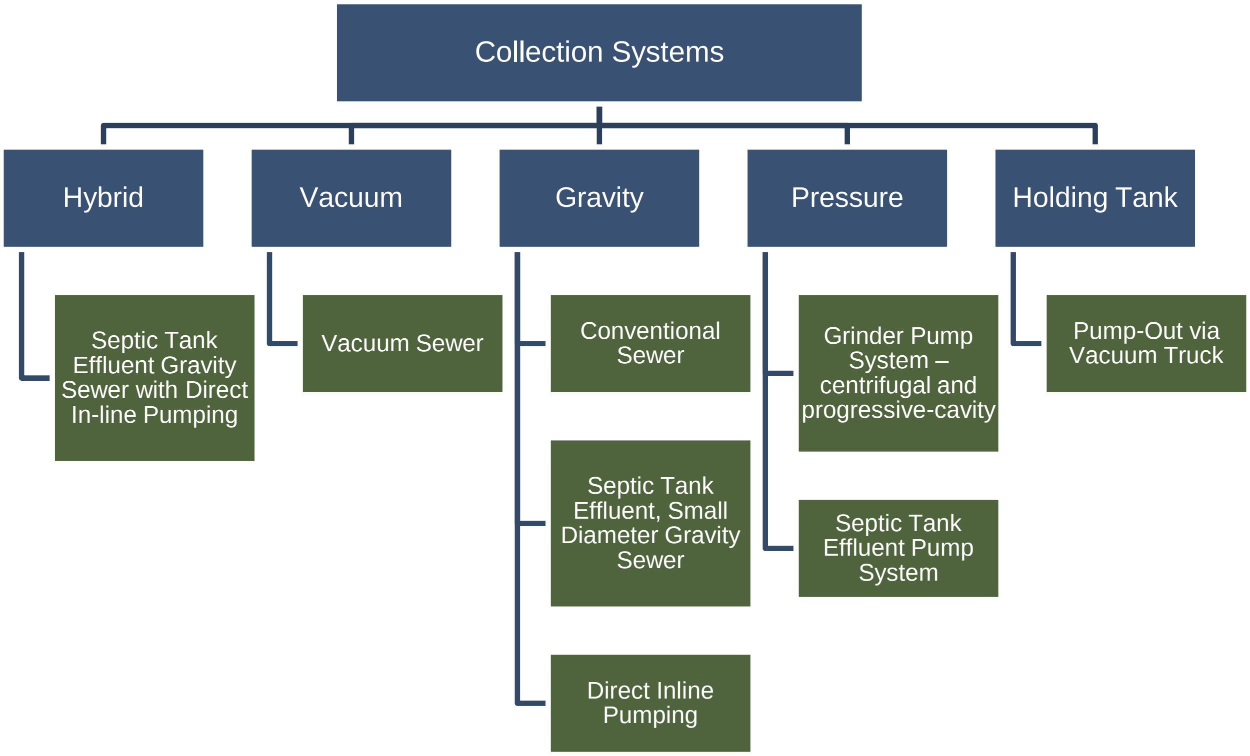


Figure 2-27: Wastewater Collection System Alternatives Summary

2.3.1 Gravity Sewer Systems

Conventional gravity sewer systems were identified as the most widely used method of wastewater collection for residential and other developed areas in the US.

2.3.1.1 Conventional Gravity Sewer

Conventional gravity sewer systems rely on slope and gravity to convey wastewater from each service connection to a gravity sewer. Due to the presence of suspended solids in raw wastewater, gravity lines generally maintain a minimum flow velocity of 2 feet per second (fps) to avoid clogging due to particulate deposition on the pipe walls (USEPA 2000). Manholes are placed on the sewer lines at intervals of 300 to 400 feet and at all intersections and changes of slopes to allow access for inspection, cleaning and repair. Because of the continuous slope, the depth of gravity sewers in areas of relatively flat topography increase with distance downstream until the depth becomes too great for economical construction. Typically, this depth is 12 to 14 feet below land surface, at which point a lift station is built to pump wastewater to a shallower gravity-sewer manhole, through a force main to another lift station, or directly to a wastewater treatment facility.

2.3.1.2 Direct Inline Pumping System

A more recent technology in collection systems identified is the direct inline pumping system (Direct IP). The Direct IP technology was developed in France and few US installations exist with long term operational data. Direct IP systems lift gravity effluent directly at the point of entry without the need for storage (wet well). Typical operation is based on continuous pumping but depended on inlet flow. Traditional gravity collection often required a wet well or a separate chamber for waste to accumulate in prior to being pumped into a force main. Direct IP could be retrofitted into existing lift stations. The elimination of the wet well reduced the excavation depths, odor issues and corrosion, and provided safe access (little to no operator exposure to wastewater) to lift station components (Industrial Flow Solutions , SIDE Industries). Figure 2-28 is a schematic of a Direct IP installation.

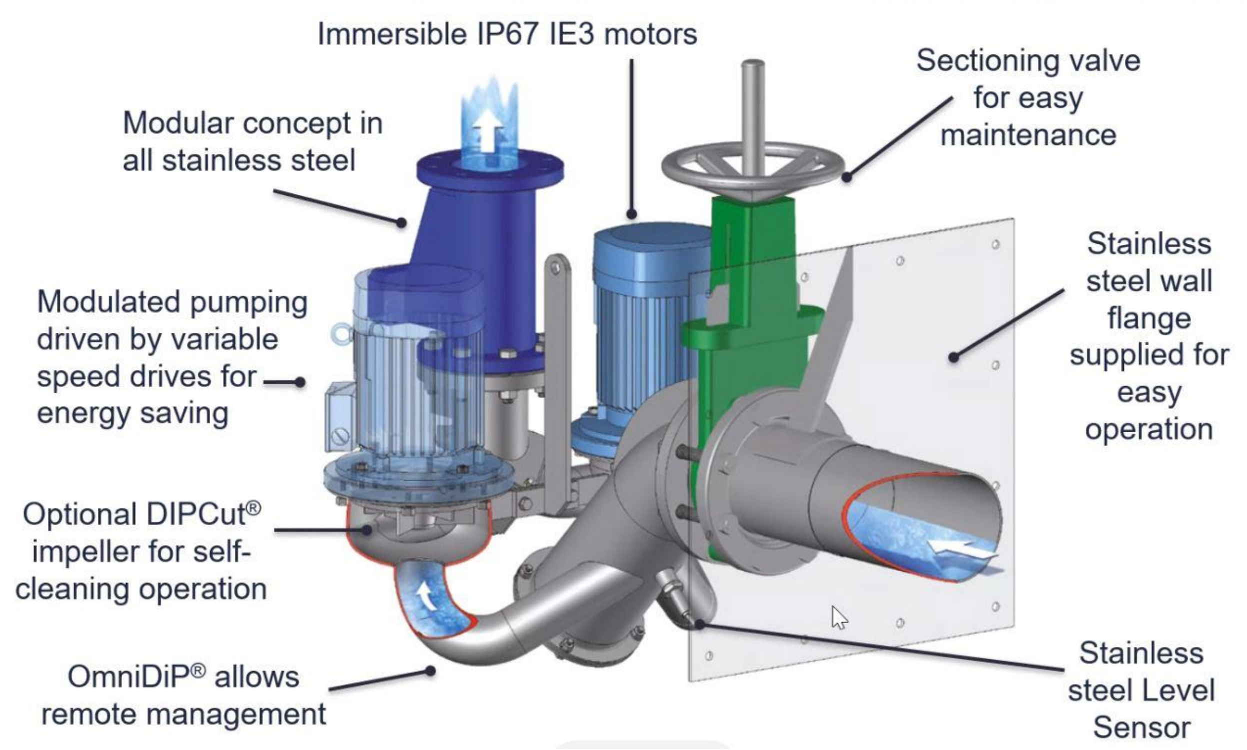


Figure 2-28: Direct IP System Schematic (Overwatch 2020)

2.3.1.3 Small-Diameter Gravity Sewer

An identified alternative to traditional gravity sewers that also relies on gravity for the conveyance of wastewater was small diameter gravity sewer (SDGS). Also known as septic tank effluent gravity (STEG) sewers, the collection system utilizes septic tanks at the wastewater source to remove solids and floating materials, such as oil and grease. Effluent from the septic tank is discharged to the SDGS. Since solids are removed in the septic tanks, SDGS diameters are reduced (as small as 3 inches) and they can be laid with inflective gradients in some areas, as long as the overall gradient is negative. Figure 2-29 depicts the general components and layout of a SDGS system.

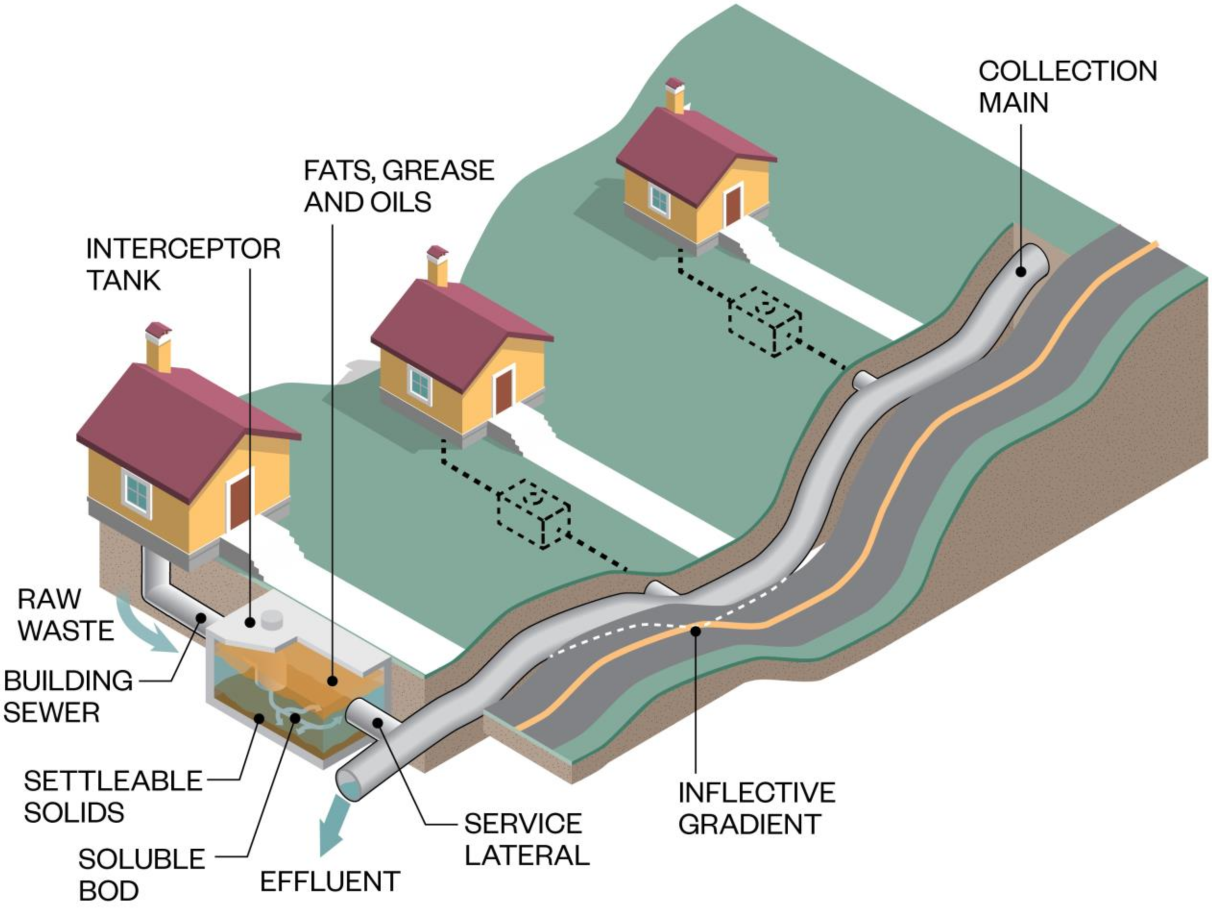


Figure 2-29: SDGS Diagram

2.3.2 Low Pressure Sewer Systems

Low pressure sewer systems utilize pumps to convey wastewater at sufficient flow velocities to deter particulate settling. Two main types of low pressure collection systems were identified: septic tank effluent pressure (STEP) sewers and grinder pump sewers (GP) (USEPA 2002).

2.3.2.1 Septic Tank Effluent Pump Systems (STEP)

Septic tank effluent pump (STEP) sewer systems were similar to SDGS systems in that they rely on septic tanks at the wastewater source for removal and decomposition of settleable and floating solids. However, instead of using SDGS lines to convey septic tank effluent to the wastewater treatment facility (WWTF), STEP systems utilize small septic tank effluent pump stations and pressure sewers. Figure 2-30 presents a STEP sewer system diagram with major components highlighted.

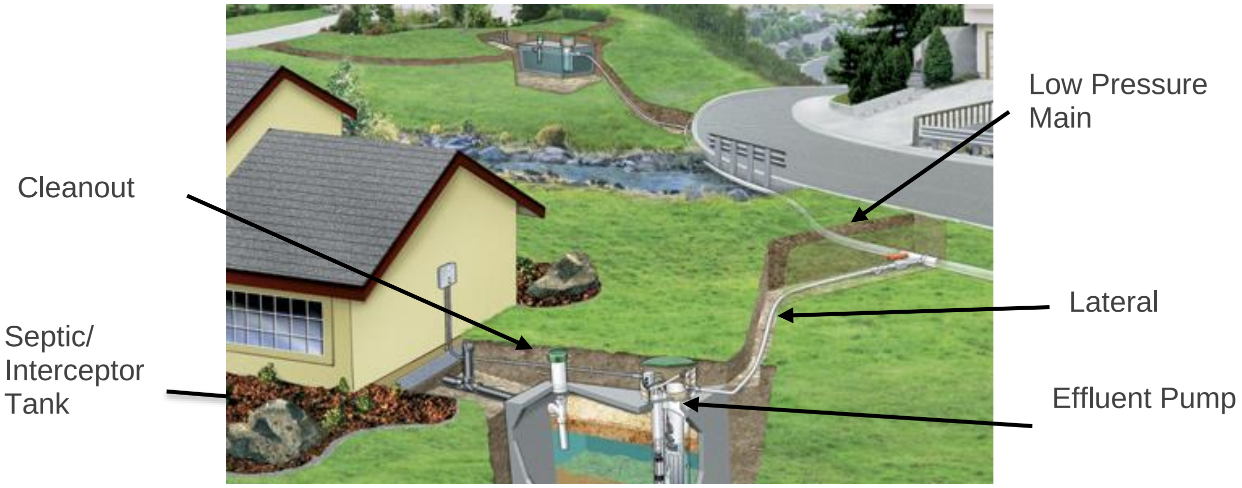


Figure 2-30: STEP Sewer Diagram (Orenco 2020)

Based on STEP systems that were operated in Florida, the maximum size of the local area served by an interconnected STEP pressure sewer system was about one square mile. Once this maximum service area was reached, the STEP pressure sewer system discharged to a lift station that pumped wastewater to the WWTF.

2.3.2.2 Grinder Pump Systems (GP)

Grinder pump (GP) sewer systems were identified as another type of low pressure sewer collection system. Specialized pumps that turn on at specific intervals (based on water level in tanks) were used to process the entire waste stream from a home into a fine slurry prior to pumping the effluent to a low pressure sewer main. A typical GP sewer system utilizes a small grinder pump station at each wastewater source (home), and small-diameter, low-pressure sewers transmit the wastewater to lift stations or directly to a WWTF. Stations serving single residential units typically utilize fiberglass wet wells 24 to 30 inches in diameter located in the right-of-way. Two common types of grinder pumps, submersible centrifugal grinder pumps and submersible progressive-cavity grinder pumps, are in widespread use. Figure 2-31 presents a GP sewer system diagram with important components highlighted.

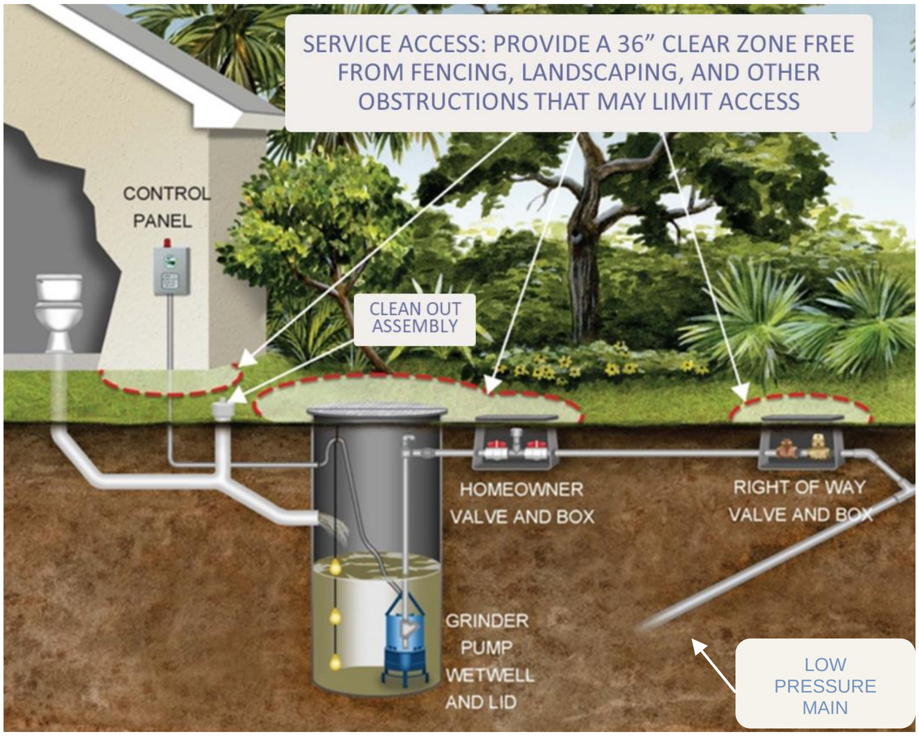


Figure 2-31: GP Sewer Diagram

2.3.3 Vacuum Sewer Systems

The components of a vacuum sewer system identified include vacuum station(s), collection system piping and isolation valves, and vacuum sewer valve pits and air terminals. Vacuum collection piping is found to typically be 4-inch to 10-inch solvent weld or push-on, rubber-gasketed PVC pipe laid in a saw-tooth pattern, with an overall minimum 0.2 percent slope. There are three main components to a vacuum system: (1) the valve pit, (2) the vacuum main, and (3) the vacuum station as depicted in Figure 2-32. Vacuum stations are usually concrete block buildings on concrete foundations with part of the structure located below grade to accommodate entry of the vacuum sewer. Vacuum stations utilize pumps to create a vacuum (suction force) in the vacuum main. Pneumatic valves within the valve pits were sensor-activated and allowed for the suction of the wastewater into the vacuum main and to the vacuum station. Once the wastewater arrived at the vacuum station, the collection tank filled, and non-clog wastewater pumps removed waste from the collection tank for transmission either to lift station(s) or directly to a WWTF.

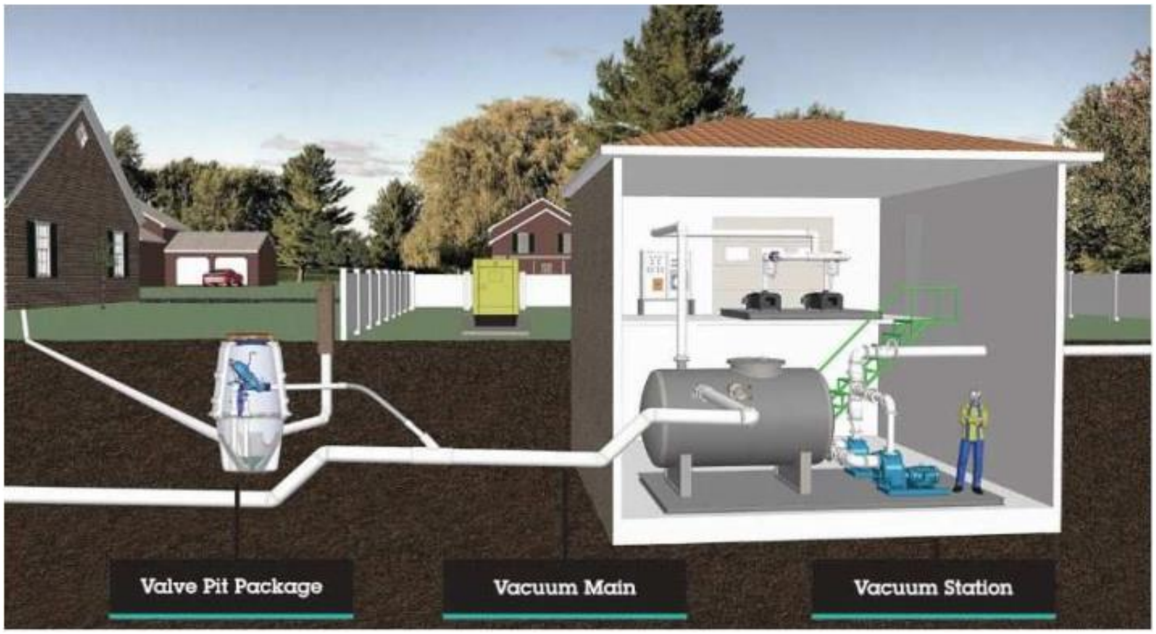


Figure 2-32: Major Components of Vacuum Sewer Systems (Airvac)

2.3.4 Hybrid or Mixed Systems

Combinations of the identified alternative wastewater collection systems discussed in this section are possible and, in many cases, lower the overall costs of the collection system. The primary concern when combining systems is for the wastewater characteristic of an upstream system to be compatible with the downstream system into which it discharges. An example of a compatible combination is SDGS and STEP systems since both waste streams employ septic tank pretreatment and have low solids content. Any of the alternative collection systems could be discharged to a conventional gravity system, as long as precautions are taken to prevent potential corrosion and odor problems caused by more anaerobic upstream systems (e.g., SDGS or STEP). Examples of incompatible combinations are vacuum or grinder pump systems discharging to SDGS or STEP systems, since the latter two systems are not designed to convey wastewater with high solids or grease.

2.3.5 Wastewater Collection Technologies Summary

Table 2-4 summarizes the advantages and disadvantages of the discussed collection system alternatives.

Table 2-4: Collection System Alternatives Comparison*

Collection System Type	Advantages	Disadvantages
Gravity – Conventional	• Well established technology • Collectors contained within the public right-of-way (R/W) • Entire waste stream conveyed from property • No power required except at lift stations	• Deep excavation or frequent lift stations required in areas of flat topography • Scour velocities could not be maintained at low flows • Manholes required • I/I common through manholes • Typically installed under roadway pavement, requiring restoration
Gravity – Direct Inline Pumping (Direct IP)	• No wet well required • Shallow lift station	• New technology • Long term O&M requirements unknown
Gravity – Small Diameter Gravity (SDGS)	• Shallow and small diameter pipe reduced excavation • Cleanouts in place of manholes • I/I reduced by fewer manholes • Usually installed in R/W	• Interceptor tanks located on private property, req. easement • Settleable solids retained on private property that req. periodic removal
Pressure – Septic Tank Effluent Pump (STEP) Systems	• Collector mains could be laid at constant depth to conform to topography • Primary treatment req. reduced • Manholes eliminated • Infiltration eliminated • Usually installed in R/W off of road pavement • Major lift stations eliminated	• Interceptor tank located on private property, req. easement • Power req. at each connection supplied by property owner • Settleable solids retained on private property that require periodic removal • Individual service lost with power outage
Pressure – Grinder Pump	• Collector mains could be laid at constant depth to conform to topography • Entire waste stream conveyed from property • Cleanout in place of manholes • I/I eliminated • Manholes eliminated • Lift stations eliminated	• Vault with grinder pump located on private property with easement required • Power req. at each connection supplied by property owner • Individual service lost with power outage
Vacuum	• Collector mains could be laid at nearly constant depth to conform to topography • Entire waste stream conveyed from property • I/I eliminated • Manholes eliminated • Collector mains and valves installed in R/W off road pavement • No power req. at connection • Standby power typically provided at central vacuum station prevents service loss during power outages	• Collector mains had to be installed to grade in a sawtooth pattern • Standby power req. at central vacuum station to prevent service loss during power outages • Limited number of manufacturers of equipment • Pipe diameters were greater than those for pressure systems

*Listed advantages and disadvantages not all inclusive

2.4 Wastewater Management Strategies

Wastewater management strategies for this project were defined as methods for managing the wastewater generated in the STPO priority areas in lieu of the existing septic systems. A scheme for classifying wastewater management strategies to allow comparisons between the alternatives was identified. This scheme consisted of two main groups: traditional wastewater management strategies and innovative component wastewater management strategies. The traditional wastewater management strategies included onsite, decentralized, centralized, and integrated management (i.e., a mixture of the first three). Figure 2-33 shows the four main traditional wastewater management strategies along with their subgroups.

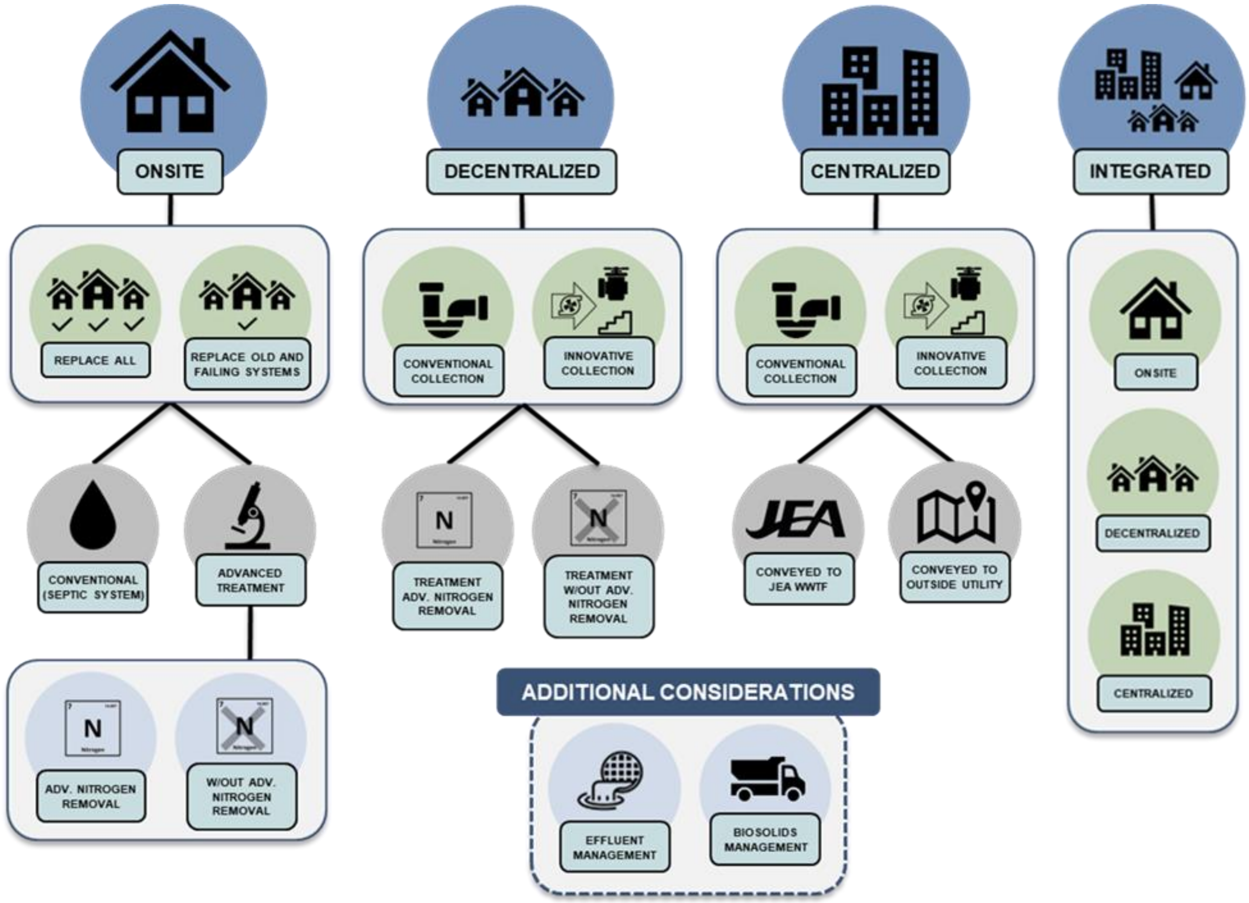


Figure 2-33: Identified Traditional Wastewater Management Strategies Alternatives

In addition, innovative component management strategies could be coupled with overall strategies such as: biosolids management, effluent management, community redevelopment, source separation, and groundwater remediation with permeable reactive barriers. Figure 2-34 shows the three innovative component wastewater management strategies along with their subgroups (if applicable).

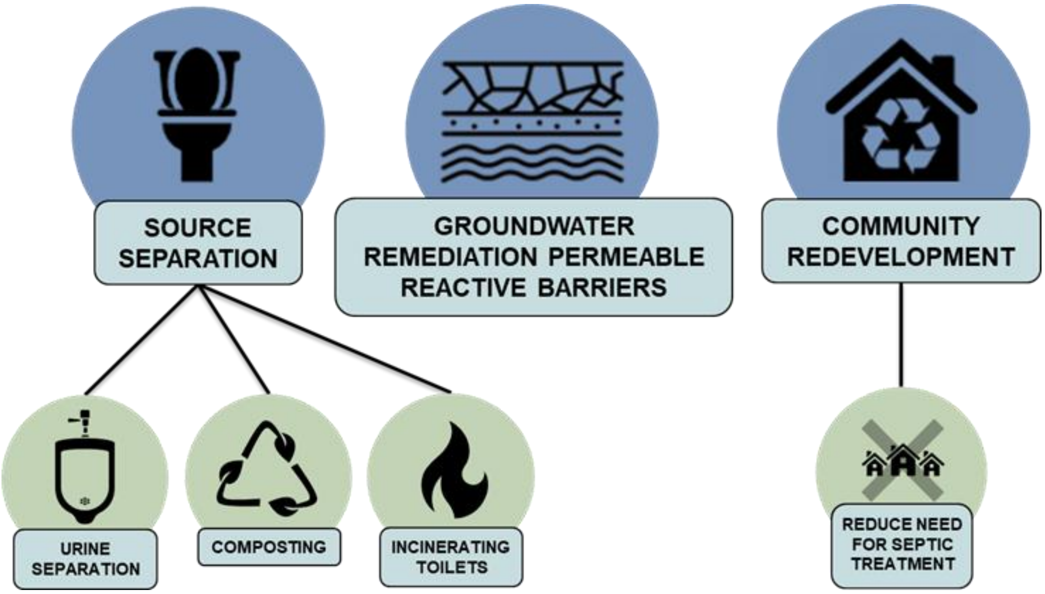


Figure 2-34: Innovative Component Wastewater Management Strategies to be Screened

2.4.1 Onsite Management Strategies

As discussed in Section 2.1.1, onsite treatment was defined as a single unit used for collection, treatment, and dispersal or reclamation of wastewater generated by a single dwelling or building. In general, onsite treatment systems are located at or near the site of wastewater generation and can include conventional, advanced or innovative treatment systems (see Section 2.2). One benefit of the onsite management strategy is the elimination of costs related to centralized sewer collection and transmission to either a decentralized or centralized treatment facility. A depiction of a conventional onsite septic system is shown in Figure 2-35.

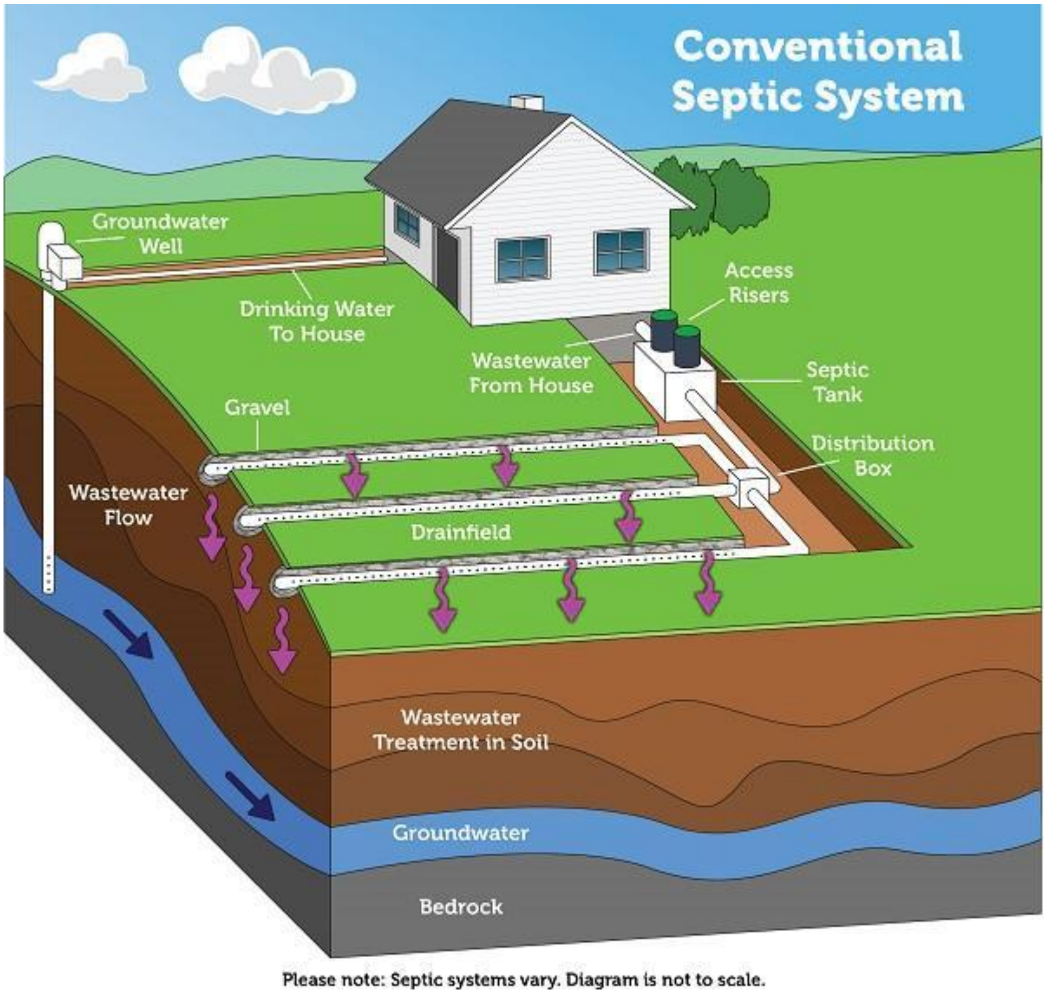


Figure 2-35: Example of Onsite Management with Conventional Septic System (USEPA 2019)

Often owners were unaware of their septic system specifications and the necessity for periodic maintenance or repair. In this “unmanaged” condition, some septic systems did not perform adequately and many had operational problems (USEPA 2005). The USEPA reviewed state and local management approaches and revealed that many programs relied on the individual homeowner for the operation and maintenance of the onsite treatment system (USEPA 2005). Homeowners (both those with and without experience dealing with onsite systems) were not trained and provided the required information needed to operate and maintain their systems. However, utilities also often lacked the legal authority to hold homeowners accountable for properly maintaining the treatment system. Thus, public education balanced with proper legal authority for the utility was necessary for a successful onsite management system.

To implement a successful onsite management strategy, a thorough plan including factors linked to the operation, maintenance, and efficiency of the onsite system should be developed. Factors such as design options, site conditions, operation and maintenance requirements/training, periodic inspections, repair and upgrade, monitoring, and financial support could be included. One core element identified was establishing the legal authority for the utility and/or private responsible management entity (RME) to enforce the plan. Ownership and management entities are discussed in Section 2.5, Institutional Frameworks.

One potential onsite management strategy identified for JEA was to consider the aging and/or failing systems and replace/repair them in phases. This strategy would allow JEA to focus on replacing only failing units versus all units within STPO priority areas; however, political hurdles (i.e., public reaction, fairness perception, etc.) might be associated with this approach. Furthermore, failing units could be somewhat difficult to define/identify. The STPO prioritization analysis included an annual review of existing septic systems by the Health Department and the City which included analysis of repair permits. Example parameters that typically are used to establish whether a unit was defined as failing included an inspection of the structural integrity of the tank, meeting current code, hydraulic/physical parameters, age of system, height of groundwater table in the vicinity of effluent dispersal, etc.

Upgrading conventional septic systems to advanced onsite treatment systems could be a low-cost approach to wastewater treatment if planned, designed, installed, operated, and maintained properly. Onsite treatment units that had wastewater treatment performance equivalent to centralized wastewater treatment plants and historical data for proven performance (see Section 2.2) were identified. If nitrogen reduction was a goal for a STPO priority area, advanced onsite nitrogen reducing systems would be applicable solutions. The advanced systems would likely require additional oversight for operation and maintenance when compared to traditional septic systems. Identified onsite management strategies are summarized in Figure 2-36.

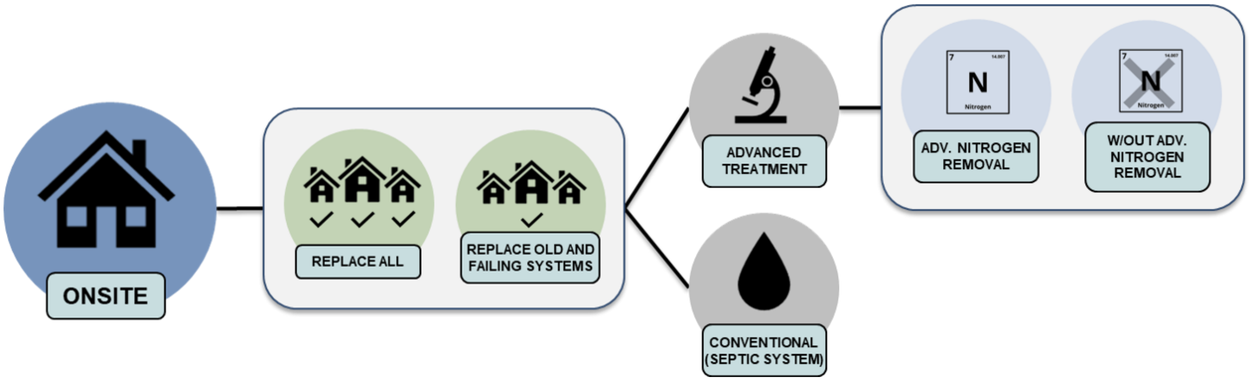


Figure 2-36: Onsite Management Strategies Alternatives

Utilities that have incorporated on-site systems into their management strategies included:

- Broad Top Township, Pennsylvania (discussed in Appendix B)
- Jamestown, Rhode Island
- Monroe County, Florida
- Hamilton County, Ohio

2.4.2 Decentralized Management Strategies

As discussed, decentralized treatment was defined as a multi-source collection and community or clustered treatment system (not an existing JEA WWTF) used to collect, treat and disperse or reclaim wastewater from a small community or service area. An example of a decentralized management strategy is shown in Figure 2-37.

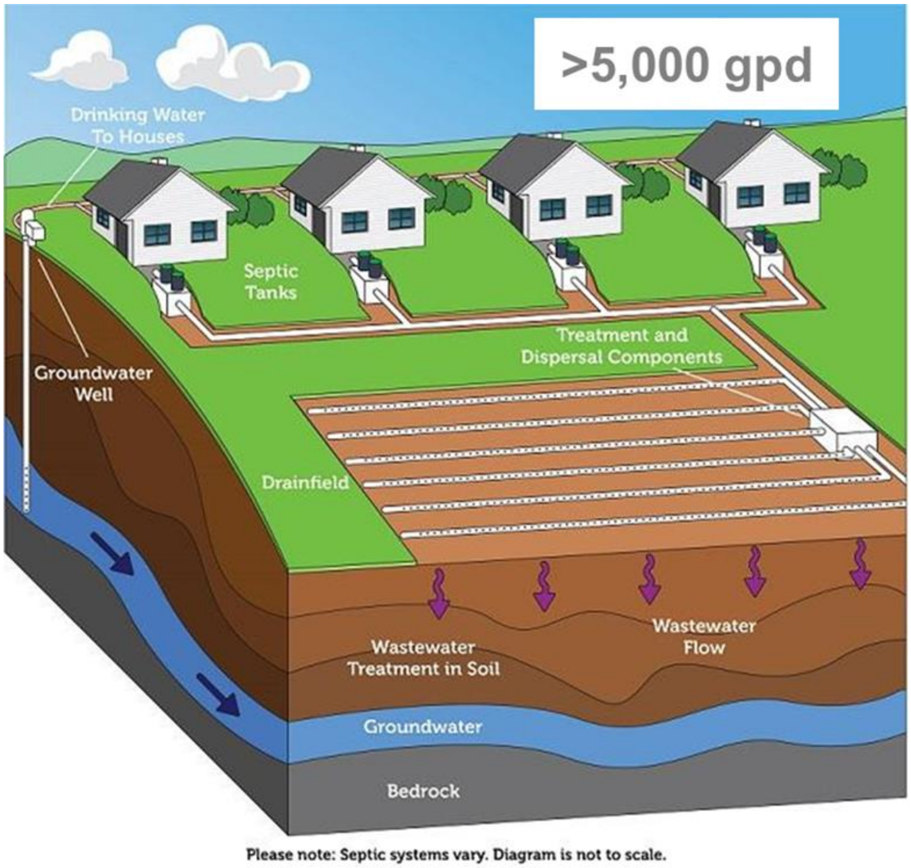


Figure 2-37: Example of Decentralized Management Strategy (USEPA 2019)

There were multiple alternatives to decentralized management strategies identified for JEA to consider (see Figure 2-38). As previously discussed, both collection system alternatives and treatment system alternatives were identified. When considering various decentralized management strategies, it was important to consider the volume of wastewater generated from the connected parcels, land area available for conveyance network and treatment facilities, and effluent management options with consideration to environmental constraints. Decentralized treatment units may include advanced treatment specifically aimed to target nitrogen removal.

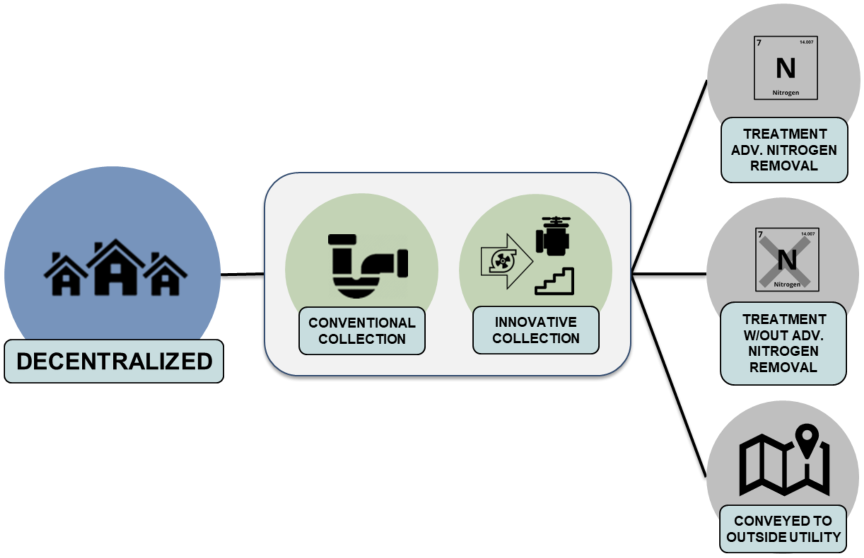


Figure 2-38: Decentralized Management Alternatives

Many utilities, including those listed below, have developed decentralized management strategy approaches.

- Rutherford County, Tennessee (discussed in Appendix B)
- Loudoun, Virginia
- Hampton Roads, Virginia
- Fairfax County, Virginia
- Keuka Lake, New York
- The Sea Ranch, California
- Otter Tail Lake, Minnesota
- Blacksburg, Virginia
- Phelps County, Missouri
- Shannon City, Iowa
- Prince George County, Maryland

2.4.3 Centralized Management Strategies

For the purpose of this project, a centralized treatment facility was defined as an existing JEA wastewater treatment facility (WWTF), traditionally called a publicly owned treatment works as defined in Title 40 of the CFR Section 122.2. The centralized management strategy alternatives included the collection system alternatives and transmission to an existing JEA WWTF. Currently, JEA owns, operates and maintains 11 WWTFs in Duval, St. Johns and Nassau counties with three additional facilities planned. For centralized management strategy assessments of the STPO priority areas, the remaining capacity of JEA's existing WWTFs would need to be considered. Many utilities, including JEA, Sarasota County, Charlotte County, Monroe County, and the Loxahatchee River District, have begun or completed the transition to a completely centralized sewer system within their urban service area.

2.4.4 Integrated Management Strategies

Integrated management strategies were defined as a mixture of the previously mentioned wastewater management strategies (onsite, decentralized, and centralized) as well as additional management and treatment processes that provided community benefits such as water reuse, satellite systems, and biosolids management. An example of a theoretical community implementing integrated management is shown in Figure 2-39. In this example, on-site systems with drip irrigation were provided to remote customers who were located far away from the centralized sewer network or generated wastewater volumes too small for a decentralized system. The bulk of the wastewater was handled via centralized collection and treatment with decentralized systems installed in less-developed parts of the community that were detached from the centralized sewer system.

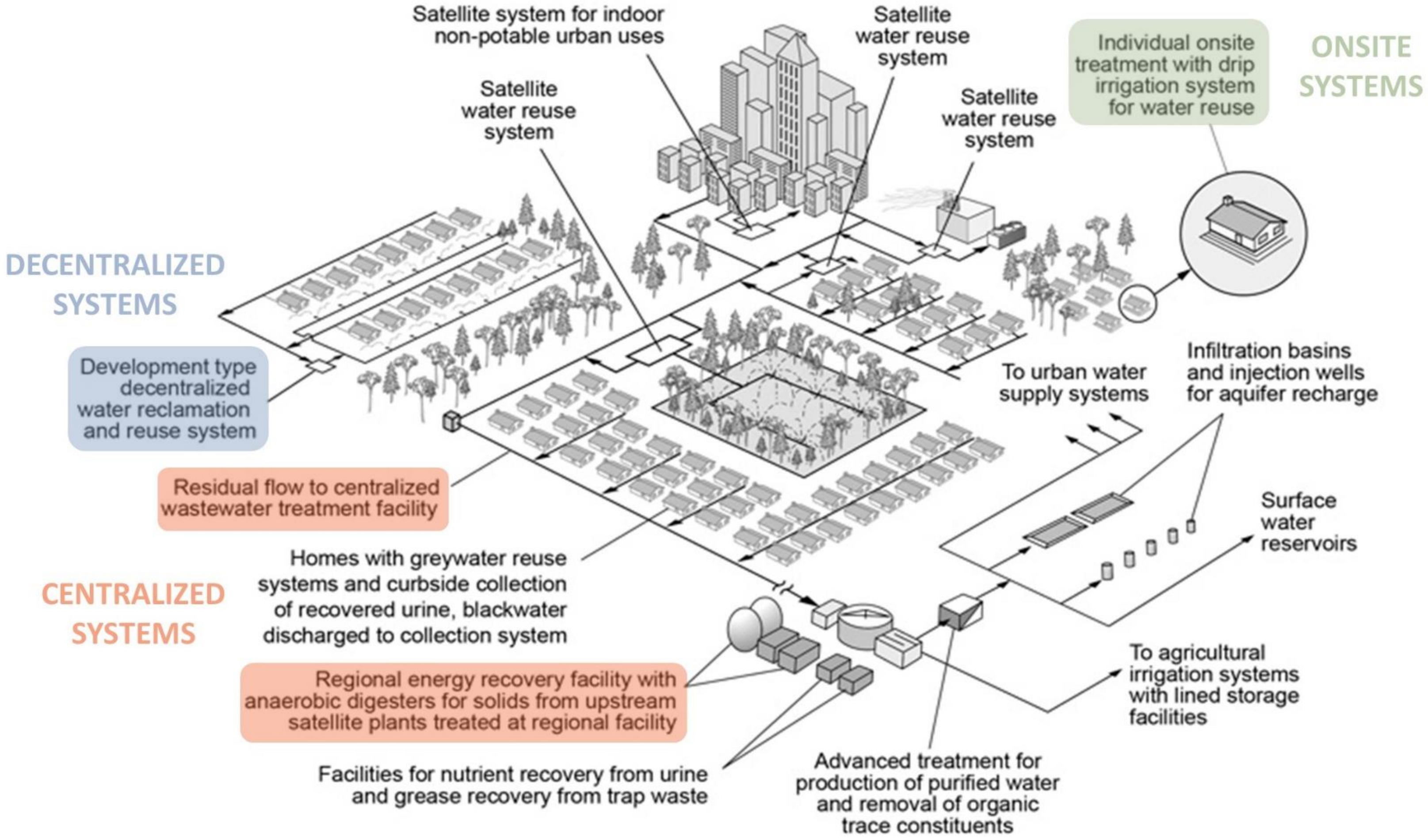


Figure 2-39: Integrated Wastewater Management Visual Example (Gikas and Tchobanoglous 2009)

Some difficulties of an integrated management strategy included complexity in managing different technologies, collection systems, solids handling methods, and effluent management practices. Each technology could have different operation and maintenance needs, requiring different training and skills. Overlapping maintenance schedules, unknown conditions of remote systems, and variable water quality between systems were some factors that presented challenges when managing an integrated wastewater system.

The following utilities have developed an integrated management system:

- Loudoun County, Virginia
    - Mixture of septic systems, decentralized, and centralized treatment.
- Upland Hills Country Club Golf Course, Upland, California
    - Centralized and decentralized systems for reclaimed water production used at a golf course.
- Hampton Roads, Virginia (Hampton Roads Sanitation District, HRSD)
    - Centralized sewer, decentralized regional facilities, and onsite systems.
- Broad Top Township, PA
    - Centralized sewer, township owned and operated onsite systems with some systems discharging the effluent to surface water.

2.4.5 Biosolids Management Strategies

JEA advised that the processing of biosolids from its WWTFs, except Blacks Ford and Monterey, is planned at the Buckman Residuals Management Facility (RMF) for the foreseeable future. The Buckman RMF is centrally located within JEA’s service area and will remain the primary location for future biosolids processing and wastewater management strategies.

JEA’s current biosolids operations include trucking to sludge storage tanks where it is pumped to the gravity belt thickeners, pumped to the Buckman Water Reclamation Facility (WRF) then directly into the gravity belt thickeners, or pumped directly to the sludge storage tanks. Following the belt thickeners, the biosolids are digested in one of three anaerobic digesters. Biogas from the digestion process is captured and used for energy production. The digested sludge is moved into a centrifuge to reduce the water content to about 20% solids. The 20% solids cake is then processed through thermal dryers to obtain a solids content of approximately 95%. The thermally dried biosolids are stored until used for land application. The current proposed FDEP rule changes on land application of biosolids may impact the availability of sites for land application.

The Buckman RMF was undergoing major upgrades to accommodate future capacity demands and to maintain an efficient process by replacing or upgrading aging infrastructure/equipment. The design of these modifications was underway. It was recommended that the potential additional biosolids generated through strategies in the IWTP Master Plan be incorporated into the ongoing facility improvement plan.

2.4.6 Effluent Management Strategies

Treated wastewater must be delivered to an ultimate endpoint. Effluent management options identified span land application and other non-potable water reuse alternatives, subsurface applications, potable reuse, and as a last resort, surface water discharge. The feasibility of each effluent management option was dependent on site specific conditions including effluent flow rates and quality, soil types, surface water availability and sensitivities (i.e., proximity and receiving water quality requirements), land availability, and potential local reuse opportunities. The relationship between effluent management strategy and effluent water quality highlighted the interdependence between effluent management and treatment. In general, the greater an effluent management option’s potential for human contact, the more stringent the effluent water quality requirements. When inadequately treated wastewater was managed through any disposal and/or reuse strategy, there was the potential for environmental degradation and human health ramifications. Alternatively, when high quality effluent was managed through these pathways, there was the potential for improved environmental service, and the conservation/augmentation of other water supplies. Individual effluent management strategies are discussed below with associated site and effluent water quality requirements.

2.4.6.1 Land Application Water Reuse

Wastewater effluent could be applied to land in various ways to achieve improved water quality, disposal, and/or irrigation benefits. Table 2-5 describes various methods of land application, including associated Florida Administrative Code regulations and discharge limits. The stringency of discharge limits was a function of the potential for human contact with the applied wastewater.

Table 2-5: Land Application Requirements in Florida

Land Application Method	Description	Florida Administrative Code Chapter	Discharge Limits
Slow-rate land application with restricted public access	• Application of reclaimed water to a vegetated land surface for treatment through the plant-soil matrix • Water percolated to groundwater and was used by vegetation • Offsite surface runoff was generally avoided • May be applied to pastures; areas to grow feed, fodder, fiber, or seed crops; tree irrigation	62-610.400 through 62.610.426	• Secondary treatment and basic disinfection • Total suspended solids less than 10 mg/L, if subsurface application was involved
Slow-rate land application with public access areas, residential irrigation, and edible crops	• Irrigation of residential lawns, golf courses, cemeteries, parks, landscape areas, edible crops, and highway medians	62-610.450 through 62.610.491	• Secondary treatment and high-level disinfection • Filtration • Chemical feed facilities for coagulant, coagulant aids, or polyelectrolytes (can be idle) • Pretreatment program • Total suspended solids less than 5 mg/L
Rapid-rate land application	• Rapid infiltration basins (RIBs) and adsorption fields • RIBs involved spreading effluent over a system of basins that may be underlain with subsurface drains • Adsorption fields involved high rates of effluent application and loading to subsurface adsorption fields, and was distinguished from drip irrigation	62-610.500 through 62.610.525	• Secondary treatment and basic disinfection • Nitrate less than 12 mg/L as nitrogen • Total suspected solids less than 10 mg/L for adsorption fields
Overland flow	• Pretreatment to surface water discharge • Treatment of domestic wastewater met effluent limitations for discharge to surface waters by sprinkling or flooding upper reaches of terraced, sloped, vegetated surfaces, such as sod farms, forests, fodder crops, pasture lands, and similar areas.	62-610.600 through 62.610.525	• Carbonaceous biochemical oxygen demand less than 40-60 mg/L • Total suspended solids less than 40 to 60 mg/L • Fecal coliforms less than 2,400 per 100 mL • Proposed preapplication treatment levels shall provide reasonable assurance that long-term performance of the land treatment system, at a minimum, resulted in an effluent meeting the secondary treatment and basic disinfection levels before effluent released to surface waters.

2.4.6.2 Non-Potable Water Reuse

In addition to the land application options described in Table 2-5, other applications of beneficial reuse of wastewater effluent were identified as being allowed by FDEP. The FDEP's Reuse Program was charged with encouraging and promoting reuse in Florida and with protecting the public health and environmental quality. Some of the newly noted non-potable reuse opportunities in Table 2-6 were held to the same water quality requirements as slow-rate land application with public access areas (Table 2-5). Whereas industrial reuse opportunities only required secondary treatment and basic disinfection by regulation, while industrial reuse customers may require treatment beyond these minimum requirements for satisfactory use.

Water reuse also has its challenges, particularly if enhanced treatment and/or substantial conveyance infrastructure were needed to achieve acceptable water quality and reach targeted customers. Water reuse generally required high-level disinfection facilities, water storage facilities, and high service pumping facilities to deliver reclaimed water from the treatment plant to customers. Reclaimed water transmission and distribution piping systems would also be required. An initial step in determining the feasibility of expanded water reuse in the City and the surrounding areas would be to conduct a benefit/cost analysis for the different service areas. This analysis should explore anticipated reclaimed water demands, willingness to pay, treatment and conveyance requirements, and potential risks.

Table 2-6: Summary of Reuse Activities and Associated Water Resource Implications (Water Reuse Work Group Water Conservation Initiative 2003)

Desirability in Terms of Potable Water Offset and Groundwater Recharge	Reuse Activity	Potable Water Offset [a]	Recharge Fraction [b]
High	Indirect potable reuse (groundwater augmentation)	100	100
	Indirect potable reuse (surface water augmentation)	100	100
	Industrial uses	100	0
	Toilet flushing	100	0
	Rapid infiltration basins (where groundwater is used)	0	90
	Efficient agricultural irrigation where irrigation is needed	75	25
	Efficient landscape irrigation (golf courses, parks, etc.)	75	10
	Efficient residential irrigation	60	40
	Cooling towers	100	0
	Vehicle washing	100	0
	Commercial laundries	100	0
	Cleaning of roads, sidewalks, and work areas	100	10
	Fire protection	100	10
	Construction dust control	100	0
	Mixing of pesticides	100	0
Moderate	Inefficient landscape irrigation (parks and other landscaped areas)	50	50
	Inefficient agricultural irrigation	50	50
	Surface water discharge with direct connection to groundwater	0	75
	Wetlands restoration (when additional water is needed)	75	10
	Inefficient residential irrigation	25	50
	Flushing and testing of sewers and reclaimed water lines	50	0
	Rapid infiltration basins where groundwater is currently not used	0	25
Low	Aesthetic features (ponds, fountains, etc.)	75	10
	Sprayfields (irrigation of grass or other cover crop where irrigation would not normally be practiced)	0	50
	Wetlands (when additional water is not needed)	0	10

[a] Percentage of reclaimed water that replaces potable quality water; depending on local conditions, the offset and recharge may not be of equal importance.

[b] Percentage of reclaimed water that augments potable quality groundwater or augments Class I surface water; depending on local conditions, the offset and recharge may not be of equal importance.

2.4.6.3 Potable Reuse

Potable reuse, in which high quality reclaimed water is used for potable water applications, may be separated into various sub-categories, as shown in Figure 2-40. Potable reuse is not a new concept and has been intentionally practiced in the United States since at least the mid-1950s; however, there are currently no federal regulations that specifically govern potable reuse in the US. Despite the lack of federal regulation, the USEPA has stated that the production of drinking water from wastewater is a permissible approach, provided all generally applicable Safe Drinking Water Act (SDWA), Clean Water Act (CWA), and state requirements were met (USEPA 2017). To date, several states have developed regulations and guidelines for indirect potable reuse (IPR), but no state has developed comprehensive, final regulations for direct potable reuse (DPR).

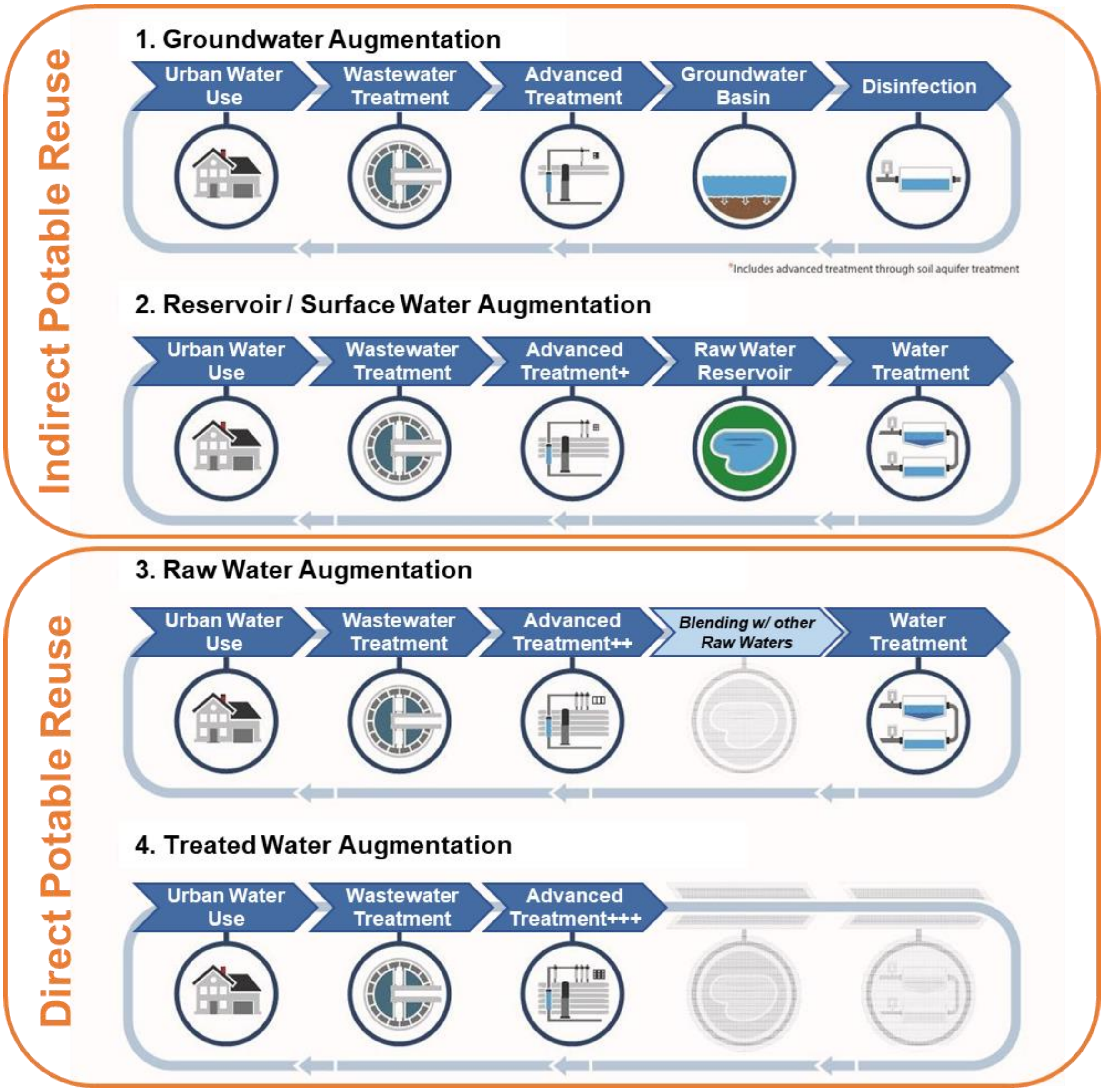


Figure 2-40: Types of Potable Reuse

2.4.6.3.1 Groundwater and Reservoir Water Augmentation

Groundwater augmentation and reservoir/surface water augmentation were considered forms of IPR due to the involvement of an environmental buffer, as defined below.

- Groundwater augmentation was defined as the planned use of reclaimed water for replenishment of a groundwater basin or an aquifer that had been designated as a public water system. Groundwater augmentation in Florida is controlled and informed by several existing regulations, as described below. JEA was exploring a groundwater replishment feasibility study to supplement its potable water supplies.
- Reservoir and/or surface water augmentation was defined as the planned placement of reclaimed water into a raw surface water supply used as a source of domestic drinking water supply for a public water system. Surface water augmentation is not yet regulated in Florida as a form of potable reuse, but it was a topic of interest for the Potable Reuse Commission (see Section 4.6.3.2). Since JEA does not have any surface water drinking water systems, this approach is not applicable to JEA.

Groundwater augmentation regulations and associated regulations include 62-520.410 F.A.C. *Classification of Ground Water, Usage, Reclassification*, 62-610.560 F.A.C. *Ground Water Recharge by Injection*, 62.610.562 F.A.C., *Salinity Barrier Systems*, and 62-610.563 F.A.C. *Waste Treatment and Disinfection*. The extent to which groundwater augmentation could be practiced is dependent on the classification and water quality of the receiving groundwater, as well as the water quality and nature of the water being injected into the aquifer.

2.4.6.3.2 Deep Well Injection

One additional form of aquifer recharge identified and practiced in Florida was deep well injection. From a regulatory perspective, deep well injection is not defined as groundwater recharge, but rather effluent management, because the injectate is unretrievable as water supply. Deep well injection requires that the receiving groundwater be classified as G-III or G-IV, and have a total dissolved solids concentration greater than 10,000 mg/L. The practice can not cause a violation of standards for adjacent Class G-I and G-II groundwaters or surface waters under the influence of groundwater.

2.4.6.3.3 Raw and Treated Water Augmentation

Raw and treated water augmentation were considered to be forms of DPR because of the lack of an enviornmental buffer, as defined below.

- Raw water augmentation is the intentional discharge of reclaimed water into a system of pipelines or aqueducts that delivered raw water to a drinking water treatment plant that provided water to a public water system.
- Treated drinking water augmentation is the planned placement of reclaimed water into the distribution system of a public water system.

While potable reuse was gaining viability as a potential source of water supply in Florida, there was still a need for a regulatory framework to permit new facilities that would treat and deliver the supply. For DPR to be implemented successfully, state requirements for pilot testing, monitoring, reporting, and operator licensing needed to be established. Accordingly, Florida has developed a framework for potable reuse implementation. The Florida Department of Environmental Protection and the Water Management Districts actively promoted and funded this initiative through the creation of the Potable Reuse Commission (PRC).

The PRC worked with the Water Research Foundation and the WateReuse Association to produce the framework guidance document for the 2020 legislative session, along with fact sheets and public education materials that could be used by stakeholders statewide. The PRC released the final guidance document to the public in January 2020 (Florida Potable Reuse Commission 2019). The recommendations included the reorganization of the current state IPR regulations, and the inclusion of new state DPR regulations under Chapter 62 of the Florida Administrative Code, which governed drinking water. The PRC also recommended the use of “appropriate treatment technology” to address pathogens and emerging constituents in reclaimed water, which contrasted with requiring the use of a specific treatment process or treatment train to achieve water quality goals.

2.4.6.4 Surface Water Discharge

Federal, state, and local regulations prohibited the disposal of untreated wastewater into storm drains and surface waters. In some cases, however, a WWTF could discharge treated wastewater into surface waters with a permit. The National Pollutant Discharge Elimination System (NPDES) program set requirements and issued permits for surface water discharges. The major surface water body in the JEA service area was the St. Johns River. Historically the River had experienced periodic algae blooms that were associated with the presence of excess nutrients. Accordingly, total nitrogen TMDLs were developed by the FDEP to limit nutrient loading into the River, thereby restoring and protecting the River. The final *Total Maximum Daily Load for Nutrients for the Lower St. Johns River Report* (July 2008) stated that the river was verified as impaired by nutrients based on elevated chlorophyll *a* and Trophic State Index levels.

Wastewater to Wetlands

The water quality improvements achieved by the passage of water through wetland systems have long been acknowledged, thus leading to the development of constructed wetlands as an attempt to replicate water quality and habitat benefits. As previously discussed, the discharge of wastewater effluent to wetland systems allowed for the natural biogeochemical processes in wetlands to further improve effluent quality in a low energy manner, ultimately supporting environmental enhancement, not degradation. The treatment provided by wetlands included nutrient assimilation and storage, heavy metal retention, organic matter decomposition, sediment filtration, and hydrologic storage and dispersion. Taken together, effluent management via wetland discharge improved water quality, flood control, and water supply via recharge. The FDEP, through Chapter 62-611, F.A.C., provided state regulations and standards for domestic wastewater discharges to wetlands.

Specific limits for wastewater discharged to treatment and receiving wetlands are summarized in Table 2-7.

Table 2-7: Discharge Limits to Treatment and Receiving Wetlands (62-611.420 F.A.C.)

Wetland Type	Discharge Limits
Treatment Wetland	• Secondary treatment with nitrification • Maximum monthly average concentrations of: 2 mg/L total ammonia as nitrogen
Receiving Wetland	• Maximum monthly average concentrations of: 2 mg/L total ammonia as nitrogen • Maximum annual average concentrations of: 5 mg/L carbonaceous biochemical oxygen demand 5 mg/L total suspended solids 1 mg/L total phosphorus as phosphorus

2.4.7 Community Redevelopment Strategies

Onsite, decentralized, and centralized wastewater management strategy approaches could incorporate opportunities for community redevelopment. For example, green infrastructure and Low Impact Design (LID) aimed to lower the environmental footprint for wastewater treatment. Example projects identified include surface water augmentation, constructed wetlands, community parks that integrate treated wastewater and stormwater treatment/storage, floating vegetative islands, rain gardens, bio-swales, subsurface retention facilities, and green roofs. The level of treatment required for incorporation would likely be based on current regulations discussed in Section 2.4.6. The benefits of LID included additional nutrient removal via natural systems, flood control, neighborhood improvement (e.g., beautification, recreation, increased property value, etc.), and improved community health.

Another radical community redevelopment approach identified was the elimination of wastewater generating infrastructure that required the existing septic system for treatment. Implementation of this approach could result in a change in Land Use. For example, there may be multiple benefits associated with relocating a school or large facility with an operationally failing wastewater treatment unit to a location served by the centralized sewer network.

2.4.8 Source Separation Strategies

The separation and targeted treatment of different domestic waste streams had been recognized as a promising concept for minimizing the cost and energy intensity of wastewater treatment and maximizing resource recovery. Motivation stemmed from the fact that individual waste streams could have largely disproportionate impacts on the treatment requirements of combined wastewater, as well as a higher potential for effective resource recovery. For example, less than 1% of municipal wastewater was typically attributable to urine on a volumetric basis, yet urine contributed greater than 75% of the nitrogen load to combined wastewater; the remaining 25% of the nitrogen load was distributed between greywater (~5%) and blackwater (~20%) (Wilsenach and Loosdrecht 2006). The disproportionate contributions of urine to the nitrogen content of combined wastewater (see Figure 2-41) indicated that efforts to remove nutrients were being applied to larger than necessary volumes of liquid when the entire flow was treated, thus resulted in increased energy and resource consumption, as well as reduced effectiveness.

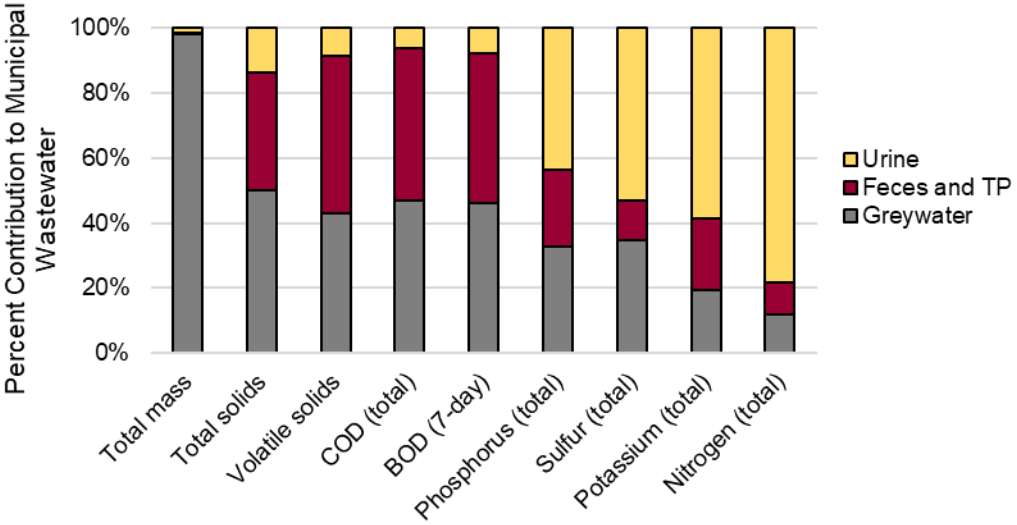


Figure 2-41: Percent Contributions to Municipal Wastewater from Greywater, Feces, Toilet Paper, and Urine (Jonsson 2005 and Rose 2015)

Wastewater source separation still required either onsite, decentralized, or centralized treatment to treat the separated waste streams. Traditionally onsite treatment focused on systems that receive the entire combined stream of household waste discharges. Future trends are likely to place increasing emphasis on concepts of water sustainability and resource recovery, entailing water infrastructure that maintains segregation of individual waste streams for treatment, recovery, and reuse. Wastewater segregation of greywater for reuse had been practiced predominately in water short areas for some time. More recently, recovery of urine for its nutrient content through the use of urine separating toilets was gaining attention as a sustainable solution to reported worldwide shortages of nutrients, particularly phosphorus. However, source separation required homeowners to replumb their home to accommodate the multiple waste streams (i.e., yellow, black, brown, and greywater) with multiple parallel pipes. It was more difficult to retrofit existing infrastructure as compared to new development.

Another identified alternative was incinerating toilets, which used heat from either an electric coil or propane torch to incinerate human waste products (urine, solids, paper) into an inert ash. Most units were self-contained and operated either solely on electricity or both electricity and propane gas. The incineration process destroyed nutrients in the waste; thus, the ash could not be used as fertilizer or soil amendment and was typically disposed in normal household solid waste (i.e., to landfill). Additional details on source separation methods and strategies are provided in Appendix B including urine separation, greywater source separation, blackwater/brownwater source separation, and incinerating toilets.

2.4.9 Groundwater Remediation Strategies

A strategy that did not include new wastewater infrastructure was remediation of wastewater impacted groundwater. This strategy relates primarily to nitrogen contamination from aging and/or failing septic systems, with approaches to treating groundwater prior to reaching surface waters. The in-situ addition of a permeable reactive media barrier (Figure 2-42) that supports denitrification through the release of carbon or other electron donors has been used to intercept wastewater plumes both in the vadose zone and in shallow water tables.

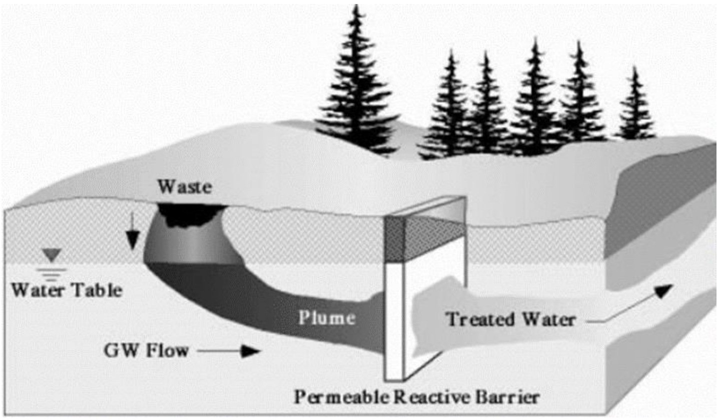


Figure 2-42: Schematic of a Permeable Reactive Barrier (Powell and Associates 2016)

Table 2-8 provides a summary of potential substrates for denitrification. It should be noted that the frequencies of injection given were approximate; true injection frequencies were site specific and depended on local biological activity, substrate retention by soil, and hydraulic loading. Additional details are provided in Appendix B including details on incorporating zero-valent iron as reactive media. Issues of concern for permeable reactive barriers incorporating reactive denitrification media included media longevity, replacement intervals, and hydraulic issues related to preferential flow paths.

Table 2-8: Substrates (Electron Donors) Used for Enhanced Anaerobic Bioremediation of Groundwater

Classification	Substrate	Typical Delivery Techniques	Approximate Frequency of Injection
Soluble Substrates	Lactate and butyrate	Injection wells or circulation systems	Continuous to monthly
	Methanol and ethanol	Injection wells or circulation systems	Continuous to monthly
	Sodium benzoate	Injection wells or circulation systems	Continuous to monthly
	Molasses, high-fructose corn syrup	Injection wells	Continuous to monthly
	Whey (soluble)	Direct injection	Monthly to annually
Slow-Release Substrates	HRC or HRC-X	Direct injection	Annually to biennially for HRC, every 3–4 years for HRC-X, potential for one-time application
	Vegetable oils	Direct injection	One-time application
	Vegetable oil emulsions	Direct injection	Every 2 to 3 years
Solid Substrates	Mulch and compost	Trenching or excavation	One-time application
	Chitin (solid)	Trenching or injection of chitin slurry	Annually to biennially, potential for one-time application

2.5 Institutional Frameworks

Institutional frameworks were defined as methods used to finance, build, and operate the various strategies and include public, private and hybrid solutions. These included owner frameworks, project delivery frameworks, and funding opportunities. The various potential approaches were explored in this phase of the program, but in-depth details on public/private strategies will be explored in the next phase of the program.

2.5.1 Ownership Frameworks

Within the ownership framework, the identified options for JEA included individual, community, JEA (i.e., self-ownership), public-private partnerships (P3s), and City of Jacksonville/Duval County. Closely linked with the owner/operator frameworks, the project delivery methods included design-bid-build, construction manager at-risk, design-build, and design-build-finance-operate. Figure 2-43 shows the ownership frameworks alternatives identified.

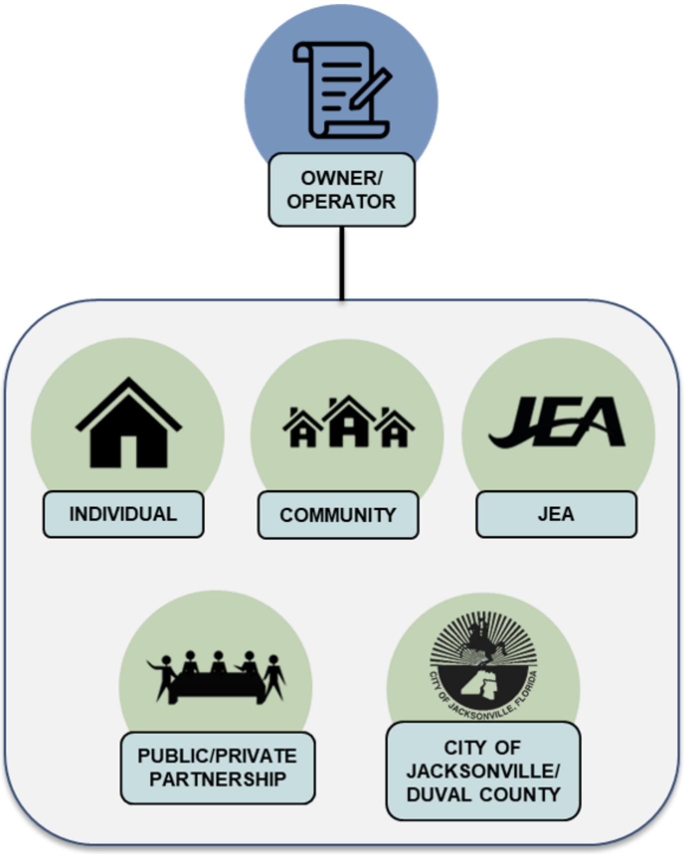


Figure 2-43: Ownership Frameworks

2.5.1.1 Homeowner/Individual and Community Ownership

Typically, onsite systems were owned and managed by the property owners where the wastewater was generated (residential or commercial). The property owners were responsible for the costs of installation, operation (e.g., solids removal and electrical costs for pumps, if needed), and maintenance. The long-term costs to operate and maintain a conventional septic system may not seem high, but if the system fails, the owner's repair bill can be expensive. Septic tank repairs could range from full replacement of the septic tank and drainfield to the less costly unclogging of septic system pipelines. While the owner should implement ongoing preventative maintenance, they have shown to often wait until septic system problems were evident before taking action. A summary of the advantages and disadvantages of individual ownership is provided later in this section.

Community ownership of wastewater systems tended to develop as communities grow and maintenance costs increase. Some neighborhoods converted to community ownership to reduce maintenance costs through economies of scale. An example of community ownership was when a homeowner's association (HOA) takes on the costs and responsibility of maintaining the community wastewater collection/treatment and effluent management system. Another example of community ownership occurred when a developer installed and sold the wastewater management system back to the community (typically a management firm or HOA). Both individual and community ownership frameworks have similar advantages and disadvantages as summarized below.

Advantages of Individual/Community Ownership:

- Costs and risks accrued to the owner instead of to JEA.
- Repairs lacked the complexity of a decentralized/centralized treatment plant.
- Such ownership did not require costly installation of a centralized collection system.

Disadvantages of Individual/Community Ownership:

- Communication delays and misinterpretations between JEA and private owner
- Systems could become neglected and operate with inefficiencies (reduced effluent quality).
- Owners sometimes did not follow manufacturer guidelines for maintenance which shortened the system's lifespan.

Some utilities were transitioning away from individual/community ownership due to the desire to control the treatment assets, reliably maintain the systems, and simplify communication protocols.

2.5.1.2 JEA Owned and Operated

JEA was contracted as the utility provider for the City of Jacksonville and had interlocal agreements to provide utilities for portions of St. Johns County, Nassau County and Clay County. JEA planned to continue its role as the primary utility provider for the City of Jacksonville and portions of the neighboring counties and would work in conjunction with these municipalities for their wastewater collection, treatment, and effluent management needs. Specifically, Chapter 751 of the Jacksonville Ordinance Code states that "the owner of a septic tank system shall connect to the sewer system within

365 days after written notification [from JEA] that the system is available for connection." If the septic system was still functioning as designed, the owner may defer this requirement until the sale of the property. Chapter 751, which is similar to Section 381.00655 F.S., sets a 365-day limit for the landowner to connect to the sewer system once it is available. Section 381.00655, F.S. also requires the utility to contact the owner one year prior to the availability of sewer service.

Under a self-owned model, JEA would have full ownership of all new systems including an expanded collection system network, decentralized treatment plants, and/or onsite treatment systems. Owning the entire system allows JEA to control all aspects of the project and processes (i.e., collection, treatment, effluent management, design, construction, operation, and maintenance). Full utility-ownership and control translate into higher risks [direct to JEA] and greater levels of manpower needed to operate and maintain the systems. For example, decentralized treatment plant(s) would require additional staff with varying levels of training to operate each facility efficiently. It would also increase JEA's internal logistical staffing requirements to operate and track the water quality and quantity of the new facilities per State requirements.

Onsite ownership and operation by municipal utilities was not well documented. An example was the Broad Top Township (discussed in Appendix B and Section 2.4.1) which has implemented this approach where the utility owned, operated, and maintained the onsite systems and assessed a monthly fee to the property owners. The Broad Top Township (Township) introduced this new form of management (i.e., utility-ownership and operation) through a Wastewater Management Plan that was written in the early 1990s. Property owners who voluntarily participated in the onsite management program turned over ownership and control of their systems for a monthly fee to the Township in return for long term maintenance, repair and/or replacement of the system. All annual inspections, pump outs (every 3 to 5 years), maintenance, repairs and water quality performance monitoring of the systems were the responsibility of the Township. The monthly fee for each equivalent dwelling unit (EDU) was initially set near $10 and has increased to today's rate of $22. The Township had a flat rate structure; each EDU was charged $22 per month for either onsite or centralized wastewater management. The Township owned approximately 750 onsite systems, which were accessed via easements. The Township collected fee revenue and federal/state grants to continue expanding the onsite management program and to maintain the centralized facilities.

2.5.1.3 Public-Private Partnership (P3)

Public private partnerships (P3) involve collaboration between a government agency and a private-sector company to design, build, finance, operate and/or maintain projects. There were three common P3 structures as listed below indicating the responsibilities of the private-sector company:

- DBF: design, build and finance
- DBFO: design, build, finance and operate
- DBFOM: design, build, finance, operate and maintain

In 2016, Deloitte compiled a list of publicly announced P3 transactions. (Deloitte 2016) A list of the projects including the utility, ownership framework, and project budget (if available) is presented below.

- Claude "Bud" Lewis Carlsbad Desalination Plant, CA, DBFOM, ~$1 billion

- Emerald Coast Utilities Authority, FL, DBFO, $53 million
- South Miami Heights Water Treatment Plant, FL, DBFOM
- East/West 84-inch Force Main, FL, DBF, $180 million
- Miami-Dade Water Distribution System Storage Tank and Main Replacements, FL, DBF, $70 million
- Northwest Wellfield Water Treatment Plant, FL, DBFOM, $450 million
- Peak Flow Management Facilities, FL, DBF, $310 million
- South Dade Wastewater Treatment Plant, FL, not specified, $200 million

The Carlsbad Desalination Project, serving San Diego County, was one of the first large-scale desalination plants in the United States and one of the largest public-private partnerships in the water industry and is discussed in more detail in Appendix B. The plant was designed to produce over 50 mgd of drinking water sourced directly from the Pacific Ocean. The P3 project had a capital cost of $980 million and funding contracts were completed within the last quarter of 2012 (Moore 2013). The P3 structure used in the project was design-build-finance-operate-maintain (DBFOM) and placed the majority of the risk on the third-party project management firm (i.e., Poseidon Water).

2.5.2 Project Delivery Frameworks

The project delivery method should fit the timeline, risk, and quality requirements of the STPO. The chosen project delivery method establishes the procedures that JEA will follow though the project’s design, bidding, construction, and operation. Utility managers should consider the following when evaluating a project delivery method.

- Desired level of owner input.
- Design or construction complexity.
- Allocation of risks.
- Schedule requirements; and
- Change order exposure.

Primary project delivery approaches discussed herein included Design-Bid-Build (DBB), Construction Management At-Risk (CMAR), Design-Build (DB), and Design-Build-Finance-Operate (DBFO). As mentioned in Section 5.1.3, DBFOM was a subset of DBFO that included the maintenance of the new project. DBB was a traditional delivery method while the other three were considered alternative delivery methods. The owner interactions with the designer and builder (shown with orange arrows) are depicted in Figure 2-44.

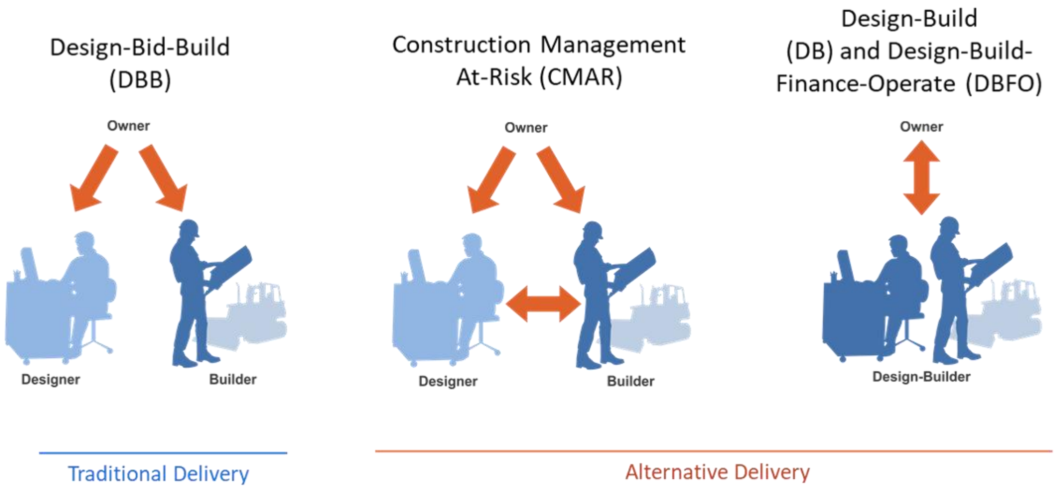


Figure 2-44: Project Delivery Frameworks (Traditional and Alternative)

2.5.2.1 *Design-Bid-Build*

The design-bid-build (DBB) project delivery method had successfully served the utility industry for many years. Procedures were well established to promote competitive bidding and to define the responsibilities of the owner, engineer, and contractor to provide a quality product which met the needs of the utility. With DBB, the design of the project was typically completed before the bid documents were released. Following the acceptance and selection of the final bid, the utility enters a construction-only contract with the winning contractor. General interaction between the Owner, Designer, and Contractor are shown in Figure 2-45.

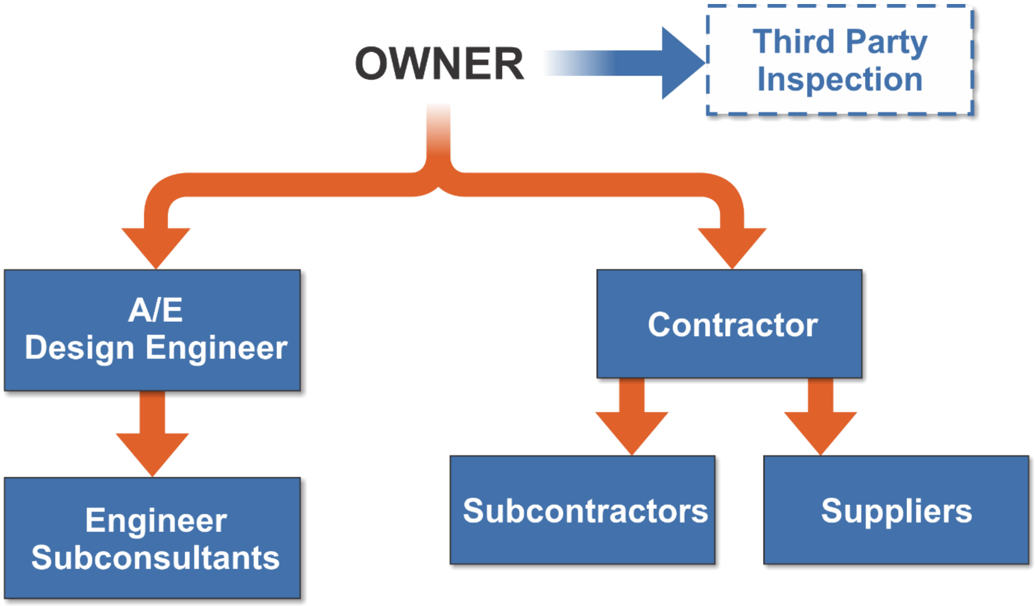


Figure 2-45: Design-Bid-Build Framework

Relative to the other project delivery methods, the advantages and disadvantages of the DBB framework are presented in Table 2-9.

Table 2-9: Advantages and Disadvantages to DBB

Advantages	Disadvantages
• JEA selects designer • JEA controls the design process through 100% completion • JEA has more input on equipment/system inputs (retains more control) • Most common project delivery method • Delivery model is well understood between participants (i.e., owner, designer, and builder)	• Compared to other project delivery methods, DBB can have longer overall project schedule (because design and construction do not overlap) • JEA manages design and construction • No incentive for designer and contractor to collaborate • Limited equipment selection because project awarded based on lowest bid • Final cost not known until the end of the project

2.5.2.2 Construction Management At-Risk

Construction Management At-Risk (CMAR) was an alternative project delivery framework where there was a deliberate overlap between the design and construction phases of the project. This overlap typically shortened the overall duration from design to operation of the project. Similar to DBB, there were two separate contracts between the designer and the contractor; however, the two were encouraged to collaborate during design to reduce unanticipated costs and design errors once construction begins.

As with other delivery methods, designers were typically selected based on qualifications associated with their services. Under a CMAR agreement, while final design/contract documents were still underway, the contractor could be selected based on qualifications (i.e., qualifications-based selection, QBS) without a hard bid for the project. In addition to the qualifications, contractors supplied price estimates for the proposed work along with overhead and fees for service. Typically, the Owner and Contractor finalized a maximum construction price as design was completed. A typical CMAR framework is shown in Figure 2-46, and a summary of advantages and disadvantages to the CMAR process are presented in Table 2-10.

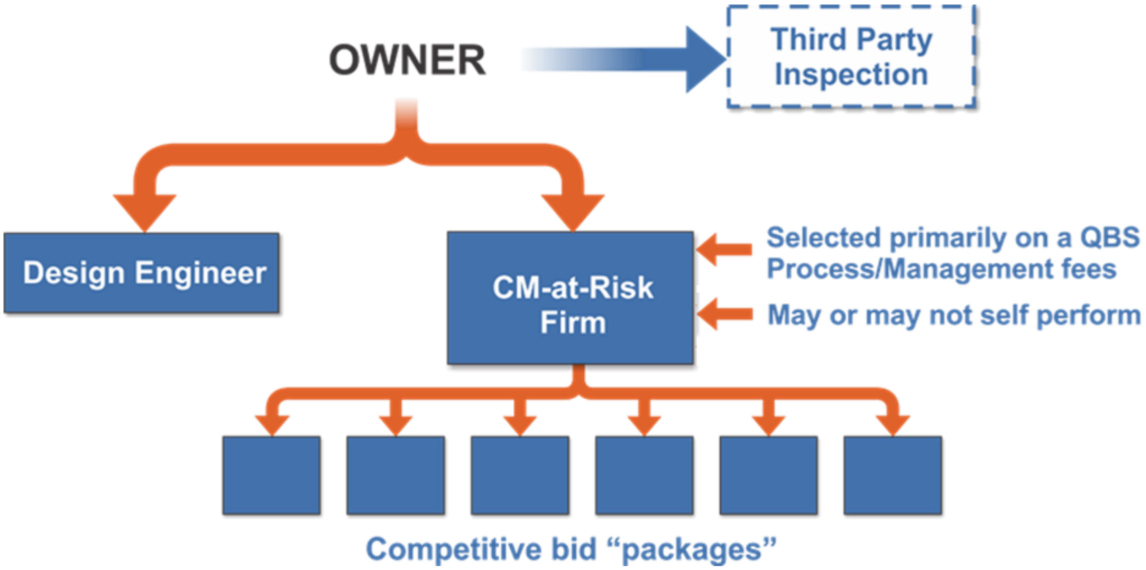


Figure 2-46: Construction Management at Risk Framework

Table 2-10: Advantages and Disadvantages to CMAR

Advantages	Disadvantages
• JEA selects designer • Integrates constructability early in the design phase • Collaboration between designer and contractor can reduce unanticipated costs and design errors once construction begins • Reduces risk and responsibility on JEA • Potential for fewer change orders • Reduces design versus construction misunderstandings • Reduces project timeline • Allows experience to determine a contractor's selection and not just the price	• Additional pre-construction contractual costs with the CM • Contractor selected without knowing full extent of project costs • JEA oversees both designer and contractor, sometimes at the same time

2.5.2.3 Design-Build and Design-Build-Finance-Operate

The design-build (DB) process was marketed as a system with reduced schedule requirements and potentially reduced change order risk when compared to design-bid-build. Quality of the design-build project was typically controlled by the 30 percent design drawings, specifications, and the proposal drawings. The design-builder and its engineer had an incentive to reduce project costs as long as their design did not conflict with the 30 percent documents. Under the DB system, the owner had more protection from errors or omissions change order issues relative to the DBB framework. Alternatively, under the DBB framework, the owner could receive credits for reduced construction costs while under the DB framework, the savings could belong entirely to the design-builder. Common DB formats identified include progressive and lump sum approaches:

- A progressive DB was similar to a CMAR, but controlled by a single entity (i.e., the design-builder). The term progressive was based on the iterative development of design, scope, and construction costs at set milestones. The result was the progressive definition of the project and its costs on an open-book basis and, like construction management at risk, an "as-bid" fee was applied to reach a mutually agreeable guaranteed maximum or lump sum price.

- Under a lump sum DB approach, an indicative design was taken to a preliminary level (usually 20-30% completion) before the design criteria package, or bridging document, was issued. The design-builder completed the detailed design upon selection (qualification and price based), often in parallel with an early start on certain construction activities, and then finished construction activities and commissions the facilities.

Similar to DB, DBFO had a similar approach, but the contract included a private party to manage the financing and operation of the final constructed project. DBFO passed risk to the private sector (e.g., design-builder, financer, or both) while constricted the owner's ability to have a say in the design and construction. This delivery method is the newest of the options identified and was commonly used in the transportation industry (e.g., toll roads). If the project was delivered via P3 or DBFO, the operations contract could be defined with a specific time frame prior to transferring operation and maintenance responsibility back to JEA. The advantages and disadvantages for DB and DBFO are shown in Table 2-11.

Table 2-11: Advantages and Disadvantages to DB and DBFO

Advantages	Disadvantages
• Potentially quickest project turnaround (compared to DBB and CMAR) • Allows for innovation by design-builder • For lump sum DB, project costs (design and construction) are known prior to design • JEA manages a single entity (design-builder) • Performance guarantees can be included within the contract prior to design • Release of funding requirements by JEA (DBFO only) • Progressive DB has more collaboration between JEA and the design-builder as compared to lump sum DB	• Compared to DBB and CMAR, JEA has less control over the designer with lump sum DB or DBFO • In lump sum DB, JEA has less control during the design • During lump sum DB, limited collaborations between JEA and the design-builder • In lump sum DB, JEA has limited participation in the selection process for subconsultant or subcontractors

2.5.3 Funding Opportunities

Projects are financed through bonds, utility rates, developer fees, grants, and/or loans. All but grants and developer fees need to be repaid by the utility's customers. Throughout the entire process of planning, design, construction and operation, public perception was identified as vital to the project's success. Regardless of the types of funding to be secured for the project, project incentives should be considered to aid public acceptance of the project. Some incentives identified include:

- Reduced or eliminated large assessments at sign-up;
- Established early hook-up incentives and discounts;
- Included credit for recent repair or replacement;
- Provided infrastructure upgrades such as water service, roads, sidewalks, and landscaping; and

- Developed affordable payment methods.

Funding opportunities identified for JEA include EPA/FDEP grants and loans, USDA loans, SJRWMD grants, variable rate schedule, homeowner special assessments, and/or private bank financing as shown in Figure 2-47 with their subgroups (if applicable).

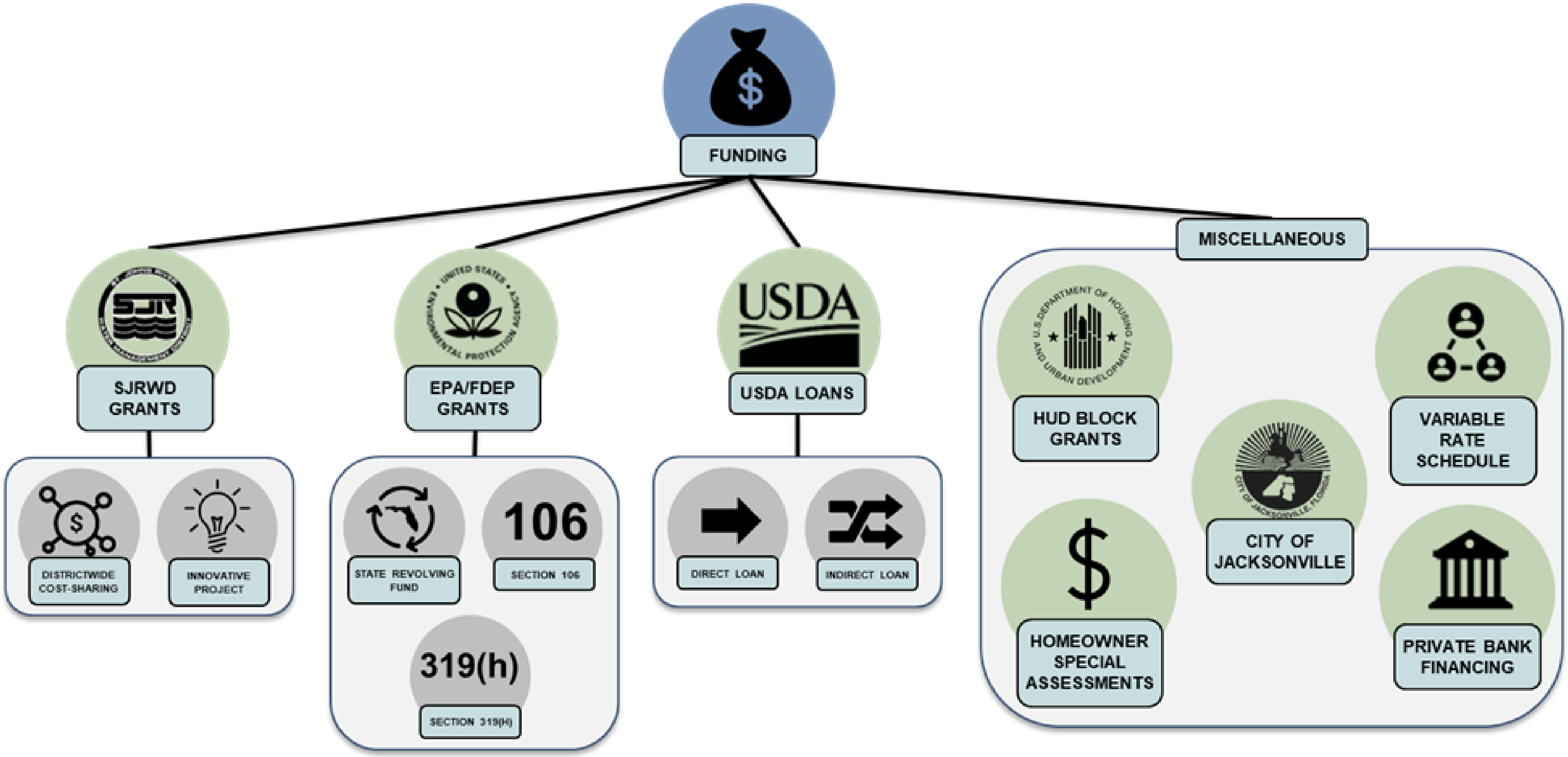


Figure 2-47: Funding Opportunities

2.5.3.1 St. Johns River Water Management District Grants

The St. Johns River Water Management District (SJRWMD) identified two funding opportunities to receive financial assistance that could be applied to water conservation or improvement projects. These two programs were called (1) Districtwide Cost-Share Funding and (2) Rural Economic Development Initiative (REDI) and Innovative Projects Cost-Share Funding (SJRWMD 2020). Projects that qualify for funding from these opportunities must satisfy at least one of the SJRWMD's core mission areas, which include the following.

1) Water Supply
    a. Projects included alternative water supply investigation or implementation, general water conservation, and water resource protection and development
    b. Projects that reduced water usage to increase process efficiency
    c. New systems that increased available water sources (e.g., wet season storage to equalize water supply in the dry season)
2) Water Quality
    a. Projects aimed to improve water quality or reduced the nutrient loading on the environment
3) Natural System Restoration
    a. Projects that can measurably benefit surface or groundwaters
4) Flood Protection
    a. Projects that addressed flood concerns and ways to mitigate them on a local (i.e., REDI communities) or regional scale

2.5.3.1.1 Districtwide Cost-Share Funding

Projects seeking Districtwide Cost-Share Funding satisfied at least one of the four core missions but funds from the Districtwide Cost-Share Program did not cover O&M costs and/or innovation. The program was a competitive process so strong applications had the best chance of success. The SJRWMD's Governing Board allocated available funds to projects. Each project was eligible for the SJRWMD's maximum award of $1.5 million, or 10% of the total available funds. Projects that secured permits and were ready to begin construction received a relatively higher score and were more likely to be granted a larger award. A project could be awarded no more than 33% of its construction costs. If the proposed project specifically aimed to help water conservation, the project received up to 50% of the construction costs. The SJRWMD's Chief of the Bureau of Project Management noted that the elements of a strong application for a septic conversion project include:

- Written commitments from at least 50% of the affected property owners;
- A plan to be implemented through a local ordinance or enforceable legal mechanism;
- Location within 0.25 mile of a water body or a springshed; and
- Completion of the project within 2 years.

Project activities funded by Districtwide Cost-Share Funding could not include planning, design, or operation and maintenance costs. Only construction costs within the right-of-way were covered using Districtwide Cost-Share Funding.

2.5.3.1.2 Rural Economic Development Initiative (REDI) and Innovative Projects Cost-Share Funding

To qualify for the REDI portion of the program, the applicant had to be defined as a rural community. Rural communities were defined in Florida Statute 288.0656(2)(d) as the following:

- A county with a population of 75,000 or fewer.
- A county with a population of 125,000 or fewer which is contiguous to a county with a population of 75,000 or fewer.
- An unincorporated federal enterprise community or an incorporated rural city with a population of 25,000 or fewer and an employment base focused on traditional agricultural or resource-based industries, located in a county not defined as rural

Through these definitions, Jacksonville/JEA would not qualify as a REDI community. Thus, to receive this funding opportunity, JEA had to provide “innovative projects”. An innovative project was defined as one that proposes the use of “new or existing technology, method or materials in a unique or not widely used way” (SJRWMD 2020). Innovative projects had to contain a construction component in the project and funds could also be used towards O&M costs. Projects using technology that had already been permitted at full-scale under the same or similar operating parameters were not considered an “innovative technology” and were not covered for Innovative Projects Cost-Share Funding. For qualifying projects, Innovative Projects Cost-Share Funding provided up to 50% of the project’s construction costs or a maximum contribution of $500,000 per applicant (SJRWMD 2020).

2.5.3.2 USEPA and FDEP Financial Assistance Programs

In general, the US Environmental Protection Agency (USEPA) awards financial assistance to individual state governing agencies. The state governing agency (i.e., FDEP for the state of Florida) allocates those funds according to state statues and financial assistance programs. For large Florida communities, such as JEA’s service areas, available funds for wastewater projects have included the State Revolving Fund, Section 106 Grants, and Section 319(h) Grants. (FDEP 2020)

2.5.3.2.1 State Revolving Fund

The State Revolving Fund (SRF) depicted in Figure 2-48 has two main programs – Clean Water SRF (CWSRF) and the Drinking Water SRF (DWSRF). The CWSRF could be used on water conservation, water resources, wastewater, and stormwater related projects and was typically funded by federal grants. The DWSRF has been focused on drinking water projects and therefore was not applicable. The “revolving” portion of the fund is shown in Figure 2-48.

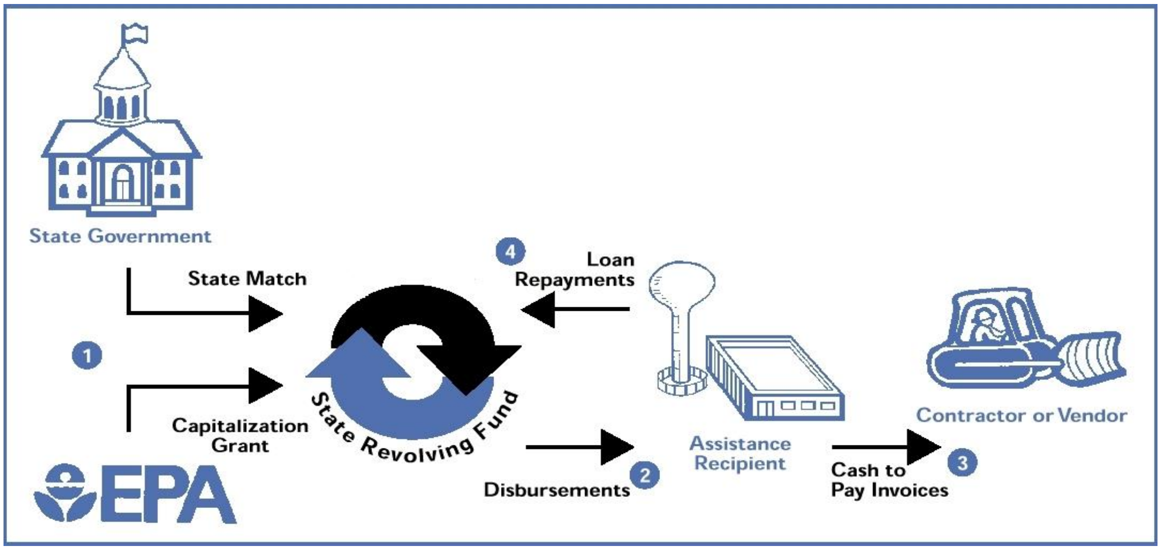


Figure 2-48: State Revolving Fund Diagram

The CWSRF has used federal, state, and other program funds to provide low-interest loans to communities for water quality projects. The CWSRF was available to local governments (city and county) and special districts and used towards “design, and build or upgrade wastewater, stormwater, and nonpoint source pollution prevention projects” (FDEP 2020). These activities have included expansion of sewer, expansion/upgrades of existing wastewater facilities, replaced water meters, and design of new facilities (onsite, decentralized, or centralized). The application process starts with a Request for Inclusion which has rolling admission (i.e., no deadlines). During a public meeting, the FDEP selected projects off the Priority List and moved them to the Funding List. The terms of the loan (interest rate and payback period) would be agreed upon during the loan application process. In general, interest rates were significantly lower than the market rate. (FDEP 2020)

2.5.3.2.2 Water Pollution (Section 106) Grant and Section 319(h) Nonpoint Source Grant

Section 106 of the Clean Water Act (33 US Code §1256) grants the USEPA the ability to provide Water Pollution Grants to eligible state agencies, interstate agencies, and federally recognized tribes. For JEA, funds would be awarded to the FDEP and the FDEP would be responsible for allocating the available funds. Through FDEP, Section 106 funds were typically awarded via Nonpoint Source Grants/Funds, also known as Section 319(h) Grants and State Water-quality Assistance Grants (stormwater specific). (USEPA 2013). The State Water-Quality Assistance Grant (SWAG) Grant (formerly known as the TMDL Grant) was a State grant for projects that reduced stormwater pollutant loadings in impaired waterbodies.

In 2019, the USEPA, with the aid of local state agencies, provided $165.4 million in the form of Federal Clean Water Section 319(h) Grants (USEPA 2020). For Florida, the FDEP was the local government agency that oversaw the process and provided funding on the USEPA’s behalf and typically awarded around $8 to $9 million annually (FDEP 2020). Section 319(h) funding can be applied to projects that aim to control pollution from nonpoint sources. Eligible projects included the following:

- Septic to sewer (centralized or decentralized);

- Public education programs for nonpoint source management;
- Ground water protection;
- Green infrastructure;
- Nonpoint pollution reduction via best management practice (BMP) implementation; and
- New technology implementation for remediation of impaired groundwater.

A grant coordinator stated that funding for septic to sewer projects was limited to the homeowner infrastructure (i.e., abandonment of septic tanks, lateral installations, and connections to sanitary sewers). It was suggested that the 319(h) grant funds be combined with WMD grants, which fund the infrastructure within the right-of-way, to fully fund a septic to sewer project. In addition, funding was not available for upgrades to existing septic systems (i.e., advanced septic installations).

2.5.3.3 Owner Special Assessments

When a significant upgrade was required to a neighborhood or individual home, part of that cost could be passed to the owner(s) via special assessments or fees. These could be collected as a permitting fee, hookup fee, surcharge fee, usage rates, and/or assessment through local taxes.

Assessment/Fees Case Study – Sarasota County, Florida

The assessment amounts could be split into several fees and rates to help recover the expense of repairing, replacing, or expanding the existing wastewater management strategy. An example of this replacement was septic to sewer. During the conversion from septic to sewer, the utility had high costs associated with the expansion of their centralized sewer network as well as the connection to each dwelling unit and removal of the individual septic systems. These costs varied depending on the project type, location, and size.

As previously mentioned, there were several ways to collect assessments and fees. One example would be a connection fee or capacity fee collected by the utility. This fee was often paid in full or financed at the time the customer received new wastewater service. Another fee that encouraged individual owners to connect was a Readiness-to-Serve fee. The Readiness-to-Serve fee was established once sewer service was available. This fee was charged even if the homeowner was not connected to the new system and was the same across the service area. Once the customer connected or switched to the new system, the fee became the base usage fee. A Sewer Surcharge fee could be added to the Readiness-to-Serve fee to help cover the additional expenses of the new system within each region. A Non-ad Valorem Assessment is a fee paid through property taxes and offsets the costs associated with parcel-specific land use. The final type of assessment was typically a one-time Demolition or Removal fee. This fee would be paid directly to the contractor or utility that completed the removal of the previous system (e.g., removal of septic tank and drainfield). An example structure used in Sarasota County is summarized in Table 2-12 for septic to sewer conversion (Sarasota County 2015).

Table 2-12: Sarasota County Septic to Sewer Fee Summary (Sarasota County 2015)

Item	**Description**	**Amount**	**Details**/Notes
1	Sewer Capacity Fee	$2,627.16	Financing was available for up to 20 years at 3.0% interest, billing is separate from the monthly utility bill and is billed monthly.
2	Sewer Readiness to Serve Charge	For households connected to the potable water system, the monthly charge was $34 to $53 based on water usage of 3,000 to 5,000 gallons. Customers who obtain potable water from private wells paid a flat fee of about $46 per month.	Once connected, sewer service was billed monthly at $14.89 per month plus $7.54 per 1,000 gallons capped at 10,000 gallons
3	Sewer Surcharge	$19 billed monthly	As of 2015, there was no lump sum payment alternative.
4	Non-ad Valorem Assessment	$165 billed annually through taxes for minimum of 20 years or $2,345 one-time payment if paid in full at time of application	This fee was not required to be paid in full as it is an automatic assessment.
5	Demolition Expenses	Varied (site specific)	Plumbing costs vary so it was recommended that several quotes be obtained.

2.5.3.4 Variable Rate Schedule

The main concept behind a variable rate structure is to establish different fees based on the different operation and maintenance costs associated with the wastewater systems across the community. However, despite its “cost-of-service” justification, there is potential for public opposition. For example, one neighbor might be on a centralized system and pay $40 per month for wastewater management. Another neighbor may be connected to a decentralized system and pay over $70 a month for wastewater services. Even though the customers are in proximity and obtain similar services, they pay different rates. Variable rate structures typically required high levels of public education and coordination with communities. The utility should clearly communicate how the fees were defined and the payment timeline.

Hampton Roads Sanitation District (HRSD) was identified as a utility which incorporates variable rates. HRSD owned and operated six large, centralized facilities and seven decentralized wastewater treatment facilities. Two of the seven decentralized facilities were operated by a third party via an operational contract (i.e., public–private partnership, P3). A variable rate structure accounted for different operating and maintenance costs associated with the region-specific treatment facilities. A summary of the rates per region are shown in Table 2-13 (HRSD 2019).

Table 2-13: HRSD Decentralized Customer Rate Schedule

Community Name	Wastewater Rate ($ per 1,000 gallons)	Minimum Bill (6,000 gallons bi-monthly water usage) ($)
King Williams	13.82	82.92
Surry	13.43	80.58
Urbanna	15.48	92.88
West Point	15.71	94.26
Other	13.43	80.58

2.5.3.5 USDA Loans

The United Stated Department of Agriculture (USDA) administers the Water and Waste Disposal Loan Program also known as the Water and Environmental Program (WEP). The goal of the program was to provide funds used for projects that improve drinking water sources/systems, sanitary sewage disposal systems, solid waste disposal systems, and storm water drainage systems. (USDA 2020) The program is open to public/government entities, private nonprofits, and federally recognized tribes and has the ability, depending on project structure, to provide up to $200 million dollars per project (USDA 2020).

Other requirements for the program identified included:

- Borrowers had to have the legal authority to construct, operate and maintain the proposed services or facilities.
- All facilities receiving federal financing had to be used for a public purpose.
- Partnerships with other federal, state, local, private, and nonprofit entities that offer financial assistance were encouraged; and
- Projects had to be financially sustainable.

Funds from the program had been delivered using two techniques: direct and indirect. Direct loans were processed between the utility and USDA directly. Direct loans could only be applied to project sites with less than 10,000 population. Indirect USDA loans, also called USDA guaranteed loans, were received when the utility interfaced with a private bank to oversee the allocation process. The private bank interfaced with the USDA on behalf of the utility. Indirect loans were secured for project sites with less than 50,000 population. Both direct and indirect USDA loans have up to a 40-year amortization period with a fixed interest rate below the market value. The program has also granted borrowers 1926(b) protection against annexation from an outside utility. A comparison between direct and indirect loans is shown in Figure 2-49.

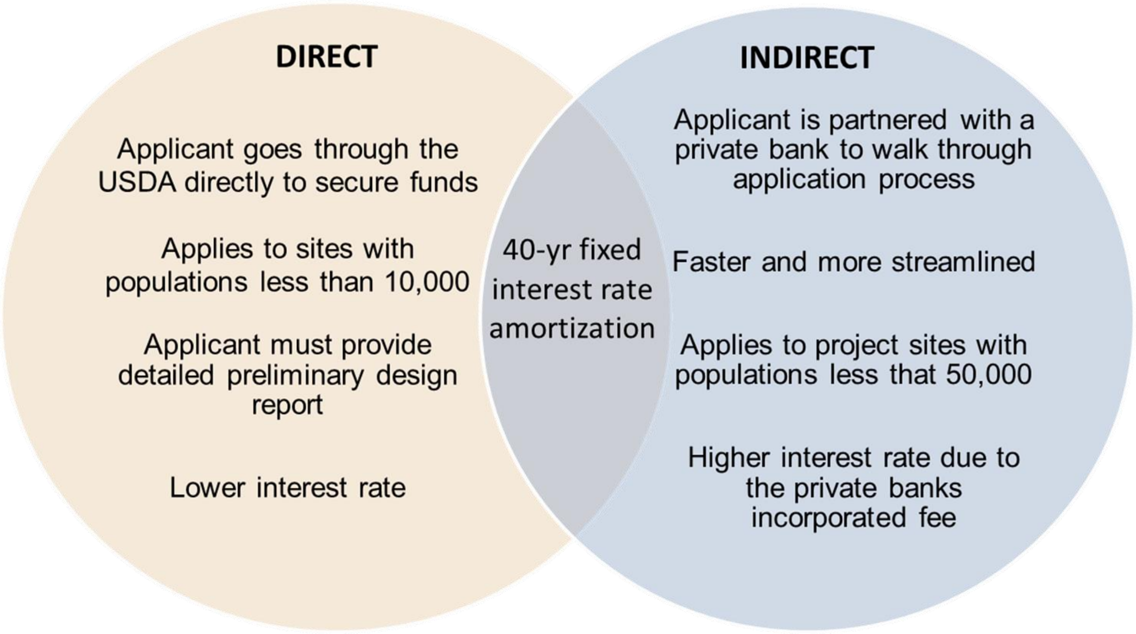


Figure 2-49: Comparison Between Direct and Indirect USDA Loans

2.5.3.6 Community Development Block Grants

The US Department of Housing and Urban Development (HUD) operates the Community Development Block Grants (CDBG) Entitlement program to provide grants for long-term needs to repair, construct, or buy public infrastructure. The program has assisted water and sewer system improvement projects and applies to cities with populations of at least 50,000 or counties with population of at least 200,000. (USHUD 2020) In addition to the population requirement, over a 1, 2, or 3-year period, as selected by the grantee, not less than 70 percent of CDBG funds must be used for activities that benefit low- and moderate-income persons. (USHUD 2020)

CDBG funds have been used for activities which include, but are not limited to:

- Acquisition of real property
- Acquisition of property for public purposes
- Construction or reconstruction of water and sewer facilities, streets, and other public works
- Relocation and demolition
- Rehabilitation of public and private buildings
- Public services, within certain limits
- Planning activities
- Activities relating to energy conservation and renewable energy resources
- Assistance to nonprofit entities for community development activities
- Assistance for profit-motivated businesses to carry out economic development and job creation/retention activities.

2.5.3.7 Private Bank Financing

In addition to grants and loans provided by government subsidized programs, one final alternative would be to secure funding through private banks (i.e., private loans). These were often the least desirable because of higher interest rates when compared to the government subsidized programs previously mentioned. To measure the value of the loan, one should examine the total life-cycle cost of the loan to factor in interest over the duration of the repayment period. Funds from private banks often come with fewer stipulations and can be acquired more quickly as compared to other funding mechanisms. The lending practices of two large private banks, Live Oak Bank and Raymond James are summarized as follows.

Live Oak Bank was the “highest volume lender nationwide” for the indirect USDA Loan program and provided 40-year fixed rate financing for wastewater related projects (Live Oak Bank 2019). As of December 31, 2018, Live Oak Bank has written a total of $1.7 billion in indirect USDA WEP Loans and $9 billion since 2008. The long loan term (i.e., 40 years) allowed the borrower to create an affordable repayment plan by keeping the minimum payment low with respect to the total borrowed amount. Interest rates were those that are typical for private loans and closely followed the market rate. The Live Oak Bank corporate office closest to Jacksonville was in Atlanta, GA. (Live Oak Bank 2019)

While Live Oak Bank provided a more personalized experience due to its smaller size, Raymond James provided a greater volume of funding opportunities. Similar to Live Oak Bank, Raymond James offers multiple development loans aimed for water and wastewater infrastructure repairs, replacements, and expansions. They can provide private loans and the previously mentioned USDA-guaranteed loans (Raymond James 2020). Raymond James has funded over 1,100 USDA WEP loans at a financing volume of $3.3 billion. (Raymond James 2020) For private loans, their interest rates would be similar to the Live Oak Bank and have followed market trends. There was a corporate Raymond James office in Jacksonville, FL.

2.6 Summary

This section documented the findings of the review performed of regional, national, and international research regarding innovative technologies, strategies, and frameworks for septic system replacement. This assessment identified various manufacturers, and the viability, limitations, challenges, and lessons learned from these technologies, strategies, and frameworks. This assessment was achieved through the synthesis of literature, conference proceedings, case studies, reports, and manufacturers technical materials both in the US and internationally. The literature review also identified technologies, management strategies and institutional frameworks that warrant further investigation. A scheme for classifying identified alternatives was created to allow comparisons between the many options.

Technologies in this evaluation included wastewater treatment and collection equipment that would apply to various wastewater management strategies. The most prevalent treatment processes used for onsite treatment were found to be biological and natural systems. Most biological processes were based on well-established treatment processes that have proven effective in municipal treatment applications including suspended growth, attached growth, and integrated fixed film activated sludge. For decentralized treatment systems, defined as treating wastewater flows between 5,000 gpd AADF and up to approximately 1,000,000 gpd AADF, biological treatment processes were the most prevalent. The identified collection and transmission technologies for the conveyance of wastewater to decentralized or centralized wastewater treatment facilities included: gravity, low pressure, and vacuum systems.

Wastewater management strategies, defined as methods for managing STPO priority areas wastewater in lieu of the existing septic systems, were identified as traditional wastewater management strategies and innovative component wastewater management strategies. The traditional wastewater management strategies identified include onsite, decentralized, centralized, and integrated management (i.e., a mixture of the first three). Identified innovative component wastewater management strategies include source separation, groundwater remediation with permeable reactive barriers, and community redevelopment.

Institutional frameworks defined as methods used to finance, build, and operate the various strategies, identified public, private and hybrid solutions were identified. Various approaches were recognized, including ownership and project delivery frameworks. The ownership framework options identified include individual, community, JEA (i.e., self-ownership), and public-private partnerships (P3s). Project delivery methods used to establish the general framework for the project's design, bidding, construction, and sometimes operation was closely linked with the owner/operator frameworks. The project delivery methods identified included design-bid-build, construction management at-risk, design-build, and design-build-finance-operate and/or maintain.

3. Technology Evaluation (Task 3)

The purpose of this section was to document the evaluation of candidate technologies identified in the literature review. The goal of the evaluation was to determine viable wastewater collection and treatment technologies for consideration in the STPO priority areas assessment. This section provides a summary of the evaluation process that was used for determining viable collection, decentralized treatment and onsite treatment technologies.

3.1 Treatment Technologies Pre-Screening Evaluation

Wastewater treatment technologies for both decentralized and onsite management strategies were evaluated. Decentralized treatment processes were defined as a multi-source collection, community or clustered treatment system used to collect, treat, and disperse and/or reclaim wastewater from a small community or service area. For the purpose of this project, decentralized treatment was considered for areas with wastewater flows between 5,000 gpd annual average daily flow (AADF) and up to approximately 1 million gallons per day (mgd) AADF, which covers the range of flow projected for the STPO areas. Decentralized treatment is currently regulated by the Florida Department of Environmental Protection (FDEP). Onsite treatment systems were defined as systems to collect, treat, and disperse or reclaim wastewater from a single dwelling or building at the site where wastewater is generated. For this project, onsite treatment was considered for properties with wastewater flows less than 5,000 gpd AADF. Onsite treatment is currently regulated by the Florida Department of Health (FDOH).

The treatment technology alternatives identified in the literature and industry best practices review were evaluated in two steps: first a preliminary screening (pre-screening) followed by a detailed screening analysis as depicted in Figure 3-1. The detailed analysis developed a short list of alternatives to be considered in Task 7.

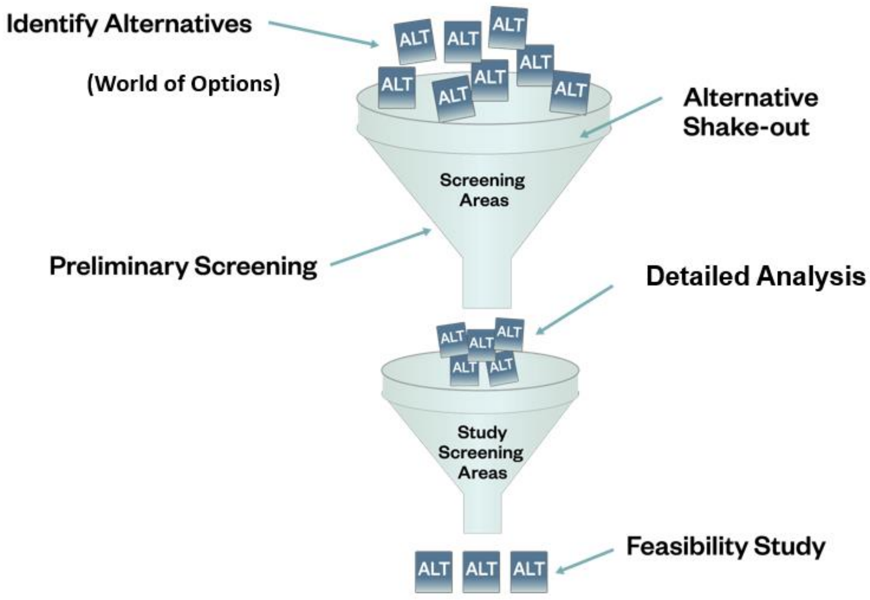


Figure 3-1: Treatment Technologies Screening Process

3.1.1 Treatment Technologies Pre-Screening

Traditional and innovative wastewater technologies were evaluated for applicability to the JEA IWTP program. Using data gathered from the literature review, each technology was first pre-screened using decision support criteria as well as input from JEA from a pre-screening session conducted February 11, 2020.

3.1.2 Treatment Technologies Pre-Screening Criteria

Three criteria were used to judge viability for further detailed analysis consideration for decentralized and onsite wastewater treatment technologies. Due to the range of flows and differing regulatory requirements, decentralized and onsite treatment systems had different parameters for pre-screening. For example, a total nitrogen (TN) of 20 mg/L or less prior to drainfield disposal, where additional treatment occurs, was considered feasible for onsite technologies based on effluent quality results of many pilot onsite treatment systems around the US whereas for decentralized treatment a TN of 10 mg/L or less was considered feasible.

1. **Meets Programmatic Goals:** The first criterion considered whether the alternative met JEA's programmatic goals of meeting certain effluent water quality standards. In addition, the feasibility of using the technology in an urban environment was considered.
    - Decentralized: treatment technologies capable of meeting effluent water quality standards of biochemical oxygen demand (BOD)/total suspended solids (TSS)/TN of 10/10/10 mg/L, respectively. Final effluent quality will depend on ultimate effluent management strategy which will be evaluated and quantified in the STPO priority area assessment (Task 7).
    - Onsite: treatment technologies capable of meeting two of the three effluent water quality standards of BOD/TSS/TN of 10/10/20 mg/L, respectively.
2. **Technology Maturity and Experience:** The second criterion considered whether the technology was proven with full-scale applications to clearly demonstrate viability in the marketplace.
    - Decentralized: treatment technologies which had at least 10 installations in the US with greater than 5 years in service
    - Onsite: treatment technologies which had at least 5 installations in the US
3. **Regulatory Considerations:** The third criterion considered whether the technology had precedence of approval in Florida (FDEP/FDOH) or reasonable assurance that it could be permitted in the current regulatory environment. For onsite treatment systems, the Florida Administrative Code (FAC) 64E-6 was reviewed for non-proprietary process type inclusion and the FDOH's list of approved performance-based treatment systems was reviewed to confirm inclusion of at least one vendor for the technology process type.

3.1.3 Decentralized Treatment Technologies Pre-Screening Results

A scheme to classify and group identified decentralized wastewater treatment technologies was developed to facilitate the evaluation and comparison of alternatives. Figure 3-2 presents the categorized decentralized treatment technologies by process type (natural, biological and physical/chemical).

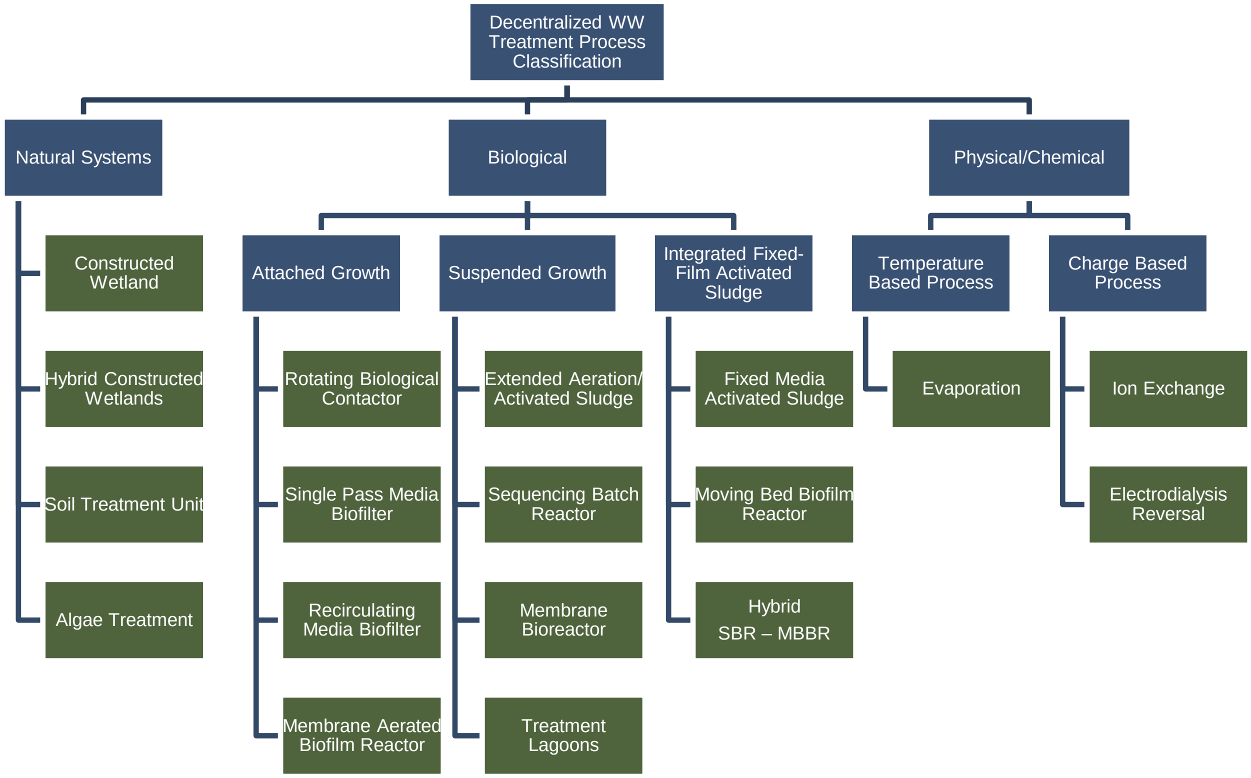


Figure 3-2: Categorized Decentralized Treatment Technologies

Using gathered data from the literature review, each technology was screened using the pre-screening decision support criteria as well as input from JEA. Keep/eliminate pre-screening results of the decentralized treatment systems are summarized in Table 3-1 and eliminated alternatives are depicted in orange coloration in Figure 3-3. The keep/eliminate screening indicated whether the decentralized wastewater treatment process type moved on to the next level of detailed screening. The pre-screening of decentralized wastewater treatment technologies alternatives resulted in the elimination of:

- Hybrid Constructed Wetlands
- Algae Treatment Process
- Constructed Wetlands
- Soil Treatment Unit
- Rotating Biological Contactors (RBC)
- Membrane Aerated Biofilm Reactor (MABR)
- Treatment Lagoons
- Hybrid SBR-MBBR
- Physical/Chemical Processes

Treatment lagoons, constructed wetlands and soil treatment units would be difficult to successfully implement within an urban environment due to space requirements for the treatment area and/or effluent dispersal. Hybrid constructed wetlands, algae treatment, MABR, hybrid SBR-MBBR and physical/chemical processes had few full-scale installations with long-term years of service. Rotating biological contactors (RBCs) were an outdated technology with a poor operational and maintenance track record and were therefore also eliminated from further consideration. Installation and years in service data were obtained from vendors as well as review of FDEP data for operating wastewater treatment facilities in Florida. Effluent quality data was gathered from vendor provided data, case studies and FDEP permitted facilities' operational data.

Table 3-1: Decentralized Treatment Technology Pre-Screening Criteria Results

Subcategory	Technology	Pre-Screening Criteria		
		Meets Programmatic Goals	Technology Maturity and Experience	Regulatory Considerations
Natural Systems				
	Constructed Wetlands (CW)	ELIMINATE	KEEP	EFFLUENT DISPOSAL
	Soil Treatment Unit (STU)	ELIMINATE	KEEP	EFFLUENT DISPOSAL
	Hybrid Constructed Wetland	KEEP	ELIMINATE	ELIMINATE
	Algae Treatment	ELIMINATE	ELIMINATE	ELIMINATE
Biological Processes				
Attached Growth	Rotating Biological Contactors (RBC)	ELIMINATE	KEEP	KEEP
	Single Pass Media Biofilter (SPMB)	KEEP	KEEP	KEEP
	Recirculating Media Biofilter (RMB)	KEEP	KEEP	KEEP
	Membrane Aerated Biofilm Reactor (MABR)	KEEP	ELIMINATE	KEEP
Suspended Growth	Extended Aeration / Activated Sludge (EA/AS)	KEEP	KEEP	KEEP
	Sequencing Batch Reactor (SBR)	KEEP	KEEP	KEEP
	Membrane Bioreactor (MBR)	KEEP	KEEP	KEEP
	Treatment Lagoons	ELIMINATE	ELIMINATE	KEEP

Subcategory	Technology	Pre-Screening Criteria		
		Meets Programmatic Goals	Technology Maturity and Experience	Regulatory Considerations
Integrated Fixed-Film Activated Sludge (IFAS)	Fixed Media Activated Sludge (FMAS)	KEEP	KEEP	KEEP
	Moving Bed Biofilm Reactor (MBBR)	KEEP	KEEP	KEEP
	Hybrid SBR-MBBR	KEEP	ELIMINATE	KEEP
Physical/ Chemical Processes				
Temperature Based Process	Evaporation / Distillation	ELIMINATE	ELIMINATE	ELIMINATE
Charge Based Process	Ion Exchange	ELIMINATE	ELIMINATE	KEEP
	Electrodialysis Reversal (EDR)	ELIMINATE	ELIMINATE	KEEP

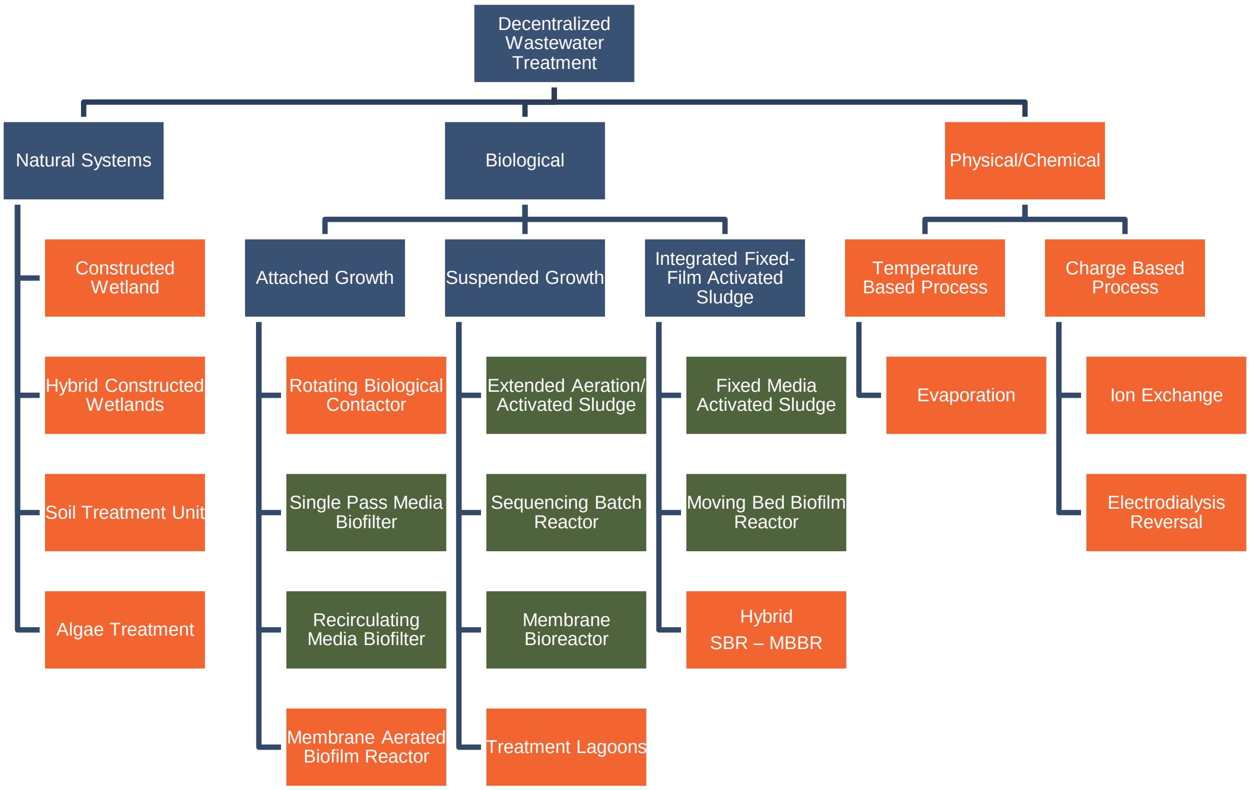


Figure 3-3: Decentralized Treatment Technologies Pre-Screening Results[1]

[1] Orange color indicates eliminated from further consideration

3.1.4 Onsite Treatment Technologies Pre-Screening Results

A similar scheme to classify and group identified onsite wastewater treatment technologies from Task 2 was developed to facilitate the evaluation and comparison of onsite treatment alternatives. Figure 3-4 presents the categorized onsite treatment technologies by process type (biological, physical/chemical and soil, plant, and wetland processes).

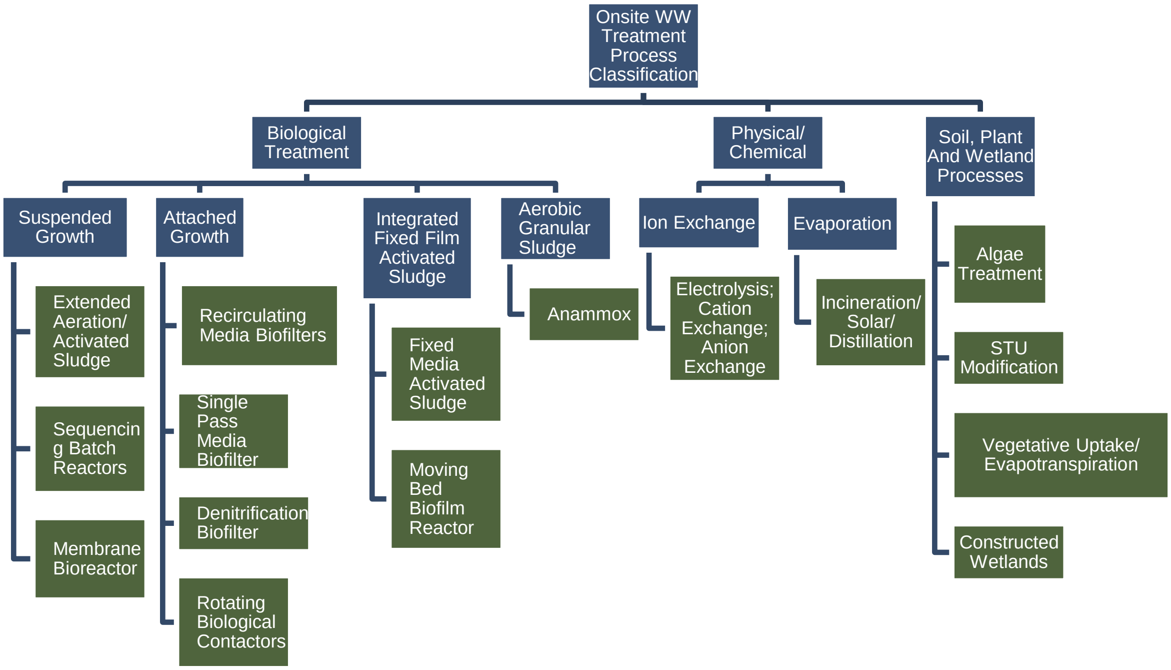


Figure 3-4: Categorized Onsite Treatment Technologies

Traditional and innovative onsite wastewater treatment systems were evaluated for applicability to the JEA IWTP program. Using information and data from the literature review, each technology was screened using similar decision support criteria as well as input from JEA from the pre-screening session. Keep/eliminate pre-screening results of the onsite treatment systems are summarized in Table 3-2 and eliminated alternatives are depicted with orange coloration in Figure 3-5. The keep/eliminate pre-screening indicated whether the onsite treatment system type moved on to the next level of detailed screening. The pre-screening of onsite wastewater treatment technologies resulted in the elimination of:

- Rotating Biological Contactors (RBC)
- Anammox
- Physical/Chemical Processes
- Algae Treatment
- Vegetative Uptake/Evapotranspiration

Vegetative uptake/evapotranspiration was found to be difficult to successfully implement within an urban environment due to space requirements. Annamox, algae treatment and physical/chemical processes have few onsite full-scale installations and were unable to meet regulatory considerations. Rotating biological contactor (RBC) was an outdated technology with few current vendors and was therefore also eliminated. Installation, years in service and effluent water quality data was obtained from vendor data, case studies, and various onsite treatment testing facilities.

Table 3-2: Onsite Treatment Pre-Screening Results

Category	Technology	Pre- Screening Criteria		
		Meets Programmatic Goals	Technology Maturity and Experience	Regulatory Considerations
Biological Processes				
Suspended Growth	Extended Aeration/ Activated Sludge (EA/AS)	KEEP	KEEP	KEEP
	Sequencing Batch Reactor (SBR)	KEEP	KEEP	KEEP
	Membrane Bioreactor (MBR)	KEEP	KEEP	KEEP
Attached Growth	Recirculating Media Biofilters (RMB)	KEEP	KEEP	KEEP
	Single Pass Media Biofilter (SPMB)	KEEP	KEEP	KEEP
	Denitrification Biofilter (DENITE)	KEEP	KEEP	KEEP
	Rotating Biological Contactors (RBC)	KEEP	KEEP	ELIMINATE
Integrated Fixed- Film Activated Sludge (IFAS)	Fixed Media Activated Sludge (FMAS)	KEEP	KEEP	KEEP
	Moving Bed Biofilm Reactor (MBBR)	KEEP	KEEP	KEEP
Aerobic Granular Sludge	Annamox	ELIMINATE	ELIMINATE	ELIMINATE
Physical/Chemical Processes				
Ion Exchange	Electrolysis, Cation/ Anion Exchange	ELIMINATE	ELIMINATE	ELIMINATE
Evaporation	Incineration, Solar, Distillation	ELIMINATE	ELIMINATE	ELIMINATE
Soil, Plant and Wetland Processes				
Soil, Plant and Wetland Processes	Algae Treatment	ELIMINATE	ELIMINATE	ELIMINATE
	STU Modification	KEEP	KEEP	KEEP
	Vegetative Uptake/Evapotranspiration	KEEP	KEEP	KEEP
	Constructed Wetlands	KEEP	KEEP	KEEP

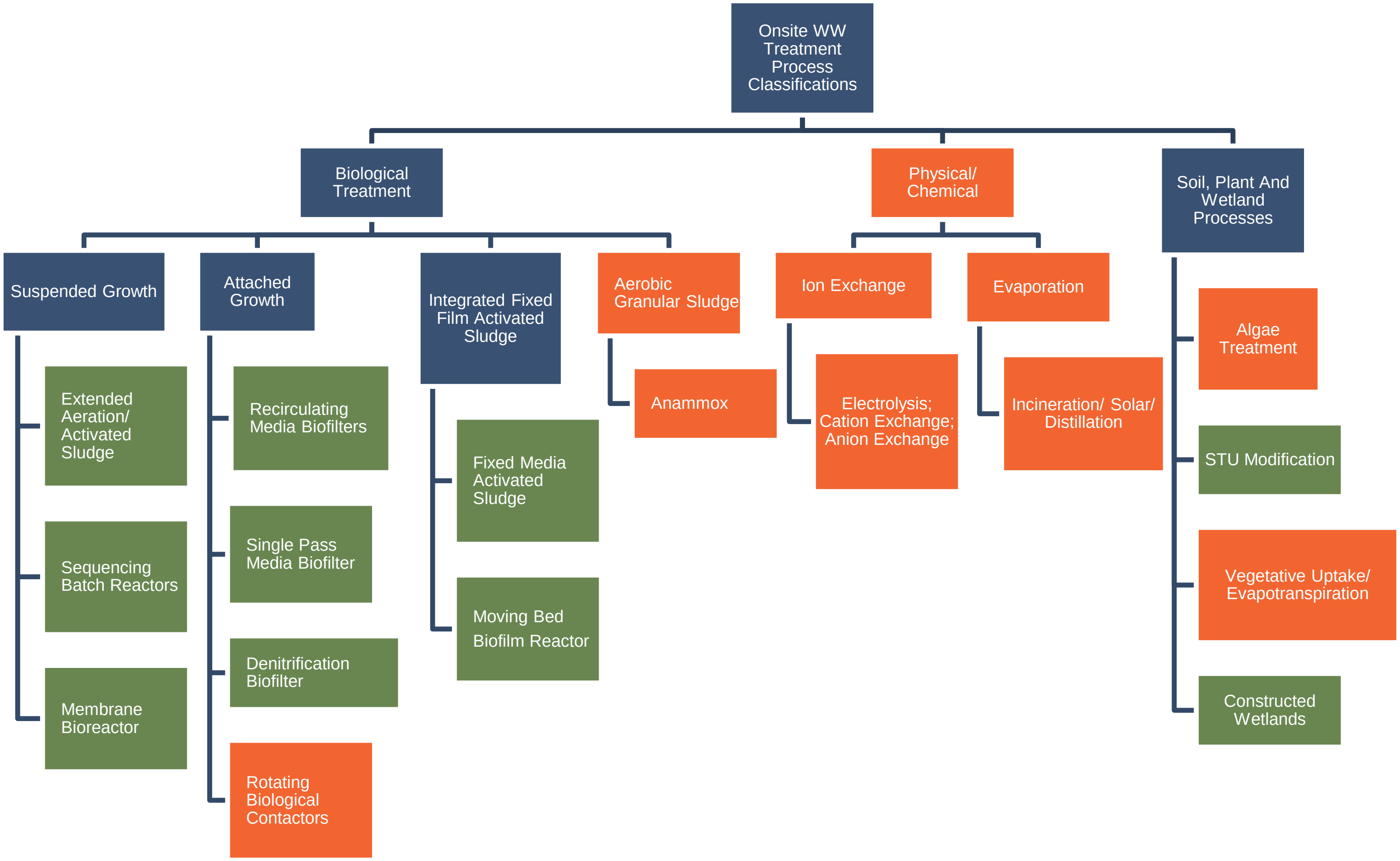


Figure 3-5: Onsite Treatment Technologies Pre-Screening Results[1]

[1] Orange color indicates eliminated from further consideration

3.1.5 Treatment Technologies Pre-Screening Summary

The keep/eliminate pre-screening evaluation determined the treatment technologies that moved on to the next level of detailed screening which included:

Decentralized:

- Single Pass Media Biofilter (SPMB)
- Recirculating Media Biofilter (RMB)
- Extended Aeration/Activated Sludge (ES/AS)
- Sequencing Batch Reactor (SBR)
- Membrane Bioreactor (MBR)
- Fixed Media Activated Sludge (FMAS)
- Moving Bed Biofilm Reactor (MBBR)

Onsite:

- Extended Aeration/Activated Sludge (EA/AS)
- Sequencing Batch Reactor (SBR)
- Membrane Bioreactor (MBR)
- Recirculating Media Biofilter (RMB)
- Single Pass Media Biofilter (SPMB)
- ATU + Denitrification Biofilter (DENITE)
- Fixed Media Activated Sludge (FMAS)
- Moving Bed Biofilm Reactor (MBBR)
- STU Modification (STU MOD)
- Constructed Wetlands (CW)

3.2 Decentralized Treatment Technologies Characterization Prior to Detailed Evaluation

3.2.1 Decentralized Treatment Technologies Flow Ranges

Decentralized treatment technologies were segregated into applicable flow ranges (see *Task 2 Literature & Industry Best Practices Review Technical Memorandum (Task 2 TM)*, Section 2.1.1) aligned with the degree of operational complexity, maintenance and operator oversight requirements, and performance reliability (Table 3-3). Treatment processes with less operational complexity and operator staffing requirements were considered feasible for the smaller daily flow ranges which also aligned with FDEP operator staffing requirements outlined in FAC 62-699.310. Decentralized treatment plant flow ranges without staffing requirements for daily operator oversight need to exhibit robust performance. Operationally complex treatment processes were considered feasible for larger daily flow ranges.

Table 3-3: Applicable Decentralized Technologies by Flow Range

Simpler Operation; More Robust Performance

O&M →

More Complex Operation; Sensitive to Upset

5,000- 50,000 gpd	50,000-150,000 gpd	125,000- 250,000 gpd	250,000-500,000 gpd	500,000- ~1,000,000 gpd
Biological *Attached Growth* • Single Pass Media Biofilter (SPMB) • Recirculating Media Biofilter (RMB)	⟺	Biological *Suspended Growth* • Extended Aeration / Activated Sludge (EA/AS) • Sequencing Batch Reactor (SBR) • Membrane Bioreactor (MBR) *IFAS* • Fixed Media Activated Sludge (FMAS) • Moving Bed Biofilm Reactor (MBBR)	⟺	Biological *Suspended Growth* • Extended Aeration / Activated Sludge (EA/AS) • Sequencing Batch Reactor (SBR) • Membrane Bioreactor (MBR) *IFAS* • Fixed Media Activated Sludge (FMAS) • Moving Bed Biofilm Reactor (MBBR)
Natural Systems for Effluent Disposal • Constructed Wetlands (CW) • Soil Treatment Unit (STU)				

As the larger flow ranges reached closer to 1 mgd, the recommended treatment systems required using a hybrid approach of both packaged systems and site constructed approach (e.g., pour-in-place concrete) and often moved away from the packaged system approach.

Prior to the detailed evaluation of treatment technologies, the STPO priority areas characterization (Task 6) was completed to determine the applicability of decentralized treatment. The characterization of the priority areas assessment limited the applicable decentralized treatment flow ranges evaluated in the detailed screening as opposed to the wide range from 5,000 gpd to approximately 1 mgd AADF.

The STPO project area distance to point of connection within the existing JEA centralized wastewater collection infrastructure was used as a criterion to determine the applicability of decentralized treatment as an alternative for the Task 7 analyses. It was determined that decentralized treatment was applicable in areas which had distances greater than 4,000 linear feet (LF) to the point of connection provided by JEA (i.e., Riverview and Northlake). In the Task 7 analyses, the associated cost (lift station, force main, etc.) to connect to the JEA centralized point of connection will be compared to the cost to connect to a close-proximity decentralized treatment facility.

The Northlake and Riverview projected wastewater AADF were approximately 76,000 gpd and 530,000 gpd, respectively. However, JEA noted during the July 17, 2020 project workshop that the Riverview boundary previously included a northern expansion in an internal assessment. The associated projected wastewater AADF for the expanded Riverview boundary would be 720,000 gpd which was therefore used in the decentralized treatment technology detailed evaluation. Northlake falls between two of the segregated flow ranges, so the next largest flow range was used in the decentralized treatment technology detailed evaluation (150,000 gpd).

3.2.2 Decentralized Treatment Technologies Process Train

Decentralized treatment technology vendors were contacted to obtain cost proposals for the Northlake and Riverview flow ranges meeting effluent water quality standards of 10, 10, 10 mg/L BOD, TSS, TN, respectively. The cost proposals are presented in Appendix D.

Proposals were requested for a packaged treatment system, however some treatment system proposals required using a hybrid approach of both packaged systems and site constructed approach (e.g., pour-in-place concrete) to meet the effluent water quality requirements. For example, for Riverview the MBR system and disinfection were provided as an off-the-shelf packaged system with the remaining plant infrastructure constructed on site. Each technology alternative (core process) was compared as the entire treatment process to meet the effluent water quality requirement, and the hybrid approach was used where required for the comparison. This methodology for process comparison ensured each technology alternative evaluated was able to meet the BOD, TSS and nutrients effluent quality requirements. In addition, the capital construction cost evaluation reflected the entire treatment system as well. Figure 3-6 presents the components of the treatment system considered in the comparison of alternatives. Table 3-4 summarizes the process components in the overall treatment system included for each core process technology evaluated.

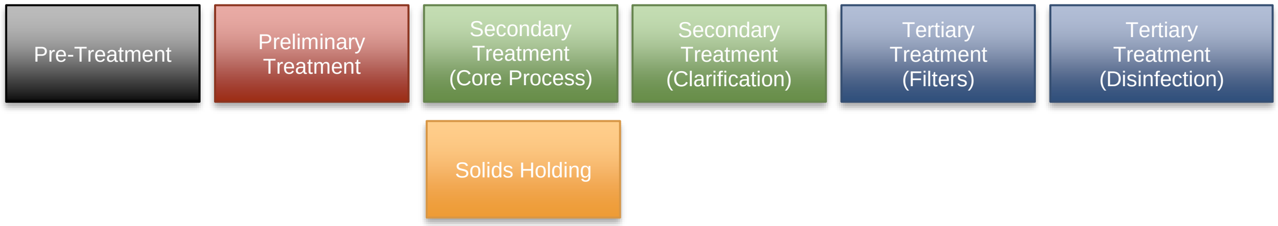


Figure 3-6: Decentralized Treatment System Process Components Diagram

Table 3-4: Additional Required Treatment Processes for Each Core Process Technology

Core Process Technology	Pre-Treatment	Preliminary Treatment		Secondary Treatment		Tertiary Treatment	
	EQ	Coarse Screening	Fine Screening	Core Process	Clarifier	Filter	Disinfection (UV or Chlorine)
Sequencing Batch Reactor (SBR)	X	X		X		X	X
Membrane Bioreactor (MBR)	X	X	X	X			X
Moving Bed Biofilm Reactor (MBBR)	X	X		X	X	X	X
Extended Aeration/ Activated Sludge (EA/ AS)	X	X		X	X	X	X
Fixed Media Activated Sludge (FMAS)	X	X		X	X	X	X
Membrane Aerated Biofilm Reactor (MABR)	X		X	X		X	X

3.3 Treatment Technologies Detailed Evaluation

3.3.1 Criteria Descriptions and Scores

The technology evaluation criteria were individually discussed with JEA and edited accordingly; a final consensus list of criteria was agreed to and adopted during the pre-screening session with JEA. The following sections summarize the criteria used for both the decentralized and onsite treatment technology detailed evaluation.

3.3.1.1 Cost

Capital Construction Cost

This criterion considered the total capital construction cost of a complete wastewater treatment system that met the pre-screening effluent water quality requirement. Cost data were solicited from vendors; however, the resultant responses were not always complete. Therefore, engineering judgment and cross-study comparisons were used to arrive at final cost estimates for both decentralized and onsite treatment systems. Preliminary planning level engineer's opinion of probable construction costs (EOPCC) to treat flows of 150,000 gpd (i.e., Northlake AADF) and 720,000 gpd (i.e., Riverview AADF) are summarized in Appendix C as well as the basis of criteria scoring for both decentralized and onsite technologies. Cost proposals from vendors are presented in Appendix D. Criterion scoring for capital construction costs are summarized in Table 3-5.

Table 3-5: Criterion Values for Capital Construction Cost

Score	Capital Construction Cost		
	Decentralized Treatment (150,000 gpd), $	Decentralized Treatment (720,000 gpd), $	Onsite Treatment
1	>$3.5M	>$12.0M	>$17,000
2		$10.0 - $12.0M	$14,000- $17,000
3	$3.0 - $3.5M	$9.0 - $10.0M	$11,000- $14,000
4		$8.0 - $9.0M	$10,000- $11,000
5	<$3.0M	<$8.0M	< $10,000

Operation and Maintenance Cost

This criterion considered the total operation and maintenance (O&M) cost which included labor for operator oversight, equipment servicing, energy costs, consumable materials (chemicals, etc.) and repair and replacement of equipment. For decentralized treatment, operator staffing requirements was determined using FAC 62-699.310 and vendor data. Table 3-6 summarizes 20-year net present cost (NPC) for decentralized treatment O&M and annual onsite treatment O&M costs for the criterion scoring.

Table 3-6: Criterion Values for O&M Cost

Score	O&M Cost		
	Decentralized Treatment (150,000 gpd), NPC[1]	Decentralized Treatment (720,000 gpd), NPC[1]	Onsite Treatment, NPC[1]
1	>$2.3M	>$13.0M	
2		$9.0M- $13.0M	> $7,200
3	$2.1M- $2.3M	$6.0M- $9.0M	
4		$3.0M- $6.0M	< $7,200
5	<$2.1M	<$3.0M	

[1] *Net present cost (NPC) based on interest rate of 3%, 20-year period.*

3.3.1.2 Implementability

Land Area Requirement

This criterion considered the footprint required for the complete treatment system, in square feet (SF). For decentralized technologies, vendors provided proposed layouts and engineering judgement was used to compare each system. For onsite technologies, the footprint included septic tank (as applicable), treatment tank(s) and drainfield. Some onsite technologies were given a drainfield reduction based on FAC 64E-6. The scores used for this criterion are presented in Table 3-7.

Table 3-7: Criterion Values for Land Area Requirements

Score	Land Area Requirements		
	Decentralized Treatment (150,000 gpd), SF	Decentralized Treatment (720,000 gpd), SF	Onsite Treatment, SF
1	>9,000	>35,000	>1,200
2			
3	5,000- 9,000	15,000- 35,000	600- 1,200
4			
5	<5,000	<15,000	<600

Construction Complexity

This criterion addressed the degree of difficulty to construct/install the treatment system. High scoring systems would be simple to install even by an untrained contractor or installer. Low scoring systems would require substantial training and/or an extensive installation process. Criterion values for construction complexity were qualitative and are listed in Table 3-8. Data for this criterion was generally unavailable in most literature reviewed, and engineering judgment was therefore used to score the various technologies based on knowledge of system components and the perceived difficulty of installation.

Table 3-8: Criterion Values for Construction Complexity

Score	Construction Complexity
1	High
2	
3	Medium
4	
5	Low

Operational Complexity

This criterion addressed the degree of complexity required to operate the treatment system. High scoring systems for onsite treatment could be operated and maintained by the homeowner with little or no effort or training. For decentralized treatment systems, literature review and engineering judgement were used based on the knowledge of the process utilized and the perceived difficulty in maintaining treatment performance. Criterion values for operational complexity were qualitative and are listed in Table 3-9.

Table 3-9: Criterion Values for Operational Complexity

Score	Operational Complexity
1	High
2	
3	Medium
4	
5	Low

3.3.1.3 Environmental Benefits

Effluent Water Quality

This criterion considered the anticipated effluent water quality achieved long-term by the complete treatment system (that met the pre-screening effluent water quality requirement). For decentralized treatment, the core process type (see Section 3.2.2) typically determined the ability to meet the total nitrogen (TN) pre-screening effluent water quality requirement, whereas the requirement to add tertiary treatment eliminated the need to score the BOD and TSS effluent quality.

Similarly, for onsite treatment, the drainfield will reduce BOD and TSS to pre-screening effluent water quality requirements and provides additional nitrogen reduction. The average concentration of TN in the final effluent prior to discharge to the drainfield was evaluated based on performance that is achieved under suitable conditions with proper and adequate operation and maintenance. Percent removal was also considered to evaluate onsite treatment performance, but literature references reporting effluent concentrations were more common for onsite treatment systems thus it was not ultimately chosen. The onsite treatment criterion values for TN effluent concentration are listed in Table 3-10. TN values used to score a given technology were based on an average of values from various sources, ranging from peer reviewed publications with systems data to FDEP permitted facilities operational performance data, and engineering judgement based on experience.

Table 3-10: Criterion Values for Effluent Water Quality

Score	Effluent Water Quality	
	Decentralized Treatment	Onsite Treatment
1	Difficulty meeting 10 mg/L TN	Difficulty meeting 20mg/L TN
2		18- 20 mg/L TN
3	Medium	12- 18 mg/L TN
4		3- 12 mg/L TN
5	Easily met 10 mg/L TN	< 3 mg/L TN

Carbon Footprint (Energy Use)

This criterion considered the environmental impact as related to carbon footprint of the treatment system. Energy use was used a surrogate for carbon footprint, and the daily (decentralized treatment) and annual (onsite treatment) energy usage of the entire treatment system, including pumps, aerators, and mixing devices was considered. Criterion values for energy requirements are listed in Table 3-11. Greater energy use was associated with more “active” technologies that employ greater numbers of liquid pumps, aeration pumps, and mechanical mixing, whereas unsaturated granular media filters that employ passive aeration would consume less energy. Energy consumption data were based on an average of values from various sources including vendor data, case studies, and engineering judgement based on historical data.

Table 3-11: Criterion Values for Carbon Footprint

Score	Carbon Footprint		
	Decentralized Treatment (150,000 gpd), kWh/day	Decentralized Treatment (720,000 gpd), kWh/day	Onsite Treatment, kWh/year
1	>1,800	>8,000	> 2,500
2	1,400- 1,800	4,000- 8,000	1,500- 2,500
3	1,100- 1,400	2,500- 4,000	1,000- 1,500
4	1,000- 1,100	1,800- 2,500	500- 1,000
5	<1,000	<1,800	< 500

Climate Resiliency

This criterion was a general judgment of the efficacy of a treatment system relative to the ability to withstand storm damage, and/or long-term ability to mitigate impacts of rising sea level and surficial groundwater table. Criterion values for climate resiliency are summarized in Table 3-12.

Table 3-12: Criterion Values for Climate Resiliency

Score	Climate Resiliency	
	Decentralized Treatment	Onsite Treatment
1	n/a	Most Impacted
2		
3		Impacted
4		
5		Least Impacted

3.3.1.4 Reliability

Treatment Performance Consistency

This criterion was a general judgment of the consistency of treatment performance defined as the sensitivity of the treatment system to upset. The standard deviation of final effluent TN concentration provided a measure of the treatment performance consistency of a technology. The sensitivity of a system was considered heavily influenced by the treatment process used. Therefore, the attribute of the performance consistency criterion is either the standard deviation of final effluent TN (if available) or the type of treatment process used, based on a review of wastewater treatment design guidelines, treatment performance and engineering judgement. Criterion values for treatment performance consistency are listed in Table 3-13.

Table 3-13: Criterion Values for Treatment Performance Consistency

Score	Treatment Performance Consistency
1	Low
2	
3	Medium
4	
5	High

Mechanical Reliability

This criterion was associated with mechanical reliability of treatment system components. Factors that can increase the need for service include a high number of mechanical components (pumps, aerators, mechanical mixers), complexity of electrical systems, complexity of design, components prone to failure, and equipment that required specialized parts and training of personnel. For onsite treatment systems, the frequency of routine service and unscheduled call-outs provided a measure of the reliability of a technology. Criterion values for performance reliability are listed in Table 3-14.

Table 3-14: Criterion Values for Mechanical Reliability

Score	Mechanical Reliability
1	Low
2	
3	Medium
4	
5	High

Restoration of Performance Difficulty

Treatment technologies occasionally fail to achieve their performance expectations. Such upsets may be due to electrical, mechanical or process upset problems. The time needed to restore treatment is an important criterion in preventing harm to the environment. The consequences of an operational failure are much less significant if treatment efficacy is restored easily. Data were generally unavailable for this criterion, so scoring (Table 3-15) was based on engineering judgment related to the treatment process.

Table 3-15: Criterion Values for Restoration of Performance Difficulty

Score	Restoration of Performance Difficulty
1	High
2	
3	Medium
4	
5	Low

3.3.1.5 Summary of Detailed Evaluation Criteria

For each of the criterion, scores were established based on cost and/or non-cost attributes for decentralized and onsite treatment technologies. Table 3-16, Table 3-17 and Table 3-18 present a summary of score assignments for each criterion for decentralized treatment (150,000 gpd), decentralized treatment (720,000 gpd) and onsite treatment, respectively. The criterion assignments were the basis for scoring and ranking of the technology classifications.

Table 3-16: Summary of Decentralized Treatment (150,000 gpd) Detailed Evaluation Criterion Scores

Category	Criteria	Score				
		1	2	3	4	5
Cost	Capital Construction Cost	>$3.52M		$3.0-3.52M		<$3.0M
	O&M Cost (20-yr)	>$2.3M		$2.1-2.3M		<$2.1M
Implementability	Land Area Requirement, SF	>9,000		5,000-9,000		<5,000
	Construction Complexity	High		Medium		Low
	Operational Complexity	High		Medium		Low
Environmental Benefits	Effluent Water Quality	Difficulty meeting 10 mg/L TN		Medium		Easily met 10 mg/L TN
	Carbon Footprint (Energy Use), kWh/day	>1,800	1,400-1,800	1,100-1,400	1,000-1,100	<1,000
	Climate Resiliency	n/a				
Reliability	Treatment Performance Consistency	Low		Medium		High
	Mechanical Reliability	Low		Medium		High
	Restoration of Performance Difficulty	High		Medium		Low

Table 3-17: Summary of Decentralized Treatment (720,000 gpd) Detailed Evaluation Criterion Scores

Category	Criteria	Score				
		1	2	3	4	5
Cost	Capital Construction Cost	>$12.0M	$10.0-12.0M	$9.0-10.0M	$8-9M	<$8.0M
	O&M Cost (20-yr)	>$13.0M	$9-13M	$6-9M	$3-6M	<$3M
Implementability	Land Area Requirement, SF	>35,000		15,000-35,000		<15,000
	Construction Complexity	High		Medium		Low
	Operational Complexity	High		Medium		Low
Environmental Benefits	Effluent Water Quality	Difficulty meeting 10 mg/L TN		Medium		Easily met 10 mg/L TN
	Carbon Footprint (Energy Use), kWh/day	>8,000	4,000-8,000	2,500-4,000	1,800-2,500	<1,800
	Climate Resiliency	n/a				
Reliability	Treatment Performance Consistency	Low		Medium		High
	Mechanical Reliability	Low		Medium		High
	Restoration of Performance Difficulty	High		Medium		Low

Table 3-18: Summary of Onsite Treatment Detailed Evaluation Criterion Scores

Category	Criteria	Score				
		1	2	3	4	5
Cost	Capital Construction Cost	>$17K	$14-17K	$11-14K	$10-11K	<$10K
	O&M Cost (20-yr)		>$7,200		<$7,200	
Implementability	Land Area Requirement, SF	>1,200		600-1,200		<600
	Construction Complexity	High		Medium		Low
	Operational Complexity	High		Medium		Low
Environmental Benefits	Effluent Water Quality, mg/L TN	Difficulty meeting 20	18-20	12-18	3-12	<3
	Carbon Footprint (Energy Use), kWh/yr	>2,500	1,500-2,500	1,000-1,500	500-1,000	<500
	Climate Resiliency	Most impacted		Impacted		Least impacted
Reliability	Treatment Performance Consistency	Low		Medium		High
	Mechanical Reliability	Low		Medium		High
	Restoration of Performance Difficulty	High		Medium		Low

3.3.2 Detailed Evaluation Criteria Weighting Factors

As a project team, it was decided that not all of the evaluation criteria were equally important, and criteria weighting was desired to reflect this. The relative weighting factor for each category of criteria was discussed at the JEA pre-screening workshop. First, each category was compared to every other category by the individual JEA stakeholders, and then the average of the individual category scores was used as the established weighting factors (Table 3-19). It was determined through the detailed evaluation that the pre-screening criteria eliminated some key criteria (secondary impacts and public perception), therefore, the eliminated category weighting factors were re-distributed (see "Revised Category Weighting Factor" in Table 3-19). Next, the relative weighting factor for each individual criterion within the categories were established for decentralized and onsite treatment.

Table 3-19: Summary of Detailed Evaluation Criteria Weighting Factors

Category	Category Weighting Factor Presented to JEA on 2/11	Revised Category Weighting Factor	Criteria	Decentralized Treatment Weighting Factor Within Category	Onsite Treatment Weighting Factor Within Category
Cost	35%	40%	Capital Construction Cost	50% (20% of Total)	50% (20% of Total)
			O&M Cost	50% (20% of Total)	50% (20% of Total)
Implementability	20%	25%	Land Area Requirement	35% (9% of Total)	35% (9% of Total)
			Construction Complexity	25% (6% of Total)	25% (6% of Total)
			Operational Complexity	40% (10% of Total)	40% (10% of Total)
Environmental Benefits	15%	20%	Effluent Water Quality	50% (10% of Total)	60% (12% of Total)
			Carbon Footprint (Energy Use)	50% (10% of Total)	25% (5% of Total)
			Climate Resiliency	n/a	15% (3% of Total)
Secondary Impacts	10%	0%	n/a	n/a	n/a
Reliability	15%	15%	Treatment Performance Consistency	50% (7.5% of Total)	50% (7.5% of Total)
			Mechanical Reliability	30% (4.5% of Total)	30% (4.5% of Total)
			Restoration of Performance Difficulty	20% (3% of Total)	20% (3% of Total)
Public Perception	5%	0%	n/a		
TOTAL	100%	100%			

3.3.3 Detailed Evaluation Results

For each of the individual technology classifications that passed the keep/eliminate pre-screening evaluation, data were acquired from a wide variety of sources focused on the ranking criteria. For each technology classification, the criterion scores were multiplied by the criterion weighting factor and summed to generate a total score. For example, the total possible score for onsite treatment using each criterion is determined by multiplying the maximum criteria score (S) and the relative weighting factor (W) together as summarized in Table 3-20.

Table 3-20: Onsite Treatment Criteria Scores and Weighting Factors

Criterion Description	Maximum Score (S)	Assigned Criterion Weighting Factor % (W)	Total Possible Score (S x W)
Capital Construction Cost	5	20	100
O&M Cost	5	20	100
Land Area Requirement	5	8.75	43.75
Construction Complexity	5	6.25	31.25
Operational Complexity	5	10	50
Effluent Water Quality	5	12	60
Carbon Footprint (Energy Use)	5	5	25
Climate Resiliency	5	3	15
Treatment Performance Consistency	5	7.5	37.5
Mechanical Reliability	5	4.5	22.5
Restoration of Performance Difficulty	5	3	15
Total Possible Score			500

The total scores for decentralized treatment technologies applicable to the Northlake flow range (150,000 gpd) are summarized in Table 3-21. The total scores for decentralized treatment technologies applicable to the Riverview flow range (720,000 gpd) are summarized in Table 3-22. Noted is that for the FMAS alternative, which had moved forward from the pre-screening evaluation, a vendor was not identified that would provide a cost proposal for the 720,000 gpd flow, and therefore FMAS was removed from further consideration for the Riverview flow range. MABR was therefore added to the detailed evaluation, which had not moved forward from the pre-screening evaluation due to a lack of installations with long-term years in operation. MABR was identified as a technology that may be considered for the Phase 3 pilot testing by JEA. These adjustments are reflected in Table 3-21 and Table 3-22. The total scores for onsite treatment technologies (<5,000 gpd) are summarized in Table 3-23.

Table 3-21: Decentralized Treatment Detailed Evaluation Total Scores- Northlake (150,000 gpd)

Flow (gpd)	Subcategory	Technology	Cost		Implementability			Environmental Benefits		Reliability			Revised Total Weighted Score	Normalized to 100
			Construction Capital Cost	O&M Cost	Land Area Requirement	Construction Complexity	Operation Complexity	Effluent Quality	Carbon Footprint (Energy Use), kWh/ day	Treatment Performance Consistency	Mechanical Reliability	Restoration of Performance Difficulty		
		Weighting Factor	20%	20%	8.75%	6.25%	10%	10%	10%	7.5%	4.5%	3%		
Northlake (150,000 gpd)	Suspended Growth	Extended Air/Activated Sludge (EA/AS)	5	3	3	3	3	3	1	2	5	1	316	63
	Suspended Growth	Sequencing Batch Reactor (SBR)	3	5	3	3	1	2	2	2	3	2	290	58
	Suspended Growth	Membrane Bioreactor (MBR)	1	1	5	3	1	5	3	5	3	4	256	51
	IFAS	Moving Bed Biofilm Reactor (MBBR)	3	1	1	3	1	3	5	3	3	3	243	49
	IFAS	Fixed Media Activated Sludge (FMAS)	1	3	5	3	3	3	1	3	5	4	270	54
	Attached Growth	Membrane Aerated Biofilm Reactor (MABR)	3	1	5	3	1	3	3	2	2	3	246	49

Table 3-22: Decentralized Treatment Detailed Evaluation Total Scores- Riverview (720,00 gpd)

Flow (gpd)	Subcategory	Technology	Cost		Implementability			Environmental Benefits		Reliability			Revised Total Weighted Score	Normalized to 100
			Construction Capital Cost	O&M Cost	Land Area Requirement	Construction Complexity	Operation Complexity	Effluent Quality	Carbon Footprint (Energy Use), kWh/ day	Treatment Performance Consistency	Mechanical Reliability	Restoration of Performance Difficulty		
		Weighting Factor	20%	20%	8.75%	6.25%	10%	10%	10%	7.5%	4.5%	3%		
Riverview (720,000 gpd)	Suspended Growth	Extended Air/Activated Sludge (EA/AS)	2	3	3	1	3	3	2	2	5	1	253	51
	Suspended Growth	Sequencing Batch Reactor (SBR)	3	4	1	1	1	2	5	2	3	2	270	54
	Suspended Growth	Membrane Bioreactor (MBR)	1	2	5	3	1	5	2	5	3	4	266	53
	IFAS	Moving Bed Biofilm Reactor (MBBR)	4	4	3	1	1	3	4	3	3	3	318	64
	Attached Growth	Membrane Aerated Biofilm Reactor (MABR)	1	2	5	3	1	3	3	2	2	3	226	45

Table 3-23: Onsite Treatment Detailed Evaluation Total Scores

Subcategory	Technology	Cost		Implementability			Environmental Benefits			Reliability			Total Weighted Score	Normalized to 100
		Construction Capital Cost	O&M Cost	Land Area Requirement	Construction Complexity	Operational Complexity	Effluent Requirements	Carbon Footprint (Energy Use), kWh/ year	Climate Resiliency	Treatment Performance Consistency	Mechanical Reliability	Restoration of Performance Difficulty		
	Weighting Factor	20%	20%	8.75%	6.25%	10%	12%	5%	3%	7.5%	4.5%	3%		
Suspended Growth	Extended Aeration/ Activated Sludge (EA/AS)	1	2	5	3	3	3	3	3	1	5	1	246	49
IFAS	Fixed Media Activated Sludge (FMAS)	3	4	3	3	3	3	2	3	3	5	4	327	65
IFAS	Moving Bed Biofilm Reactor (MBBR)	5	4	5	1	1	4	5	3	4	3	3	375	75
Attached Growth	Recirculating Media Biofilters (RMB)	5	2	3	1	1	2	3	3	4	3	4	286	57
Suspended Growth	Membrane Bioreactor (MBR)	1	2	3	1	1	2	2	3	4	3	4	201	40
Suspended Growth	Sequencing Batch Reactor (SBR)	4	4	3	1	1	4	4	3	2	3	2	314	63
Attached Growth	Single Pass Media Biofilter (SPMB)	3	4	1	4	4	1	5	3	3	5	5	320	64
Attached Growth	ATU + Denitrification Biofilter (Tank)	2	4	1	4	3	4	3	3	3	5	5	316	63
Constructed Wetlands	Constructed Wetlands (CW)	2	2	1	3	3	3	3	1	3	5	5	252	50
STU Modification	STU Modification (STU MOD)	4	4	3	3	4	3	5	1	3	5	5	369	74

3.4 Treatment Technologies Evaluation Summary

Table 3-24 and Table 3-25 summarize some of the advantages and disadvantages of the decentralized treatment and onsite treatment technology screened alternatives.

Table 3-24: Advantages and Disadvantages to Viable Decentralized Treatment Technologies

Technology	Advantages	Disadvantages
Extended Aeration/ Activated Sludge (EA/AS)	• Many decentralized treatment units available that incorporate variations on the activated sludge process • Low capital cost • High mechanical reliability	• High energy requirement • Poor restoration of performance • Steel packaged container system
Sequencing Batch Reactor (SBR)	• Low O&M costs	• Required oversight and maintenance • Susceptible to process upset
Fixed Media Activated Sludge (FMAS)	• Commonly used to convert conventional aerobic activated sludge treatment processes to nitrifying-denitrifying systems • Minimal land area required • High mechanical reliability	• High capital cost • High energy requirement
Membrane Bioreactor (MBR)	• Several types of membrane systems and configurations available • Reduced footprint of wastewater treatment plants by replacing final clarifiers • Provided necessary filtration step required for achieving reclaimed water quality effluent • High effluent quality • High treatment performance consistency	• High occurrence and control of fouling on membrane surfaces via sparging (gas) or chemical cleans • High capital cost • High O&M costs • High operational complexity
Membrane Aerated Biofilm Reactor (MABR)	• Demonstrated the ability for simultaneous carbon and nitrogen removal • Minimal land area required	• Few US installations and years of service • Complex operation which required operator oversight • Few manufacturers offered modular MABR systems • High O&M costs
Moving Bed Biofilm Reactor (MBBR)	• Several commercially available MBBR systems identified • Moderate energy requirement	• High operational complexity

Table 3-25: Advantages and Disadvantages to Viable Onsite Wastewater Technologies

Technology	Advantages	Disadvantages
Moving Bed Biofilm Reactor (MBBR)	• High treatment performance • Low capital cost • Minimal land area required • Low energy requirement	• High construction complexity • High operational complexity
STU Modification (STU MOD)	• Low land area required • Low construction complexity • Low operational complexity • Low energy requirements • High mechanical reliability	• Issues of concern included media longevity, replacement intervals, and hydraulic issues related to preferential flow paths • Poor climate resiliency
Fixed Media Activated Sludge (FMAS)	• Small footprint • Consistently reduced BOD, TSS and TN • High mechanical reliability	• Somewhat complex operation as compared to conventional onsite systems • Relied heavily on proper dissolved oxygen (DO) levels within the reactor for treatment performance • High energy required
Single Pass Media Biofilter (SPMB)	• Simple in operation and maintenance • Some porous media showed capability to accept higher hydraulic loading rates without compromising nitrification, which allowed for smaller footprint requirements as compared to traditional sand media filters • High mechanical reliability • High restoration of performance	• Sand filters required maintenance visits to keep the surface of the beds clean and prevent clogging of the surface layer of the reactor • High land area required
ATU + Denitrification Biofilter (DENITE)	• Outperformed most other onsite wastewater treatment system for nitrogen removal • High treatment performance • High mechanical reliability • High restoration of performance	• Required an initial nitrification step which added overall system footprint either as tankage or soil treatment unit area • High land area required • Poor climate resiliency
Sequencing Batch Reactor (SBR)	• Low energy required • Good treatment performance	• High operational complexity • Moderate mechanical reliability • Low restoration of performance

The technologies summarized above are viable wastewater treatment technologies for consideration in the STPO priority areas wastewater capital improvements assessment (Task 7).

3.5 Collection System Technologies Evaluation

Wastewater collection technologies for the collection/conveyance of wastewater to decentralized or centralized wastewater treatment facilities were evaluated. A scheme to classify and group identified wastewater collection system technologies identified in the literature and industry best practices review was developed to facilitate the evaluation and comparison of alternatives. Conventional gravity-sewer systems and alternative wastewater collection methods categorized as pressure or vacuum were reviewed (Figure 3-7). Also included was a no-sewer alternative consisting of holding tanks at individual points of connection with pump-out via vacuum truck and transport to a treatment facility.

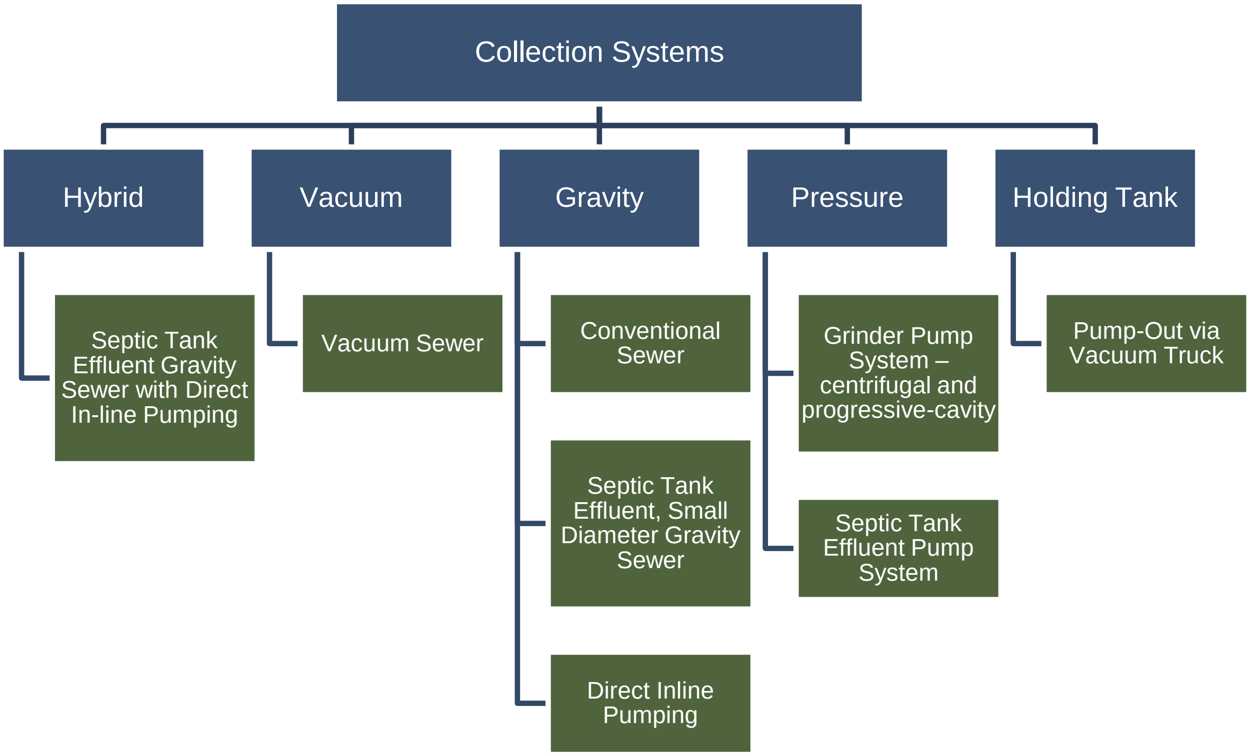


Figure 3-7: Wastewater Collection System Alternatives Summary

3.5.1 Collection Technologies Screening Criteria

Traditional and innovative wastewater collection system technologies were evaluated for applicability to the JEA IWTP program. The collection system alternatives were evaluated using criteria to conduct a screening process and eliminate options prior to the more detailed evaluation as part of the STPO priority areas wastewater capital improvements assessment. The screening process used was a qualitative keep/eliminate analysis. An alternative with an “eliminated” rating was removed from further consideration.

Three criteria were used to judge viability for further consideration:

1. **Met Programmatic Goals:** The first criterion considered whether the alternative met JEA's programmatic goal of eliminating existing septic tanks. This criterion was influenced by feedback from the JEA IWTP project team.

2. **Regulatory Considerations**: The second criterion considered whether the alternative had precedence or reasonable assurance of permittability in the current regulatory environment.

3. **Technology Maturity and Experience:** The third criterion considered whether the technology had sufficient full-scale applications to clearly demonstrate viability in the marketplace.

3.5.2 Collection Technologies Screening Results

Using information derived from the literature review, each strategy was screened using decision support criteria as well as input from JEA from a screening session conducted February 11, 2020. An eliminate rating for any of the three criteria resulted in elimination of the collection technology for further consideration. As noted during the Task 2.2 Brainstorming Session conducted December 19, 2019, JEA expressed the desire to eliminate reliance on reusing or installing replacement septic tanks. The screening of collection system alternatives resulted in the elimination of:

- Septic tank effluent, small diameter gravity sewer (SDGS)
- Direct inline pumping
- Septic tank effluent pump system (STEP)
- Pump-out via vacuum truck
- Septic tank effluent gravity sewer with direct in-line pumping

The keep/eliminate results for the screening of the wastewater collection system technologies are summarized in Table 3-26 and eliminated alternatives are depicted in orange in Figure 3-8. The remaining collection system alternatives will be coupled with wastewater management strategies and institutional frameworks in the Task 7 evaluation. Table 3-27 summarizes the advantages and disadvantages of the remaining wastewater collection system alternatives.

Table 3-26: Wastewater Collection System Technologies Keep/Eliminate Results

Collection System Type	Met Programmatic Goals	Regulatory Considerations	Technology Maturity and Experience
Gravity Sewer			
Conventional Sewer	KEEP	KEEP	KEEP
Effluent Small Diameter	ELIMINATE	KEEP	KEEP
Direct Inline Pumping	KEEP	ELIMINATE	ELIMINATE
Pressure			
Grinder Pump System – centrifugal and progressive cavity	KEEP	KEEP	KEEP
Septic Tank Effluent Pump System (STEP)	ELIMINATE	KEEP	KEEP
Vacuum			
Vacuum Sewer	KEEP	KEEP	KEEP
Hybrid			
Using a mix of “Keep”	KEEP		
Using a mix that includes “Eliminate”	ELIMINATE		
Holding Tank	ELIMINATE	KEEP	KEEP

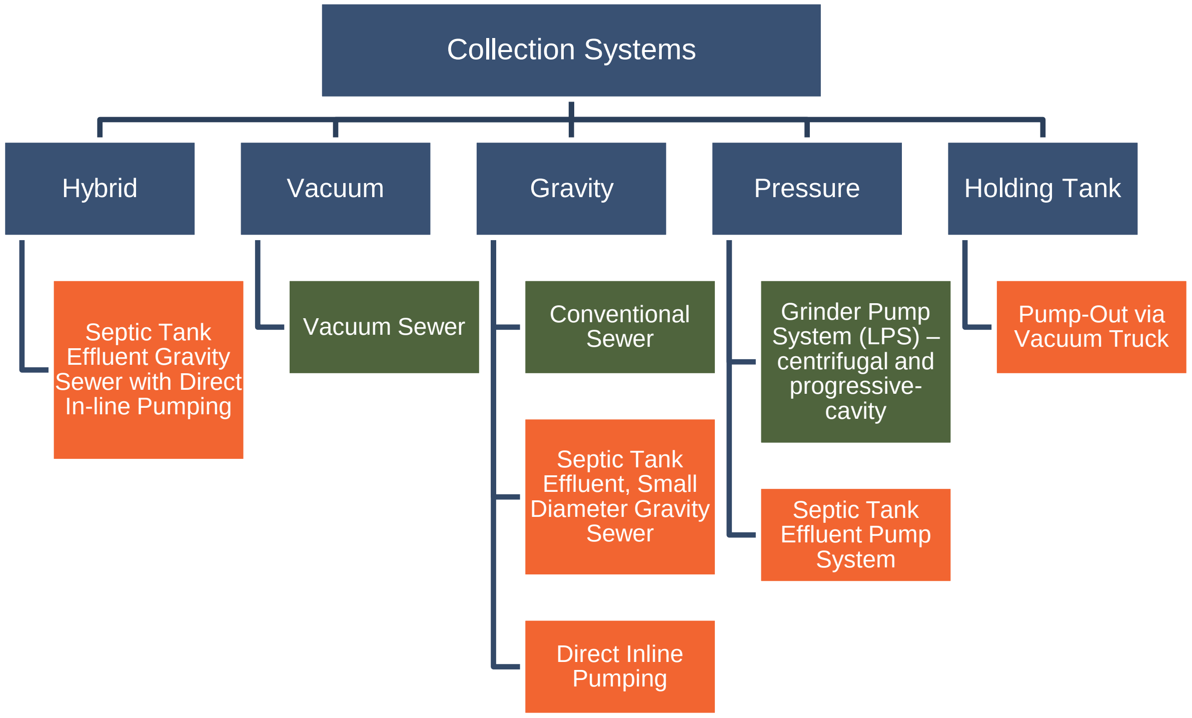


Figure 3-8: Collection System Screening Results[1]

[1] Orange color indicates eliminated from further consideration

Table 3-27: Advantages and Disadvantages to Viable Wastewater Collection System Technologies

Collection System Technology	Advantages	Disadvantages
Gravity – Conventional	• Entire waste stream conveyed from property • Well established technology • Collectors contained within the public right-of-way (ROW) • Entire waste stream conveyed from property • No power required except at lift stations	• Deep excavation or frequent lift stations because of flat topography • Scour velocities sometimes not maintained at low flows • Manholes required • Infiltration/ Inflow (I/I) common through manholes • Typically installed under roadway pavement, increasing restoration costs
Pressure – Grinder Pump	• Entire waste stream conveyed from property • Collector mains may be laid at constant depth to conform to topography • Entire waste stream conveyed from property • Cleanouts in place of manholes • I/I greatly reduced • Manholes eliminated • Lift stations eliminated	• Vault with grinder pump located on private property with easement required • Power required at each connection supplied by property owner • Individual service lost with power outage • Residents often object to the presence of the equipment.
Vacuum	• Entire waste stream conveyed from property • Collector mains may be laid at nearly constant depth to conform to topography • I/I greatly reduced • Manholes eliminated • Collector mains and valves installed in R/W off road pavement • No power required at connection • Standby power typically provided at central vacuum station prevents service loss during power outages	• Collector mains must be installed to grade in a sawtooth pattern • Standby power required at central vacuum station to prevent service loss during power outages • Limited number of manufacturers of equipment • Pipe diameters are greater than those for pressure systems

4. Wastewater Management Strategies and Institutional Frameworks Evaluation (Task 4)

The purpose of this section is to document the evaluation of wastewater management strategies and institutional frameworks identified in the literature review. The goal of the evaluation was to determine viable strategies and frameworks for consideration in the STPO priority areas wastewater capital improvements assessment (Task 7).

4.1 Screening Process Overview

A scheme to classify and group identified wastewater management strategies and institutional frameworks from the literature review was developed to facilitate the evaluation and comparison of alternatives. The alternatives were evaluated using criteria to conduct a screening process and eliminate options prior to the more detailed evaluation as part of the STPO priority areas wastewater capital improvements assessment. The screening process used was a qualitative keep/eliminate analysis. An alternative with an “eliminated” rating was removed from further consideration.

4.2 Wastewater Management Strategies Evaluation

Wastewater management strategies for this project were defined as methods for managing STPO priority area wastewater in lieu of the existing septic systems. A scheme for classifying wastewater management strategies to allow comparisons between the alternatives was identified in the literature and industry best practices review. This scheme consisted of two main groups: traditional wastewater management strategies (see Figure 4-1) and innovative wastewater management strategies (see Figure 4-2). The traditional wastewater management strategies included onsite, decentralized, centralized, and integrated management (i.e., a mixture of the first three).

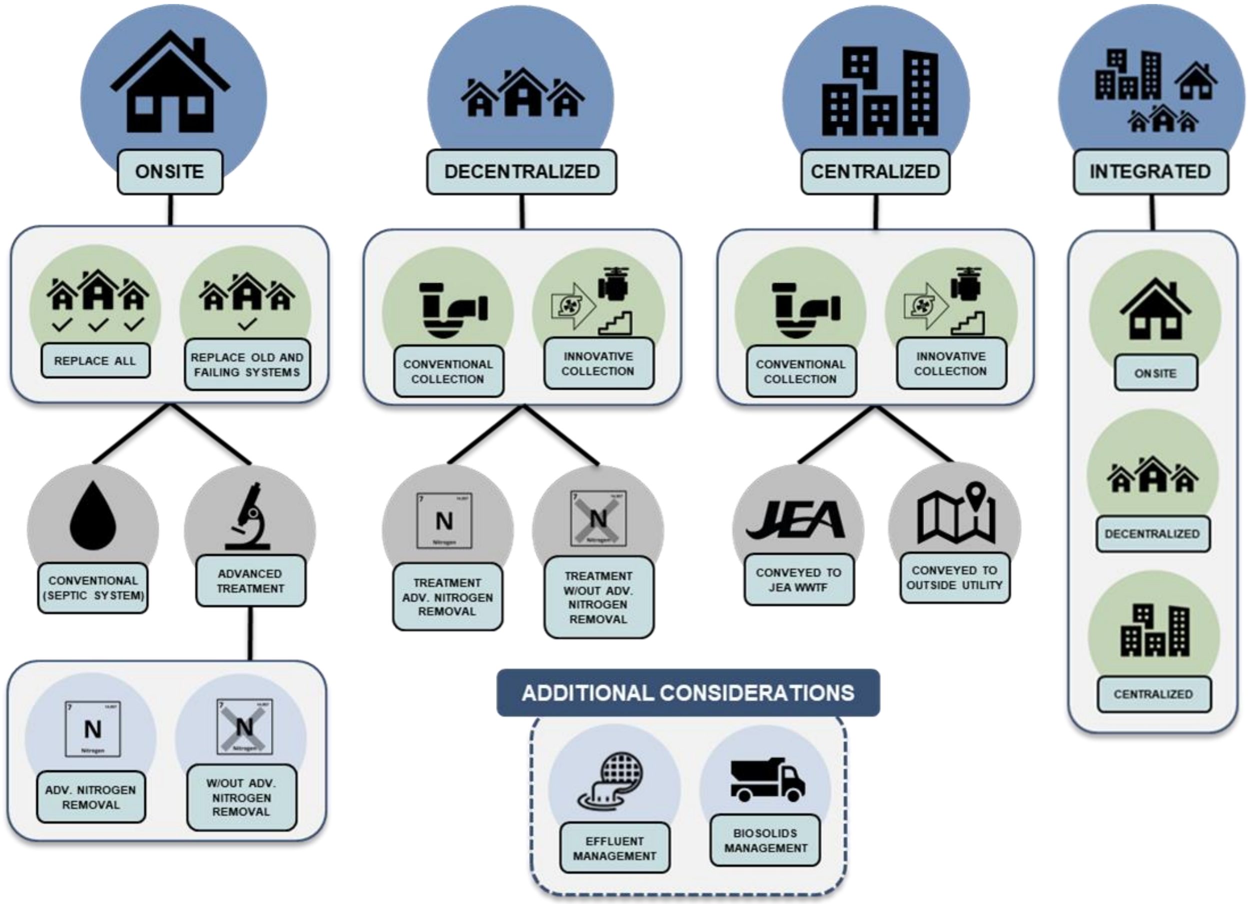


Figure 4-1: Identified Traditional Wastewater Management Strategy Alternatives

The wastewater management strategy scheme established several alternative solutions, herein referred to as “pathways”. An example pathway is “replace all onsite septic systems with advanced onsite systems with capability of advanced nitrogen removal”. Each subgroup along the pathway (e.g., onsite, replace all, advanced treatment, and advanced nitrogen removal) was screened against criteria. In addition, innovative management strategies were identified including source separation, groundwater remediation with permeable reactive barriers, and community redevelopment. Figure 4-2 depicts the three innovative wastewater management strategies and subgroups.

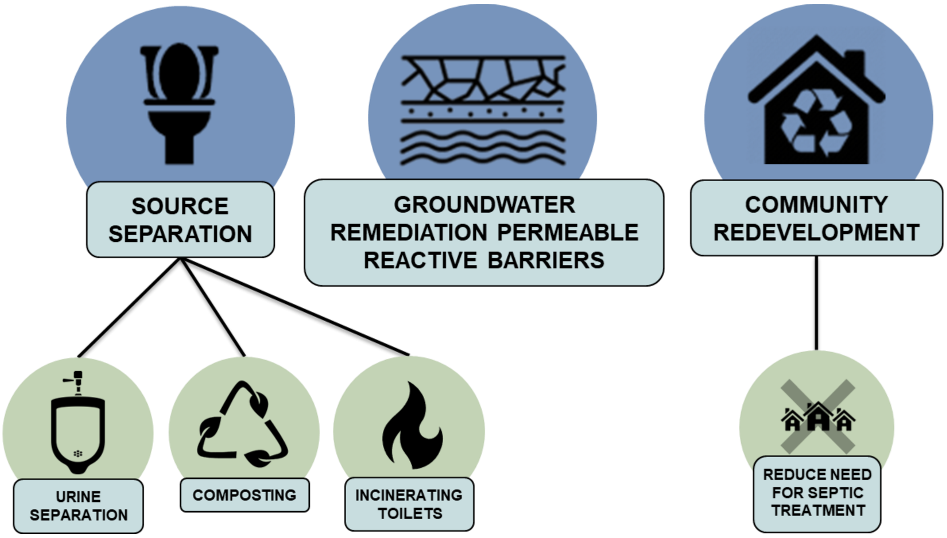


Figure 4-2: Identified Innovative Wastewater Management Strategy Alternatives

4.2.1 Wastewater Management Strategies Screening

Traditional and innovative wastewater management strategies were evaluated for applicability to the JEA IWTP program. Using data from the literature review, each strategy was screened using decision support criteria as well as input from JEA from a screening session conducted February 11, 2020.

4.2.1.1 Wastewater Management Strategies Screening Criteria

The criteria used in the screening process are depicted in Figure 4-3. Four criteria were used to judge viability for further consideration:

Proven Strategy: The first criterion considered whether the alternative was a proven strategy with: history of use, example case studies, and/or positive/successful implementation in other locations. To define “proven strategy”, data collected during the literature review were used to quantify examples (i.e., case studies) of the strategy being used either in Florida (preferred) or elsewhere in the United States. In addition to the case study data, JEA provided input on direct experience as applicable.

Physical Implementation Feasible: The second criterion considered whether the physical implementation of the alternative was feasible. This criterion considered the relative amount of land required and construction complexity.

Secondary Impacts: The third criterion considered secondary impacts which included aesthetics, odor, community disruption, and public perception for typical applications.

Environmental Benefits: The final criterion considered environmental benefits. Environmental benefits examined the effluent quality and reuse opportunities for each alternative.

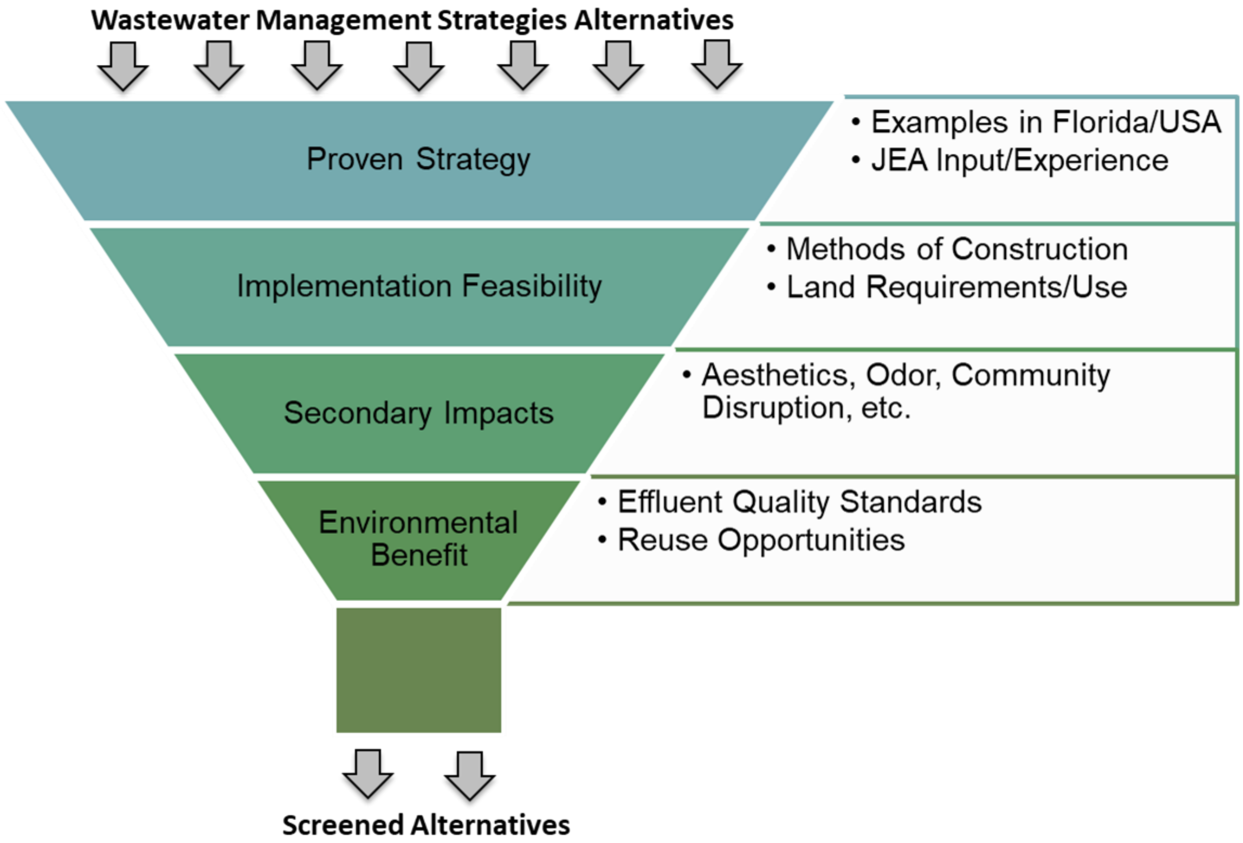


Figure 4-3: Graphical Representation of Wastewater Management Strategies Alternatives Screening Process

4.2.1.2 Traditional Wastewater Management Strategies Screening Results

The keep/eliminate screening indicated whether the strategy moved on to the next phase of the project. The screening of traditional wastewater management strategy alternatives resulted in the elimination of "conveyance to an outside utility" from further consideration for decentralized and centralized management and "without advanced nitrogen removal" for decentralized management as depicted in Table 4-1. As noted during the Task 2.2 Brainstorming Session, JEA eliminated conveyance to an outside utility as an alternative due to complexities associated with implementation. Treatment with advanced nitrogen removal was defined as effluent water quality with less than 10 mg/L total nitrogen. Decentralized treatment facilities would need to meet similar effluent quality as the centralized treatment facilities for environmental benefits; therefore, decentralized treatment without advanced nitrogen removal was eliminated. The keep/eliminate results for the screening of the traditional wastewater management strategies are summarized in Table 4-1 and eliminated alternatives are depicted in orange in Figure 4-4.

Table 4-1: Traditional Wastewater Management Strategies Keep/Eliminate Results

Management Strategy	Proven Strategy	Implementation Feasibility	Secondary Impact	Environmental Benefit
Onsite Management				
Replace All Septic Systems				
Conventional Treatment	KEEP	KEEP	KEEP	KEEP
Advanced Treatment				
With Advanced Nitrogen Removal	KEEP	KEEP	KEEP	KEEP
Without Advanced Nitrogen Removal	KEEP	KEEP	KEEP	KEEP
Replace Old and Failing Septic Systems Only				
Conventional Treatment	KEEP	KEEP	KEEP	KEEP
Advanced Treatment				
With Advanced Nitrogen Removal	KEEP	KEEP	KEEP	KEEP
Without Advanced Nitrogen Removal	KEEP	KEEP	KEEP	KEEP
Decentralized Management				
Traditional Collection	KEEP	KEEP	KEEP	KEEP
Innovative Collection	KEEP	KEEP	KEEP	KEEP
With Advanced Nitrogen Removal	KEEP	KEEP	KEEP	KEEP
Without Advanced Nitrogen Removal	KEEP	KEEP	KEEP	ELIMINATE
Centralized Management				
Traditional Collection	KEEP	KEEP	KEEP	KEEP
Innovative Collection	KEEP	KEEP	KEEP	KEEP
Conveyed to Outside Utility	N/A	ELIMINATE	N/A	N/A
Conveyed to JEA WWTF	KEEP	KEEP	KEEP	KEEP
Integrated Management	KEEP	KEEP	KEEP	KEEP

N/A = not applicable or already eliminated by at least one criterion

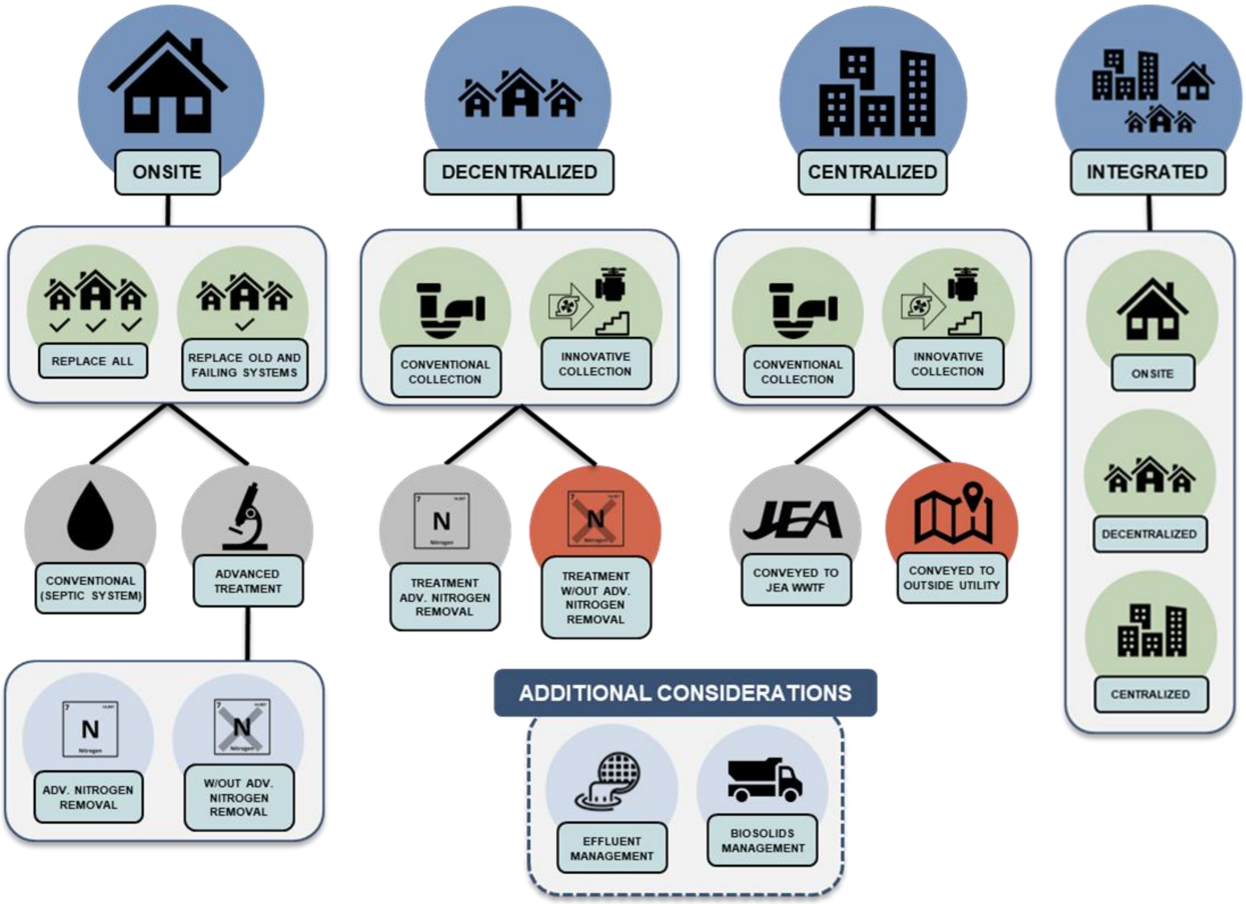


Figure 4-4: Traditional Wastewater Management Strategies Screening Results[1]
[1]Orange color indicates eliminated from further consideration

4.2.1.3 Innovative Wastewater Management Strategies Screening Results

The innovative wastewater management strategies were screened using the same criteria as the traditional wastewater management strategies. Table 4-2 and Figure 4-5 summarize the results of the keep/eliminate analysis for each alternative. The evaluation eliminated urine separation, composting toilets, incinerating toilets, groundwater remediation via permeable reactive barriers, and community redevelopment as viable options for further consideration for reasons summarized below.

- **Source Separation:** Urine separation, composting toilets, and incinerating toilets were found to be proven strategies under the source separation category. These source separation strategies have been successfully implemented at both the household and community scale; however, the significant social and infrastructure investment needed for source separation generally warrants unique drivers for its implementation (e.g., the need for alternative fertilizers; stringent nutrient restrictions in an isolated area). Incinerating toilets are further discussed in Appendix E. Urine separation would require houses and commercial buildings to be completely replumbed with collection dedicated to each targeted waste stream, i.e., yellow, brown, black, and/or grey water (Larsen 2016). The separated waste streams not only would require unique collection systems, but also independent treatment systems designed with the unique characteristics of the source separated waste stream in mind.

  - For urine source separation, the treatment objective was typically disinfection and nutrient removal due to urine being a major nutrient contributor to combined wastewater (Wilsenach, Schuurbiers et al. 2007). Under the implementation feasibility criterion, urine separation was considered "eliminated" because of the cumbersome effort to implement the strategy (e.g., re-plumbing, separate collection systems, and additional specialized treatment) and therefore was not investigated further as a viable alternative.

  - Incinerating toilets were considered a proven strategy. They were found to be minimally invasive to install and require no water to operate. However, incinerating toilets have a high electrical demand, require the installation of new toilets, require a liner with every use, and common replacement parts are the heating coil and blower fan resulting in high life cycle costs. In addition, public acceptance may be difficult with additional electricity costs, potential odor (waste and vented smoke), learning curves to use bowl liners, blower noise and aesthetics. Therefore, due to the negative secondary impacts for incinerating toilets, they were considered "eliminated" and were not investigated further as a viable solution.

  - Composting toilets (i.e., eco-toilets) were considered a proven strategy. They were found to be minimally invasive to install and require little (if any) water to operate. However, composting toilets required a medium (i.e., bulking media) for waste to be deposited in for the composting process to occur (Hijikata, Yamauchi et al. 2015). A survey in Cape Cod, Massachusetts found that less than 50% of homeowners were "completely willing" to use eco-toilets and less than 30% of homeowners were "completely willing" to install eco-toilets in their own home (Wood, Blackhurst et al. 2017). In addition to low public acceptance, composting toilets would require the user to change composting media as part of the maintenance of the toilet. Therefore, due to the negative secondary impacts for composting toilets, they were considered "eliminated" and were not investigated further as a viable solution.

- **Permeable Reactive Barriers:** Groundwater remediation via permeable reactive barriers have been successfully implemented across the US, primarily at industrial sites (Interstate Technology & Regulatory Council 2005). However, they have limited large-scale (i.e., multiple parcel or city-scale) use within Florida and the US. One of the primary goals of the STPO program was to eliminate existing septic systems. Implementation of permeable reactive barriers would intercept the wastewater plume from aging or failing septic systems but not fulfill the goal of eliminating the existing systems; thus, it was considered an eliminated solution as a long-term alternative, but it is possible JEA could elect to implement as a phased approach.

- **Community Redevelopment**: A change in land use to reduce the need for septic systems would be difficult to implement and was therefore eliminated from future considerations. The land use change would include conversion of residential and commercial parcels to other uses such as green space (i.e., recreational parks, wetlands, etc.). This would present a major disruption for the residents; thus, it was not investigated further.

Table 4-2: Innovative Wastewater Management Strategies Keep/Eliminate Results

Management Strategy	Proven Strategy	Implementation Feasibility	Secondary Impact	Environmental Benefit
Source Separation				
Urine Separation	KEEP	ELIMINATE	ELIMINATE	N/A
Composting Toilets	KEEP	KEEP	ELIMINATE	N/A
Incinerating Toilets	KEEP	KEEP	ELIMINATE	N/A
Groundwater Remediation Permeable Reactive Barriers	ELIMINATE	ELIMINATE	N/A	N/A
Community Redevelopment				
Reduce Need for Septic Treatment	N/A	ELIMINATE	ELIMINATE	N/A

N/A = not applicable or already eliminated by at least one criterion

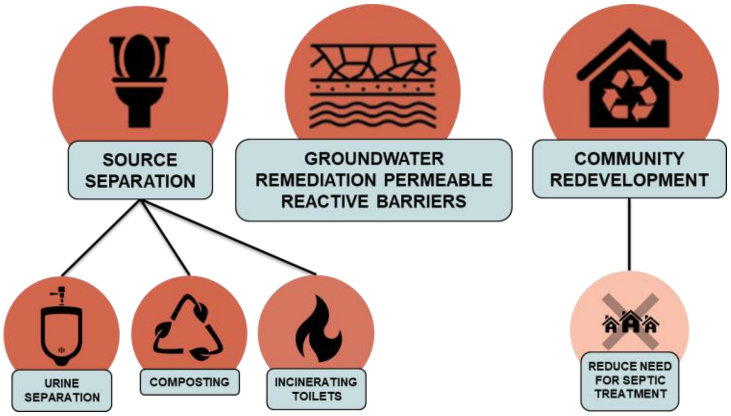


Figure 4-5: Innovative Wastewater Management Strategies Screening Results[1]
[1]Orange color indicates eliminated from further consideration

4.2.1.4 Effluent Management Strategies

Once wastewater is collected and treated, it must be delivered to an ultimate endpoint. If wastewater is diverted to an existing centralized system, the existing effluent management strategy for the given system will be leveraged. For onsite and decentralized technology alternatives, the effluent management options under consideration included land application and other non-potable reclaimed water alternatives, subsurface applications, potable reuse, and surface water discharge (Figure 4-6). These options were not subjected to the screening process described above because the favorability of each option will be dependent on the selected wastewater treatment option and site-specific conditions for each STPO priority project area. For example, the extent to which any effluent management strategy would be practiced depends on effluent availability and quality, local soil types, the proximity and classification of nearby surface waters, land availability, and potential reclaimed water customers.

However, the effluent management strategy “discharge to surface water” was eliminated from further consideration across all STPOs, as indicated by the orange coloration in Figure 4-6. The discharge to surface water option represented a discharge permitted by the National Pollutant Discharge Elimination System (NPDES) program to the St. Johns River because it is the major surface water body in the JEA service area. Surface water discharge of treated effluent was not anticipated to be a feasible effluent management option in the future because of the proposed Florida Senate Bill 1656 which would prohibit domestic wastewater treatment facilities from disposing of effluent, reclaimed water, or reuse water by surface water discharge throughout the State. Also, JEA and FDEP have historically demonstrated commitment to the minimization of nutrient discharges to the St. Johns River; thus, discharge to surface water was eliminated as a viable effluent management strategy. Beyond discharge to surface water, the overall advantages and disadvantages of the remaining effluent management strategies are presented in Table 4-3.

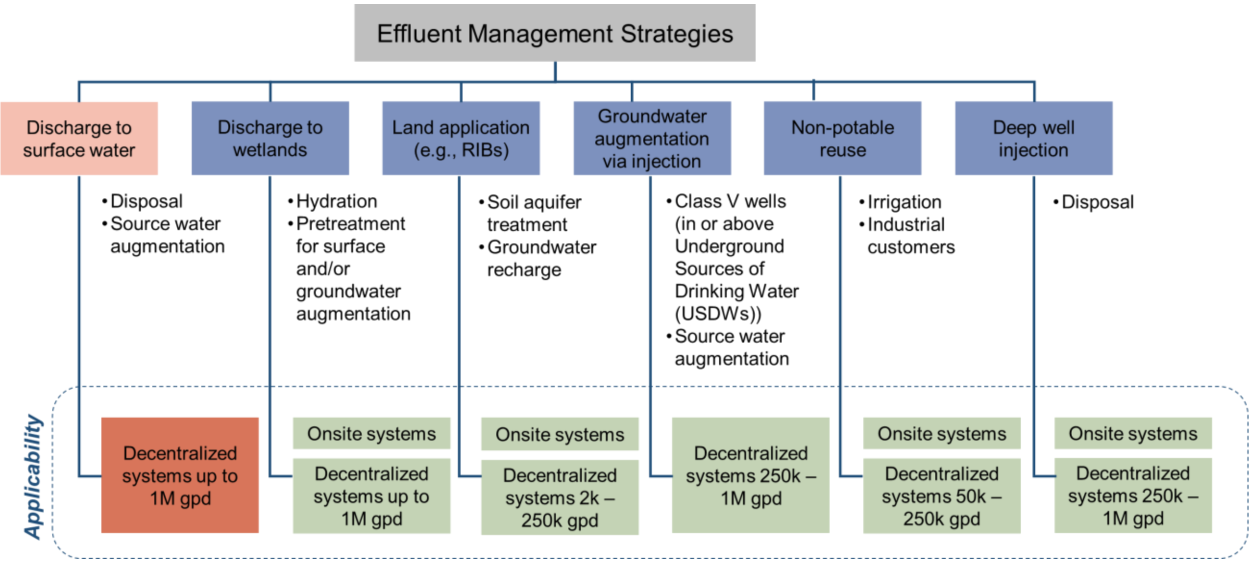


Figure 4-6: Effluent Management Strategies Screening Results[1]

[1] Orange color indicates eliminated from further consideration; flows > 1 MGD are assumed to be diverted to an existing centralized treatment system, thus benefitting from the associated existing effluent management strategy

Table 4-3: Advantages and Disadvantages to Potential Effluent Management Strategies

Effluent Management Strategy	Advantages	Disadvantages
Discharge to Wetlands	• Biological oxygen demand, total suspended solids, metals, nutrients, and trace organic compound removal capabilities • Low energy footprint • No chemical usage • Year-round operation is feasible in Florida climate • Contribute to green space within a community • No waste production	• Target treatment rates require substantial land area • The rate of organic material and nutrient removal is sensitive to changes in temperature • Organic material and nutrients are bound in wetland sediments and accumulate over time • Mosquitoes and other insect vectors may be a problem with standing waters • Beavers and other natural events can impact flora and fauna through hydrologic modifications and herbivory within an existing wetland and impact downstream water quality conditions
Land Application	• Some flexibility in treatment and effluent water quality requirements because they depend on the specific application (i.e., potential for human contact) • Low energy footprint • Provides a means for potential groundwater recharge • Many applications are classified by FDEP as water reclamation rather than disposal	• Requires long-term commitment of a significant land area • May require periodic maintenance to remove accumulated deposits, organic matter, etc. that impact infiltration • Potential for public opposition depending on the land application methodology / location
Groundwater Augmentation via Injection	• Increases groundwater availability for water supply • May benefit land subsidence and/or saltwater intrusion in some areas • Reduces contaminant loads to surface waters • Independent of current water demands, development patterns, industry changes, etc. • Minimizes distribution infrastructure requirements	• Typically necessitates stringent treatment and effluent water quality requirements • Potential for public opposition
Non-Potable Reclaimed Water	• Beneficial reclaimed water use of effluent enables potable water offsets • Potential agreement between effluent quality and reclaimed water applications (e.g., nutrients for irrigation) • Long history of implementation in Florida	• Dependent on reclaimed water demands that may be uncertain (e.g., seasonal variability, technological changes that impact water needs, uncertain development, etc.) • Potential disagreement between effluent quality and reclaimed water applications (e.g., nutrients, organic carbon in industrial applications) • Infrastructure required to reach customers may be prohibitive
Deep Well Injection	• Relatively more cost-effective treatment and effluent water quality requirements	• Effluent is disposed of and no longer available to be used as reclaimed water (Class I wells beneath the lower most USDW)

4.2.1.5 Biosolids Management Strategies

JEA advised that biosolids from its WWTFs, except Blacks Ford and Mandarin, are planned to be processed at the Buckman Residuals Management Facility (RMF) for the foreseeable future. Therefore, the Buckman RMF, centrally located within JEA's service area, would remain the primary location for biosolids processing for future wastewater management strategies. JEA indicated the Buckman RMF should be the means for biosolids management for all additional biosolids generated through strategies in the IWTP Master Plan, and additional identified biosolids management strategy alternatives were not evaluated.

4.3 Institutional Frameworks Evaluation

Institutional frameworks were defined as methods used to build, operate, maintain, and finance the various strategies and included public, private and hybrid solutions. The results of the Task 2 literature review led to development of a scheme for examining institutional frameworks summarized in Figure 4-7.

Within the owner/operator framework scheme, the alternatives included individual, community, JEA (i.e., utility-ownership), public-private partnerships (P3s), and City of Jacksonville/Duval County. Closely linked with the owner/operator frameworks, the project delivery alternatives included design-bid-build, construction manager at-risk, design-build, and design-build-finance-operate-maintain.

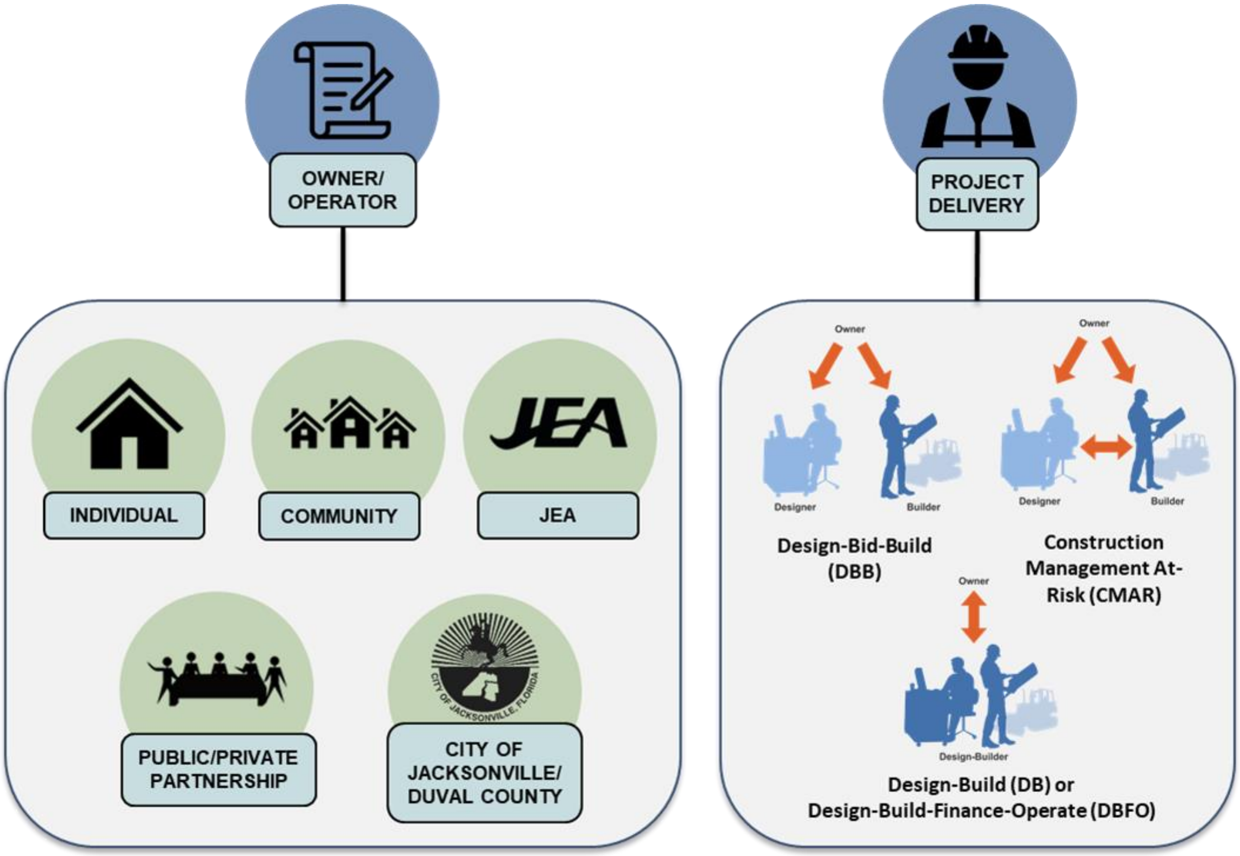


Figure 4-7: Identified Ownership and Project Delivery Framework Alternatives

Identified possible funding sources are summarized in Figure 4-8 and included the St. Johns River Water Management District (SJRWMD), Florida Department of Environmental Protection (FDEP), US Environmental Protection Agency (USEPA), US Department of Agriculture (USDA), US Department of Housing and Urban Development (HUD), and Private Banks (e.g., Raymond James). In addition to the grants and loans potentially provided by these agencies, JEA could finance through tariffs and/or assessments. Also, JEA may wish to explore funding options in concert with the City of Jacksonville.

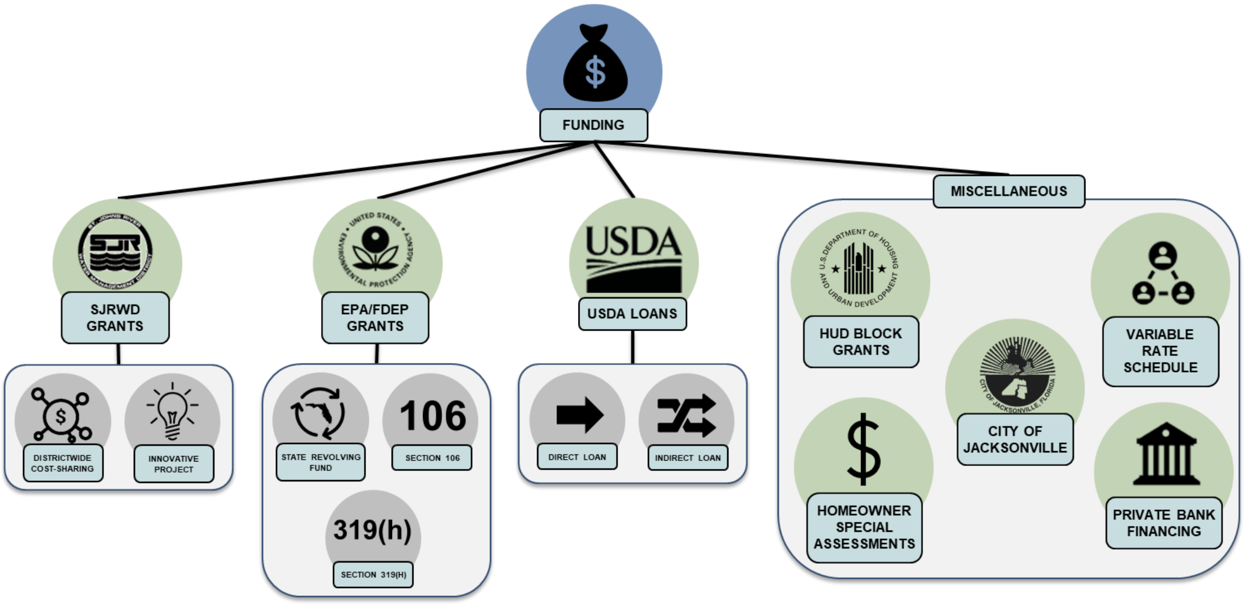


Figure 4-8: Identified Funding Alternatives

4.3.1 Institutional Frameworks Screening

A similar keep/eliminate analysis was used to evaluate identified institutional frameworks and funding mechanism alternatives. The criteria for institutional frameworks differed from the wastewater management strategies because it focused on applicability and whether programmatic goals were met.

4.3.1.1 Institutional Frameworks Screening Criteria

The criteria developed for the ownership structures, project delivery methods, and funding opportunities included two criteria:

- **Feasibility**: The first criterion considered whether the alternative was feasible to the Jacksonville, FL area and/or JEA.
- **Met Programmatic Goals:** The second criterion considered whether the alternative met JEA’s programmatic goals. The establishment of keep/eliminate for this criterion was influenced by feedback from the JEA IWTP project team.

4.3.1.2 Institutional Frameworks Screening Results

JEA expressed the desire to own all improved collection and treatment systems; therefore individual, community, City of Jacksonville and Duval County ownership options were eliminated from further consideration based on not meeting programmatic goals. All identified project delivery methods were defined as feasible and met the programmatic goals. The results of the keep/eliminate analysis are shown in Table 4-4 and in Figure 4-9. Identified risk and rewards of the remaining owner/operator frameworks and project delivery frameworks are presented in Table 4-5 and Table 4-6, respectively.

Table 4-4: Ownership Structure and Project Delivery Keep/Eliminate Results

Ownership Structure or Project Delivery	Feasibility	Met Programmatic Goals
Owner/Operator Frameworks		
Individual Owner	KEEP	ELIMINATE
Community Ownership	KEEP	ELIMINATE
JEA Ownership	KEEP	KEEP
Public Private Partnership	KEEP	KEEP
City of Jacksonville and/or Duval County	KEEP	ELIMINATE
Project Delivery Frameworks		
Design-Bid-Build	KEEP	KEEP
Construction Management At-Risk	KEEP	KEEP
Design-Build	KEEP	KEEP
Design-Build-Finance	KEEP	KEEP
Design-Build-Finance-Operate	KEEP	KEEP
Design-Build-Finance-Operate-Maintain	KEEP	KEEP

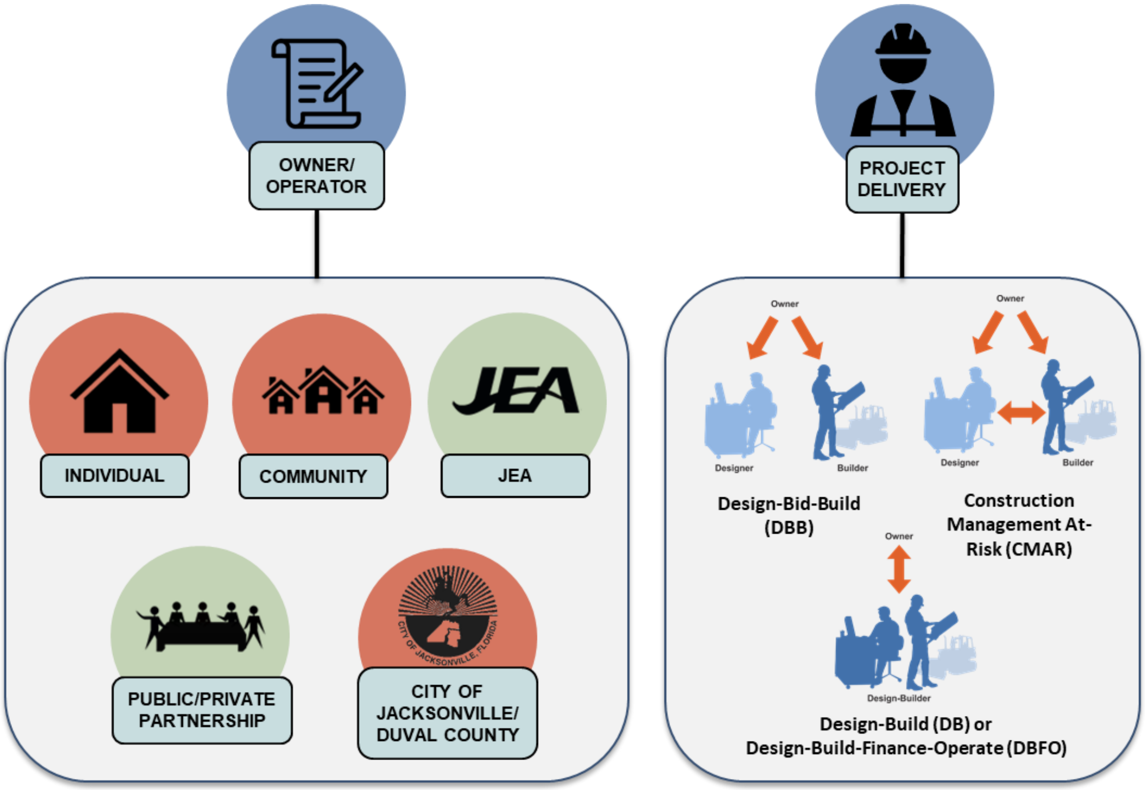


Figure 4-9: Ownership and Project Delivery Frameworks Screening Results[1]

[1] Orange color indicates eliminated from further consideration

Table 4-5: Advantages and Disadvantages to Potential Ownership Frameworks

Ownership Structure	Advantages	Disadvantages
JEA Ownership	• JEA has full control over the design and implementation of the new systems • JEA owns the infrastructure providing asset growth for the utility • JEA self manages the systems to improve longevity of projects	• As the sole owner of the treatment system(s), JEA will take on all risk • Additional staff may need to be hired to manage the new system(s) • Staff training may be needed for new treatment technologies implemented • All funding for projects must be organized and secured by JEA • Traditional project delivery methods are typically slower than P3 deliveries
Public/Private Partnership (P3)	• Third party can facilitate or completely manage funding for the project • Third party can manage staffing for operation and maintenance of the system • Through private funding, the third party may save time and money on project delivery	• Responsibilities/risk between the private entity and JEA will vary, but JEA will maintain the responsibility for the overall treatment systems and meeting its goals • Communication between the third party and JEA will define the project's success • JEA has less control over how the third party manages the project • Some third-party financial decisions may have negative impacts to project's longevity

Table 4-6: Advantages and Disadvantages of Potential Project Delivery Frameworks

Project Delivery Method	Advantages	Disadvantages
Design-Bid-Build (DBB)	• JEA selects designer and controls the design process through 100% completion • JEA has more input on equipment/system inputs (retains more control) • Delivery model is well understood between participants (i.e., owner, designer, and builder)	• Compared to other project delivery methods, DBB can have longer overall project schedule (because design and construction do not overlap) • No incentive for designer and contractor to collaborate • Limited equipment selection because project awarded based on lowest bid • Final cost not known until the end of the project
Construction Management At-Risk (CMAR)	• JEA selects designer • Integrates constructability early in the design phase • Collaboration between designer and contractor can reduce unanticipated costs and design errors once construction begins • Potential for fewer change orders • Reduces design versus construction misunderstandings • Reduces project timeline • Allows experience to determine a contractor’s selection and not just the price (qualification driven selection)	• Additional pre-construction contractual costs with the CM • Contractor selected without knowing full extent of project costs • JEA oversees both designer and contractor, sometimes at the same time
Design-Build (DB) and Design-Build-Finance-Operate (DBFO)	• Potentially quickest project turnaround (compared to DBB and CMAR) • Allows for innovation by design-builder • For lump sum DB, project costs (design and construction) are known prior to design • JEA manages a single entity (design-builder) creating more streamlined communication • Performance guarantees can be included within the contract prior to design • Progressive DB has more collaboration between JEA and the design-builder as compared to lump sum DB	• Compared to DBB and CMAR, JEA has less control over the designer with lump sum DB or DBFO • In lump sum DB, JEA has less control during the design • During lump sum DB, limited collaborations between JEA and the design-builder • In lump sum DB, JEA has limited participation in the selection process for subconsultant or subcontractors • Greater level of unknowns (e.g., newer delivery methods and innovative technologies have been tested less) • During DBFO, funding is defined by the third party and is not the responsibility of JEA

Funding opportunities were also screened using similar criteria. Table 4-7 and Figure 4-10 summarize the results of the keep/eliminate analysis for funding mechanisms. JEA indicated that loans are not preferred; therefore, the State Revolving Fund, Direct and Indirect USDA Loans, and Private Bank Loans were eliminated from further consideration.

Table 4-7: Funding Opportunities Keep/Eliminate Results

Funding Source/Program	**Feasibility**	**Meets Programmatic Goals**
SJRWMD Districtwide Cost-Sharing	KEEP	KEEP
SJRWMD Innovative Project	KEEP	KEEP
State Revolving Fund (Loan)	KEEP	ELIMINATE
Section 106 Grant	KEEP	KEEP
Section 319(h) Grant	KEEP	KEEP
Direct USDA Loan	KEEP	ELIMINATE
Indirect USDA Loan	KEEP	ELIMINATE
HUD Block Grant	KEEP	KEEP
Variable Rate Schedule	KEEP	KEEP
Homeowner Special Assessments	KEEP	KEEP
City of Jacksonville	KEEP	KEEP
Private Bank Financing (i.e., Private Loan)	KEEP	ELIMINATE

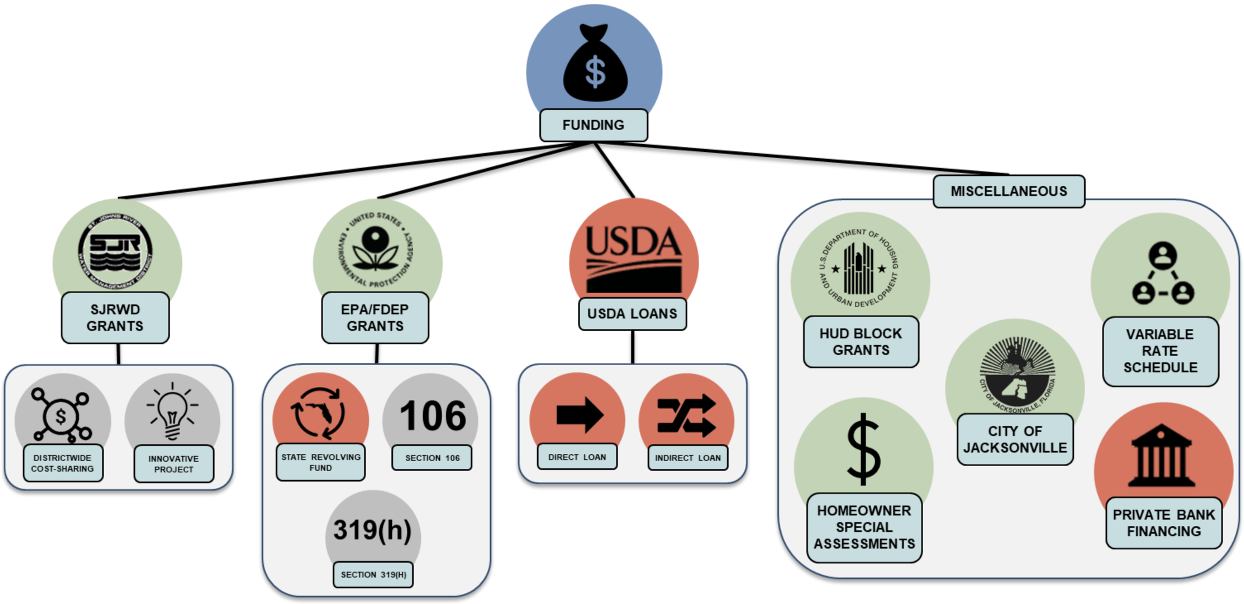


Figure 4-10: Funding Alternatives Screening Results[1]

[1] Orange color indicates eliminated from further consideration

4.4 Wastewater Management Strategies and Institutional Frameworks Evaluation Summary

Using the keep/eliminate criteria analysis, traditional and innovative wastewater management strategies were screened. The remaining alternatives considered in Task 7 are shown in Figure 4-11.

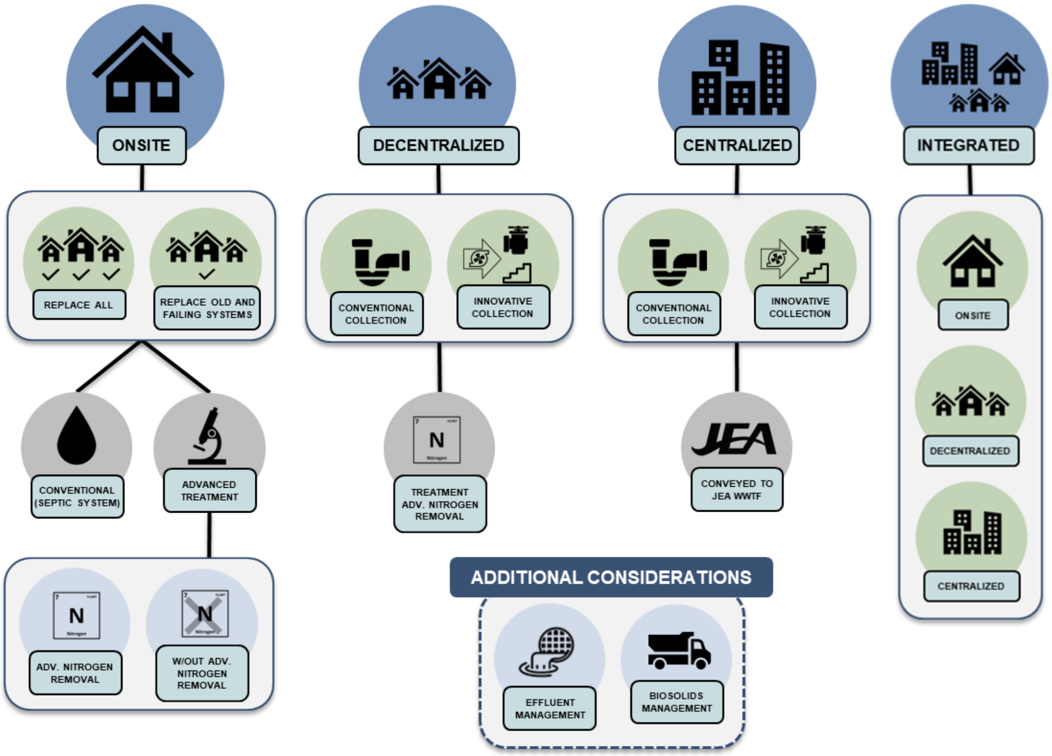


Figure 4-11: Traditional and Innovative Wastewater Management Strategies for Further Consideration

Using the keep/eliminate criteria analysis, institutional frameworks (i.e., owner/operator and project delivery) and funding mechanisms were screened. The remaining alternatives considered in Task 7 are shown in Figure 4-12 and Figure 4-13.

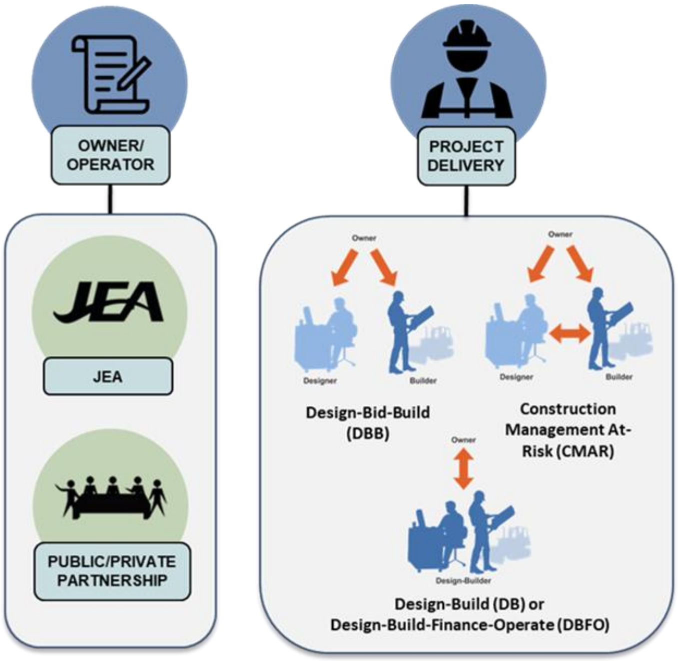


Figure 4-12: Ownership and Project Delivery Frameworks for Further Consideration

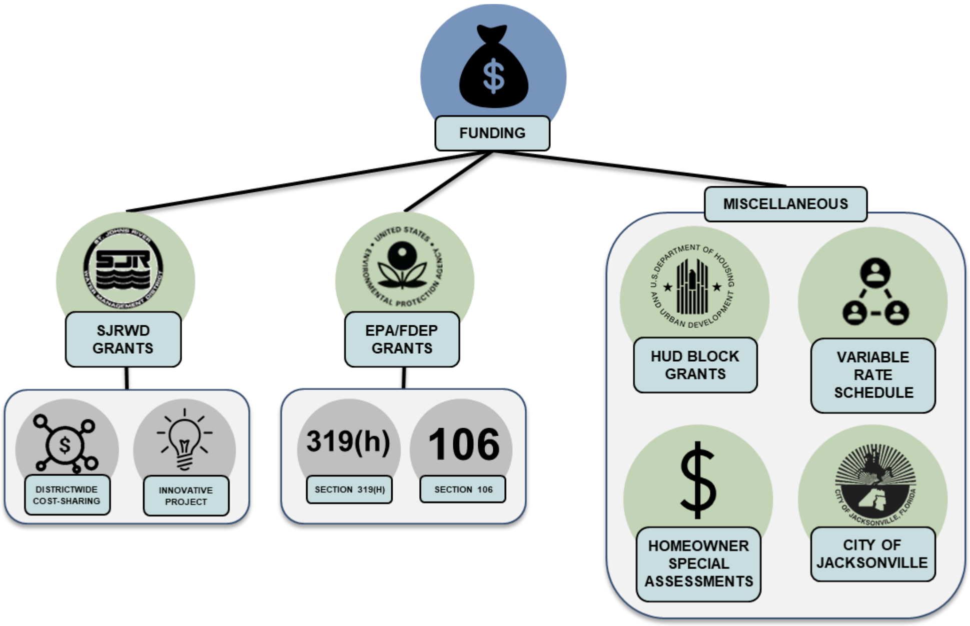


Figure 4-13: Funding Alternatives for Further Consideration

5. Characterization of STPO Priority Areas (Task 6)

The purpose of this section is to document the characterization of the remaining 32 STPO priority areas (see Appendix F) within the JEA Innovative Wastewater Treatment Program. Such characterization was used in the detailed analysis of screening wastewater capital improvements in Task 7 (Figure 5-1).

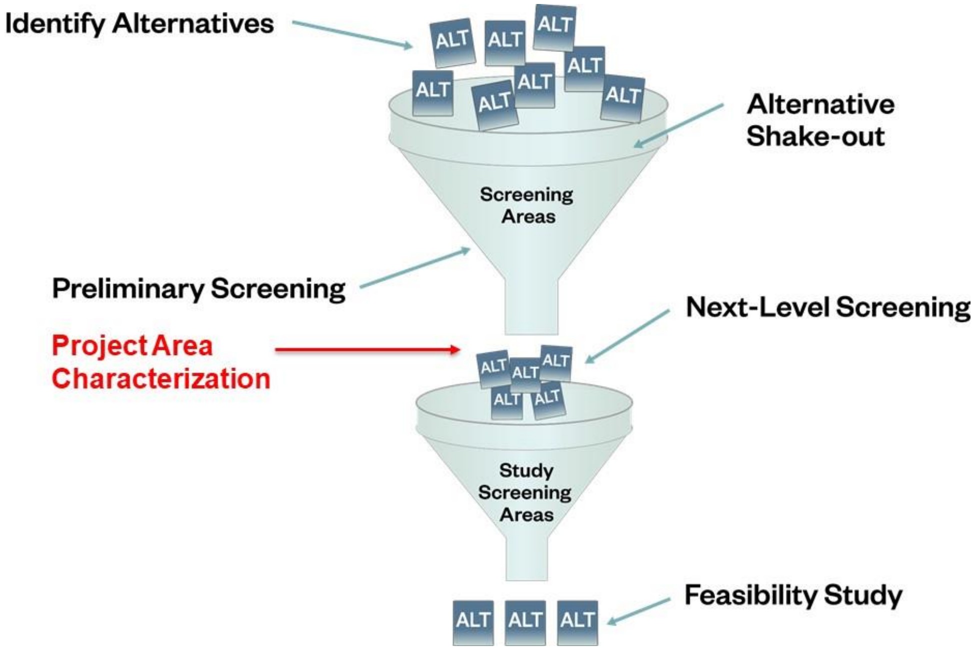


Figure 5-1: Overview of Screening Process Using Decision Making Criteria

The available data utilized in the characterization included:

- Geographic Information System (GIS) data for existing wastewater and water customers, wastewater collection system gravity and pressure mains, lift stations, wastewater treatment facility (WWTF) service areas and available capacity;
- Historical customer-level water consumption data;
- Future and existing land use;
- Topographic data;
- Groundwater data;
- Sea level rise data;
- Surface water quality;
- Soil surveys;

- Federally listed critical species/habitats;
- Site visit observations.

Additional details on data collection and processing are provided in Appendix G, and the site visit observations are summarized in Appendix H.

The remaining 32 STPO priority areas were grouped according to existing JEA wastewater treatment facilities (WWTF) service areas depicted in Figure 5-2. JEA considered grouping by the maintenance and operations assigned responsibility District areas but ultimately elected to categorize by WWTF service area. The STPO priority areas were located within six WWTF service areas: Arlington East, Buckman, Cedar Bay (District 2), Mandarin, Monterey, and Southwest. Currently no STPO project areas are within the Blacks Ford, Julington Creek Plantation (JCP), Ponte Vedra, Ponce de Leon, and Nassau Regional service areas.

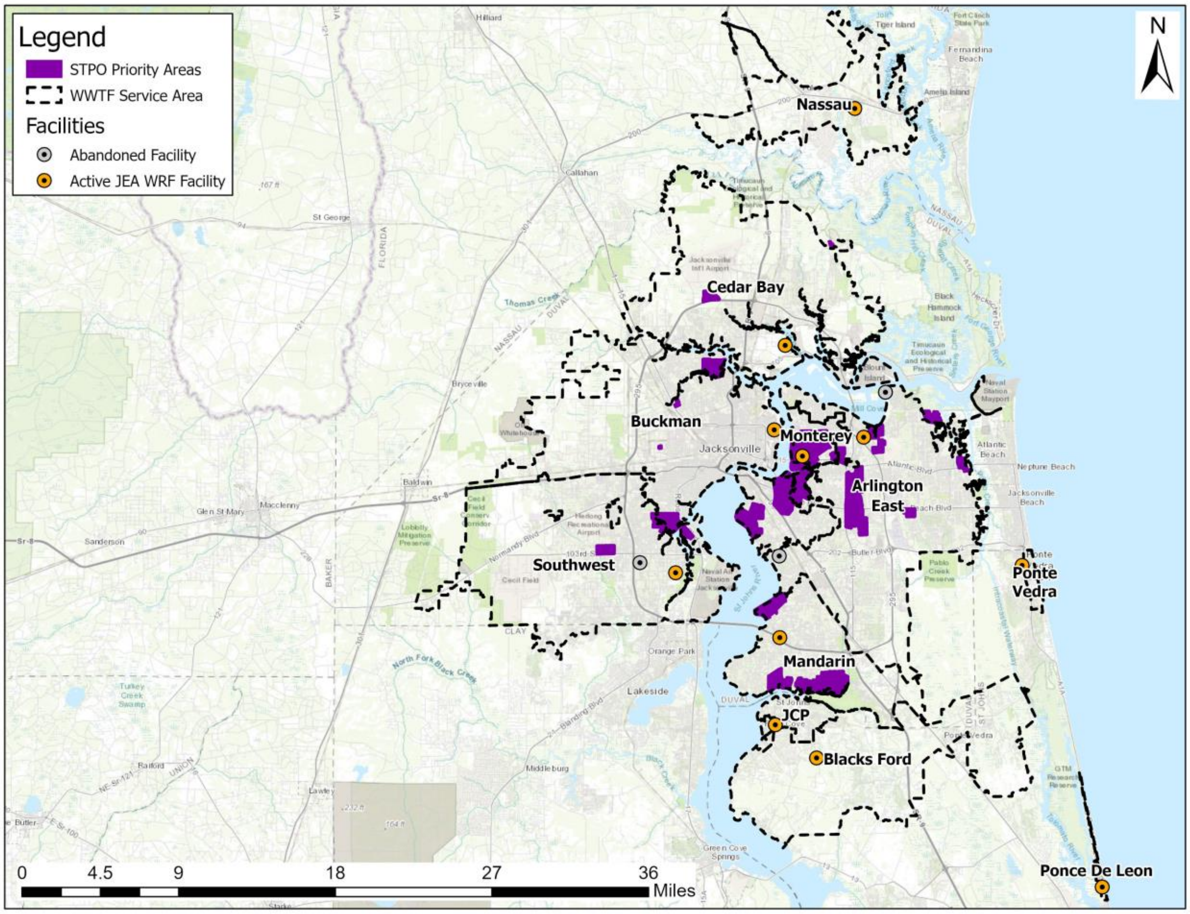


Figure 5-2: Overview of STPO Priority Areas

5.1 Characterization Attributes

The STPO priority area characterization included an analysis of existing customers, septic system density, land use, existing utilities, topography, and environmental factors (including sea level rise). Public receptivity was not evaluated and will be addressed internally by JEA (in accordance with April 21, 2020 progress meeting direction).

5.1.1 Identification of Septic Parcels

The first step for the STPO priority areas characterization was to determine which septic parcels to include in the evaluation (see Appendix G.2.1 for the process used). Through this evaluation, it was determined that the remaining 32 STPO priority areas included approximately 23,000 septic system parcels (Table 5-1) which were a mixture of residential and commercial, institutional, and industrial (CII) development. For the residential parcels, the number of equivalent dwelling units (EDUs) and average parcel acreage was determined. Generally, the STPO priority areas were primarily residential and fully developed with only a few undeveloped lots remaining. Table 5-1 summarizes certain metrics for the 32 remaining STPO priority areas considered. The individual STPO priority area metrics are discussed in the following Sections.

Table 5-1: General Overall Characterization of STPO Priority Areas

Description	Units	Minimum	Maximum	Average	Total
Total Parcels (#)	#	35	4,802	896	28,669
Septic Parcels (#)	#	34	3,714	719	22,998
Proportion Septic Parcels	%	49	100	83	
Proportion Residential Parcels	%	80	100	95	
Equivalent Dwelling Units	#	32	4,239	693	22,165
Avg Res. Parcel Acreage	acres	0.19	1.82	0.43	
Vacant Acreage	acres	0	157	27	864
Vacant Government Owned Acreage	acres	0	28	4	133

5.1.2 Wastewater Flow Generation Projections

The existing and future land use designations of the septic parcels were considered to enable estimation of wastewater flow rates for each STPO priority area (see Appendix G.2.5 for methodology). For planning purposes, wastewater flow projections can be developed using metered data, inferred and modeled measurements. Two methods were used to estimate the residential STPO priority area flow:

1. Wastewater flow projections were estimated using average historical water consumption meter data for the last seven years which indicated the average single family home consumed approximately 187 gallons per day (gpd), however:
    a. outdoor water usage was included
    b. groundwater infiltration and rainfall derived infiltration and inflow to sewers were excluded
2. Wastewater flow projections were estimated using JEA water and wastewater system planning (WWSP) design guidelines, which assumed wastewater flows for one equivalent residential connection (ERC) to be 280 gpd.

For both methodologies described above, septic parcels with commercial, industrial, and institutional land use designations used water meter data to estimate annual average daily flow (AADF). If available, the average water meter data for the CII parcel was used. If the CII parcel water meter data was not available, the average water meter data for parcels with a similar use description within the JEA service area was used as outlined in Appendix G, Table G-3. The combined residential and CII wastewater flow projections for the STPO priority areas are summarized in Table 5-2.

Table 5-2: Wastewater Flow Generation Projections for STPO Priority Areas

Description	Units	Minimum	Maximum	Average	Total
Water Meter AADF	gpd	6,650	790,300	164,900	5,275,600
Planning AADF	gpd	9,650	1,133,200	230,000	7,357,700

Figure 5-3 presents the JEA WWTF service areas which included the 32 remaining STPO priority areas. The JEA Annual Water Resource Master Plan (2019), included wastewater flow projections for the WWTF services areas through the year 2040 (Table 5-3). However, JEA noted that recent changes to planned improvements at the wastewater treatment facilities altered the year 2040 projections. Revised year 2040 wastewater flow projections were provided August 10, 2020. Based on these projections and the referenced improvements, the Arlington East, Monterey and Southwest WWTFs may not have available capacity to accommodate the estimated additional STPO priority areas flow. However, JEA noted that there is time to make appropriate changes at JEA's WWTFs to accommodate additional flow if needed.

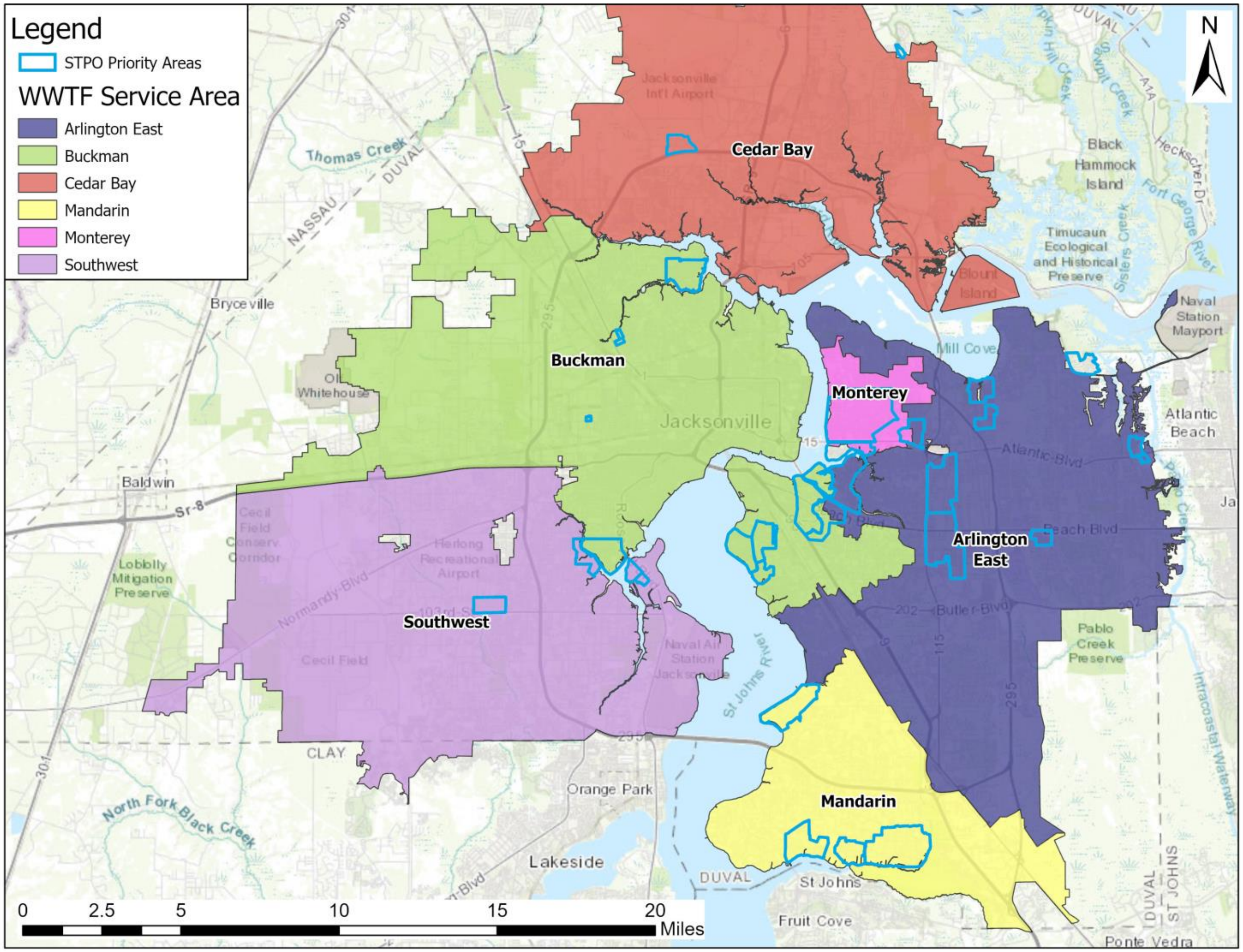


Figure 5-3: Impacted JEA WWTF Service Areas

Table 5-3: WWTF Available Capacity and Estimated Additional STPO Priority Areas Flow

JEA Annual Water Resources Master Plan[1]					Estimated Additional AADF Flow from STPO Priority Areas[3], MGD	Received 8/10/2020		Including Additional STPO Flow, Projected Available Capacity in 2040, MGD (%)
JEA WWTF Service Area	**AADF as of May 2018, MGD**	**AADF Projections for 2040[1], MGD**	**Permitted Capacity, MGD**	**Projected Available Capacity in 2040, MGD (%)**		**Revised AADF Projections for 2040[2], MGD**	**Projected Available Capacity in 2040, MGD (%)**	
A	B	C	D	E= D-C	F	G	H= D-G	I= D-(F+G)
Arlington East	22.40	20.97	25.00	4.03 (16%)	1.94	*24.14*	*0.86* *(3%)*	-1.08 (- 4%)
Buckman	28.33	39.47	52.50	13.03 (25%)	1.81	*30.17*	*22.33* *(43%)*	20.52 (39%)
Cedar Bay (District 2)	5.66	8.67	10.00	1.33 (13%)	0.09	*8.10*	*1.9* *(19%)*	1.81 (18%)
Mandarin	8.03	7.49	8.75	1.26 (14%)	1.24	*6.59*	*2.16* *(25%)*	0.92 (10%)
Monterey	1.32	1.84	3.60	1.76 (49%)	1.30	*2.13*	*1.47* *(41%)*	0.17 (5%)
Southwest	11.95	14.16	14.00 [18.00[2]]	[18.00[2]] 3.84 (21%)	0.97	*14.27*	*[16.00[2]]* *1.73* *(11%)*	0.76 (5%)
Total					**7.36**			

[1] Source: JEA Annual Water Resource Master Plan, September 2019

[2] Design was planned for expanding the Southwest WWTF treatment capacity to 18 MGD from 14 MGD but was revised to 16 MGD.

[3] Planning level wastewater flow projection estimate of 280 gpd per ERC which was compared to water meter data.

5.1.3 Other Existing Infrastructure

Relative restoration costs (low, medium, high) were established by considering the road type and width; existing curbs, gutters and/or sidewalks; right-of-way (ROW) width; existing large trees; and stormwater infrastructure using a combination of GIS data, aerials, and site visit observations (Appendix H). The type of existing electric service infrastructure and placement within the ROW was also noted. In addition, a metric for relative sewer cost was calculated as the total frontage road length within the STPO priority areas (correlated to length of new sewer pipe) divided by the number of residential parcels (included single family, multi-family, mobile homes, condominiums, and vacant residential). In addition, since STPO projects have historically included water service for unserved parcels, the proportion of existing water customers was determined (Table 5-4).

Table 5-4: Other Existing Infrastructure in STPO Priority Areas

Description	Minimum	Maximum	Average	Total
Proportion Water Customers (% of Septic Parcels)	0	100	79	
Road Length (ft)	1,625	249,600	49,800	1,594,100
Rd Length, ft ÷ # Res Parcels (ft/parcel)	49	115	75	

5.1.4 Environmental Factors

In addition to the previously discussed metrics, environmental factors were included. Environmental factor metrics included: United States Department of Agriculture (USDA) Natural Resources Conversation Service (NRCS) soil rating for use of septic tank absorption fields, depth to groundwater, topography, proximity to applicable total maximum daily load (TMDL) impaired waters, the Florida Aquifer Vulnerability Assessment (FAVA) vulnerability rating for the surficial aquifer system, and susceptibility to flooding and climate change which is discussed in Section 5.11.

5.1.4.1 USDA NRCS Soil Rating and Depth to Groundwater

USDA NRCS soil surveys include a septic tank absorption field rating. Soil between the depths of 24 and 60 inches were evaluated to determine the rating. The ratings were based on the soil properties that affect absorption of the effluent, construction and maintenance of the systems, and public health. “Not limited” indicated that the soil had features that were very favorable for the specified use. Good performance and very low maintenance can be expected. “Somewhat limited” indicated that the soil had features that were moderately favorable for the specified use. “Very limited” indicated that the soil had one or more features that were unfavorable for the specified use. In addition, the USDA NRCS soil surveys included a depth to seasonal high water table which was noted.

5.1.4.2 Topography

The Florida Department of Emergency Management 2 ft topographic contour maps were used to determine the approximate change in elevation across the STPO priority area extents. The topographic change in elevation within the STPO boundary was classified as: flat (if < 10 ft), low variability (if ranged from 10 to 15 ft), moderate variability (if ranged from 15 to 25 ft), or high variability (if > 25 ft).

5.1.4.3 FDEP TMDLs

The Florida Department of Environmental Protection (FDEP) Water Quality Restoration Program, developed and adopted a scientifically derived restoration target, known as a Total Maximum Daily Load (TMDL) for each impaired waterbody or group of related waters. The Basin Management Action Plan for the Lower St. Johns River Basin and its tributaries included load reductions to achieve nutrient and fecal coliform TMDLs. FDEP had established water body identification numbers (WBIDs) that were listed as impaired. Table 5-5 summarizes the number of septic parcels within the 32 remaining STPO priority areas which were within WBID TMDL boundaries for fecal coliform and/or nutrients.

Table 5-5: STPO Priority Area Parcels within WBID TMDL Boundaries

Description	Total
Fecal Coliform TMDL (# of Septic Parcels)	7,745
Nutrient TMDL (# of Septic Parcels)	3,763

5.1.4.4 FDEP FAVA Rating

The geologic and hydrogeologic conditions of Duval County have been described in numerous publications over the past century. Initially, the US Geological Survey (USGS) defined the geologic conditions based on various classification schemes for sedimentary rocks. With recent emphasis on groundwater resources, research throughout the 1990s by the Florida Geological Survey (FGS), Water Management Districts, and the USGS shifted toward re-defining the geology of an area into hydrostratigraphic units. In general, the hydrogeology of Duval County was represented by two regional aquifer systems; the Surficial Aquifer System (SAS) and the Floridan Aquifer System (FAS). In 2019, FDEP prepared the most recent update to the Florida Aquifer Vulnerability Assessment (FAVA) which predicted the intrinsic relative vulnerability (vulnerable, more vulnerable, or most vulnerable) of Florida’s aquifer systems to contamination from land surface. The existing septic systems discharge treated effluent to the SAS. Approximately 69% of the STPO priority area septic parcels were located where the SAS was classified as being the most vulnerable (Figure 5-4) according to the FAVA study.

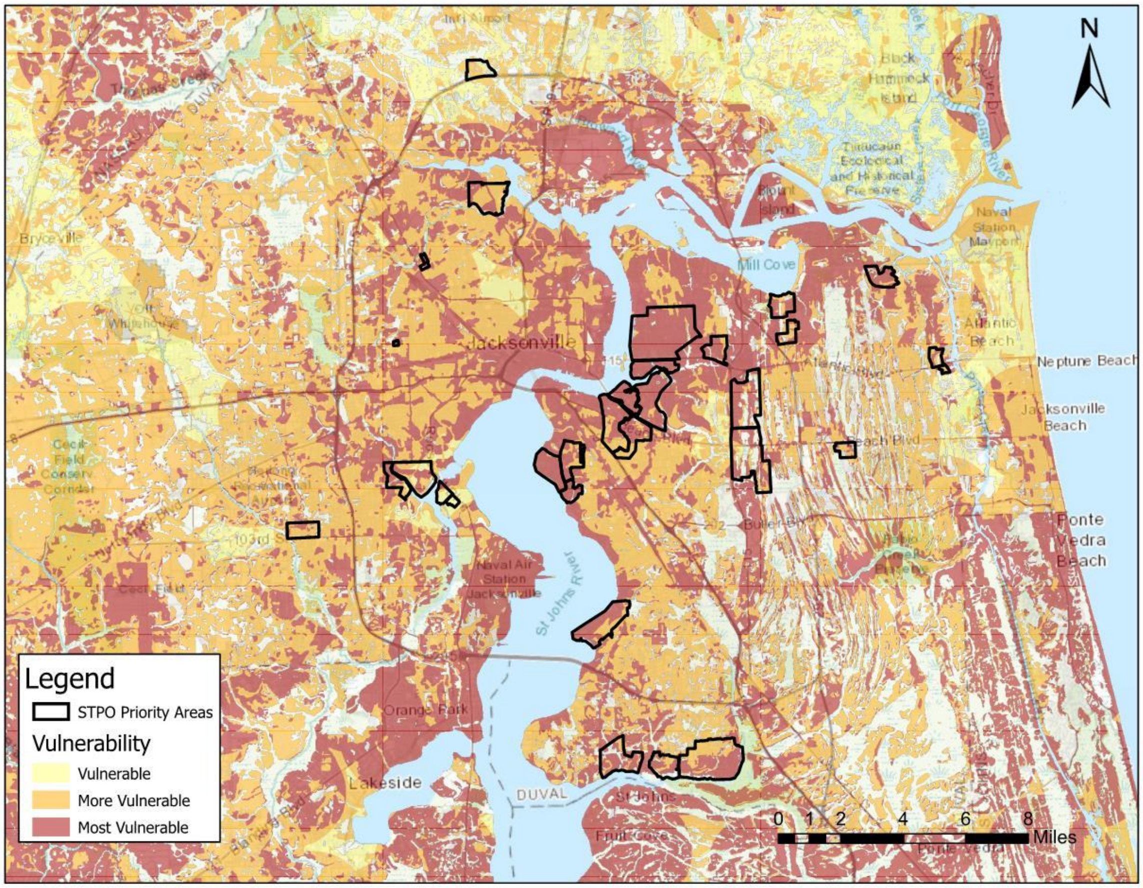


Figure 5-4: Surficial Aquifer System (SAS) Vulnerability Map

The following sections provide STPO priority areas specific characterization data (also summarized in Appendix I), organized by WWTF service area.

5.2 Arlington East WWTF Service Area

The Arlington East WWTF has a permitted capacity of 25 MGD. The revised projected YR2040 wastewater AADF was approximately 24.14 MGD, resulting in an available capacity of 0.86 MGD (or approximately 3%). The additional flow from STPO priority areas in the Arlington East service area was estimated to be approximately 1.9 MGD, which was more than the available capacity as previously noted (Table 5-3). The Arlington East service area included nine STPO priority areas— Atlantic Highlands, Holly Oaks, Lone Star Park, Mill Creek, Mt. Pleasant, Oakhaven, Pablo Point, Sans Pareil, and Southside Estates. Figure 5-5 depicts the extent of the service area, the STPO priority areas boundaries and impaired waters with TMDL limits for fecal coliform and nutrients.

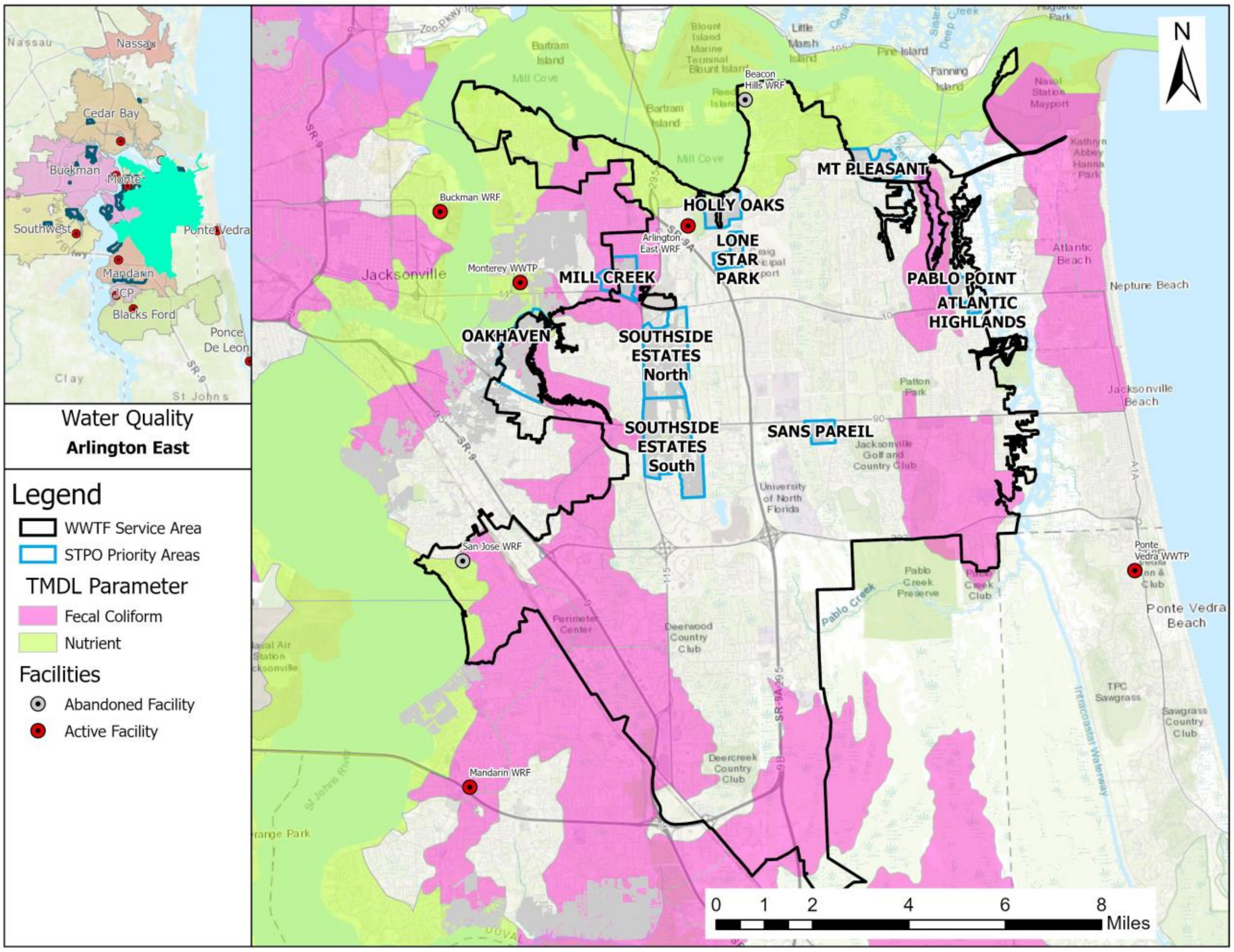


Figure 5-5: Arlington East Service Area Map

5.2.1 Atlantic Highlands

Atlantic Highlands was ranked #10 in the JEA 2019 STPO prioritization matrix. The STPO priority area's boundary had 108 total parcels of which 106 were septic parcels (depicted as purple parcels in Figure 5-6), which equated to an AADF of approximately 22,080 to 30,850 gpd. The dashed line in Figure 5-6 depicts an approximate road length of 7,580 feet (ft) which equated to approximately 79 ft per residential septic parcel. The average residential parcel acreage was 0.21 acres.

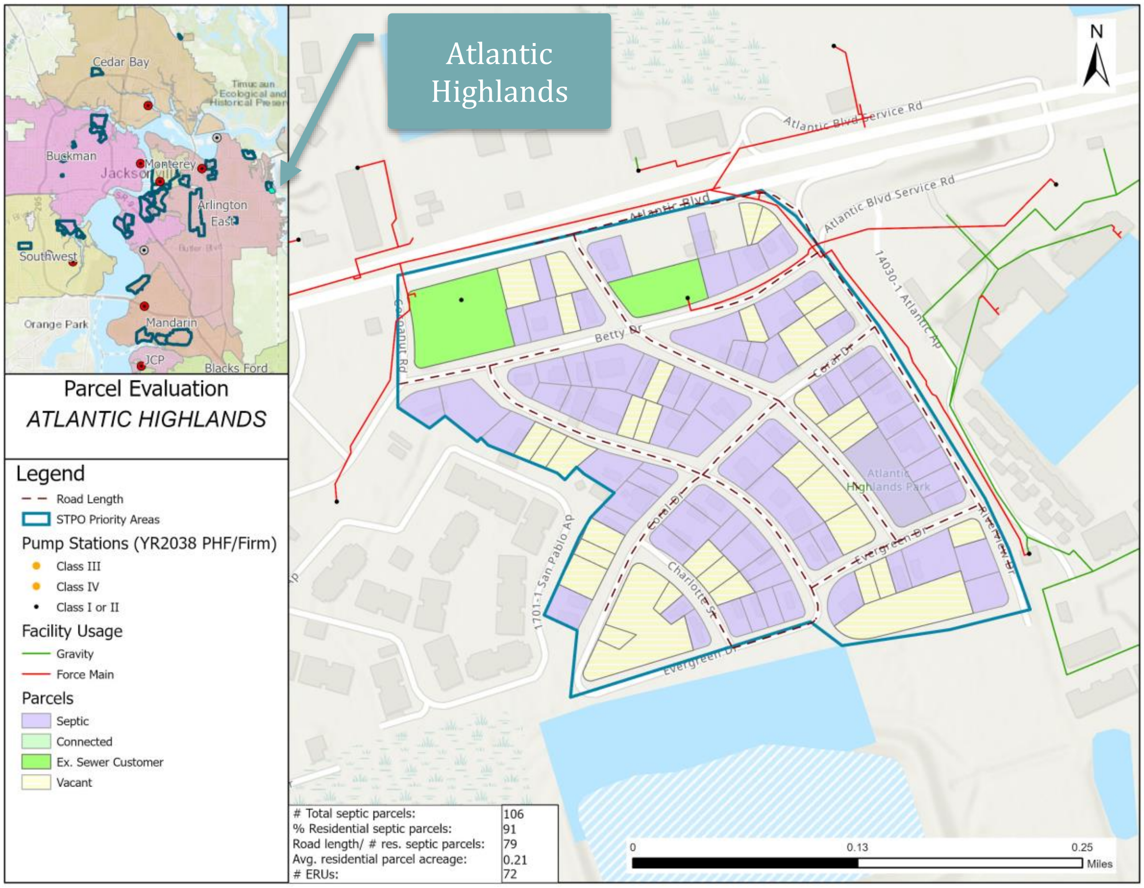


Figure 5-6: Atlantic Highlands Septic Parcels

The topography of the septic parcels was flat; elevations ranged from 10 to 12 ft (see Appendix F.1, Figure F.1-3). A review of aerial maps (Figure F.1-10) and site visit data (Figure 5-7 and Figure 5-8) characterized restoration costs to be low (asphalt roads with no curbs, gutters, or sidewalks but large trees in ROW) relative to other STPO priority areas. The road width ranged from 8 to 16 ft, and the ROW width ranged from 35 to 40 ft. The electric supply was overhead. The depth to water table varied from 8 to 76 inches below grade (Figure F.1-4), and the soil rating for conventional septic systems was very limited (Figure F.1-12). Approximately 21% of the parcels were existing water customers (see Figure F.1-7). None of the septic parcels were within FDEP total maximum daily load (TMDL) boundaries for fecal coliform and nutrients (see Figure F.1-5). Approximately 16% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.1-11). A summary of these parameters is presented in Table 5-6.

Figure 5-7: Atlantic Highlands STPO Priority Area, Sunnyside Ave near Betty Dr Site Visit Photo

Figure 5-8: Atlantic Highlands STPO Priority Area, Evergreen Dr near Charlotte St Site Visit Photo

Table 5-6: Atlantic Highlands Characterization

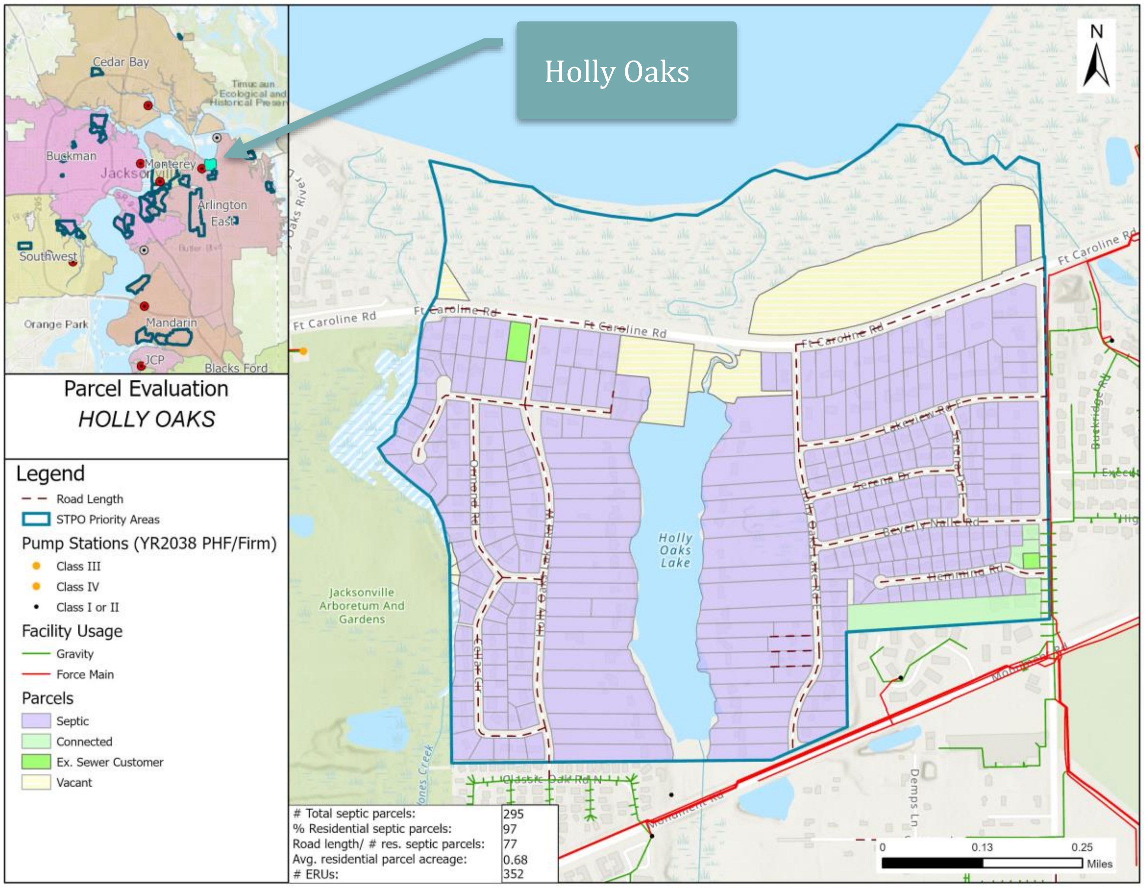
Description	Value	Units
2019 STPO Prioritization Ranking	10	
Total Parcels	108	#
Septic Parcels	106	#
Proportion Septic	98	%
Proportion Residential	91	%
Average Res. Parcel Acreage	0.21	acres
Water Meter AADF	22,074	gpd
Planning AADF (gpd)	30,853	gpd
Rd. Length ÷ Res. Parcels	79	ft/parcel
Proportion Ex. Water Customers	21	%
Restoration Costs	low	
Topography	flat	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	16	%
Proportion SAS More Vulnerable Septic Parcels	84	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	7.5	acres
Vacant Government Owned Acreage	0	acres

Existing wetlands/surface water included:

- Within the boundary: Freshwater Forested/Shrub Wetland
- Surrounding the boundary: Freshwater Forested/Shrub Wetland

5.2.2 Holly Oaks

Holly Oaks was ranked #24 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 302 total parcels of which 295 were septic parcels (depicted as purple parcels in Figure 5-9), which equated to an AADF of approximately 95,300 to 128,200 gpd. The dashed line in Figure 5-9 depicts an approximate road length of 22,020 ft which equated to approximately 77 ft per residential septic parcel. The average residential parcel acreage was 0.68 acres, and this average lot size calculation was impacted by numerous large, narrow, and deep waterfront residential parcels along Holly Oaks Lake (the average large lot size was 1.67 acres and the average small lot size was 0.33 acres). These lots may be difficult to serve via gravity sewers.



# Total septic parcels:	295
% Residential septic parcels:	97
Road length/ # res. septic parcels:	77
Avg. residential parcel acreage:	0.68
# ERUs:	352

Figure 5-9: Holly Oaks Septic Parcels

The topography of septic parcels was highly variable; elevations ranged from 6 to 38 ft (see Appendix F.10 Figure F.10-3). A review of aerial maps (Figure F.10-10) and site visit data (see Figure 5-10 and Figure 5-11) characterized restoration costs to be medium (roads have curbs or gutters and some large trees) relative to other STPO priority areas. The road width ranged from 20 to 25 ft, and the ROW width ranged from 40 to 50 ft. The electric supply was overhead. The depth to water table varied from 0 to 147 inches below grade (Figure F.10-4). The soil rating for conventional septic systems was very limited (Figure F.10-12). Approximately 80% of the parcels were existing water customers (Figure F.10-7). Approximately 0% and 4% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.10-5), respectively. Approximately 88% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.10-11). A summary of these parameters is presented in Table 5-7.

Figure 5-10: Holly Oaks STPO Priority Area, Lakeview Rd W Site Visit Photo

Figure 5-11: Holly Oaks STPO Priority Area, Lakeview Rd E Site Visit Photo

Table 5-7: Holly Oaks Characterization

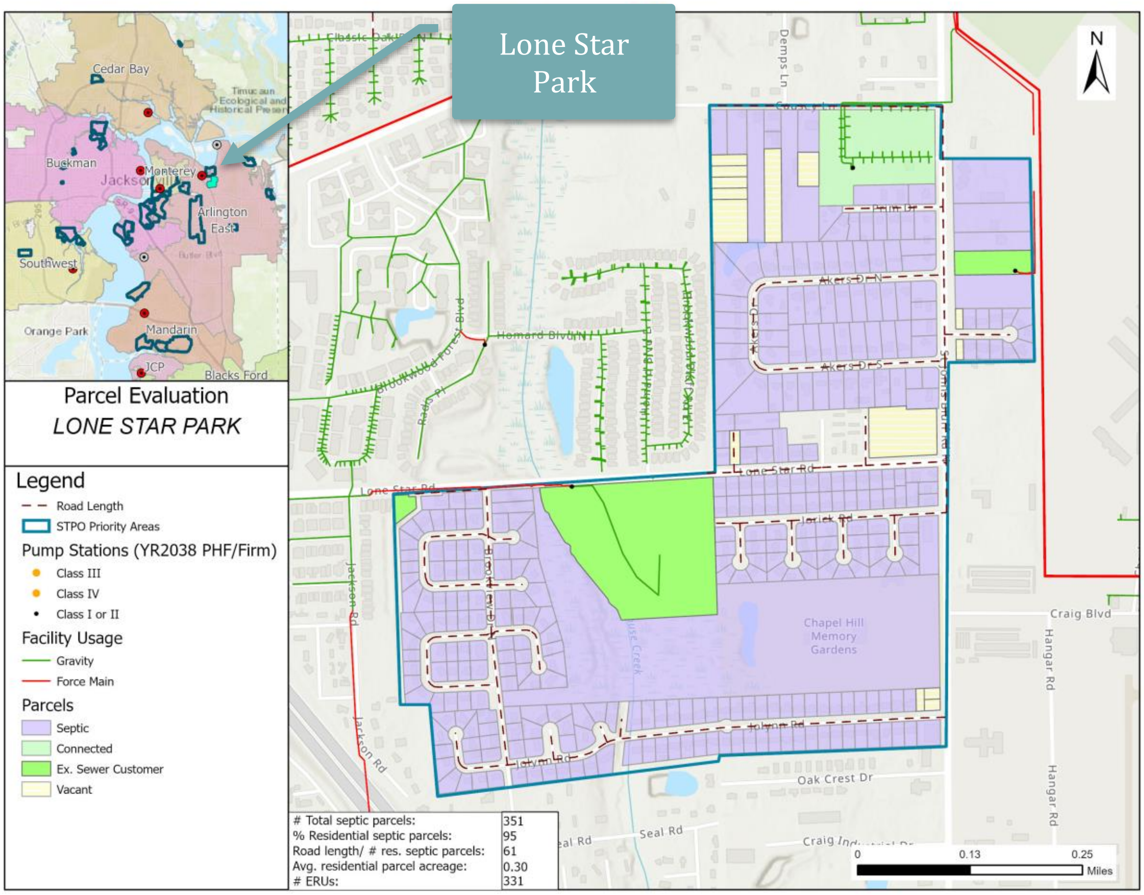
Description	Value	Units
2019 STPO Prioritization Ranking	24	
Total Parcels	302	#
Septic Parcels	295	#
Proportion Septic	98	%
Proportion Residential	97	%
Average Res. Parcel Acreage	0.68	acres
Water Meter AADF	95,319	gpd
Planning AADF (gpd)	128,202	gpd
Rd. Length ÷ Res. Parcels	77	ft/parcel
Proportion Ex. Water Customers	80	%
Restoration Costs	medium	
Topography	highly variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	4	%
Proportion SAS Most Vulnerable Septic Parcels	88	%
Proportion SAS More Vulnerable Septic Parcels	12	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	28	acres
Vacant Government Owned Acreage	5.6	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Estuarine and Marine Wetland
    - Freshwater Pond
    - Riverine
- Surrounding the boundary:
    - Estuarine and Marine Deepwater
    - Estuarine and Marine Wetland
    - Freshwater Forested/Shrub Wetland

5.2.3 Lone Star Park

Lone Star Park was ranked #22 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 354 total parcels of which 351 were septic parcels (depicted as purple parcels in Figure 5-12), which equated to an AADF of approximately 76,850 to 108,250 gpd. The dashed line in Figure 5-12 depicts an approximate road length of 20,350 ft which equated to approximately 61 ft per residential septic parcel. The average residential parcel acreage was 0.30 acres.



# Total septic parcels:	351
% Residential septic parcels:	95
Road length/ # res. septic parcels:	61
Avg. residential parcel acreage:	0.30
# ERUs:	331

Figure 5-12: Lone Star Park Septic Parcels

The topography of septic parcels was highly variable; elevations ranged from 12 to 50 ft (see Appendix F.16 Figure F.16-3). A review of aerial maps (Figure F.16-10) and site visit data (Figure 5-13,

Figure 5-14) characterized restoration costs to be medium (asphalt roads with no curbs, gutters or large trees but some sidewalks and stormwater features in ROW) relative to other STPO priority areas. The road width ranged from 22 to 24 ft, and the ROW width ranged from 35 to 50 ft. The electric supply was overhead. The depth to water table varied from 0 to 147 inches below grade (Figure F.16-4), and the soil rating for conventional septic systems was very limited (Figure F.16-12). Approximately 92% of the parcels were existing water customers (Figure F.16-7). None of the septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.16-5). Approximately 38% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.16-11). A summary of these parameters is presented in Table 5-8.

Figure 5-13: Lone Star Park STPO Priority Area, Colonial Ct N and Brookview Dr N Intersection Site Visit Photo

Figure 5-14: Lone Star Park STPO Priority Area, Jorick Rd Site Visit Photo

Table 5-8: Lone Star Park Characterization

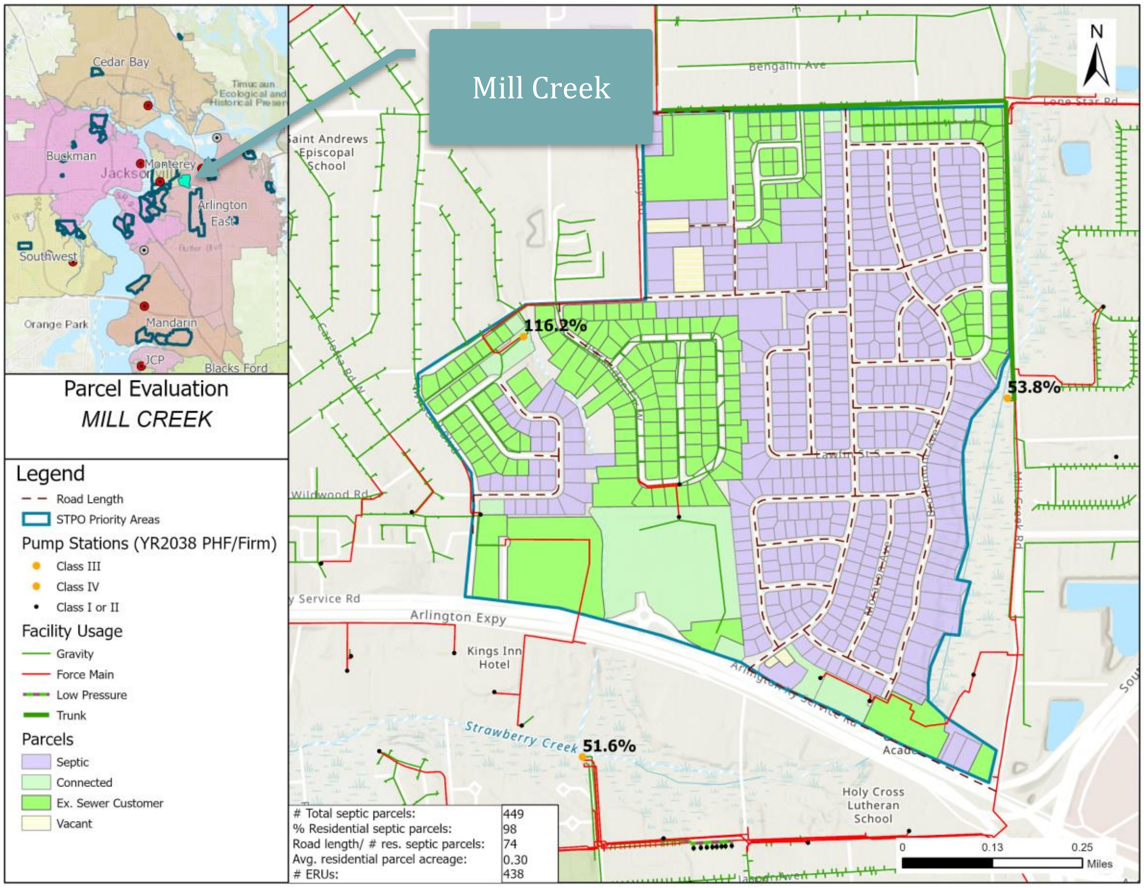
Description	Value	Units
2019 STPO Prioritization Ranking	22	
Total Parcels	354	#
Septic Parcels	351	#
Proportion Septic	99	%
Proportion Residential	95	%
Average Res. Parcel Acreage	0.30	acres
Water Meter AADF	76,862	gpd
Planning AADF (gpd)	108,226	gpd
Rd. Length ÷ Res. Parcels	61	ft/parcel
Proportion Ex. Water Customers	92	%
Restoration Costs	medium	
Topography	highly variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	38	%
Proportion SAS More Vulnerable Septic Parcels	62	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	8.0	acres
Vacant Government Owned Acreage	2.8	acres

Existing wetlands/surface water included:

- Within the boundary: Freshwater Forested/Shrub Wetland
- Surrounding the boundary: Freshwater Forested/Shrub Wetland

5.2.4 Mill Creek

Mill Creek was ranked #21 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 687 total parcels of which 449 were septic parcels (depicted as purple parcels Figure 5-15), which equated to an AADF of approximately 88,200 to 129,120 gpd using water meter data. The dashed line in Figure 5-15 depicts an approximate road length of 32,550 ft which equated to approximately 74 ft per residential septic parcel. The average residential parcel acreage was 0.3 acres.



# Total septic parcels:	449
% Residential septic parcels:	98
Road length/ # res. septic parcels:	74
Avg. residential parcel acreage:	0.30
# ERUs:	438

Figure 5-15: Mill Creek Septic Parcels

The topography of the septic parcels was highly variable; elevations ranged from 16 to 46 ft (see Appendix F.17 and Figure F.17-3). A review of aerial maps (Figure F.17-10) and site visit data (Figure 5-16 and Figure 5-17) characterized restoration costs to be medium (asphalt roads with curbs and gutters) relative to other STPO priority areas. The road width ranged from 18 to 27 ft, and the ROW width ranged from 40 to 45 ft. The electric supply was overhead. The depth to water table varied from 0 to 147 inches below grade (Appendix F.17-4), and the soil rating for conventional septic systems was very limited (Figure F.17-12). Approximately 95% of the parcels were existing water customers (Figure F.17-7). Approximately 100% and 0% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.17-5), respectively. Approximately 68% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.17-11). A summary of these parameters is presented in Table 5-9.

Figure 5-16: Mill Creek STPO Priority Area, Carlotta Rd E and Middleton Rd Site Visit Photo

Figure 5-17: Mill Creek STPO Priority Area, Malverne Ave Site Visit Photo

Table 5-9: Mill Creek Characterization

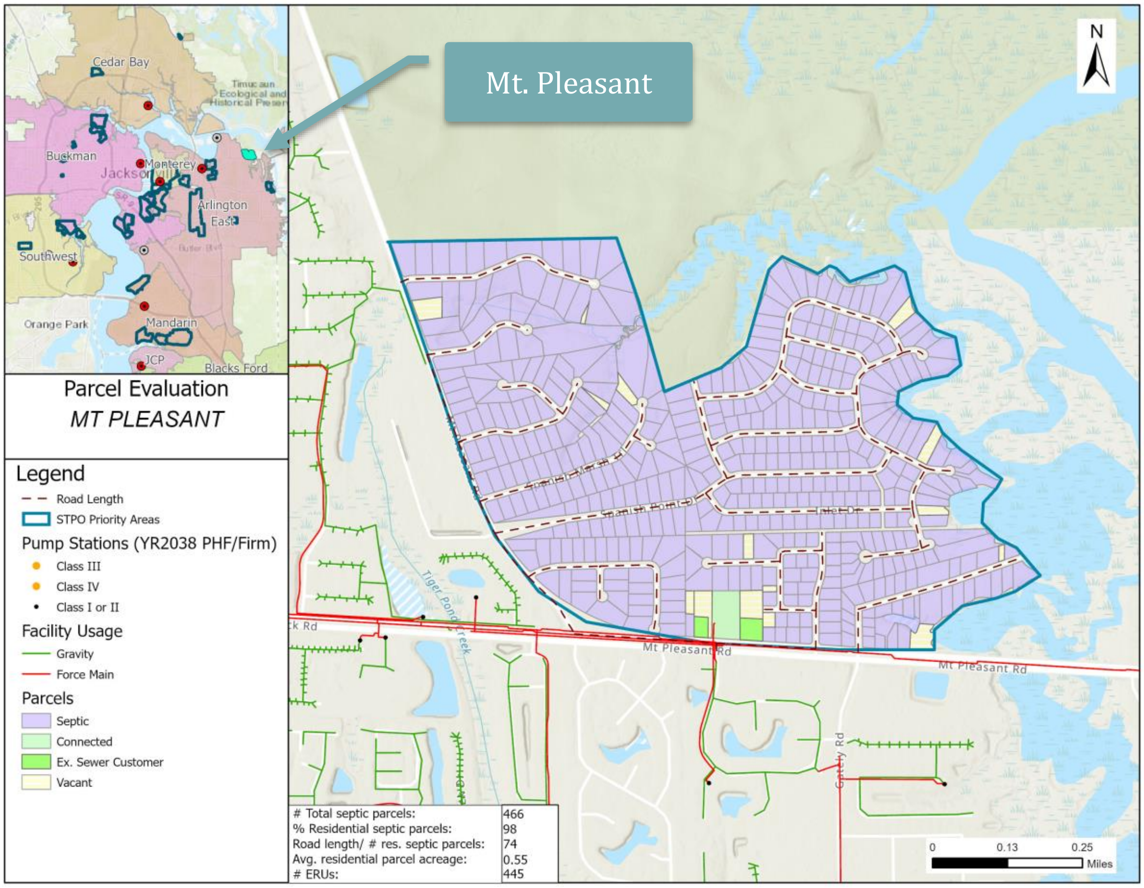
Description	Value	Units
2019 STPO Prioritization Ranking	21	
Total Parcels	687	#
Septic Parcels	449	#
Proportion Septic	65	%
Proportion Residential	98	%
Average Res. Parcel Acreage	0.3	acres
Water Meter AADF	88,201	gpd
Planning AADF (gpd)	129,119	gpd
Rd. Length ÷ Res. Parcels	74	ft/parcel
Proportion Ex. Water Customers	95	%
Restoration Costs	medium	
Topography	highly variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	100	%
Proportion Nutrient TMDL Septic Parcels	18	%
Proportion SAS Most Vulnerable Septic Parcels	68	%
Proportion SAS More Vulnerable Septic Parcels	32	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	2.8	acres
Vacant Government Owned Acreage	0	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Riverine
- Surrounding the boundary:
    - Freshwater Forested/Shrub Wetland
    - Riverine

5.2.5 Mt. Pleasant

Mt. Pleasant was ranked #35 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 469 total parcels of which 466 were septic parcels (depicted as purple parcels in Figure 5-18) which equated to an AADF of approximately 97,180 to 139,120 gpd. The dashed line in Figure 5-18 depicts an approximate road length of 33,700 ft which equated to approximately 74 ft per residential septic parcel. The average residential parcel acreage was 0.55 acres.



# Total septic parcels:	466
% Residential septic parcels:	98
Road length/ # res. septic parcels:	74
Avg. residential parcel acreage:	0.55
# ERUs:	445

Figure 5-18: Mt. Pleasant Septic Parcels

The topography of septic parcels was highly variable; elevation ranged from 6 to 40 ft (see Appendix F.18 Figure A.18-3). A review of aerial maps (Figure F.18-10) and site visit data (Figure 5-19 and Figure 5-20) characterized restoration costs to be low (asphalt roads with no curbs, gutter, or sidewalks with some stormwater features in the ROW) relative to other STPO priority areas. The road width ranged from 22 to 25 ft, and the ROW width ranged from 40 to 50 ft. The electric supply varied (overhead and underground). The depth to water table varied from 8 to 147 inches below grade (Figure F.18-4), and in general the soil rating for conventional septic systems was very limited (Figure F.18-13). Approximately 69% of the parcels were existing water customers (Figure F.18-7). Approximately 0% and 1% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.18-5), respectively. Approximately 88% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.18-11). In addition, a few of the septic parcels were within the Timucuan Ecological and Historic Preserve Outstanding Water boundary (see Figure F.18-12). A summary of these parameters is presented in Table 5-10.

Figure 5-19: Mt Pleasant STPO Priority Area, N Pleasantview Dr Site Visit Photo

Figure 5-20: Mt. Pleasant STPO Priority Area, Pleasant Point Ln Site Visit Photo

Table 5-10: Mt. Pleasant Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	35	
Total Parcels	469	#
Septic Parcels	466	#
Proportion Septic	99	%
Proportion Residential	98	%
Average Res. Parcel Acreage	0.55	acres
Water Meter AADF	97,176	gpd
Planning AADF (gpd)	139,121	gpd
Rd. Length ÷ Res. Parcels	74	ft/parcel
Proportion Ex. Water Customers	69	%
Restoration Costs	low	
Topography	highly variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	1	%
Proportion SAS Most Vulnerable Septic Parcels	88	%
Proportion SAS More Vulnerable Septic Parcels	12	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	8.6	acres
Vacant Government Owned Acreage	0.3	acres

Mt. Pleasant was adjacent to an Outstanding Florida Water (see Appendix F.18 Figure F.18-12):

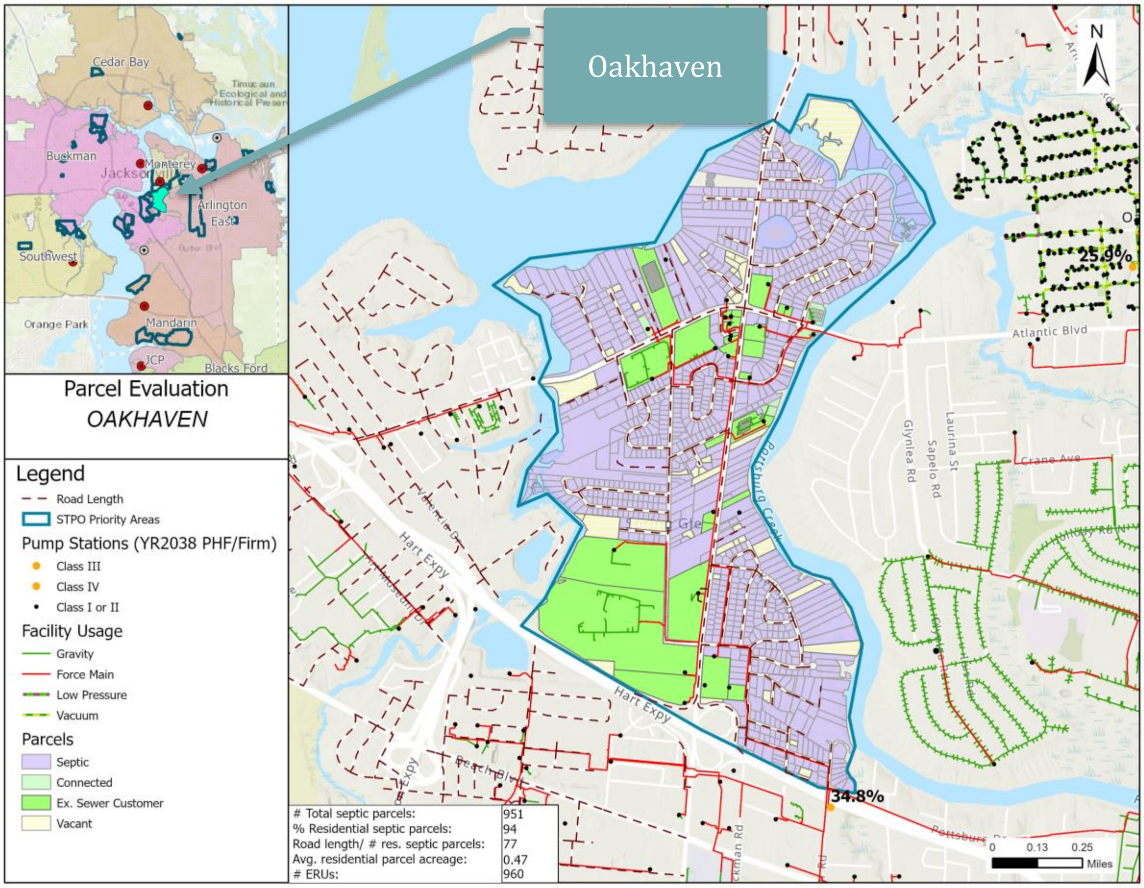
- Timucuan Ecological and Historic Preserve

Existing wetlands/surface water included:

- Within the boundary: Freshwater Forested/Shrub Wetland
- Surrounding the boundary: Freshwater Forested/Shrub Wetland

5.2.6 Oakhaven

Oakhaven was ranked #20 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 1,198 total parcels of which 951 were septic parcels (depicted as purple parcels in Figure 5-21), which equated to an AADF of approximately 228,200 to 321,600 gpd. The dashed line in Figure 5-21 depicts an approximate road length of 68,940 ft which equated to approximately 77 ft per residential septic parcel. The average residential parcel acreage was 0.47 acres. There were numerous deep, narrow waterfront lots in this STPO priority area that may be difficult to serve via gravity sewers.



# Total septic parcels:	951
% Residential septic parcels:	94
Road length/ # res. septic parcels:	77
Avg. residential parcel acreage:	0.47
# ERUs:	960

Figure 5-21: Oakhaven Septic Parcels

The topography of septic parcels was highly variable; elevations ranged from 6 to 32 ft (see Appendix F.21 Figure F.21-3). A review of aerial maps (Figure F.21-10) and site visit data (Figure 5-22 and Figure 5-23) characterized restoration costs to be medium (asphalt roads with curbs and gutters, stormwater drainage features and some large trees in ROW) relative to other STPO priority areas. The road width ranged from 18 to 25 ft, and the ROW width ranged from 35 to 40 ft. The electric supply varied (overhead and underground). The depth to water table varied from 0 to 147 inches below grade (Figure F.21-4), and the soil rating for conventional septic systems was very limited (Figure F.21-12). Approximately 95% of the parcels were existing water customers (see Appendix F.5 Figure 7). Approximately 40% and 34% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.21-5), respectively. Approximately 95% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.21-11). A summary of these parameters is presented in Table 5-11.

Figure 5-22: Oakhaven STPO Priority Area, Bartram Rd S Site Visit Photo

Figure 5-23: Oakhaven STPO Priority Area, River Hills Dr Site Visit Photo

Table 5-11: Oakhaven Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	20	
Total Parcels	1198	#
Septic Parcels	951	#
Proportion Septic	79	%
Proportion Residential	94	%
Average Res. Parcel Acreage	0.47	acres
Water Meter AADF	228,202	gpd
Planning AADF (gpd)	321,603	gpd
Rd. Length ÷ Res. Parcels	77	ft/parcel
Proportion Ex. Water Customers	95	%
Restoration Costs	medium	
Topography	highly variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	40	%
Proportion Nutrient TMDL Septic Parcels	34	%
Proportion SAS Most Vulnerable Septic Parcels	95	%
Proportion SAS More Vulnerable Septic Parcels	5	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	44	acres
Vacant Government Owned Acreage	15	acres

Existing wetlands/surface water included:

- Within the boundary
  - Freshwater Forested/Shrub Wetland
  - Freshwater Pond
  - Estuarine and Marine Deepwater
  - Estuarine and Marine Wetland
  - Riverine
- Surrounding the boundary:
  - Freshwater Forested/Shrub Wetland
  - Estuarine and Marine Deepwater
  - Estuarine and Marine Wetland

5.2.7 Pablo Point

Pablo Point was ranked #34 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 249 total parcels of which 242 were septic parcels (depicted as purple parcels in Figure 5-24), which equated to an AADF of approximately 48,856 to 70,903 gpd. The dashed line in Figure 5-24 depicts an approximate road length of 14,300 ft which equated to approximately 61 ft per residential septic parcel. The average residential parcel acreage was 0.39 acres. There were some deep, narrow lots that may be difficult to serve with gravity sewers.

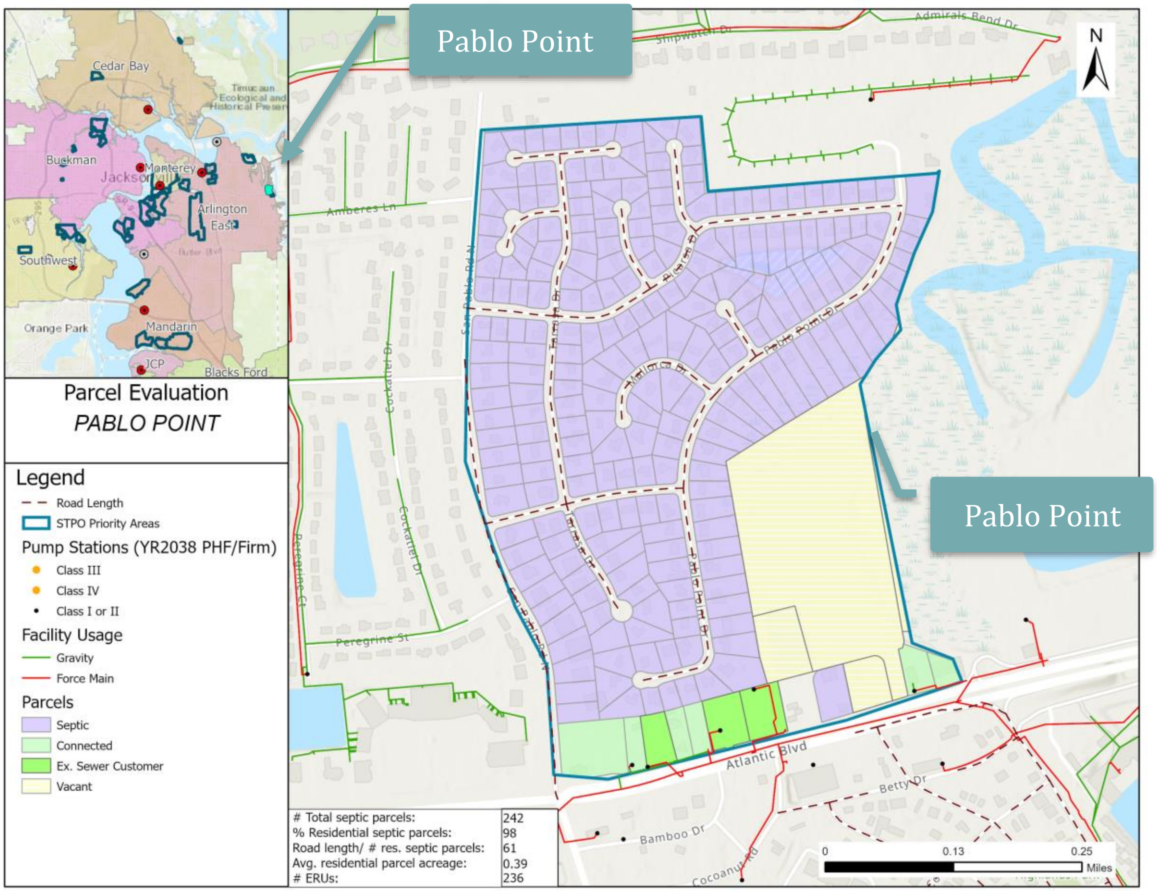


Figure 5-24: Pablo Point Septic Parcels

There was low variability of topography for the septic parcels; elevations ranged from 2 to 14 ft (see Appendix F.24 Figure F.24-3). A review of aerial maps (Figure F.24-10) and site visit data (Figure 5-25 and Figure 5-26) characterized restoration costs to be medium (asphalt roads with curbs and gutters, some stormwater infrastructure, and large trees in the ROW) relative to other STPO priority areas. The road and the ROW widths were approximately 24 and 40 ft, respectively. The electric supply was underground. The depth to water table varied from 8 to 53 inches below grade (Figure F.24-4), and the soil rating for conventional septic was very limited (Figure F.24-12). Approximately 98% of the parcels were existing water customers (Figure F.24-7). None of the septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.24-5). Approximately 38% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.24-11). A summary of these parameters is presented in Table 5-12.

Figure 5-25: Pablo Point STPO Priority Area, Pablo Point Dr Site Visit Photo

Figure 5-26: Pablo Point STPO Priority Area, Saltbush Ct Site Visit Photo

Table 5-12: Pablo Point Characterization

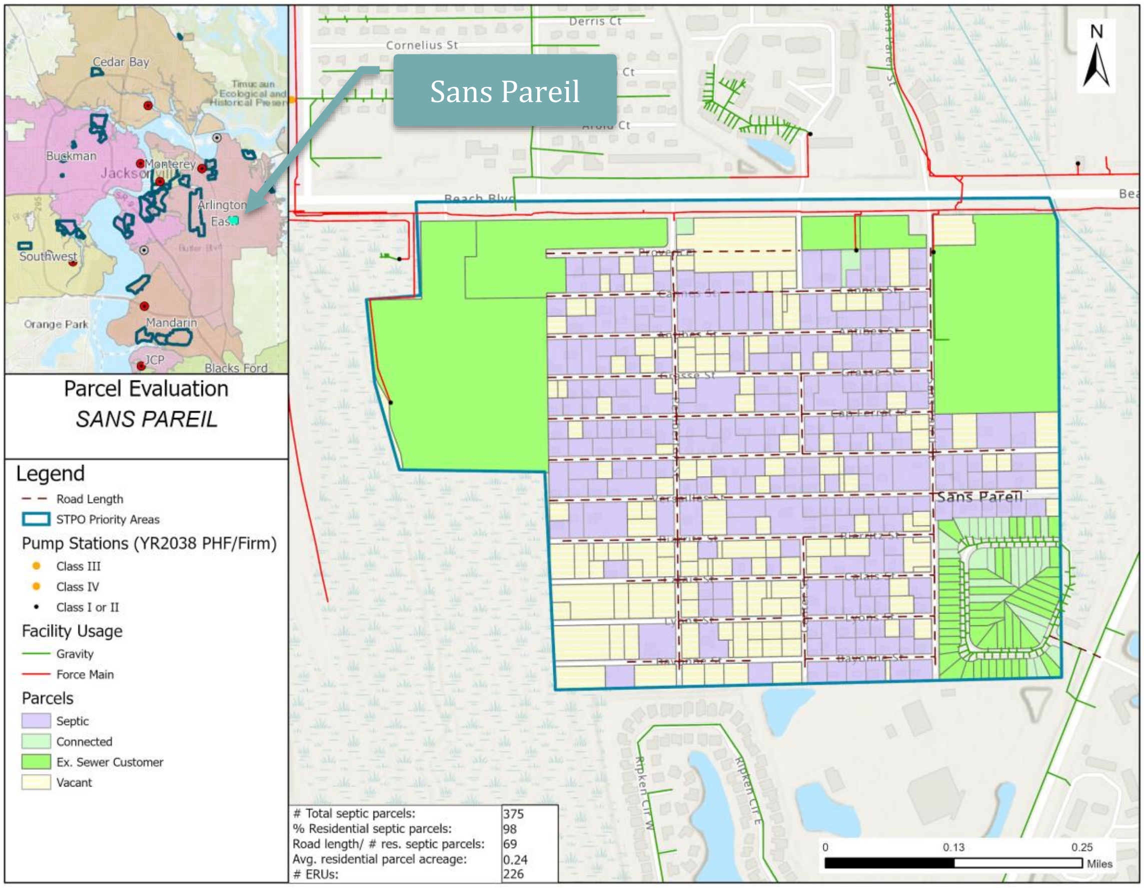
Description	Value	Units
2019 STPO Prioritization Ranking	34	
Total Parcels	249	#
Septic Parcels	242	#
Proportion Septic	97	%
Proportion Residential	98	%
Average Res. Parcel Acreage	0.39	acres
Water Meter AADF	48,856	gpd
Planning AADF (gpd)	70,903	gpd
Rd. Length ÷ Res. Parcels	61	ft/parcel
Proportion Ex. Water Customers	98	%
Restoration Costs	medium	
Topography	low variability	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	38	%
Proportion SAS More Vulnerable Septic Parcels	62	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	24	acres
Vacant Government Owned Acreage	2.5	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Freshwater Pond
    - Estuarine and Marine Wetland
- Surrounding the boundary:
    - Estuarine and Marine Wetland
    - Freshwater Forested/Shrub Wetland

5.2.8 Sans Pareil

Sans Pareil was ranked #13 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 457 total parcels of which 375 were septic parcels (depicted as purple parcels in Figure 5-27), which equated to an AADF of approximately 85,880 to 107,430 gpd. The dashed line in Figure 5-27 depicts an approximate road length of 25,490 ft which equated to approximately 69 ft per residential septic parcel. The average residential parcel acreage was 0.24 acres. There were numerous vacant parcels in this STPO priority area.



# Total septic parcels:	375
% Residential septic parcels:	98
Road length/ # res. septic parcels:	69
Avg. residential parcel acreage:	0.24
# ERUs:	226

Figure 5-27: Sans Pareil Septic Parcels

There was low variability of topography for the septic parcels; elevations ranged from 32 to 44 ft (see Appendix F.27 Figure A.27-3). A review of aerial maps (Figure F.27-10) and site visit data (Figure 5-28 and Figure 5-29) characterized restoration costs to be very low (dirt roads) relative to the other STPO priority areas. The road width ranged from 8 to 24 ft, and the ROW width ranged from 30 to 35 ft. The electric supply was overhead. The depth to water table varied from 0 to 147 inches below grade (Figure F.27-4), and the soil rating for conventional septic systems was very limited (Figure F.27-12). Approximately 5% of the parcels were existing water customers (Figure F.27-7). None of the septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.27-5).

Approximately 39% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.27-11). A summary of these parameters is presented in Table 5-13.

Figure 5-28: Sans Pareil STPO Priority Area, Lyons St Site Visit Photo

Figure 5-29: Sans Pareil STPO Priority Area, Grasse St Site Visit Photo

Table 5-13: Sans Pareil Characterization

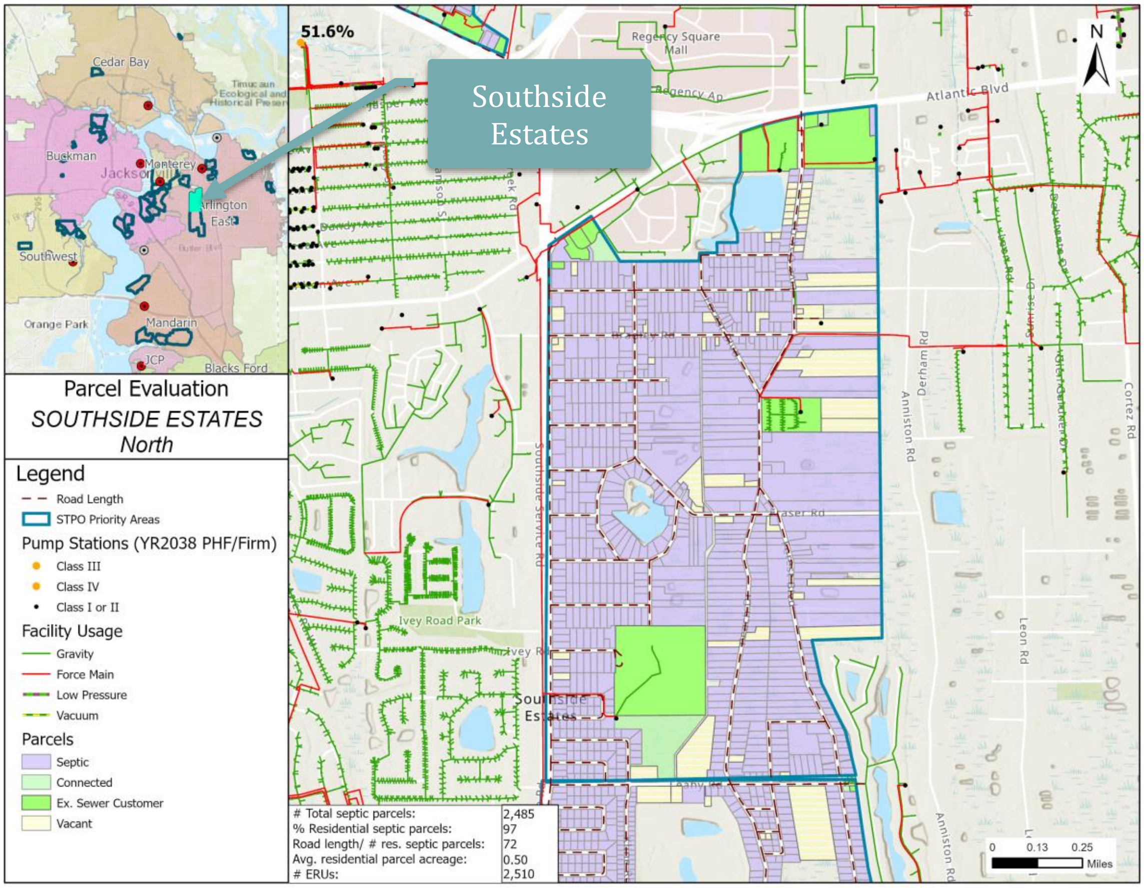
Description	Value	Units
2019 STPO Prioritization Ranking	13	
Total Parcels	457	#
Septic Parcels	375	#
Proportion Septic	82	%
Proportion Residential	98	%
Average Res. Parcel Acreage	0.24	acres
Water Meter AADF	85,876	gpd
Planning AADF (gpd)	107,429	gpd
Rd. Length ÷ Res. Parcels	69	ft/parcel
Proportion Ex. Water Customers	5	%
Restoration Costs	low	
Topography	low variability	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	39	%
Proportion SAS More Vulnerable Septic Parcels	61	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	37	acres
Vacant Government Owned Acreage	0	acres

Existing wetlands/surface water included:

- Within the boundary
  - Freshwater Forested/Shrub Wetland
  - Freshwater Pond
- Surrounding the boundary:
  - Riverine
  - Freshwater Forested/Shrub Wetland

5.2.9 Southside Estates

Southside Estates was ranked #29 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 2,554 total parcels of which 2,485 were septic parcels (depicted as purple parcels in Figure 5-30 and Figure 5-31), which equated to an AADF of approximately 660,300 to 905,370 gpd. The dashed line in Figure 5-30 (north portion) and Figure 5-31 (south portion) depicts an approximate road length of 171,560 ft which equated to approximately 72 ft per residential septic parcel. The average residential parcel acreage was 0.50 acres.



# Total septic parcels:	2,485
% Residential septic parcels:	97
Road length/ # res. septic parcels:	72
Avg. residential parcel acreage:	0.50
# ERUs:	2,510

Figure 5-30: Southside Estates (North) Septic Parcels

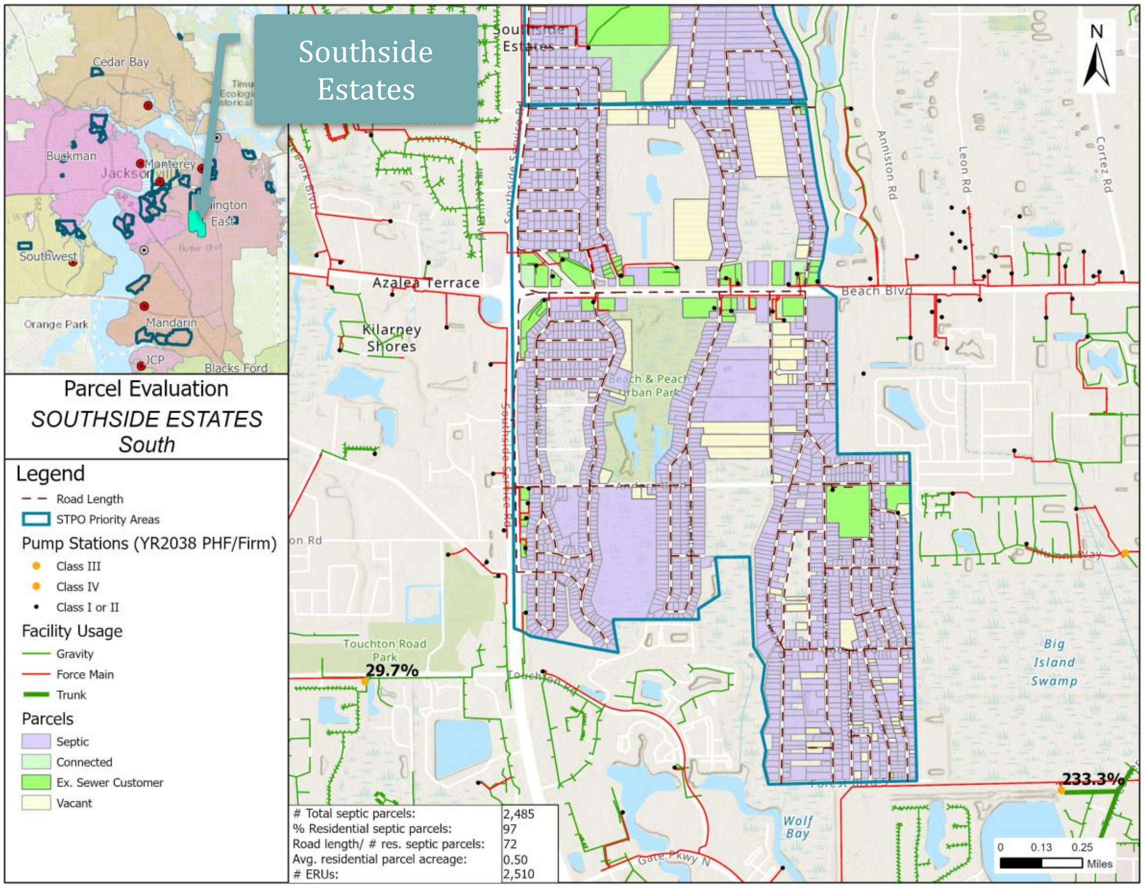


Figure 5-31: Southside Estates (South) Septic Parcels

There was moderate variability of topography for the septic parcels; elevations ranged from 44 to 66 ft (see Appendix F.28 Figures F.28-5 and F.28-6). A review of aerial maps (Figures F.28-17) and site visit data (Figure 5-32, Figure 5-33, Figure 5-34, and Figure 5-35) characterized restoration costs to be medium (asphalt roads with no curbs or gutters but some sidewalks, large trees and stormwater features in ROW) relative to other STPO priority areas. The electric supply was overhead. The depth to water table varied from 0 to 147 inches below grade (Figures F.28-7 and F.28-8), and the soil rating for conventional septic systems was generally very limited (Figures F.28-20 and F.28-21). Approximately 93% of the parcels were existing water customers (Figures F.28-13 and F.28-14). None of the septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figures F.28-9 and F.28-10). Approximately 69% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figures F.28-18 and F.28-19). A summary of these parameters is presented in Table 5-14.

Figure 5-32: Southside Estates (North) STPO Priority Area , Intersection of Hilltop Blvd and Cunningham Rd Site Visit Photo

Figure 5-33: Southside Estates (North) STPO Priority Area, Halsey Rd Looking West Site Visit Photo

Figure 5-34: Southside Estates (South) STPO Priority Area, Bunnell Dr Site Visit Photo

Figure 5-35: Southside Estates (South) STPO Priority Area, N Anson Pl Site Visit Photo

Table 5-14: Southside Estates Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	29	
Total Parcels	2554	#
Septic Parcels	2485	#
Proportion Septic	97	%
Proportion Residential	97	%
Average Res. Parcel Acreage	0.50	acres
Water Meter AADF	660,294	gpd
Planning AADF (gpd)	905,368	gpd
Rd. Length ÷ Res. Parcels	72	ft/parcel
Proportion Ex. Water Customers	93	%
Restoration Costs	medium	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	69	%
Proportion SAS More Vulnerable Septic Parcels	27	%
Proportion SAS Vulnerable Septic Parcels	3	%
Vacant Acreage	158	acres
Vacant Government Owned Acreage	28	acres

Existing wetlands/surface water included:

- Within the boundary
  - Freshwater Forested/Shrub Wetland
  - Freshwater Pond
  - Freshwater Emergent Wetland
  - Riverine
- Surrounding the boundary:
  - Riverine
  - Freshwater Forested/Shrub Wetland

5.3 Buckman WWTF Service Area

The Buckman WWTF has a permitted capacity of 52.5 MGD. The revised projected YR2040 wastewater AADF was approximately 30.2 MGD, resulting in an available capacity of 22.3 MGD (or approximately 43%). The additional flow from STPO priority areas in the service area was estimated to be approximately 1.8 MGD, which was less than the available capacity (Table 5-3). The Buckman service area included 10 STPO priority areas — Emerson, Empire Point, Freeman, Kinard, Oak Lawn, Odessa, Point La Vista, Riverview, Spring Glen and St. Nicholas. Figure 5-36 depicts the extent of the service area, the STPO priority area boundaries and impaired waters with TMDL limits for fecal coliform, nutrients and dissolved oxygen.

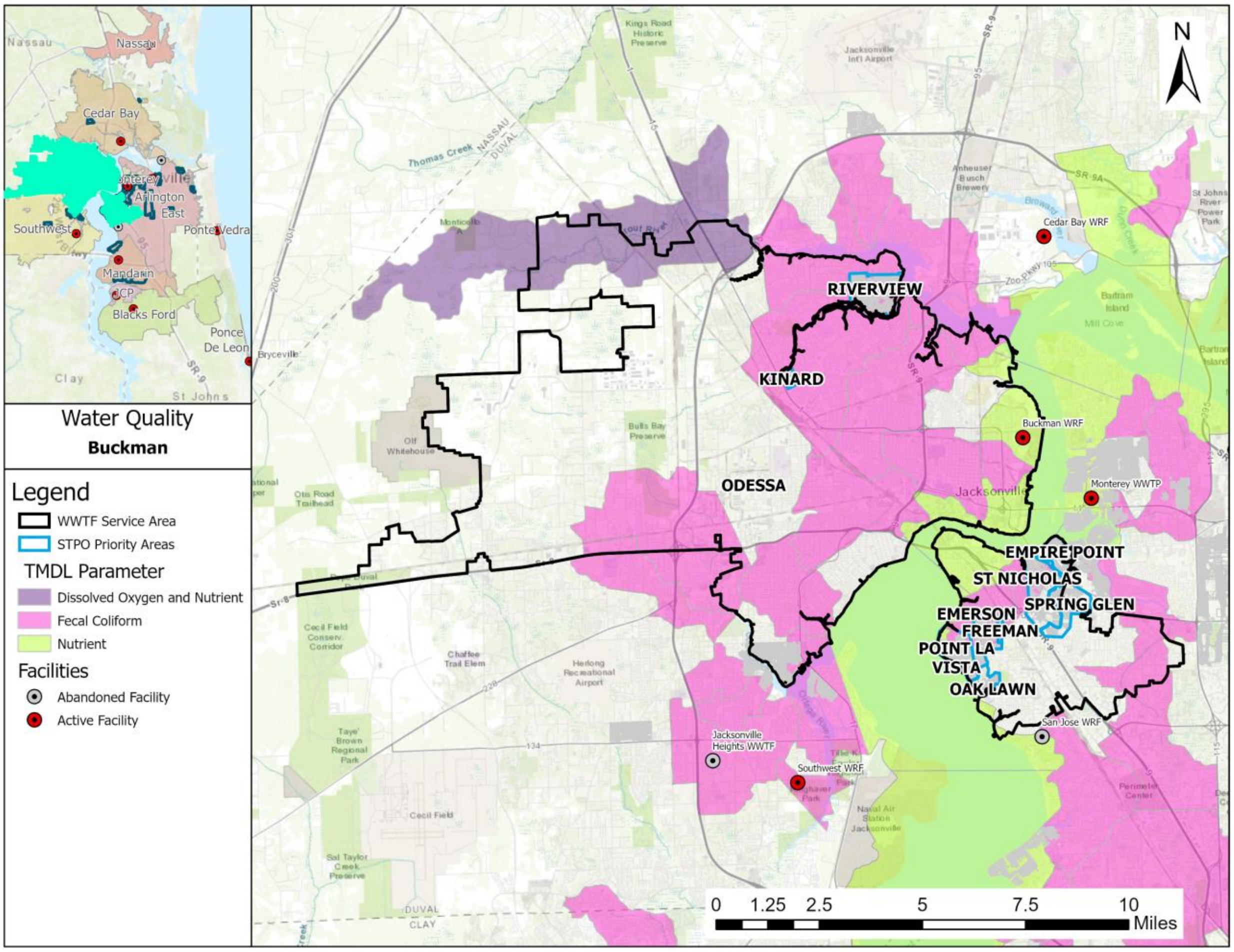
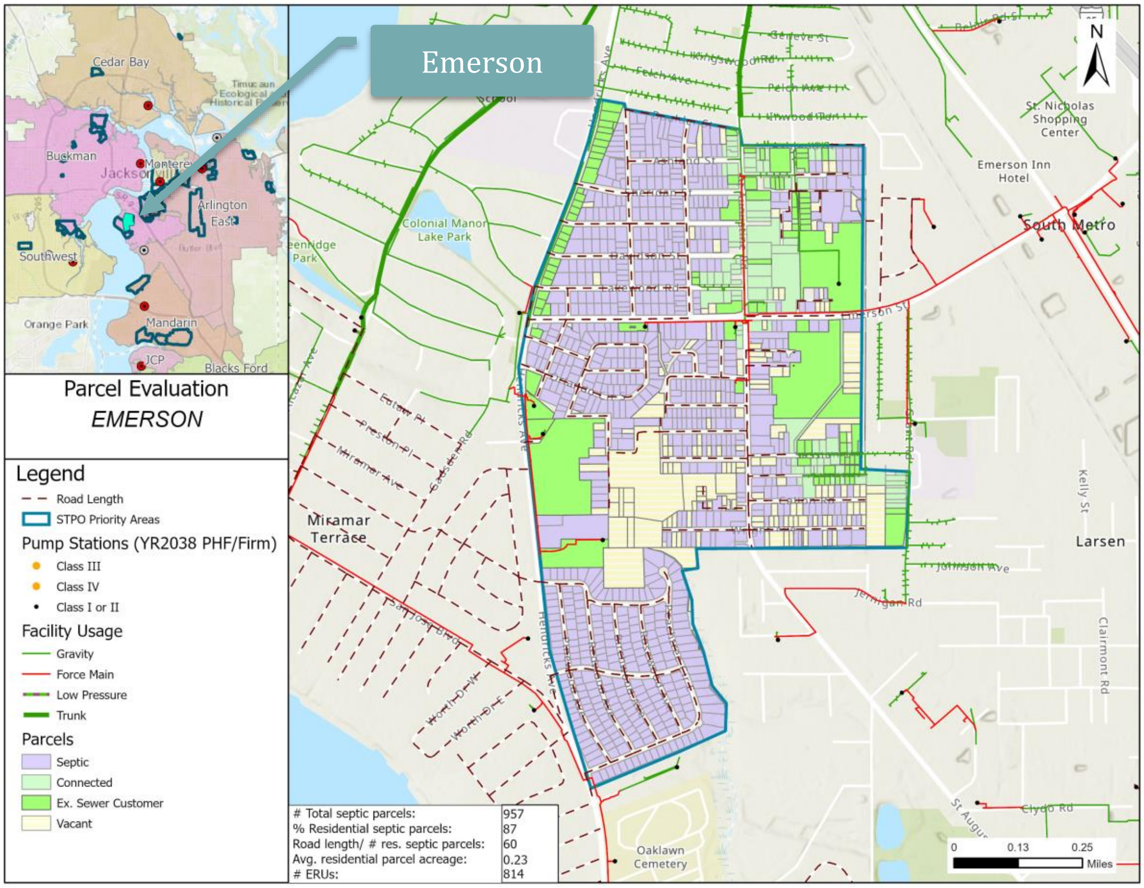


Figure 5-36: Buckman Service Area

5.3.1 Emerson

Emerson was ranked #5 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 1,145 total parcels of which 957 were septic parcels (depicted as purple parcels in Figure 5-37), which equated to an AADF of approximately 223,120 to 302,760 gpd. The dashed line in Figure 5-37 depicts an approximate road length of 49,810 ft which equated to approximately 60 ft per residential septic parcel. The average residential parcel acreage was 0.23 acres.



# Total septic parcels:	957
% Residential septic parcels:	87
Road length/ # res. septic parcels:	60
Avg. residential parcel acreage:	0.23
# ERUs:	814

Figure 5-37: Emerson Septic Parcels

There was low variability of topography for the septic parcels; elevations ranged from 10 to 24 ft (see Appendix F.7 Figure F.7-3). A review of aerial maps (Figure F.7-10) and site visit data (Figure 5-38 and Figure 5-39) characterized restoration costs to be low (asphalt roads with no curbs or gutters, but some sidewalks, stormwater drainage features and large trees in ROW) relative to other STPO priority areas. The electric supply was overhead. The depth to water table varied from 0 to 145 inches below grade (Figure F.7-4), and in general the soil rating for conventional septic systems was very limited (Figure F.7-12). Approximately 88% of the parcels were existing water customers (Figure F.7-7). Approximately 62% and 10% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.7-5), respectively. Approximately 67% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.7-11). A summary of these parameters is presented in Table 5-15.

Figure 5-38: Emerson STPO Priority Area, Peachtree Cir S Site Visit Photo

Figure 5-39: Emerson STPO Priority Area, Lakewood Rd Site Visit Photo

Table 5-15: Emerson Characterization

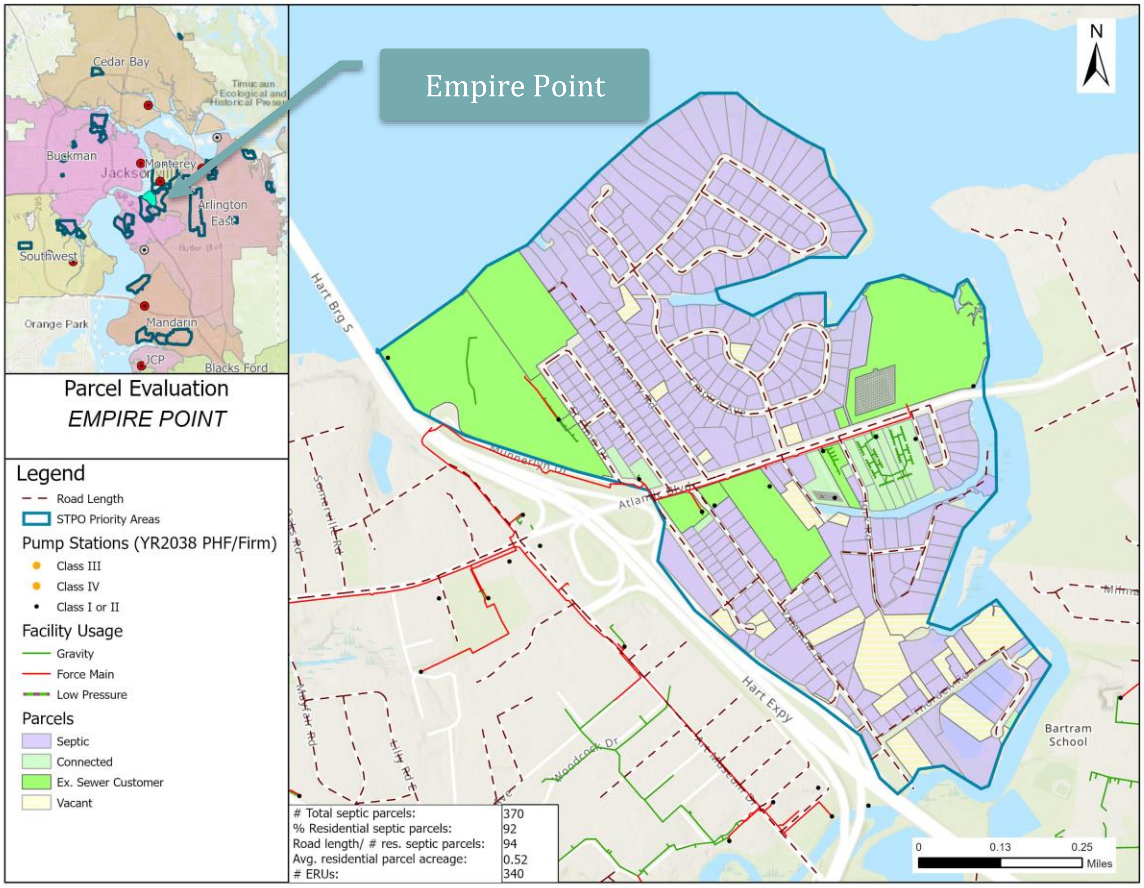
Description	Value	Units
2019 STPO Prioritization Ranking	5	
Total Parcels	1145	#
Septic Parcels	957	#
Proportion Septic	84	%
Proportion Residential	87	%
Average Res. Parcel Acreage	0.23	acres
Water Meter AADF	223,117	gpd
Planning AADF (gpd)	302,755	gpd
Rd. Length ÷ Res. Parcels	60	ft/parcel
Proportion Ex. Water Customers	88	%
Restoration Costs	low	
Topography	low variability	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	62	%
Proportion Nutrient TMDL Septic Parcels	10	%
Proportion SAS Most Vulnerable Septic Parcels	67	%
Proportion SAS More Vulnerable Septic Parcels	33	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	55	acres
Vacant Government Owned Acreage	15	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Riverine
- Surrounding the boundary:
    - Freshwater Forested/Shrub Wetland
    - Riverine

5.3.2 Empire Point

Empire Point was ranked #15 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 732 total parcels of which 370 were septic parcels (depicted as purple parcels in Figure 5-40), which equated to an AADF of approximately 101,870 to 134,100 gpd. The dashed line in Figure 5-40 depicts an approximate road length of 32,045 ft which equated to approximately 94 ft per residential septic parcel. The average residential parcel acreage was 0.52 acres. There were numerous large, deep, narrow waterfront lots that may be difficult to serve with gravity sewers.



# Total septic parcels:	370
% Residential septic parcels:	92
Road length/ # res. septic parcels:	94
Avg. residential parcel acreage:	0.52
# ERUs:	340

Figure 5-40: Empire Point Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 2 to 26 ft (see Appendix F.8 Figure A.8-3). A review of aerial maps (Figure F.8-10) and site visit data (Figure 5-41 and Figure 5-42) characterized restoration costs to be low (asphalt roads with no curbs, gutter, or sidewalks with a few large trees in the ROW) relative to other STPO priority areas. The road width ranged from 16 to 20 ft, and the ROW width ranged from 30 to 40 ft. The electric supply varied (overhead and underground). The depth to water table varied from 7 to 147 inches below grade (Figure F.8-4), and in general the soil rating for conventional septic systems was very limited (Figure F.8-12). Approximately 98% of the parcels were existing water customers (Figure F.8-7). Approximately 0% and 8% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.8-5), respectively.

Approximately 99% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.8-11). A summary of these parameters is presented in Table 5-16.

Figure 5-41: Empire Point STPO Priority Area, River Point Rd Site Visit Photo

Figure 5-42: Empire Point STPO Priority Area, Rankin Dr E Site Visit Photo

Table 5-16: Empire Point Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	15	
Total Parcels	732	#
Septic Parcels	370	#
Proportion Septic	51	%
Proportion Residential	92	%
Average Res. Parcel Acreage	0.52	acres
Water Meter AADF	101,868	gpd
Planning AADF (gpd)	134,096	gpd
Rd. Length ÷ Res. Parcels	94	ft/parcel
Proportion Ex. Water Customers	98	%
Restoration Costs	low	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	8	%
Proportion SAS Most Vulnerable Septic Parcels	99	%
Proportion SAS More Vulnerable Septic Parcels	1	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	22	acres
Vacant Government Owned Acreage	0.9	acres

Existing wetlands/surface water included:

- Within the boundary
  - Estuarine and Marine Deepwater
  - Estuarine and Marine Wetland
  - Freshwater Pond
  - Riverine
- Surrounding the boundary:
  - Estuarine and Marine Deepwater
  - Estuarine and Marine Wetland

5.3.3 Freeman

Freeman was ranked #19 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 124 total parcels of which 63 were septic parcels (depicted as purple parcels in Figure 5-43), which equated to an AADF of approximately 16,360 to 21,490 gpd. The dashed line in Figure 5-43 depicts an approximate road length of 2,990 ft which equated to approximately 52 ft per residential septic parcel. The average residential parcel acreage was 0.19 acres.

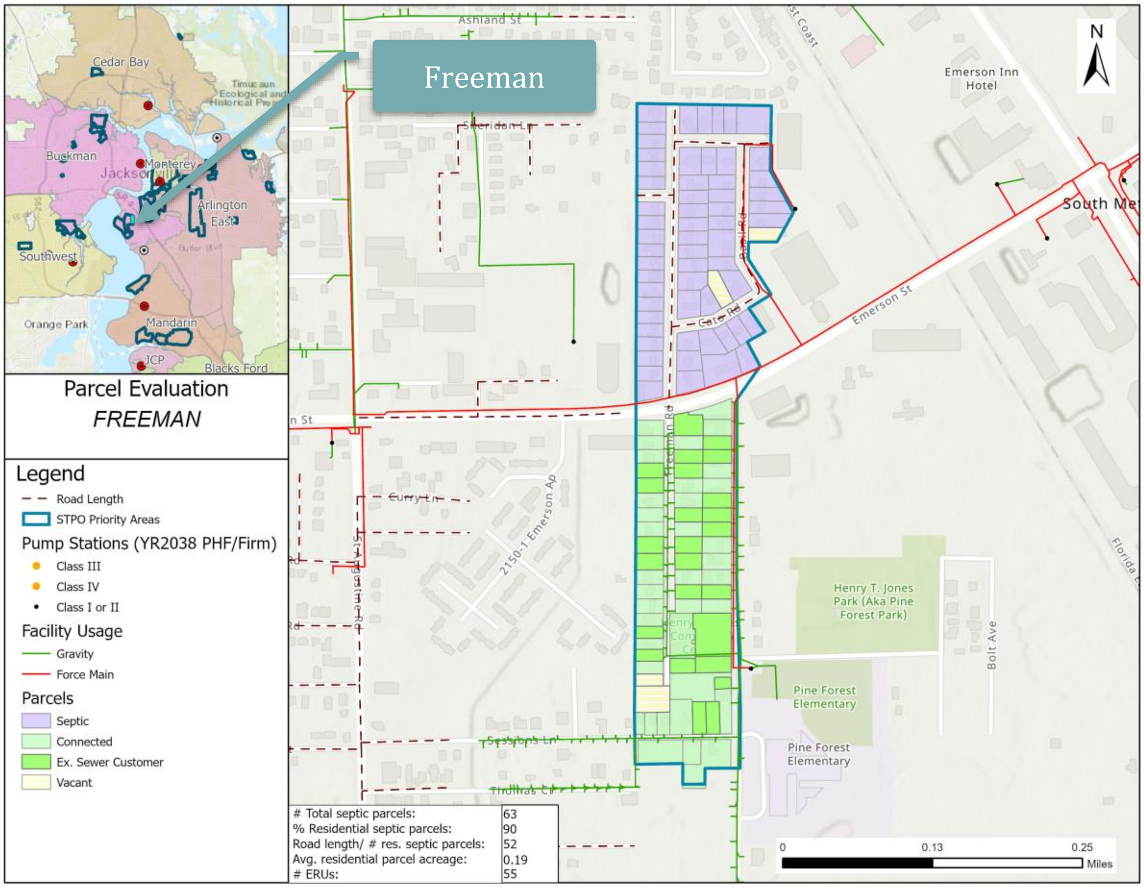


Figure 5-43: Freeman Septic Parcels

The topography of the septic parcels was relatively flat; elevations ranged from 24 to 26 ft (see Appendix F.9 Figure F.9-3). A review of aerial maps (Figure F.9-10) and site visit data (Figure 5-44 and Figure 5-45) characterized restoration costs to be medium (asphalt roads with no curbs/gutters, few sidewalks, large trees and stormwater drainage features in ROW) relative to other STPO priority areas. The road width ranged from 16 to 18 ft, and the ROW width was 60 ft. The electric supply was overhead. The depth to water table was 31 inches below grade (Figure F.9-4), and in general the soil rating for conventional septic systems was very limited (Figure F.9-12). All the septic parcels were existing water customers (Figure F.7). Approximately 100% and 0% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.9-5), respectively. Approximately 5% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.9-11). A summary of these parameters is presented in Table 5-17.

Figure 5-44: Freeman STPO Priority Area, Freeman Rd Site Visit Photo

Figure 5-45: Freeman STPO Priority Area, Freeman Rd Site Visit Photo

Table 5-17: Freeman Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	19	
Total Parcels	124	#
Septic Parcels	63	#
Proportion Septic	51	%
Proportion Residential	90	%
Average Res. Parcel Acreage	0.19	acres
Water Meter AADF	16,355	gpd
Planning AADF (gpd)	21,493	gpd
Rd. Length ÷ Res. Parcels	52	ft/parcel
Proportion Ex. Water Customers	100	%
Restoration Costs	medium	
Topography	flat	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	100	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	5	%
Proportion SAS More Vulnerable Septic Parcels	95	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	1.0	acres
Vacant Government Owned Acreage	0.6	acres

There were no existing wetlands/surface water within or surrounding the STPO priority area boundary.

5.3.4 Kinard

Kinard was ranked #14 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 84 total parcels all of which were septic parcels (depicted as purple parcels in Figure 5-46), which equated to an AADF of approximately 30,430 to 36,400 gpd. The dashed line in Figure 5-46 depicts an approximate road length of 6,430 ft which equated to approximately 78 ft per residential septic parcel. The average residential parcel acreage was 0.44 acres. There were several large, vacant parcels within this area.

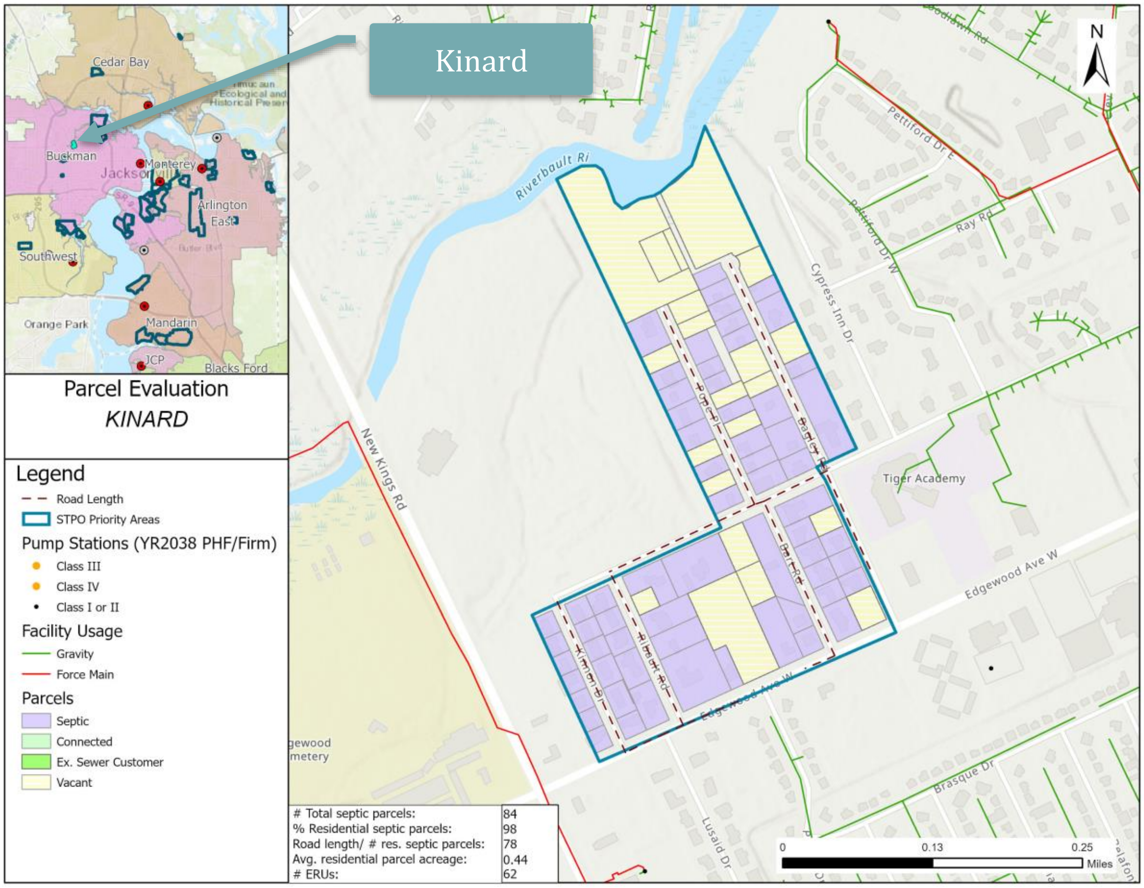


Figure 5-46: Kinard Septic Parcels

There was low variability of topography for the septic parcels; elevations ranged from 4 to 18 ft (see Appendix F.14 Figure F.14-3). A review of aerial maps (Figure F.14-10) and site visit data (Figure 5-47 and Figure 5-48) characterized restoration costs to be medium (asphalt roads with sidewalks and stormwater swales and a few large trees in the ROW) relative to other STPO priority areas. The road width ranged from 16 to 24 ft, and the ROW width ranged from 40 to 50 ft. The electric supply was overhead. The depth to water table varied from 31 to 69 inches below grade (Figure F.14-4), and the soil rating for conventional septic systems was very limited (Figure F.14-12). Approximately 67% of the parcels were existing water customers (Figure F.14-7). Approximately 100% and 0% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.14-5), respectively. Approximately 74% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.14-11). A summary of these parameters is presented in Table 5-18.

Figure 5-47: Kinard STPO Priority Area, Kinnon Dr Site Visit Photo

Figure 5-48: Kinard STPO Priority Area, Pope Pl Site Visit Photo

Table 5-18: Kinard Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	14	
Total Parcels	84	#
Septic Parcels	84	#
Proportion Septic	100	%
Proportion Residential	98	%
Average Res. Parcel Acreage	0.44	acres
Water Meter AADF	30,428	gpd
Planning AADF (gpd)	36,407	gpd
Rd. Length ÷ Res. Parcels	78	ft/parcel
Proportion Ex. Water Customers	67	%
Restoration Costs	medium	
Topography	low variability	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	100	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	74	%
Proportion SAS More Vulnerable Septic Parcels	26	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	16	acres
Vacant Government Owned Acreage	0	acres

Existing wetlands/surface water included:

- Within the boundary
    - Riverine
- Surrounding the boundary:
    - Freshwater Forested/Shrub Wetland
    - Riverine

5.3.5 Oak Lawn

Oak Lawn was ranked #11 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 471 total parcels of which 235 were septic parcels (depicted as purple parcels in Figure 5-49), which equated to an AADF of approximately 47,920 to 69,500 gpd. The dashed line in Figure 5-49 depicts an approximate road length of 13,970 ft which equated to approximately 61 ft per residential septic parcel. The average residential parcel acreage was 0.30 acres.

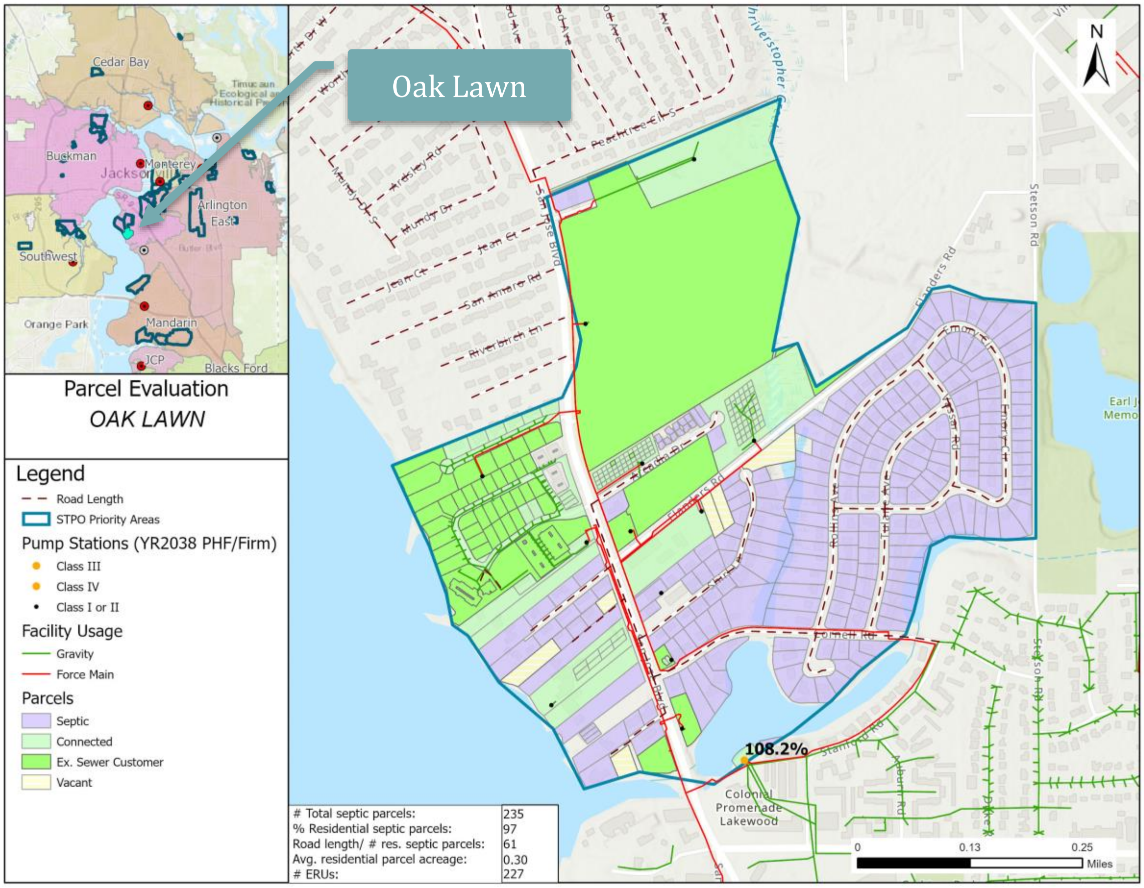


Figure 5-49: Oak Lawn Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 2 to 22 ft (see Appendix F.20 Figure F.20-3). A review of aerial maps (Figure F.20-10) and site visit data (Figure 5-50 and Figure 5-51) characterized restoration costs to be medium (asphalt roads with curbs and gutters) relative to other STPO priority areas. The road width ranged from 20 to 24 ft, and the ROW width ranged from 40 to 60 ft. The electric supply was overhead. The depth to water table varied from 0 to 147 inches below grade (Figure F.20-4), and in general the soil rating for conventional septic systems was generally very limited (Figure F.20-12). Approximately 90% of the parcels were existing water customers (Figure F.20-7). Approximately 0% and 6% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.20-5), respectively. Approximately 98% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.20-11). A summary of these parameters is presented in Table 5-19.

Figure 5-50: Oak Lawn STPO Priority Area, Cornell Rd Site Visit Photo

Figure 5-51: Oak Lawn STPO Priority Area, Rollins Ave and Vassar Rd Intersection Site Visit Photo

Table 5-19: Oak Lawn Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	11	
Total Parcels	471	#
Septic Parcels	235	#
Proportion Septic	50	%
Proportion Residential	97	%
Average Res. Parcel Acreage	0.3	acres
Water Meter AADF	47,916	gpd
Planning AADF (gpd)	69,496	gpd
Rd. Length ÷ Res. Parcels	61	ft/parcel
Proportion Ex. Water Customers	90	%
Restoration Costs	medium	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	6	%
Proportion SAS Most Vulnerable Septic Parcels	98	%
Proportion SAS More Vulnerable Septic Parcels	2	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	3.1	acres
Vacant Government Owned Acreage	0	acres

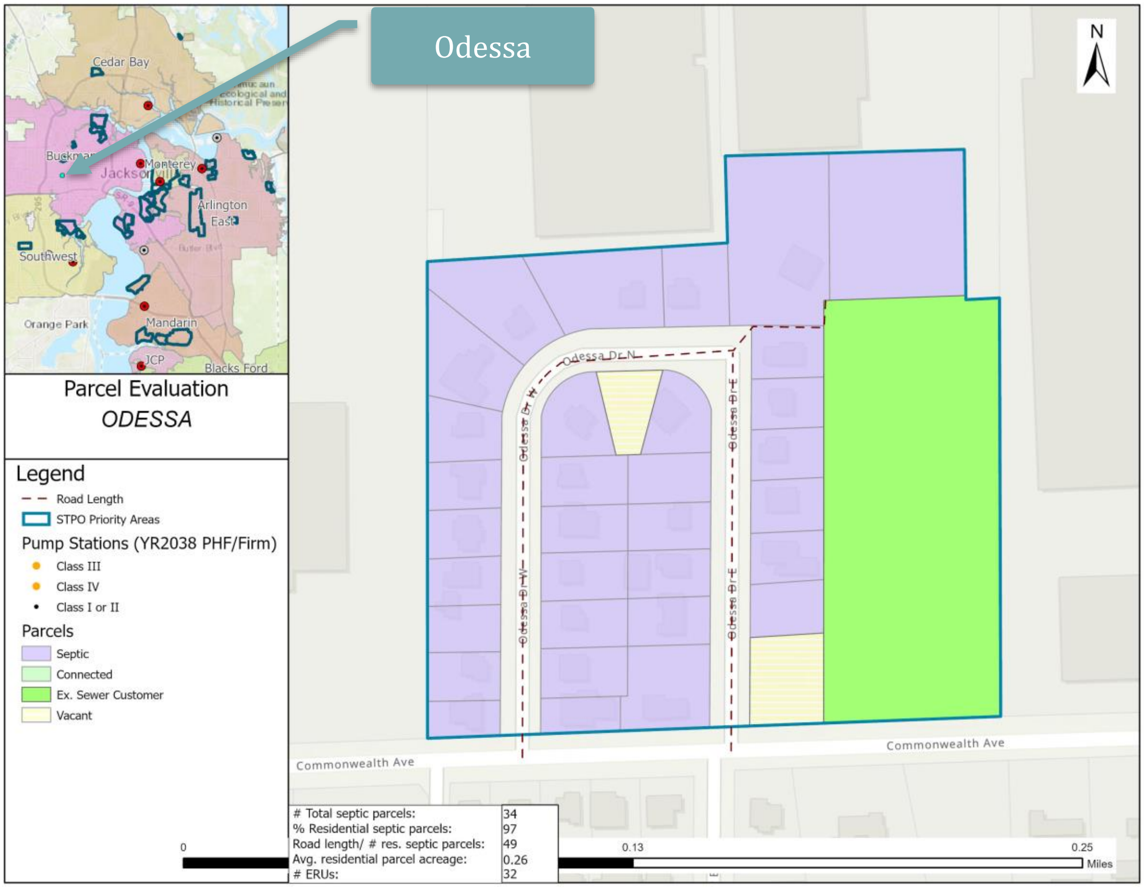
Existing wetlands/surface water included:

- Within the boundary
    - Estuarine and Marine Deepwater
    - Freshwater Forested/Shrub Wetland
    - Freshwater Pond
    - Riverine
- Surrounding the boundary:
    - Estuarine and Marine Deepwater
    - Freshwater Forested/Shrub Wetland
    - Freshwater Pond
    - Riverine

5.3.6 Odessa

Odessa was ranked #32 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 35 total parcels of which 34 were septic parcels (depicted as purple parcels in Figure 5-52), which equated to an AADF of approximately 6,650 to 9,640 gpd. The dashed line in Figure 5-52 depicts an approximate road length of 1,630 ft which equated to approximately 49 ft per residential septic parcel.

The average residential parcel acreage was 0.26 acres.



# Total septic parcels:	34
% Residential septic parcels:	97
Road length/ # res. septic parcels:	49
Avg. residential parcel acreage:	0.26
# ERUs:	32

Figure 5-52: Odessa Septic Parcels

The topography of the septic parcels was relatively flat; elevations ranged from 20 to 24 ft (see Appendix F.22 Figure F.22-3). A review of aerial maps (Figure F.22-10) and site visit data (Figure 5-53 and Figure 5-54) characterized restoration costs to be low (asphalt roads with no curbs, gutters, or sidewalks) relative to other STPO priority areas. The road width was approximately 18 ft, and the ROW width ranged from 40 to 50 ft. The electric supply was overhead. The depth to water table varied from 15 to 23 inches below grade (Figure F.22-4), and in general the soil rating for conventional septic systems was very limited (Figure F.22-12). Approximately 97% of the parcels were existing water customers (Figure F.22-7). None of the septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.22-5). None of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.22-11). A summary of these parameters is presented in Table 5-20.

Figure 5-53: Odessa STPO Priority Area, Odessa Dr W Site Visit Photo

Figure 5-54: Odessa STPO Priority Area, Odessa Dr E Site Visit Photo

Table 5-20: Odessa Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	32	
Total Parcels	35	#
Septic Parcels	34	#
Proportion Septic	97	%
Proportion Residential	97	%
Average Res. Parcel Acreage	0.26	acres
Water Meter AADF	6,648	gpd
Planning AADF (gpd)	9,638	gpd
Rd. Length ÷ Res. Parcels	49	ft/parcel
Proportion Ex. Water Customers	97	%
Restoration Costs	low	
Topography	flat	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	0	%
Proportion SAS More Vulnerable Septic Parcels	100	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	0.5	acres
Vacant Government Owned Acreage	0	acres

Existing wetlands/surface water included:

- Within the boundary: None
- Surrounding the boundary: Riverine

5.3.7 Point La Vista

Point La Vista was ranked #27 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 1,083 total parcels of which 866 were septic parcels (depicted as purple parcels in Figure 5-55), which equated to an AADF of approximately 169,649 to 250,270 gpd. The dashed line in Figure 5-55 depicts an approximate road length of 51,820 ft which equated to approximately 61 ft per residential septic parcel. The average residential parcel acreage was 0.32 acres. There were numerous large, deep, narrow parcels that may be difficult to serve with gravity sewers in this STPO priority area.

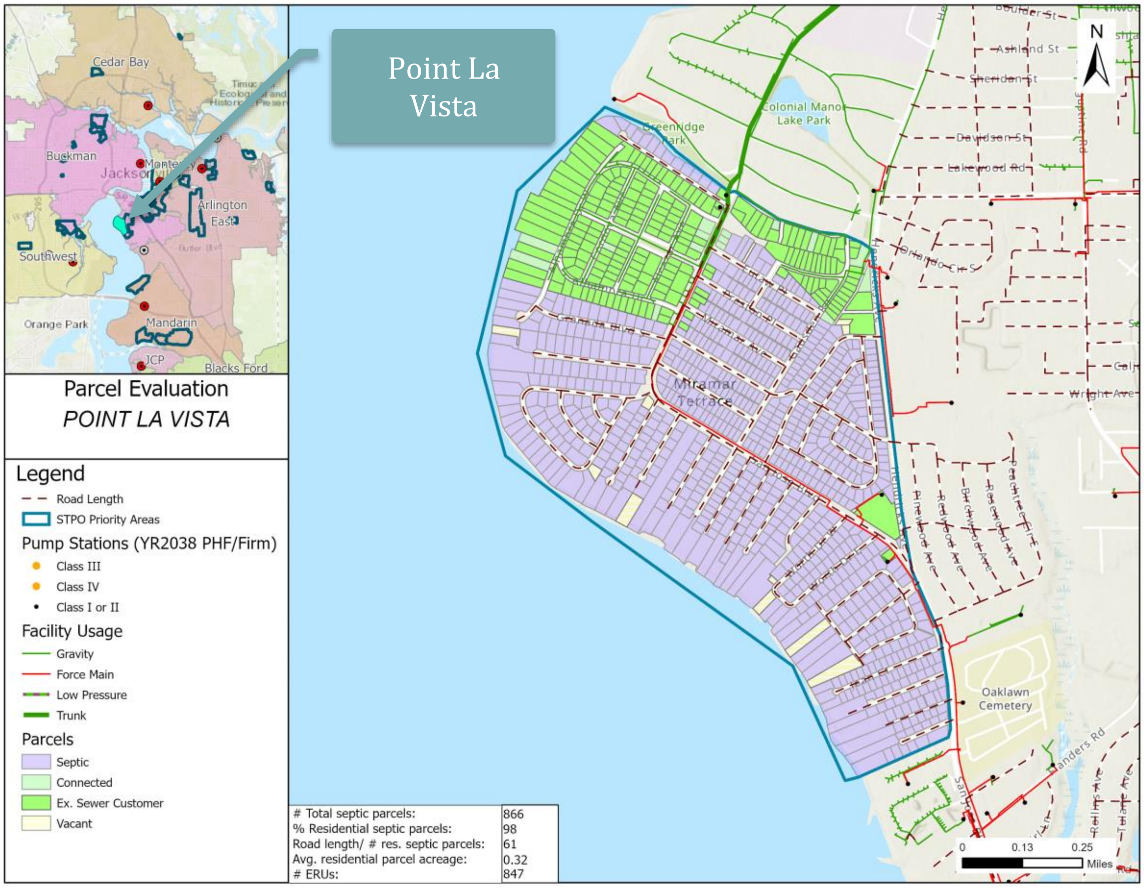


Figure 5-55: Point La Vista Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 2 to 22 ft (see Appendix F.25 Figure F.25-3). A review of aerial maps (Figure F.25-10) and site visit data (Figure 5-56 and Figure 5-57) characterized restoration costs to be high (some roads have curbs, gutters and sidewalks) relative to other STPO priority areas. The road width ranged from 20 to 30 ft, and the ROW width ranged from 30 to 75 ft. The electric supply varied (overhead and underground). The depth to water table varied from 31 to 147 inches below grade (Figure F.25-4), and in general the soil rating for conventional septic systems was very limited (Figure F.25-12). Approximately 95% of the parcels were existing water customers (Figure F.25-7). Approximately 15% and 84% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.25-5), respectively. All of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.25-11). A summary of these parameters is presented in Table 5-21.

Figure 5-56: Point La Vista STPO Priority Area, Point La Vista Rd N Site Visit Photo

Figure 5-57: Point La Vista STPO Priority Area, E Worth Dr Site Visit Photo

Table 5-21: Point La Vista Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	27	
Total Parcels	1083	#
Septic Parcels	866	#
Proportion Septic	80	%
Proportion Residential	98	%
Average Res. Parcel Acreage	0.32	acres
Water Meter AADF	169,649	gpd
Planning AADF (gpd)	250,268	gpd
Rd. Length ÷ Res. Parcels	61	ft/parcel
Proportion Ex. Water Customers	95	%
Restoration Costs	high	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	15	%
Proportion Nutrient TMDL Septic Parcels	84	%
Proportion SAS Most Vulnerable Septic Parcels	100	%
Proportion SAS More Vulnerable Septic Parcels	0	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	7.3	acres
Vacant Government Owned Acreage	0.3	acres

Existing wetlands/surface water included:

- Within the boundary
    - Estuarine and Marine Deepwater
    - Riverine
- Surrounding the boundary:
    - Riverine
    - Estuarine and Marine Deepwater

5.3.8 Riverview

Riverview was ranked #4 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 1,793 total parcels of which 1,768 were septic parcels (depicted as purple parcels in Figure 5-58), which equated to an AADF of approximately 393,970 to 528,290 gpd. The dashed line in Figure 5-58 depicts an approximate road length of 121,060 ft which equated to approximately 74 ft per residential septic parcel. The average residential parcel acreage was 0.22 acres.

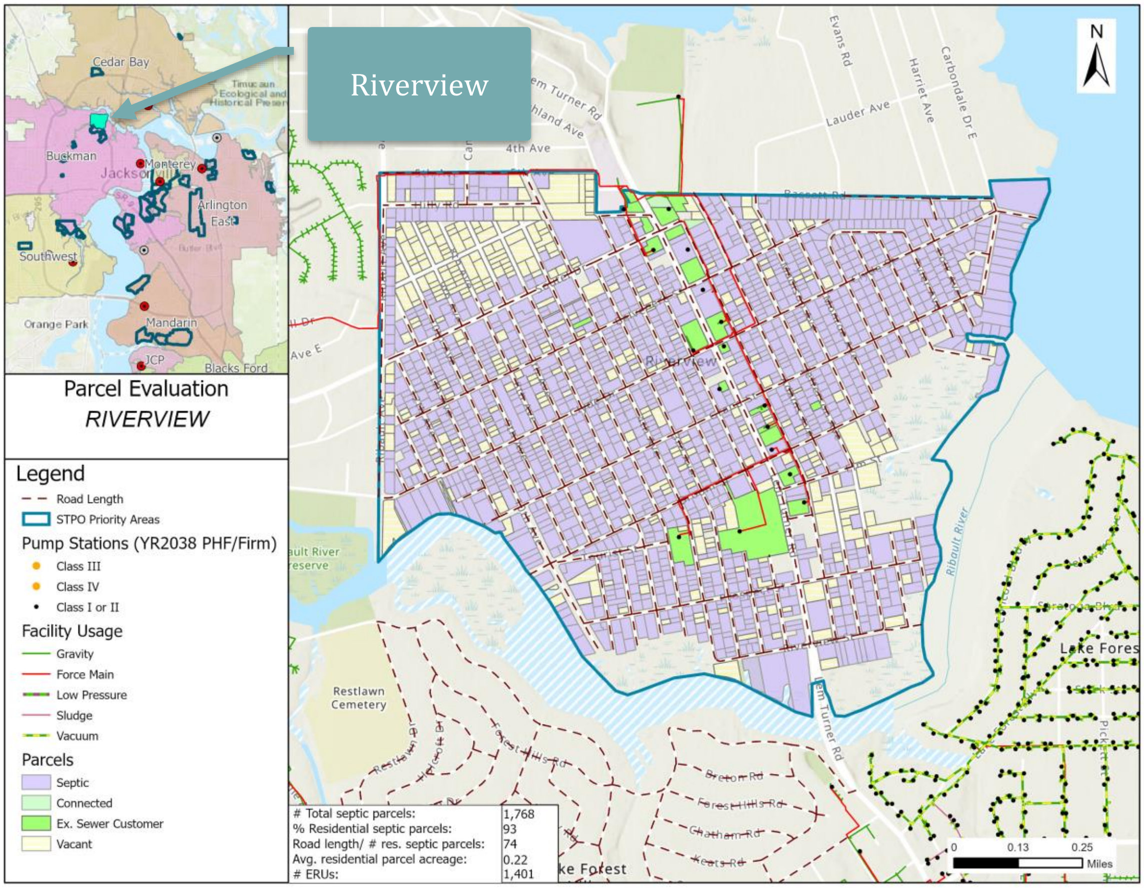


Figure 5-58: Riverview Septic Parcels

The topography of septic parcels was highly variable, and elevations ranged from 2 to 38 ft (see Appendix F.26 Figure F.26-3). A review of aerial maps (Figure F.26-10) and site visit data (Figure 5-59 and Figure 5-60) characterized restoration costs to be medium (asphalt roads with curbs, stormwater swales and sidewalks in some areas) relative to other STPO priority areas. The road width ranged from 16 to 20 ft, and the ROW width ranged from 35 to 50 ft. The electric supply was overhead. The depth to water table varied from 8 to 147 inches below grade (Figure F.26-4), and the soil rating for conventional septic systems was variable (not rated, somewhat limited and very limited see Figure F.26-18). Approximately 87% of the parcels were existing water customers (Figure F.26-7). Approximately 100% and 0% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.26-5), respectively. Approximately 31% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.26-17). A summary of these parameters is presented in Table 5-22.

Figure 5-59: Riverview STPO Priority Area, Prospect St and 3rd Ave Intersection Site Visit Photo

Figure 5-60: Riverview STPO Priority Area, Carbondale Dr E Site Visit Photo

Table 5-22: Riverview Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	4	
Total Parcels	1793	#
Septic Parcels	1768	#
Proportion Septic	99	%
Proportion Residential	93	%
Average Res. Parcel Acreage	0.22	acres
Water Meter AADF	393,970	gpd
Planning AADF (gpd)	528,287	gpd
Rd. Length ÷ Res. Parcels	74	ft/parcel
Proportion Ex. Water Customers	87	%
Restoration Costs	medium	
Topography	highly variable	
Soil Rating for conventional septic systems	variable	
Proportion Fecal Coliform TMDL Septic Parcels	100	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	31	%
Proportion SAS More Vulnerable Septic Parcels	69	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	79	acres
Vacant Government Owned Acreage	2.8	acres

Existing wetlands/surface water included:

- Within the boundary
    - Estuarine and Marine Wetland
    - Estuarine and Marine Deepwater
    - Freshwater Pond
    - Riverine
    - Freshwater Forested/Shrub Wetland
- Surrounding the boundary:
    - Estuarine and Marine Wetland
    - Estuarine and Marine Deepwater

5.3.9 Spring Glen

Spring Glen was ranked #17 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 873 total parcels of which 629 were septic parcels (depicted as purple parcels in Figure 5-61), which equated to an AADF of approximately 147,970 to 203,400 gpd. The dashed line in Figure 5-61 depicts an approximate road length of 51,749 ft which equated to approximately 97 ft per residential septic parcel. The average residential parcel acreage was 0.32 acres.

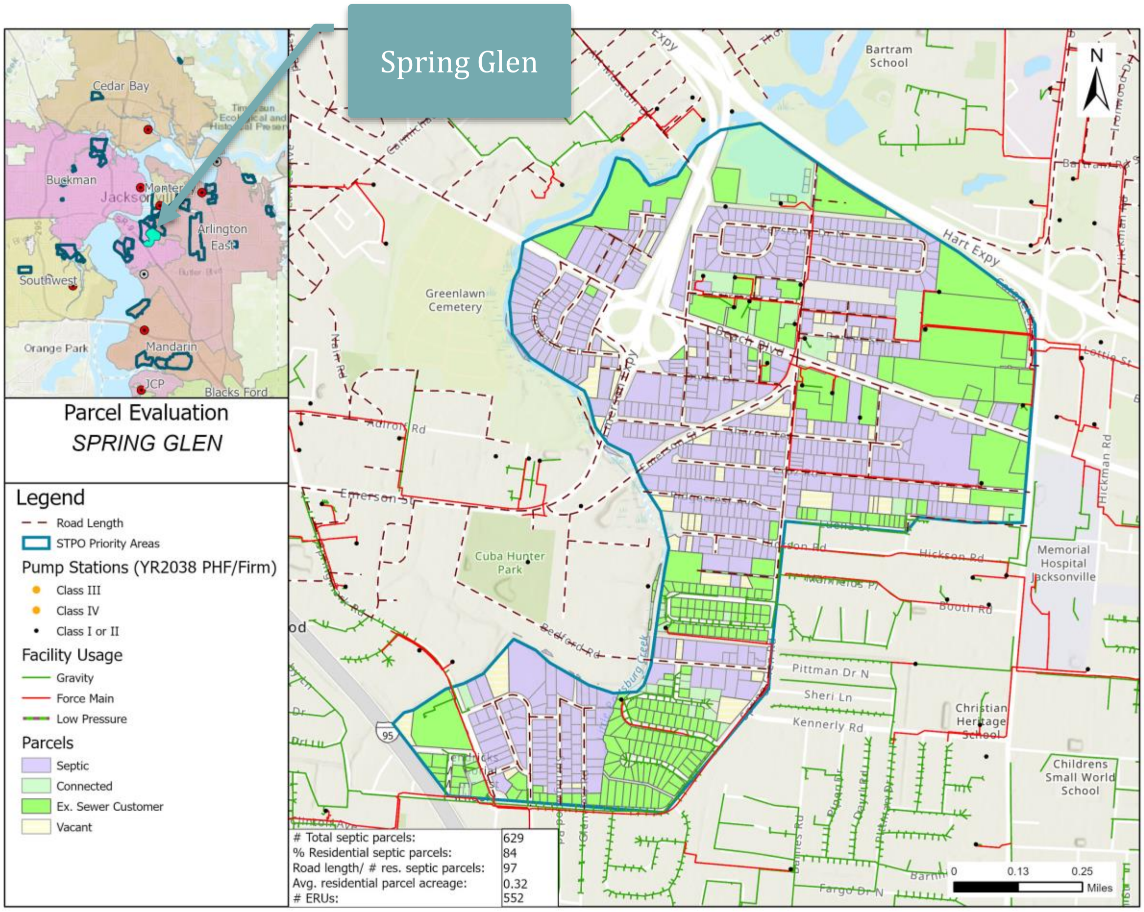


Figure 5-61: Spring Glen Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 6 to 24 ft (see Appendix F.29 Figure F.29-3). A review of aerial maps (Figure F.29-10) and site visit data (Figure 5-62 and Figure 5-63) characterized restoration costs to be medium (asphalt roads with sidewalks and stormwater swales in some areas) relative to other STPO priority areas. The road width ranged from 18 to 24 ft, and the ROW width ranged from 40 to 50 ft. The electric supply was overhead. The depth to water table varied from 0 to 145 inches below grade (Figure F.29-4), and the soil rating for conventional septic systems was generally very limited (Figure F.29-12). Approximately 98% of the parcels were existing water customers (Figure F.29-7). None of the septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.29-5). Approximately 66% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.29-11). A summary of these parameters is presented in Table 5-23.

Figure 5-62 Spring Glen STPO Priority Area, Sharon Terrace Site Visit Photo

Figure 5-63: Spring Glen STPO Priority Area, Springwood Rd Site Visit Photo

Table 5-23: Spring Glen Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	17	
Total Parcels	873	#
Septic Parcels	629	#
Proportion Septic	72	%
Proportion Residential	84	%
Average Res. Parcel Acreage	0.32	acres
Water Meter AADF	147,972	gpd
Planning AADF (gpd)	203,403	gpd
Rd. Length ÷ Res. Parcels	97	ft/parcel
Proportion Ex. Water Customers	98	%
Restoration Costs	medium	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	69	%
Proportion SAS More Vulnerable Septic Parcels	34	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	21	acres
Vacant Government Owned Acreage	7	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Riverine
    - Freshwater Pond
- Surrounding the boundary:
    - Estuarine and Marine Deepwater
    - Freshwater Forested/Shrub Wetland
    - Riverine

5.3.10 St. Nicholas

St. Nicholas was ranked #6 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 1,384 total parcels of which 751 were septic parcels (depicted as purple parcels in Figure 5-64), which equated to an AADF of approximately 198,670 to 255,820 gpd. The dashed line in Figure 5-64 depicts an approximate road length of 68,700 ft which equated to approximately 115 ft per residential septic parcel. The average residential parcel acreage was 0.32 acres. There were large, deep, narrow waterfront lots in this area that may be difficult to serve via gravity sewers.

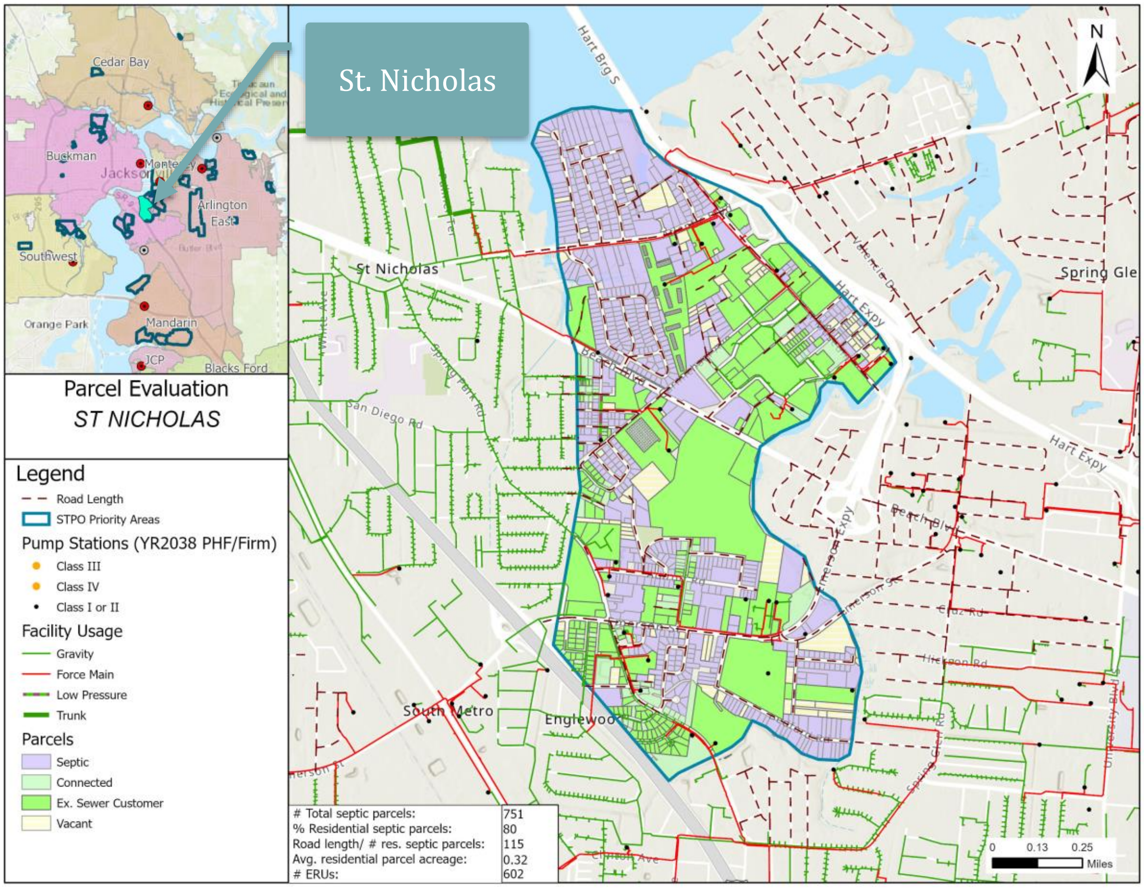


Figure 5-64: St. Nicholas Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 2 to 26 ft (see Appendix F.30 Figure F.30-3). A review of aerial maps (Figure F.30-10) and site visit data (Figure 5-65 and Figure 5-66) characterized restoration costs to be medium (asphalt roads with curbs, gutters and many large trees in the ROW) relative to other STPO priority areas. The road width ranged from 15 to 24 ft, and the ROW width ranged from 30 to 50 ft. The electric supply was overhead. The depth to water table varied from 0 to 147 inches below grade (Figure F.30-4), and the soil rating for conventional septic systems was generally very limited (Figure F.30-12). Approximately 94% of the parcels were existing water customers (Figure F.30-7). Approximately 46% and 12% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.30-5), respectively. Approximately 61% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.30-11). A summary of these parameters is presented in Table 5-24.

Figure 5-65: St. Nicholas STPO Priority Area, Somerville Rd and Halliday Ln Intersection Site Visit Photo

Figure 5-66: St. Nicholas STPO Priority Area, Welaka St Site Visit Photo

Table 5-24: St. Nicholas Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	6	
Total Parcels	1384	#
Septic Parcels	751	#
Proportion Septic	54	%
Proportion Residential	80	%
Average Res. Parcel Acreage	0.32	acres
Water Meter AADF	198,666	gpd
Planning AADF (gpd)	255,819	gpd
Rd. Length ÷ Res. Parcels	115	ft/parcel
Proportion Ex. Water Customers	94	%
Restoration Costs	medium	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	46	%
Proportion Nutrient TMDL Septic Parcels	12	%
Proportion SAS Most Vulnerable Septic Parcels	61	%
Proportion SAS More Vulnerable Septic Parcels	39	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	48	acres
Vacant Government Owned Acreage	11	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Riverine
    - Freshwater Pond
- Surrounding the boundary:
    - Estuarine and Marine Deepwater
    - Freshwater Forested/Shrub Wetland
    - Riverine

5.4 Cedar Bay (District 2) WWTF Service Area

The Cedar Bay (District 2) WWTF has a permitted capacity of 10 MGD. The revised projected YR2040 wastewater AADF was approximately 8.1 MGD, resulting in an available capacity of 1.9 MGD (or approximately 19%). The additional flow from STPO priority areas in the service area was estimated to be approximately 0.1 MGD, which was less than the available capacity (Table 5-3). The Cedar Bay (District 2) service area included two STPO priority areas — Northlake and The Cape. Figure 5-67 depicts the extent of the service area, the STPO priority area boundaries and impaired waters with TMDL limits for fecal coliform, nutrients and dissolved oxygen.

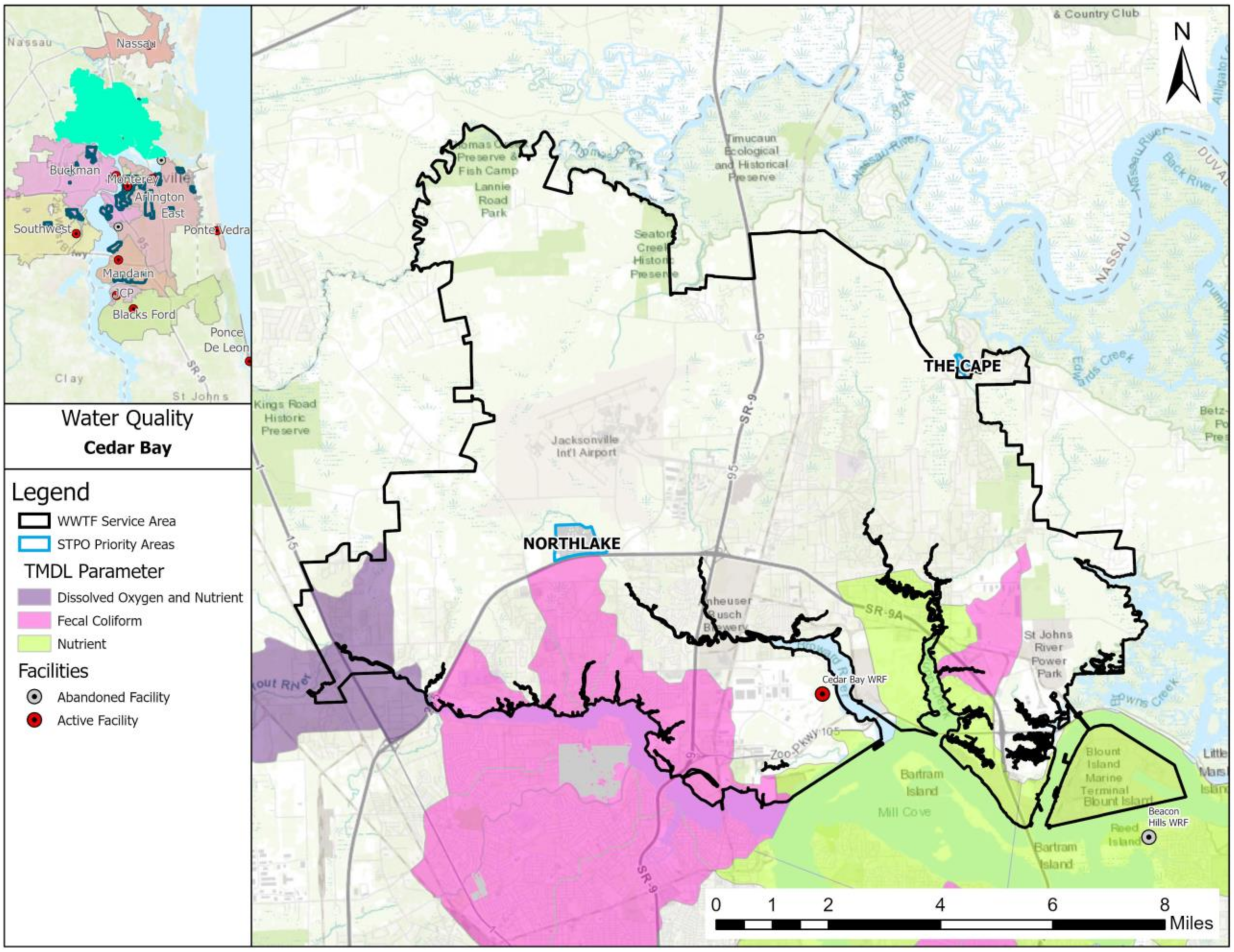
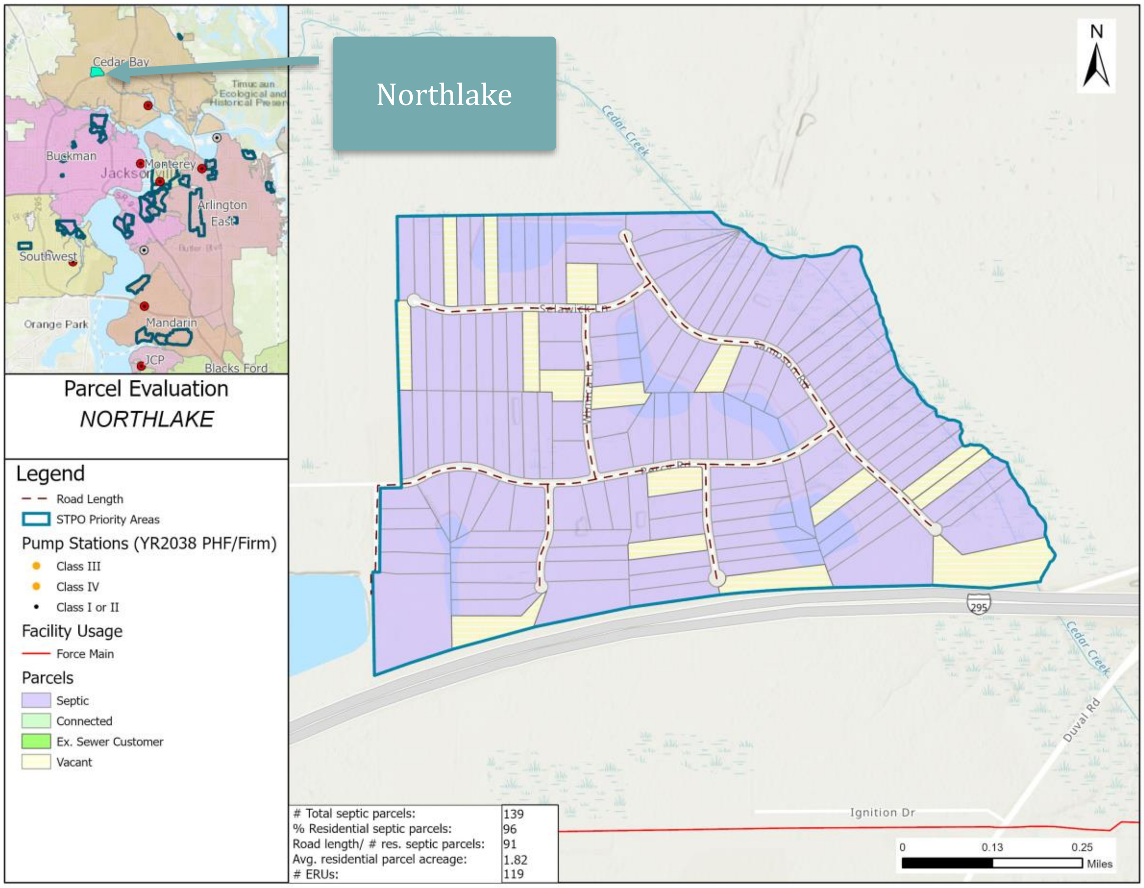


Figure 5-67: Cedar Bay Service Area

5.4.1 Northlake

Northlake was ranked #25 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 139 total parcels which were all septic parcels (depicted as purple parcels in Figure 5-68), which equated to an AADF of approximately 64,700 to 76,000 gpd. The dashed line in Figure 5-68 depicts an approximate road length of 12,240 ft which equated to approximately 91 ft per residential septic parcel. The average residential parcel acreage was 1.82 acres.



# Total septic parcels:	139
% Residential septic parcels:	96
Road length/ # res. septic parcels:	91
Avg. residential parcel acreage:	1.82
# ERUs:	119

Figure 5-68: Northlake Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 4 to 24 ft (see Appendix F.19 Figure F.19-3). A review of aerial maps (Figure F.19-10) and site visit data (Figure 5-69 and Figure 5-70) characterized restoration costs to be low (asphalt roads with no curbs, gutters, or sidewalks with stormwater swales in the ROW) relative to other STPO priority areas. The neighborhood was homogenous with large brick mailboxes. The road width was approximately 20 ft, and ROW width was approximately 60 ft. The electric supply was overhead. The depth to water table varied from 0 to 31 inches below grade (Figure F.19-4), and the soil rating for conventional septic systems was in general very limited (Figure F.19-12). None of the parcels were existing water customers (Figure F.19-7). None of the septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.19-5). Approximately 17% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.19-11). A summary of these parameters is presented in Table 5-25.

Figure 5-69: Northlake STPO Priority Area, Percy Ln Site Visit Photo

Figure 5-70: Northlake STPO Priority Area, Selawick Ln Site Visit Photo

Table 5-25: Northlake Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	25	
Total Parcels	139	#
Septic Parcels	139	#
Proportion Septic	100	%
Proportion Residential	96	%
Average Res. Parcel Acreage	1.82	acres
Water Meter AADF	64,703	gpd
Planning AADF (gpd)	76,007	gpd
Rd. Length ÷ Res. Parcels	91	ft/parcel
Proportion Ex. Water Customers	0	%
Restoration Costs	low	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	17	%
Proportion SAS More Vulnerable Septic Parcels	71	%
Proportion SAS Vulnerable Septic Parcels	12	%
Vacant Acreage	31	acres
Vacant Government Owned Acreage	0	acres

Existing wetlands/surface water included:

- Within the boundary: Freshwater Forested/Shrub Wetland
- Surrounding the boundary: Freshwater Forested/Shrub Wetland

5.4.2 The Cape

The Cape was ranked #33 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 38 total parcels which were all septic parcels (depicted as purple parcels Figure 5-71), which equated to an AADF of approximately 12,800 to 15,980 gpd. The dashed line in Figure 5-71 depicts an approximate road length of 3,420 ft which equated to approximately 92 ft per residential septic parcel. The average residential parcel acreage was 0.87 acres.

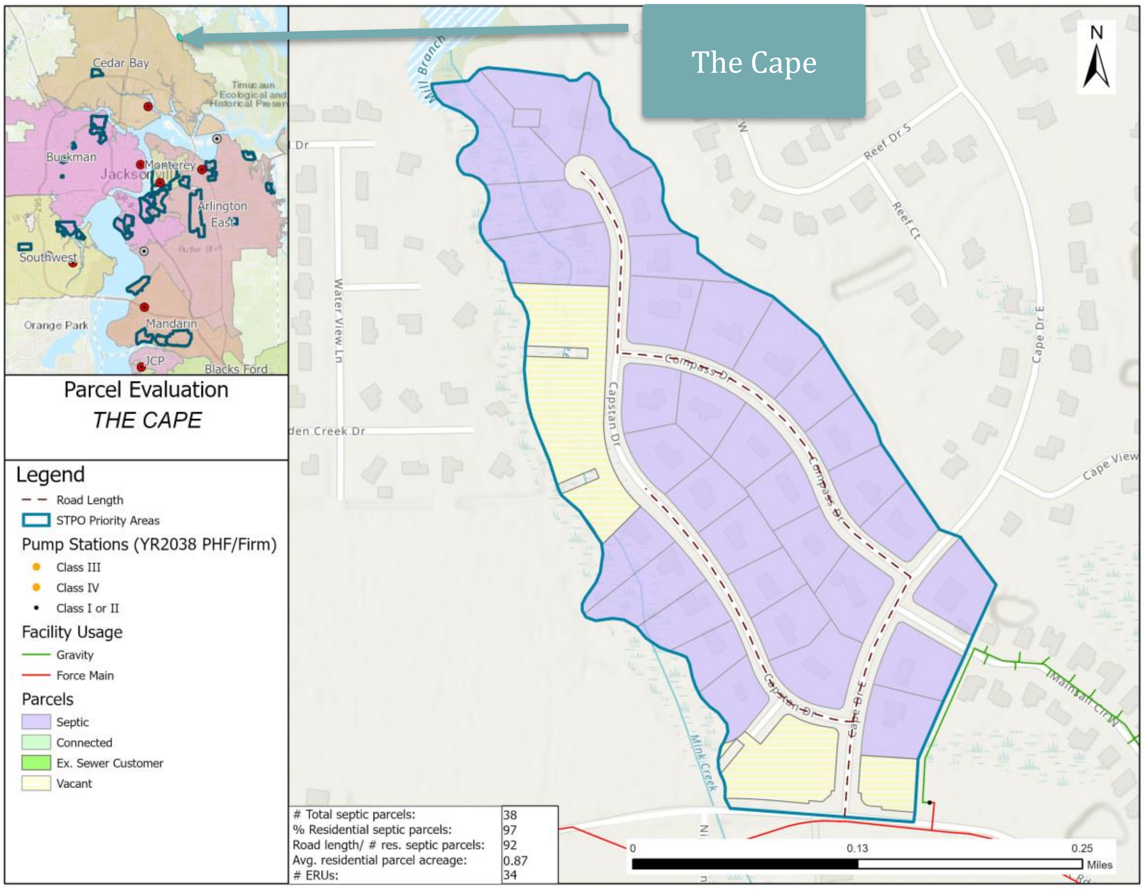


Figure 5-71: The Cape Septic Parcels

There was low variability of topography for the septic parcels; elevations ranged from 2 to 16 ft (see Appendix F.31 Figure F.31-3). A review of aerial maps (Figure F.31-10) and site visit data (Figure 5-72 and Figure 5-73) characterized restoration costs to be low (asphalt roads with no curbs, gutter, or sidewalks and some stormwater swales in the ROW) relative to other STPO priority areas. The road width ranged from 22 to 24 ft, and the ROW width was approximately 50 ft. The electric supply was underground. The depth to water table varied from 0 to 53 inches below grade (Figure F.31-4), and in general the soil rating for conventional septic systems was very limited (Figure F.31-12). Approximately 13% of the parcels were existing water customers (Figure F.31-7). None of the septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.31-5). Approximately 34% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.31-11). A summary of these parameters is presented in Table 5-26.

Figure 5-72: The Cape STPO Priority Area, Compass Dr Site Visit Photo

Figure 5-73: The Cape STPO Priority Area, Capstan Dr Site Visit Photo

Table 5-26: The Cape Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	33	
Total Parcels	38	#
Septic Parcels	38	#
Proportion Septic	100	%
Proportion Residential	97	%
Average Res. Parcel Acreage	0.87	acres
Water Meter AADF	12,803	gpd
Planning AADF (gpd)	15,979	gpd
Rd. Length ÷ Res. Parcels	92	ft/parcel
Proportion Ex. Water Customers	13	%
Restoration Costs	low	
Topography	low variability	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	34	%
Proportion SAS More Vulnerable Septic Parcels	61	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	5.4	acres
Vacant Government Owned Acreage	0	acres

The Cape was in close proximity to three Outstanding Florida Waters (see Appendix F.31 Figure F.31-12):

- Timucuan Ecological and Historic Preserve
- Nassau River – St. Johns River Marshes Aquatic Preserve
- Nassau Valley State Reserve

Existing wetlands/surface water included:

- Within the boundary
  - Freshwater Forested/Shrub Wetland
  - Estuarine and Marine Wetland
- Surrounding the boundary:
  - Freshwater Forested/Shrub Wetland
  - Estuarine and Marine Wetland

5.5 Mandarin WWTF Service Area

The Mandarin WWTF has a permitted capacity of 8.75 MGD. The revised projected YR2040 wastewater AADF was approximately 6.6 MGD, which resulted in an available capacity of 2.1 MGD (or approximately 25%). The additional flow from STPO priority areas in the service area was estimated to be approximately 1.24 MGD, which was less than the available capacity if planned improvements were incorporated (Table 5-3). The Mandarin service area included four STPO priority areas— Beauclerc Gardens, Hood Landing II, Julington Creek, and Julington Hills. Figure 5-74 depicts the extent of the service area, the STPO priority area boundaries and impaired waters with TMDL limits for fecal coliform and nutrients.

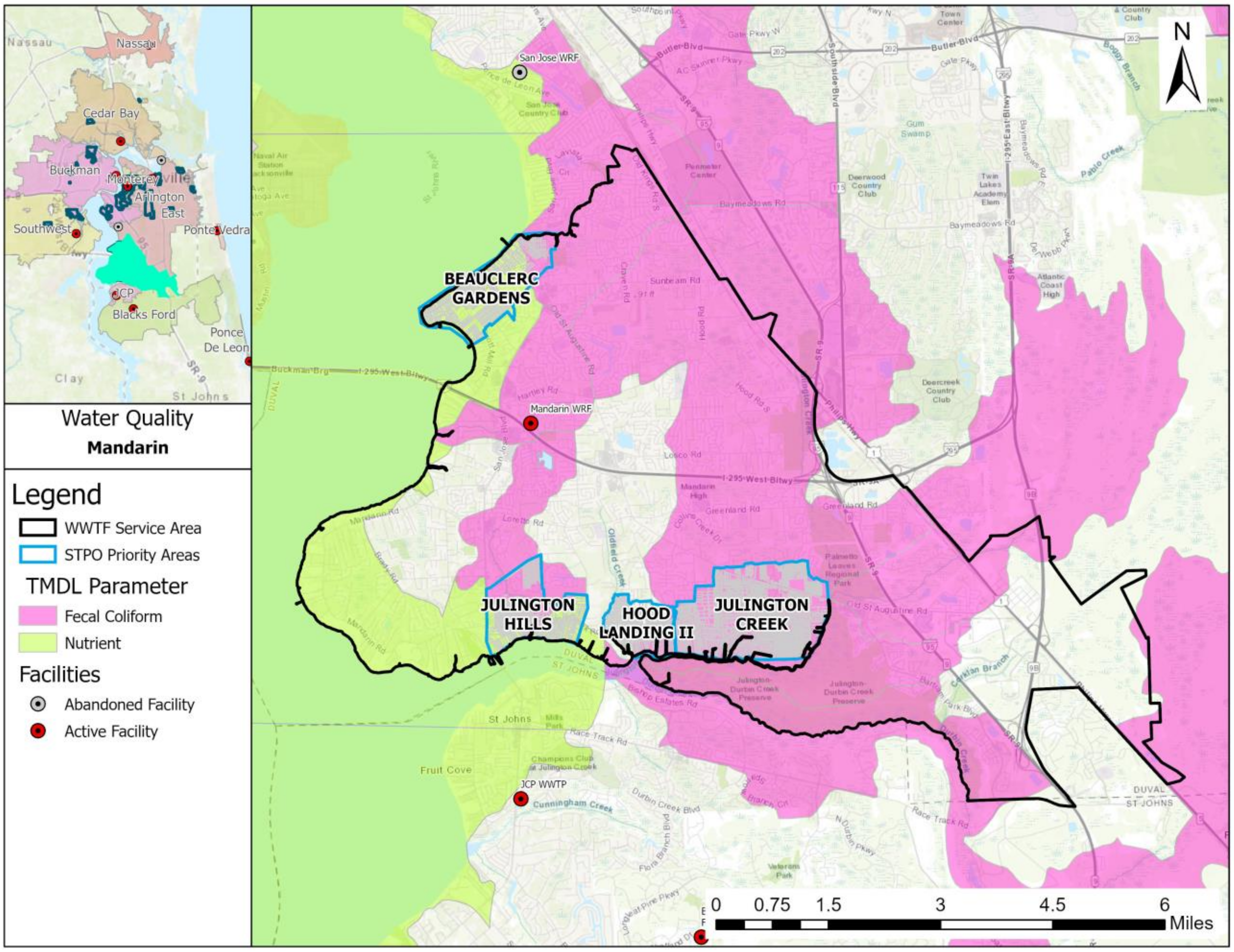


Figure 5-74: Mandarin Service Area

5.5.1 Beauclerc Gardens

Beauclerc Gardens was ranked #28 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 1,265 total parcels of which 615 were septic parcels (depicted as purple parcels Figure 5-75), which equated to an AADF of approximately 129,590 to 187,180 gpd. The dashed line in Figure 5-75 depicts an approximate road length of 53,820 ft which equated to approximately 90 ft per residential septic parcel. The average residential parcel acreage was 0.62 acres. There were large, deep, narrow waterfront parcels in this area that may be difficult to serve via gravity sewers.

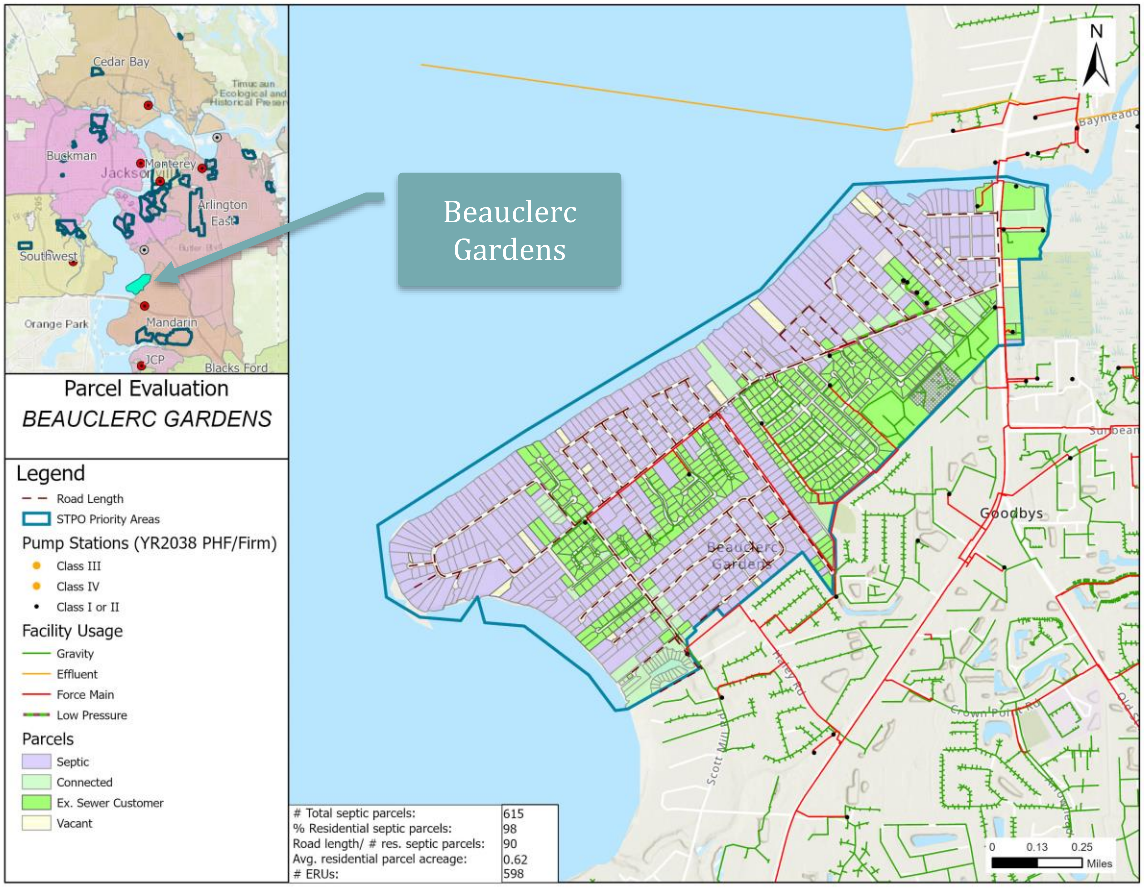


Figure 5-75: Beauclerc Gardens Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 2 to 26 ft (see Appendix F.2 Figure F.2-3). A review of aerial maps (Figure F.2-10) and site visit data (Figure 5-76 and Figure 5-77) characterized restoration costs to be high (asphalt roads with curbs, gutters, and sidewalks) relative to other STPO priority areas. The road width ranged from 20 to 25 ft, and the ROW width ranged from 35 to 50 ft. The electric supply was overhead. The depth to water table varied from 7 to 147 inches below grade (Figure F.2-4), and the soil rating for conventional septic systems was in general very limited (Figure F.2-12). Approximately 69% of the parcels were existing water customers (Figure F.2-7). Approximately 15% and 85% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.2-5), respectively. Approximately 80% of the septic parcels were classified as more vulnerable in the SAS vulnerability assessment (see Figure F.2-11). A summary of these parameters is presented in Table 5-27.

Figure 5-76: Beauclerc Gardens STPO Priority Area, Forest Cir Site Visit Photo

Figure 5-77: Beauclerc Gardens STPO Priority Area, Kings Colony Rd Site Visit Photo

Table 5-27: Beauclerc Gardens Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	28	
Total Parcels	1265	#
Septic Parcels	615	#
Proportion Septic	49	%
Proportion Residential	98	%
Average Res. Parcel Acreage	0.62	acres
Water Meter AADF	129,589	gpd
Planning AADF (gpd)	187,181	gpd
Rd. Length ÷ Res. Parcels	90	ft/parcel
Proportion Ex. Water Customers	69	%
Restoration Costs	high	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	15	%
Proportion Nutrient TMDL Septic Parcels	85	%
Proportion SAS Most Vulnerable Septic Parcels	80	%
Proportion SAS More Vulnerable Septic Parcels	20	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	12	acres
Vacant Government Owned Acreage	3	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Freshwater Pond
    - Riverine
    - Estuarine and Marine Deepwater
- Surrounding the boundary:
    - Freshwater Forested/Shrub Wetland
    - Riverine
    - Estuarine and Marine Deepwater

5.5.2 Hood Landing II

Hood Landing II was ranked #26 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 632 total parcels of which 533 were septic parcels (depicted as purple parcels Figure 5-78), which equated to an AADF of approximately 116,074 to 164,900 gpd. The dashed line in Figure 5-78 depicts an approximate road length of 35,460 ft which equated to approximately 67 ft per residential septic parcel. The average residential parcel acreage was 0.53 acres. There were large, deep, narrow parcels in this area that may be difficult to serve via gravity sewers.

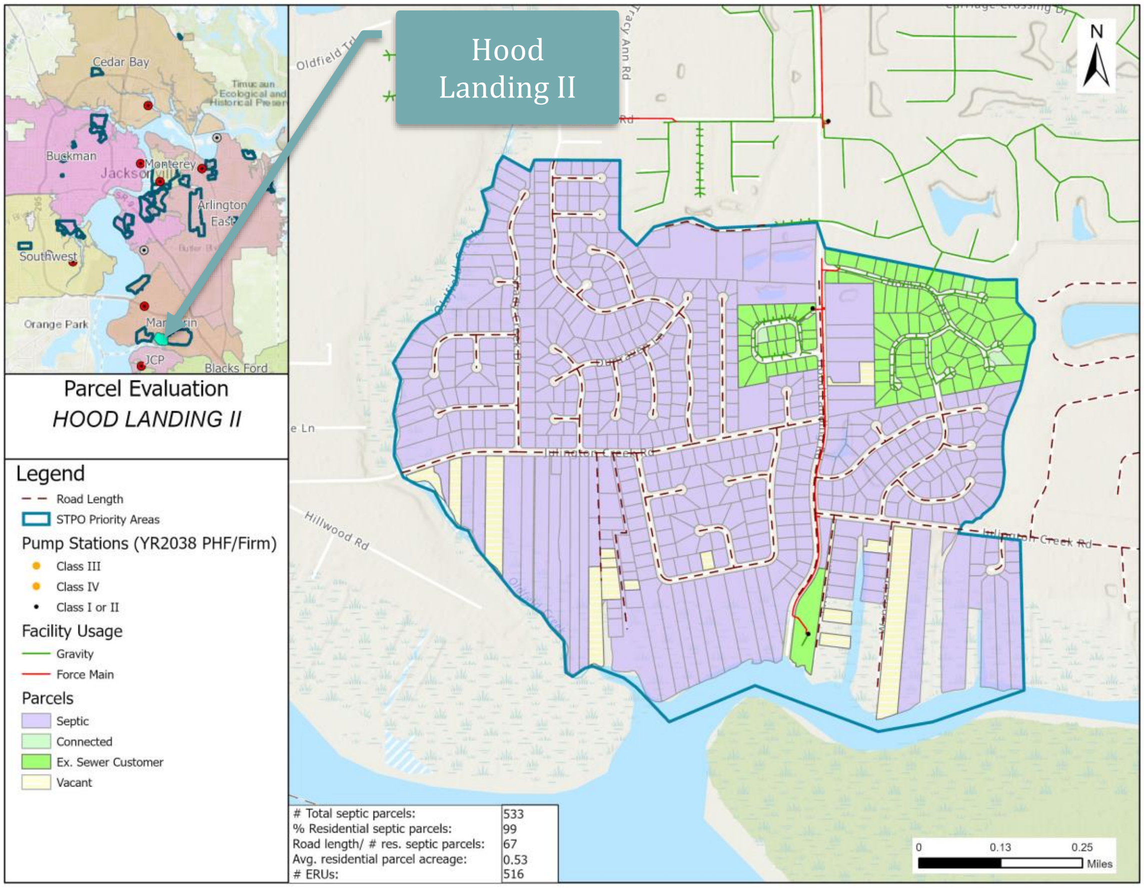


Figure 5-78: Hood Landing II Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 4 to 26 ft (see Appendix F.11 Figure F.11-3). A review of aerial maps (Figure F.11-10) and site visit data (Figure 5-79 and Figure 5-80) characterized restoration costs as high (asphalt roads with curbs, gutters, and sidewalks) relative to other STPO priority areas. The road width ranged from 10 to 24 ft, and the ROW width ranged from 24 to 40 ft. The electric supply varied (underground and overhead). The depth to water table varied from 0 to 147 inches below grade (Figure F.11-4), and the soil rating for conventional septic systems was very limited (Figure F.11-12). Approximately 94% of the parcels were existing water customers (Figure F.11-7). Approximately 31% and 0% of septic parcels were within FDEP total maximum daily load (TMDL) boundaries for fecal coliform or nutrients (Figure F.11-5), respectively. Approximately 72% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.11-11). A summary of these parameters is presented in Table 5-28.

Figure 5-79: Hood Landing II STPO Priority Area, Dunraven Trl Site Visit Photo

Figure 5-80: Hood Landing II STPO Priority Area, Morning Dove Dr Site Visit Photo

Table 5-28: Hood Landing II Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	26	
Total Parcels	632	#
Septic Parcels	533	#
Proportion Septic	84	%
Proportion Residential	99	%
Average Res. Parcel Acreage	0.53	acres
Water Meter AADF	116,074	gpd
Planning AADF (gpd)	164,904	gpd
Rd. Length ÷ Res. Parcels	67	ft/parcel
Proportion Ex. Water Customers	94	%
Restoration Costs	high	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	31	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	72	%
Proportion SAS More Vulnerable Septic Parcels	28	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	17	acres
Vacant Government Owned Acreage	0.5	acres

Existing wetlands/surface water included:

- Within the boundary
  - Freshwater Forested/Shrub Wetland
  - Freshwater Pond
  - Riverine
  - Estuarine and Marine Deepwater
- Surrounding the boundary:
  - Freshwater Forested/Shrub Wetland
  - Estuarine and Marine Deepwater

5.5.3 Julington Creek

Julington Creek was ranked #9 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 2,528 total parcels of which 2,186 were septic parcels (depicted as purple parcels Figure 5-81), which equated to an AADF of approximately 468,160 to 664,560 gpd. The dashed line in Figure 5-81 depicts an approximate road length of 140,470 ft which equated to approximately 65 ft per residential septic parcel. The average residential parcel acreage was 0.46 acres. There were large, deep, narrow waterfront parcels in this area that may be difficult to serve via gravity sewers.

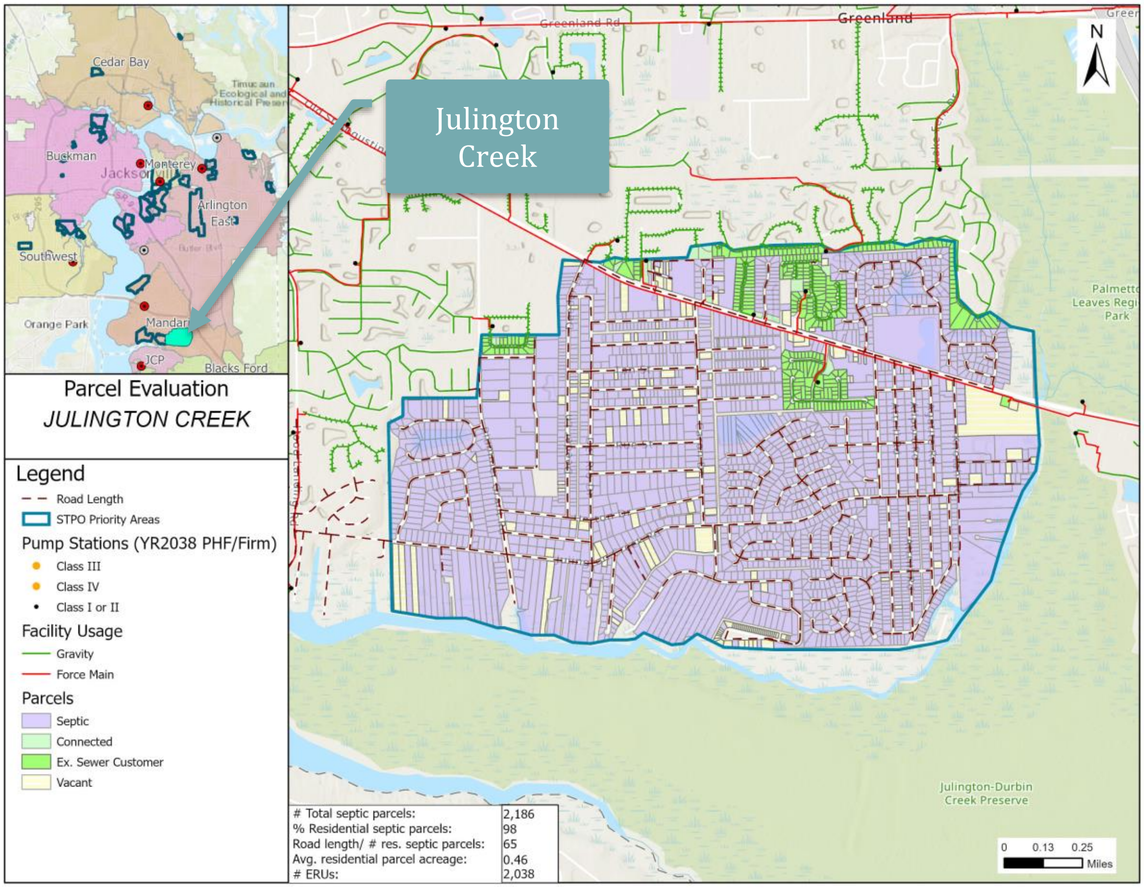


Figure 5-81: Julington Creek Septic Parcels

The topography of the septic parcels was highly variable; elevations ranged from 2 to 30 ft (see Appendix F.12 Figure F.12-3). A review of aerial maps (Figure F.12-10) and site visit data (Figure 5-82, Figure 5-83 and Figure 5-84) characterized restoration costs to be high (asphalt roads with curbs, gutters, and/or sidewalks and some stormwater swales in the ROW) relative to other STPO priority areas. The road width ranged from 22 to 25 ft, and the ROW width ranged from 35 to 50 ft. The electric supply varied (overhead and underground). The depth to water table varied from 0 to 147 inches below grade (Figure F.12-4), and the soil rating for conventional septic systems was in general very limited (Figure F.12-18). Approximately 59% of the parcels were existing water customers (Figure F.12-7). Approximately 100% and 0% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.12-5), respectively. Approximately 65% of the septic parcels were classified as most vulnerable in the

SAS vulnerability assessment (see Figure F.12-17). A summary of these parameters is presented in Table 5-29.

Figure 5-82: Julington Creek STPO Priority Area, Wilderness Ln N Site Visit Photo

Figure 5-83: Julington Creek STPO Priority Area, Autumnbrook Trl E Site Visit Photo

Figure 5-84: Julington Creek STPO Priority Area, Sand Ridge Dr Site Visit Photo

Table 5-29: Julington Creek Characterization

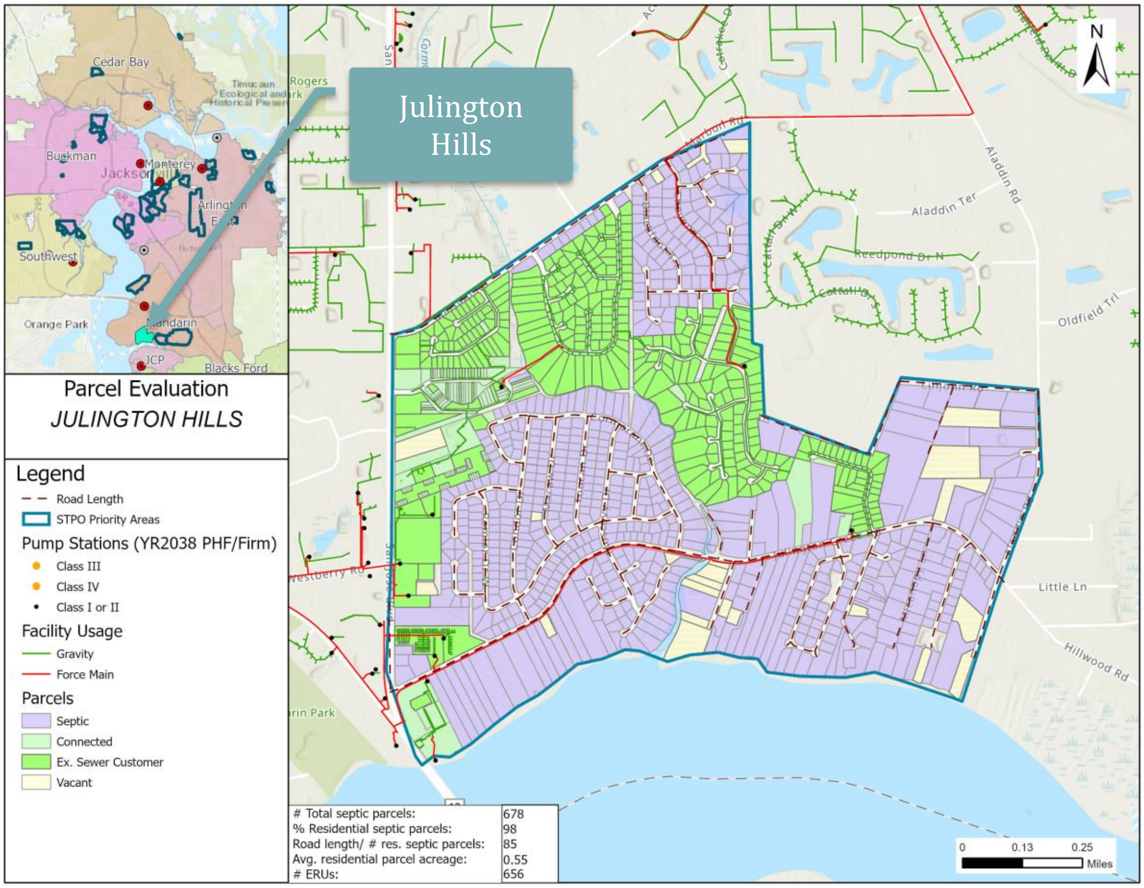
Description	Value	Units
2019 STPO Prioritization Ranking	9	
Total Parcels	2528	#
Septic Parcels	2186	#
Proportion Septic	86	%
Proportion Residential	98	%
Average Res. Parcel Acreage	0.46	acres
Water Meter AADF	468,159	gpd
Planning AADF (gpd)	664,557	gpd
Rd. Length ÷ Res. Parcels	65	ft/parcel
Proportion Ex. Water Customers	59	%
Restoration Costs	high	
Topography	highly variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	100	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	65	%
Proportion SAS More Vulnerable Septic Parcels	35	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	80	acres
Vacant Government Owned Acreage	21	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Freshwater Pond
    - Riverine
- Surrounding the boundary:
    - Freshwater Forested/Shrub Wetland
    - Estuarine
    - Freshwater Emergent Wetland

5.5.4 Julington Hills

Julington Hills was ranked #23 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 1,174 total parcels of which 678 were septic parcels (depicted as purple parcels Figure 5-85), which equated to an AADF of approximately 163,620 to 226,240 gpd. The dashed line in Figure 5-85 depicts an approximate road length of 56,620 ft which equated to approximately 85 ft per residential septic parcel. The average residential parcel acreage was 0.55 acres. This area also included numerous large, deep, narrow waterfront parcels that may be difficult to serve via gravity sewers.



# Total septic parcels:	678
% Residential septic parcels:	98
Road length/ # res. septic parcels:	85
Avg. residential parcel acreage:	0.55
# ERUs:	656

Figure 5-85: Julington Hills Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 4 to 22 ft (see Appendix F.13 Figure F.13-3). A review of aerial maps (Figure F.13-10) and site visit data (Figure 5-86, and Figure 5-87) characterized restoration costs to be high (asphalt roads with curbs, gutters, sidewalks and in the ROW stormwater swales and many large trees) relative to other STPO priority areas. The road width ranged from 24 to 27 ft, and the ROW width ranged from 40 to 50 ft. The electric supply varied (overhead and underground). The depth to water table varied from 0 to 147 inches below grade (Figure F.13-4), and the soil rating for conventional septic systems was in general very limited (Figure F.13-12). Approximately 90% of the parcels were existing water customers (Figure F.13-7). Approximately 47% and 52% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.13-5), respectively. Approximately 75% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.13-11). A summary of these parameters is presented in Table 5-30.

Figure 5-86: Julington Hills STPO Priority Area, Julington Creek Rd Site Visit Photo

Figure 5-87: Julington Hills STPO Priority Area, Edenbridge Ct Site Visit Photo

Table 5-30: Julington Hills Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	23	
Total Parcels	1174	#
Septic Parcels	678	#
Proportion Septic	58	%
Proportion Residential	98	%
Average Res. Parcel Acreage	0.55	acres
Water Meter AADF	163,617	gpd
Planning AADF (gpd)	226,237	gpd
Rd. Length ÷ Res. Parcels	85	ft/parcel
Proportion Ex. Water Customers	90	%
Restoration Costs	high	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	47	%
Proportion Nutrient TMDL Septic Parcels	52	%
Proportion SAS Most Vulnerable Septic Parcels	75	%
Proportion SAS More Vulnerable Septic Parcels	25	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	30	acres
Vacant Government Owned Acreage	1.3	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Freshwater Pond
    - Riverine
    - Estuarine and Marine Deepwater
- Surrounding the boundary:
    - Freshwater Forested/Shrub Wetland
    - Freshwater Pond
    - Riverine
    - Estuarine and Marine Deepwater

5.6 Monterey WWTF Service Area

The Monterey WWTF has a permitted capacity of 3.6 MGD. The revised projected YR2040 wastewater AADF was approximately 2.1 MGD, which resulted in an available capacity of 1.5 MGD (or approximately 41%). The additional flow from STPO priority areas in the service area was estimated to be approximately 1.3 MGD, which was comparable to the available capacity (Table 5-3) as previously noted. The Monterey service area included two STPO priority areas—Clifton and Eggleston Heights. Figure 5-88 depicts the extent of the service area, the STPO priority area boundaries and impaired waters with TMDL limits for fecal coliform and nutrients.

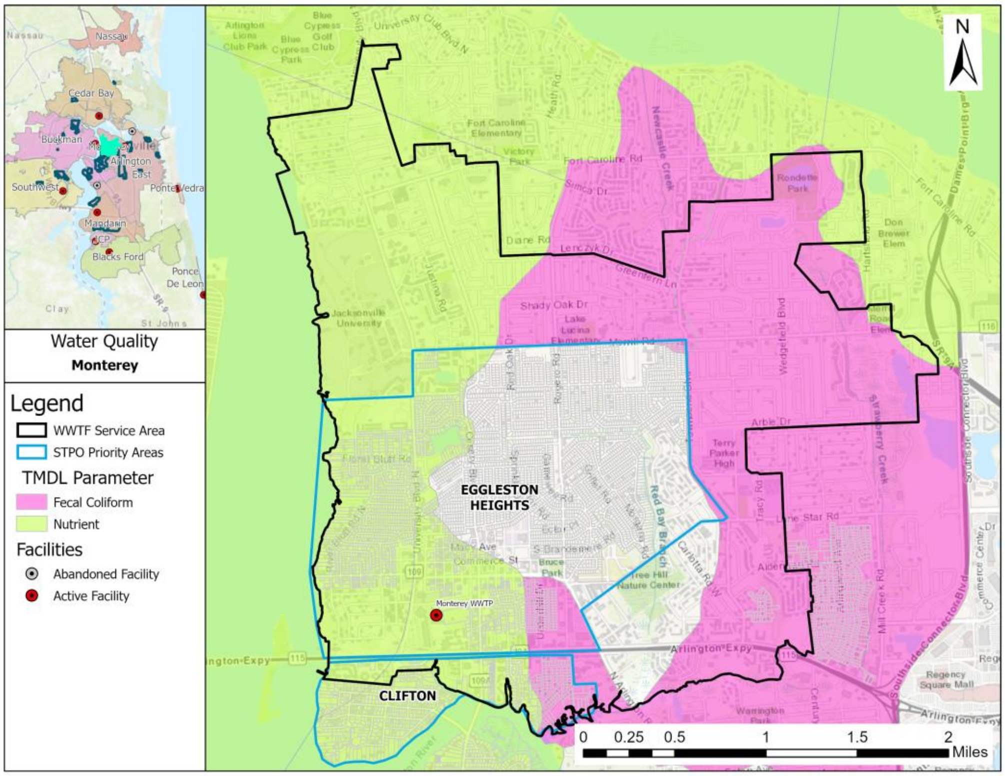


Figure 5-88: Monterey Service Area

5.6.1 Clifton

Clifton was ranked #30 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 596 total parcels of which 564 were septic parcels (depicted as purple parcels Figure 5-89), which equated to an AADF of approximately 119,570 to 171,700 gpd. The dashed line in Figure 5-89 depicts an approximate road length of 43,800 ft which equated to approximately 82 ft per residential septic parcel. The average residential parcel acreage was 0.40 acres. This STPO priority area included numerous large, deep, narrow waterfront lots that may be difficult to serve via gravity sewers.

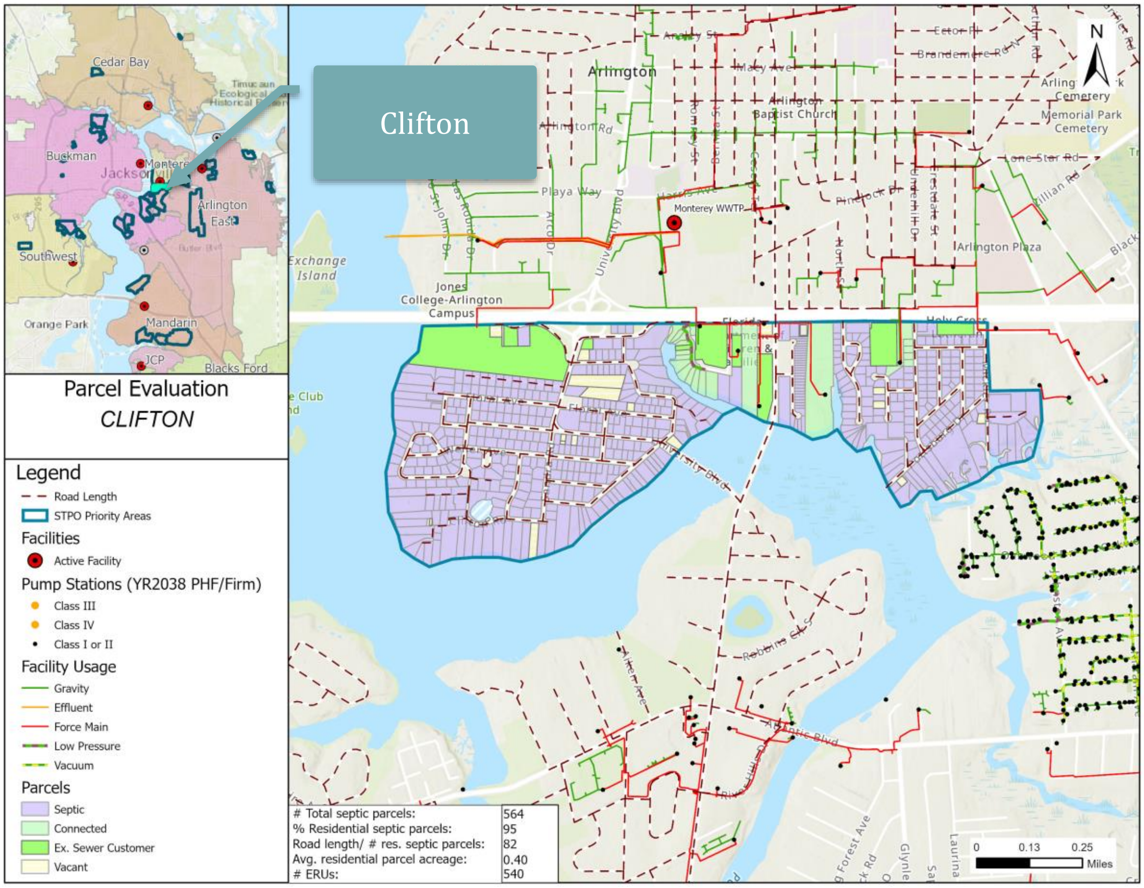


Figure 5-89: Clifton Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 2 to 22 ft (see Appendix F.5 Figure F.5-3). A review of aerial maps (Figure F.5-10) and site visit data (Figure 5-90 and Figure 5-91) characterized restoration costs to be medium (asphalt roads with curbs and large trees in the ROW) relative to other STPO priority areas. The road width ranged from 18 to 20 ft, and the ROW width was approximately 35 ft. The electric supply was overhead. The depth to water table varied from 0 to 147 inches below grade (Figure F.5-4), and in general the soil rating for conventional septic systems was very limited (Figure F.5-12). Approximately 96% of the parcels were existing water customers (Figure F.5-7). Approximately 19% and 81% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.5-5), respectively. All of the septic parcels were classified as most vulnerable in the

SAS vulnerability assessment (see Figure F.5-11). A summary of these parameters is presented in Table 5-31.

Figure 5-90: Clifton STPO Priority Area, W Noble Cir Site Visit Photo

Figure 5-91: Clifton STPO Priority Area, Kasimir Dr Site Visit Photo

Table 5-31: Clifton Characterization

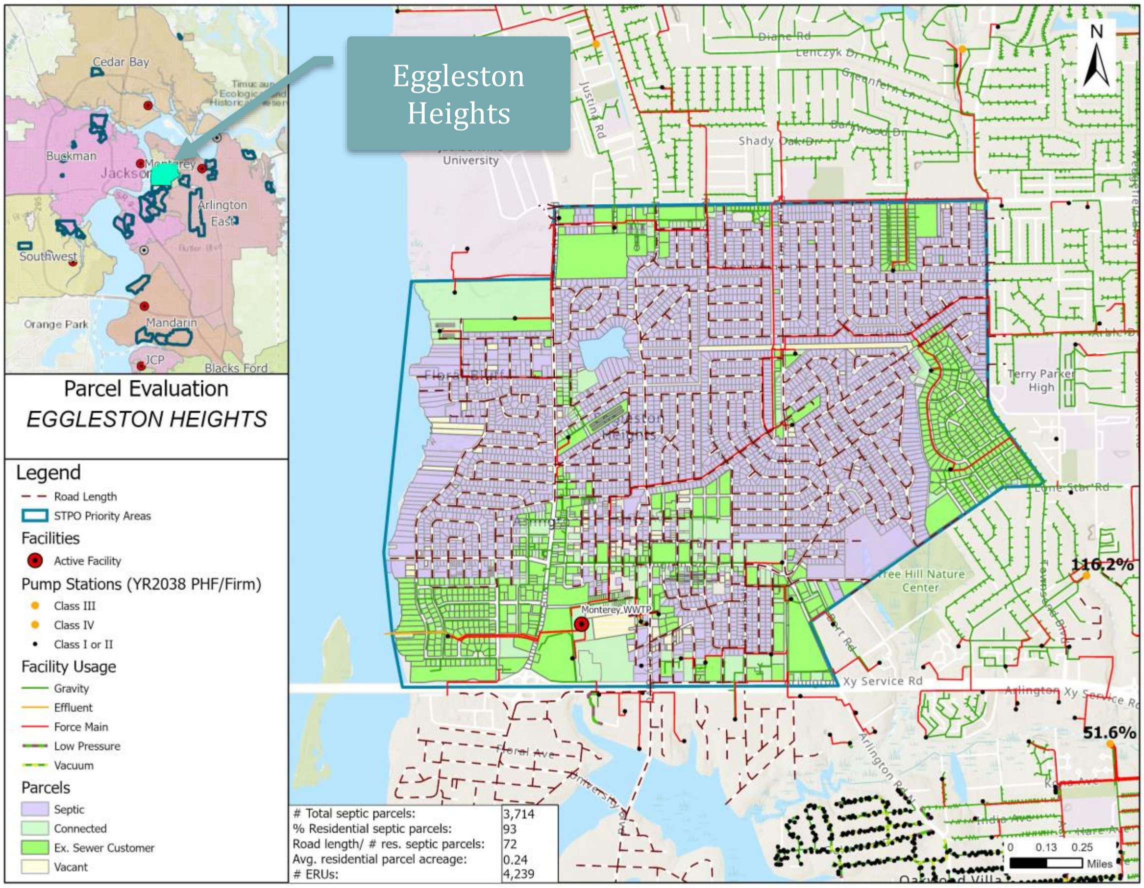
Description	Value	Units
2019 STPO Prioritization Ranking	30	
Total Parcels	596	#
Septic Parcels	564	#
Proportion Septic	95	%
Proportion Residential	95	%
Average Res. Parcel Acreage	0.4	acres
Water Meter AADF	119,567	gpd
Planning AADF (gpd)	171,702	gpd
Rd. Length ÷ Res. Parcels	82	ft/parcel
Proportion Ex. Water Customers	96	%
Restoration Costs	medium	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	19	%
Proportion Nutrient TMDL Septic Parcels	81	%
Proportion SAS Most Vulnerable Septic Parcels	100	%
Proportion SAS More Vulnerable Septic Parcels	0	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	9.1	acres
Vacant Government Owned Acreage	1.0	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Estuarine and Marine Wetland
    - Freshwater Pond
    - Riverine
    - Estuarine and Marine Deepwater
- Surrounding the boundary:
    - Estuarine and Marine Deepwater
    - Estuarine and Marine Wetland
    - Freshwater Forested/Shrub Wetland

5.6.2 Eggleston Heights

Eggleston Heights was ranked #8 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 4,802 total parcels of which 3,714 were septic parcels (depicted as purple parcels Figure 5-92), which equated to an AADF of approximately 790,300 to 1,133,000 gpd. The dashed line in Figure 5-92 depicts an approximate road length of 249,610 ft which equated to approximately 72 ft per residential septic parcel. The average residential parcel acreage was 0.24 acres. There were some deep, narrow waterfront parcels in this STPO priority area that may be difficult to serve via gravity sewers.



# Total septic parcels:	3,714
% Residential septic parcels:	93
Road length/ # res. septic parcels:	72
Avg. residential parcel acreage:	0.24
# ERUs:	4,239

Figure 5-92: Eggleston Heights Septic Parcels

The topography of the septic parcels was highly variable; elevations ranged from 8 to 50 ft (see Appendix F.6 Figure F.6-3). A review of aerial maps (Figure F.6-10) and site visit data (Figure 5-93 and Figure 5-94) characterized restoration costs to be high (asphalt roads with curbs, gutters, sidewalks and in the ROW stormwater swales with a few large trees) relative to other STPO priority areas. The road width ranged from 22 to 25 ft, and the ROW width ranged from 40 to 50 ft. The electric supply varied (overhead and underground). The depth to water table varied from 0 to 147 inches below grade (Figure F.6-4), and in general the soil rating for conventional septic systems was very limited (Figure F.6-18). Approximately 98% of the parcels were existing water customers (Figure F.6-7). Approximately 3% and 30% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.6-5), respectively. Approximately 96% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.6-17). A summary of these parameters is presented in Table 5-32.

Figure 5-93: Eggleston Heights STPO Priority Area, Arlington Rd Site Visit Photo

Figure 5-94: Eggleston Heights STPO Priority Area, Sprinkle Dr N Site Visit Photo

Table 5-32: Eggleston Heights Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	8	
Total Parcels	4802	#
Septic Parcels	3714	#
Proportion Septic	77	%
Proportion Residential	93	%
Average Res. Parcel Acreage	0.24	acres
Water Meter AADF	790,289	gpd
Planning AADF (gpd)	1,133,166	gpd
Rd. Length ÷ Res. Parcels	72	ft/parcel
Proportion Ex. Water Customers	98	%
Restoration Costs	high	
Topography	highly variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	3	%
Proportion Nutrient TMDL Septic Parcels	30	%
Proportion SAS Most Vulnerable Septic Parcels	96	%
Proportion SAS More Vulnerable Septic Parcels	4	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	46	acres
Vacant Government Owned Acreage	10	acres

Existing wetlands/surface water included:

- Within the boundary
  - Freshwater Forested/Shrub Wetland
  - Estuarine and Marine Wetland
  - Freshwater Pond
  - Riverine
  - Estuarine and Marine Deepwater
- Surrounding the boundary:
  - Estuarine and Marine Deepwater
  - Estuarine and Marine Wetland
  - Freshwater Forested/Shrub Wetland
  - Riverine

5.7 Southwest WWTF Service Area

The Southwest WWTF has a current permitted capacity of 14 MGD with a planned expansion to 16 MGD. The revised projected YR2040 wastewater AADF was approximately 14.27 MGD, which resulted in an available capacity of 1.73 MGD (or approximately 11%) with the expansion to 16 MGD completed. The additional flow from STPO priority areas in the service area was estimated to be approximately 1.0 MGD, which was less than the available capacity with the expansion (Table 5-3). The Southwest service area included five STPO priority areas—Cedar River, Champion Forest, Lakeshore, Ortega, and Westfield. Figure 5-95 depicts the extent of the service area, the STPO priority area boundaries and impaired waters with TMDL limits for fecal coliform and nutrients.

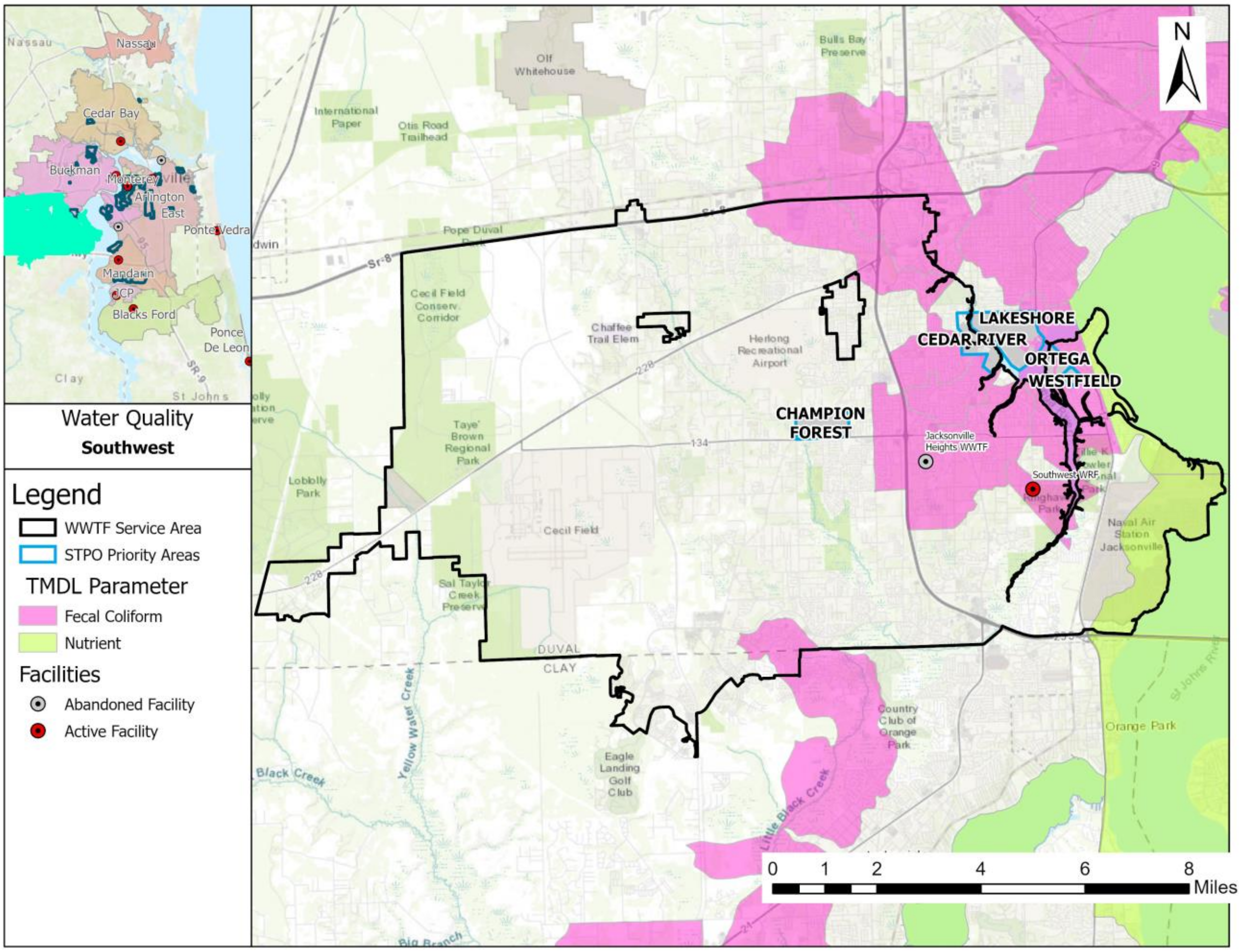


Figure 5-95: Southwest Service Area

5.7.1 Cedar River

Cedar River was ranked #16 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 592 total parcels of which 428 were septic parcels (depicted as purple parcels Figure 5-96), which equated to an AADF of approximately 98,705 to 133,570 gpd. The dashed line in Figure 5-96 depicts an approximate road length of 28,110 ft which equated to approximately 69 ft per residential septic parcel. The average residential parcel acreage was 0.32 acres. There were numerous deep, narrow waterfront parcels in this STPO priority area that may be difficult to serve via gravity sewers.

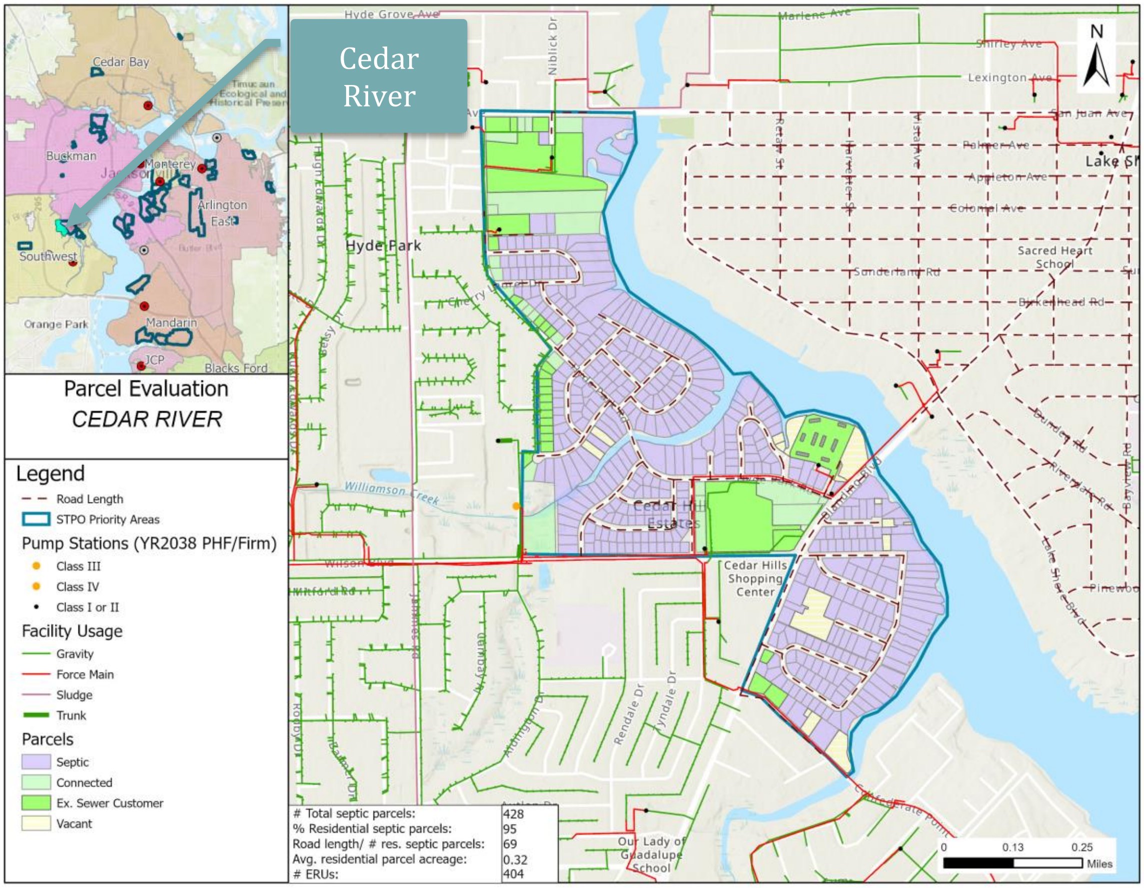


Figure 5-96: Cedar River Septic Parcels

The topography of the septic parcels was moderately variable; elevations ranged from 6 to 24 ft (see Appendix F.3 Figure F.3-3). A review of aerial maps (Figure F.3-10) and site visit data (Figure 5-97 and Figure 5-98) characterized restoration costs to be medium (asphalt roads with curbs, gutters and/or in the ROW stormwater swales with some large trees) relative to other STPO priority areas. The road width ranged from 22 to 24 ft, and the ROW width ranged from 40 to 50 ft. The electric supply was overhead. The depth to water table varied from 31 to 147 inches below grade (Figure F.3- 4), and in general the soil rating for conventional septic systems was very limited (Figure F.3-12). Approximately 92% of the parcels were existing water customers (Figure F.3-7). Approximately 48% and 0% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.3-5), respectively. Approximately 59% of the septic parcels were classified as more vulnerable in the SAS vulnerability assessment (see Figure F.3-11). A summary of these parameters is presented in Table 5-33.

Figure 5-97: Cedar River STPO Priority Area, Barlad Dr Site Visit Photo

Figure 5-98: Cedar River STPO Priority Area, Cedarcrest Dr Site Visit Photo

Table 5-33: Cedar River Characterization

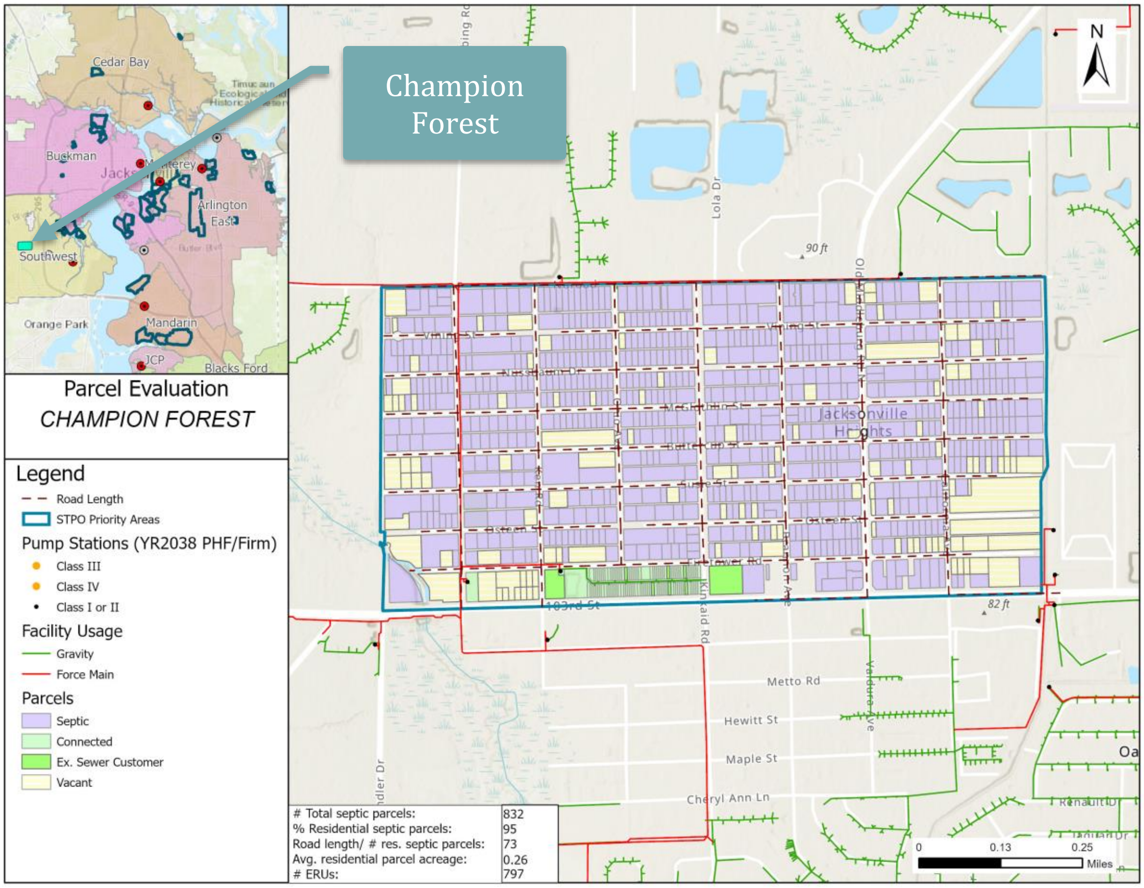
Description	Value	Units
2019 STPO Prioritization Ranking	16	
Total Parcels	592	#
Septic Parcels	428	#
Proportion Septic	72	%
Proportion Residential	95	%
Average Res. Parcel Acreage	0.32	acres
Water Meter AADF	98,705	gpd
Planning AADF (gpd)	133,568	gpd
Rd. Length ÷ Res. Parcels	69	ft/parcel
Proportion Ex. Water Customers	92	%
Restoration Costs	medium	
Topography	moderately variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	48	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	59	%
Proportion SAS More Vulnerable Septic Parcels	31	%
Proportion SAS Vulnerable Septic Parcels	11	%
Vacant Acreage	10	acres
Vacant Government Owned Acreage	2	acres

Existing wetlands/surface water included:

- Within the boundary
    - Freshwater Forested/Shrub Wetland
    - Riverine
- Surrounding the boundary:
    - Freshwater Forested/Shrub Wetland
    - Riverine

5.7.2 Champion Forest

Champion Forest was ranked #7 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 941 total parcels of which 832 were septic parcels (depicted as purple parcels Figure 5-99), which equated to an AADF of approximately 188,545 to 283,960 gpd. The dashed line in Figure 5-99 depicts an approximate road length of 58,030 ft which equated to approximately 73 ft per residential septic parcel. The average residential parcel acreage was 0.26 acres.



# Total septic parcels:	832
% Residential septic parcels:	95
Road length/ # res. septic parcels:	73
Avg. residential parcel acreage:	0.26
# ERUs:	797

Figure 5-99: Champion Forest Septic Parcels

The topography of the septic parcels was highly variable; elevations ranged from 34 to 90 ft (see Appendix F.4 Figure F.4-3). A review of aerial maps (Figure F.4-10) and site visit data (Figure 5-100 and Figure 5-101) characterized restoration costs to be low (asphalt roads with no curbs, gutter, or sidewalks) relative to other STPO priority areas. The road width was approximately 22 ft, and the ROW width ranged from 35 to 50 ft. The electric supply was overhead. The depth to water table varied from 0 to 76 inches below grade (Figure F.4-4), and the soil rating for conventional septic systems was very limited (Figure F.4-12). Approximately 65% of the parcels were existing water customers (Figure F.4-7). None of the septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.4-5). Approximately 32% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.4-11). A summary of these parameters is presented in Table 5-34.

Figure 5-100: Champion Forest STPO Priority Area, Nussbaum Dr near Ken Rd Intersection Site Visit Photo

Figure 5-101: Champion Forest STPO Priority Area, Susie St near California Ave Intersection Site Visit Photo

Table 5-34: Champion Forest Characterization

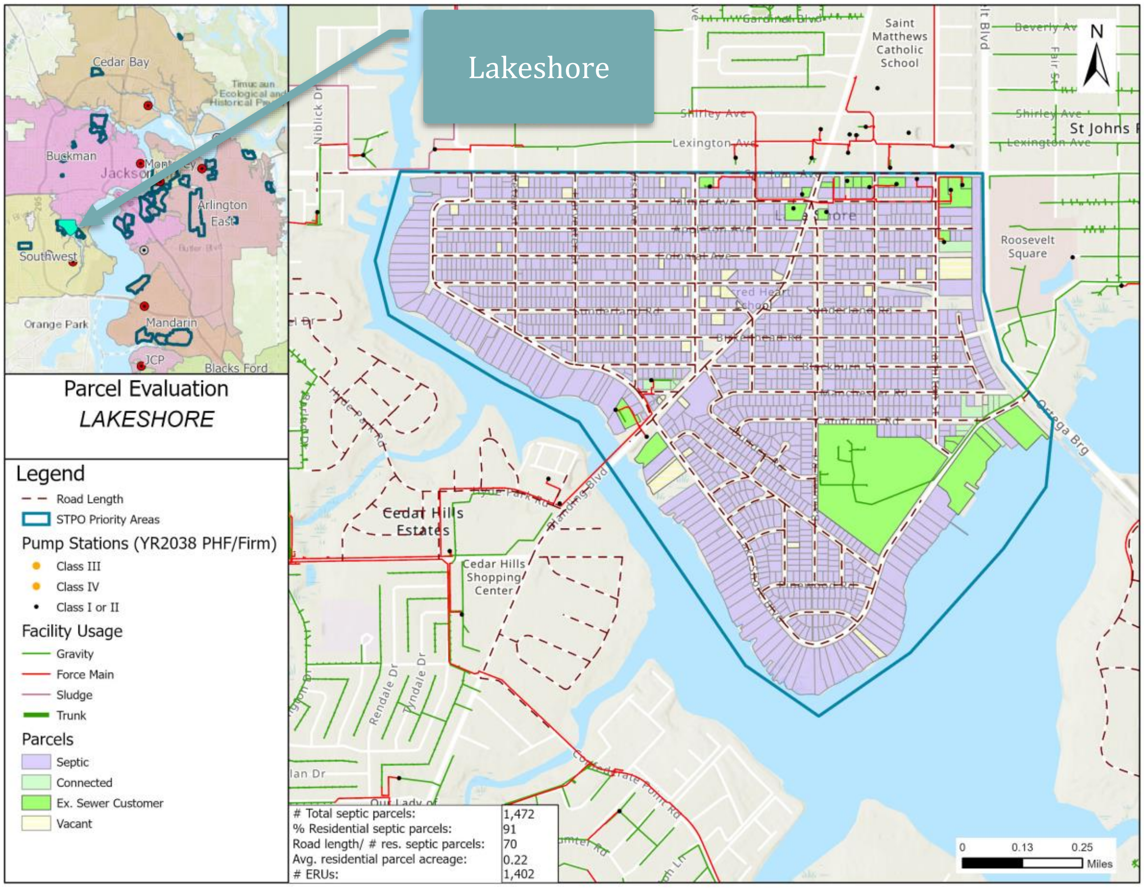
Description	Value	Units
2019 STPO Prioritization Ranking	7	
Total Parcels	941	#
Septic Parcels	832	#
Proportion Septic	88	%
Proportion Residential	95	%
Average Res. Parcel Acreage	0.26	acres
Water Meter AADF	188,545	gpd
Planning AADF (gpd)	283,961	gpd
Rd. Length ÷ Res. Parcels	73	ft/parcel
Proportion Ex. Water Customers	65	%
Restoration Costs	low	
Topography	highly variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	0	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	32	%
Proportion SAS More Vulnerable Septic Parcels	68	%
Proportion SAS Vulnerable Septic Parcels	0	%
Vacant Acreage	42	acres
Vacant Government Owned Acreage	0.1	acres

Existing wetlands/surface water included:

- Within the boundary
  - Freshwater Forested/Shrub Wetland
  - Riverine
- Surrounding the boundary:
  - Freshwater Forested/Shrub Wetland
  - Riverine

5.7.3 Lakeshore

Lakeshore was ranked #18 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 1,508 total parcels of which 1,472 were septic parcels (depicted as purple parcels in Figure 5-102), which equated to an AADF of approximately 322,500 to 456,180 gpd. The dashed line in Figure 5-102 depicts an approximate road length of 93,570 ft which equated to approximately 70 ft per residential septic parcel. The average residential parcel acreage was 0.22 acres. This STPO priority area also included numerous deep, narrow waterfront parcels that may be difficult to serve via gravity sewers.



# Total septic parcels:	1,472
% Residential septic parcels:	91
Road length/ # res. septic parcels:	70
Avg. residential parcel acreage:	0.22
# ERUs:	1,402

Figure 5-102: Lakeshore Septic Parcels

The topography of the septic parcels had relatively low variability; elevations ranged from 8 to 18 ft (see Appendix F.15 Figure F.15-3). A review of aerial maps (Figure F.15-10) and site visit data (Figure 5-103, Figure 5-104, Figure 5-105) characterized restoration costs to be medium (asphalt roads with some sidewalks, stormwater swales and trees in the ROW) relative to other STPO priority areas. The road width ranged from 18 to 24 ft, and the ROW width ranged from 40 to 50 ft. The electric supply was overhead. The depth to water table varied from 0 to 147 inches below grade (Figure F.15-4), and in general the soil rating for conventional septic systems was very limited (Figure F.15-12). Approximately 95% of the parcels were existing water customers (Figure F.15-7). Approximately 28% and 0% of septic parcels were within FDEP TMDL boundaries for fecal coliform and nutrients (Figure F.15-5), respectively.

Approximately 52% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.15-11). A summary of these parameters is presented in Table 5-35.

Figure 5-103: Lakeshore STPO Priority Area, Tulipwood Rd and Lake Shore Blvd Intersection Site Visit Photo

Figure 5-104: Lakeshore STPO Priority Area, Cedarwood Rd Site Visit Photo

Figure 5-105: Lakeshore STPO Priority Area, Colonial Ave near Harvester St Intersection Site Visit Photo

Table 5-35: Lakeshore Characterization

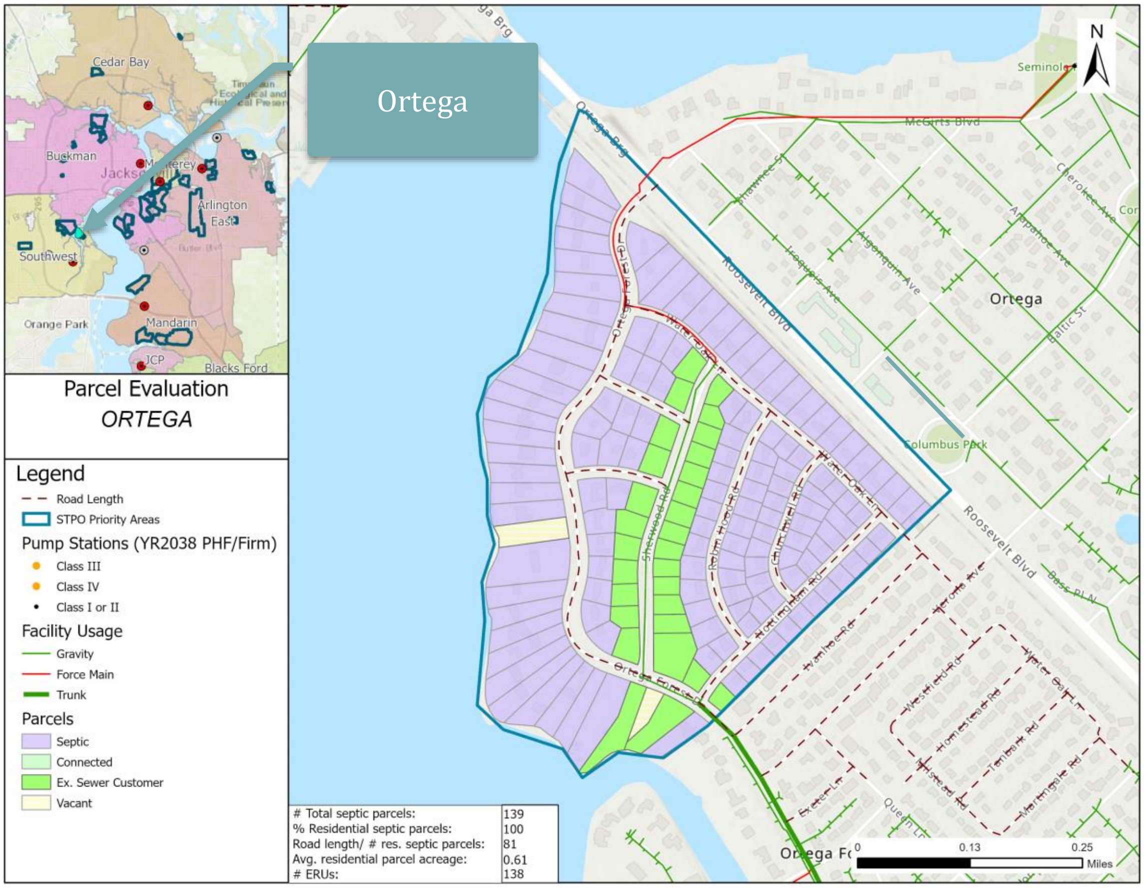
Description	Value	Units
2019 STPO Prioritization Ranking	18	
Total Parcels	1508	#
Septic Parcels	1472	#
Proportion Septic	98	%
Proportion Residential	91	%
Average Res. Parcel Acreage	0.22	acres
Water Meter AADF	322,496	gpd
Planning AADF (gpd)	456,180	gpd
Rd. Length ÷ Res. Parcels	70	ft/parcel
Proportion Ex. Water Customers	95	%
Restoration Costs	medium	
Topography	low variability	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	28	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	52	%
Proportion SAS More Vulnerable Septic Parcels	29	%
Proportion SAS Vulnerable Septic Parcels	19	%
Vacant Acreage	11	acres
Vacant Government Owned Acreage	2.6	acres

Existing wetlands/surface water included:

- Within the boundary
  - Riverine
  - Estuarine and Marine Deepwater
- Surrounding the boundary:
  - Riverine
  - Estuarine and Marine Deepwater

5.7.4 Ortega

Ortega was ranked #31 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 168 total parcels of which 139 were septic parcels (depicted as purple parcels Figure 5-106), which equated to an AADF of approximately 27,530 to 40,610 gpd. The dashed line in Figure 5-106 depicts an approximate road length of 11,200 ft which equated to approximately 81 ft per residential septic parcel. The average residential parcel acreage was 0.61 acres. There were numerous deep, narrow waterfront parcels in this STPO priority area that may be difficult to serve via gravity sewers.



# Total septic parcels:	139
% Residential septic parcels:	100
Road length/ # res. septic parcels:	81
Avg. residential parcel acreage:	0.61
# ERUs:	138

Figure 5-106: Ortega Septic Parcels

The topography of the septic parcels was highly variable; elevations ranged from 0 to 26 ft (see Appendix F.23 Figure F.23-3). A review of aerial maps (Figure F.23-10) and site visit data (Figure 5-107 and Figure 5-108) characterized restoration costs to be medium (asphalt roads with sidewalks, stormwater swales and large trees in the ROW) relative to other STPO priority areas. The road width was approximately 20 ft, and the ROW width ranged from 40 to 50 ft. The electric supply was overhead. The depth to water table varied from 15 to 147 inches below grade (Figure F.23-4), and the soil rating for conventional septic systems was very limited (Figure F.23-12). Approximately 94% of the parcels were existing water customers (Figure F.23-7). Approximately 100% and 0% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.23-5), respectively. Approximately 14% of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.23-11). A summary of these parameters is presented in Table 5-36.

Figure 5-107: Ortega STPO Priority Area, Ortega Forest Dr Site Visit Photo

Figure 5-108: Ortega STPO Priority Area, Water Oak Ln Site Visit Photo

Table 5-36: Ortega Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	31	
Total Parcels	168	#
Septic Parcels	139	#
Proportion Septic	83	%
Proportion Residential	100	%
Average Res. Parcel Acreage	0.61	acres
Water Meter AADF	27,527	gpd
Planning AADF (gpd)	40,606	gpd
Rd. Length ÷ Res. Parcels	81	ft/parcel
Proportion Ex. Water Customers	94	%
Restoration Costs	medium	
Topography	highly variable	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	100	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	14	%
Proportion SAS More Vulnerable Septic Parcels	14	%
Proportion SAS Vulnerable Septic Parcels	71	%
Vacant Acreage	1.8	acres
Vacant Government Owned Acreage	0	acres

Existing wetlands/surface water included:

- Within the boundary: Freshwater Forested/Shrub Wetland
- Surrounding the boundary: Freshwater Forested/Shrub Wetland

5.7.5 Westfield

Westfield was ranked #12 in the JEA 2019 STPO prioritization matrix. The STPO priority area boundary had 184 total parcels of which 183 were septic parcels (depicted as purple parcels Figure 5-109), which equated to an AADF of approximately 34,080 to 51,160 gpd. The dashed line in Figure 5-109 depicts an approximate road length of 11,040 ft which equated to approximately 61 ft per residential septic parcel. The average residential parcel acreage was 0.25 acres.

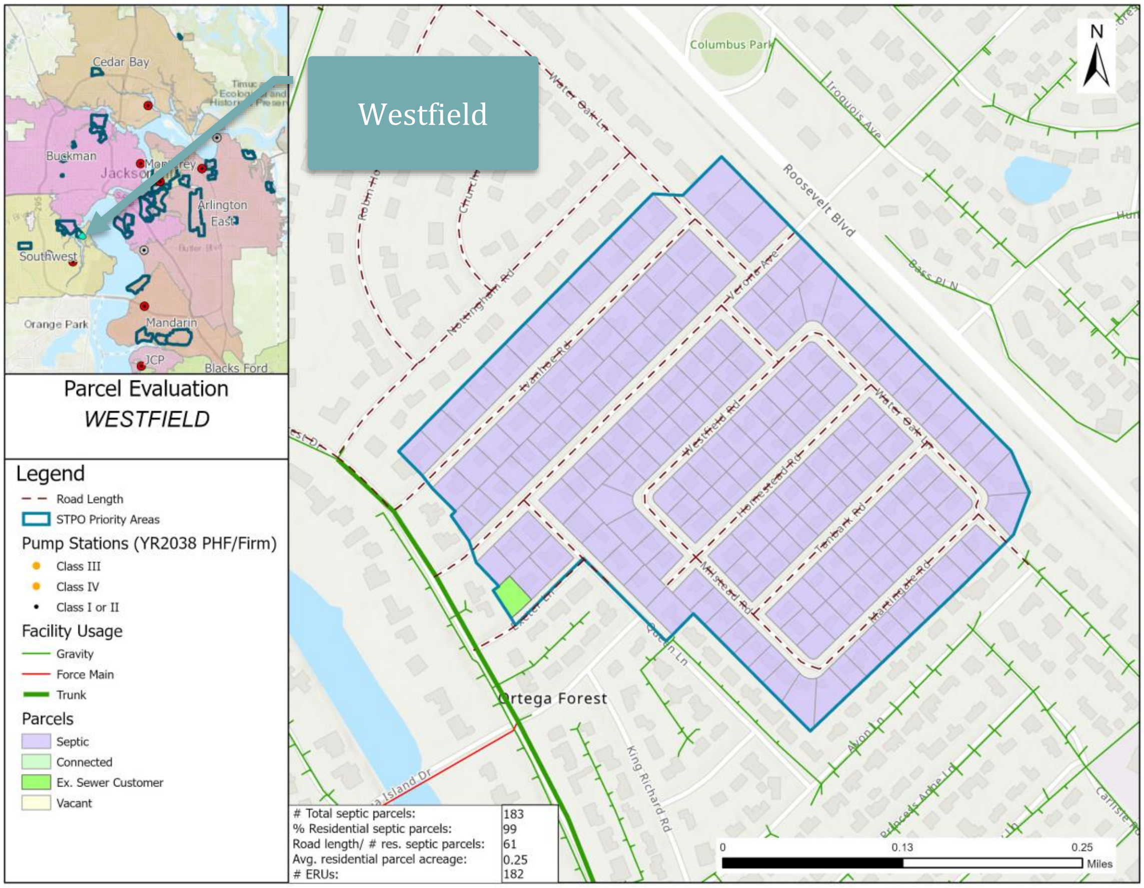


Figure 5-109: Westfield Septic Parcels

The topography of the septic parcels was flat; elevations ranged from 16 to 24 ft (see Appendix F.32 Figure F.32-3). A review of aerial maps (Figure F.32-7) and site visit data (Figure 5-110 and Figure 5-111) characterized restoration costs to be low (asphalt road with no curbs, gutters or stormwater swales) relative to other STPO priority areas. The road widths ranged from 18 to 22 ft, and the ROW width ranged from 40 to 50 ft. The electric supply was overhead. The depth to water table varied from 15 to 31 inches below grade (Figure F.32-4), and the soil rating for conventional septic systems was very limited (Figure F.32-12). All of the septic parcels were existing water customers (Figure F.32-7). Approximately 100% and 0% of septic parcels were within FDEP TMDL boundaries for fecal coliform or nutrients (Figure F.32-5), respectively. None of the septic parcels were classified as most vulnerable in the SAS vulnerability assessment (see Figure F.32-11). A summary of these parameters is presented in Table 5-37.

Figure 5-110: Westfield STPO Priority Area, Milstead Rd Site Visit Photo

Figure 5-111: Westfield STPO Priority Area, Ivanhoe Rd Site Visit Photo

Table 5-37: Westfield Characterization

Description	Value	Units
2019 STPO Prioritization Ranking	12	
Total Parcels	184	#
Septic Parcels	183	#
Proportion Septic	99	%
Proportion Residential	99	%
Average Res. Parcel Acreage	0.25	acres
Water Meter AADF	34,076	gpd
Planning AADF (gpd)	51,164	gpd
Rd. Length ÷ Res. Parcels	61	ft/parcel
Proportion Ex. Water Customers	100	%
Restoration Costs	low	
Topography	flat	
Soil Rating for conventional septic systems	very limited	
Proportion Fecal Coliform TMDL Septic Parcels	100	%
Proportion Nutrient TMDL Septic Parcels	0	%
Proportion SAS Most Vulnerable Septic Parcels	0	%
Proportion SAS More Vulnerable Septic Parcels	0	%
Proportion SAS Vulnerable Septic Parcels	100	%
Vacant Acreage	0	acres
Vacant Government Owned Acreage	0	acres

There were no existing wetlands/surface water within or surrounding the boundary.

5.8 Adjacent Septic Parcels to STPO Priority Areas for Consideration

As discussed in Section 1.2, thirty-five priority STPO areas (and associated boundaries) were established by JEA. As part of the STPO priority areas characterization assessment, Hazen considered adjacent septic parcels to the STPO priority area boundaries to possibly include. Table 5-38 presents the number of adjacent parcels that could relatively easily be added to the STPO priority areas. Most of these adjacent parcels were on a road where sewer service would likely be planned for the STPO priority area. Figure 5-112 through Figure 5-120 show the proximity of these adjacent septic parcels (orange in color with red stars) to the STPO priority area boundaries (blue line) and STPO priority area septic parcels (purple in color), as applicable.

Table 5-38: Adjacent Parcels to STPO Priority Areas for Consideration

STPO Priority Areas	# Septic Parcels in STPO Priority Areas	# of Adjacent Septic Parcels
Beauclerc Gardens	615	3
Emerson	957	4
Hood Landing II	533	12
Julington Hills	678	40
Lakeshore	1,472	41
Mt Pleasant	466	8
Pablo Point	242	20
Riverview	1,768	43
Spring Glen	629	3
Total	**7,360**	**174**

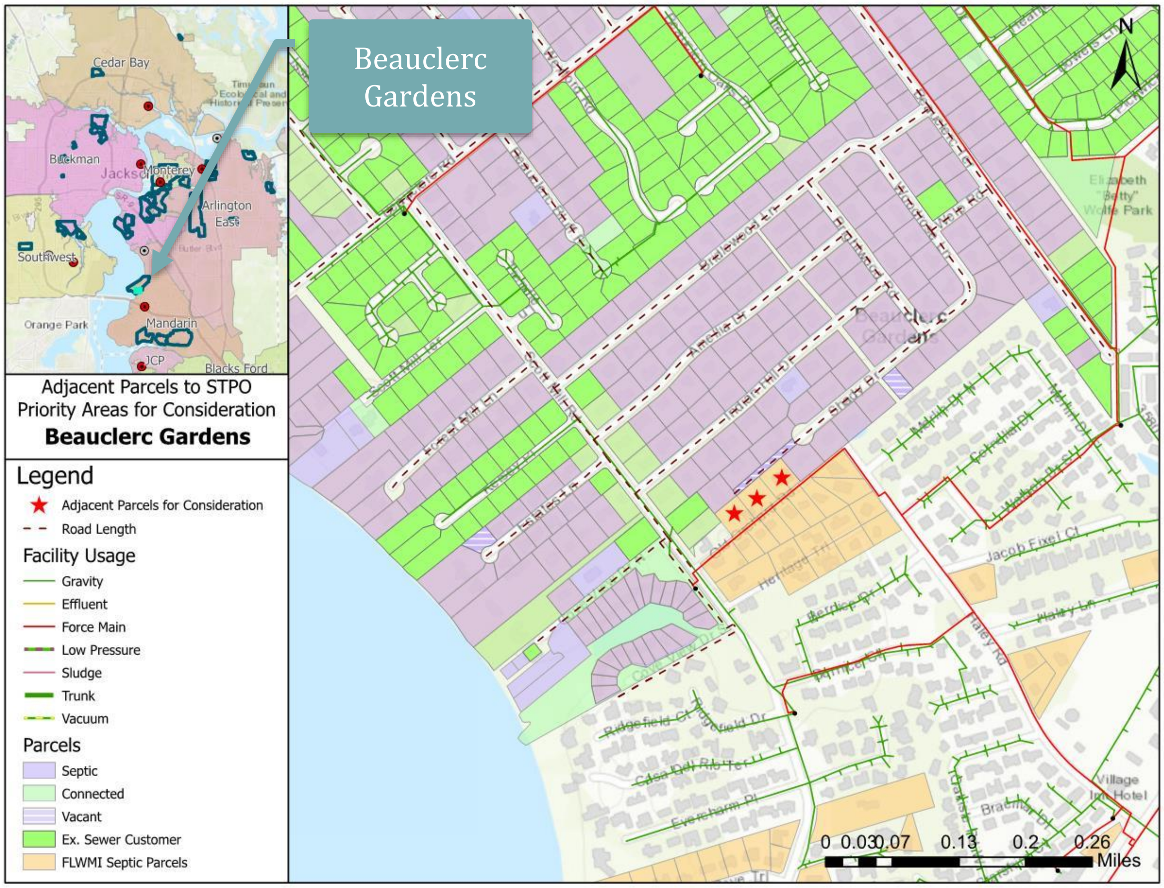


Figure 5-112: Adjacent Septic Parcels to Beauclerc Gardens for Consideration

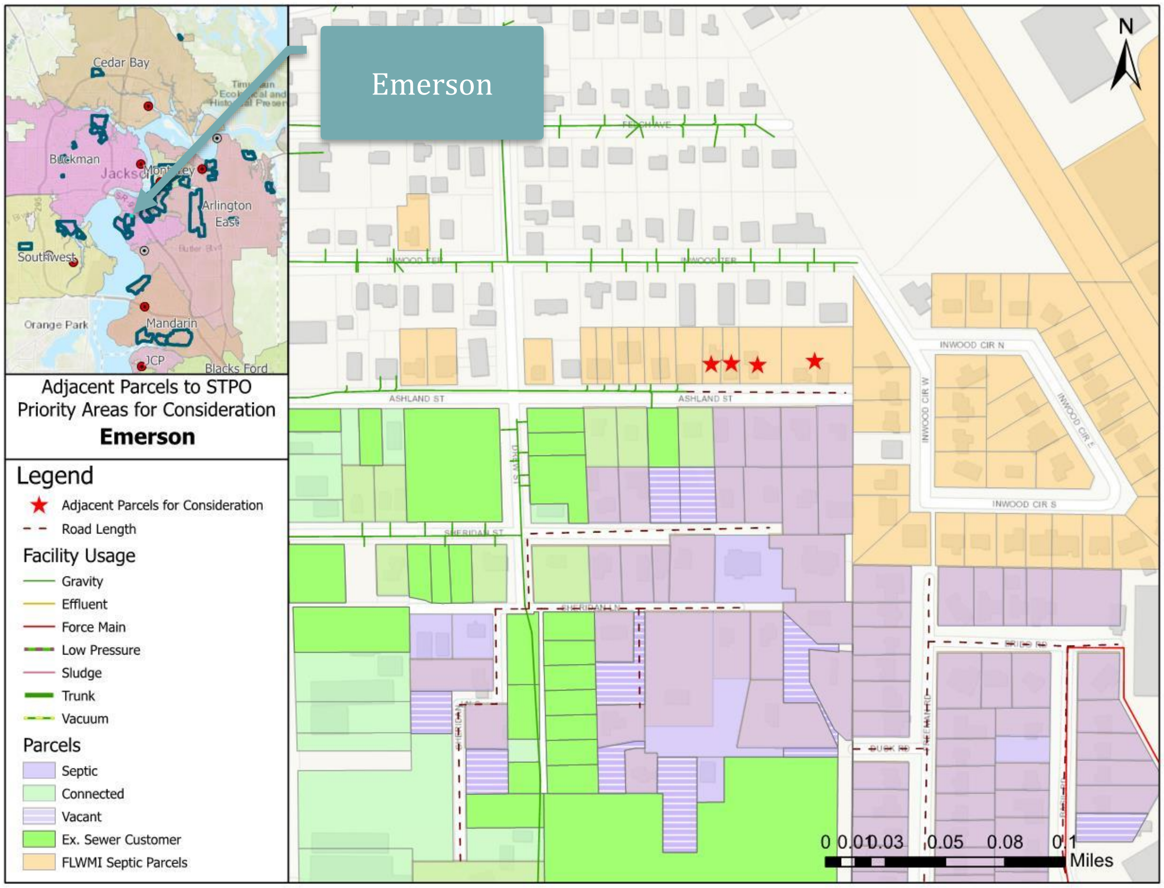


Figure 5-113: Adjacent Septic Parcels to Emerson for Consideration

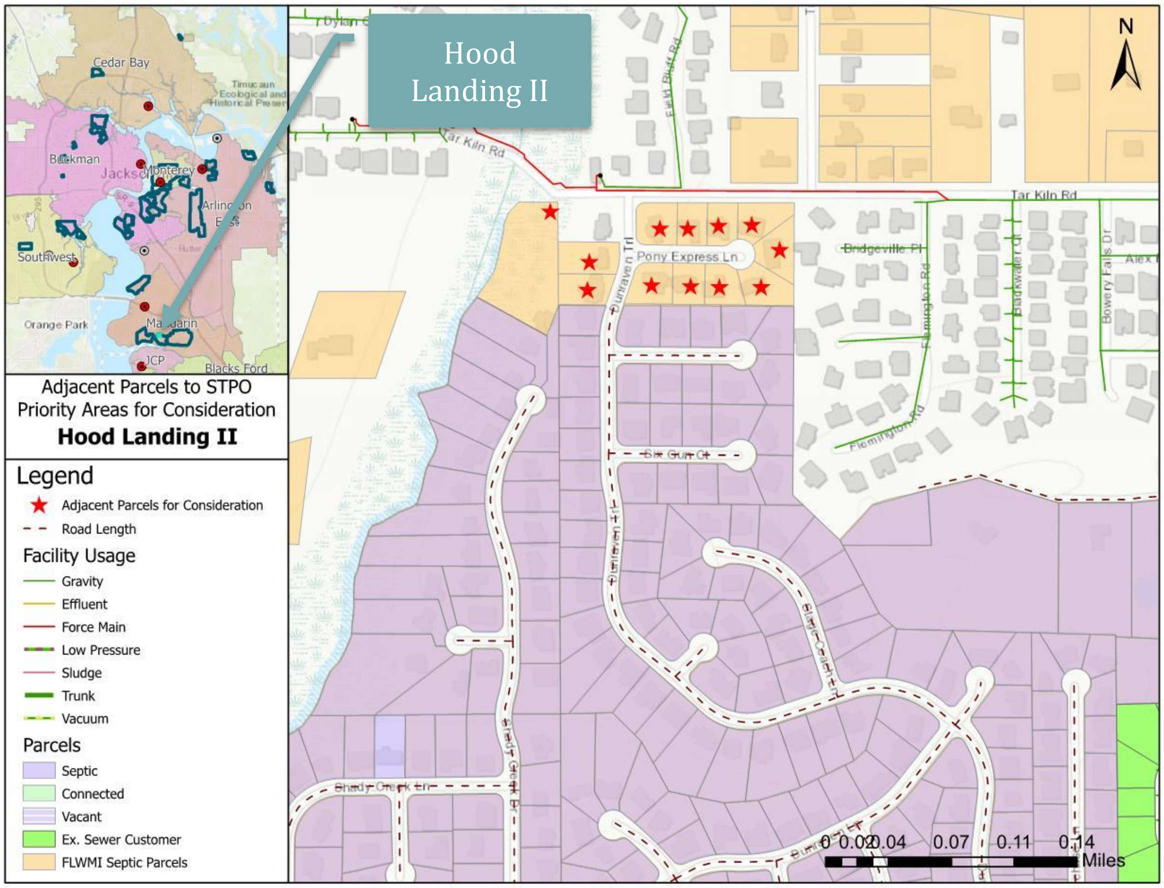


Figure 5-114: Adjacent Septic Parcels to Hood Landing II for Consideration

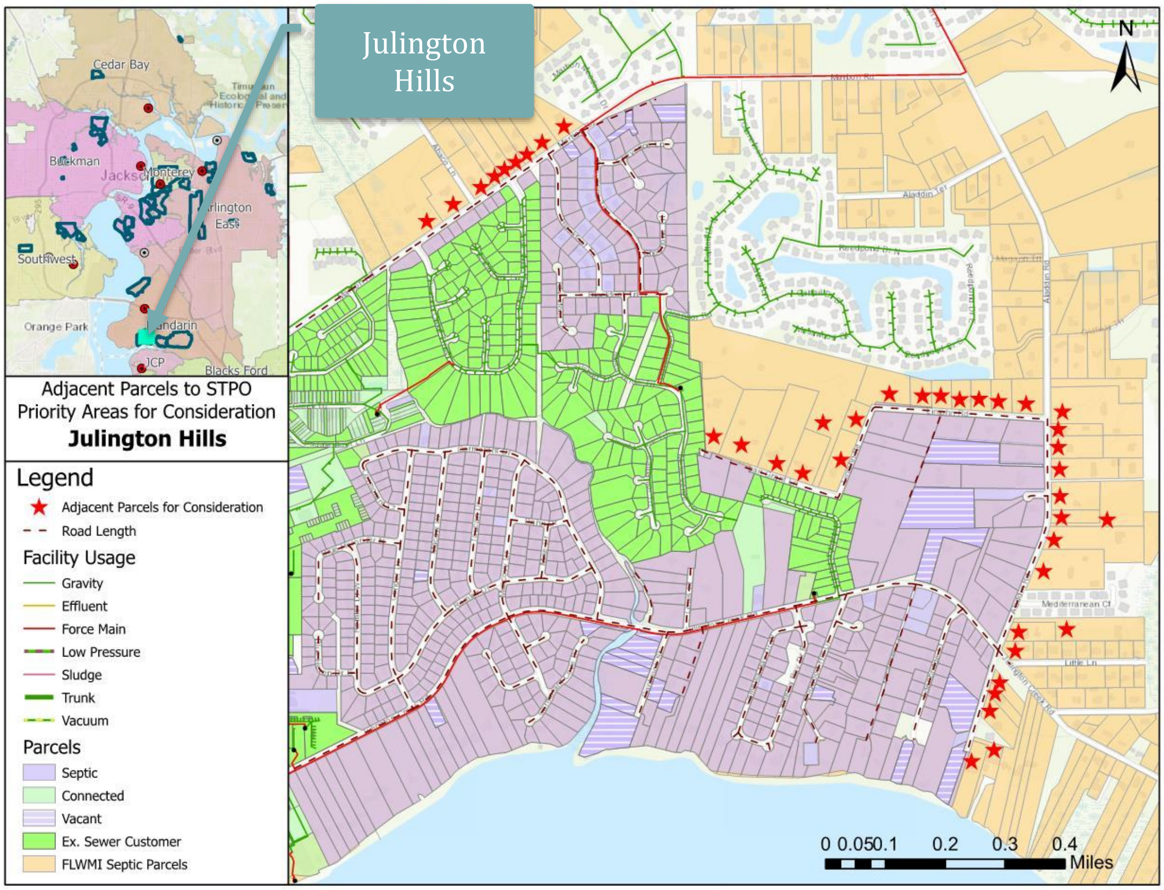


Figure 5-115: Adjacent Septic Parcels to Julington Hills for Consideration

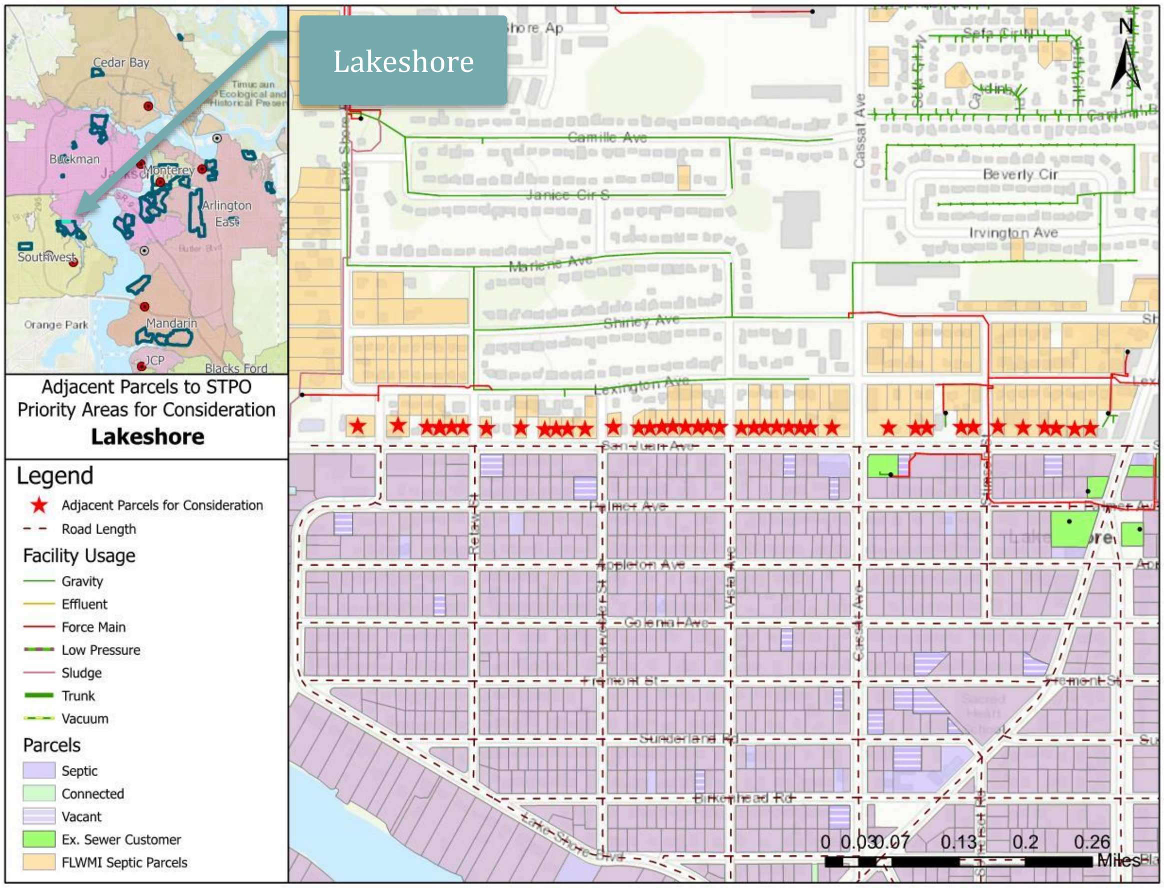


Figure 5-116: Adjacent Septic Parcels to Lakeshore for Consideration

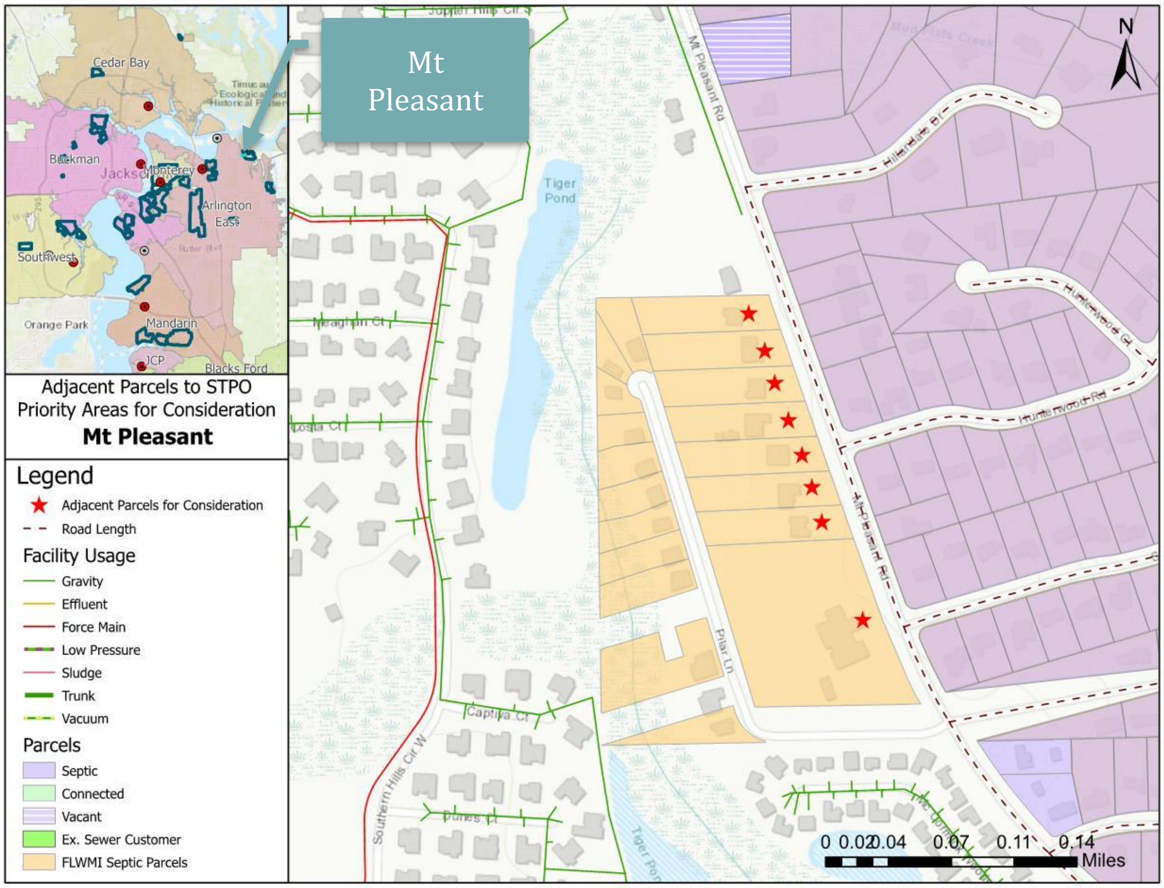


Figure 5-117: Adjacent Septic Parcels to Mt Pleasant for Consideration

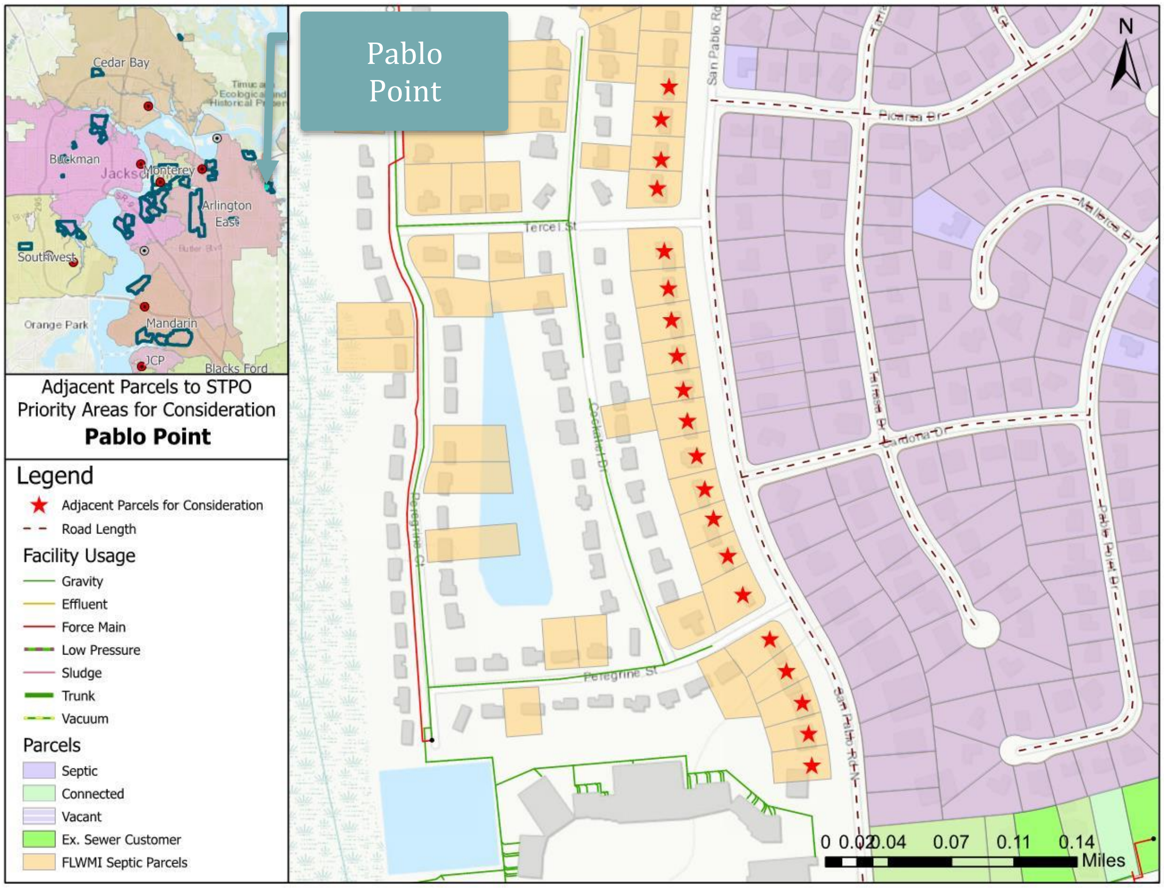


Figure 5-118: Adjacent Septic Parcels to Pablo Point for Consideration

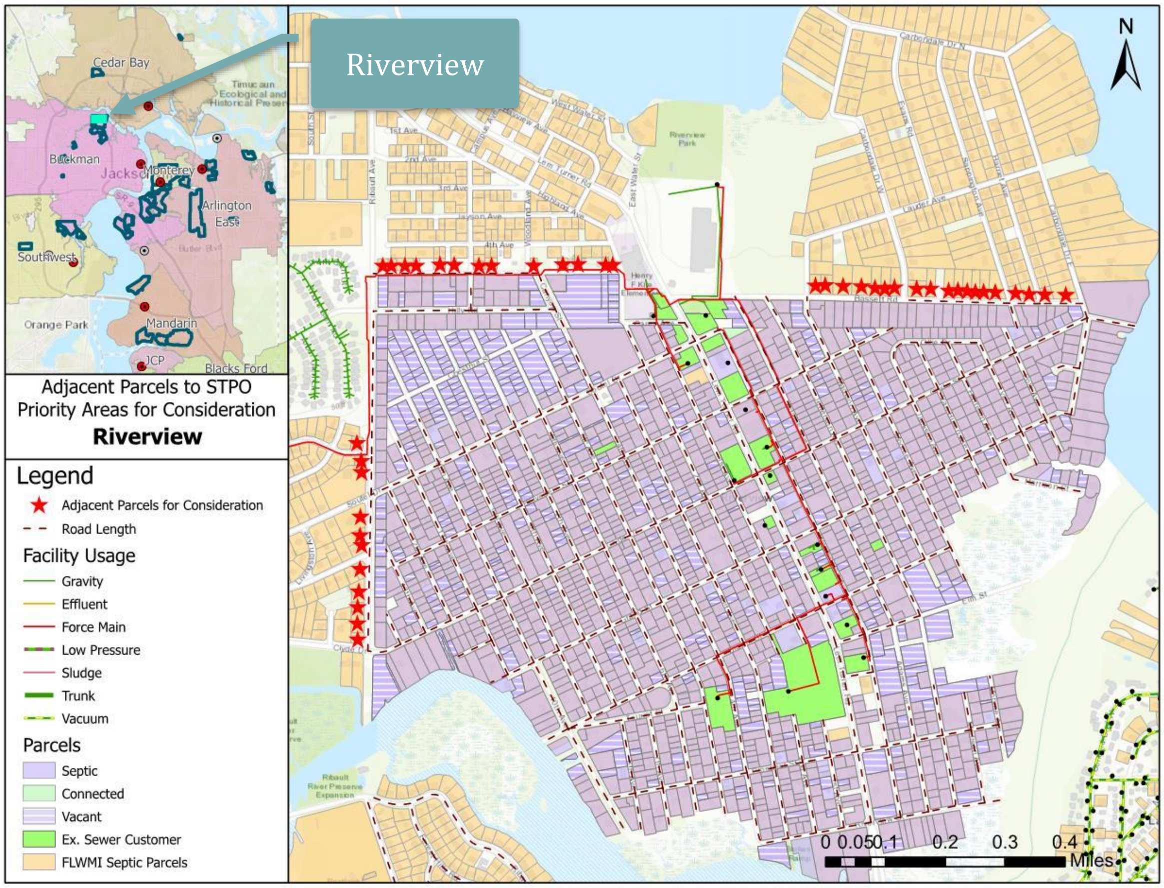


Figure 5-119: Adjacent Septic Parcels to Riverview for Consideration

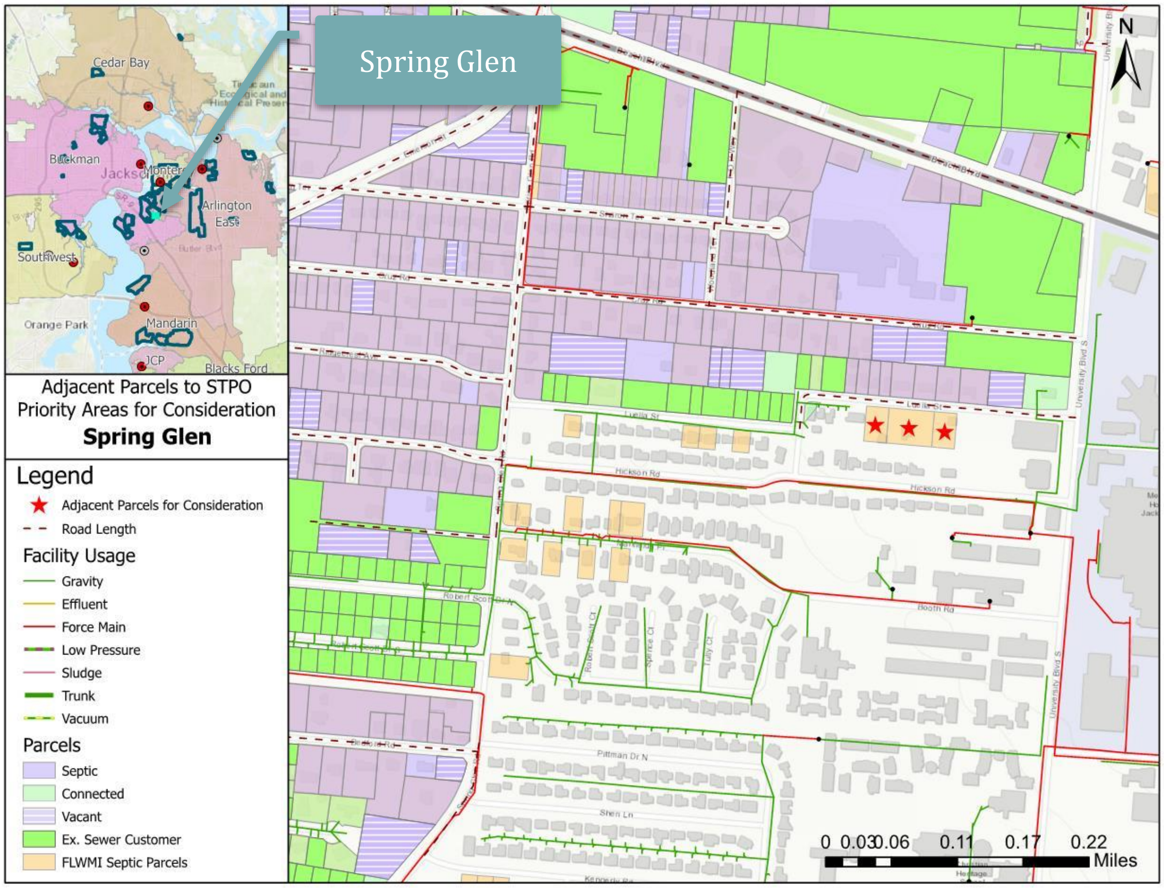


Figure 5-120: Adjacent Septic Parcels to Spring Glen for Consideration

5.9 Additional Environmental Considerations

Various funding sources may require additional details on environmental considerations to establish the projects have no significant environmental impact. These sources often include an environmental review to identify any significant adverse effects upon surface water bodies including Outstanding Florida Water, wetlands (see site visit aerials), critical habitats, archaeological/historical sites (not evaluated), floodplains (see Section 4), or air quality.

5.9.1 Outstanding Florida Water

Outstanding Florida Water was a water designated worthy of special protection because of its natural attributes. There were a few Outstanding Florida Waters in the Jacksonville area (Figure 5-121). There were two STPO priority areas adjacent to Outstanding Florida Waters: Mt. Pleasant and The Cape.

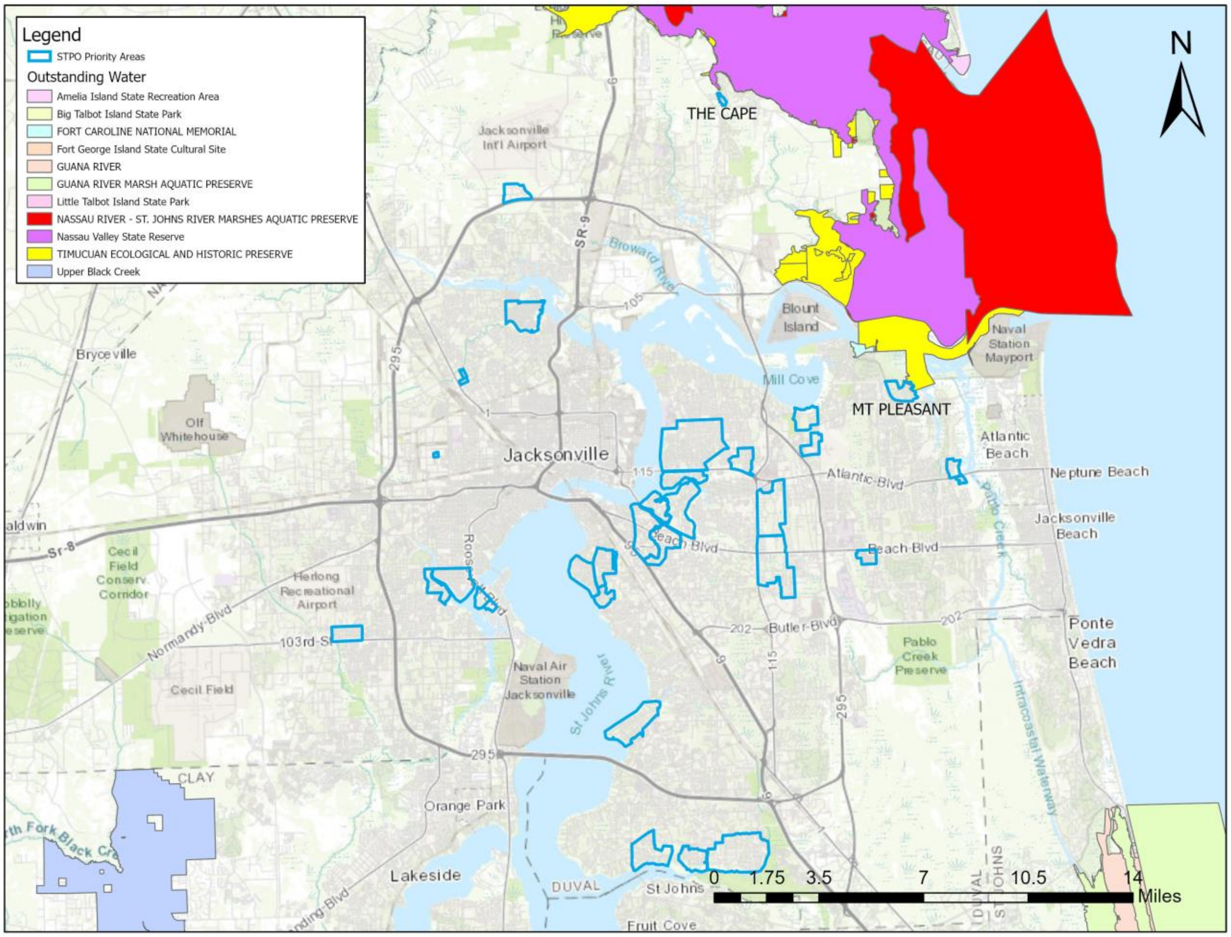


Figure 5-121: Outstanding Florida Waters

5.9.2 Critical Habitats

The U.S. Fish & Wildlife Service (USFWS) identifies critical habitats as well as threatened and endangered species. Appendix G includes a list of the threatened and endangered species that were known or were believed to occur in general vicinity of the STPO priority areas. Figure 5-122 shows the three critical habitat boundaries identified within the Jacksonville area which included:

- Loggerhead sea turtle: not applicable
- Piping plover: not applicable
- West Indian manatee: within the St. Johns River area which bordered several STPO priority areas including Beauclerc Gardens, Beverly Hills, Cedar River, Clifton, Eggleston Heights, Empire Point, Hood Landing II, Holly Oaks, Julington Creek, Julington Hills, Lakeshore, Mt. Pleasant, Oak Haven, Oaklawn, Ortega, Point La Vista, Riverview, and St. Nicholas.

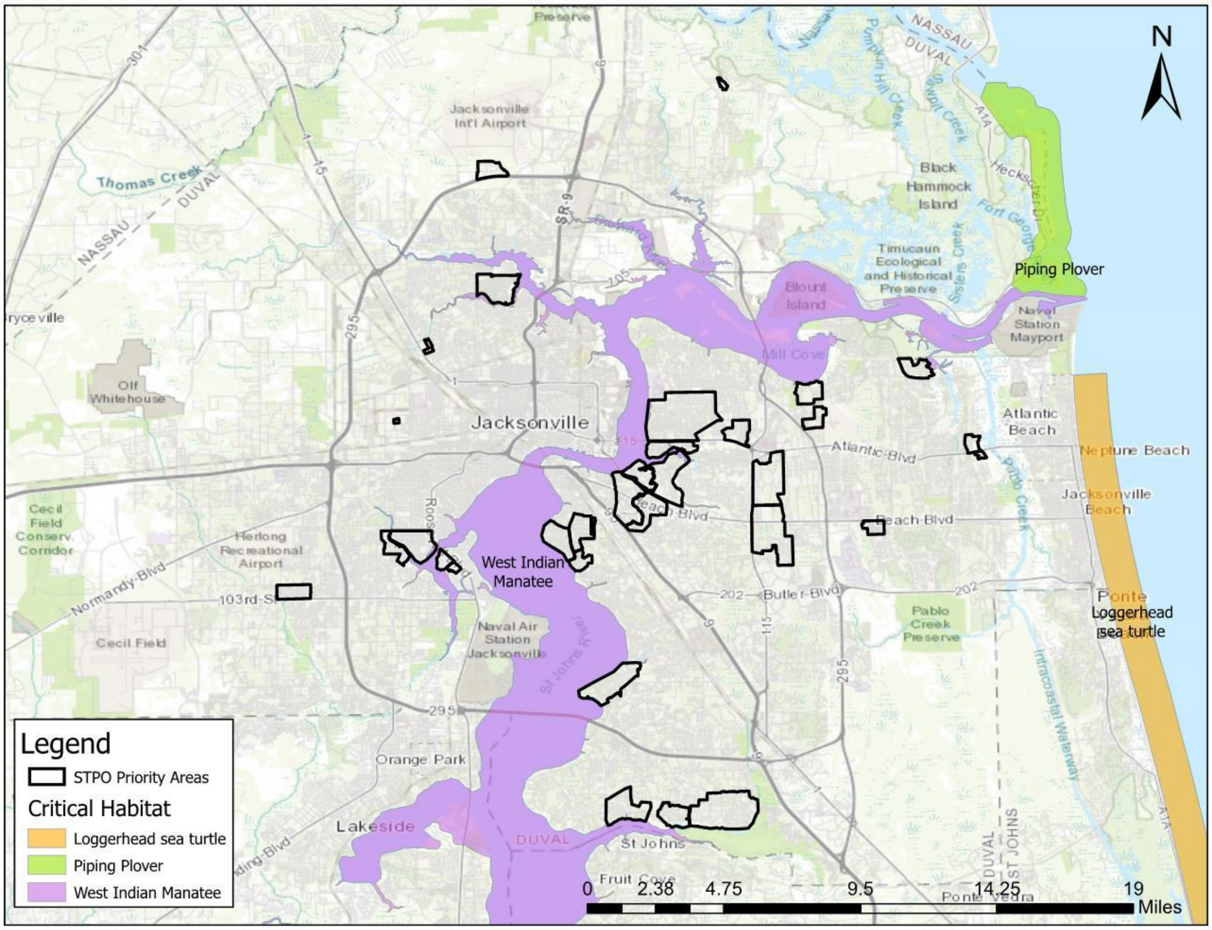


Figure 5-122: USFWS Critical Habitat Boundaries

5.9.3 Air Quality

The FDEP monitors and records ambient air quality continuously. This data can be found on the Florida's Air Quality System (FLAQS) website, which includes daily, monthly, and highest readings, attainment status, and contaminant levels. The attainment status of an area determines whether or not said region is in compliance with FDEP regulations. The City of Jacksonville received its attainment status from ten monitoring locations: Kooker Park, Sheffield Elementary School, Minerva Street (no longer operational), Cedar Bay Road, Rosselle Street (no longer operational), Fort Caroline Road (no longer operational), Mandarin Road, Mayo Clinic, Cisco Drive, and Pepsi Place (Figure 5-123). According to the FLAQS, Duval County was an "attainment" area since:

- Sheffield Elementary had a 3-Year Attainment Average for Ozone of 60 parts per billion (ppb), which was less than the National Ambient Air Quality Standard of 70 ppb.
- Cedar Bay STP had a 3-Year Attainment Average for SO2 of 10 ppb which was less than the National Ambient Air Quality Standard of 75 ppb.

- Mayo Clinic had a 3-Year Attainment Average for Ozone of 61 parts per billion (ppb), which was less than the National Ambient Air Quality Standard of 70 ppb.

- Cisco Drive had a 3-Year Attainment Average for Ozone of 61 parts per billion (ppb), which was less than the National Ambient Air Quality Standard of 70 ppb.

- Pepsi Place had a 3-Year Attainment Average for NO2 of 39 ppb which was less than the National Ambient Air Quality Standard of 100 ppb. In addition, Pepsi Place had a CO highest hourly value of 1.3 parts per million (ppm) and highest 8-hour value of 1.1 ppm, which were less than the National Ambient Air Quality Standard of 35 ppm and 9 ppm, respectively.

The construction of the STPO projects should not create any impact on the existing air quality in the County.

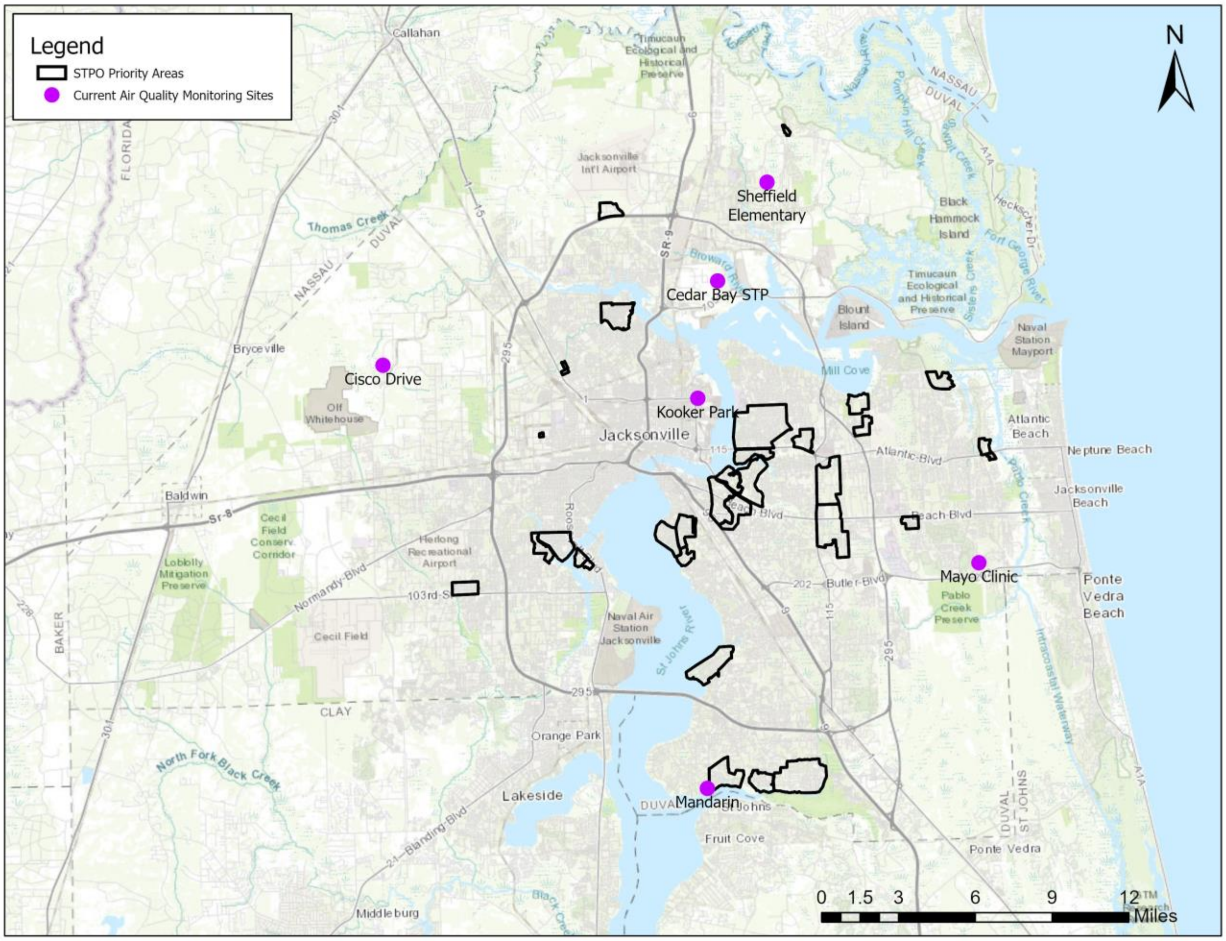
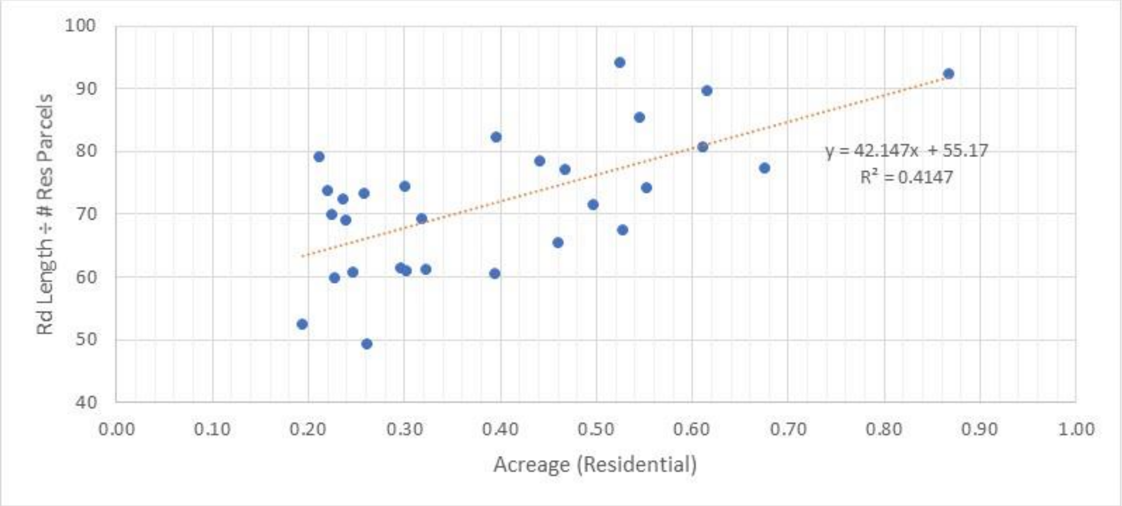


Figure 5-123: STPO Project Area Air Quality Monitoring Sites Map

5.10 Representative STPO Priority Areas

The 32 remaining STPO priority areas were categorized based on similar septic system density (i.e., lot size) characteristics. The average lot size somewhat correlated with the road length/parcel metric as Figure 5-124 shows.



*Outlier STPO priority areas include Northlake, St. Nicholas and Spring Glen, which were removed.

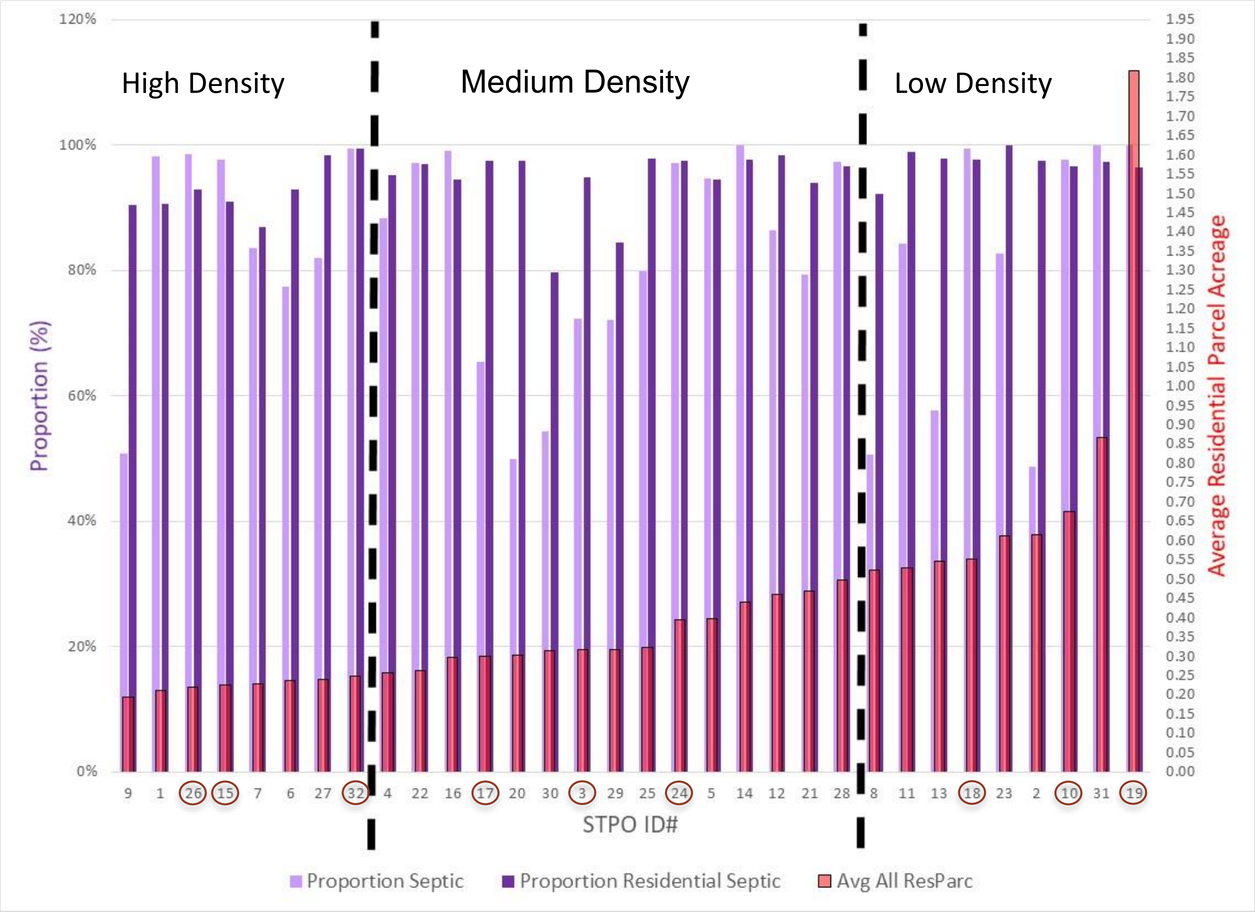
Figure 5-124: STPO Priority Areas Average Lot Size Comparison to Road Length per Parcel

The STPO priority areas were then categorized as low (>0.5 acre average lot size), medium (0.25 to 0.5 acre average lot size), or high (<0.25 acre average lots size) housing density. STPO priority areas with total septic parcels near the average for the density category, relatively high proportion of septic parcels, and relatively high proportion of residential parcels (summarized in Table 5-39 and highlighted in Figure 5-125) were considered in choosing representative STPO priority areas (outlined in Table 5-40) for more detailed planning level cost analysis for various wastewater capital improvements. The STPO priority areas with very few or very many parcels were eliminated as being representative for cost estimation purposes. In addition, for the medium density type, STPO priority areas with a mixture of small and large parcels and/or large vacant acreage artificially creating a medium average parcel acreage were not considered as being representative for planning level cost estimation purposes.

Table 5-39: STPO Priority Areas Categorization

ID	STPO priority areas	# Septic	# Res	% Septic	% Res	Res Acres	Density
9	FREEMAN	63	57	51%	90%	0.19	High
1	ATLANTIC HIGHLANDS	106	96	98%	91%	0.21	High
32	WESTFIELD	183	182	99%	99%	0.25	High
27	SANS PAREIL	375	369	82%	98%	0.24	High
7	EMERSON	957	832	84%	87%	0.23	High
15	LAKESHORE	1472	1338	98%	91%	0.22	High
26	RIVERVIEW	1768	1642	99%	93%	0.22	High
6	EGGLESTON HEIGHTS	3714	3453	77%	93%	0.24	High
22	ODESSA	34	33	97%	97%	0.26	Medium
14	KINARD	84	82	100%	98%	0.44	Medium
20	OAK LAWN	235	229	50%	97%	0.30	Medium
24	PABLO POINT	242	236	97%	98%	0.39	Medium
16	LONE STAR PARK	351	332	99%	95%	0.30	Medium
3	CEDAR RIVER	428	406	72%	95%	0.32	Medium
17	MILL CREEK	449	438	65%	98%	0.30	Medium
5	CLIFTON	564	533	95%	95%	0.40	Medium
29	SPRING GLEN	629	531	72%	84%	0.32	Medium
30	ST NICHOLAS	751	599	54%	80%	0.32	Medium
4	CHAMPION FOREST	832	792	88%	95%	0.26	Medium
25	POINT LA VISTA	866	848	80%	98%	0.32	Medium
21	OAKHAVEN	951	894	79%	94%	0.47	Medium
12	JULINGTON CREEK	2186	2152	86%	98%	0.46	Medium
28	SOUTHSIDE ESTATES	2485	2399	97%	97%	0.50	Medium
31	THE CAPE	38	37	100%	97%	0.87	Low
19	NORTHLAKE	139	134	100%	96%	1.82	Low
23	ORTEGA	139	139	83%	100%	0.61	Low
10	HOLLY OAKS	295	285	98%	97%	0.68	Low
8	EMPIRE POINT	370	341	51%	92%	0.52	Low
18	MT PLEASANT	466	455	99%	98%	0.55	Low
11	HOOD LANDING II	533	527	84%	99%	0.53	Low
2	BEAUCLERC GARDENS	615	600	49%	98%	0.62	Low
13	JULINGTON HILLS	678	663	58%	98%	0.55	Low

*Orange/pink highlights indicate STPO priority areas chosen as representative areas for planning level cost estimates.



*Red circles around STPO priority area ID# indicate STPO priority areas chosen as representative areas.

Figure 5-125: STPO Priority Areas Proportion of Septic and Residential versus Average Residential Parcel Acreage

As noted during the assessment, some STPO priority areas included waterfront parcels which were typically long, narrow, large lots along with small parcels inland and topography varied lower near the river and higher inland (see example area Beauclerc Gardens Figure 5-126). The waterfront lots may be difficult to serve via gravity sewers, while the inland lots would not. The use of several different wastewater management approaches (hybrid) may be most cost effective for these areas. Therefore, three STPO priority areas were selected as representative hybrid areas. The representative STPO priority areas are outlined in Table 5-40.

Figure 5-126: Example of Potential Hybrid Solution Area in Beauclerc Gardens

Table 5-40: Representative STPO priority areas for IWTP Task 7 Cost Analysis

Housing Density			
High (<0.25 acre avg. lot size)	**Medium (0.25 – 0.5 acre avg. lot size)**	**Low (>0.5 acre avg. lot size)**	**Hybrid (highly variable lot sizes)**
Westfield	Pablo Point	Northlake	Mt. Pleasant
Lakeshore	Cedar River	Holly Oaks	Cedar River
Riverview	Mill Creek	Mt. Pleasant	Riverview

5.11 Impact of Sea Level Rise

In March 2013, the Regional Community Institute of Northeast Florida, Inc. (Regional Community Institute of Northeast Florida 2013, Teeple, Moehring et al. 2015, NOAA 2017, NOAA 2020), invited coastal and riverfront communities in the region to participate in community resiliency assessments. These assessments were intended to inform its work on a regional action plan for sea level rise and to begin dialogue in the region on the potential for impacts related to sea level rise. While representing an important start, it does not appear that the assessments correlated predicted sea level rise to rise in the surficial groundwater table in the Duval County area, which is an important consideration for planning wastewater management strategies.

Studies in south Florida were identified, including Broward and Miami-Dade Counties, which developed and calibrated coupled surface-water/groundwater models and clearly determined that rising sea levels caused increased water-table elevations and decreased hydraulic gradients across the system (Hughes and White 2016). It is noted that the groundwater system in northeastern Florida was composed of surficial and intermediate aquifer systems and the underlying Floridan aquifer system (Figure 5-127). Moreover, the surficial aquifer system in northeast Florida was less managed than the surficial system in south Florida, which had a multitude of natural rivers, artificial canals and myriad control structures which, to an extent, were reflected in the modeling exercises to control the surface and groundwater. Additionally, the hydrogeologic attributes of south Florida and Jacksonville aquifer systems were only partially analogous. Hence, while informative, the Broward and Miami-Dade results should be used with care relative to the specific hydrological conditions which exist in Duval county.

There was a North Florida-Southeast Georgia (NFSEG) regional groundwater flow model developed which was a product of the North Florida Regional Water Supply Partnership to be used for water supply planning and establishment/assessment of minimum flows and minimum water levels. The final model report (Grubbs 2019) stated that generally, the water table of the surficial aquifer system (Figure 5-127) was a subdued reflection of land surface. A domain-wide map of the water table was not available, due to a lack of available water level data in many areas. The water levels of the surficial aquifer system relative to those of the underlying Floridan aquifer system determined the direction of leakage to or from the Floridan aquifer system in semiconfined to confined regions of the Floridan aquifer systems (Grubbs 2019). It was noted that in Jacksonville, FL significant hydraulic contact with the St. Johns River was limited to the surficial aquifer system, as the Floridan aquifer system in this area was heavily confined, the intermediate confining unit being on the order of 400 ft thick. Hence, sea level rise can be expected to influence the water table elevation in the surficial aquifer directly and through river stage increases over time due to tidal effects.

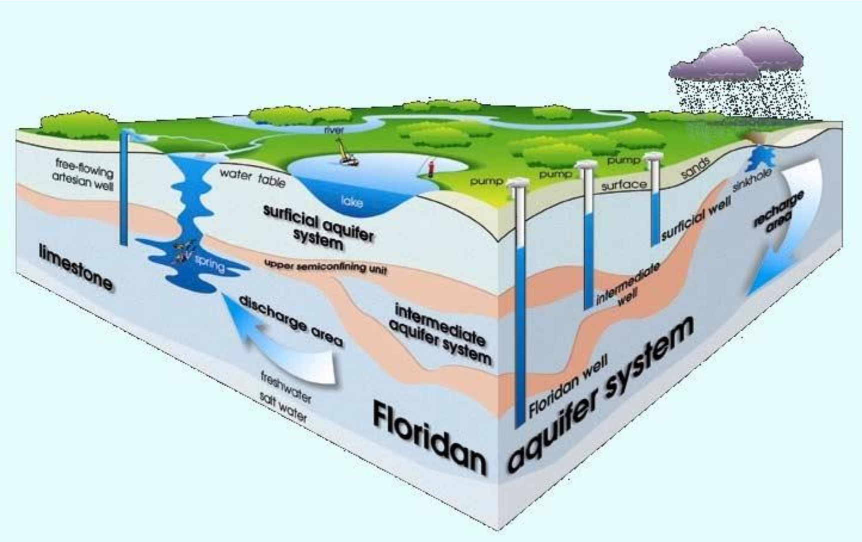
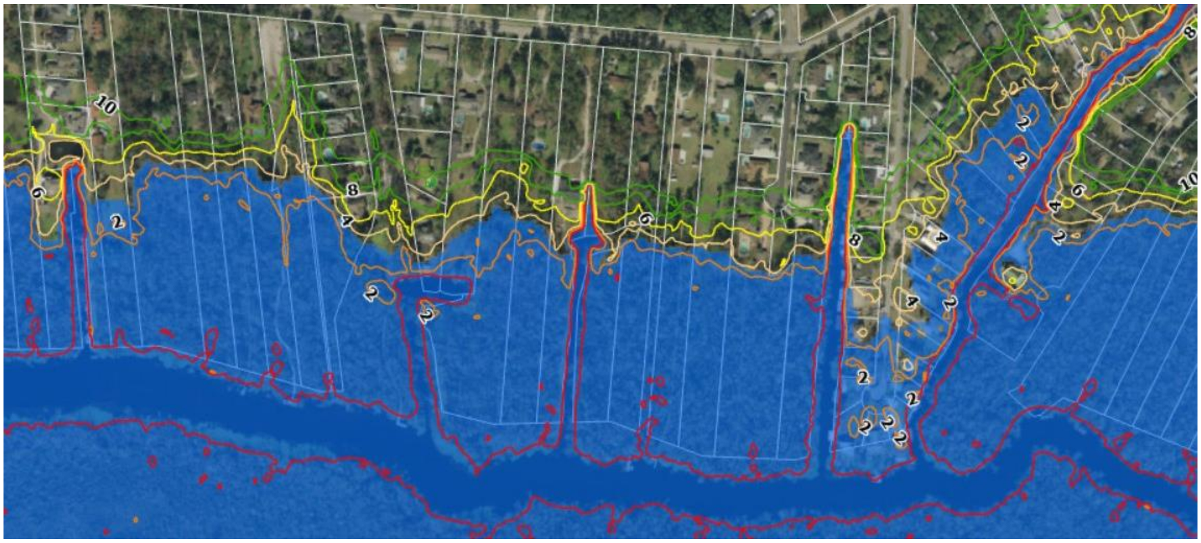


Figure 5-127: Conceptual Diagram of Surface Water Management in Duval County

Hazen assessed general susceptibility to flooding and climate change for each STPO priority area (see Appendix F, Figure 6) using a dataset created by the National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management (NOAA 2020, Build Community Resilience 2020). The predicted impact of a sea level rise of 3 ft corresponding to the year 2060 on septic parcels within the STPO priority areas was determined by comparison to current topography and structures on the lots.

This assessment indicated that 21 of the 32 remaining STPO priority areas included septic parcels that will be impacted by the predicted 3 ft sea level rise. As an example, Figure 5-128 shows the predicted impact of a 3 ft sea level rise (shown in blue) on septic parcels in the Julington Creek project area. The imagery under the sea level rise layer shows the land as-is in 2020 and current topographic contours.



* The aerial imagery shows the current land

Figure 5-128: Example Impact of a 3 ft Sea Level Rise on Septic Parcels within Julington Creek

The assessment indicated that parcels with a topographic elevation below 6 ft could be significantly impacted by future sea level rise, with expected groundwater rise limiting the unsaturated thickness of the soil vadose zone which would hinder operation of some onsite wastewater treatment systems and other technologies. Therefore, onsite wastewater treatment including a drainfield should not be considered a feasible solution for these areas. Updates to the Duval County area analysis should be made as better information with surficial groundwater modeling coupled with sea level rise is made available for the Duval County area.

6. Development of Recommended STPO Priority Areas Wastewater Improvements (Task 7)

Task 7 incorporated previously completed evaluations in Tasks 2 through 5 (Phase 1) and Task 6 for development of recommended STPO priority areas wastewater capital improvements.

6.1 Pre-Screening of STPO Priority Area Wastewater Improvements

The onsite, decentralized, and centralized wastewater improvement alternatives were further screened for applicability to the STPO priority areas using decision support criteria as well as input from JEA from a screening session conducted November 17, 2020.

6.1.1 Onsite Wastewater Improvement Pre-Screening

For this project, onsite wastewater improvements were defined as a single unit used for collection, treatment, and dispersal or reclamation of wastewater generated by a single dwelling or building. In general, onsite treatment systems are located at or near the site of wastewater generation and can include conventional, advanced or innovative treatment systems. Upgrading conventional septic systems to advanced onsite treatment systems could be a low-cost approach to wastewater treatment if planned, designed, installed, operated, and maintained properly.

However, using the results of the Task 6 sea level rise estimations, the resultant reduction in the unsaturated soil zone thickness and pollutant attenuation was also considered. As such, only the STPO priority areas not expected to be impacted by sea level rise and an average parcel acreage greater than 0.25 acres included onsite treatment technologies as a solution alternative in the detailed evaluation. Hence, the six STPO priority areas suitable for consideration of onsite wastewater improvements as a solution alternative are outlined in Table 6-2.

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Table 6-1: Onsite Pre-Screening Results

STPO Priority Areas Considered an Onsite Wastewater Improvement
Champion Forest
Lone Star Park
Mill Creek
Northlake
Odessa
Southside Estates

6.1.2 Decentralized Wastewater Improvement Pre-Screening

For this project, decentralized wastewater improvements were defined as multi-source collection and community or clustered treatment system (not an existing JEA WWTF) used to collect, treat and disperse or reclaim wastewater from a small community or service area. For STPO priority areas either located far away from existing JEA infrastructure or within an area of the JEA service area with limited available capacity, a low-cost approach to wastewater treatment could be a new decentralized wastewater treatment facility. A preliminary cost analysis for new infrastructure to the POC indicated that only the areas with a POC greater than 4,000 linear feet from the boundary have the potential to offset the additional cost of a decentralized wastewater capital improvement. Hence, the two STPO priority areas suitable for consideration of a decentralized wastewater improvement are outlined in Table 6-2.

Table 6-2: Decentralized Strategy Pre-Screening Results

STPO Priority Areas Considered a Decentralized Wastewater Improvement
Northlake
Riverview

6.1.3 Collection System Evaluation for Decentralized and Centralized Wastewater Improvements

Figure 6-1 summarizes the applicable collection and transmission technologies remaining from the Phase 1 assessment for the conveyance of wastewater to decentralized or centralized wastewater treatment facilities.

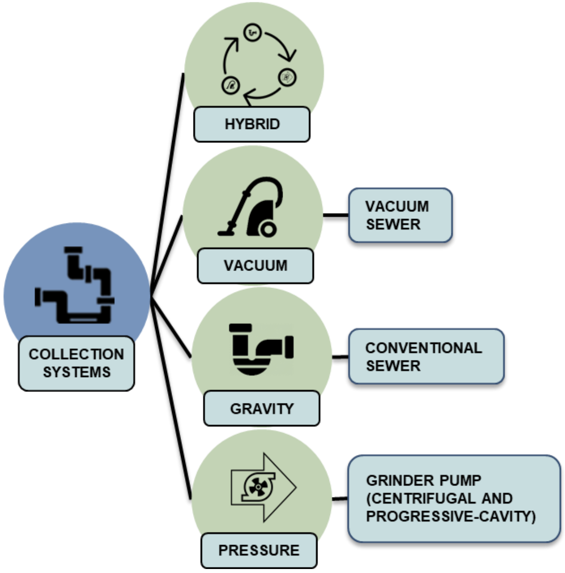


Figure 6-1: Collection System Technologies Remaining from Phase 1 Assessment

Using the results of the Task 6 sea level rise estimations, the STPO priority areas impacted by both sea level rise and consisting of a mixture of long, narrow parcels at the riverfront with smaller lots inland would result in multiple lift stations for a gravity sewer approach. Therefore, these STPO priority areas included a hybrid collection system alternative for decentralized and/or centralized wastewater improvements. A hybrid collection system for this project is defined as a combination of low pressure or vacuum sewer and gravity sewer to limit the number of lift stations required. If homes in low elevation areas near the riverfront are not able to connect via gravity to the main in the right-of-way, a different type of hybrid solution would be needed and would be determined in detailed design. Hence, seventeen STPO priority areas considered hybrid collection system as a decentralized or centralized (as applicable) wastewater improvement alternative as outlined in Table 6-3.

Table 6-3: Hybrid Collection System Wastewater Improvement Pre-Screening Results

STPO Priority Areas Considered a Hybrid Collection System Strategy
Beauclerc Gardens
Cedar River
Clifton
Empire Point
Holly Oaks
Hood Landing II
Julington Creek
Julington Hills
Lakeshore
Mt. Pleasant
Oak Lawn
Oakhaven
Ortega
Point La Vista
Riverview
Spring Glen
St. Nicholas

6.1.4 Wastewater Improvements Pre-Screening Summary

Table 6-4 presents a summary of the results of the wastewater capital improvement pre-screening. These wastewater improvements will be considered for the STPO priority areas along with vacuum and low pressure collection systems for decentralized and centralized wastewater improvements (as applicable). Vacuum and low pressure collection systems were assumed to be feasible for all of the STPO priority areas.

Table 6-4: Results of the Pre-Screening

Onsite	Decentralized	Hybrid
Champion Forest Lone Star Park Mill Creek Northlake Odessa Southside Estates	Northlake Riverview	Beauclerc Gardens Cedar River Clifton Empire Point Holly Oaks Hood Landing II Julington Creek Julington Hills Lakeshore Mt. Pleasant Oak Lawn Oakhaven Ortega Point La Vista Riverview Spring Glen St Nicholas

Table 6-5 presents the results of the wastewater capital improvements pre-screening for each STPO priority area.

Table 6-5: Wastewater Improvements Pre-Screening Results by STPO Priority Area

	Atlantic Highlands	Beauclerc Gardens	Cedar River	Champion Forest	Clifton	Eggleston Heights	Emerson	Empire Point	Freeman	Holly Oaks	Hood Landing II	Julington Creek	Julington Hills	Kinard	Lakeshore	Lone Star Park	Mill Creek	Mt Pleasant	Northlake	Oak Lawn	Oakhaven	Odessa	Ortega	Pablo Point	Point La Vista	Riverview	Sans Pareil	Southside Estates	Spring Glen	St Nicholas	The Cape	Westfield
Onsite				X												X	X		X			X						X				
Centralized																																
Gravity	X			X		X	X		X					X		X	X		X			X		X			X	X			X	X
LPS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Vacuum	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hybrid		X	X		X			X		X	X	X	X		X			X		X	X		X		X	X			X	X		
Decentralized																																
Gravity																			X													
LPS																			X							X						
Vacuum																			X							X						
Hybrid																										X						

Note:
X=Wastewater management strategy alternative was included in the detailed evaluation.
LPS = Low pressure system

6.2 Detailed Evaluation of STPO Priority Wastewater Capital Improvements

Pre-screening was followed by a detailed evaluation including multiple selection criteria and weighting factors which were combined for a total score and resulted in one wastewater capital improvement recommendation per STPO priority area. Section 4 describes each criteria and the chosen weighting factors; then summarizes scores and recommendations.

6.2.1 Criteria Descriptions and Scores

A simple numerical ranking system was developed to prioritize the STPO priority area wastewater capital improvements based on nine criteria. Each criterion was scored against its particular attribute using a scale ranging from 1 to 4, with 1 being the least favorable and 4 being the most favorable score.

The STPO priority area wastewater management strategies criteria were individually discussed with JEA and edited accordingly. A final consensus list of criteria was agreed to and adopted on January 21, 2021 during a workshop with JEA (Table 6-6). The criteria can be separated into five categories, four of which characterize technology options relative to each other, regardless of the STPO priority area in question; the remaining category, cost effectiveness, involves scores that are specific to the technology and STPO priority area under consideration.

Table 6-6: Wastewater Capital Improvement Detailed Evaluation Criteria

	Category	Criterion
Technology Specific Criteria	Regulatory Uncertainty	Regulatory Uncertainty
	Management of Operation	Ease of Management
	Maximize Reliability	Sensitivity to Flooding
		Power Outages, Emergency Storage, Reliability of Equipment
	Maximize Public Acceptance	Odor
		Aesthetics (noise, visual)
		Construction Impacts
		Ease Private and Neighborhood Property Restrictions
STPO Priority Area Specific Criteria	Cost Effectiveness	Net Present Cost

6.2.1.1 Regulatory Uncertainty

The recently approved Senate Bill 712 transfers the oversight of onsite systems from Florida Department of Health (DOH) to Florida Department of Environmental Protection (FDEP) by June 30, 2021. There is uncertainty how this will impact future regulations of onsite systems. Moreover, future uncertainties related to climate change are expected to affect various stratagems differently (for example, as the surficial aquifer unsaturated zone diminishes, regulations regarding onsite systems may change). It is unknown at this time how proposed rules and regulations such as the Senate Bill 1656 (so-called zero discharge rule) and discharge of compounds of emerging concern will ultimately affect the various sewer collection systems from a regulatory perspective. Table 6-8 presents the scores used for each technology type.

Table 6-7: Criterion Values for Regulatory Uncertainty

	Onsite Treatment	Gravity Sewer Collection	Vacuum Sewer Collection	Low Pressure Sewer Collection	Hybrid Sewer Collection
Criteria Score	2	4	4	4	4

6.2.1.2 *Management of Operation*

This category included consideration for staff training for required maintenance, operation, complexity of system, etc. From conversations with JEA, it was assumed that operation and maintenance (O&M) for onsite treatment would be managed by a third party and thus scored similar to gravity sewer collection systems. The associated cost for third party management of onsite treatment systems was accounted for in the O&M costs. Table 3-10 presents the criteria scores used for each technology type.

Table 6-8: Criterion Values for Ease of Management

	Onsite Treatment	Gravity Sewer Collection	Vacuum Sewer Collection	Low Pressure Sewer Collection	Hybrid Sewer Collection
Criteria Score	4	4	2	2	3

6.2.1.3 *Maximize Reliability*

Sensitivity to Flooding

This category included consideration for technology sensitivity to flood conditions including infiltration and inflow (I/I) and susceptibility to electrical failures. All sewer collection system technologies are susceptible to flooding but gravity and low pressure systems were determined to be more so than vacuum whereas onsite treatment was determined to be most susceptible to flood conditions impacting treatment. Table 6-10 presents the criteria scores used for each technology type.

Table 6-9: Criterion Values for Sensitivity to Flooding

	Onsite Treatment	Gravity Sewer Collection	Vacuum Sewer Collection	Low Pressure Sewer Collection	Hybrid Sewer Collection
Criteria Score	1	2	3	2.5	2.3

Power Outages, Emergency Storage, Reliability of Equipment

In addition, emergency storage volume for power outage events was considered as related to susceptibility to system back-ups. All vacuum stations and most lift stations within JEA's system are designed with emergency back-up power supply or have plans in place to supply emergency power to smaller, neighborhoods lift stations. Low pressure collection systems and onsite treatment systems were determined to be the most susceptible to power outages, however onsite systems tend to provide more emergency storage within the treatment system. Table 6-10 presents the criteria scores used for each technology type.

Table 6-10: Criterion Values for Power Outages, Emergency Storage and Reliability of Equipment

	Onsite Treatment	Gravity Sewer Collection	Vacuum Sewer Collection	Low Pressure Sewer Collection	Hybrid Sewer Collection
Criteria Score	2	3	3	1	2.0

6.2.1.4 Maximize Public Acceptance

Odor

This category included consideration for odor complaints from homeowners. Vacuum sewer collection systems suck odors from the pits located on the property to the station. Onsite and low pressure sewer collection systems have infrastructure on-lot that have the potential for odors. Table 6-11 presents the criteria scores used for each technology type.

Table 6-11: Criterion Values for Odor

	Onsite Treatment	Gravity Sewer Collection	Vacuum Sewer Collection	Low Pressure Sewer Collection	Hybrid Sewer Collection
Criteria Score	2	3	4	2	2.5

Aesthetics (noise, visual)

In addition, this category included consideration for aesthetic complaints from homeowners. The ability for the technology system components to blend into a residential setting was considered. Again, onsite and low pressure collection systems were determined to be the most susceptible to complaints with infrastructure on-lot, but also vacuum stations have noisy pumps and air terminals that may cause complaints. Table 6-13 presents the criteria scores used for each technology type.

Table 6-12: Criterion Values for Aesthetics (noise, visual)

	Onsite Treatment	Gravity Sewer Collection	Vacuum Sewer Collection	Low Pressure Sewer Collection	Hybrid Sewer Collection
Criteria Score	1	4	3	2	3

Construction Impacts

In addition, this category included consideration for construction impacts perceived by the homeowners including maintenance of traffic (MOT) requirements during construction, disruption of wastewater service, work on the yard for onsite, etc. Table 6-13 presents the criteria scores used for each technology type.

Table 6-13: Criterion Values for Construction Impacts

	Onsite Treatment	Gravity Sewer Collection	Vacuum Sewer Collection	Low Pressure Sewer Collection	Hybrid Sewer Collection
Criteria Score	4	1	2	3	2

Ease Private and Neighborhood Property Restrictions

Lastly, this category included consideration for the ease of private and neighborhood property restrictions on the lot as perceived by the homeowners. A potential benefit with a sewer collection system is the potential for reclassification of land use based on the elimination of the septic system. In addition, homeowners could expand their building structures when onsite is not present. Low pressure and vacuum sewer systems still require use of the right-of-way whereas gravity sewers would be designed down the center of the road. Table 6-14 presents the criteria scores used for each technology type.

Table 6-14: Criterion Values for Ease Private and Neighborhood Property Restrictions

	Onsite Treatment	Gravity Sewer Collection	Vacuum Sewer Collection	Low Pressure Sewer Collection	Hybrid Sewer Collection
Criteria Score	1	4	3	3	3.5

6.2.1.5 Cost Effectiveness

This category included consideration for overall 20-year lifecycle net present cost to determine the most cost-effective wastewater management strategy considered for each STPO priority area. This criterion included the upfront planning level construction capital cost and long-term O&M cost based on the framework developed for the representative STPO priority areas established in Task 6. Capital construction cost estimates were developed to a planning level (Class 5) estimate as defined by the Association for Advancement of Cost Engineering (AACE) and were based on a design-bid-build project delivery framework. The capital construction costs included connection to existing wastewater infrastructure and restoration costs but did not include new water services, stormwater infrastructure nor consideration for future projects planned by FDOT, the City or JEA that may offset some of the cost burden.

Preliminary conceptual layouts are presented in Appendix K for each strategy considered for the nine representative areas (high, medium and low density) including gravity, vacuum, low pressure and hybrid collection systems. Cost estimates were developed for the representative areas by density type, and those costs were used to develop a per lot connection for the remaining STPO priority areas by density type. Development of the capital construction costs and cost estimates for the representative areas are presented in Appendix L. Development of the long-term O&M costs over 20-years for the representative areas are presented in Appendix M. Net present costs were scored by ranking the highest cost wastewater management strategy alternative with the lowest criteria score and the lowest cost strategy with the highest criteria score for each STPO priority area and using the same scale (ranging from 1 to 4) as previously described.

6.2.2 Summary of Wastewater Capital Improvement Detailed Evaluation Criteria

Table 3-16 presents a summary of the raw, unweighted scores that were assigned to onsite treatment, gravity collection, vacuum collection, low pressure collection, and hybrid collection wastewater capital improvements across criteria. Scores ranging from 1 to 4 were assigned, with 1 being the least favorable and 4 being the most favorable.

Table 6-15: Summary of Detailed Evaluation Criterion Scores

		Criteria Scores				
Category	**Criteria**	**Onsite Treatment**	**Gravity Sewer Collection**	**Vacuum Sewer Collection**	**LPS Sewer Collection**	**Hybrid Sewer Collection**
Regulatory Uncertainty	Regulatory Uncertainty	2	4	4	4	4
Management of Operation	Ease of Management	4	4	2	2	3
Maximize Reliability	Sensitivity to Flooding	1	2	3	2.5	2.3
	Power Outages, Emergency Storage, Reliability of Equipment	2	3	3	1	2
Maximize Public Acceptance	Odor	2	3	4	2	2.5
	Aesthetics (noise, visual)	1	4	3	2	3
	Construction Impacts	4	1	2	3	2
	Ease Private and Neighborhood Property Restrictions	1	4	3	3	3.5
Cost Effectiveness	Net Present Cost (20-Years)	n/a, STPO priority area specific				

6.2.3 Wastewater Capital Improvements Detailed Evaluation Criteria Weighting Factors

The project team recognized that the criteria in Table 6-6 have differing levels of importance in the decision-making process, thus requiring the assignment of weighting factors to criteria that reflect JEA's valuation structure. The relative weighting factor for each criterion was discussed with JEA stakeholders during multiple workshops. The final criteria weighting factors are summarized in Table 3-19 and Figure 6-2. The sensitivity of results to the assumed weighting factors was explored, as discussed in Appendix N.

Table 6-16: Summary of Wastewater Improvements Detailed Evaluation Criteria Weighting Factors

Category	Criteria	Criteria Weighting within Category (%)	Total Weighting per Criteria (%)
Regulatory Uncertainty	Regulatory Uncertainty	100.0%	5.0%
Management of Operation	Ease of Management	100.0%	13.8%
Maximize Reliability	Sensitivity to Flooding	50.0%	12.5%
	Power Outages, Emergency Storage, Reliability of Equipment	50.0%	12.5%
Maximize Public Acceptance	Odor	35.0%	5.3%
	Aesthetics (noise, visual)	30.0%	4.5%
	Construction Impacts	17.5%	2.6%
	Ease Private and Neighborhood Property Restrictions	17.5%	2.6%
Cost Effectiveness	20-year Net Present Cost	100.0%	41.3%
Total		***N/A***	***100%***

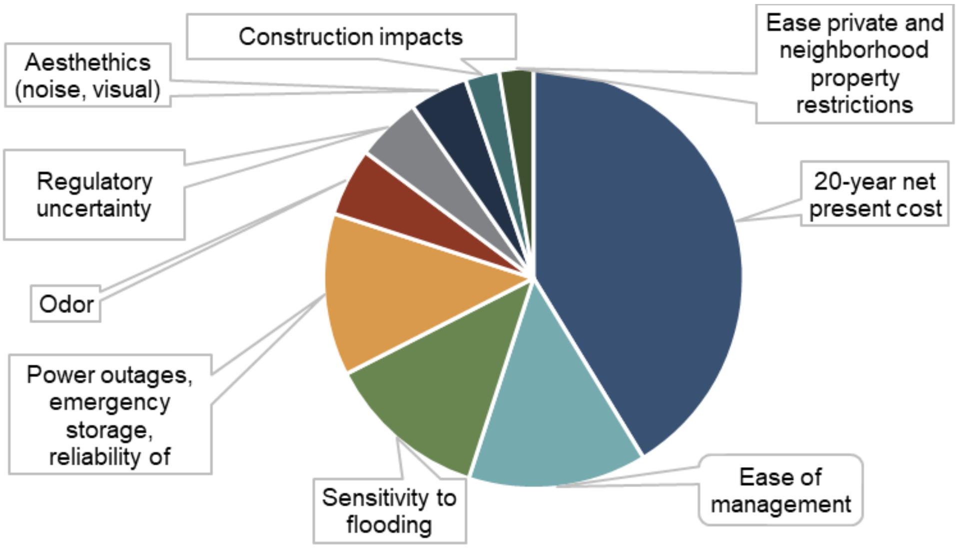


Figure 6-2: Visualization of Criteria Weightings

6.2.4 Wastewater Capital Improvements Detailed Evaluation Total Score

Criteria scores were normalized, weighted, and combined in accordance with the following steps to determine a total score for each wastewater capital improvement option in a given STPO priority area:

1. For each STPO priority area, unweighted criteria scores and costs were normalized to a range of 0 to 1, with 0 being the least favorable score and 1 being the most favorable score.
    a. For example, for a given STPO priority area, the lowest cost option was assigned with a score 1 and the highest cost option was assigned with a score of 0; intermediate cost options were assigned with scores between 0 and 1 depending on their proximity to the lowest and highest costs.
2. Normalized scores were multiplied by the associated criteria weighting and then multiplied by 100.
3. The weighted, normalized scores for each option within a given STPO priority area were then summed to arrive at the total score, with the maximum possible score being 100. A wastewater capital improvement option in a given STPO priority area would only receive a total score of 100 if it received a 4 for all technology criteria and was the lowest cost option.

6.2.5 Wastewater Improvement Detailed Evaluation Recommendations

Table 6-17 and Figure 6-3 present the top ranked wastewater capital improvement for each STPO priority area based on the results of the detailed evaluation.

Table 6-17: Top Ranked Wastewater Capital Improvement

STPO Priority Area	Gravity	Vacuum	Low Pressure	Onsite
Atlantic Highlands	X			
Beauclerc Gardens		X		
Cedar River		X		
Champion Forest		X		
Clifton		X		
Eggleston Heights		X		
Emerson		X		
Empire Point		X		
Freeman	X			
Holly Oaks		X		
Hood Landing II		X		
Julington Creek		X		
Julington Hills		X		
Kinard			X	
Lakeshore		X		
Lone Star Park		X		
Mill Creek		X		
Mt Pleasant		X		
Northlake				X
Oak Lawn		X		
Oakhaven		X		
Odessa				X
Ortega			X	
Pablo Point		X		
Point La Vista		X		
Riverview		X (Decentralized)		
Sans Pareil		X		
Southside Estates		X		
Spring Glen		X		
St Nicholas		X		
The Cape	X			
Westfield		X		
TOTAL	**3**	**25**	**2**	**2**

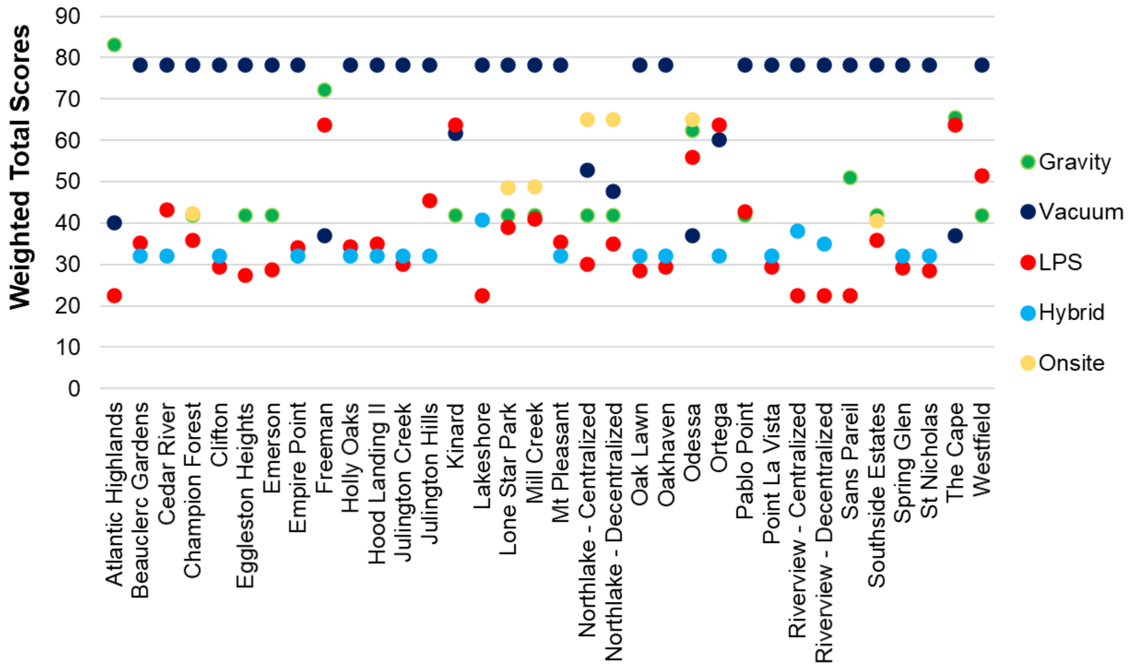


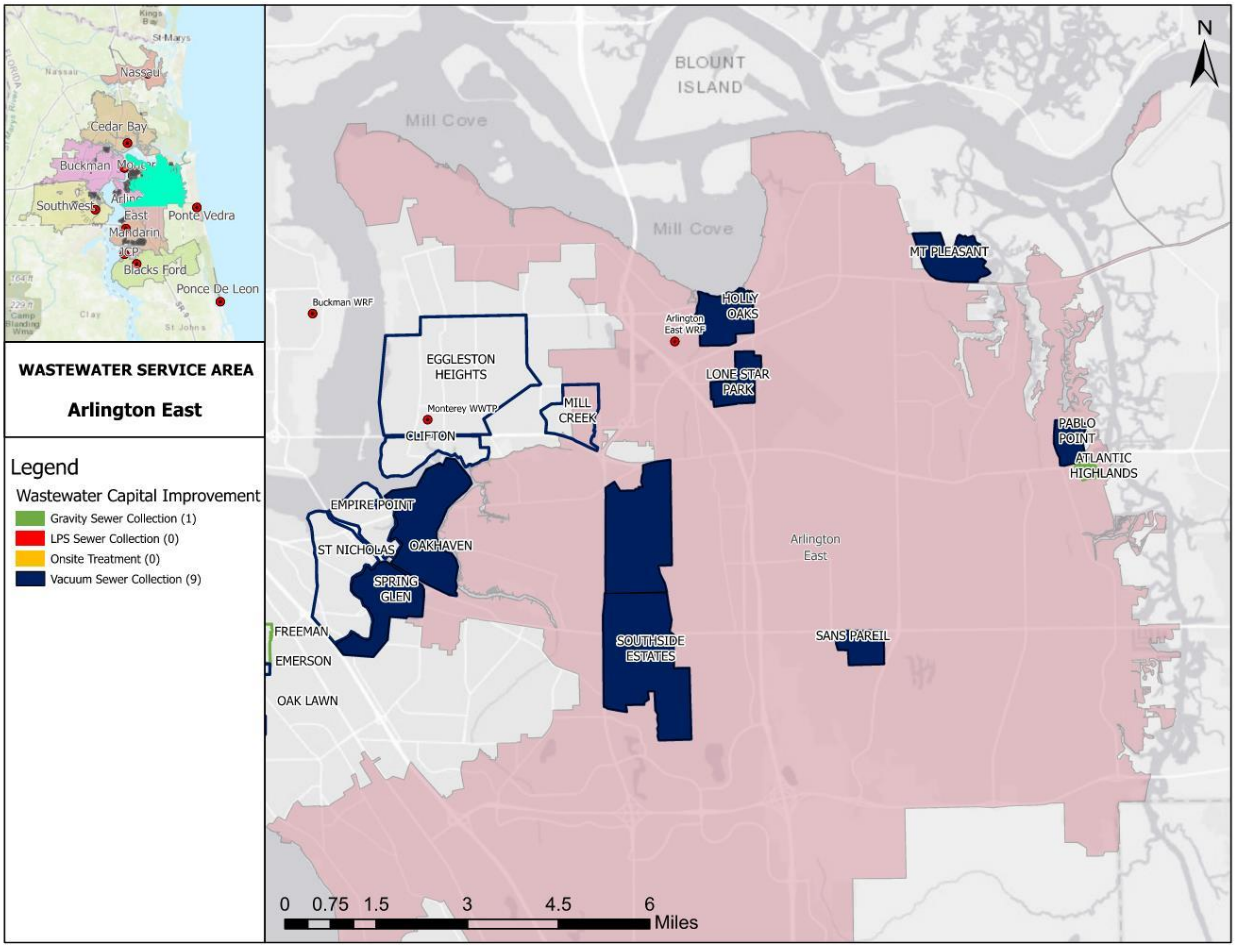
Figure 6-3: Visualization of Wastewater Capital Improvement Rankings across STPO Priority Areas

Table 6-18 presents a summary of the resulting number of STPO priority areas with similar top ranked wastewater capital improvements.

Table 6-18: Summary of Recommended Wastewater Capital Improvements

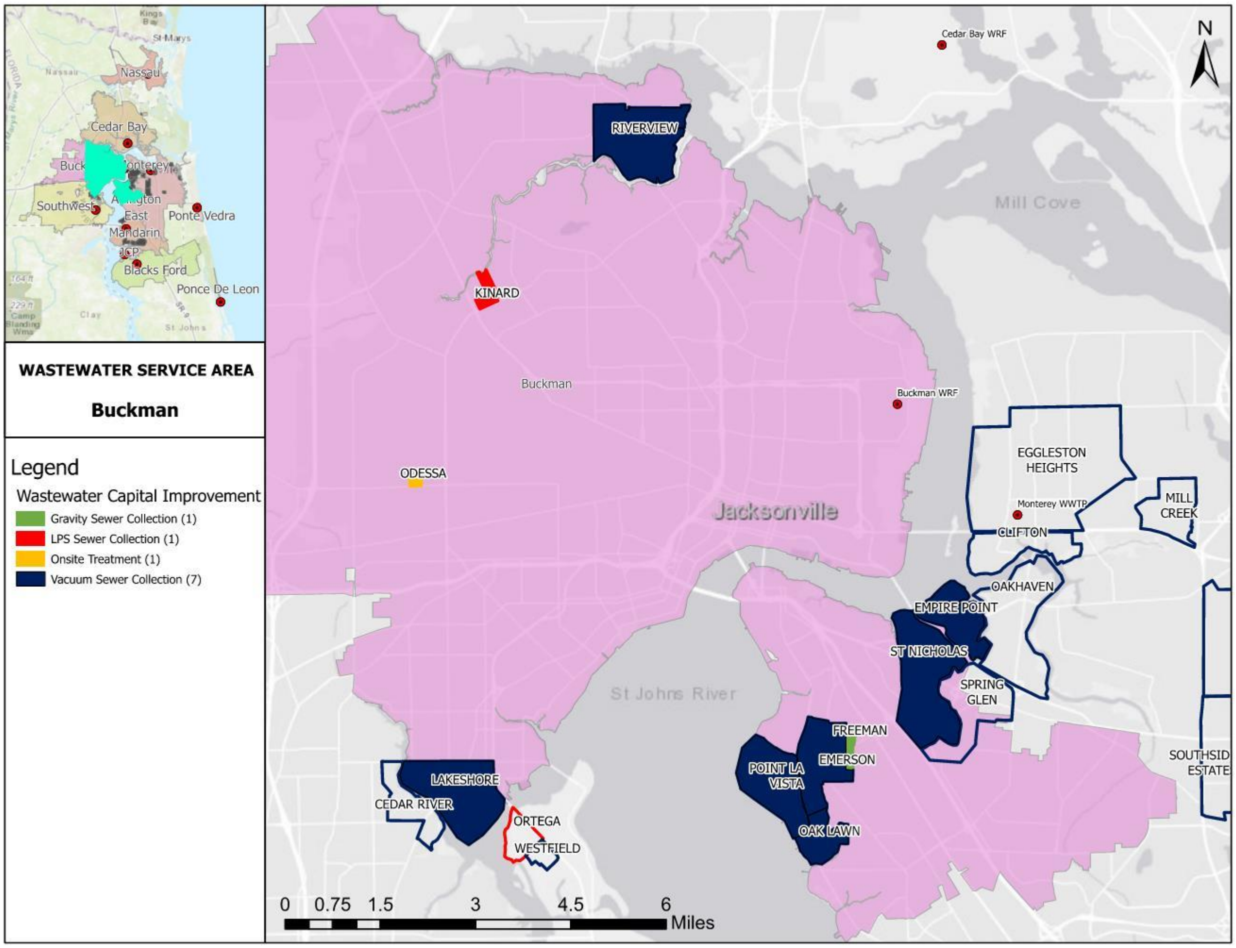
Top Ranked Wastewater Capital Improvements	No. STPO Priority Areas
Centralized- Gravity	3
Centralized- Low Pressure	2
Centralized- Vacuum	24
Centralized- Hybrid	0
Decentralized- Gravity	0
Decentralized- Low Pressure	0
Decentralized- Vacuum	1
Decentralized- Hybrid	0
Onsite	2

Wastewater capital improvements which ranked the highest for only one STPO priority area should be evaluated more closely. For instance, a decentralized vacuum sewer collection system was the highest ranked strategy for the Riverview STPO priority area, but the net present cost difference between the centralized and decentralized wastewater improvements may not warrant a decentralized approach. In addition, an assessment of potential effluent management strategies and the associated cost for the new decentralized treatment facility has not been conducted nor included in the cost. Potential effluent management strategies could include reuse (non-potable direct and indirect), land application, and/or groundwater injection (reuse or deep well). Figure 6-4 through Figure 6-9 presents maps depicting the top ranked wastewater capital improvements for each STPO priority area for the various existing JEA WWTF wastewater service areas.



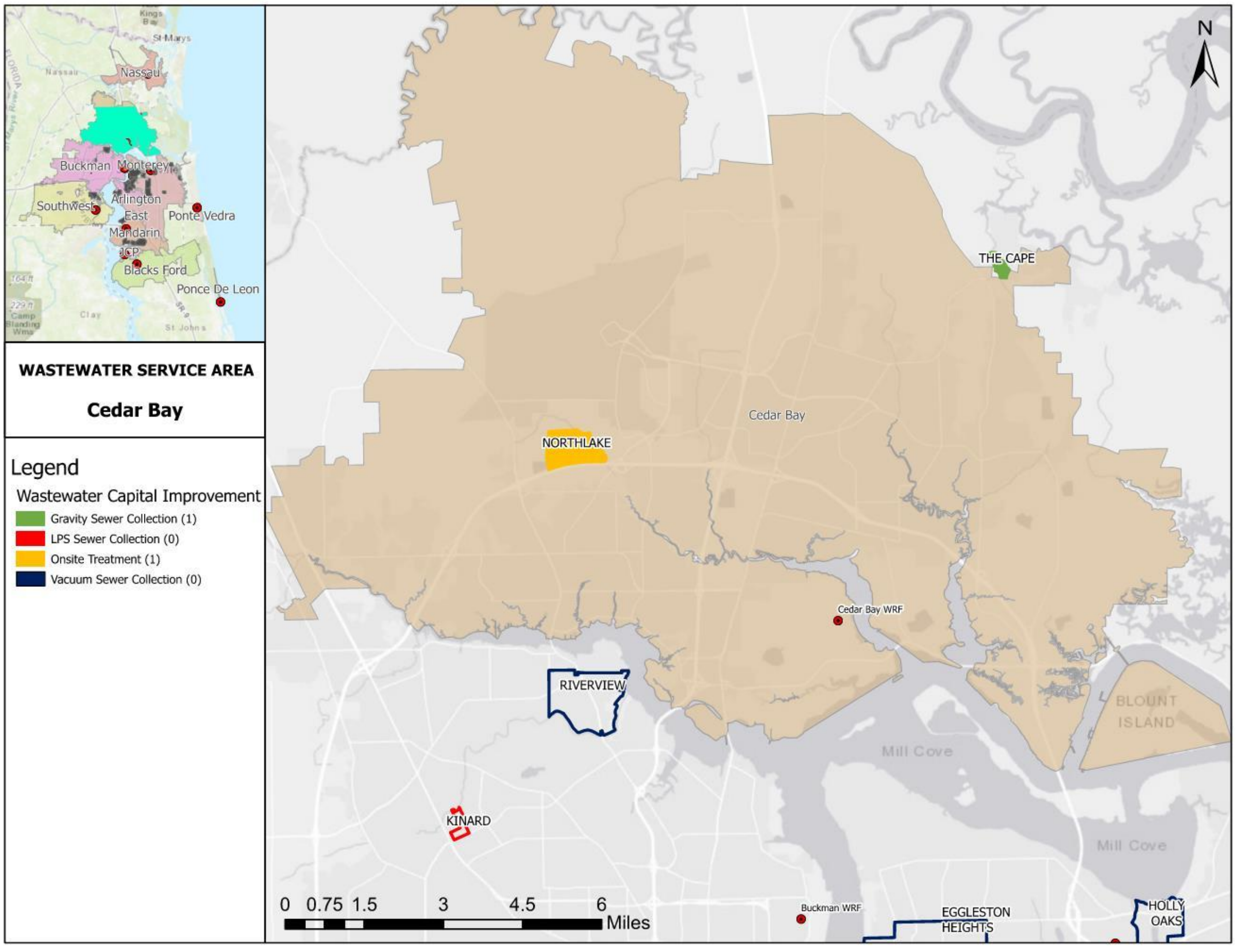
Note: STPO priority areas without shading lie outside this WWTF service area

Figure 6-4: Summary of Wastewater Capital Improvements Recommended for Arlington East WWTF Service Area STPO Areas



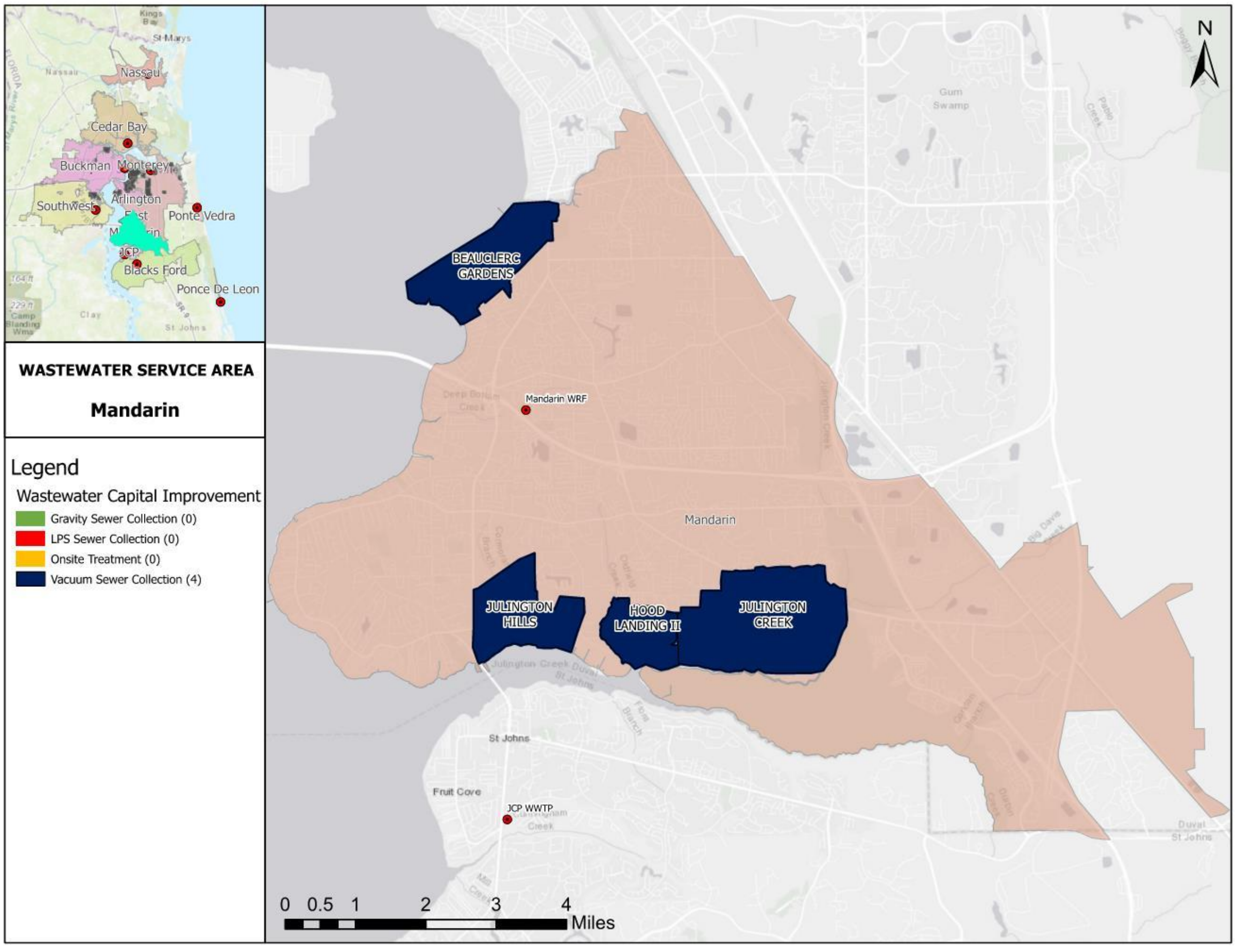
Note: STPO priority areas without shading lie outside this WWTF service area

Figure 6-5: Summary of Wastewater Capital Improvements Recommended for Buckman WWTF Service Area STPO Areas



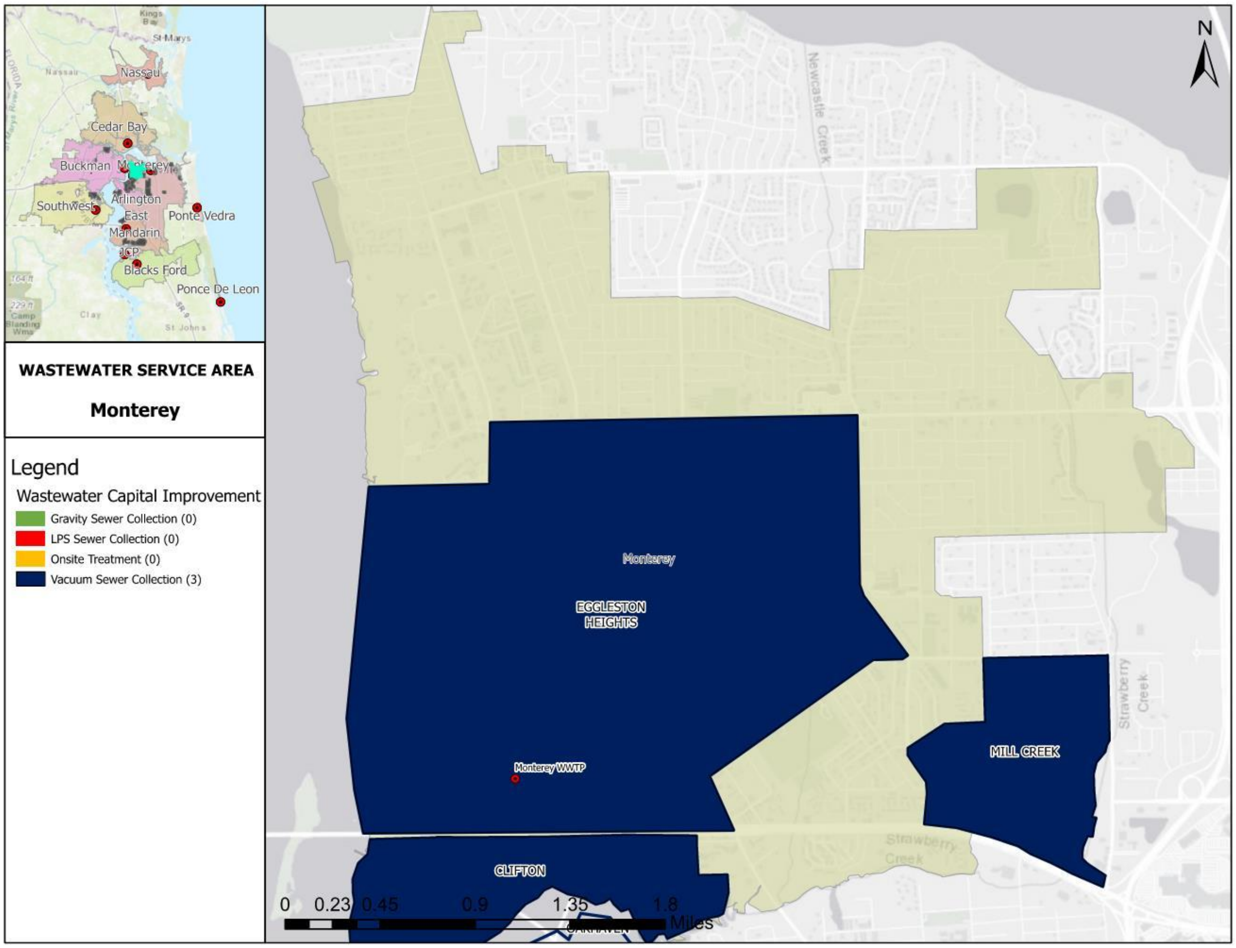
Note: STPO priority areas without shading lie outside this WWTF service area

Figure 6-6: Summary of Wastewater Capital Improvements Recommended for Cedar Bay WWTF Service Area STPO Areas



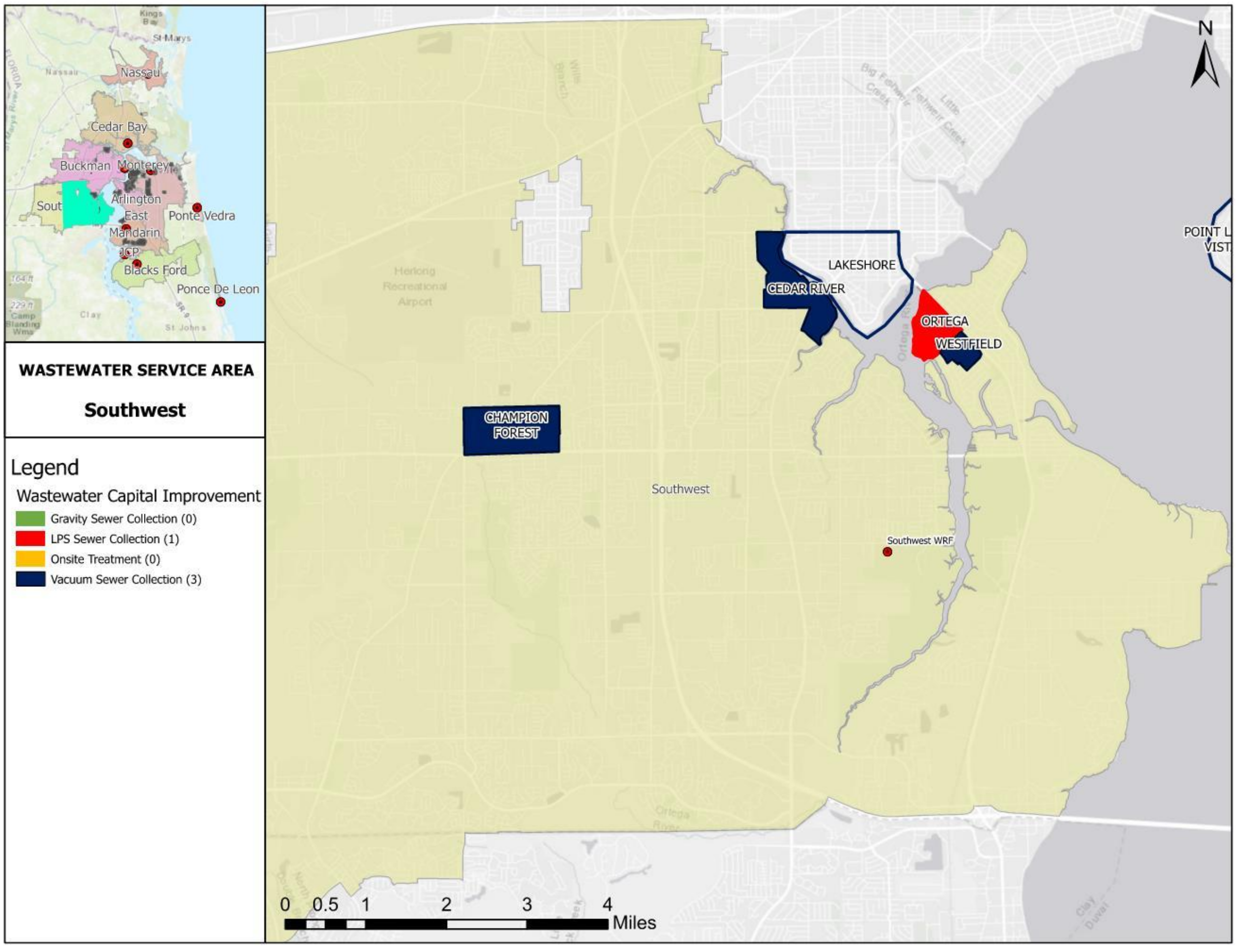
Note: STPO priority areas without shading lie outside this WWTF service area

Figure 6-7: Summary of Wastewater Capital Improvements Recommended for Mandarin WWTF Service Area STPO Areas



Note: STPO priority areas without shading lie outside this WWTF service area

Figure 6-8: Summary of Wastewater Capital Improvements Recommended for Monterey WWTF Service Area STPO Areas



Note: STPO priority areas without shading lie outside this WWTF service area

Figure 6-9: Summary of Wastewater Capital Improvements Recommended for Southwest WWTF Service Area STPO Areas

6.3 Funding Opportunities

Figure 6-10 summarizes the funding alternatives identified in Phase 1 for the JEA septic tank phaseout program. Additional details on potential funding sources including the typical amount of available funds and restrictions, are summarized in Appendix O. Funding opportunities are difficult to plan for at this early planning stage.

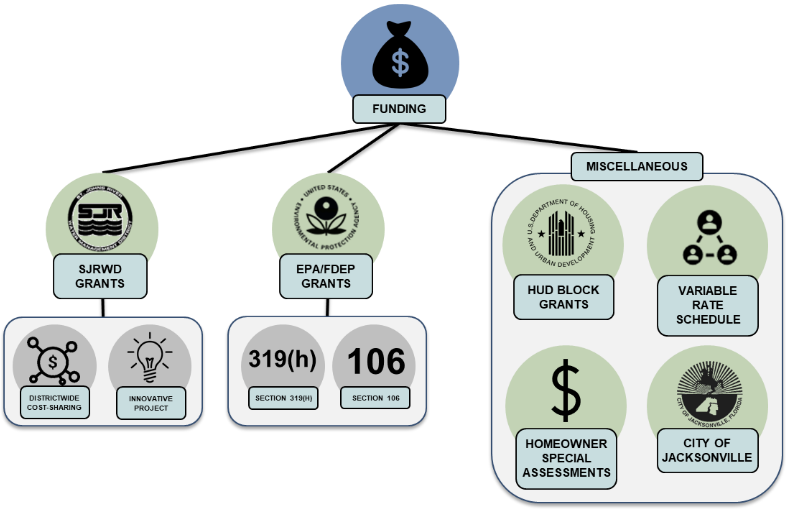


Figure 6-10: Funding Alternatives Identified in Phase 1

6.4 Summary

An initial pre-screening analysis of wastewater capital improvements determined applicable strategies for further consideration for each STPO priority area. Vacuum and low pressure collection systems were assumed to be feasible for all of the STPO priority areas. Table 6-19 presents the results of pre-screening of the STPO priority area wastewater capital improvements.

Table 6-19: Results of the Pre-Screening of STPO Priority Area Wastewater Capital Improvements

Onsite	Decentralized	Hybrid
Champion Forest Lone Star Park Mill Creek Northlake Odessa Southside Estates	Northlake Riverview	Beauclerc Gardens Cedar River Clifton Empire Point Holly Oaks Hood Landing II Julington Creek Julington Hills Lakeshore Mt. Pleasant Oak Lawn Oakhaven Ortega Point La Vista Riverview Spring Glen St Nicholas

In Task 6, nine representative STPO priority areas were identified. For the representative areas, preliminary layouts were created for gravity, low pressure and vacuum collection systems. An additional three areas were chosen as representative areas for hybrid collection systems. Planning level cost estimates were developed for the representative areas for each collection type. These planning level cost estimates were used to estimate costs for the remaining priority areas. These costs, along with an additional eight criteria, were used to further evaluate solutions for each STPO priority area. Technology specific criteria scores were combined with priority area specific net present cost estimates including construction capital and 20-year O&M costs for each alternative. The detailed evaluation resulted in a top ranked wastewater capital improvement for each STPO priority area as outlined in Table 6-20. Net present costs for all wastewater improvements are presented in Appendix P.

Table 6-20: Top Ranked Wastewater Capital Improvement

STPO Priority Area	Wastewater Improvement
Atlantic Highlands	Gravity
Beauclerc Gardens	Vacuum
Cedar River	Vacuum
Champion Forest	Vacuum
Clifton	Vacuum
Eggleston Heights	Vacuum
Emerson	Vacuum
Empire Point	Vacuum
Freeman	Gravity
Holly Oaks	Vacuum
Hood Landing II	Vacuum
Julington Creek	Vacuum
Julington Hills	Vacuum
Kinard	Low pressure
Lakeshore	Vacuum
Lone Star Park	Vacuum
Mill Creek	Vacuum
Mt Pleasant	Vacuum
Northlake	Onsite
Oak Lawn	Vacuum
Oakhaven	Vacuum
Odessa	Onsite
Ortega	Low pressure
Pablo Point	Vacuum
Point La Vista	Vacuum
Riverview	Decentralized-Vacuum
Sans Pareil	Vacuum
Southside Estates	Vacuum
Spring Glen	Vacuum
St Nicholas	Vacuum
The Cape	Gravity
Westfield	Vacuum

7. Summary and Recommendations

The conclusions and recommendations presented in this Master Plan result from a comprehensive 1.5-year study effort, which included evaluations of multiple technologies, wastewater management strategies and institutional frameworks. An overarching goal of the study was to identify best value methods for accomplishing the large-scale septic to sewer conversion program. Figure 6-4 through Figure 6-9 in the previous Section illustrated the recommended wastewater capital improvement for each STPO priority area. The septic tank conversions contemplated herein were evaluated (using weighted criteria) without consideration of other major construction within the public right-of-way. It is possible that certain conversion project areas may ultimately include investments in water service, stormwater drainage, or other infrastructure which, if considered, could affect the weighted criteria analysis conclusions. For example, if a project area were to include major water and drainage improvements, the entire right-of-way may require roadway reconstruction. In such an instance, it is possible that a different sewer approach (e.g. gravity instead of vacuum) may ultimately represent a better value to the City and JEA. Moreover, the technology evaluation presented herein could be affected by changes to legislation, available funding, etc. Hence, review of all such factors during detailed design is recommended to validate the approaches identified within this Master Plan.

The identified conversion program represents a significant infrastructure investment and is likely to be economically challenging to implement. As such, we suggest that a goal of the City and JEA should be to phase this program and seek grant monies to help offset capital costs.

7.1 Capital Improvement Plan

This section presents a summary of the wastewater capital improvement construction costs related to providing wastewater services for the STPO priority project areas. The capital construction costs do not include new water services nor new stormwater drainage aspects to the project areas. The wastewater service capital costs for the Program were discussed in detail in Section 6. The construction cost estimates were prepared based on March 2021 pricing. A total of approximately 22,998 prioritized unsewered parcels in the JEA service area were evaluated for potential wastewater management strategies. Of the total parcels, 22,395 (97%) parcels were recommended to be served by a vacuum collection system, 207 connections were recommended to be served by a gravity collection system, and 223 connections by a low pressure collection system. The remaining 173 connections were recommended to be served by implementation of advanced onsite treatment systems all as summarized in Table 7-1.

There are very few vacuum sewer system vendors in the U.S., and utility purchasing department concerns occasionally arise due to limited competition for such equipment. In the past decade or more, Airvac Systems, a subsidiary of Aqseptence Group, has been the predominant vacuum sewer equipment provider in the U.S. Since vacuum sewers are ranked highly for the JEA STPO program and are likely to be procured, it should be noted there may be issues derived from limited competition which might concern the JEA Procurement Department. Many municipalities in Florida have specified Airvac equipment for vacuum sewer service, via several different methods acceptable to their respective purchasing/ procurement departments. These methods typically resulted in a “sole source” procurement of the equipment. Recognizing the potential of higher pricing due to lack of competition, certain utilities took steps to control costs. These steps included direct purchase of equipment (which comes with attendant risks), and various pre-negotiation methods.

Table 7-1: Recommended Wastewater Capital Improvements

Top Ranked Wastewater Capital Improvements	No. STPO Priority Areas	Number of Septic Parcels to be Phased out
Centralized- Vacuum	25	22,395
Centralized- Gravity	3	207
Centralized- Low Pressure	2	223
Advanced Onsite Treatment Systems	2	173
Decentralized- Vacuum	0	0
Centralized- Hybrid	0	0
Decentralized- Gravity	0	0
Decentralized- Low Pressure	0	0
Decentralized- Hybrid	0	0

Planning level cost estimates were prepared for each STPO priority project area for the purpose of defining the total sewer related capital improvement costs for the JEA STPO Program, not including new water services nor new stormwater drainage aspects to the project areas. A summary of the estimated construction capital and 20-year O&M lifecycle net present value of costs (NPC) for the STPO priority project areas are summarized in Table 7-2.

Table 7-2: STPO Priority Areas Program Cost[1] Summary

Description	Phase-Out Cost 32 STPO Priority Areas	Phase-Out Cost Per Connection (Average)
Estimated Total Capital Costs	$743M	$37K
Estimated 20-year O&M NPC[2]	$79M	$4K
Estimated Total NPC	$822M	$41K

[1] Preliminary engineer's opinion of probable construction costs (EOPCC) have been prepared based upon Master Plan level information. Because of the level of scope development at this stage the estimate is an "Order of Magnitude" estimate as defined by the Association for the Advancement of Cost Engineering International (AACE) Class 5. The expected range of accuracy for this type of estimate is - 50% to +100%. These costs have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material cost, competitive market conditions, final project scope, implementation schedule, and other variable conditions. As a result, the final project costs will vary from the estimate presented herein. The capital construction costs do not include new water services nor new stormwater drainage aspects to the project areas. Costs associated with expanded treatment plant capacity necessary to accommodate additional flows from each service area were not evaluated as part of this study.

[2] The presented 20-year O&M net present costs (NPC) were determined based on 2.5% discount rate, the current rate for Federal Water Projects.

Total capital construction costs were estimated at $743 million with costs ranging from $1.2 million to over $103 million for the project areas as summarized in Table 7-3. Costs include estimated costs for constructing collection systems, vacuum pump stations, lift stations, major transmission systems, low pressure collection systems, and advanced onsite systems. The capital construction costs do not include new water services nor new stormwater drainage aspects to the project areas. Costs associated with expanded treatment plant capacity necessary to accommodate additional flows from each service area were not evaluated as part of this study. Based on the wastewater flow projections and the referenced wastewater improvements, the Arlington East, Monterey and Southwest WWTFs may not have available capacity to accommodate the estimated additional STPO priority areas flow by Year 2040. However, JEA noted that there is time to make appropriate changes at JEA's WWTFs to accommodate additional flow if needed. These costs will need to be accounted for in the Utility's budget cycle when any one of the service areas within the JEA study area is included as a capital improvement project.

Table 7-3: Implementation Schedule and Summary of Costs[1]

2020 STPO Prioritization Matrix Rank	STPO Priority Area	# of Parcels	Estimated Capital Construction Cost[1] ($M)	Estimated 20-YR O&M NPC[2] ($M)	NPC ($M)	Recommended Wastewater Capital Improvement
4	Riverview	1,768	53.6	11.3	64.9	Vacuum
5	St Nicholas	751	24.7	2.32	27.1	Vacuum
6	Emerson	957	27.1	2.9	30.0	Vacuum
7	Champion Forest	832	27.2	2.57	29.7	Vacuum
8	Eggleston Heights	3,714	103	11.3	114.5	Vacuum
9	Julington Creek	2,186	66.6	6.75	73.4	Vacuum
10	Oak Lawn	235	9.48	0.733	10.2	Vacuum
11	Atlantic Highlands	106	4.76	0.310	5.06	Gravity
12	Kinard	84	3.5	0.468	4.00	Low Pressure
13	Westfield	183	7.19	0.561	7.75	Vacuum
14	Sans Pareil	375	12.2	1.14	13.3	Vacuum
15	Empire Point	370	15.0	1.19	16.2	Vacuum
16	Cedar River	428	15.3	1.33	16.6	Vacuum
17	Spring Glen	629	21.2	1.95	23.2	Vacuum
18	Lakeshore	1,472	40.7	4.47	45.1	Vacuum
19	Freeman	63	3.45	0.187	3.64	Gravity
20	Oakhaven	951	30.7	2.95	33.6	Vacuum
21	Mill Creek	449	16.0	1.39	17.4	Vacuum
22	Lone Star Park	351	13.1	1.09	14.2	Vacuum
23	Julington Hills	678	25.4	2.17	27.5	Vacuum
24	Holly Oaks	295	12.5	0.951	13.4	Vacuum
25	Northlake	139	5.10	1.78	6.87	Onsite
26	Hood Landing II	533	20.5	1.70	22.2	Vacuum
27	Point La Vista	866	28.2	2.68	30.9	Vacuum
28	Beauclerc Gardens	615	23.3	1.96	25.2	Vacuum
29	Southside Estates	2,485	75.1	7.69	82.8	Vacuum
30	Clifton	564	19.7	1.75	21.4	Vacuum
31	Ortega	139	6.24	0.779	7.02	Low Pressure
32	Odessa	34	1.20	0.436	1.64	Onsite
33	The Cape	38	2.48	0.140	2.62	Gravity

2020 STPO Prioritization Matrix Rank	STPO Priority Area	# of Parcels	Estimated Capital Construction Cost[1] ($M)	Estimated 20-YR O&M NPC[2] ($M)	NPC ($M)	Recommended Wastewater Capital Improvement
34	Mt Pleasant	466	18.4	1.50	19.9	Vacuum
35	Pablo Point	242	9.72	0.748	10.5	Vacuum
	Total	22,998	$743	$79	$822	

[1] Preliminary EOPCC have been prepared based upon Master Plan level information. Because of the level of scope development at this stage the estimate is an "Order of Magnitude" estimate as defined by the Association for the Advancement of Cost Engineering International (AACE) Class 5. The expected range of accuracy for this type of estimate is - 50% to +100%. These costs have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material cost, competitive market conditions, final project scope, implementation schedule, and other variable conditions. As a result, the final project costs will vary from the estimate presented herein. The capital construction costs do not include new water services, new stormwater drainage aspects to the project areas. Costs associated with expanded treatment plant capacity necessary to accommodate additional flows from each service area were not evaluated as part of this study.

[2] The presented 20-year O&M net present costs (NPC) were determined based on 2.5% discount rate, the current rate for Federal Water Projects.

The implementation of projects is prioritized based on the results of the 2020 STPO prioritization matrix prepared with City and DOH input (Appendix Q). The STPO prioritization matrix top 10 projects are summarized in Table 7-4 which also summarizes the cumulative project number of units and phase-out costs. Each STPO project area is identified as independent capital improvement project within the Utility's budget process as monies and funding become available. Details on potential funding sources including typical amount of available funds and restrictions, are summarized in Appendix O. JEA should consider that combining project areas in close proximity (such as Westfield and Odessa) may reduce overall project costs if combined as one wastewater capital improvement project.

Table 7-4: Top Prioritized STPO Priority Areas Program Cost Summary

No.	Project Area Designation	No. of Septic System Units Within Area	Cumulative No. of Units	Phase-Out Capital Cost[1] ($M)	Cumulative Phase-Out Capital Cost[1] ($M)	Water Service Required[2]
1	Riverview	1,768	1,768	$61.2	$61.2	✓
2	St. Nicholas	751	2,519	$24.7	$85.9	
3	Emerson	957	3,476	$27.1	$113.0	
4	Champion Forest	832	4,308	$27.2	$140.2	✓
5	Eggleston Heights	3,714	8,022	$103.3	$243.4	
6	Julington Creek	2,186	10,208	$66.6	$310.1	✓
7	Oak Lawn	235	10,443	$9.5	$319.5	
8	Atlantic Highlands	106	10,549	$4.7	$324.3	✓
9	Kinard	84	10,633	$3.5	$327.8	✓
10	Westfield	183	10,816	$7.2	$335.0	

[1] Preliminary EOPCC have been prepared based upon Master Plan level information. Because of the level of scope development at this stage the estimate is an "Order of Magnitude" estimate as defined by the Association for the Advancement of Cost Engineering International (AACE) Class 5. The expected range of accuracy for this type of estimate is - 50% to +100%. These costs have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material cost, competitive market conditions, final project scope, implementation schedule, and other variable conditions. As a result, the final project costs will vary from the estimate presented herein. The capital construction costs do not include new water services nor new stormwater drainage aspects to the project areas. Costs associated with expanded treatment plant capacity necessary to accommodate additional flows from each service area were not evaluated as part of this study.

[2] The STPO prioritization matrix estimates the number of lots with existing water service and includes estimated costs for providing water service to project areas without existing water service.

7.2 Next Steps

This section provides guidance on the future direction of the STPO Program and those efforts which are needed to support that direction. Based on the results of this project, various efforts and programs are recommended to facilitate meeting goals and objectives of the STPO Program. Such efforts and programs include the following:

1. **Development of an Implementation Plan**. The Implementation Plan would identify methods and strategies to finance the wastewater capital improvements in coordination with the City and provide conceptual plans for the top ranked recommended wastewater capital improvements. A benefits and cost allocation evaluation of the Program would assist in the development of financing program policies and procedures. In addition, the Implementation Plan could include development of narrative and graphics as needed to seek grant funding for the program.

2. **Purchasing Review.** JEA should consider early implementation of a purchasing strategy designed to ensure adequate pricing protection recognizing the potential for large scale implementation of vacuum technology and the limited quantity of qualified suppliers.

3. **Design Standards**. As JEA proceeds with the design and construction of wastewater improvements, update the current Water & Wastewater Standards Manual as it pertains to the use of advanced onsite, low pressure and vacuum sewer technologies as needed.

4. **Interdepartmental Coordination**. JEA should continue its interdepartmental coordination with the City as the Program moves forward. These efforts become particularly critical when other capital improvement projects (e.g., stormwater) geographically intersect with the STPO program. This will result in a cost savings to Jacksonville residents and keep construction disturbance to a minimum.

5. **Funding**. JEA should continue to aggressively pursue the securing of outside agency grants and other forms of “cost free” capital to minimize the financial effects of the Program.

6. **Phase 3: Potential Pilot Projects.** JEA should consider potential pilot projects to determine technical feasibility and as a tool to inform homeowners. Potential pilot projects to facilitate the evaluation of benefits include innovative wastewater management strategies and/or technologies such as advanced onsite treatment and management, remote/web based monitoring for onsite treatment, vacuum and low pressure sewer collection systems. The STPO priority project areas where advanced onsite treatment was the top ranked wastewater capital improvement (i.e. Northlake and Odessa) were priority projects #25 and 32 in the 2020 prioritization matrix.

7. **Phase 4: Public Education Program**. Most importantly, the development of a Public Education Program regarding the wastewater improvements selected and scheduled for implementation will increase citizen awareness and help to address citizen’s concerns regarding the ongoing STPO wastewater improvements program. Various program elements could include:
    - Stakeholder analysis
    - Media releases
    - Web page updates
    - Surveys
    - Public information materials
    - Public presentations

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Appendix A: Research Findings of Wastewater Treatment Technologies

This Appendix supplements Section 2.2. This section evaluates applicable wastewater treatment technologies for onsite and decentralized treatment systems.

Appendix B: Research Findings of Wastewater Management Strategies and Frameworks

This Appendix supplements Section 2.5 and Section 2.6. These sections evaluate wastewater management strategies and institutional frameworks.

Appendix C: Basis of Criteria Scoring

Appendix D: Cost Proposals

Appendix E: Incinerating Toilets Technical Memorandum

Appendix F: STPO Priority Area Maps

Appendix G: Data Collection and Processing

Appendix H: Summary of STPO Priority Area Site Visits

Appendix I: Summary of STPO Priority Area Characteristics

Appendix J: Summary of STPO Priority Area Point of Connections

Appendix K: Preliminary Layouts

Appendix L: Capital Construction Cost Estimates

Appendix M: O&M Cost Estimates

Appendix N: Sensitivity Analysis

Appendix O: Funding Opportunities

Appendix P: Net Present Cost Estimates

Appendix Q: 2020 STPO Prioritization Matrix

Appendix R: Summary of STPO Priority Area Characteristics and Recommendations