SESD

Wastewater Treatment
For a Cleaner Environment

SOUTH ESSEX SEWERAGE DISTRICT

COMPREHENSIVE WASTEWATER MANAGEMENT PLAN

JANUARY 21, 2026

ACCEPTED BY
THE SOUTH ESSEX
SEWERAGE BOARD ON:
JANUARY 21, 2026

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List of Attachments

Attachment 1 – Wastewater Facilities Management Plan (WFMP)

Attachment 2 - Collection System Capital Improvement Plan (CSCIP)

Attachment 3 – Capital Finance Presentation Overview Memorandum Dated August 11, 2025 (An Updated Memo will be Provided Once it is Completed)

1 INTRODUCTION

1.1 PURPOSE OF DOCUMENT

This Comprehensive Wastewater Management Facilities Plan (CWMP) documents the evaluation, analysis, impacts and financial funding strategy for needed improvements to the South Essex Sewerage District's (SESD or District) infrastructure and assets, as further detailed in the Wastewater Facilities Management Plan (WFMP) and Collection System Capital Improvement Plan (CSCIP) to provide reliable, efficient and sustainable treatment, collection and conveyance of wastewater to protect the public health and environment within the District's service area. This plan has been developed to support a District-wide capital improvement plan to maintain the District's assets, many of which are beyond their design life or in need of rehabilitation or improvement.

This report includes a Phased Capital Improvements Plan for the 2025 to 2045 planning period.

1.2 PLAN FLEXIBILITY

The District-Wide Recommended Capital Improvement Plan presented in this report, including the individual projects lists in Tables 53, 54, and 55, was prepared to provide a path forward to resolve the needs identified. The costs to implement this District-Wide Recommended Capital Improvement Plan are substantial, and it is important to consider that it may be necessary to modify portions of the plan based on the available financial resources of SESD's member communities. The District-Wide Recommended Capital Improvement Plan will likely need to be adjusted and modified over time based on financing and other changing conditions.

1.3 PREPLANNING ACTIVITIES

The District's Board approved funding for the Wastewater Facilities Management Plan in Fiscal Year 2020 and 2021 budgets. Following budget approval, the District prepared a qualifications-based selection process for professional engineering services in February 2022. The District advertised and requested qualifications/proposals (RFQ/P) for the preparation of a Wastewater Facilities Management Plan (Project E-2041) and subsequently awarded an engineering contract to AECOM Technical Services, Inc. (AECOM) of Chelmsford, Massachusetts in July 2022. The Board Approved the selection of the engineer at the July 2022 Board Meeting.

In 2023, SESD staff identified the need for a parallel investigation of the District's collection system infrastructure. The District's Board approved funding for the Collection System Capital Improvement Plan in the Fiscal Year 2025 budget. Following budget approval, the District awarded an engineering contract to CDM Smith Inc. (CDM Smith) of Boston, Massachusetts in July 2024. The Board approved the agreement with CDM Smith at the June 5, 2024, Board Meeting.

1.4 PLAN OF STUDY

1.4.1 Development of Engineering Scope of Work and Engineer Selection

The engineering scope of work for the WFMP was developed prior to the RFQ/P advertisement in February 2022 and then provided to professional engineering firms to use in preparation of their submission to the RFQ/P. Following the engineer selection in July 2022 a detailed scope of work was developed with AECOM in September 2022 which became the final approved scope of work for the Wastewater Facilities Management Plan. The engineering scope of work for the CSCIP was developed in conjunction with CDM Smith in the winter of 2023 – 2024 as part of planning for the FY 2025 budget year. The scope was further detailed and became the final approved scope of work for the CSCIP.

1.4.1.1 Wastewater Treatment Facility Evaluation

The initial task for the WFMP evaluation included an analysis and update of current and planned future Flows and Loads to the Wastewater treatment plant. The District prepares detailed flows and loads analysis to determine assessments to each member community prior to each Fiscal Years Budget cycle. Therefore, the update of existing conditions and flow and load projections are annually evaluated and relatively easy to compile and included in the revised design criteria.

Subsequent tasks included asset condition assessment, alternatives development, ranking of alternatives, recommendations and summaries. The WFMP completed by AECOM also included the assessment of pumping stations and metering facilities. A detailed asset condition assessment was completed for each pumping station, plant process and building system to determine needed improvements.

1.4.1.2 Collection System Evaluation

CDM Smith had previously prepared a draft Collection System Condition Assessment Plan in December 2017. The plan included a list of technologies that should be considered to inspect the pipelines but did not include field inspections. CDM Smith was then contracted in 2023 with follow-on field inspections and investigations to obtain additional information on the structural condition of the pipelines in the collection system. The technologies included a combination of electromagnetic multi-sensor deployment and CCTV inspection. A more detailed collection system asset condition and evaluation was completed for all the District's gravity interceptors, force mains, siphons and junction chambers from 2023 to 2025. The asset condition was rated, and priorities were developed for needed improvements for each pipeline or structure. The initial task of the CSCIP was to review and combine the investigatory work to date as well as compile the known information about the remaining collection system assets. Subsequent tasks included the development of alternatives for the repair, refurbishment, or replacement of the assets, ranking of alternatives, estimates of costs, recommendations, and summaries. A Capital Improvement Plan was then prepared for the Collection System to augment the Wastewater Facilities Management Plan.

1.4.2 Financial Consultant Support

In 2021 the District staff reached out to the University of Massachusetts Collins Center for financial management and financial policy discussions based on a recommendation from our auditing firm. The Collins Center is a non-profit Commonwealth-affiliated agency that is dedicated to improving efficiency, effectiveness, governance, and accountability at all levels of government, with a particular focus on local and state government. The Center's aim is to enable public entities to provide high quality services to the people they serve on a sustainable basis.

The District developed a two-phase approach with the first phase assessing the District's current financial management practices and developing financial policies which was completed in 2022. The second phase included the development of capital financing strategies, a revenue and expenditure forecast, and a recommended funding scenario to support the Facilities Planning process.

1.4.3 District Implementation of CMOM Plan of Study and Program

The District prepared a qualifications-based selection process for professional engineering services for strategic planning, developing and implementation of a Computerized Maintenance Management System (CMMS) and Asset Management Program in September 2016 and awarded an engineering services contract to Jacobs, Inc. (CH2M HILL, Inc.) in December 2016.

1.4.4 Integration with Asset Management Program

The asset management program included Lucity as the CMMS software platform and all District infrastructure assets (approximately 2000 individual elements). The CMMS implementation was completed in four (4) phases over approximately eight years, from 2016 to 2024, and is being used on a continuous basis to schedule predictive maintenance activities and reactive maintenance activities each month. The CMMS software assisted with the risk and consequence of failure for many of the WFMP assets and helped to prioritize the needs for asset renewal and life expectancy. In addition, for the collection system assets, asset management included a GIS map, database, and risk assessment of the collection system prepared by CDM Smith in 2017 as part of the District's NPDES Permit compliance as well as to comply with the 314 CMR 12 Maintenance of Treatment Works and Sewer Systems Section 12.04 – Infiltration/Inflow Analysis. This asset management database and risk assessment were updated as part of the CSCIP.

1.5 PLANNING AREA

(See also from WFMP Task 1- Flows and Loads, Task 2 Pump Station Evaluation and Task 3 Wastewater Treatment Plant Evaluation)

The District's service area includes the five member communities including Beverly, Danvers, Marblehead, Peabody and Salem and a small portion of Middleton and several State and Local Institutions as outlined below:

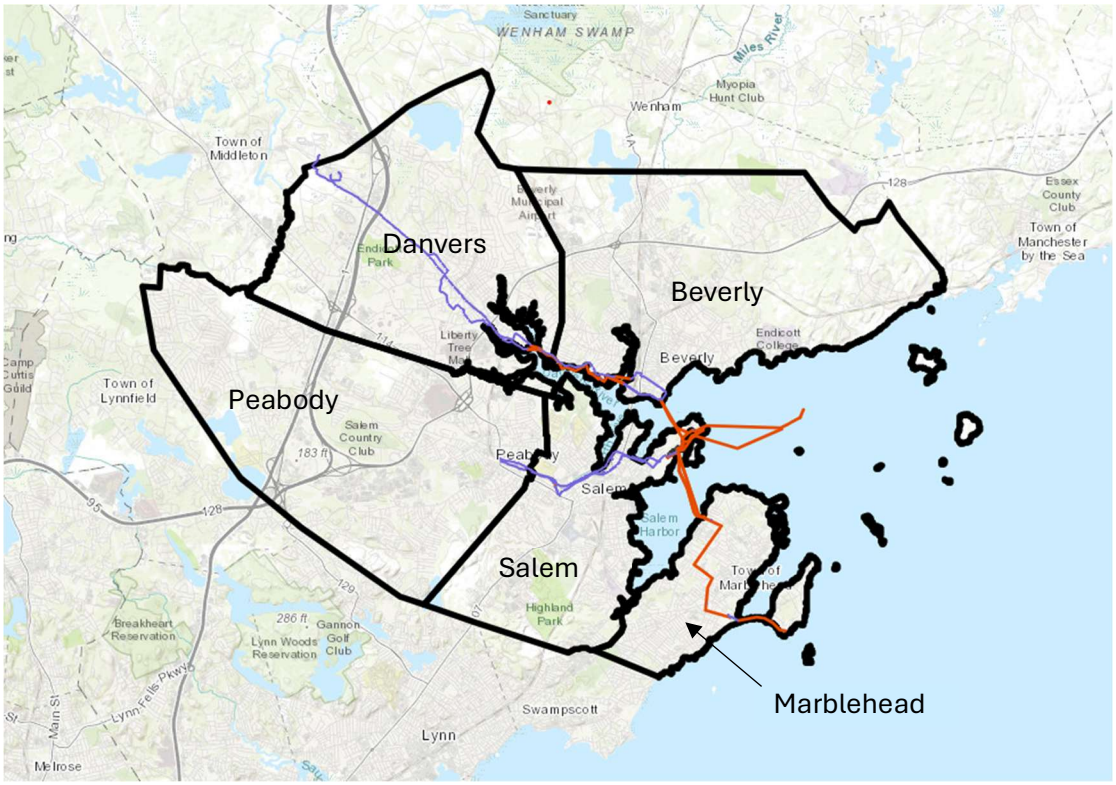


Figure 1: District Sewer Service Area

1.6 Organization of CWMP Document

This Comprehensive Wastewater Management Plan is generally organized by the Department of Environmental Protection, Bureau of Municipal Facilities Guidance for Comprehensive Wastewater Management Planning dated January 1996. Separate chapters were written for the Development and Evaluation of Alternatives for the Collection System, Development and Evaluation of Alternatives for the Pumping Stations, and Development and Evaluation of Alternatives for the Wastewater Treatment Facility to help with overall document organization.

Elements of the District's Wastewater Facilities Management Plan (WFMP) and Collection System Capital Improvement Plan (CSCIP) as well as the Capital Finance Presentation Overview Memorandum which summarizes the District's financial planning work with the Collins Center were integrated to prepare this combined CWMP for the 2025 to 2045 planning period. These three documents are attached. References to the relevant sections or tables in the WFMP, CSCIP, and Capital Finance Memorandum are provided in the CWMP.

2 ASSESSMENT OF CURRENT CONDITIONS

(See also WFMP Task 1- Flows and Loads and Task 2 and Task 3 and CSCIP Task 2 and 3)

An assessment of the current conditions of the District's facilities including the five pumping stations, wastewater treatment plant and collection system were completed by a team of technical specialists from AECOM and CDM Smith as well as District staff and included in the Wastewater Facilities Management Plan and Collection System CIP. The purpose of these assessments was to document the following:

- Physical condition of major equipment and structures
- Known or inferred condition of District pipelines
- Design limitations (i.e., hydraulic restrictions, unsatisfactory equipment performance or access)
- Adequacy of existing electrical and control systems
- Adequacy of the heating, ventilation, and air conditioning systems
- Compliance with building code regulations
- Provide a basis for estimating capital and operating costs

2.1 SOUTH ESSEX SEWERAGE DISTRICT

The South Essex Sewerage District (SESD or District) owns, operates and maintains a 29.7 million gallon per day (MGD) centralized secondary wastewater treatment plant (WWTP) located at 50 Fort Avenue in Salem that discharges to the Salem Sound. The District provides wastewater services to the approximately 188,000 residents that live in our service area as well as many commercial customers and a number of industries. The District's regional wastewater treatment plant serves five (5) member communities including Bevely, Danvers, Marblehead, Peabody and Salem as well as a small portion of Middleton and several State and Local Institutions. The District also owns, operates, and maintains approximately 29 miles of wastewater gravity interceptors, force mains and pressure mains, one off-site metering station, two on-site pump stations, and three off-site pump stations within its geographical service area. The member communities own and operate their respective collector sewer systems, which discharge into the District's interceptors. Further, the SESD system is a separated system and there are no Combined Sewer Overflows (CSOs) that need to be addressed.

2.2 EXISTING CONDITIONS

2.2.1 Collection System Existing Conditions

(See also CSCIP Task 2 – Existing Conditions)

The CSCIP contained a summary of the known conditions of the District's Collection System. For each of the assets, the infrastructure was described and known condition was summarized, including references to the most recent inspection work.

The condition assessment of the Collection System was based on a combination of CCTV, Multi-sensory robotic inspection and visual inspection of gravity sewers and force mains was completed where access was possible. Additionally, there was a confined space entry and structural inspection of several important junction structures. The conveyance piping was graded and rated based on National Association of Sewer Service Companies (NASSCO) ratings. The details of the procedures for the inspections of each of the assets are shown in the tables and attachments to the CSCIP.

A review of Infiltration and Inflow (I/I) was not a part of this assessment. SESD only owns and maintains the interceptors and larger pipes which make up a small proportion of the overall collection system and thus do not represent a significant source of I/I. SESD's capital plan is focused only on District infrastructure. The individual member communities are including I/I removal within the cities and towns as part of their induvial capital planning efforts

For additional information, see Section 4.2 of this CWMP.

2.2.2 Treatment Facility and Pump Stations Existing Conditions

(See also WFMP Task 1- Flows and Loads, Task 2 Pump Station Evaluation and Task 3 Wastewater Treatment Plant Evaluation)

The last major upgrade of the wastewater treatment plant was completed in 1998. Since that time several pieces of equipment and rehabilitation of some process structural elements have been completed to increase service life or replace equipment due to obsolescence or failure, however no major upgrades to process or systems have occurred as compared to the secondary upgrades in the 1990's. There have also been several equipment upgrades to the pumping stations, but no extensive or major improvements have been completed since the 1990's.

The WFMP included an evaluation of the District's WWTP and pump stations. The procedure followed and the findings for each of the facilities and an evaluation of their capacity as compared to current and projected flow and load conditions are included in WFMP Task 2 and Task 3. The grading categories, description of categories and ratings are presented in detail in the condition assessment Tables within the WFMP report. The grading scale used for the building facilities was poor, fair or good and applied to the following design categories:

- Architectural
- Structural
- Roof
- Site
- Piping and Valves
- HVAC
- Plumbing
- Electrical
- Controls

For additional information, see Section 4.3 of this CWMP.

2.3 EXISTING WASTEWATER FLOWS AND LOADS

(See also WFMP Task 1 Task 2 and Task 3, Flows and Loads)

Table 1 (WFMP Task 1, Table 4) below presents a summary of the wastewater flows conveyed by each of the District's raw wastewater pump stations. The average flows to each pump station showed no discernable trend year over year but some year-to-year variation in large part due to variations in rainfall. The maximum difference of any one annual average flow to a single pump station from the five-year average was 14.0% for the Influent Pump Station. For all the other pump stations, the maximum difference was typically between 11-12%.

Table 1: District Pump Station Summary of Annual Flows (2017-2021)

Danvers Pump Station						
	2017	**2018**	**2019**	**2020**	**2021**	**5 yr.**
Average Flow, MGD	4.05	4.36	4.06	3.68	4.53	4.14
% From 5 yr. Avg.	-2.0%	5.5%	-1.8%	-11.1%	9.4%	-
Beverly Pump Station						
	2017	**2018**	**2019**	**2020**	**2021**	**5 yr.**
Average Flow, MGD	9.59	10.10	9.49	8.58	10.81	9.72
% From 5 yr. Avg.	-1.3%	3.9%	-2.3%	-11.7%	11.3%	-
Influent Pump Station						
	2017	**2018**	**2019**	**2020**	**2021**	**5 yr.**
Average Flow, MGD	13.04	14.51	13.51	12.64	15.86	13.91
% From 5 yr. Avg.	-6.3%	4.3%	-2.9%	-9.1%	14.0%	-
Marblehead Pump Station						
	2017	**2018**	**2019**	**2020**	**2021**	**5 yr.**
Average Flow, MGD	2.05	2.34	2.11	1.90	2.25	2.13
% From 5 yr. Avg.	-3.6%	9.8%	-0.9%	-11.0%	5.6%	-
Salem Neck Pump Station						
	2017	**2018**	**2019**	**2020**	**2021**	**5 yr.**
Average Flow, MGD	0.23	0.24	0.24	0.20	0.24	0.23
% From 5 yr. Avg.	-2.2%	5.6%	1.7%	-11.5%	2.9%	-

2.3.1 Pump Station Peak Flows

To analyze peak flows to the pump stations, the District provided 15-minute flow data for calendar year 2021. The calendar year 2021 was selected to analyze for peak flows as it is one of the wettest years on record in the region and it shows the impact of heavy rainfall on the District's and member communities' collection systems relative to average conditions. Table 2 (WFMP, Task 1, Table 5)

presents a summary of the peak flows at each pump station based on the 15-minute flow data for 2021. The Salem Neck Pump Station operates with an on/off strategy, meaning that the pumps turn on at full speed at the high level in the wet well and turn off once the wet well reaches the low level. This gives larger peaks than the other three (3) larger pump stations that directly flow the District's WWTP, which maintain a level setpoint using a variable frequency drive to control pump speed. The Marblehead Pump Station had a higher peaking factor than the other pump stations due to the smaller size of the collection system.

Table 2: Summary of 2021 Pump Station Peak Flow Data

	Danvers	Beverly	Influent	Marblehead	Salem Neck
Average Flow, MGD	4.53	10.81	15.86	2.25	0.24
Max Day Flow, MGD	11.26	28.22	42.97	8.41	0.64
Peak Hourly Flow, MGD	13.52	38.50	52.19	12.02	1.26
Peaking Factor[1]	2.99	3.56	3.28	5.35	5.31

(1) Peaking factor was calculated as the peak flow divided by the average flow

2.3.2 Current Wastewater Treatment Plant Flows

2.3.2.1 Industrial

The majority of the wastewater flow to the District's WWTP is from residential and commercial sources. The District administers an Industrial Pretreatment Program (IPP) in accordance with state and federal requirements. Through this program, the District permits discharges to their member communities' sewer systems for 21 significant industrial users (SIUs) as of calendar year 2021. These 21 SIUs are permitted to discharge a maximum of 6.35 MGD to the District's facilities, which represents approximately 23% of the five-year average flow, 21.4% of the design average flow, and 6.4% of the design peak flow. Of the SIUs, Rousselot, who manufactures gelatin products at their Peabody facility, is the largest with a permitted discharge of 4.0 MGD, or 63.0% of the total permitted industrial flow. Salem Harbor Power Station, which is the next largest industrial user, is permitted for 0.375 MGD or 5.9% of the total permitted industrial flows. Discharges from the District's industrial users are typically considerably less than their maximum permitted flow. Rousselot, for example, discharged an average of 1.58 MGD between 2017-2021, representing 39.6% of their permitted flow. Rousselot's average flow from 2017 to 2021 accounted for 5.8% of the total flow as shown in Table 3 (WFMP Task 1, Table 6).

Table 3: Rousselot Average Annual Flows

	2017	2018	2019	2020	2021	5 yr.
Flow, MGD	1.54	1.65	1.60	1.49	1.63	1.58
% from 5 yr. Avg.	2.7%	4.5%	0.9%	-5.6%	2.9%	-

2.3.2.2 Septage and Recreational Vehicle (RV) Disposal

Septage and RV waste are received at the District's WWTP from residents of the member communities. The maximum annual average septage flow from 2017-2021 was 0.032 MGD (32,000 gpd), which represents approximately 0.01% of the total plant flow. Due to the limited contribution of septage and RV waste to the WWTP flow, septage and RV waste will not be discussed in detail.

2.3.2.3 Middleton/Institutional

Wastewater flows to the District's WWTP are primarily composed of residential flows from the five most significant member communities of Salem, Beverly, Peabody, Danvers, and Marblehead. There are also wastewater flows to the District's WWTP from Middleton and several state and county institutions (i.e. other entities). These wastewater flows from other entities are estimated by the District utilizing water usage data. These flows account for an average of 0.28 MGD for the 2017-2021 analysis period, which is approximately 1% of the total flow to the plant and is conveyed through the Danvers and Beverly interceptors and the Danvers and Beverly pump stations.

2.3.2.4 WWTP Flow Contribution by Community

All the flows except for septage and RV waste received at the WWTP and sludge received from the Danvers Water Treatment Plant (WTP) are conveyed from the five (5) raw wastewater pump stations. The fraction of flow received from each pump station year over year is quite consistent.

The breakdown of the fraction of the flow to the WWTP by community is summarized in Table 4 (WFMP Task 1, Table 7). Peabody contributes the most flow with 35.0%, while Beverly and Salem contribute similar fractions of flow with 21.5% and 19.5%, respectively. Danvers is the fourth largest flow contributor with 14.9% of the flow, while Marblehead is the smallest of the major contributors with 8.2% of the flow to the WWTP. Other entities contribute 1.0% of the flow as well.

Table 4: Community Flow Breakdown

	5 yr. Average Flow, MGD	**% of Total Flow**
Danvers	3.86	14.8%
Beverly	5.58	21.5%
Peabody	9.09	35.0%
Salem	5.06	19.5%
Marblehead	2.13	8.2%
Other Entities	0.28	1.1%
Total	25.99	100%

2.3.2.5 Wastewater Flows

The WWTP effluent flows measured by the effluent flow meter are summarized in Table 5 (WFMP Task 1, Table 8). An analysis of effluent flow data shows little year over year trend but some year-to-year variation. This variation in flow is likely due to annual variations in precipitation and the resulting impacts of infiltration/inflow (I/I) in the member communities' collection systems due to

precipitation. The analysis of the monthly average WWTP flow versus the rainfall as measured at the WWTP may be seen in the WFMP Task 1, Figure 4. A correlation between increased flows and increased precipitation may be seen in this plot. Similarly, increases in flow due to elevated I/I results in a decrease in the concentration of both total suspended solids (TSS) and carbonaceous biochemical oxygen demand (cBOD) in the wastewater due to dilution. The maximum percent difference from the five-year average flow of 13.3% was observed in 2021, likely due to the increased precipitation in 2021, one of the wettest years on record in the area, with a total rainfall 22.9% higher than the five-year average. Average flows over the 5-year period are within 12% of the 2017 design year basis. Calendar year 2021 was an outlier, where effluent flows were approximately equal to the design basis.

Table 5: Summary of WWTP Effluent Flows (2017-2021)

	2017	2018	2019	2020	2021	5 yr.	Design[1]
Average Flow, MGD	24.93	27.68	25.49	23.39	29.72	26.24	29.71
Max Month Flow[2], MGD	44.24	47.04	36.51	36.82	40.32	47.04	-
Max Daily Flow[3], MGD	70.71	70.60	63.95	57.55	78.21	78.21	85.77
Peak Flow[4], MGD	85.9	78.9	74.9	66.9	98.9	98.9	98.8
% From 5 yr. Avg.	-5.0%	5.5%	-2.9%	-10.9%	13.3%	-	13.2%

(1) CDM 2017 WWTP Design Basis
(2) Max month flows are the maximum 30-day rolling average
(3) Max daily flows are the maximum of the total daily flows
(4) Peak flows are the maximum instantaneous flow

2.3.2.6 Wastewater Treatment Plant Peak Flows

The analysis of peak flow for the WWTP was based on flow data collected every 15 minutes at each pump station during 2021, a historically wet year. The relevant pump station data was summed to calculate the total influent flow for the WWTP. It should be noted that the sum of the pump station flows does not equal the measured WWTP effluent flow and is typically slightly less than the measured effluent flow. Table 6 (WFMP Task 1, Table 9) below presents analysis of the 15-minute pump station flows from 2021. This data underestimates the average flow by 1.7% as compared to the average of the 2021 daily effluent flow data of 29.72 MGD. The peak flow from this data, however, is slightly higher (2.3%) than the peak WWTP effluent flow of 98.9 MGD. A plot of the distribution of the hourly WWTP influent flows as a histogram and cumulative frequency plot may be seen in the WFMP Task 1, Figure 8.

Table 6: Summary of 2021 Calculated WWTP Influent Flow Data

	Flow
Average, MGD	29.21
Max Day[1], MGD	79.28
Peak Hour, MGD	101.19

(1) Max Day flows are the maximum of the daily flows

2.3.3 Current Wastewater Treatment Plant Loads

2.3.3.1 Industrial

This section discusses the industrial loads to the Districts WWTP. A considerable fraction of the TSS load could potentially come from industrial users. Using the 90th percentile of the load from each industrial user, the fraction of the five-year average TSS load could be as high as 18.1%. Rousselot on average contributed 3.9% of the total WWTP TSS load, so large variations will likely be insignificant to the WWTP as a whole. Rousselot has ceased operation at the end of 2023 which reduced the industrial wastewater loads unless a new wet industry opens at its former location.

2.3.3.2 Total Wastewater Loads

Table 7 below presents the daily influent TSS and cBOD loads to the WWTP. These loads were calculated from the influent TSS and cBOD concentrations analyzed from composite samples collected by the influent sampler in the Grit Building and the effluent flow from the WWTP as measured by the effluent flow meter. This data shows no discernable year over year trend in either the influent TSS or cBOD load and limited variation in the load. The maximum percentage difference from the five-year average was decreases of 7.2% and 8.1% for TSS and cBOD loads, respectively. Both maximum differences occurred in 2020. It is likely this decrease in load may be due to the COVID-19 pandemic, which began in mid-March 2020. These changes are, however, less than and not correlated with the changes in flow to the WWTP. This is likely attributable to the fact that I/I typically does not appreciably change average WWTP loading, only flow.

Table 7: Summary of WWTP Loads (2017-2021)

TSS							
	2017	**2018**	**2019**	**2020**	**2021**	**5 yr.**	**Design[1]**
Average Load, lbs/day	47,715	46,914	48,864	43,687	48,300	47,086	47,400
Max Month Load[2], lbs/day	66,554	63,716	67,725	57,890	64,978	63,795	99,500[4]
Peaking Factor[3]	1.39	1.36	1.39	1.33	1.35	1.35	2.10
% From 5 yr. Avg.	1.3%	-0.4%	3.8%	-7.2%	2.6%	-	0.7%
cBOD							
	2017	**2018**	**2019**	**2020**	**2021**	**5 yr.**	**Design[1]**
Average Load, lbs/day	36,881	35,456	35,093	31,759	33,807	34,575	46,100
Max Month Load[2], lbs/day	45,747	44,310	44,134	38,436	40,749	42,820	87,600[5]
Peaking Factor[3]	1.24	1.25	1.26	1.21	1.21	1.24	1.90
% From 5 yr. Avg.	6.7%	2.5%	1.5%	-8.1%	-2.2%	-	33.3%

(1) CDM 2017 WWTP Design Basis
(2) Max month loads were determined statistically from daily load data as the (1-1/12) = 91.7th percentile of the data.
(3) Peaking factor was calculated as the ratio of the max month load to the average load.
(4) CDM's Design Basis "Maximum TSS".
(5) CDM's Design Basis "Maximum cBOD".

Table 7 above presents the statistical maximum month and max month to average day peaking for the TSS and cBOD load to the WWTP. The maximum TSS and cBOD loads were observed on a day with both high flow and a high TSS or cBOD concentration. A statistical maximum month parameter is used instead of an arithmetic max month because it reduces impact of extreme outliers in analytical data.

Several figures in the WFMP (Task 1, Figures 12 thru 18) present the TSS load and cBOD loads on a seasonal average basis. Some minor variations from year to year both up and down can be observed with no discernable trend in the TSS loads and a minor downward in the cBOD loads. It is likely that the slight increasing trend in seasonal average TSS load from summer 2020 through summer 2021 is primarily explained by the natural variations in load seen by all WWTPs and is not a definitive long-term increasing trend requiring further consideration for future conditions. A similar trend between 2020 and 2021 can be seen in the cBOD loads.

3 ASSESSMENT OF FUTURE CONDITIONS

The future conditions assessment was developed based on community data and information obtained from the District's annual flow and loads reports. Flows and loads reports are completed as a part of the annual fiscal year budgeting process (July 1st through June 30th) to allocate member community cost assessments. Every five years the District completes a re-apportionment of the flows and loads by each member community to determine needed percentage changes to the apportionments. As a part of the annual budgeting process the assessments are an average of the previous three years' data with the first year's data rolling -off the average each subsequent year.

3.1 PLANNING PERIOD

(See also WFMP, Task 1 Flows and Loads)

A current conditions analysis was performed utilizing five years of daily flow and load data as well as daily rainfall data from the calendar year 2017 through calendar year 2021 provided by the District.

Future flows for the next 20-year planning period were projected using input from the member communities on anticipated needs within their communities. The flow was projected for the planning period of 2021 to 2041, however the planning period for the capital program for the CWMP is 2025 to 2045.

It is notable that an article in the Salem News was published in March of 2023 saying that Rousselot's plant in Peabody is going to close at the end of 2023. Rousselot ceased operations in early 2024 and the property is now vacant and for sale. This change in conditions has reduced the flow and loads to the District's WWTP. However, long term impacts are highly dependent on what replaces Rousselot's plant at that location if anything does. To remain conservative in this analysis and due to the uncertainty and difficulty in making accurate predictions, this analysis will consider Rousselot's historical flows and loads and assume that they remain constant in the future by whatever is constructed at the site.

3.2 LAND USE

(See also WFMP Task 1 Flows & Loads, Commonwealth GIS Information, Demographics)

The following Figure 2 is a land use map obtained from Mass GIS Mapping digital image files from 2016 and covers the District's service area. The land use within the District is significantly built out with some areas of infill development possible due to recent changes in the Commonwealths 40B regulations. However, large increases in housing are not anticipated compared with the current level of urbanization in the member communities.

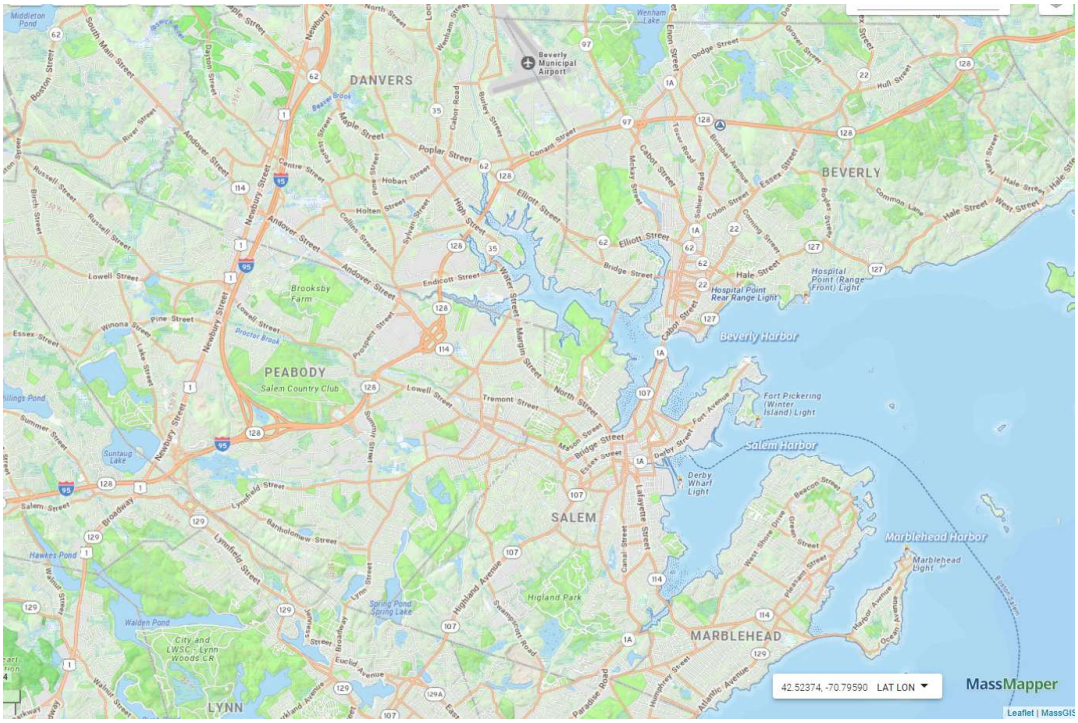


Figure 2: South Essex Land Use Area Map and Regional Transportation Network

The following Figure 3 image was taken from the Districts GIS data layers and includes the main intercepting sewers and force mains and City and Town boundaries.

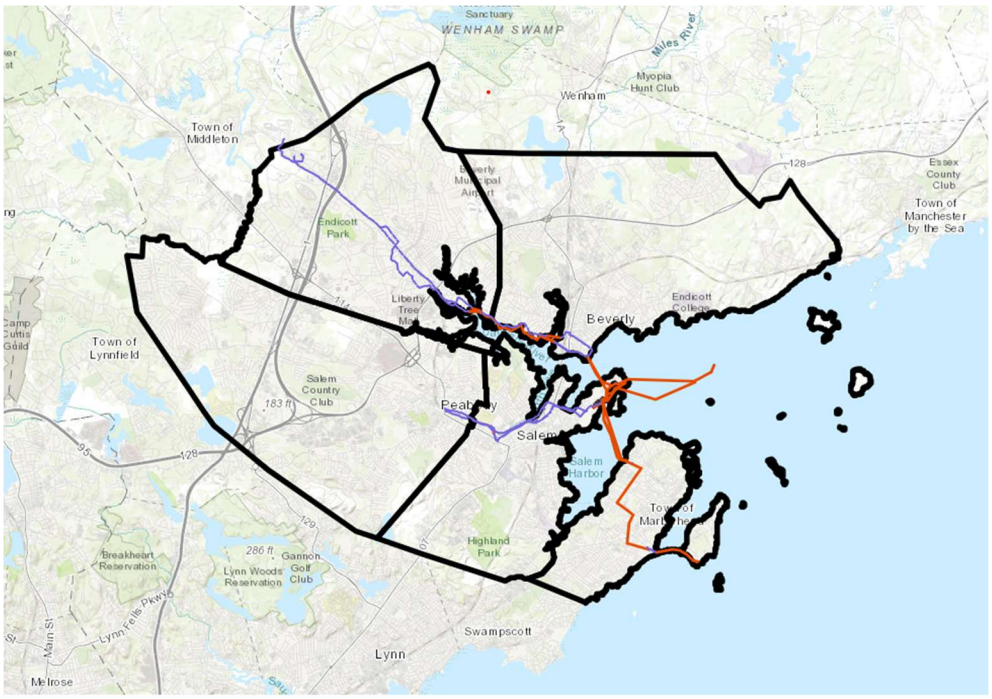


Figure 3: SESD Main Interceptors, Water Crossings and Effluent Outfall

3.3 Demographic and Economic Projections

(See also WFMP Task 1 Flows and Loads)

The District's WWTP currently treats the flows from its five (5) member communities and the other entities noted above. The total population served by the District's facilities is approximately 188,000. The majority of the District's wastewater originates from residential sources, though there are twenty-one (21) permitted industrial users. These industrial users notably include four (4) water treatment plants (WTPs) and Rousselot Peabody, Inc. (Rousselot), which manufactures gelatin products at their facility in Peabody. Rousselot was the single largest flow and load contributor of all industrial users.

3.3.1 Summary of Inclusions and Exclusions

A current conditions analysis was performed utilizing five years of daily flow and load data as well as daily rainfall data from calendar year 2017 through calendar year 2021 provided by the District. The average plant water flow of 1.1 MGD is subtracted from flows measured by the effluent flow meters for this report. This correction for the plant water was used because the WWTP effluent flow meter measures the flow upstream of where the plant water is taken. The plant water is recycled throughout the plant and thus is effectively double counted by the effluent flow meter.

Peak flows to the remote pump stations were based on an analysis of 15-minute data for each pump station from calendar year 2021. The peak hour flow was then determined from the 15-minute flow data. The population served by the WWTP has been determined based on the population data included in the District's 2021 annual flows and loads report.

Future flows for the next 20-year planning period (through calendar year 2041) were projected using input from the member communities on anticipated needs within their communities.

As previously stated, the recent closure of Rousselot has reduced the flow and loads to the District's WWTP. To remain conservative in this analysis and due to the uncertainty and difficulty in making accurate predictions, this analysis will consider Rousselot's historical flows and loads and assume that they remain constant in the future by whatever is constructed at the site.

3.4 Forecasts of Flows and Wasteloads

(See also WFMP Task 1 Flows & Loads and Annual Collection System O&M reports)

3.4.1 Future Flows

Information about growth over the next 20 years was provided by the District's five member communities. These growth estimates were used to project the future flows to the plant. First, the peaking factor for the overall plant was calculated using the peak flow from the WWTP and the 5-year average plant effluent flow, see Table 8 below (WFMP, Task 1, Table 12).

Table 8: WWTP Peaking Factor Calculation

5 yr Average Plant Effluent Flow, MGD	26.2
Peak Flow, MGD	98.9
Peaking Factor	3.77

The average flow to each community was calculated using data from the pump and metering stations that flow into the plant, see Table 9 below (WFMP Task 1, Table 13). The sum of these average community flows was slightly lower than the WWTP effluent flow. Therefore, the average community flows were proportionally scaled such that their sum was equivalent to the corrected WWTP flow. The estimated growth percentage given by the member communities was used to calculate the projected average flow for each community and these were summed up to find the projected average WWTP flow. From this projected average flow, the peaking factor from Table 8 (WFMP Task 1, Table 12) was applied to calculate the projected peak flow. It is notable that the flow from the other entities includes the small flows from Middleton and several state and county institutions, and the flow from the community of Beverly includes the small part of Danvers that is downstream of the Danvers Pump Station. It is also noted that Rousselot, the District's largest SIU ceased operations in early 2024 (which is after the 5-year time period used to estimate District flows). Due to the uncertainty in the future of this site, it has been assumed that whatever is established at this site will provide the same flow contribution as current.

Table 9: Projected Future Community and WWTP Flows

	Danvers	**Beverly[1]**	**Peabody[2]**	**Salem**	**Marblehead**	**Other Entities**	**Total**
5 yr. Average Flow, MGD	3.86	5.58	9.09	5.06	2.13	0.28	26.0
% of Total Flow	14.8%	21.5%	35.0%	19.5%	8.2%	1.1%	100.0%
5 yr. Average Flow Scaled to Plant Effluent Flow, MGD	3.89	5.64	9.17	5.10	2.15	0.28	26.2
Estimated growth	1.0%	13.2%	1.0%	5.0%	1.0%	1.0%	-
2041 Projected Average Flow, MGD	3.93	6.38	9.27	5.36	2.17	0.29	27.4
						Projected Peak Flow, MGD	103.2

(1) Beverly flows include the small part of Danvers downstream of the Danvers Pump Station
(2) Peabody flows include approximately 1.6 MGD of flow from Rousselot
(3) Based on historical population growth and possibility of infill development, the minimum projected community growth is set to 1%

This method of estimating future flows is reliant on the estimated growth provided by the five communities. Most of these communities are largely sewered and there is limited undeveloped land, so the majority of the growth is anticipated through infill development. Further, as previously noted, I/I was not separately analyzed as part of the study work. Rather, the I/I impacting the system as generated in the individual communities is reflected in the Peak Hourly Rates in Tables 9, 10, and 11. Further, the projections completed did not consider any potential reduction in flow we may see in the future from ongoing water conservation efforts in the District communities.

The future flows to the pump stations were projected with a similar method to the WWTP flows, see Table 10 below (WFMP, Task 1, Table 14). The projected average pump station flows were calculated from the growth estimates from each community. The key difference, however, is that the 5-year average flows for each pump station that the projections are based on were not scaled to equal the WWTP effluent flows. The peaking factor for each pump station was calculated using the 2021 peak hourly flow and the 5-year average flow. This peaking factor was then applied to the projected average flow for each pump station to calculate the projected peak flow.

Table 10: Projected Pump Station Flows

	Danvers	Beverly	Influent[1]	Marblehead	Salem Neck	Total
5 yr. Average Flow, MGD	4.1	9.7	13.9	2.1	0.2	26.0
2041 Projected Average Flow, MGD	4.2	10.5	14.2	2.2	0.2	27.1
2021 Peak Hourly Flow, MGD	13.5	38.5	52.2	12.0	1.3	-
Peaking Factor	3.27	3.96	3.75	5.65	5.46	-
2041 Projected Peak Flow, MGD	13.7	41.6	53.4	12.1	1.3	-

(1) Influent Pump Station flows include approximately 1.6 MGD of flow from Rousselot

3.4.2 Future Loads

The future TSS and cBOD loads were calculated based on the 5-year average WWTP effluent flow and the 5-year average influent load, see Table 11 below (WFMP, Task1, Table 15). From these two values, the average influent concentration of TSS and cBOD were calculated. Based on the projected plant effluent flow and the average influent concentration, the projected influent load was calculated. The maximum month load peaking factor was used to calculate the projected max month load.

Table 11: Projected WWTP TSS and cBOD Loads

	TSS	cBOD	Flow
5 yr. Average Plant Effluent Flow, MGD	-	-	26.2
5 yr. Average Influent Load, lbs/day	47,086	34,575	-
5 yr. Average Influent Concentration, mg/L	215	158	-
2041 Projected Plant Effluent Flow, MGD	-	-	27.4
2041 Projected Influent Load, lbs/day	49,200	36,100	-
Peaking Factor	1.35	1.24	-
2041 Projected Peak Hourly Effluent Flow, MGD			103.2
2041 Projected Max Month Load, lbs/day	66,600	44,700	-

4 WASTEWATER NEEDS PROBLEM IDENTIFICATION

(See also WFMP Task 2 Pump Station Evaluation, and Task 3 WWTP Evaluation and CSCIP)

The evaluation of the current conditions and operation of the various major systems and processes at the South Essex Sewerage District's collection system, pumping stations and WWTP were completed to assess its capability to reliably operate and continue conveying and treating wastewater for the next 20 years.

4.1 ONSITE WASTEWATER DISPOSAL

The District's assets include a regional wastewater treatment plant and three remote off-site pumping stations and an effluent outfall. There is no onsite wastewater disposal currently allowed within the District's assets or Service Area.

4.2 WASTEWATER COLLECTION SYSTEM INFRASTRUCTURE

(See also CSCIP Section 2 and 3)

The wastewater collection and conveyance system is comprised of intercepting sewers, force mains, siphons, junction structures, pumping stations and metering facilities as described in the Collection Systems Capital Improvement Plan. The needs evaluation for the pumping stations is discussed in Section 4.3.

As previously discussed, an analysis of I/I was not a part of this assessment. The focus of SESD's planning is on the condition, reliability, and redundancy of the critical interceptor system to ensure it can provide reliable wastewater collection. SESD only owns and maintains the interceptors and larger pipes which make up a small proportion of the overall collection system and thus do not represent a significant source of I/I. SESD's capital plan is focused only on District infrastructure. The individual member communities are including I/I removal within the cities and towns as part of their induvial capital planning efforts.

Further, the SESD system is a separated system and there are no Combined Sewer Overflows (CSOs) that need to be addressed. In addition, no expansion of the sewer system to additional communities or large undeveloped areas of the existing SESD member communities is currently under consideration. Growth within the SESD member communities will primarily be infill growth.

4.2.1 Collection System Condition Assessment

Section 2 of the CSCIP provides information on the known condition of the District's collection system infrastructure. Each of the significant components of the collection system are reviewed, including:

- WWTP Outfall
- Beverly Tunnel
- Beverly Water Street Interceptor
- Beverly Harbor Force Main

- Beverly Beach Interceptor
- Beverly Force Main
- Danvers Porter River Siphon
- Beverly Bass River Siphon
- Marblehead Force Main
- Danvers Force Main
- Peabody Salem Interceptor
- Danvers Doty Avenue Gravity Main
- Peabody Walnut Street Gravity Main
- Salem Derby Street Gravity Main
- Danvers Porter River Gravity Main
- Danvers Beaver Brook Gravity Main
- Danvers River Street Gravity Main
- Danvers Maple Street Gravity Main
- Danvers Brookside Avenue Gravity Main

Each collection system component is described and summarized, the condition (if known) is summarized, and any recent rehabilitation or repair work is described.

4.2.2 Collection System Risk Assessment

Section 3 of the CSCIP provides an updated risk assessment for the District's collection system infrastructure. CDM Smith created a risk model for the District's collection system infrastructure in 2017 that assessed the Probability of Failure and the Consequence of Failure for each asset in order to prioritize collection system investigations. As part of the CSCIP, this risk model was updated. The updated risk model can now be used to identify the high-risk assets and prioritize them for assessment, repairs, or replacement.

Section 3 of the CSCIP includes a list of the probability of failure risk factors and the consequence of failure risk factors. Table 12 (CSCIP Task 3) below summarizes the SESD Critical Infrastructure Priority Ranking List as determined by the updated risk model.

Table 12 SESD Critical Infrastructure Priority Ranking List

Infrastructure	Probability of Failure Score	Consequence of Failure Score	Risk Score	Normalized Risk Score
Beverly Bass River Siphon Chambers	148	186	334	1000
Marblehead Force Main	112	132	244	730
Beverly Harbor Force Main	110	138	247	740
Beverly Force Main	54	105	159	480
Beverly Bass River Siphon Barrels	148	174	322	1000
Beverly Water Street Interceptor	122	121	243	754

Infrastructure	Probability of Failure Score	Consequence of Failure Score	Risk Score	Normalized Risk Score
Danvers Doty Avenue Gravity Main	45	68	112	336
Peabody Walnut Street Gravity Main	45	68	112	336
Peabody Salem Interceptor	85	103	188	729
Salem Derby Street Gravity Main	45	68	112	336
Beverly Beach Interceptor	113	167	279	836
Danvers Force Main	122	85	207	619
Danvers Porter River Gravity Main	45	68	112	336
Danvers Beaver Brook Gravity Main	45	68	112	336
Danvers River Street Gravity Main	45	68	112	336
Danvers Maple Street Gravity Main	45	68	112	336
Danvers Brookside Avenue Gravity Main	45	53	98	293
WWTP Outfall Force Main (Overland)	67	119	186	594
Beverly Tunnel	46	129	175	524
Marblehead Force Main - Salem Harbor Crossing	53	143	197	589
Danvers Porter River Siphon	61	163	224	671
WWTP Outfall Force Main (Subaqueous)	67	119	186	594

4.3 WASTEWATER TREATMENT

4.3.1 Permit Requirements, Compliance History, and Treatment Goals

The District's WWTP discharges are regulated under a National Pollutant Discharge Elimination System (NPDES) permit that was issued by the New England EPA. This permit has limits for effluent flow, carbonaceous biochemical oxygen demand (cBOD), total suspended solids (TSS), fecal coliforms, enterococci, residual chlorine, pH, and whole effluent toxicity.

Permit compliance over the analysis period of 2017-2021 has been reasonably good, with the most problematic violations being with effluent flow (12 month rolling average), whole effluent toxicity, TSS percent removal, TSS monthly load, and TSS weekly load. Minor issues with the enterococci permit limits were also noted. The TSS permit issues are likely related to the performance and sizing limitations of the Secondary Clarifiers, whereas the enterococci issues were considerably

reduced by a sampling protocol revision in late 2019. Further information on the permit requirements and compliance history is provided in the WFMP. (Task 1, Tables 2.1, 2.2, and 2.3)

4.3.2 Wastewater Treatment Plant Capacity Evaluation

4.3.2.1 Flows and Loads Comparison to Design

Table 13 (WFMP Task 3) below compares current and projected flows and loads to the design flows and loads from the secondary WWTP upgrade in the 1990's. The key takeaways are that the WWTP projected flows and loads are close to or slightly above the design basis. An important consideration, however, is the improved TSS and cBOD removal efficiency of the primary clarifiers as compared to the design basis. For TSS loading, this means that adequate capacity is likely still available at future loading. For cBOD loading, considerable excess capacity is available as seen by the primary effluent cBOD loading. Thus, an expansion of the WWTP is not required.

Table 13 Design Versus Current and Projected Flows and Loads

	Design Basis[1]	Current[2]	Current Percent of Design	Projected 2041[3]	Projected Percent of Design
Flow (MGD)					
Annual Average	29.7	26.2	88%	27.2	92%
Max Day	85.8	78.2	91%	-	-
Peak Hourly	98.8	98.9	100%	103.2	104%
TSS Load (lbs/day)					
Influent					
Annual Average	47,400	47,100	99%	49,200	104%
Max Day	99,500	127,400	128%	-	-
Primary Effluent					
Annual Average	20,800	14,800	71%	-	-
Max Day	41,600	39,700	95%		
cBOD Load (lbs/day)					
Influent					
Annual Average	46,100	34,600	75%	36,100	78%
Max Day	87,600	97,500	111%	-	-
Primary Effluent					
Annual Average	42,200	19,400	46%	-	-
Max Day	75,100	36,200	48%		

(1) Secondary system design basis from the late 1990's

(2) Based on 5 years of operational data from 2017-2021

(3) Projected 2041 based on District and member community input

4.3.2.2 Wastewater Treatment Plant Hydraulic Capacity Evaluation

A hydraulic model was developed, and model runs were performed and analyzed for various WWTP flow conditions to assess the plant's capacity to pass peak hourly flows and identify hydraulic bottlenecks. Table 14 (WFMP Task 3) below summarizes the hydraulic capacity of the WWTP. The WWTP has sufficient capacity for pass flows under average day flow conditions, however the hydraulic capacity is limited under both current and future max day and peak hourly flow

conditions for most of the treatment areas in the secondary treatment train. Consideration to increase the capacity of the WWTP is necessary to hydraulically pass peak hourly flows.

Table 14 WWTP Hydraulic Capacity Summary

Treatment Unit	Flow Conditions with Hydraulic Constraints	Capacity Issue/Constraint
Grit Chambers	None	None
Primary Clarifiers	None	None
Oxygen Reactors Distribution Box	Max Daily and Peak Hourly	Backup from downstream
Oxygen Reactors	Max Daily and Peak Hourly	Backup from downstream
Secondary Clarifiers	Max Daily and Peak Hourly	- High head loss at inlet piping and 48-in. pipes connecting to Oxygen Reactors effluent channel - Requires opening of "scum gate"
Chlorine Contact Tanks	Max Daily and Peak Hourly	- High head loss at static mixer, 48" Secondary Clarifier effluent piping, and 48 in. pipe and fittings - Upstream butterfly valves
Effluent Pump Station	None	None

4.3.2.3 Pump Station Hydraulic Capacity

The flow capacities of the pump stations are summarized in Table 15 below (WFMP Task 2, Table 9). To define the capacity of each of the pump stations, it is recommended that the "firm station capacity" be considered. The firm station capacity is defined as the total pumping capacity of all installed pumps, assuming one of the largest pumps is out of service. The screen/grinder capacities include the design capacities of all available automatic screens and for all the grinders at the Marblehead Pump Station.

The current max hourly flows and future max hourly flows are as presented in the flows and loads technical memorandum. Except for the Danvers Pump Station, all of the pump stations have additional available capacity available when compared to both the current and future maximum hourly flows. Besides the Danvers Pump Station, the pump stations have between 6.4% and 10.8% capacity available compared to the future maximum hourly flows. This means that even if peak flows are higher than projected, the pumps will likely not be the limiting factor for passing the flow and preventing sewer backups and overflows. It is also notable that the screen or grinder capacity is higher than the pump capacity for each pump station that has screening or grinders when only automated systems are considered except for the Danvers Pump Station. However, the Danvers Pump Station has an additional manual bar screen in a separate channel that can pass additional flows over the capacity of the automatic screen if peak flows increase to that point.

Table 15 Pump Station Current and Future Hydraulic Capacity

	Current Screen/Grinder Capacity[1], MGD	Current Pump Capacity[2], MGD	Current Max Hourly Flow[4], MGD	Future Max Hourly Design Flow, MGD	Available Pump Capacity (Future)
Danvers	14	12.0-13.0[3]	13.5	13.7	0%
Beverly	86.4	46.1	38.5	41.6	10.8%
Peabody/Salem Influent	105	56.8	52.2	53.4	6.4%
Marblehead	13.96	13.0	12.0	12.1	7.4%
Salem Neck	n/a	1.4	1.3	1.3	7.7%

(1) Screen capacity is based on all the available automatic screens in service or all the grinders in service at the Marblehead Pump Station.

(2) Pump capacity is based on the design capacity of all the pumps with one of the largest pumps out of service.

(3) Capacity limitation as described in CDM Smith Final Technical Memorandum No.5, December 2014.

(4) Actual max hour flows based on data between 2017 and 2021.

4.3.2.4 Liquid Stream Process Capacity Evaluation

4.3.2.4.1 Septage Receiving

The septage receiving facility generally has adequate capacity and no reported operational challenges were noted.

4.3.2.4.2 Aerated Grit Chambers

The aerated grit chambers are adequately sized when all four chambers are in service at peak hourly flows. The key consideration to improve the process removal efficiency of the grit chambers is to ensure that all four chambers are able to be operational during peak flow events. In order to do this, improvements to grit removal from the chambers and classification and storage of removed grit should be considered.

4.3.2.4.3 Primary Clarifiers

The Primary Clarifiers are adequately sized for average and peak hourly flows and have higher TSS and cBOD removal efficiency than was projected when the secondary treatment system was installed in the late 1990s.

4.3.2.4.4 Oxygen Reactors

The Oxygen Reactors have approximately double the capacity necessary to treat the primary effluent cBOD load from a biological treatment perspective. As a result, the District typically operates just two of the four reactors at a given time. The Oxygen Reactors have historically performed well under this operating strategy and have had no major capacity-related challenges.

4.3.2.4.5 Oxygen Generation

The pressure swing adsorption (PSA) system has adequate capacity to supply high purity oxygen (HPO) to the Oxygen Reactors and functions adequately. The backup liquid oxygen system also functions adequately when required and provides adequate capacity.

4.3.2.4.6 Oxygen Reactor Mixer/Aerators

The mixer/aerators in the Oxygen Reactors have adequate capacity to deliver the oxygen from the headspace into the liquid phase for biological treatment.

4.3.2.4.7 Secondary Clarifiers

The Secondary Clarifiers are adequately sized for average daily flows but are undersized for peak hourly flows. This is due to high surface overflow rates on the Secondary Clarifiers, as the solids loading is below literature guidelines due to the low mixed liquor solids concentrations for high purity oxygen cBOD removal processes.

The undersizing of the Secondary Clarifiers has resulted in challenges with TSS permit violations at high flows, particularly above 65 MGD. Scum buildup in the Secondary Clarifiers due to poor scum removal from the tanks is also a significant challenge. Scum buildup in the clarifiers is hypothesized as one potential contributor to elevated effluent TSS at peak hourly flows.

4.3.2.4.8 Disinfection

The Chlorine Contact Tanks at the District's WWTP are able to provide adequate disinfection at the current peak hourly flows. The Chlorine Contact Tanks are sized to maintain a minimum 15-minute detention time at peak hourly flows, though current guidelines require a 30-minute detention time at peak hourly flows. Some challenges with meeting the permit limit for Enterococci disinfection have been noted, however, adequate disinfection is attainable with the current configuration, though it results in increased chemical usage relative to contact tanks with longer detention times, which has financial implications for the District's operations.

4.3.2.4.9 Effluent Pump Station

The low head pumps at the effluent pump station are adequately sized, though the high head pumps may be undersized for future flows. While the District has noted that there has not been a scenario where they have not been able to convey flow from the facility. The motors on the high head pumps were rewound to 900 HP approximately 10 years ago. As a result, the pumps and motors have not been tested together to confirm actual operating conditions.

4.3.2.4.10 Plant Water System

The plant water system was recently replaced with a new system which was completed in the spring of 2025. This system should meet the District's needs for the foreseeable future.

4.3.2.4.11 Projected Liquid Stream Capacity Summary

Table 16 (WFMP, Task 3, Table 0.3) below summarizes process capacity for unit processes at the District's WWTP with the capacity for each unit converted into the common unit of flow for comparison. For average flow conditions, all of the unit processes have adequate capacity to treat current flows, projected future flows, and the design rated flow. Under peak hourly flows, two unit processes are limited. The Effluent Pump Station is rated for the design peak hourly flow, but its rated capacity is below both the current and future peak hourly flows. The high head pump motors in the Effluent Pump Station were rewound to increase the power from 800 HP to 900 HP approximately 10 years ago and likely have more capacity than they were originally designed for and thus should not be considered for replacement in the alternatives analysis. The Secondary Clarifiers, however, have considerably less capacity than required at the peak hourly flows for

design, current, and projected future flows. The capacity for the Secondary Clarifiers is based on recommendations of industry standard guidelines for the surface overflow rate at peak hourly flows and is confirmed by plant operating experience and operating data. Consideration should be given in the alternatives analysis to increase the capacity of the Secondary Clarifiers.

Table 16: Process Capacity Summary

Condition	**Average Flow, MGD**	**Peak Hourly Flow, MGD**	-
Design Current Projected	29.7 26.2 27.4	98.8 98.9 103.2	-
Treatment Unit	**Average Flow Capacity, MGD**	**Peak Hourly Flow Capacity, MGD**	**Capacity Limitation Basis**
Aerated Grit Chambers	n/a	119.2	Minimum detention time with 4 chambers
Primary Clarifiers	47.0	117.6	Hydraulic loading rates of 1,000 and 2,500 gpd/sf at average and peak hourly flows
Oxygen Reactors (biological)	79.9	n/a	F/M ratio of 0.72 lbs BOD/lb MLVSS-day (current) and an MLSS of 2,500 mg/L
Oxygen Generation	43.8	n/a	Current ratio of 1.42 oxygen provided per lb cBOD
Oxygen Reactors (Mixer/Aerators)	96	n/a	Mixer/aerator oxygen transfer rate of 2,630 lbs/hr
Secondary Clarifiers	32.4	64.8	Surface overflow rates of 600 and 1,200 gpd/sf at average and peak hourly flows
Chlorine Contact Tanks	n/a	101.3	15-minute detention time
Effluent Pump Station	n/a	98.6	Pump capacity at 106 ft TDH with 800 HP motors

4.3.2.5 Residuals Management and Disposal Practices Evaluation

Residuals generated at the WWTP are managed by the District onsite until they are transported offsite for final disposal by a third-party contractor.

Table 17 below (WFMP Task 3, Table 0.4) shows the design and average sludge production rates from 2017-2021 and provides a comparison to the design basis. The average day sludge production for the current conditions is below the design production for primary sludge, waste activated sludge (WAS), and the total sludge. The max day sludge production for current conditions is slightly higher than the design production for the primary sludge but is lower for WAS and the total sludge production. Variation is also seen in the average total sludge production in a given calendar month, though no month exceeded the design average sludge production.

Table 17: Sludge Production Summary

	Design Production	Current Production	Current Volatile Solids Fraction	Current Percent of Design Load
Primary Sludge[1] (lbs/day)				
Average	31,200	26,400	81%	84%
Max Month	-	40,000	-	-
Max Day	59,300	62,500	-	105%
Secondary Sludge/WAS[2] (lbs/day)				
Average	26,400	16,000	92%[4]	61%
Max Month	-	22,700	-	-
Max Day	39,600	33,100	-	84%
Total Sludge[3] (lbs/day)				
Average	57,600	42,300	82%	74%
Max Month	-	62,700	-	-
Max Day	98,900	95,500	-	97%

(1) Current production of primary sludge is calculated from the gallons of primary sludge blended and the percent solids of the primary sludge
(2) Current production of secondary sludge is from District data for total lbs of WAS
(3) Current production of total sludge is the sum of the primary and secondary sludge
(4) WAS volatile solids fraction was assumed to be the same as the mixed liquor

4.3.2.5.1 Thickening

The gravity belt thickeners (GBTs) thicken WAS from the Secondary Clarifiers and have sufficient capacity and perform well. The GBTs require less processing time than was assumed for their design due to the reduced quantities of WAS produced as compared to design and the current processing schedule of 7 days per week, rather than the 5 day per week schedule assumed during design.

4.3.2.5.2 Dewatering

The belt filter presses (BFPs) dewater blended sludge consisting of primary sludge and thickened WAS have sufficient capacity and perform well. The BFPs require less processing time than was assumed for their design due to the lower sludge production than the design. The District currently directly loads trucks from the BFPs to avoid using the cake storage silos due to operation and maintenance challenges with the silos. This results in the BFPs operating overnight so that sludge can be trucked off site at night due to odor concerns in the surrounding area.

4.3.2.5.3 Scum Thickening

The scum concentrators thicken both primary and secondary scum. They operate well and are generally able to process the scum produced from the primary and secondary systems.

4.3.2.5.4 Storage and Conveyance

The Primary Sludge Storage Tanks, Thickened WAS Storage Tanks, and Blended Sludge Storage Tanks all have comparable storage times to their design basis and are able to provide flexibility with

the current operational strategy. The Cake Storage Silos are not operational due to operational challenges and high maintenance costs. Cake is instead direct loaded into trucks.

The systems in place to convey the cake from the BFPs to trucks for hauling offsite are problematic but do have sufficient capacity for the cake that is produced. The conveyance systems also require that solids be moved across several different levels of the Operations Building. The maintenance of this equipment is extensive which is problematic for overall sludge processing operations.

4.3.2.5.5 Disposal

Casella is currently contracted with the District to manage the ultimate disposal of solids produced at the WWTP. They dispose of the dewatered cake at landfills, composting facilities, and incinerators across the region. The District is billed per wet ton of solids produced and Casella has surcharges for various items, such as the time drivers have to wait for trucks to be loaded and fuel price increases. Third party disposal will need to be rebid in 2026 concurrent with the end of the current agreement.

4.3.2.5.6 Residuals Handling Summary

Residuals management systems at the WWTP have sufficient capacity and function well overall. The current residuals management practices are labor intensive and the challenges with the existing sludge storage systems limit operational flexibility. Providing reliable cake storage in the future would also improve operations and allow operations staff to decouple dewatering and hauling schedules, likely resulting in cost savings for the District.

4.3.2.5.7 Future Residuals Management Needs and Challenges

In addition to plant process improvement, long-term biosolids management will consider beneficial reuse, energy neutrality, and/or disposal of the plant's residuals. A preliminary market assessment was conducted and is provided as Appendix D to WFMP Task 3.

Figure 4 below (WFMP, Task 3, Figure 0.1) provides a high level biosolids management road map that can be used to guide the assessment for long term management. Some of these options may be better long-term solutions because of market constraints, energy and resource recovery, disposal, and potentially PFAS destruction.

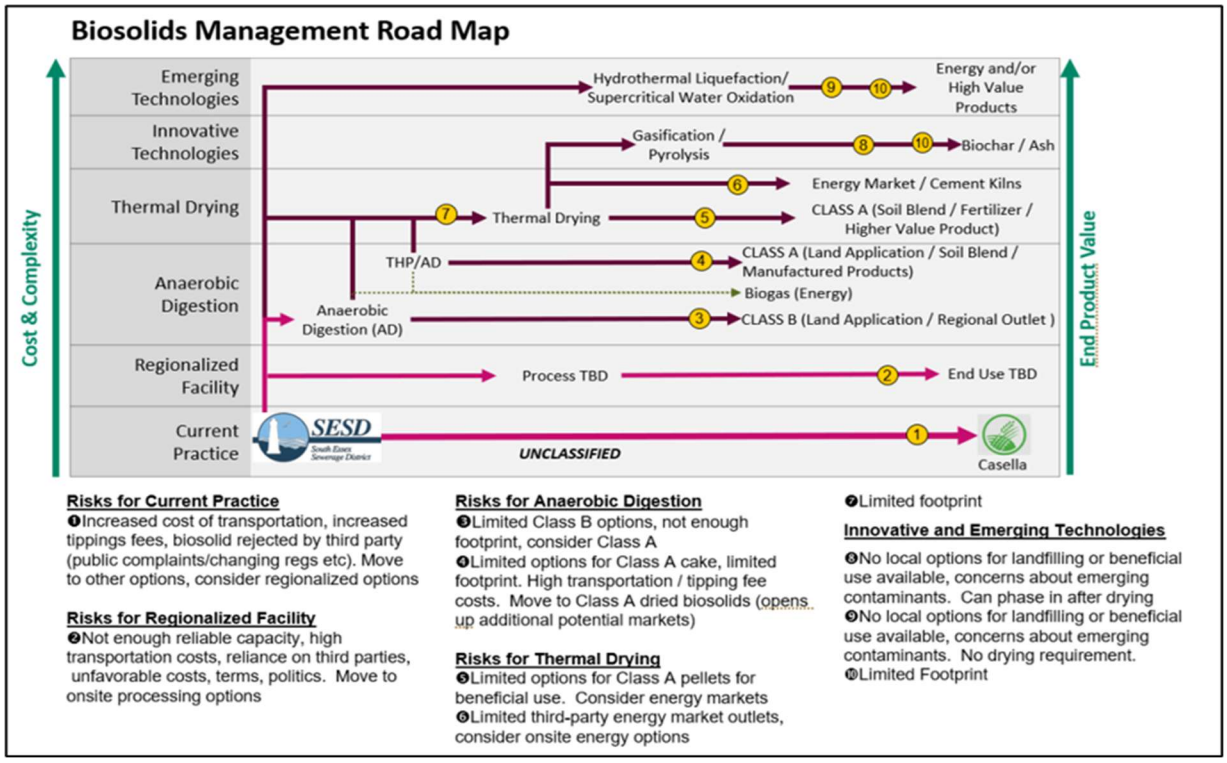


Figure 4: Biosolids Management Road Map

4.3.2.5.8 Additional Investigations

During this project, the District received bench scale testing results from two (2) screw press manufacturers. As part of concept design, future pilot testing may be recommended of the most promising technologies to confirm suitability for full scale implementation.

4.3.2.6 Odor Control Process Evaluation

4.3.2.6.1 Background

The entirety of the District's WWTP liquid and solids treatment processes are enclosed due to the proximity of the site to downtown Salem. Several odor control systems of the processes that produce odorous emissions are operated by the District to treat air prior to discharge through elevated stacks. These odor control systems generally include two stage wet scrubbers followed by granular activated carbon adsorbers.

4.3.2.6.2 Regulatory Summary

Odorous emissions are regulated by MassDEP, which approved the Conditional Plan for the WWTP in September 1994. This plan approval includes specific conditions for each odor control system at the WWTP, including identifying the installed equipment, stack diameter and elevations, removal efficiency for hydrogen sulfide, and controlled emission rates for both hydrogen sulfide and volatile organic compounds on an annual basis.

4.3.2.6.3 Odor Control Facilities

Odor Control Facility "A" serves the aerated grit building and consists of packed bed wet scrubbers followed by granular activated carbon adsorbers prior to discharge out of a stack for dispersion.

Odor Control Facility “B” serves the primary influent and effluent buildings, the primary clarifier tanks and a portion of the sludge processing building.

Odor Control Facility “C” serves the oxygen reactors and headspace ventilation air from the distribution box, secondary clarifiers and channels, chlorine contact basins, effluent pump station wet well and the secondary clarifier influent and effluent buildings. This system has no treatment of the process air and discharges via a stack.

Odor Control Facility “E” serves the influent pump station. This system is also a two-stage system, including a mist scrubber followed by carbon adsorbers.

Odor Control Facility “G” treats odorous air exhausted from the sludge dewatering area, truckway, and sludge cake storage area. The system consists of caustic, acid, and caustic/sodium hypochlorite packed tower scrubbers. Lime stabilization is no longer practiced resulting in several of the scrubbers no longer being required.

The Salem Neck Pump Station Odor Control System consists of a multi-pass deep bed carbon adsorption system.

4.3.2.6.4 Performance Evaluation

As indicated by data from 2022 and 2023 provided by the District, the overall removals of hydrogen sulfide in the system are typically 99.9% or more from the scrubber inlet to the discharge of stacks.

4.3.2.6.5 Summary of Deficiencies and Needs for Future Odor Control Systems

Much of the equipment is nearing the end of its useful life and should be considered for replacement. While alternative approaches may provide similar performance to the existing dual step process, the limited availability of land may limit the viability of alternative technologies. Should wet scrubbing continue to be utilized in the future, optimization of these systems should be considered with current instrumentation and control technology to provide for optimal efficiency of these systems.

As part of the alternatives analysis, evaluation of alternative odor control approaches and changes to air volumes should be considered. Changes to the existing odor control processes will likely trigger regulatory review of emissions from the facility. As such, it is recommended that the District continue to maintain operational data for each of the systems throughout the year to support future regulatory coordination.

4.3.3 Wastewater Pumping Station Facilities Condition Assessment

(See also WFMP Task 2, Pump Station Evaluation)

A review of the condition of the existing pump station facilities was also performed as a part of the WFMP. This review included examination of existing record plans and site visits conducted in conjunction with the District staff in November and December 2022 and January 2023. AECOM’s technical specialists in the areas of architecture, structures, mechanical, building services (i.e., HVAC and Plumbing), electrical, and instrumentation systems visually observed the condition of the existing facilities. A similar rating system was used for the pumping station as the wastewater treatment plant.

The condition of each of the District's off-site and on-site pumping and metering stations were evaluated as part of the study, including the following:

- Peabody / Salem Influent Pump Station
- Beverly Pump Station
- Danvers Pump Station
- Marblehead Pump Station
- Peabody Metering Station
- Beverly Metering Station
- Salem Neck Pump Station

A narrative describing each facility is included in Task 2 Memo. Further, a matrix summarizing the findings for each is included in the Executive Summary of the Task 2 Memo.

4.3.4 Wastewater Treatment Facilities Condition Assessment

(See also WFMP Task 3 WWTP Eval and Odor Control)

4.3.4.1 Asset Condition Assessment and Building Systems, Safety and Ancillary Systems Evaluation

As part of the WFMP, an assessment of the existing wastewater treatment facility was conducted. This review included examination of existing record plans and site visits conducted in conjunction with the District staff in December 2022 and January 2023. AECOM's technical specialists in the areas of architectural, structural, mechanical, building services (i.e., HVAC and Plumbing), electrical, and instrumentation systems visually observed the condition of the existing facilities.

- Physical condition of major equipment and structures
- Design limitations (i.e., hydraulic restrictions, unsatisfactory equipment performance or access)
- Adequacy of existing electrical and control systems
- Adequacy of the heating, ventilation, and air conditioning systems
- Compliance with building code regulations

Each of the significant buildings at the treatment plant were evaluated, including the following:

- Grit Building
- Primary Clarifier Buildings
- Oxygen Reactor and Oxygen Generation Buildings
- Secondary Clarifier Buildings
- Chlorination Building
- Effluent Pump Station
- Administration / Maintenance Building
- Operations Building
- Main Electrical Building
- Odor Control Facilities

The results of the assessments are included in the main body of the report (WFMP Task 3, Sections 6 and 7). In addition, the matrix tables summarizing the findings of the evaluation of each facility were developed for the Executive Summary of the WFMP Table 18 presents the grading standards that these ratings are based on.

Table 18: Condition Assessment Grading Standards

Condition	Description
Very Good	Sound physical condition. Asset likely to perform adequately without major work for 25 years or more.
Good	Acceptable physical condition; minimal short-term failure risk but potential for deterioration in long-term (10 years plus). Only minor work required (if any).
Fair	Significant deterioration evident; failure unlikely within next 5 years but further deterioration likely and major replacement likely necessary within next 10 years. Minor components or isolated sections of the asset need replacement or repair now, but asset still functions safely at adequate level of service. Work required but asset is still serviceable.
Poor	Failure is likely in short-term. Likely need to replace most or all of asset within 5 years. No immediate risk to health or safety but work required within 5 years to maintain safe operation. Substantial work required in short-term, asset barely serviceable.
Very Poor	Failed or failure imminent. Immediate need to replace most or all of asset. Health and safety hazards exist which present a possible risk to public safety or asset cannot be serviced/operated without risk to personnel. Major work or replacement required urgently.

4.3.4.2 Summary of Wastewater Treatment Facilities Condition Assessment Findings

There are several needs and priorities for the renewal and upgrades systems based on the evaluation of the Districts WWTP assets. Some assets have higher priorities due to equipment obsolescence and the required amount of time necessary to repair equipment. Some critical safety systems require immediate attention to maintain system redundancy and for life safety. Those priorities and the critical assets are documented and managed within the existing asset management CMMS System. Based on the process and hydraulic evaluation the treatment plant has several limitations in wet weather when secondary clarifiers or other process tankage is down for maintenance. However, during normal daily flow and process loads there is adequate capacity and redundancy to maintain permit compliance.

5 DEVELOPMENT AND EVALUATION OF ALTERNATIVES – COLLECTION SYSTEM INFRASTRUCTURE

5.1 DEVELOPMENT OF WASTEWATER CONVEYANCE ALTERNATIVES

(See also WFMP Task 6 and Task 7 Evaluations and Prioritization and CSCIP Chapters 4 and 5)

This section presents an overview of the sewer rehabilitation and replacement techniques that are being evaluated as potential alternatives for the District's collection system critical infrastructure. These techniques are evaluated for their primary applicability and cost effectiveness based on several factors including feasibility, ability to restore structural integrity, corrosion resistance, constructability, cost, and technical limitations and constraints.

5.1.1 Identification and Screening of Wastewater Conveyance Alternatives

With an existing wastewater collection system in place that must be kept operational, there were limited opportunities to substantial reconfiguration of the wastewater conveyance system. Therefore, the only alternatives available are the do nothing alternative with ongoing repairs when pipelines fail, upgrades to the existing pipelines, or replacement of the existing pipelines. The alternatives analysis process became a balance of upgrading the highest risk pipelines in the best technical and most cost-effective manner, while continuing to monitor and assess the remaining infrastructure that has remaining service life. Additional information on the identification, screening, and selection of wastewater conveyance alternatives is discussed below.

5.1.2 Considerations for Development of Wastewater Conveyance Alternatives

In considering applicable rehabilitation and replacement techniques, it is important to evaluate factors that will impact the feasibility and overall success of the approach. This section identifies and summarizes these considerations at a high level and subsequent sections will review these considerations for each element of the District's infrastructure included in this plan. The review is presented at the conceptual level, and a more detailed analysis should be performed as projects near implementation. Additionally, technology is continually evolving and constraints that exist at the time of this writing may no longer exist in the future.

5.1.2.1 Technical Feasibility

Selection of appropriate rehabilitation and replacement techniques must consider the problem or conditions that are to be addressed. Alternatives presented in this section can improve and restore structural integrity, address internal corrosion, provide redundancy and replace infrastructure approaching the end of its useful life. Additional considerations should include techniques that have been proven in similar situations, maintain hydraulic capacity and that can be implemented to minimize risk.

5.1.2.2 Structural Considerations

Given the age, material of construction, and condition of the critical infrastructure, full structural rehabilitation is desired and appropriate. Structural rehabilitation techniques do not rely on the

integrity or strength of the existing host pipe. These techniques offer full stand-alone structural properties. Feasible rehabilitation techniques must be capable of supporting the full static, live, and water load conditions on the existing critical infrastructure.

5.1.2.3 Corrosion Resistance

Rehabilitation and replacement techniques evaluated for use on the critical infrastructure must provide corrosion resistance. The environment inside sewer systems, particularly force mains and large interceptors, can often become highly corrosive and condition assessments performed by the District have identified internal corrosion in some cases at significant levels. External corrosion is also a primary concern due to soil conditions and the subaqueous / marine environment.

5.1.2.4 Redundancy

The District has expressed a desire to establish some degree of redundancy to the infrastructure elements included in this project, when feasible. Many of the infrastructure elements in this plan are the only means of conveyance, and failure would result in a situation that could significantly impact public health and the environment. While redundancy is not always feasible, approaches developed in this plan will include evaluation of parallel pipelines, new pipelines with rehabilitation of the existing, and other approaches to provide cost effective alternate conveyance.

5.1.2.5 Bypass Considerations

Bypass of the existing wastewater flow is required for rehabilitation and replacement of conveyance infrastructure. The degree of bypass will depend on the approach selected for renewal. In some cases, the existing pipelines may remain in full or partial service during construction of a parallel pipeline on an adjacent or new route. Rehabilitation also generally requires full or partial bypass depending on the selected technique and system redundancy. Flow handling for large scale infrastructure can be difficult and expensive and can be complicated by the physical constraints that exist in much of the project area. Selection of the recommended rehabilitation and replacement techniques will consider the best bypass approach from both technical and cost-effective standpoints.

5.1.2.6 Construction Considerations

The infrastructure included in this plan consists of large diameter pipelines constructed in fully developed areas with constraints that include limited and/or difficult access, subaqueous environments, and sensitive environmental areas. Rehabilitation and replacement techniques evaluated for each element consider the construction requirements to perform the work including access and staging requirements; disruption to residents, businesses, and traffic; construction duration; and, environmental and permitting requirements.

5.1.2.7 Cost Effectiveness

Cost effectiveness is always a consideration in selection of the best approach for infrastructure renewal. Cost effectiveness should not be the lowest cost alternative but should consider the overall life cycle cost of the approach and other related costs including soft costs during implementation such as impact to the community.

5.1.2.8 Contractors

Installation of rehabilitation measures often requires the use of specialized applicators and contractors. Depending on the technique or process, sometimes the number of contractors is very limited or occasionally sole source. Consideration should be given to the field of appropriate and qualified contractors for each process to allow competitive bidding and pricing.

5.1.3 Evaluation of Sewer Rehabilitation and Replacement Techniques

An evaluation of potential rehabilitation techniques was performed to identify the primary applicability and cost effectiveness of each technique as alternatives for the critical infrastructure. This section presents a brief description of the techniques and other considerations for installation that are specific to each. Table 19 (CSCIP, Table 4-1) presents a summary of the sewer rehabilitation techniques summary. In addition, Section 4 of the Collection System CIP presents a summary review of each of the technologies included in the table below.

Table 19: Rehabilitation Techniques and Cost Effectiveness

Technology	Local Contractor	Structural Repair	Corrosion Resistance	Applicable Diameters	Diameter Reduction	Proven Technology	Cost
Cured in Place Pipe (CIPP) - Gravity	Many	Yes	High	6-in to 48-in	Minimal	Very common technique	Moderate
Cured in Place Pipe (CIPP) - Pressure	Limited	Yes	High	4-in to 96-in	Minimal	Limited track record / local application	High
Centrifugally Applied Geopolymer Lining	Limited	Yes	Moderate	≥ 54-in	Minimal	Limited track record / local application	Moderate
Slip-lining	Some	Yes	High	Most diameters and non-circular	Moderate to High	Limited track record / local application	Low
Replace with Parallel Pipe	Many	Yes	High	Any	None	Very common technique	High

5.1.4 Other Alternatives Considered

5.1.4.1 Optimization of Existing Facilities

Since the District does not own the collection system or local pumping stations there is limited optimization possible in the District's interceptor sewers, force mains and siphons within a member community. Further, the system is already reasonably optimized since SSO's are rare within the District's conveyance system and the procedures for maximizing wet weather flow to the Districts pumping stations and WWTP are well known. Operations staff follow Standard Operating Procedures (SOPs) when heavy rain events occur.

5.1.4.2 Regional Solutions

The District was formed in 1925 as a regional wastewater utility. Since the District is already a regional wastewater facility this is not applicable.

5.1.4.3 Alternative Technologies

No alternative technologies to those listed in the table above were evaluated. Further, pressure, STEP, or vacuum sewer systems are not cost-effective retrofit for the SESD interceptor infrastructure. While there are other technologies available, it is critical that any technical solution be well established prior to implementing it on large infrastructure, such as those in the District's collection system. As work progresses on designing each of the collection system projects, detailed evaluations will be completed, which will include up to date assessments of available alternative technologies.

5.2 Evaluation of Wastewater Conveyance Alternatives

(See also CSCIP Chapters 5 and 6)

This section summarizes the recommended conceptual rehabilitation / replacement approach for each infrastructure element. Also included are implementation considerations.

5.2.1 Beverly Bass River Siphon Chambers

CDM Smith recommends rehabilitation and restoration of the existing Upstream and Downstream concrete Bass River Siphon Chambers.

5.2.1.1 Conceptual Approach

Elements of the conceptual approach are presented below:

Upstream Bass River Siphon Chamber

- Extensive interior work including steel cable removal from the 24- and 30-in siphon barrels, demolition, gate replacement, concrete restoration and coating, and roof replacement. It is assumed that the structural elements of the chamber are intact and work will be focused on the concrete fill and interior elements.
- Wastewater flow handling and a temporary bypass pumping system will be required to isolate portions of the chamber perform the work.

- Moderate excavation and surface restoration will be required to expose the chamber and manage flow diversion.
- The site around the chamber is highly constrained with difficult access via a small dead-end road, close proximity to residents and environmental constraints. it is anticipated that significant coordination will be required to perform the work.

Downstream Bass River Siphon Chamber

- Restoration including demolition, gate replacement, grating replacement, and concrete restoration and coating.
- Wastewater flow handling and a temporary bypass pumping system will be required to isolate portions of the chamber to perform the work.
- It is anticipated that the majority of the work can be performed internally with little or no excavation or site disruption.

5.2.1.2 Opinion of Probable Costs

The OPCC for rehabilitating and restoring the Beverly Bass River Siphon Chambers is $4,800,000. This estimate includes excavation, demo, repair, replacement, restoration, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.2 Marblehead Force Main

CDM Smith recommends the installation of 5,600 linear feet and 6,700 linear feet of new 24-in and 30-in HDPE pipelines, respectively. The new pipelines will be redundant force mains parallel to the existing 24-in and 30-in AC Marblehead Force Main.

5.2.2.1 Conceptual Approach

Elements of the conceptual approach, including installation/construction considerations, site constrains, flow management, and other related concerns are summarized as follows:

- Flow handling and temporary bypass pumping systems will be limited as the existing force main can remain active during installation. Flow handling will be required during final connections to the existing line.
- Caution is recommended in the installation of a parallel force main adjacent to the existing line. Due to the unknown condition of the asbestos cement pipeline, limited work area, presence of ledge and other factors, construction techniques should consider constraints on blasting and vibration and otherwise minimize existing condition impacts. While not part of this investigation, alternative alignments could also be considered.
- Special consideration will be required for connecting the parallel line to the Marblehead Pumping Station (Upstream), navigating the diameter change, and connecting into the downstream portion in Stramski's Beach.
- Significant excavation and surface restoration will be required.
- The parallel line will be HDPE and installed by open cut techniques.
- The existing force main is recommended to remain in place and maintained as a standby force main.

- Significant staging areas will be required to accommodate construction equipment, vehicles, material, etc.
- Traffic control will be required due to the population density and narrow streets in Marblehead.

5.2.2.2 Opinion of Probable Costs

The OPCC for installing a new parallel HDPE line is $28,900,000. This estimate includes excavation, surface restoration, paving, furnishing and installing the new HDPE pipe, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation. The OPCC does not include costs for easement and land access agreements.

5.2.3 Beverly Harbor Force Main

The existing Beverly Harbor Force Main is a single 42-inch ductile iron force main. The existing force main has been in service since 1985 and cannot be assessed due to very challenging access constraints. The record drawing depicts the pipe being polyethylene wrapped; however, the wrapping was not seen in the construction photographs taken when it was constructed. CDM Smith recommends parallel replacement of the existing 42-in CLDI Beverly Harbor Force Main with two new 42-in HDPE pipelines at are approximately 2,850 linear feet each within a new alignment or a combination of a new alignment and an existing alignment.

Two new pipeline connections will also be required and modifications made along the Pump Station discharge header between Water Street and Sandy Point Beach and across the Harbor to Deadhorse Beach to incorporate the necessary redundancy in the new pipelines.

5.2.3.1 Conceptual Approach

Elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are summarized as follows:

- Flow handling and temporary bypass pumping systems will be limited to the work required to connect to the existing force main. The existing force main can remain active during installation and provide the majority of flow handling.
- Special consideration and effort will be required for connecting the parallel replacement line to the upstream Beverly Pumping Station and the downstream portion across Beverly Harbor in Dead Horse Beach. There are considerable space constraints in the area around the pump station
- Installation of the parallel replacement line will require subaqueous construction. It has been assumed that subaqueous dredge and fill construction supported by barges will be used to install the new force main.
- The parallel replacement pipelines will be HDPE.
- Two new parallel HDPE replacement lines will be installed and connected to the collection system. After construction of the parallel HDPE pipelines, the old existing CLDI pipeline will either be abandoned or kept in place for an offline standby.
- Moderate excavation and surface restoration will be required.

- Significant staging areas will be required to accommodate construction equipment, vehicles, material, etc.
- Traffic control will be required due to the population density and narrow streets along Water Street (Beverly) and in the Salem Neck neighborhood.

5.2.3.2 Opinion of Probable Costs

The OPCC for installing a new parallel HDPE replacement line is $27,000,000. This estimate includes excavation, surface restoration, paving, furnishing and installing the two new HDPE pipes, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.4 Beverly Force Main

CDM Smith recommends parallel replacement of the existing 42-in and 48-in CI Beverly Force Main with approximately 3,300 linear feet of new 42-in and 48-in HDPE pipeline.

5.2.4.1 Conceptual Approach

Elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are presented below:

- Flow handling and temporary bypass pumping systems will not be required as the existing force main can remain active during installation.
- Special consideration will be required for connecting the parallel line to the upstream portion (Dead Horse Beach), navigating the diameter change, and connecting into the WWTP Influent Pumping Station (downstream).
- Significant excavation and surface restoration will be required.
- The parallel replacement line will be HDPE and installed by open cut techniques.
- Significant staging areas will be required to accommodate construction equipment, vehicles, material, etc.
- Traffic control will be required due to the population density and narrow streets in the Salem Neck neighborhood.

5.2.4.2 Opinion of Probable Costs

The OPCC for installing a new parallel HDPE replacement line is $19,400,000. This estimate includes excavation, surface restoration, paving, furnishing and installing the new HDPE pipe, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.5 Beverly Bass River Siphon Barrels

CDM Smith recommends approximately 1,500 linear feet of CIPP lining as the rehabilitation technique for the (two) 24-in and (one) 30-in CLDI Beverly Bass River Siphon Barrels.

5.2.5.1 Conceptual Approach

Elements of the conceptual approach, including installation considerations and site constraints, flow management, construction considerations and other related concerns, are summarized as follows:

- It is assumed that the upstream and downstream siphon chambers will be rehabilitated and restored prior to CIPP lining the siphon barrels.
- Rehabilitation will be performed on one barrel at a time with the remaining siphon barrels available for handing flow and therefore minimizing bypass pumping.
- Surface of pipe must be cleaned and inspected, with all loose material removed prior to installing the liner.
- Siphon diameter and length will likely require on-site liner wet out. Staging area requirements will need to be considered particularly due to staging area limitations at upstream siphon chamber.
- Dewatering of siphon barrels during execution of the work will require additional planning and effort.
- Some surface restoration will be required due to chamber excavation and repair.
- Coordination with residents on Hobart Avenue will be required.

5.2.5.2 Opinion of Probable Costs

The OPCC for CIPP lining the Bass River Siphon is $5,500,000. This estimate includes cleaning and CCTV inspections, furnishing and installing pre-liners and liners, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.6 Beverly Water Street Interceptor

CDM Smith recommends approximately 1,900 linear feet of centrifugally applied geopolymer liner as the rehabilitation technique for the 54-in reinforced concrete (Class IV) Beverly Water Street Interceptor.

5.2.6.1 Conceptual Approach

Elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are summarized as follows:

- Temporary bypass pumping system will need to be setup using the access manholes along
- Surface of pipe must be cleaned and inspected, with all loose material removed prior to installing the liner. Similarly, control of active infiltration and leaks will be necessary.
- Geopolymer liner will be applied using a specialized spray application system mounted on a sled that can be inserted into the interceptor through the access manholes.
- Traffic control will be required due to the population density and lack of available space along Water Street

5.2.6.2 Opinion of Probable Costs

The OPCC for geopolymer lining of the Beverly Water Street Interceptor is $5,600,000. This estimate includes bypass pumping, cleaning and television inspection, furnishing and installing the geopolymer liner, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.7 Danvers Doty Avenue Gravity Main

CDM Smith recommends approximately 6,700 linear feet of CIPP lining as the rehabilitation technique for the 30-in x 42-in and 33-in x 34-in concrete non-reinforced Danvers Doty Avenue Gravity Main.

5.2.7.1 Conceptual Approach

Elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are presented below:

- The Danvers Doty Avenue Gravity Main must be rehabilitated prior to rehabilitation of the Danvers Force Main.
- Temporary bypass pumping system will need to be setup using the access manholes along the alignment.
- Wastewater flow could potentially be diverted to the redundant Danvers Force Main using a temporary bypass pumping system.
- Manhole risers may need to be removed and reinstalled to facilitate liner installation.
- Dewatering at this diameter and length will be challenging and require additional planning and effort.
- For larger diameter gravity mains, wet out must be done on-site due to the weight of the impregnated liner and difficulties in trucking and handling. On-site wet out requires a larger staging area for the additional equipment and resin tankers
- Surface of pipe must be cleaned and inspected, with all loose material removed prior to installing the liner.
- Traffic control will be required due to the population density and lack of available space along the alignment.

5.2.7.2 Opinion of Probable Costs

The OPCC for CIPP lining the Danvers Doty Avenue Gravity Main is $10,000,000. This estimate includes bypass pumping, cleaning and television inspection, furnishing and installing pre-liners and liners, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.8 Danvers Force Main

CDM Smith recommends parallel replacement of the existing 30-in CLDI Danvers Force Main with approximately 7,500 linear feet of new 30-in HDPE pipeline.

5.2.8.1 Conceptual Approach

Elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are presented below:

- Flow handling and temporary bypass pumping systems will be limited as the existing force main can remain active during installation. Likely periods requiring bypass will be when the new pipeline is tied into the existing system. In addition to the Danvers Force Main, the pumping station also has the ability to discharge a portion of flow to the adjacent gravity main.
- If the redundant gravity main is to be used for temporary bypass pumping, the gravity main should be rehabilitated (CIPP lined) prior to parallel pipe replacement. Rehabilitation of the gravity main is programmed in advance of the Danvers Force Main in the CIP.
- Special consideration to minimize disruption to the existing system will be required for connecting the parallel replacement line to the upstream Danvers Pumping Station on Doty Avenue and the (downstream) Upstream Bass River Siphon Chamber.
- Installation of the parallel replacement line will include complex subaqueous construction. It has been assumed that subaqueous dredge and fill construction supported by barges will be used to install the new force main.
- The parallel replacement line will be HDPE.
- The existing force main will be taken offline once the new parallel replacement line is installed and connected to the collection system. The existing main will serve as redundant infrastructure.
- Significant excavation and surface restoration will be required.
- Significant staging areas will be required to accommodate construction equipment, vehicles, material, etc.
- Traffic control will be required due to the population density and narrow streets along the alignment.

5.2.8.2 Opinion of Probable Costs

The OPCC for installing a new parallel HDPE replacement line is $19,800,000. This estimate includes excavation, surface restoration, paving, furnishing and installing the new HDPE pipe, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.9 Peabody Walnut Street Gravity Main

CDM Smith recommends approximately 2,400 linear feet of CIPP lining as the rehabilitation technique for the 30-in to 48-in brick and 54-in RCP Peabody Walnut Street Gravity Main.

5.2.9.1 Conceptual Approach

Elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are presented below:

- The Peabody Walnut Street Gravity Main must be rehabilitated prior to rehabilitation of the Peabody Salem Interceptor.
- Wastewater flow handling will be accomplished using the redundant Peabody Salem Interceptor. A temporary bypass pumping system will need to be setup between the two pipelines using the access manholes.
- Manhole risers may need to be removed and reinstalled to facilitate liner installation.
- Dewatering at this diameter and length will be challenging and require additional planning and effort.
- For larger diameter gravity mains, wet out must be done on-site due to the weight of the impregnated liner and difficulties in trucking and handling. On-site wet out requires a larger staging area for the additional equipment and resin tankers
- Surface of pipe must be cleaned and inspected, with all loose material removed prior to installing the liner.
- Traffic control will be required on Walnut Street.

5.2.9.2 Opinion of Probable Costs

The OPCC for CIPP lining the Peabody Walnut Street Gravity Main is $4,900,000. This estimate includes bypass pumping, cleaning and television inspection, furnishing and installing pre-liners and liners, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.10 Peabody Salem Interceptor

CDM Smith recommends approximately 16,100 linear feet of centrifugally applied geopolymer liner as the rehabilitation technique for the 78-in and 84-in reinforced concrete Peabody Salem Interceptor.

Prior to rehabilitating the existing Interceptor, the pipeline will require heavy cleaning to remove accumulated sediment, determine the extent of the deterioration and confirm that centrifugally applied geopolymer is a cost-effective method of rehabilitation as well as CCTV of the North River Siphon.

5.2.10.1 Conceptual Approach

Elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are summarized as follows:

- Bypass pumping and flow diversion are required to perform the rehabilitation of the Peabody Salem interceptor. There are options to utilize existing parallel conveyance system to reduce the bypass including diversion of flow to the Walnut Street sewer in the upper portion. It is recommended that rehabilitation of the Walnut Street sewer be coordinated with this project, with the Walnut Street work performed first.
- Dewatering at this diameter will be challenging and require additional planning and effort.
- Surface of pipe must be cleaned and inspected, with all loose material removed prior to installing the liner. Active infiltration and leaks will also need to be controlled during the installation.

- Geopolymer liner will be applied using a specialized spray application system mounted on a sled that can be inserted into the interceptor through the access manholes.
- Traffic control will be required due to the population density and vehicle traffic in the project area.

5.2.10.2 Opinion of Probable Costs

The OPCC for the short-term work at the Peabody Salem Interceptor is $2,150,000. This estimate includes heavy cleaning, residuals disposal, and CCTV inspection of the North River siphon. The price includes a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

The OPCC for the long-term geopolymer lining of the Peabody Salem Interceptor is $36,000,000. This estimate includes bypass pumping, cleaning and television inspection, furnishing and installing the geopolymer liner, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.11 Salem Derby Street Gravity Main

CDM Smith recommends approximately 700 linear feet of centrifugally applied geopolymer liner as the rehabilitation technique for the 54-in RCP and 72-in brick Salem Derby Street Gravity Main.

5.2.11.1 Conceptual Approach

Elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are presented below:

- Wastewater flow handling will be accomplished using the redundant Peabody Salem Interceptor. A temporary bypass pumping system will need to be setup between the two pipelines using the access manholes.
- Dewatering at this diameter will be challenging and require additional planning and effort.
- Surface of pipe must be cleaned and inspected, with all loose material removed prior to installing the liner.
- Geopolymer liner will be applied using a specialized spray application system mounted on a sled that can be inserted into the gravity main through the access manholes.
- Traffic control will be required due to the population density and vehicle traffic in the project area.
- Manhole risers may need to be removed and reinstalled to facilitate liner installation.

5.2.11.2 Opinion of Probable Costs

The OPCC for geopolymer lining of the Salem Derby Stret Gravity Main is $2,700,000. This estimate includes bypass pumping, cleaning and television inspection, furnishing and installing the geopolymer liner, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.12 Danvers Gravity Mains

There are five major collection systems gravity pipelines within the Danvers Collection System that will need to be rehabilitated that are described in the Collection System Capital Improvement Plan.

- Danvers Porter River Gravity Main (42-in and 48-in reinforced concrete)
- Danvers Beaver Brook Gravity Main (30-in and 36-in reinforced concrete)
- Danvers River Street Gravity Main (27-in x 36-in and 27-in x 28-in rectangular non-reinforced concrete)
- Danvers Maple Street Gravity Main (10-in and 15-in vitrified clay and 21-in to 36-in reinforced concrete)
- Danvers Brookside Avenue Gravity Main (15-in clay tile and 24-in x 27-in non-reinforced concrete)

However, there is a need to complete field investigations to determine the conditions and needs for these sewers prior to scheduling or preparing capital budgets to complete this work.

5.2.12.1 Conceptual Approach

Condition Assessment and Prioritization study

The first phase of work for the Danvers gravity sewer mains is to complete a condition assessment. This will be accomplished by complaint multi-sensor pipe inspections (i.e., Red Zone) of the gravity mains to determine pipe conditions. Based on the results, the gravity main rehabilitation work will be assessed for criticality and prioritized. When necessary due to available capital funding some segments may be pushed into the future.

Danvers Gravity Sewer Mains Rehabilitation

Once the conditions of the Danvers gravity sewer mains is known and required rehabilitation is prioritized, projects will be identified to make the necessary repairs. Repairs will depend on the location and diameter of the gravity sewer mains. The conceptual approach is as follows:

- Bypass pumping and flow diversion is required to perform the rehabilitation of the sewers.
- Dewatering the larger pipeline diameter sewers will be challenging and require additional planning and effort. The gravity main less than 15 inches should require less effort.
- Surface of pipe must be cleaned and inspected, with all loose material removed prior to installing the liner. Active infiltration will also need to be controlled during the installation.
- Geopolymer liner will be applied using a specialized spray application system mounted on a sled in the larger pipelines.
- Cured in place liner will be used in the smaller circular pipelines. that can be inserted into the interceptor through the access manholes. CIP Liner may also be used in combination with the geopolymer liner on sections of larger diameter circular pipes that are in heavy traffic areas.
- Traffic control may be required due to the population density and vehicle traffic in the project area.

5.2.12.2 Opinion of Probable Costs

The OPCC for the Danvers Gravity Sewer Mains Condition Assessment and Prioritization Study is $2,000,000. This cost includes initial cleaning, Multi-Sensor inspection, and flow management as required to complete the work.

OPCC costs for rehabilitation of the Danvers gravity sewer networks described above have been developed and are included in the Collection system CIP, however, they have not bee included in the overall CIP costs at this time.

5.2.13 WWTP Outfall Force Main

CDM Smith recommends parallel replacement of the existing 66-in non-reinforced concrete overland portion of the WWTP Outfall Force Main with approximately 3,100 linear feet of new 66-in HDPE pipeline. The subaqueous portion (Salem Harbor) will be assessed, and recommendations provided in the future.

5.2.13.1 Conceptual Approach

Key elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are summarized as follows:

- Flow handling and temporary bypass pumping systems will be minimized since the existing force main can remain active during installation. Bypass and flow handling will be required for the connection to the existing line.
- Special consideration will be required for connecting the parallel replacement line to the District's WWTP Effluent Pumping Station and the Salem Harbor portion of the outfall.
- Significant excavation and surface restoration will be required.
- Further evaluation of the alignment of the replacement line is required. Consideration should be given to an "in street" route to eliminate the current crossing of the tidal flats area of the current alignment.
- The parallel replacement line will be HDPE.
- The existing force main will be taken offline once the new parallel replacement line is installed and connected to the collection system.
- Significant staging areas will be required to accommodate construction equipment, vehicles, material, etc.
- Traffic control will be required due to the population density and narrow streets in the Salem Neck neighborhood.
- Likely significant permitting requirements depending on final alignment.

5.2.13.2 Opinion of Probable Costs

The OPCC for installing a new parallel HDPE replacement line is $11,900,000. This estimate includes excavation, surface restoration, paving, furnishing and installing the new HDPE pipe, a 30 percent construction contingency, and a 25 percent allowance for engineering and implementation.

5.2.14 Beverly Beach Interceptor

Due to the unknown condition of the Beverly Beach Interceptor, CDM Smith recommends both short and long-term actions to manage this infrastructure. Short term (Tier 1) actions should include a condition assessment of the interceptor while the longer term (Tier 4) action includes construction of the recommended rehabilitation alternative.

It is recommended that a preliminary phase of work be performed to better define the scope of this project consisting of a multi sensor inspection (MSI) and further development of the rehabilitation concept. This will allow the District and City of Beverly to better establish existing conditions and verify the recommended rehabilitation, conceptual construction approach, potential alternate alignments, and opinion of probable construction cost.

CDM Smith recommends parallel replacement of the existing 48-in cast iron Beverly Beach Interceptor with approximately 600 linear feet of new 48-in HDPE pipeline. Once the Beverly Beach Interceptor condition assessment and concept development phase is complete, the recommended rehabilitation, conceptual approach, and opinion of probable construction cost will be revisited and verified.

5.2.14.1 Conceptual Approach

Preliminary elements of the conceptual approach, including installation/construction considerations, site constraints, flow management, and other related concerns are summarized as follows:

- Due to the Beverly Beach Interceptor receiving the City of Beverly's flow, the City of Beverly will need to be directly involved in all stages of the proposed project.
- Flow handling and temporary bypass pumping systems will likely be limited to when the new pipeline is tied into the existing system. The existing interceptor can remain active during installation and provide the majority of flow handling.
- Special consideration and effort to minimize disruption to the existing system will be required for connecting the parallel replacement line to the upstream manhole structure buried within Sandy Point Beach and the downstream Beverly Pumping Station Wet Well on Water Street. There are considerable space constraints in both areas.
- Installation of the parallel replacement line will require complex construction within Sandy Point Beach and Beverly Harbor.
- The parallel replacement line will be HDPE.
- The existing interceptor will be taken offline once the new parallel replacement line is installed and connected to the collection system.

5.2.14.2 Opinion of Probable Costs

Given the high risk score it is recommended that the Beverly Beach Interceptor Condition Assessment and Concept Development be included in the Tier 1 projects. The planning level cost for this proposed work is approximately $150,000 and includes coordination and execution of the MSI program and further development of the overall rehabilitation concept. An initial concept and considerations are presented in the following section.

Due to the uncertainty associated with this project, a placeholder of $5,000,000 has been included for the parallel replacement of the Beverly Beach Interceptor. This OPCC will be revisited and verified during the condition assessment and conceptual development phase.

5.3 Conclusions and Recommended Upgrades for Wastewater Conveyance Upgrades

5.3.1 Summary of Recommended Improvements

Table 20 (CSCIP Table 6.1) summarizes the probable cost estimates for the recommended collection system upgrade alternatives. Cost estimates are at the conceptual level and include significant contingency and allowances that reflect the limited development of the concepts including an estimate of permitting costs. The OPCC reflects current cost conditions at the time of this report (June 2025) and do not include escalation to the anticipated year of construction; escalation of CIP costs will be applied in financial models being developed separately by the District as part of this CIP process. OPCCs should be reevaluated during preliminary and final design.

Table 20: Collection System 20-year Capital Improvement Plan Cost Estimates

Project Element	2024 Cost (Millions of Dollars)
Bass River Siphon Chambers	$ 4.8
Marblehead Force Main	$ 28.9
Beverly Harbor Force Main	$ 27.0
Beverly Beach Interceptor Assessment	$ 0.15
Peabody Salem Interceptor Heavy Cleaning	$ 2.15
Beverly Force Main (landbased portion)	$ 19.4
Bass River Siphon Barrels	$ 5.5
Beverly Water Street Interceptor	$ 5.6
Danvers Doty Avenue Gravity Sewer	$ 10.0
Danvers Gravity Collection System Condition Assessment	$ 2.0
Peabody Walnut Street Gravity Sewer	$ 4.9
Peabody Salem Interceptor	$ 36.0
Salem Derby Street Gravity Sewer	$ 2.7

Beverly Beach Interceptor Rehabilitation	$	5.00
Danvers Doty Avenue Force Main	$	19.8
WWTP Outfall Force Main (Land Based Portion)	$	11.9
Total	**$**	**185.8**

5.3.2 Present Worth and Cost Effectiveness Analysis for Conveyance System Upgrades

A Present-Worth Analysis for the collection system alternatives was not conducted since no significant reconfiguration and modification of the collection system is required or proposed and each alternative considered for pipeline rehabilitation will have the same operating costs. Similarly, an Equivalent Uniform Annual Costs value was not prepared. The focus of this evaluation is on capital costs.

The collection system pipelines cost effective analysis considered many factors including risk scores, criticality and site-specific constraints to determine priority, appropriate rehabilitation technology including costs for the upgrades. These factors are all discussed in the CSCIP and the assessment reports within the CIP (CSCIP Table 3-1, 3-3, 4-1).

5.4 Environmental Permitting and Other Impacts for Conveyance System Upgrades

5.4.1 Permitting Considerations

Environmental permits and approvals are required whenever proposed work may affect certain environmentally sensitive resources, including waterways such as the Beverly Harbor, wetland resource areas, habitats of rare or endangered species, and historical and archaeological sites.

The applicable local, state, and federal permits that are anticipated to be required, including a brief description and estimated timeframe, are presented in the following subsections. Additional local, state, and federal permits may be required based on final design.

Table 21 (CSCIP Table 6-2) below identifies the anticipated permits for each infrastructure project included in this CWMP.

Table 21: Environmental Permitting Requirements

Infrastructure	MassDEP Chapter 91 License	US Army Corps of Engineers Section 404/10 Permit	Notice of Intent Conservation Commission	401 Water Quality Certification	Massachusetts Environmental Policy Act (MEPA) Approval	NPDES Construction General Permit (CGP)	Coordination with Massachusetts Historical Commission (MHC) and	Project Notification - Conservation Commission	Massachusetts Department of Transportation (MassDOT) State Highway Access Permit	MBTA Access Permit
Beverly Bass River Siphon Chambers			X			X	X			
Marblehead Force Main			X			X	X		X	
Beverly Harbor Force Main	X	X	X	X	X	X	X			
Beverly Beach Interceptor	X	X	X	X	X	X	X			
Beverly Force Main			X			X	X			
Beverly Bass River Siphon Barrels			X			X	X			
Beverly Water Street Interceptor								X		
Danvers Doty Avenue Gravity Main								X		
Danvers Force Main	X	X	X	X	X	X	X			
Peabody Walnut Street Gravity Main								X		
Peabody Salem Interceptor								X		X
Salem Derby Street Gravity Main								X		
WWTP Outfall Force Main	X	X	X	X	X	X	X			

Additional permits may also be required for some projects for Coastal Impacts, Ocean Sanctuary impacts, and Archeological Impacts, particularly for the sub-aqueous Beverly Harbor Force Main Replacement. This will be assessed on a project-by-project basis. Interbasin Transfer of Flows impacts are not expected since there is no change in the configuration of the sewer system.

5.4.1.1 MassDEP Chapter 91 License

The Public Waterfront Act MGL Chapter 91 and its regulations require a Chapter 91 waterways license or permit for any activity located in or overflowed tidelands, filled tidelands, Great Ponds and certain non-tidal rivers and streams located throughout the Commonwealth. The estimated timeframe for this permit is 1 year.

5.4.1.2 US Army Corps of Engineers Section 404/10 Permit

Section 404 of the Clean Water Act requires authorization from the Secretary of the Army, acting through the Corps of Engineers, for the discharge of dredged or fill material into all waters of the United States, including wetlands. A Corps permit is required whether the work is permanent or temporary. Section 10 requires authorization is require for work or structures in, over or under navigable waters of the United States. The estimated timeframe for this permit is 6 months to 1 year.

5.4.1.3 Notice of Intent – Conservation Commission

To protect the Commonwealth's wetland resources, the Massachusetts Wetlands Protection Act prohibits the removal, dredging, filling, or altering of wetlands without a permit. To obtain a permit (called an Order of Conditions), you must submit an application to the local Conservation Commission and MassDEP. The Notice of Intent (NOI) application provides the Conservation Commission and MassDEP with a complete and accurate description of the site and proposed work. The estimated timeframe for this permit is 60 days.

5.4.1.4 401 Water Quality Certification

Under section 401, a federal agency may not issue a license or permit that may result in a discharge into waters of the United States (WOTUS) unless a state or tribe with TAS either grant a certification or waive its opportunity to certify. A section 401 certification indicates the licensed or permitted project will be consistent with certain CWA programs, such as water quality standards and effluent guidelines, as well as with other appropriate provisions of state (or tribal) law. States and tribes with TAS can choose to grant a certification with or without conditions, deny certification, or waive. A section 401 certification's conditions must become a term of the license or permit. The estimated timeframe for this permit is 6 months to 1 year.

5.4.1.5 Massachusetts Environmental Policy Act (MEPA) Approval

MEPA requires that State Agencies study the environmental consequences of their actions and that they take all feasible measures to avoid or minimize and mitigate damage to the environment, as defined by the MEPA regulations. MEPA review is not a permitting process and does not result in the substantive approval or denial of a project. MEPA does not pass judgment on whether a project is environmentally beneficial, or whether a project can or should receive a particular permit. MEPA requires public study, disclosure, and development of feasible mitigation for a proposed project. The estimated timeframe for this permit is 45 to 60 days.

5.4.1.6 NPDES Construction General Permit (CGP)

EPA regulates construction stormwater discharges from construction activities (such as clearing, grading, excavating, stockpiling, etc.) under the NPDES stormwater program. Documenting compliance with the NPDES Construction General Permit (CGP) is required for construction sites that disturb 1 acre or more of land. An NPDES CGP also allows for discharge of non-turbid groundwater or stormwater to Waters of the Commonwealth. A Stormwater Pollution Prevention Plan (SWPPP) addressing stormwater runoff management during construction must be prepared describing erosion and sedimentation controls as well as the method of treatment and ultimate discharge of stormwater and/or uncontaminated groundwater to be used during construction. To document compliance with the CGP, an electronic Notice of Intent (eNOI) must be submitted to the EPA-Region 1 and the SWPPP must be complete by the time the eNOI is submitted. A project-specific permit is not generally issued by EPA. The SWPPP is not reviewed by EPA but must be kept on site in case EPA requests a copy. The Contractor typically documents compliance with the NPDES CGP, prepares the SWPPP, and files the eNOI with EPA at least 14 days prior to the start of construction. A Notice of Termination must be submitted when construction is completed.

5.4.1.7 Coordination with Massachusetts Historical Commission (MHC) and Project Notification Form (PNF) Submittal

The Massachusetts Historical Commission (MHC) is the state agency which functions as the State Historic Preservation Office (SHPO) in Massachusetts and identifies, evaluates, and protects the state's significant cultural resources under Section 106 of the National Historic Preservation Act (NHPA). Compliance with Section 106 and/or M.G.L Chapter 9, Sections 26-27c, as amended by Chapter 254 if the Acts of 1988 (950 CMR 71.00) is also required as part of the USACE permitting review process. A Project Notification Form (PNF) is required to initiate MHC review. The PNF will include: a detailed narrative description of the proposed project; a description of the existing conditions and the nature of any past development of disturbances on the project site, if any; a list of all the federal and state funds, licenses, and permits required for the project; photographs of existing areas to be disturbed; and a USGS project location map and proposed site plan. The estimated timeframe for this permit is 30 days.

5.4.1.8 Project Notification – Conservation Commission

When CIPP lining work is restricted to local streets only with access manholes that will be used to facilitate installation of the liner, only a written project notification to the local Conservation Commission is anticipated to be required for the proposed work. The written project notification is typically provided during the design phase, usually at 60% design.

5.4.1.9 Massachusetts Department of Transportation (MassDOT) State Highway Access Permit

Highway access permits are required when physical work or activities take place within, or impact, the State Highway Right-of-Way or property owned or under the custody and control of MassDOT-Highway. The estimated timeframe for this permit is 6 months to 1 year.

5.4.1.10 MBTA Access Permit

Prior to entering and/or performing any work on or over MBTA property or within the MBTA's Zone of Influence (ZOI), an MBTA license must be obtained. This License Agreement will facilitate a review of the proposed work and will be approved with an order of conditions that may include MBTA design review and construction oversight, dependent upon the nature of the proposed work. The estimated timeframe for this permit is 4 to 6 months.

5.4.2 Direct Impacts

The short-term direct impacts for the collection system upgrades are temporary in nature during construction to maintain sewer services. These impacts include noise, dust, traffic control, and potentially impacts to businesses if significant excavation work or bypass pumping is required as well as mitigation of odors during the rehabilitation of the pipelines when conducting CIPP lining. The long-term direct impacts include increases in service life of the pipeline or structure, reinstating flow capacity, and in some cases increases in system redundancy.

5.4.3 Indirect Impacts

The indirect impacts include the reduction of long-term risk for wastewater entering waterways and other environmentally sensitive areas as well as reduction in operating costs and increasing the ability to better maintain the assets for the long term.

6 DEVELOPMENT AND EVALUATION OF ALTERNATIVES – PUMPING STATIONS

6.1 DEVELOPMENT OF PUMPING STATION ALTERNATIVES

(See also WFMP Task 6)

6.1.1 Identification and Screening of Pumping Station Alternatives

With an existing wastewater collection system in place that must be kept operational, there were limited opportunities to substantial reconfiguration of the pumping stations. Therefore, the only alternatives available are the do nothing alternative with ongoing repairs when systems fail, upgrades to the existing pumping stations, or replacement of the existing pumping stations. In addition, the District has an identified need for new screens with tighter bar spacing to eliminate maintenance and ragging issues associated with non-flushable wipes at the WWTP. The District did not feel that the do-nothing alternative was sustainable and this alternative was not carried forward. The other three approaches are described below.

6.1.1.1 Capital Upgrades and Rehabilitation of Existing Processes and Equipment

Under this alternative, repairs and the replacement of equipment would be made proactively to address aging infrastructure before it fails as part of a capital program and will include the costs for replacing the screens with smaller apertures as well as screening wash presses. Further, the pumping station operation could be optimized during these projects including increases to pumping capacity with wet and drywell configuration/size as well as resizing pumps for energy efficiency. This approach will minimize the risk of unexpected loss of service and limit the time District maintenance staff spends on de-ragging pumps, clarifiers, and other equipment in the wastewater process flow at both the pump stations and the WWTP. The costs for the alternatives assume that all the upgrades would be undertaken as one project at each pump station, although future consideration could be given to dividing the project into smaller pieces if desired and beneficial to District capital financing, operational flexibility, or other drivers. Dividing the project would likely result in higher costs to the District as design, bidding, mobilization, and general conditions costs would be incurred multiple times, as well as complicate overall maintenance of operations and District staff capacity.

6.1.1.2 New Processes, Facilities and Equipment

Under this alternative, the pump or metering station would be replaced in its entirety with a new structure and equipment. With the exception of the Danvers Pump Station, this alternative is not viable for the District's pump and metering stations due to limitations in available land area at the facilities as well as the overall needs of the facilities. All pump stations, with the exception of the Danvers Pump Station, have adequate capacity for the projected flow increases over the project planning period. As a result, full replacement was only considered for the Danvers Pump Station due to the availability of land at the existing site, future flooding concerns at the existing building, and hydraulic limitations that exist within the existing station that are not feasible to remedy with a capital upgrade project of the existing infrastructure.

6.1.1.3 Raw Wastewater Screening Discussion

Raw wastewater screening or grinding (in the case of Marblehead Pump Station) was included in the offsite stations to reduce the amount of rags and other debris that would otherwise damage downstream equipment. This equipment was included in the original pump station design to reduce the clogging of pumping equipment, reduce wear and tear on the equipment at the WWTP and reduce operations and maintenance costs. Screen sizes are classified as coarse screens (apertures greater than 1/4-inch) and fine screens (apertures less than 1/4-inch). Coarse screens are typically installed at traditional activated sludge plants, with fine screens being installed at facilities with tertiary processes to protect critical downstream equipment. However fine screens are being retrofitted into most treatment plants and replacing coarse screens. The Beverly Pump Station has two mechanically cleaned bar screens; the older screen has a 1-inch bar spacing and the newer mechanically cleaned screen has a 3/8-inch bar spacing. The Danvers Pump Station and Peabody/Salem Influent Pump Station have mechanically cleaned screens with 1-inch bar spacing. The Salem Neck Pump Station does not have any screens or grinders. The Marblehead Pump Station has grinders with 1/2-inch apertures. In the case of Marblehead Pumping Station, a new type of screening technology would be required to replace the existing comminutors and eliminate rags reforming after the grinders. Based on feedback from the District, considerable maintenance effort is expended to address the ragging of process pumps and other unit processes at the treatment plant and pump stations.

Based on current industry guidelines and AECOM design recommendations, the largest screen aperture that would be recommended for a headworks facility or final screening step prior to a treatment facility (such as the Beverly and Peabody/Salem Influent Pump Stations) would be 3/8-inch (10 mm). For facilities such as the Danvers Pump Station which is screened again at the Beverly Pump Station prior to entering the treatment process, a maximum screen aperture of 1/2-inch (13 mm) is recommended. As part of concept design, the final screen aperture would be selected based on typical design criteria for coarse screen installation, including physical location, approach velocity, submergence, clear openings, head loss, screenings conveyance, cleaning and compaction, screenings disposal, and control strategies. These detailed calculations will be conducted as part of conceptual and final design.

For the purposes of this alternatives evaluation, the incremental capital cost increase associated with reduced screen bar spacing is not a significant cost given the magnitude of the capital costs being included in the overall capital improvement program. This alternatives evaluation will include the costs for replacing the existing larger coarse screens with smaller 3/8-inch aperture mechanically cleaned screens and will include screenings washing and compaction to minimize screenings odors and disposal costs. The goal of the new screens is to reduce the wear and tear on downstream equipment, reduce pump ragging, and reduce maintenance labor costs.

6.1.2 Other Alternatives Considered

6.1.2.1 Optimization of Existing Facilities

Since the District does not own the collection system or local pumping stations there are limited opportunities to substantially modify the District's interceptor sewers, force mains and siphons within a member community in order to better optimize the system. Further, the system is already

reasonable optimized since SSO's are rare within the Districts conveyance system and the procedures for maximizing wet weather flow to the Districts pumping stations and WWTP are well known. Operations staff follow Standard Operating Procedures (SOPs) when heavy rain events occur.

Given that the pump stations will remain largely in their same location and with similar capacity, there are opportunities to optimize the pump station systems. As noted above, installation of tighter bar racks will optimize the screening removal and better protect the pumps. The pumping sizing and configuration of each facility will be reassessed during the design phase to look for increased pumping facility, although two of the three stations already have jockey pumps so a significant increase in efficiency is not expected. The District's three larger remote pump stations are already equipped with VFDs and recently replaced level control systems. Additional consideration will be given to increase insulation, ventilation, heating, and cooling systems during the upgrades to optimize space conditioning and protect the equipment.

6.1.2.2 Regional Solutions

The District was formed in 1925 as a regional wastewater utility. Since the District is already a regional wastewater facility this is not applicable.

6.1.2.3 Alternative Technologies

There are three (3) unit processes completed at the pumping stations including raw wastewater screening and disposal, pumping and odor control. The configuration of the wet and drywells may be considered with a major pump station capacity expansion. Therefore, alternative technology is likely limited to the raw wastewater screening and disposal unit process and potentially odor control system upgrades. The type of raw wastewater pumping equipment would likely be based on centrifugal pumps. The replacement of screens in kind is problematic due to the ragging of pumps and downstream equipment. In the case of Marblehead Pumping Station, a new type of screening technology would be required to replace the existing comminutors and eliminate rags reforming after the grinders. The selection of odor control upgrades would likely include replacement in kind of the carbon and fan system since there is typically not a significant amount of hydrogen sulfide generated at the remote pumping stations.

6.2 EVALUATION OF PUMPING STATION ALTERNATIVES

6.2.1 Peabody/Salem Influent Pumping Station

The WFMP Pump Station Evaluation Report (Task 2) recommended several improvements be considered at the Peabody/Salem Pump Station based on the condition assessment.

Cost estimates have been developed for the overall capital upgrade of upgrading the facility as a comprehensive project. The construction of a new facility is not viable for the Peabody Salem Influent Pump Station, so this cost has also not been evaluated.

An opinion of the probable cost for the rehabilitation of this pump station has been developed based on the recommendations noted in Table 3.1 above. This cost is presented in Table 22 below (WFMP Task 6, Table 3.2).

Table 22: Peabody/Salem Influent Pump Station Opinion of Cost

Rehabilitation Element	Estimated Cost
Site	$193,000
Architectural & Structural	$711,000
Process Mechanical	$7,496,000
HVAC	$577,000
Plumbing	$28,000
Electrical	$4,370,000
Controls	$70,000
Estimated Construction Cost	*$13,450,000*
Construction Contingency/Engineering Allowance (40%)	$5,380,000
Rounded TOTAL	**$18,900,000**

6.2.2 Beverly Pump Station

The WFMP Pump Station Evaluation Report recommended several improvements be considered at the Beverly Pump Station based on the condition assessment. The alternatives proposed for this pump station are to 1) continue to maintain the existing pump station in its current condition without implementing any significant planned capital improvements or upgrades or 2) replace and rehabilitate the pump station components that were identified to be in poor and/or fair condition.

As depicted in WFMP Task 6, Table 1.1, the Beverly Pump Station has adequate capacity in its current configuration to provide reliable service to the District over the project planning period. As a result, the overall drivers for the upgrade of the Beverly Pump Station are asset condition/age and existing screen aperture. As described in the WFMP Task 6, Section 2.2 of this report, reducing the overall screen aperture at the District's pump stations is a priority due to the amount of effort operations and maintenance staff spend addressing ragging of downstream equipment.

Table 23 below (WFMP Task 6, Table 4.1) summarizes the actions required to upgrade the pump station under Alternatives 1 and 2 based on the asset condition assessment completed in WFMP Task 2. Additional details regarding certain critical systems and recommended upgrades are further described below.

- The existing low voltage electrical distribution equipment is nearing the end of its useful life and the ability to locate spare parts will become increasingly challenging over the project planning period.
- One of the two existing mechanical screens was replaced as part of a recent upgrade. It is recommended that the remaining screen with 1-inch spacing be retrofitted with a screen with a smaller aperture to improve solids capture and reduce ragging impacts to downstream equipment.
- The existing sewage pumps are approximately 30 years old and should be considered for replacement as part of a facility upgrade.
- Construction of a perimeter flood protection barrier as described in the *Vulnerability Assessment and Feasibility Study* prepared by Tetra Tech dated June 30, 2021.

- Replacement of the existing chain-link fence with a new architectural fence that is more aesthetically appealing is recommended.

Table 23: Beverly Pump Station Upgrades

Area	Summary	Action Item
Site	Chain-Link Fence	Replace with Architectural Fence
	Asphalt Pavement	Repair/Replace
Resiliency	Resiliency Upgrade	Install Perimeter Flood Wall
Architectural & Structural	Stone Cornice, Brick Mortar, Joint Sealant	Repair/Repoint/Replace
	Downspout	Replace
	Window Frames and Louvers, Interior Doors and Hardware	Replace
	Exterior Metal Doors Sill Trim	Replace
	Interior Ceiling and Wall Paint and Floor Coating	Repaint/Recoat
	Wet Side Concrete Floor, Channels, and Wet Wells	Recoat
	Painted Steel Stairs and Railings	Recoat
	Loading Dock and Roll-off Retaining Walls	Repair Concrete Coating
	Pump Gallery Ships Ladder	Replace with a New Ships Ladder
	Roll-up Door	Replace
	Aluminum Railings and Concrete Stairs	Replace
	Roof System	No Action
	Timber Roof Framing and Metal Trusses	No Action
Process Mechanical & Odor Control	Wet Well No. 1 Cast Influent Slide Gate	Replace
	Wet Well No. 2 Influent Gate into Wet Well No. 3	Rehabilitate
	Influent Gate into Wet Well No. 3	Rehabilitate
	Wet Well No. 1 (IDI Climber Screen)	Replace with smaller aperture screen
	Wet Well No. 2 (Manual Bar Rack)	No Action
	Wet Well No.3 (Vulcan Screen and Wash Press)	No Action
	Raw Wastewater Pumps	Replace/Rehabilitate
	Piping, Supports, and Valves	Replace/Rehabilitate
	Odor Control System	Replace
HVAC	Furnace, Ductwork, and Appurtenances	Replace
	Electric Cabinet Heaters and Rooftop Fans	Replace
	Air Conditioning	Provide New
	Exterior Generator Exhaust Pipe	Clean/Repair
Plumbing	Cold Water Service	Replace/Rehabilitate
	Washdown Station	Provide New
	Sump Pump	Replace/Rehabilitate

Area	Summary	Action Item
	Plumbing Vent System	Upgrade
Electrical	Main Distribution Equipment (MCCs, Utility Transformer, Pump Drives)	Replace
	Standby Diesel Generator and ATS	Replace
	Fire Alarm System	Replace
	Emergency Lighting and Station Lighting System	Replace
	Receptacles and Hand Switches	Replace
	Exit Signs	Replace
Controls	Venturi Flow Meter	Replace
	Cold Water Service Meter & Master Reduced-Pressure Principle BFP	Replace
	Gas Monitoring System	No Action
	PLCs	Replace

6.2.2.1 Beverly Pumping Station Opinion of Probable Cost

As described in WFMP Task 6, Section 4, costs have been developed for the overall capital upgrade of the facility as a comprehensive project. The construction of a new facility is not viable for the Beverly Pump Station so this cost has not been evaluated.

An opinion of the probable cost for the rehabilitation of this pump station has been developed based on the recommendations noted in Table 23 above. This cost is presented in Table 24 below.

Table 24: Beverly Pump Station Opinion of Cost

Rehabilitation Element	Estimated Cost
Site	$189,000
Resiliency	$8,060,000
Architectural & Structural	$254,000
Process Mechanical & Odor Control	$5,856,000
HVAC	$201,000
Plumbing	$40,000
Electrical	$3,872,000
Controls	$183,000
Estimated Construction Cost	*$18,660,000*
Construction Contingency/Engineering Allowance (40%)	$7,460,000
Rounded TOTAL	**$26,200,000**

6.2.3 Danvers Pump Station

The Danvers Pump Station was originally constructed in the 1920s and is in fair condition based on its age and time since its last upgrade. However, this facility has several constraints, including insufficient standby pumping capacity for high flows, several building code-related challenges (including access and egress limitations), and operational and maintenance challenges.

Additionally, it is located below the current 100-year floodplain and is near the limits of the Level 2 Massachusetts Coast Flood Risk Model (MC-FRM) design flood elevations. The WFMP Task 2 Pump Station Evaluation Report recommended several improvements to be considered at the Danvers Pump Station based on the results of the condition assessment.

In 2014, CDM Smith prepared a Technical Memorandum regarding the Danvers Pump Station. In the Technical Memorandum, they concluded that the pump station was too small to serve the long-term needs of the District and planning should begin to plan for its replacement. AECOM has reviewed the Technical Memorandum and agrees with the findings of the study. Based on the recommendations provided in the 2014 CDM Smith memorandum, the full replacement of the station to increase its capacity and to allow the facility to continue providing reliable service to the Town of Danvers and the upstream state institutions that it serves should be considered. As a result, the analysis completed under this project focused on the full replacement of the Danvers Pump Station with a new pump station better suited to the long-term needs of the District and the Town of Danvers. A conceptual site plan for this replacement is shown in Figure 5. A rehabilitation alternative was not considered for the Danvers Pump Station due to the findings of the 2014 memorandum which indicates that the station in its existing configuration lacks adequate redundancy and capacity to align with current recommended guidelines for wastewater facilities and has access limitations for operations and maintenance staff.

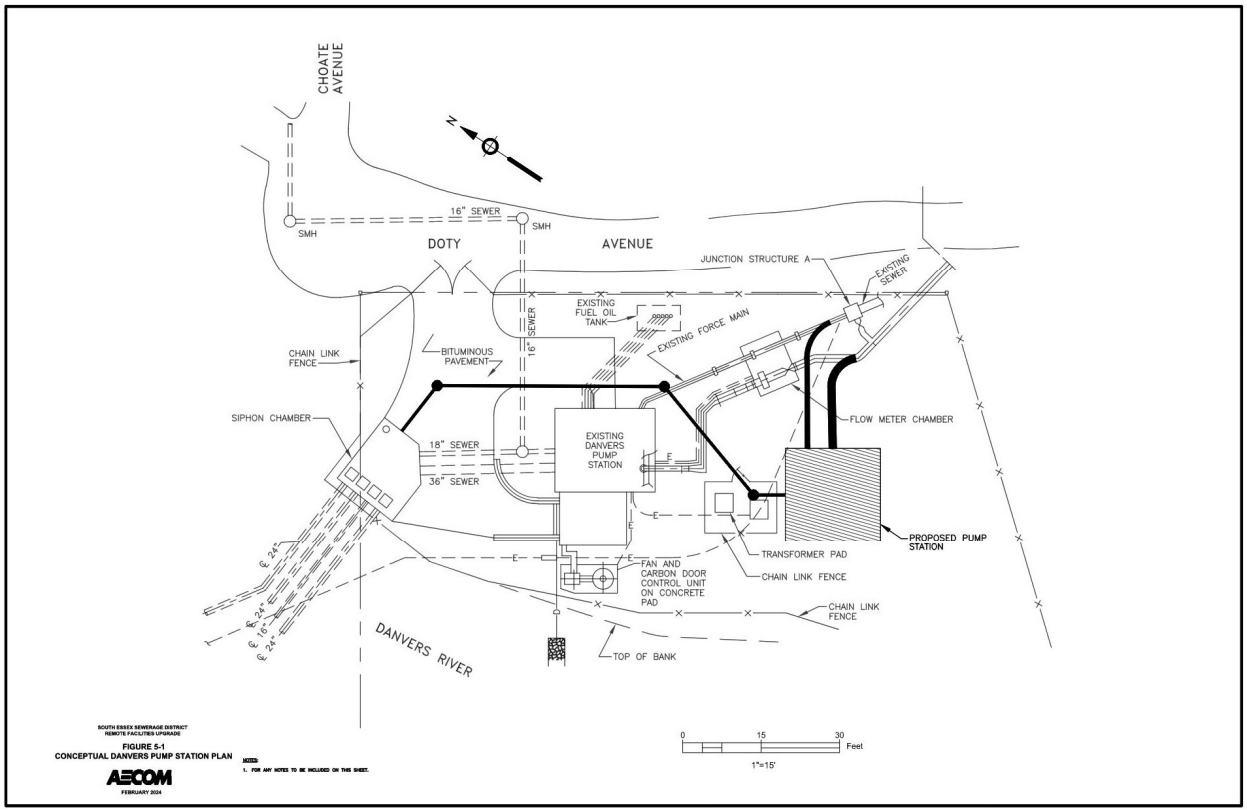


Figure 5: Conceptual Danvers Pump Station Plan

6.2.3.1 Danvers Pump Station Opinion of Probable Cost

As described in WFMP Task 6, Section 5, it is recommended that the Danvers Pump Station be replaced in its entirety to address the access and capacity limitations that exist at the facility. As a result of this recommendation, the cost for a replacement pump station has been developed as part of this report. The feasibility of upgrading the pump station in its existing configuration was determined to not be viable. As such, no cost was developed for deferring the upgrade of the station as part of a maintenance-based approach.

An opinion of cost for the pump station replacement is presented in Table 25 below (WFMP Task 6, Table 5.1).

Table 25: Danvers Pump Station Opinion of Cost

Rehabilitation Element	**Estimated Cost**
Site	$696,000
Architectural & Structural	$6,390,000
Process Mechanical & Odor Control	$5,964,000
HVAC	$119,000
Plumbing	$62,000
Electrical	$2,346,000
Controls	$1,174,000
Estimated Construction Cost	*$16,760,000*
Construction Contingency/Engineering Allowance (40%)	$6,700,000
Rounded TOTAL	**$23,500,000**

6.2.4 Marblehead Pump Station

The Marblehead Pump Station was constructed in 1977 and is located directly adjacent to Devereaux Beach and the Atlantic Ocean. The Pump Station Evaluation Report recommended several improvements to be considered at the Marblehead Pump Station based on condition assessments by AECOM's architects and engineers. The alternatives proposed for this pump station are to 1) continue to maintain the existing pump station in its current condition without implementing any significant planned changes or upgrades, 2) replace and rehabilitate the pump station components that were identified to be in poor and/or fair condition including replacing the existing channel grinders in kind, or 3) replace and rehabilitate the pump station components that were identified to be in poor and/or fair condition and replacing the existing channel grinders with screens.

As depicted in Table 39 below, WFMP, Task 6 Table 1.1, the Marblehead Pump Station has adequate capacity in its current configuration to provide reliable service to the District over the project planning period. As a result, the overall drivers for the upgrade of the Marblehead Pump Station are in an asset condition/age and the replacement of the existing grinders is recommended. As described in WFMP Task 6, Section 6 of the report, reducing the overall screen aperture at the District's pump stations with screens is a priority due to the amount of effort operations and maintenance staff spend addressing ragging of downstream equipment. As the Marblehead Pump

Station has grinders, the alternative was developed to replace the existing channel grinders with mechanical screens to reduce the ragging of downstream equipment, reducing the required maintenance of downstream processes. The alternative of replacing the existing channel grinders in kind was developed for comparison as the cost to replace the grinders in kind is less than replacing them with screens due to higher equipment costs and structural modifications required for the channels to accommodate screens.

Table 26 (WFMP Task 6, Table 6.1) below summarizes the recommended upgrades at the Marblehead Pump Station based on the condition assessment and overall process needs. Additional details regarding certain critical systems and recommended upgrades are further described below.

- The existing low voltage electrical distribution equipment is nearing the end of its useful life and the ability to locate spare parts will become increasingly challenging over the project planning period.
- Consider replacement of the existing channel grinders with a mechanically cleaned screen(s).
- The existing sewage pumps are approximately 30 years old and should be considered for replacement as part of a facility upgrade.
- Continued evaluation of anticipated future flood levels at the pump station based on current Federal Emergency Management Agency (FEMA) flood elevations and future flooding predictions as predicated by the MC-FRM.

Table 26: Marblehead Pump Station Upgrades

Area	Summary	Action Item
Site	Transformer Wooden Fence	Replace
	Asphalt Pavement	No Action
	Perimeter Fencing	Provide New[1]
Architectural & Structural	Interior Glazed Masonry Walls	No Action
	Generator Room Entrance Door and Louver Intel Coating	Clean/Repair
	Doors, Louvers, and Windows Sealant	Replace
	Basement Wall Paint and Elastomeric Floor Coating	Recoat
	All Exterior Doors and Hardware	Replace
	Aluminum Stairs and Railings	No Action
	Single Entry Doors	Add Guardrail
	Wallboard and Base Surround of the Duct Chase	Replace
	Concrete Apron and Loading Dock Slab	No Action
	Roof System (Asphalt Roof Shingles and Underlayment)	Replace
	Metal Roof Soffit Fascia	Replace
Process Mechanical & Odor Control	Monorail	No Action
	Channel Grinders	Replace in Kind or Replace with Smaller Aperture Screens
	Main Influent Gate	Replace

Area	Summary	Action Item
	Slide Gates	Replace
	Raw Wastewater Pumps	Replace
	Piping, Supports, and Valves	Replace
	Odor Control System	Replace
HVAC	Hot Water Boiler and Appurtenances	No Action
	Hot Water Heating Unit Ventilator	Replace
	Louver System	No Action
	Ductwork and Fans	No Action
	Generator's Room HVAC Controls	Upgrade
	Dampers	Replace
	Generator Exterior Exhaust Pipe	Clean/Repaint
Plumbing	Cold Water Service	Replace Lavatory Service Valve
	Process Space Cold Water Supply	No Action
	Floor Drains	Clean
	Sump Pumps and Gutter Drains	No Action
	Water Closet and Fixtures	No Action
Electrical	Main Distribution Equipment (MCCs, Utility Transformer, Pump Drives)	Replace
	Natural Gas Generator and ATS	Replace
	Fire Alarm System	No Action
	Emergency Lighting and Station Lighting System	Replace
	Receptacles and Hand Switches	Replace
	Exit Signs	Replace
Controls	Level Transducers and Venturi Flow Meter	Replace
	Wet Well Vacuum Truck Connection	Replace
	PLCs	Replace

(1) Perimeter fencing does not currently exist and installing/providing perimeter fencing is recommended.

6.2.4.1 Opinion of Probable Cost

As described WFMP Task 6, Section 6, costs have been developed for the overall capital upgrade of the facility as a comprehensive project. The construction of a new facility is not viable for the Marblehead Pump Station so this cost has not been evaluated.

An opinion of probable cost for the rehabilitation of this pump station for both the alternative of replacing the channel grinders in kind and replacing the channel grinders with screens has been developed based on the recommendations noted in Table 26 (WFMP Table 6.1) above. The opinion of cost presented in Table 27, (WFMP Table 6.2) below is based on 2024 pricing for ease of comparison between pump station and wastewater treatment plant alternatives.

Table 27: Marblehead Pump Station Opinion of Cost

Rehabilitation Elements	Estimated Cost (Rehabilitation – Grinders)	Estimated Cost (Rehabilitation – Screens)
Site	$115,000	$115,000
Architectural & Structural	$137,000	$166,000
Process Mechanical & Odor Control	$3,578,000	$4,915,000
HVAC	$58,000	$58,000
Plumbing	$15,000	$15,000
Electrical	$3,297,000	$3,297,000
Controls	$140,000	$140,000
Estimated Construction Cost	*$7,370,000*	*$8,710,000*
Construction Contingency/Engineering Allowance (40%)	$2,950,000	$3,480,000
Rounded TOTAL	**$10,400,000**	**$12,200,000**

AECOM recommends installing fine screens as an alternative to grinders as it addresses ragging issues and enhances downstream treatment processes by effectively removing smaller particles and preventing the accumulation of ragging materials that often clog and disrupt grinder systems.

6.2.5 Peabody Metering Station

The Pump Station Evaluation Report prepared under WFMP Task 6 recommended a number of improvements be considered at the Peabody Metering Station based on condition assessments completed by AECOM's technical staff. As described in the WFMP Task 2, Section 2, the alternatives considered are to 1) continue to maintain the existing metering station in its current condition without implementing any significant planned changes or upgrades or 2) replace and rehabilitate the metering station components that were identified to be in poor and/or fair condition.

The Peabody Metering Station is a small facility with limited mechanical electrical and mechanical equipment.

Table 28 (WFMP Task 6, Table 7.1) below summarizes the recommended upgrades at the Peabody Metering Station based on the condition assessment and overall process needs. Additional details regarding the replacement and/or upgrade of critical systems are further described below.

- The existing low voltage electrical distribution equipment is nearing the end of its useful life and the ability to locate spare parts will become increasingly challenging over the project planning period.
- Increase the curb height for existing fans, hatches, etc. that enter the below grade structure and add stop log barriers at the main structure entrance to protect from future risk of flood water ingress from the adjacent North River.

- Improved site access for District operations and maintenance staff, including revised access drive and fencing to allow for vehicles to be located off the paved roadway prior to exiting from vehicles.

Table 28: Peabody Metering Station Upgrades

Area	Summary	Action Item
Site	Exterior Concrete Slab	Repair/Crack Injection
	Raising Concrete Curb	Raise/Recoat
	Fencing	Replace
Resiliency	Stackable Flood Barrier Stop Logs	Install
Architectural & Structural	Interior Dry Walls	Clean/Patch/Repair
	Interior Door and Hardware	Replace
	Basement Interior Walls Paint	Recoat
	Exterior Sealant Joint	Repair/Replace
	Exterior Door and Hardware	Replace
	Steel Stairs and Railings	Coat
	Elastomeric Floor Coating	Recoat
	Foundation Walls and Slab	Recoat
	Louver Frame and Sill	Clean/Repair
	Pre-cast Concrete Roof	No Action
	Roof System	Replace
Process Mechanical	Piping, Supports, and Valves	No Action
HVAC	Electric Unit Heaters and Fans	No Action
	Ductwork	No Action
Plumbing	Cold Water Service	No Action
	Electric Water Heater	No Action
	Janitor's Sink	No Action
	Utility Room Floor Drain	Clean
	Sump Pumps	No Action
Electrical	All Fixtures	No Action
	Emergency Lighting and Station Lighting System	No Action
	Receptacles and Hand Switches	Replace
	Panelboards	Replace
	Exit Signs	No Action
Controls	Magnetic Flow Meter	Replace
	PLCs	Replace

6.2.5.1 Opinion of Probable Cost

As described in WFMP Task 6, Section 7, costs have been developed for the overall capital upgrade of the facility as a comprehensive project. The construction of a new facility is not viable for the Peabody Metering Station so this cost has not been evaluated.

An opinion of the probable cost for the rehabilitation of this metering station has been developed based on the recommendations noted in Table 41, (WFMP Task 6, Table 7.1) above. This cost is presented in Table 29 (WFMP Task 6, Table 7.2) below.

Table 29: Peabody Metering Station Opinion of Cost

Rehabilitation Element	**Estimated Cost**
Site	$407,000
Resiliency	$44,000
Architectural & Structural	$243,000
Plumbing	$2,000
Electrical	$95,000
Controls	$111,000
Estimated Construction Cost	**$910,000**
Construction Contingency/Engineering Allowance (40%)	$360,000
Rounded TOTAL	**$1,300,000**

6.2.6 Beverly Metering Station

The existing Beverly Metering Station is located on the grounds of the SESD WWTP. This structure houses the flow meter transmitter and raw wastewater sampling equipment serving the force main from the Beverly Pump Station, as well as an air release that serves the WWTP effluent outfall pipe. This is a small facility with limited mechanical and electrical equipment. The Pump Station Evaluation Report recommended a number of improvements to be considered at the Beverly Metering Station based on condition assessments by AECOM's architects and engineers. The alternatives proposed for this pump station are to 1) continue to maintain the existing pump station in its current condition without implementing any significant planned changes or upgrades or 2) replace and rehabilitate the pump station components that were identified to be in poor and/or fair condition.

Table 30 (WFMP Task 6, Table 8.1) below summarizes the recommended upgrades at the Beverly Metering Station based on the condition assessment and overall process needs. Additional details regarding the replacement and/or upgrade of critical systems are further described below.

- The existing low voltage electrical distribution equipment is nearing the end of its useful life and the ability to locate spare parts will become increasingly challenging.
- Repair of existing building superstructure, including roof and exterior brick façade.

Table 30: Beverly Metering Station Upgrades

Area	Summary	Action Item
Site	Drainage System	Regrade
Architectural & Structural	Brick Veneer	No Action
	Interior Walls Coating	Recoat
	Pre-cast Concrete Roof	No Action
	Roof System	Replace
Process Mechanical	Piping, Supports, and Valves	No Action
	Effluent Outfall Air Release	No Action
HVAC	Electric Unit Heaters and Fans	No Action
Electrical	Interior Lighting	Replace
	Receptacles and Hand Switches	Replace
	Panelboards, Dry-Type Transformer	Replace
Controls	Magnetic Flow Meter Transmitter	Replace[1]
	Automatic Sampler	No Action

(1) Critical equipment approaching the end of useful life

6.2.6.1 Opinion of Probable Cost

As described in WFMP Task 6, Section 8, costs have been developed for the overall capital upgrade of the facility as a comprehensive project. The construction of a new facility is not viable for the Beverly Metering Station, so this cost has not been evaluated.

An opinion of the probable cost for the rehabilitation of this metering station has been developed based on the recommendations noted in Table 30 above. This cost is presented in Table 31 (WFMP Task 6 Table 8.2) below.

Table 31: Beverly Metering Station Opinion of Cost

Rehabilitation Element	Estimated Cost
Architectural & Structural	$86,000
Electrical	$62,000
Controls	$61,000
Estimated Construction Cost	**$210,000**
Construction Contingency/Engineering Allowance (40%)	$84,000
Rounded TOTAL	**$300,000**

6.2.7 Salem Neck Pump Station

The Salem Neck Pump Station is responsible for pumping wastewater flow from the Salem Willows as well as wastewater generated on the WWTP site. The wastewater is pumped from the wet well to the Beverly force main which discharges into the influent channel of the grit chambers. The Pump Station Evaluation Report recommended several improvements be considered at the Salem Neck

Pump Station based on condition assessments by AECOM's technical staff. The alternatives proposed for this pump station are to 1) continue to maintain the existing pump station in its current condition without implementing any significant planned changes or upgrades or 2) replace and rehabilitate the pump station components that were identified to be in poor and/or fair condition.

Table 32 (WFMP Task 6, Table 9.1) below summarizes the recommended upgrades at the Salem Neck Station based on the condition assessment and overall process needs. Additional details regarding the replacement and/or upgrade of critical systems are further described below.

- The existing low voltage electrical distribution equipment is nearing the end of its useful life and the ability to locate spare parts will become increasingly challenging.
- The Salem Neck Odor Control Facility associated with the Salem Neck Pump Station is in need of replacement. This odor control system cost and further discussion is included as a part of the WWTP Alternatives Analysis completed under WFMP Task 7 of this project.
- Repair of existing cracks and groundwater infiltration at the lower-level pump room.

Table 32: Salem Neck Pump Station Upgrades

Area	Summary	Action Item
Architectural & Structural	Interior Stair Wall Coating	Crack Inject
	Interior Doors and Hardware	Replace
	Concrete Stairs and Aluminum Railings	No Action
	Basement Foundation Wall	Patch
	Pre-cast Concrete Roof	No Action
	Roof System	Replace
Process Mechanical	Raw Wastewater Pumps	Replace
	Influent Gate	Replace
	Monorail	No Action
	Piping, Supports, and Valves	Replace
HVAC	Electric Unit Heaters and Fans	Replace
	Ductwork	No Action
Plumbing	Non-Metered and Non-Potable Protected Cold Water Service	No Action
	Sump Pumps	No Action
Electrical	Main Distribution Equipment (MCCs, Controllers, etc.)	Replace
	Fire Alarm System	No Action
	Emergency Lighting and Station Lighting System	No Action
	Receptacles and Hand Switches	No Action
	Exit Signs	No Action
Controls	Gas Monitoring System	Replace
	Ultrasonic Level Transducer	Replace
	PLCs	Replace

6.2.7.1 Opinion of Probable Cost

As described in WFMP Task 6, Section 9, costs have been developed for the overall capital upgrade of the facility as a comprehensive project. The construction of a new facility is not viable for the Salem Neck Pump Station so this cost has not been evaluated.

An opinion of probable cost for the rehabilitation of this pump station has been developed based on the recommendations noted in Table 32 above. This cost is presented in Table 33 (WFMP Task 6, Table 9.2) below.

Table 33: Salem Neck Pump Station Opinion of Cost

Rehabilitation Element	**Estimated Cost**
Architectural & Structural	$174,000
Process Mechanical	$775,000
HVAC	$16,000
Electrical	$424,000
Controls	$224,000
Estimated Construction Cost	**$1,620,000**
Construction Contingency/Engineering Allowance (40%)	$650,000
Rounded TOTAL	**$2,300,000**

6.3 CONCLUSIONS AND RECOMMENDED UPGRADES FOR PUMPING STATIONS

6.3.1 Summary of Recommended Improvements

In summary, the majority of the District's wastewater pump and metering stations are in need of comprehensive upgrades. These facilities were last upgraded as part of an overall capital program in the mid to late 1990s with the facilities and equipment showing their age even with the District's robust maintenance program. This section summarizes the overall recommendations for upgrades at the District's wastewater pump and metering stations and develops an overall cost in current dollars for upgrade of the subject facilities.

6.3.1.1 Peabody/Salem Influent Pump Station

As described in WFMP Task 6 Section 10, the Peabody/Salem Influent Pump Station is located on the site of the WWTP. Raw wastewater from the cities of Peabody and Salem flow by gravity to this station where it is then lifted into the aerated grit chambers. Major components suggested for upgrade at the facility include replacement of the low voltage electrical distribution equipment, restoration of the concrete in the lower-level screening room, replacement of the three mechanically cleaned screens with smaller aperture screens, upgrade of the HVAC system, pipe and surface coating work, and replacement of the roofing system.

6.3.1.2 Beverly Pump Station

As described in WFMP Task 6, Section 10, the Beverly Pump Station conveys flow from the cities of Beverly and Danvers to the District's WWTP. The Beverly Pump Station was more recently retrofitted with a single new screen, upgraded control systems. Major components recommended for upgrade at the Beverly Pump Station include replacement of the other mechanically cleaned screen with a smaller aperture screen, upgrade of the HVAC system, replacement of the low voltage electrical distribution equipment, and construction of a perimeter flood wall/barrier.

6.3.1.3 Danvers Pump Station

As described in WFMP Task 6, Section 10, the Danvers Pump Station has several limitations that result in a recommendation to replace the station in its entirety. The main drivers for this recommendation are the availability of land area on the existing site, the future flood risk of the existing facility, the lack of redundancy with one of the largest pumps out of service (i.e. firm capacity), and the limitations for operations and maintenance access to the lower level pumping equipment.

6.3.1.4 Marblehead Pump Station

As described in WFMP Task 6, Section 10, the Marblehead Pump Station is in need of upgrades to address the long term goals of the District. One of the main drivers for upgrade of the Marblehead Pump Station is the replacement of the existing channel grinders with a mechanically cleaned screen. Other recommended upgrades include the replacement of the low voltage electrical distribution equipment, addition of flood protection barriers at the exterior doors and replacement of the existing shingled roof.

6.3.1.5 Peabody Metering Station

As described in WFMP Task 6, Section 10, the Peabody Metering Station has limited mechanical and electrical components. The District does not consider this facility a critical facility for operations as it is used as a means for apportioning flow from the City of Peabody prior to the first connection of flow from Salem. Recommended upgrades to the Peabody metering station include the replacement of the magnetic flow meter and raising exterior curbs and adding stop log barriers to prevent the risk of flooding from the adjacent North River and improvements in site access to improve safety for District operations staff when arriving at the facility.

6.3.1.6 Beverly Metering Station

As described in WFMP Task 6, Section 10, the Beverly Metering Station is a small single room facility with limited components, including an automatic sampler, sample pump and air release valve for the effluent force main. Major components recommended for upgrade include replacement of the low voltage electrical distribution equipment, replacement of the sampling equipment, replacement of the air release valve, and replacement of the roofing system and repairs to external brickwork.

6.3.1.7 Salem Neck Pump Station

As described in WFMP Task 6, Section 10, the Salem Neck Pump Station conveys flow from the Salem Willows area of Salem, as well as all wastewater flows generated on the WWTP site. Major components in need of upgrade at this facility include the replacement of the low voltage electrical distribution system, replacement of the control system, replacement of the pumps, replacement of the hazardous gas monitoring system, replacement of the roofing system, and the repair of groundwater infiltration located in the lower-level pump room. The station is provided with a single wet well and does not have any screens or grinders to address ragging. Consideration of a screen was not considered particularly viable due to the configuration of the piping entering the wet-well as well as the limited domestic flow that flows to this station.

6.3.2 Recommended Upgrade Approach

As described in WFMP Task 6, Section 2, the two main alternatives considered for the District's wastewater pump and metering stations are the overall comprehensive capital upgrade alternative and maintenance-based approach. Due to the limitations with each of these facilities, the overall replacement of the facilities was not considered a viable alternative for all of the facilities with the exception of the Danvers Pump Station. As a result, it is recommended that the District move forward with planning to implement the pump station rehabilitation projects using the capital-based approach as this is the least costly and most predictable means to address the challenges with the existing facilities. It is estimated that the maintenance-based approach would result in approximately 50% to 75% higher costs to the District over the course of the planning period over the overall comprehensive capital upgrade approach. This comprehensive capital upgrade approach allows the District to proactively plan for capital projects that will be able to be strategically funded through a logical capital improvement program (CIP) without placing undue burden on District engineering, operations, and maintenance staff.

6.3.3 Overall Capital Cost for Recommended Upgrades at Wastewater Pump and Metering Stations

As described in WFMP Task 6, Section 2, capital cost estimates were developed for each of the pump and metering stations. Provided below is an overall total of the work recommended to be implemented at these facilities. It should be noted that these recommended upgrades can most advantageously be implemented under a single capital project for each pump and metering station but could be split out into smaller projects based on District priorities and/or funding availability. The overall recommended CIP will be developed in this manner as part of the later tasks completed under this project. The estimated opinion of the cost of these projects is noted below in Table 34 (WFMP Task 6, Table10.1).

Table 34: Summary of Estimated Opinion of Cost

Description	Estimated Opinion of Cost
Influent Pump Station	$18,900,000
Beverly Pump Station	$26,200,000
Danvers Pump Station	$23,500,000
Marblehead Pump Station	$12,200,000
Peabody Metering Station	$1,300,000
Beverly Metering Station	$300,000
Salem Neck Pump Station	$2,300,000
TOTAL	**$84,700,000**

6.3.4 Present Worth and Cost Effectiveness Analysis for Pumping Station Upgrades

A Present-Worth Analysis for the pumping station alternatives was not conducted since no significant reconfiguration and modification of the pumping stations is required or proposed and each alternative considered for pumping station upgrades will have similar operating costs. Similarly, an Equivalent Uniform Annual Costs value was not prepared. The focus of this evaluation is on capital costs.

The pumping station cost effective analysis considered many factors including risk scores, criticality and site-specific constraints to determine priority, appropriate rehabilitation technology or new construction alternatives where necessary, including capital costs for the upgrades. These factors are all discussed in the Pumping Station evaluation (WFMP Task 2, Table 9, WFMP Task 6, Section 2).

6.4 Environmental Permitting and Other Impacts for Pumping Station Upgrades

6.4.1 Permitting Considerations

Environmental permits and approvals are required whenever proposed work may affect certain environmentally sensitive resources, including waterways such as wetland resource areas, habitats of rare or endangered species, and historical and archaeological sites. The Danvers, Beverly, and Marblehead Pumping Station are the three pumping station upgrades that will likely require environmental permitting.

The applicable local, state, and federal permits that are anticipated to be required are presented in Table 35. Additional local, state, and federal permits may be required based on final design.

Table 35: Pump Station Upgrades Environmental Permitting Summary

Infrastructure	MassDEP Chapter 91 License	US Army Corps of Engineers Section 404/10 Permit	Notice of Intent Conservation Commission	401 Water Quality Certification	Massachusetts Environmental Policy Act (MEPA) Approval	NPDES Construction General Permit (CGP)	Coordination with Massachusetts Historical Commission (MHC) and	Massachusetts Department of Transportation (MassDOT) State Highway Access Permit	MBTA Access Permit
Beverly Pumping Station	X	X	X	X	X	X	X		
Danvers Pumping Station	X	X	X	X	X	X	X		
Marblehead Pumping Station			X			X			

Additional permits may also be required for some projects for Coastal Impacts, Ocean Sanctuary impacts, and Archeological Impacts. These will be assessed on a project-by-project basis. Interbasin Transfer of Flows impacts are not expected since there is no change in the configuration of the sewer system or pumping stations.

6.4.2 Direct Impacts

The impacts related to the Beverly Pump Station upgrades for flooding resiliency will require permits from several federal, state and local agencies to allow the construction of a flood wall as noted above. The permitting requirements could require building code variances from the City to install the wall in close proximately the pump station, Water Street and the beach as well as other local businesses. The foundation design for the wall would impact the surrounding areas and approvals may require changes to the property boundaries or securing temporary construction or permanent easements.

The environmental impacts associated with the relocation of the Danvers Pumping Station within the existing property boundaries in Danvers will likely require building code revisions as well as other mitigating factors to relocate the pump station and wet well on the property closer to the Porter River and adjacent properties.

There may also need to be mitigation related to the impacts associated with the line-of-sight view of the Porter River.

6.4.3 Indirect Impacts

Indirect impacts likely include construction traffic and construction noise but these impacts will be temporary during construction. The design of the new pumping station will include odor control so there should be no indirect impacts due to new odor control facilities at the pumping station.

7 DEVELOPMENT AND EVALUATION OF ALTERNATIVES – WASTEWATER TREATMENT FACILITIES

7.1 DEVELOPMENT OF WASTEWATER TREATMENT ALTERNATIVES

(See also WFMP Task 3 WWTP Evaluation and Task 7 WWTP Process and Equipment Alternatives)

The following section identifies and describes how alternatives were developed for the needed upgrades for wastewater treatment processes and facilities.

7.1.1 Identification and Screening of Wastewater Treatment Plant Upgrades Alternatives

The overall approach to the alternatives to be considered for the wastewater treatment plant site included a no change or status quo alternative and either one or two alternatives for the partial and/or full replacement of the facilities.

To help identify the alternatives to be carried into the detailed alternatives analysis, an alternatives screening exercise was conducted using Blue Ribbon Panels. These Blue-Ribbon panels were workshops where SESD staff and AECOM subject matter experts met to brainstorm, discuss, and vet viable alternatives to identify the most beneficial alternatives to carry forward. Three Blue-Ribbon panels were conducted including one on biological treatment and wet weather capacity, one on residuals dewatering and residuals management, and one on odor control optimization.

The alternatives that were screened for feasibility at the wastewater treatment plant were constrained due to the limitations on available footprint for new treatment processes. The need for new treatment processes or modifications to existing facilities were evaluated to maintain operations during construction and allow access for construction of any new facilities. This includes the feasibility of upgrades to the residuals process, high purity oxygen process, secondary clarification process and chlorine contract. Temporary facilities for staging of residuals operations were considered as necessary to maintain residuals processing flexibility.

Upgrades that were determined to be able to be constructed within existing building footprints or modifications to building footprints were ranked higher than alternatives that required new structures and foundations. Upgrades to major electrical distribution systems, where required, were also considered to maintain operations and proper safety controls during planned system expansion and upgrades.

7.1.2 Other Alternatives Considered

7.1.2.1 Optimization of Existing Facilities

(See also WFMP Task 3 Section 3 and Section 4)

The District's preferred approach to upgrades at the WWTP is focused on optimization of existing facilities. In all cases, this is one of the alternatives considered, and in many cases including residuals dewatering upgrades, we weather secondary treatment capacity, and grit treatment, it is the preferred alternative as it is also the most cost-effective approach.

There are several limitations that are currently in place that preclude further optimization of residuals processing operations and deferral of future processing and disposal costs. The most pressing constraint is cake storage, residuals transportation and disposal due to new PFAS regulations and the mitigation of the generation of potential odors at nighttime during transportation and hauling. The second important limitation is the current belt filter press technology used for dewatering residuals and limits volume reduction to about 23 percent solids.

The District has developed alternatives in the Wastewater Facilities Management Plan to help reduce or mitigate these constraints.

7.1.2.2 Regional Solutions

(WFMP Task 3- Section 4.2 Future Residuals Management Needs and Challenges))

The SESD CWMP did evaluate regional solutions, in particular for wastewater management and disposal. Regional projects are being discussed among regional utilities and progress is ongoing regarding the New England Regional Biosolids (NERB) project, which is focused on the potential of building a regional biosolids processing facility for the solids generated by the Narragansett Bay Commission, Springfield Water and Sewer Commission, and the Upper Blackstone Clean Water Facility. Discussions have not identified an equitable solution among the parties interested. The SESD has expressed interest in maintaining an open conversation regarding the potential opportunities but there has been no further development on a regional solution. Siting constraints and transportation costs for a centralized processing location have affected the progress of the discussions. Regional solutions for the WWTP itself and for the odor control facilities were not considered since SESD is already a regional utility.

7.1.2.3 Other Wastewater Alternatives

The CWMP Guidance suggests a range of wastewater alternatives that should be considered for the service area in addition to the baseline alternatives. The majority of these alternatives are discussed in chapter 8 of this CWMP. However, one alternative not discussed elsewhere is alternative disposal of wastewater including reuse and land application. The District has explored options for reuse, primarily for cooling water at the nearby powerplant. However, this power plant was recently rebuilt and uses air cooled cooling towers. Land application of the district's flow rate of in excess of 25 MGD is not considered to be technically viable given the flow rate and our location in the middle of the City of Salem.

7.1.2.4 Alternative Technologies

(WFMP Task 7- Various Sections)

Alternative technologies were considered for a number of wastewater treatment plant upgrades, including for increasing the wet weather capacity of the WWTP, odor control, and residuals management. The alternative technologies evaluated are described in a process and fatal flaw analysis as a part of the WFMP Task 7, Section 0 and included expert panel evaluations for the liquids, residuals and odor control processes at the wastewater treatment plant. The outcome of those discussions and priorities are described in the life cycle costs and Tables in WFMP Task 7.

7.2 EVALUATION OF WASTEWATER TREATMENT PLANT ALTERNATIVES

(See also WFMP Task 3 and Task 7 Various Sections)

The purpose of this Section is to document the alternatives evaluated and analyzed to address the physical condition and operational challenges identified as part of Task 3 of the WFMP for the District's WWTP. Each alternative and its various components and considerations are evaluated capital and operations and maintenance costs for each alternative are compared, and the recommended alternative is highlighted.

7.2.1 WWTP Hydraulics

A previous study undertaken by the District in 2011 served to develop design level alternatives to increase the hydraulic capacity at the District's WWTP. The modifications recommended by this study were projected to improve the hydraulic profile and improve plant operations at high flows but were not projected to improve the overall hydraulic capacity above the design capacity. None of the alternatives developed in the previous study were implemented as described except for rewinding the high head effluent pump motors.

Alternatives to improve hydraulics in the District's WWTP are included in the alternatives in WFMP Task 7, Section 2.2 and include removing the static mixer, modifications to the Secondary Clarifiers influent piping and hydraulics, and connecting the two independent sides of the grit chambers effluent channel.

7.2.2 Liquid Process

A fatal flaw analysis was developed for the liquid process alternatives to assess potential options available for each process area and eliminate alternatives that are not feasible or provide no benefit over the existing process. Upon completion of the fatal flaw analysis, a Blue-Ribbon panel was hosted with independent subject matter experts from AECOM and the District to further narrow down the feasible alternatives to a maximum of two (2) alternatives per process area to evaluate in more detail. The outcomes of the Blue-Ribbon panel and the evaluation of the identified alternatives are discussed in the following sections.

7.2.2.1 Grit Removal

The District's WWTP currently has four aerated grit chambers to remove grit from the influent wastewater of which three are typically in operation at any given time. Accumulated grit is periodically removed from the chambers manually with a clamshell bucket and stored in the unused grit chamber until it is disposed with solids periodically.

Two alternatives were considered for grit removal: (1) Remove grit from the existing aerated grit chambers with a shaftless screw at the bottom of each chamber, pump the grit as a slurry from a sump at the effluent end of each chamber, and wash the grit in grit washers before conveying the washed and dewatered grit to a dumpster for disposal. (2) Replace the existing clamshell bucket removal system and bridge crane in kind and provide several self-dumping hoppers as a means for storage.

The life cycle cost for the grit screws, pumps, and washers alternative was estimated to be higher than the cost of the replace in kind alternative and is driven by the capital cost of more equipment and building modifications, see Table 36 below (WFMP Task 7, Table 0.1). The grit screws, pumps, and washers alternative, however, is recommended to be carried forward due to the considerable benefits of reduced grit carryover to downstream processes and the ease of operations.

Table 36: Grit Alternatives Life Cycle Costs

Cost Item	Grit Screws, Pumps, and Washers Alternative	Grit Replace in Kind Alternative
Capital	$5,100,000	$2,900,000
20 Year Present Worth O&M	$3,900,000	$3,400,000
20 Year Life Cycle	*$9,000,000*	*$6,300,000*

7.2.2.2 Primary Treatment

The District's WWTP currently has seven rectangular primary clarifiers with a common influent and effluent channel that perform well and are currently in the process of being upgraded.

The only alternative considered for the primary clarifiers was to co-settle waste activated sludge (WAS) with primary sludge in the primary clarifiers to replace mechanical thickening. Due to peak surface overflow rates in the primary clarifiers above the literature recommended rates, the cost for a Chemically Enhanced Primary Treatment (CEPT) process was included in this alternative.

The life cycle cost for the WAS Co-Settling alternative is shown in Table 37 below (WFMP Task 7 Table 0.2). This alternative is compared with the alternative to continue with mechanical thickening in WFMP Task 7, Section 0.2.3.2 of the executive summary.

Table 37: Primary Clarifiers Alternative Life Cycle Costs

Cost Item	WAS Co-Settling Alternative
Capital	$6,400,000
20 Year Present Worth O&M	$2,600,000
20 Year Life Cycle	*$9,000,000*

7.2.2.3 BOD Removal/Oxygen Reactors

The District's WWTP currently has four parallel trains of Oxygen Reactors that operate with high purity oxygen (HPO) provided to the headspace of the reactors and mixer/aerators that transfer the oxygen into the liquid phase. Typically, only two of the four trains are operated at any given time as the Oxygen Reactors have approximately twice the capacity required.

Two alternatives were considered for the Oxygen Reactors: (1) retrofit the existing reactors to operate using an air activated sludge process with air provided by blowers and find bubble diffusers. (2) keep the existing high purity oxygen (HPO) process and make several targeted improvements to the operation and control of the reactors.

The life cycle cost for the BOD removal/Oxygen Reactor alternatives are not a fair comparison because the high purity oxygen alternative does not include the cost of oxygen generation. These costs are compared in WFMP Task 7, Section 0.2.2.5 of the executive summary.

7.2.2.4 Oxygen Generation

The District currently uses a pressure swing adsorption (PSA) system to generate high purity oxygen (HPO) for the Oxygen Reactors. This system is well maintained, is in overall good condition and meets the needs of the treatment process.

The two alternatives considered for oxygen generation were to (1) rehabilitate the existing PSA system or (2) replace the existing PSA system with a new vacuum pressure swing adsorption system (VPSA). Another alternative that was effectively considered was to replace the existing PSA with blowers to provide air per the air activated sludge alternative for the Oxygen Reactors.

The life cycle costs for the VPSA alternative were 2% higher than the alternative to refurbish the PSA, which are effectively equal given the level of project definition, see Table 38, (WFMP Task 7, Table 0.3). The VPSA alternative has a much higher capital cost but a much lower operation and maintenance cost, which is driven by lower energy usage. It is recommended that the VPSA alternative be carried forward for oxygen generation due to its lower energy usage, ability to size the system to the oxygen requirements of the Oxygen Reactors, and the ability to find qualified technicians to service the system in the future. The VPSA and HPO alternative costs are compared to the air activated sludge costs in WFMP Task 7, Section 0.2.2.5 of the executive summary.

Table 38: Oxygen Generation Life Cycle Costs

Cost Item	VPSA Alternative	Refurbish PSA Alternative
Capital	$12,070,000	$4,790,000
20 Year Present Worth O&M	$11,090,000	$17,970,000
20 Year Life Cycle	*$23,160,000*	*$22,760,000*

7.2.2.5 Oxygen Reactors and Oxygen Generation Comparison

The VPSA and HPO alternative costs are compared to the air activated sludge costs here as comparing the costs for the air activated sludge alternative to the HPO alternative does not provide a direct comparison of the costs as the cost for oxygen generation is considered separately for the HPO alternative and the cost for air blowers is included in the air activated sludge alternative.

The total life cycle cost for the HPO and VPSA alternative was determined to be less than 1% lower than the air activated sludge alternative, see Table 39 (WFMP Task 7, Table 0.4). This difference in cost is within the margin of error for this level of estimate, thus these alternatives are effectively equal in terms of life cycle cost. It is recommended that the HPO and VPSA alternative is carried forward over the air activated sludge process as it would require fewer intensive modifications to the Oxygen Reactors and Odor Control Facility C, use less electricity to operate, and avoid any potential challenges with modifying the District's air permit for increased air flow.

Table 39: Oxygen Reactors and Oxygen Generator Life Cycle Costs

Cost Item	Air Activated Sludge	HPO and VPSA
Capital	$18,000,000	$14,600,000
20 Year Present Worth O&M	$27,000,000	$30,100,000
20 Year Life Cycle	$45,000,000	$44,700,000

7.2.2.6 Secondary Solids Separation

The District's WWTP currently has seven stacked rectangular secondary clarifiers for secondary solids separation. The secondary clarifiers are currently hydraulically overloaded at high flows.

Two alternatives were evaluated for secondary solids separation: (1) Install a partial bypass of the secondary clarifiers during wet weather and treat that flow using a sand ballasted flocculation system. (2) Implement a myriad of secondary clarifier improvements and optimizations to improve secondary clarifier performance including using the anaerobic selectors on the Oxygen Reactors, selective wasting/sludge densification, modifications to the baffles and weirs in the secondary clarifiers, upgrades to the scum removal system, and improvements to facilitate monitoring of effluent quality.

The life cycle cost for the secondary solids separation alternatives is shown in Table 40 (WFMP Task 7, Table 0.5). The cost for the secondary clarifier improvements alternative does not include the costs for upgrades to the scum removal system as these improvements are recommended to be implemented with either alternative. The sand ballasted flocculation alternative has the highest probability of success at remedying the challenges that the District has with meeting their effluent TSS permit at high flows, however, the additional capital and O&M cost of this alternative is significant as well as limitations with physically siting the sand ballasted flocculation system within the WWTP site. Additional land may be required for the sand ballasted flocculation alternative and that cost was not included in this analysis.

The secondary clarifier improvements alternative, while more cost effective, will not be provided with a process guarantee like the sand ballasted flocculation alternative and its overall success at remedying the existing operational challenges cannot be guaranteed. It is recommended to implement the components of the secondary clarifier improvements alternative incrementally and assess their effectiveness at improving effluent TSS at high flows. Should improved effluent TSS permit compliance not be achieved with this alternative it may be necessary to consider the sand ballasted flocculation alternative, particularly if a regulatory driver is realized. For the purposes of this facilities plan, the cost of the secondary clarifier improvements alternative is to be included.

Table 40: Secondary Solids Separation Life Cycle Costs

Cost Item	Sand Ballasted Flocculation Alternative	Secondary Clarifier Improvements Alternative
Capital	$25,600,000	$13,100,000
20 Year Present Worth O&M	$8,400,000	$3,100,000
20 Year Life Cycle	*$34,000,000*	*$16,200,000*

7.2.2.7 Disinfection

Currently, effluent from the secondary clarifiers at the District's WWTP flows into a single static mixer and into two serpentine Chlorine Contact Tanks for disinfection.

The alternative considered for disinfection was to optimize and improve the current mixing system for the Chlorine Contact Tanks, including removing the existing static mixer and installing an induction mixer.

The life cycle cost for the disinfection alternative is shown in Table 41 (WFMP Task 7, Table 0.6). It is recommended that the static mixer removal and induction mixer installation alternative be included for implementation in order to improve the hydraulic profile and potentially improve the sodium hypochlorite mixing and effectiveness.

Table 41: Disinfection Alternative Life Cycle Costs

Cost Item	Disinfection Alternative
Capital	$2,500,000
20 Year Present Worth O&M	$700,000
20 Year Life Cycle	*$3,200,000*

7.2.3 Residuals Management and Disposal

A fatal flaw analysis was also developed for the residuals management and disposal alternatives to assess the options available and eliminate alternatives that are not feasible or provide no benefit over the existing infrastructure. A Blue-Ribbon Panel was hosted with subject matter experts and the District to narrow down the feasible alternatives to a maximum of two (2) alternatives to evaluate in more detail. The outcomes of the Blue-Ribbon Panel and the evaluation of the identified alternatives are discussed in the following sections.

7.2.3.1 Thickening

Currently the District thickens waste activated sludge (WAS) using gravity belt thickeners (GBTs). Due to lack of WAS storage, wasting and thickening processes are run concurrently.

The alternatives considered for WAS thickening were to (1) replace the existing GBTs in kind and (2) replace the existing GBTs with rotary drum thickeners (RDTs). Additionally, the alternative to eliminate WAS thickening was considered previously and is compared to the recommended mechanical thickening alternative in WFMP Task 7, Section 0.2.3.2 of the executive summary.

The life cycle cost for the RDT alternative is 3% more than the GBT replace in kind alternative. This difference in cost is within the margin of error for this level of estimate, thus these alternatives are effectively equal in terms of life cycle cost, see Table 42 (WFMP Task 7, Table 0.7). It is recommended that the RDT alternative be included for thickening over the GBT replace in kind alternative. Even though RDTs would include more intensive construction and require the use of liquid polymer, RDTs are an enclosed process that would reduce odors, would not require a dedicated operator during operation, and would enable longer thickening/wasting hours that would improve control of the solids retention time (SRT) in the Oxygen Reactors.

Table 42: Thickening Alternative Life Cycle Costs

Cost Item	GBT Replace in Kind Alternative	RDT Alternative
Capital	$4,000,000	$4,600,000
20 Year Present Worth O&M	$7,800,000	$7,500,000
20 Year Life Cycle	*$11,800,000*	*$12,100,000*

7.2.3.2 WAS Co-Settling and Thickening Comparison

The WAS co-settling alternative for the primary clarifiers and the recommended RDT thickening alternative are compared in this section as they are presented in separate sections but are direct comparisons of cost.

The total life cycle cost of the RDT thickening alternative was determined to be 34% higher than the WAS co-settling alternative, see Table 43 (WFMP Task 7, Table 0.8). The WAS co-settling alternative has some considerable disadvantages, however, including the lower blended sludge concentration produced, the reduced recommended primary clarifier overflow rates that are exceeded during high flows, and the technology falling out of practice in the wastewater industry. These downsides are balanced out by the potential cost savings of the alternative, as well as the simplicity of operations over mechanical thickening. RDTs, on the other hand, are reliable and proven technology that would not disrupt the existing process, though would result in more operator-intensive operations as compared to the co-settling alternative. For the purposes of this analysis, it is recommended that the higher cost of the RDT thickening alternative be included primarily due to the uncertainty in the WAS co-settling alternative. It is also recommended that a demonstration study be performed for WAS co-settling in advance of implementing the RDT thickening alternative to identify potential process disruptions at high flows, if chemically enhanced primary treatment (CEPT) will be required, and to inform design decisions for WAS co-settling. Should the demonstration study indicate that the approach is viable, WAS co-settling could be pursued as a cost saving measure.

Table 43: WAS Co-Settling and Thickening Life Cycle Costs

Cost Item	WAS Co-Settling	Thickening – RDTs
Capital	$6,400,000	$4,600,000
20 Year Present Worth O&M	$2,600,000	$7,500,000
20 Year Life Cycle	*$9,000,000*	*$12,100,000*

7.2.3.3 Dewatering

The District currently has four belt filter presses (BFPs) that dewater blended primary sludge and thickened WAS.

The alternatives considered for dewatering were to replace the existing BFPs in kind or replace the existing BFPs with either screw presses or centrifuges to optimize the percent solids in the dewatered cake.

The life cycle cost of the dewatering alternatives are all relatively close, with the highest cost alternative of rebuilding the BFPs being 5% higher than the lowest cost alternative of centrifuges, see Table 44 (WFMP Task 7, Table 0.9). These life cycle costs are primarily driven by the cost of residuals disposal. Given the lower dewatering performance of BFPs on the sludge at SESD, uncertainty with future cake disposal costs, and more intensive operations, it is recommended that the BFP alternative be removed from consideration. Due to the high sensitivity of the life cycle costs for screw presses and centrifuges on the assumptions made for polymer consumption and cake solids, it is recommended that pilot testing of both technologies is undertaken to reduce the uncertainty of this analysis before making a final decision. Screw presses, however, generally align

better with the District's non-monetary priorities as they consume less energy and are less operator intensive. For the purposes of this analysis, the higher capital cost of centrifuges was carried forward.

Table 44: Dewatering Life Cycle Costs

Cost Item	BFP Rebuild Alternative	Screw Presses Alternative	Centrifuges Alternative
Capital	$6,800,000	$11,900,000	$12,100,000
20 Year Present Worth O&M	$113,900,000	$106,400,000	$101,500,000
20 Year Life Cycle	*$120,700,000*	*$118,300,000*	*$113,600,000*

7.2.3.4 Cake Storage

The District currently has cake storage silos at their WWTP, but these silos are not in use due to operational challenges and the high cost for maintenance. Dewatered sludge is directly loaded into trucks that haul cake for ultimate disposal.

Two alternatives were considered for cake storage: (1) Install new cake storage silos in the Operations Building Truckway No. 2. (2) Build a new cake storage garage adjacent to the Operations Building to enable four trucks and trailers to be dropped and independently loaded with cake. Repurposing of the existing cake and lime silo areas in the Operations Building for a cake storage garage may be viable pending a more detailed structural review of the existing Operations Building addition, though this alternative was not analyzed in detail.

The life cycle cost for the cake silos alternative is 3% more than the cake storage garage alternative. This difference in cost is within the margin of error for this level of estimate, thus these alternatives are effectively equal in terms of life cycle cost, see Table 45 (WFMP Task 7, Table 0.10). The cake silo alternative is recommended to be carried forward as it would provide more storage than the cake storage garage alternative, does not require sludge haulers storing or sequencing trucks and trailers, and provides flexibility for future downstream processes. The cake silo alternative, however, does have the significant disadvantage of the risk of the sludge loadout mechanism failing and requiring challenging and costly hand removal of cake from the silos.

Table 45: Cake Storage Life Cycle Costs

Cost Item	Cake Silo Alternative	Cake Storage Garage Alternative
Capital	$11,000,000	$9,900,000
20 Year Present Worth O&M	$3,400,000	$4,900,000
20 Year Life Cycle	*$14,400,000*	*$14,800,000*

7.2.3.5 Long Term Residuals Options

The long-term residuals options for the District's WWTP of anaerobic digestion, drying, pyrolysis/gasification, and supercritical water oxidation were evaluated at a high level to determine the order of magnitude cost and potential return on investment.

The results of the long-term residuals options analysis showed that a future thermal mass reduction process may be viable particularly if hauling and tipping fees significantly increase. Currently, the most viable option would be thermal drying. Should drying be considered, future options to add gasification or pyrolysis should also be considered. If drying is not implemented, further monitoring of other processes such as supercritical water oxidation could be considered once reference facilities are in operation to demonstrate vendor assumptions and system reliability. The results of the analysis did not show a strong driver to implement anaerobic digestion and there would be major footprint challenges to implement on the site and it is not recommended to be considered further at this time.

7.2.4 Odor Control

The six odor control facilities at the District's WWTP generally consist of two stages prior to being discharged from a stack. The first stage consists of wet scrubbers with hypochlorite and caustic for primary hydrogen sulfide (H2S) removal, and the second stage consists of carbon adsorption vessels for H2S polishing and volatile organic carbon (VOC) removal.

The general alternatives considered are to either replace the wet scrubbers with bio-trickling filters for H2S removal, replace the wet scrubbers in kind, or rehabilitate the existing wet scrubbers for continued use. A carbon adsorption system for final polishing at each odor control system would be maintained for all alternatives.

The capital costs for the alternatives for each odor control facility were estimated. The capital cost for the biofilters was higher than the replacement in kind alternative for Odor Control Facility A and G; The capital cost for the biofilters was lower than the replacement in kind alternative for Odor Control Facility B. For Odor Control Facility C and E and the Salem Neck Odor Control Facility, the replacement in kind alternative was the only viable alternative. Operations and Maintenance costs were not estimated for the odor control alternatives. It is recommended that a detailed odor control study be performed provide a defensible strategy that would provide the technical basis for a change to the District's odor control processes that will support the regulatory process. As part of this study, the overall capital and lifecycle costs should be revisited to decide on which technology to proceed with. For the purposes of this facility, the cost for the replacement in kind alternative for each odor control facility is to be carried forward to give a conservative estimate of the cost, as opportunity may exist to lower this capital cost for several of the systems based on future process decisions.

7.2.5 WWTP Assets Condition Assessment

Based on the results of facility assessments completed under WFMP Task 3 and Task 7 of this project, most of the treatment plant assets will need to be upgraded or replaced during the planning horizon. The condition assessment aimed to identify assets that are nearing the end of their useful life, and outline recommendations for improving the overall condition and operational reliability of the plant. Equipment slated for replacement due to a change in service or process is covered under the alternatives in WFMP Task 7, Section 0.2 of the executive summary.

The alternatives proposed for each building/structure of the treatment plant are to 1) continue to maintain the existing building in its current condition without implementing any significant planned

changes or upgrades or 2) replace and rehabilitate the building components that were identified to be in poor and/or fair condition.

Capital costs were estimated for the replacement and rehabilitate approach for each building/structure of the treatment plant. For the maintenance-based approach, due to the difficulty in developing costs for the indeterminate factors, such as economies of scale, lack of funding vehicles, unplanned repairs, and increased maintenance costs, costs were not discretely calculated or presented in this report. Across the multitude of recommended upgrades at the District facility, it is estimated that this maintenance-based approach could cost the District approximately 50% to 75% more over the course of the overall planning period to implement recommended upgrades in this manner. It is recommended that the replacement and rehabilitation approach be included for implementation.

7.3 Conclusions and Recommended Upgrades for the Wastewater Treatment Facilities

7.3.1 Summary of the Recommended Improvements

The alternatives recommended to be included are summarized in Table 46 (WFMP Task 7, Table 0.11). In addition to these costs, several studies are recommended to be undertaken including a pilot study for different dewatering technologies, a pilot study for selective wasting, and an odor control study. These capital costs will be used in conjunction with the pump and metering station alternatives capital costs from Task 6 of the facilities plan to develop a capital improvement plan for the District's WWTP and pump and metering stations.

Table 46: Recommended Alternatives

	Capital Cost
Liquid Process Alternatives	
Grit System	$5,100,000
High Purity Oxygen + VPSA	$14,600,000
Secondary Clarifier Improvements	$13,100,000
Chlorine Contact Tank	$2,500,000
Subtotal	*$35,300,000*
Residuals Alternatives	
Thickening – RDTs	$4,600,000
Dewatering – Centrifuge	$12,100,000
Cake Silos	$11,000,000
Subtotal	*$27,700,000*
Odor Control Alternatives	
Odor Control Facility A Replace In Kind	$12,900,000
Odor Control Facility B Replace In Kind	$21,100,000
Odor Control Facility C Replace In Kind	$600,000

	Capital Cost
Odor Control Facility E Replace In Kind	$4,800,000
Odor Control Facility G Replace In Kind	$12,300,000
Salem Neck Odor Control Facility Replace In Kind	$600,000
Subtotal	*$52,300,000*
Condition Assessment	
Grit Building	$12,700,000
Primary Clarifiers Buildings	$9,900,000
Oxygen Reactors and Gallery	$6,400,000
Oxygen Generation Building	$4,400,000
Secondary Clarifiers and Buildings	$29,000,000
Chlorination Building	$2,700,000
Effluent Pump Station	$8,700,000
Operations Building	$46,100,000
Administration and Maintenance Building	$13,300,000
Main Electrical Building	$12,300,000
Site Improvements	$1,600,000
Subtotal	*$147,100,000*
TOTAL	**$262,400,000**

7.3.2 Present Worth and Cost Effectiveness Analysis for WWTP Upgrades

Present-Worth Costs were generated for many of the wastewater treatment plant alternatives and are included in the costs tables for the individual alternatives above. These costs were prepared by AECOM using their engineering judgement and standard cost estimating methods and protocols. The same method was used for all alternatives. The Equivalent Uniform Annual Costs value was not prepared since the present worth costs are preferred by the District.

The wastewater treatment plant cost effective analysis considered many factors including technology selection, risk scores, criticality and site-specific constraints to determine priority, appropriate rehabilitation, maintenance of plant operations or new construction alternatives including capital and operations and maintenance costs for the upgrades. These factors are all discussed in the Wastewater Treatment Plant evaluation (WFMP Task 3 and CWMP Task 7).

7.4 Environmental Permitting and Other Impacts for WWTP Upgrades

7.4.1 Permitting Considerations

Environmental permits and approvals are required whenever proposed work may affect certain environmentally sensitive resources, including waterways such as wetland resource areas, habitats of rare or endangered species, and historical and archaeological sites. The impacts to environmentally sensitive areas will be minimal on the wastewater treatment plant site. The primary impacts will be related to mitigation of potential dust and nuisance odors and traffic

control and access for construction vehicles during construction. Treatment of construction dewatering will be treated as necessary and managed at the treatment plant.

The applicable local, state, and federal permits that are anticipated to be required, are presented in Table 47 below. Additional local, state, and federal permits may be required based on final design.

Table 47: Wastewater Treatment Plant Upgrades Environmental Permitting Summary

Infrastructure	MassDEP Chapter 91 License	US Army Corps of Engineers Section 404/10 Permit	Notice of Intent Conservation Commission	401 Water Quality Certification	Massachusetts Environmental Policy Act (MEPA) Approval	NPDES Construction General Permit (CGP)	Coordination with Massachusetts Historical Commission (MHC) and	Project Notification - Conservation Commission	Massachusetts Department of Transportation (MassDOT) State Highway Access Permit	MBTA Access Permit
WWTP On-Site Upgrades			X		X	X	X	X		

Additional permits may also be required for some projects for Coastal Impacts and Ocean Sanctuary impacts, particularly if building construction or modification is required in close proximity to the Salem Harbor or if changes to the NPDES Permit Limits are triggered. This will be assessed on a project-by-project basis. Interbasin Transfer of Flows impacts are not expected since there is no change in the configuration of the sewer system.

7.4.2 Direct Impacts

The main impacts that will need to be mitigated during construction include temporary odor control measures, stormwater management and treatment and minimizing traffic in adjacent neighborhood and local streets. Construction traffic will be limited to main streets and tracking pads will be used for mitigation of dust and soil containment. Odor control will be monitored and should there be a need to mitigate nuisance odors from construction or operations, additional odor control will be provided through covering containers and capturing and treating odorous air near the source.

7.4.3 Indirect Impacts

It is not anticipated that any impacts will occur to water resources nor are NPDES permit exceedances permitted during construction activities. Should temporary mitigation be required it will be addressed as a part of the final design and construction sequencing and staging for new facilities or processes and submitted to MassDEP for approval.

8 ADDITIONAL CONSIDERATIONS REGARDING EVALUATION OF ALTERNATIVES

8.1 INSTITUTIONAL ARRANGEMENTS

The District is currently constrained by MGL Chapter 59 section 20B (Proposition 2-1/2), proscriptive enabling legislation inclusive of jurisdictional boundaries, and strict apportionment agreements between members.

A major constraint is that the overall budget cannot be increased more than 2-1/2 percent a year. This constraint has precluded the ability to absorb the larger capital costs for the recommended capital upgrades program within the operating budget and would require either overrides in four out of five member communities or changes to enabling legislation on a project basis or a program basis to allow the District to obtain capital bonding or financial aid for increases beyond the current enabling legislation limits to support a long term program debt structure.

The District was formed by enabling legislation (Chapter 339 of the Acts of 1925) which have been modified over time with other follow-on legislation. This legislation established and maintains precise jurisdictional boundaries, which SESD cannot expand without an act of legislation. There has been no consideration given to changing the District's jurisdictional boundaries and the current planning work does not envision expanding the service area. The legislation also disallows accepting any wastewater that originates from outside of the service area – thus limiting SESD's ability to manage regional septage or truck in food waste. These were predetermined assumptions in the overall preparation of the Comprehensive Wastewater Management Plan and Wastewater Facilities Management Plan.

One additional constraint is established apportionment agreements between the communities that were modified in 1994. These agreements, which were signed at the City Executive level, establish an equitable method of establishing payment for the District's services and for capital upgrades. However, if a new facility or process is constructed, these agreements may need to be modified, which could be a difficult process.

8.2 FLOW AND WASTE REDUCTION

The District's Collection System Standard Operating Procedures strives to maximize the conveyance of all flows to the wastewater treatment plant and mitigate any potential for a sanitary sewer overflow in the collection system. The District has successfully reduced SSO's, and at this point SSOs will only occur during rainstorms in excess of 2-inches or in cases of failed infrastructure. There are provisions incorporated in the District's standard operating procedures to maximize flow to the treatment plant based on a high flow plan of operation. There are several projects described in the CWMP to increase the hydraulic and wet weather treatment capacity of the SESD WWTP.

The reduction of residuals volumes is a major reason for upgrading the residuals process. One of the primary drivers of the residuals process upgrade included in the WFMP is to improve the dewatering process to produce a dewatered sludge with a higher solids content, reducing the volume that needs to be disposed. There is also an interest by the District in providing flexibility for beneficial reuse in the future should an opportunity be found that was feasible and economically viable.

Flow reduction from other measures such as water conservation measures, reduction of I/I, changes in land use regulations, industrial wastewater reuse, promotion of the use of private conventional septic systems, and pollution prevention initiatives were not extensively considered since the SESD collection system, pump stations, and WWTP have sufficient capacity and due to the complexity and legal issues of managing these changes across five member communities as a regional wastewater district. Further, as previously noted, I/I was not considered as part of this evaluation since the individual member communities own and maintain their own collection systems and this planning effort is focused on the District infrastructure.

8.3 Decentralized Facilities

SESD serves well established and developed communities on the North Shore with extensive sewer collection systems. There is no established need and no discussion of constructing decentralized facilities for unsewered areas within the District boundaries.

There has been some consideration to the siting of a future residuals processing facility located remotely from the District's WWTP site; however, it is not a high priority due to side-stream processing requirements, land ownership, and environmental permitting challenges and constraints. The District currently owns landfill air rights at the Peabody Landfill site but this was not formally included in the decentralized facilities discussion.

8.4 Sewer System Configuration

As previously noted, SESD serves well established and developed communities on the North Shore with extensive sewer collection systems. The systems within the member communities are owned and maintained by the individual cities and towns. The District owns and maintains the interceptor network. Further, the SESD system is a separated system and there are no Combined Sewer Overflows (CSOs) that need to be addressed.

There are no significant expansions of the sewer system to additional communities or large undeveloped areas of the existing SESD member communities that are currently under consideration and anticipated future flows are largely unchanged. Further, no significant reconfiguration or modifications to the interceptor system is anticipated in this plan. The focus of SESD's planning is on the condition, reliability, and redundancy of the critical interceptor system to ensure it can provide reliable wastewater collection. Therefore, the planning effort did not include an evaluation or alternatives analysis of system-wide changes. Rather, as individual system components are being replaced or upgraded, we do anticipate alternatives analysis of routes, sizes, materials, construction techniques, etcetera during the design phase of these projects.

In addition, the District does maintain a Sewer Use Ordinance to protect the interceptor network. The District revised the Sewer Use Ordinance in May 2023 to incorporate changes to several provisions within them to provide better definitions and reflect changes in guidance by the USEPA. Additionally, the Regulations, Monitoring and Enforcement of the Industrial Pretreatment Program were updated in April 2023 as well as certain provisions in the Enforcement Response Guidelines.

8.5 Residuals Disposal

SESD currently has a third party vendor transport and dispose of its residuals. This process will likely continue for the near future. SESD has explored and would support a regional approach to residuals management. The District has had conversations with several private entities who have investigated developing such a facility. There is also a group of Northeast WWTPs (the Narragansett Sewer Commission, Springfield Water & Sewer Commission and Upper Blackstone WPCF) who prepared a study for a centralized regional residuals processing facility in which the District would be interested in. However, implementation of the regional facility envisioned by this study has not yet materialized due to environmental permitting, economics, and other siting constraints.

8.6 Location of Facilities

The existing wastewater treatment plant is already centrally located as a facility. The plant site was thoroughly investigated and vetted during the Facilities Planning process for the secondary plant expansion in the 1990s. The entire collection system is hydraulically interconnected such that any major changes to the conveyance and treatment of the wastewater would be extremely challenging and require multiple levels of environmental and jurisdictional approvals. For these reasons, there was no consideration given to a change in location within the WFMP or CWMP.

There are two pump stations that are located in areas at risk of storm surges and sea level rise. The District has evaluated options and the facilities plan includes constructing a new pump station in Danvers on the same site at a higher elevation and constructing a flood wall at the Beverly Pump Station. Additional modifications or further changes in locations of these two facilities will continue to be evaluated within the 50-year planning horizon.

8.7 Revision of Wasteload Allocation

The existing waste load allocation for Total suspended solids and biological oxygen demand is currently adequate for the 20-year capital planning horizon so there is no need to revise the waste load or design criteria for the 20-year CIP. In addition, due to the cessation of operations of Rousselot the waste load will likely remain the same or possibly be somewhat reduced.

8.8 Phased Construction

The 20-year CIP is currently broken into four tiers to allow construction of the necessary upgrades to be completed in a logically phased approach. The highest ranked project priorities are included in the first tier or phase of the 20-year CIP. Chapter 9 of the CWMP below describes the plan in detail.

8.9 FLEXIBILITY

The WFMP has grouped the project priorities into four tiers or priorities to allow for a phased approach to construction as described in Chapter 9. Each tier is comprised of a series of projects that were envisioned in the planning effort. For this level of planning, the scope of the projects is still general in nature, and a high level of contingency has been carried to allow for modifying the updated scope as required. This will allow for adequate flexibility as the required work is implemented to respond to changes in conditions.

8.10 RELIABILITY

The existing pumping stations and wastewater treatment plant can reliably convey and treat the wastewater and have adequate redundancy for average day flows.

The Beverly, Marblehead, Peabody Salem and Salem Neck pumping stations have adequate capacity to treat current and future peak flows and the design rated flow. However, the Danvers Pumping Station does not have adequate firm capacity to treat peak flows with one pump out of service. Upgrades for this limitation are included in the WFMP within the recommended pump station upgrades.

For average flow conditions, all the wastewater treatment plant unit processes have adequate capacity to treat current flows, projected future flows, and the design rated flow.

The Secondary Clarification Process has less capacity than required at the peak hourly flows for design, current, and projected future flows. The capacity for the Secondary Clarifiers is based on recommendations of industry standard guidelines for the surface overflow rate at peak hourly flows and is confirmed by plant operating experience and operating data. Upgrades for this limitation are included in the WFMP.

The Effluent Pump Station is rated for the design peak hourly flow, but its rated capacity is below the current future peak hourly flows. The high head pump motors in the Effluent Pump Station were rewound to increase the motor power from 800 HP to 900 HP approximately 10 years ago. Additional modifications to the pumps or VFD settings will need to be investigated to increase the capacity of the high head pumping system if peak flows are observed to increase.

9 PLAN SELECTION AND RECOMMENDED PLAN

9.1 PLAN SELECTION

9.1.1 General

This section describes the methodology and evaluation for the selection of the recommended plan.

9.1.2 Comparison And Ranking of Projects

9.1.2.1 Project List Development

For the Collection System projects, the recommended upgrades from Section 5 and Section 6 of the CSCIP were carried forward to the project list. This is with the exception of five upgrades associated with rehabilitation of the Danvers Collection System, which were not carried forward at this time. In their place, an assessment step was added to determine the actual condition of this infrastructure. This study was listed as a separate project.

For the Pump Station and Wastewater Treatment Plant projects, the recommended upgrades from the Task 6- Pump and Metering Stations Alternatives Analysis and Task 7- Wastewater Treatment Plant Alternatives Analysis were carried forward to the project list. Follow on studies to better define upgrade details that were recommended in the Wastewater Treatment Plant Alternatives Analysis were also included as projects.

9.1.2.2 Project Ranking Process: Collection System Risk Model

A risk model was used to prioritize the collection system projects. The Collection System Risk Model uses the risk of failure and consequence of failure for each collection system asset to identify the overall risk and identify the high priority projects. was an update of a risk model initially developed in 2017. See Table 48 for the Probability of Failure Risk Factors (CSCIP Table 3-1) and Table 49 for the Consequence of Failure Risk Factors (CSCIP Table 3-2) used in the Collection System Risk Model. The Collection System Risk Model is further described in Section 3 of the CSCIP.

Table 48: Collection System Risk Model Probability of Failure Risk Factors

ID	Criteria	Factor Description	Weight
P1	Railway Crossings	Railway vibration may cause pipeline joint failure or electrified railways may have more stray current potential.	1
P2	Past Breaks / Leaks / Service History Issues	Previous breaks, failures or maintenance issues in a pipeline section and/or known sections of poor pipeline conditions provide physical indications of weaker pipe.	5
P3	Pipe Age or Vintage	Age of main contributes, in general, to condition of pipelines. Older pipelines generally will be in a worse	4

		condition than newer pipelines, with exceptions for known vintages of poor quality.	
P4	Pipe Lining	Metallic pipelines with internal linings (CIPP) or external coatings (polyethylene wrap) have a better chance of remaining in good condition.	3
P5	Class of Pipe	Class of pipe may reflect pipe thickness that is important to life of pipeline especially with metallic pipe.	3
P6	Bury Depth	Mains buried in shallow conditions have a higher chance of failure due to less protection from live loads and mains buried deeper have more soil load on them.	3
P7	Number of Connections	More laterals or pipeline connections may result in gas build-up or corrosion due to caustic flow turbulence.	2
P8	Proximity to Saltwater / Swamp / Ground Water	Metallic pipelines in salt, groundwater or swampland may corrode more quickly.	4
P9	Installation Issues	Pipelines with known installation issues (fill, contractor, etc.)	3
P10	Electrical Transmission Lines	Proximity to high tension electrical transmission main towers may cause higher potential for steel band/pipeline corrosion due to stray current.	1
P11	Gas Pocket Reduction	Pipelines with air release valves (ARVs) are more likely to fail than those that do not due to the fact that these pipelines have known engineering issues that cause gas buildup and the maintenance of the ARVs over their history is not known.	4
P12	Hydrogen Sulfide Corrosion	Locations exhibiting hydrogen sulfide corrosion.	5
P13	Known Maintenance Problem Areas	Areas of known grease/clogging, inflow/infiltration, etc.	4
P14	Inspection Ranking	Ranking based on CCTV or other inspection data.	5
P15	Specialty Crossings	Pipelines with aerial mounting or under waterbodies have a higher risk of failure.	3.5
P16	Sea Level Rise	Pipelines that will be inundated due to sea level rise have a higher risk of failure	1

Table 49: Collection System Risk Model Consequence of Failure Risk Factors

ID	Criteria	Factor Description	Weight
C1	Damage or Disruption to Sensitive Locations	Some locations are more sensitive to flooding damage or disruption to important areas such as hospitals, schools, police, fire, government buildings, tourist centers, and historic zones.	5
C2	Damage or Disruption to Roadways Using Street Classes	Roadways of different travel classes should be ranked differently for flooding or repair disruption.	3
C3	Damage or Disruption to Railway	Damage to railway bed due to causing slowdown in service due to flooding or repair disruption.	3.5
C4	Service Outage - Overall Based on Connection	Community size served at connection point.	4
C5	Duration of Outage Due to Deep Pipes	Deeper pipelines will cost more to repair.	3
C6	Duration of Outage Due to Hard to Repair Locations	Harder to reach pipelines will cost more to repair.	3
C7	Duration of Outage Due to Diameter	Large diameter or pipes of specific material will cost more to repair, may take longer to repair, or are harder to get parts for.	1
C8	Environmental Impact	General environmental impact and sensitive habitats.	4
C9	Flooding Potential - Diameter/Flow	Larger pipelines or pipelines with more pressure will release more during a failure.	2
C10	General Disruption to Life - Special Economic Zones	Areas of high-visibility activity, ball park, historic, airport, etc. were higher ranked for pipeline failure or flooding disruption.	3.5
C11	General Disruption to Life - Population Density	Densely populated areas will generally have a greater consequence during a failure.	1
C12	Specialty Crossing	Pipelines connected to bridges or water crossings could damage these structures.	2.5
C13	Highly Consequential	Pipelines that if they fail have overwhelming consequence to system operation or public health and safety.	5

The consequence of failure and risk of failure ratings were summed and then normalized to a maximum score of 1,000 to compute a normalized risk score. The summary of the collection system projects risk scores are presented in Table 50 (CSCIP, Table 3.3).

Table 50: Collection System Risk Model Risk Score Summary

Infrastructure	Probability of Failure Score	Consequence of Failure Score	Risk Score	Normalized Risk Score	Tier
Beverly Bass River Siphon Chambers	148	186	334	1000	1
Marblehead Force Main	112	132	244	730	1
Beverly Harbor Force Main	110	138	247	740	1
Beverly Force Main	54	105	159	480	2
Beverly Bass River Siphon Barrels	148	174	322	1000	2
Beverly Water Street Interceptor	122	121	243	754	2
Danvers Doty Avenue Gravity Main	45	68	112	336	2
Danvers Gravity Sewers / Assessment	45	68	112	336	2
Peabody Walnut Street Gravity Main	45	68	112	336	3
Peabody Salem Interceptor	85	103	188	729	3
Salem Derby Street Gravity Main	45	68	112	336	3
Beverly Beach Interceptor	113	167	279	836	4
Danvers Force Main	122	85	207	619	4
WWTP Outfall Force Main (Overland)	67	119	186	594	4
Beverly Tunnel	46	129	175	524	N/A
Marblehead Force Main - Salem Harbor Crossing	53	143	197	589	N/A
Danvers Porter River Siphon	61	163	224	671	N/A
WWTP Outfall Force Main (Subaqueous)	67	119	186	594	N/A

9.1.2.3 Project Ranking Process: WWTP Decision Model

A decision model was also developed as a tool to help prioritize the wastewater treatment facilities, including the pump station projects. The model used four evaluation criteria that were rated on a scale of 1-10 for each project. The evaluation criteria included the consequence of failure, the risk of failure, operation and maintenance/energy savings, and improvement to plant operations. See Table 51 (WFMP Task 8-11, Table 2.1) for the definitions of these criteria.

The consequence of failure and risk of failure ratings were multiplied together and divided by 10 to compute a failure risk quotient criteria. Each criterion was assigned a weight to account for its relative importance (50 for the failure risk quotient, 20 for operation and maintenance/energy savings, and 30 for improvement to plant operations). A total weighted score for each project was computed from the weight and rating of each evaluation criterion, and the weighted scores were ordered to determine the relative project rank. The wastewater treatment facilities project rankings are presented in WFMP Task 8-11, Appendix B.

Table 51: Evaluation Criteria Definitions for Wastewater Treatment Facilities

	Rating Definition					
	1	**3**	**5**	**7**	**9**	**10**
Consequence of Failure	Failure has no impact on the treatment process	Failure has small impact on treatment process, could include non-critical system outage, minor permit violation, and/or neutral media coverage	Failure has moderate impact on treatment process, could include short term critical system outage, permit violation with regulatory sanction possible, and/or negative media coverage	Failure has major impact on treatment process, could include moderate term critical system outage, permit violation with regulatory sanction likely, and/or considerable negative media coverage	Failure has severe impact on treatment process, could include long term critical system outage (temporary systems possibly required), permit violation with regulatory sanction, and/or negative media coverage with possible political opposition	Failure has severe impact on treatment process, could include long term critical system outage (temporary systems required), permit violation with consent decree, and/or negative media coverage with political opposition
Risk of Failure	Condition of existing facility is very good, age of systems are <20% of the service life	Condition of existing facility is good, age of systems are 20-40% of the service life	Condition of existing facility is fair, age of systems are 40-60% of the service life	Condition of existing facility is poor, age of systems are 60-80% of the service life	Condition of existing facility is very poor, age of systems are >80% of the service life	Condition of existing facility is at extremely high failure risk, age of systems are equal to or over the service life
Failure Risk Quotient (Calculated)	Calculated as the consequence of failure times the risk of failure and divided by 10 to have a minimum value of 0.1 and a maximum of 10					
O&M/Energy Savings	Equivalent O&M cost and no energy savings compared to the existing process	Small O&M cost savings (<20%) and/or some energy savings compared to the existing process	Moderate O&M cost savings (20-40%) and/or considerable energy savings compared to the existing process	Large O&M cost savings (40-60%) and/or large energy savings compared to the existing process	High O&M cost savings (60-80%) and/or high energy savings compared to the existing process	Very high O&M cost savings (>80%) and/or very high energy savings compared to the existing process
Improvement to Plant Operations	No improvement to plant operations processes	Some improvement to plant operations processes	Moderate improvement to plant operations processes	Large improvement to plant operations processes	Very large improvement to plant operations processes	Extremely large improvement to plant operations processes

9.1.2.4 Priority Tiers

The project ranks determined in the collection system risk model and wastewater treatment facilities decision model were used to assign a priority tier for each project. A total of 4 priority tiers were developed. The tiers represent the criticality of the project and the timeframe in which the project is intended to be implemented in the 20-year capital improvement plan. The tier definitions are shown in Table 52. The tiers assigned to projects do not line up perfectly with the project ranks, as the project ranks were intended to be a tool used to inform the assignment to the tiers. The same tiers were used for wastewater treatment facilities and collection system assets.

Table 52: Project Tier Definitions

Project Tier	Project Timeframe
1	0-5 yrs
2	5-10 yrs
3	10-15 yrs
4	15-20 yrs

9.1.2.5 Collection System Assets Prioritized Project List

A workshop was held with CDM Smith and key personnel at the District to get feedback on the preliminary tiers assigned to the collection system projects. The intent of this workshop was to refine the tiers assigned to projects based on the priorities of the District personnel present, the condition of the assets in each project, and the available redundancies. Several projects were flagged for more timely completion and project tiers were adjusted based on the workshop discussions.

The Wastewater Collection System Assets Prioritized Project List provided in Table 53 was prepared to provide a path forward to resolve the needs identified. The costs to implement the identified projects are substantial, and it is important to consider that it may be necessary to modify portions of the plan based on the available financial resources of SESD's member communities. The Wastewater Collection System Assets Prioritized Project List will likely need to be adjusted and modified over time based on financing and other changing conditions.

The final project list for the Collection system projects is shown in Table 53 (CSCIP, Table 6.1). The estimated costs for each project were based on cost estimates presented in Section 6 of the CSCIP. These costs are presented in 2024 dollars.

Table 53: Wastewater Collection System Assets Prioritized Project List

Project Element	Tier	2024 Cost (Millions of Dollars)	Tier 1 Costs	Tier 2 Costs	Tier 3 Costs	Tier 4 Costs	Project Description
Bass River Siphon Chambers	1	$4.8	4.8				Rehabilitate US and DS chambers. Extensive interior work on US + DS chambers including cable removal, gate and grating replacement, concrete restoration and coating.
Marblehead Force Main	1	$28.9	28.9				Parallel installation of redundant force main including 5,600LF 24" HDPE, 6,700 LF of 30" HDPE and appurtenant work
Beverly Harbor Force Main	1	$27.0	27.0				Parallel replacement of exist. 42" DI FM with new 42" HDPE FM, connections to existing system, and appurtenant work.
Beverly Beach Interceptor Assessment	1	$0.15	0.15				Condition assessment and rehabilitation alternatives analysis to validate proposed replacement / rehabilitation approach.
Peabody Salem Interceptor Heavy Cleaning	1	$2.15	2.15				Heavy cleaning of the existing large diameter gravity sewer lines (approx. 16,000 LF of 78" & 84" RCP) as well as disposal of the solids removed during the cleaning.
Beverly Force Main (land-based portion)	2	$19.4		19.4			Parallel replacement of exist. FM with 1,300 LF 42" DI and 2,000 LF 48" DI
Bass River Siphon Barrels	2	$5.5		5.5			Clean and CIPPL of three 1,500LF siphon barrels (24", 24" & 30")
Beverly Water Street Interceptor	2	$5.6		5.6			Rehabilitation of existing large diameter gravity sewer (approx. 1,900 LF of 54" RCP) using geopolymer spray applied lining.
Danvers Doty Avenue Gravity Sewer	2	$10.0		10.0			Rehabilitation of approximately 1,800LF of 30x42 and 4,900LF of 33x34 existing oblong concrete sewer pipe using CIPPL
Danvers Gravity Sewer Mains Assessment	2	$2.0		2.0			Condition assessment and identification of required rehabilitation of the Danvers gravity system including 18,000 LF of Multi-Sensor Inspection (MSI) and 22,000 LF of CCTV,
Peabody Walnut Street Gravity Sewer	3	$4.9			4.9		Rehabilitation of existing brick gravity sewer lines (approx. 2,400LF of 30", 40", 46", and 48" brick) using CIPPL
Peabody Salem Interceptor	3	$36.0			36.0		Rehabilitation of existing large diameter gravity sewer lines (approx. 16,000 LF of 78" & 84" RCP) using geopolymer spray applied lining.
Salem Derby Street Gravity Sewer	3	$2.7			2.7		Rehabilitation of existing large diameter gravity sewer (approx. 700LF of 72" brick) using geopolymer spray applied lining
Beverly Beach Interceptor Rehabilitation	4	5.0				5.0	Parallel replacement of existing 48" CI interceptor with 48" HDPE pipe. Work includes land-based and subaqueous segments. OPCC will be revisited and verified during the condition assessment phase.
Danvers Doty Avenue Force Main	4	$19.8				19.8	Parallel replacement of existing 30" DI interceptor with 30" HDPE pipe. Work includes land-based and subaqueous segments.
WWTP Outfall Force Main (Land Based Portion)	4	$11.9				11.9	Parallel replacement with new pipeline in adjacent alignment. Land-based and subaqueous construction.
Beverly Tunnel	N/A	N/A					No action recommended.

Marblehead Force Main - Salem Harbor Crossing	N/A	N/A					Recent replacement.
Danvers Porter River Siphons	N/A	N/A					Recent rehabilitation.
Danvers Gravity Mains (5 Sections)	N/A	N/A					Assess in Future pending results of Danvers Gravity Sewer Mains Assessment and Prioritization Study.
WWTP Outfall Force Main (Subaqueous Portion)	N/A	N/A					Assess in Future
SUBTOTAL BY TIER		185.8	63.0	42.5	43.6	36.7	
GRAND TOTAL						**185.8**	

Notes:

Costs based on conceptual rehabilitation / replacement scheme
Costs include 30% construction contingency and 20% allowance for engineering and implementation

9.1.2.6 Wastewater Treatment Facilities Prioritized Project List

A workshop was held with AECOM and key personnel at the District to get feedback on the preliminary tiers assigned to the projects. The intent of this workshop was to refine the tiers assigned to projects based on the priorities of the District personnel present, the condition and operability of the assets in each project, and the likelihood of the assets in each project to be operable when the assets are slated to be replaced. Aspects of several previously defined projects or projects elements were moved to new projects or into other projects and project tiers were adjusted based on the workshop discussions.

The final prioritized project list for the wastewater treatment facilities projects (including pumping stations) is shown in Table 54 (WFMP Task 8-11, Table 2.3). Additional details on the projects can be found in the WFMP Task Memo 8-11, Appendix A.

The Wastewater Treatment Facilities and Pumping Stations Prioritized Project List provided in Table 54 was prepared to provide a path forward to resolve the needs identified. The costs to implement the identified projects are substantial, and it is important to consider that it may be necessary to modify portions of the plan based on the available financial resources of SESD's member communities. The Wastewater Treatment Facilities and Pumping Stations Prioritized Project List will likely need to be adjusted and modified over time based on financing and other changing conditions.

The estimated costs for each project were based on cost estimates prepared in Task 6-Pump and Metering Stations Alternatives Analysis and Task 7- Wastewater Treatment Plant Alternatives Analysis. The costs are presented in 2024 dollars.

Table 54: Wastewater Treatment Facilities and Pumping Stations Prioritized Project List

Project ID	Project Element Title	Estimated Cost (Millions of 2024 dollars)[1]	Major Components	Tier Rational
			Teir 1 (0-5 yrs)	
ADM_01	Dewatering Pilot	$0.5	Pilot study for dewatering technologies (centrifuges and screw presses).	Needs to be completed in advance of the dewatering upgrade project (RES_02)
ADM_02	Co-settling Demonstration	$1.5	Demonstration study for WAS co-settling technology.	Needs to be completed in advance of both the thickening upgrade or WAS co-settling project (RES_03) and the dewatering upgrade project (RES_02)
ADM_03	Secondary Clarifiers Hydraulic Study	$0.5	Study on the hydraulics of the Secondary Clarifiers to potentially improve performance.	Needs to be completed in advance of the design of modifications to the Secondary Clarifiers to improve performance.
ADM_04	Selective Wasting Pilot and Contact Stabilization Study	$1.0	Pilot Study for selective wasting technology and study on contact stabilization.	Needs to be completed in advance of the selective wasting project (WTP_11) and the contact stabilization project (WTP_12).
ADM_05	Odor Control Study Phase 1	$0.5	Study to further understand WWTP odors and odor control alternatives; Phase 1 Data Collection.	Needs to be completed in advance of the second phase of the odor control study (ADM_06) and in advance of any odor control upgrades (WTP_13, WTP_18, WTP_19)
PSU_01	Pump Station Screening Upgrades	$4.4	Screen and gate replacement and associated concrete work at the Beverly and Marblehead Pump Stations. At Marblehead Pump Station. Includes the replacement of the roof, some architectural work, and some site work associated with the replacement of grinders with screens.	To mitigate the issue of excessive ragging at the WWTP, which causes additional challenges and cost for operations and maintenance.
PSU_02	Influent Pump Station High Priority Items	$14.6	Dresser coupling repair, flow meter replacement, and heating/HVAC upgrades in the Influent Pump Station. Includes mechanical process equipment (pumps, piping, gates, screen), primary electrical distribution equipment, controls, and heating/HVAC.	To mitigate the risk of catastrophic failure of the critical assets replaced in this project that are at the end of their useful life and to improve environmental conditions for operator safety and equipment longevity.
RES_01	Cake Storage	$11.0	Cost for installation of cake silos in the Operations Building. Could be replaced with the cost for a cake storage garage.	To allow decoupling of dewatering and cake hauling to reduce costs by allowing dewatering during extended hours during the day.
RES_02	Dewatering Upgrade	$14.5	Upgrade of the dewatering system to screw presses or centrifuges. Includes mechanical, electrical, and controls costs for dewatering equipment and auxiliary equipment, like polymer system and feed pumps.	Projected solids disposal cost savings of replacing the existing belt filter presses due to higher percentage cake solids
RES_03	Thickening Upgrade or WAS Co-settling	$5.5	Upgrade of the thickening system to rotary drum thickeners. Includes mechanical, electrical, and controls for dewatering	Poor condition of the existing thickening equipment and potential cost savings with WAS co-settling.

Project ID	Project Element Title	Estimated Cost (Millions of 2024 dollars)[1]	Major Components	Tier Rational
			equipment and auxiliary equipment, like polymer system and feed pumps. Could be replaced with the cost to implement WAS co-settling.	
WTP_01	Scum Removal Improvements	$9.3	Improvements to the secondary scum removal system. Includes helical skimmers in the Oxygen Reactors and Secondary Clarifiers, hot water system in the Secondary Effluent Building, plant water spray headers on the effluent of the Secondary Clarifiers, and rehabilitation of the scum tanks.	Significant operational challenges caused by poor secondary scum removal and likelihood of secondary scum contributing to high effluent TSS at high flows.
WTP_02	Secondary Clarifiers Improvements - effluent visibility and monitoring, interim RAS monitoring improvements.	$1.8	Includes turbidity probes for each clarifier and hatches with safety grating on the effluent side of the Secondary Clarifiers. Includes improvements to monitoring return activated sludge (RAS) rates.	Operational improvements intended to improve high effluent TSS at high flows.
WTP_03	Secondary Clarifiers Improvements - baffle/weir modifications	$3.5	Includes implementation of any recommendations from a study on the hydraulics of the secondary clarifiers, particularly for baffle and weir improvements.	Potential improvement in the performance of the secondary clarifier and to improve high effluent TSS conditions at high flows. Needs to be completed after the secondary clarifier hydraulic study (ADM_04).
WTP_04	Static Mixer Removal	$2.5	Includes removal of the static mixer, addition of an induction mixer, bypass of the Secondary Clarifier Effluent piping, and condition-based replacement of hypochlorite and bisulfite piping.	Improvement to the hydraulic profile in the secondary system to reduce overtopping channels in the secondary system at high flows. Address the poor condition of the chemical piping.
WTP_05	RV Dump Station Relocation	$0.4	Relocation of the RV dump station.	Improve operational and logistical challenges of RVs dumping at the WWTP.
Tier 2 (5-10 yrs)				
ADM_06	Odor Control Study Phase 2	$1.0	Study to further understand odor control alternatives and cost; Phase 2 Detailed Evaluation.	Needs to be completed after the first phase of the odor control study (ADM_05) and in advance of any odor control upgrades (WTP_13, WTP_18, WTP_19).
PSU_03	Influent Pump Station Upgrade Phase 2	$4.3	Upgrade of the pump station including site work, architectural, structural, plumbing, and the remainder of the electrical costs.	Assets in this project are non-critical and in a reasonable condition, expected to last another 5-10 years before failure.
PSU_04	Beverly Pump Station Upgrade	$13.5	Upgrade of the pump station and rehabilitation including site work, architectural, structural, process mechanical, odor control, HVAC, plumbing, electrical, and controls upgrades. Does not include the screen replacement, gates replacement, and flood protection.	Assets in this project are in a reasonable condition and expected to last another 5-10 years.
PSU_06	Marblehead Pump Station Upgrade	$9.2	Upgrade of the pump station and rehabilitation including site work, architectural, structural, process mechanical, odor control, HVAC, plumbing, electrical, and controls upgrades. Does not include the replacement of the grinders with screens, the replacement of the	Assets in this project are in a reasonable condition and expected to last another 5-10 years.

Project ID	Project Element Title	Estimated Cost (Millions of 2024 dollars)[1]	Major Components	Tier Rational
			roof, some architectural work, and some site work that is associated with the replacement of the grinders with screens.	
PSU_07	Peabody Metering Station Upgrade	$1.3	Upgrade of the metering station and rehabilitation including site work, resiliency, architectural, structural, plumbing, electrical, and controls upgrades.	Assets in this project are in a reasonable condition and expected to last another 5-10 years.
WTP_06	RAS System Improvements	$5.1	Replacement of RAS pumps, WAS pumps, Secondary Clarifier tank drain pumps, modifications to the RAS piping, new RAS flow meters, and other I&C costs.	Improvement to plant operations provided by the option and equipment reaching the end of its useful life.
WTP_07	Beverly Metering Station	$0.3	Upgrade of the metering station and rehabilitation including architectural, structural, electrical, and controls upgrades.	Assets in this project are in a reasonable condition and expected to last another 5-10 years.
WTP_08	Salem Neck Pump Station	$2.3	Upgrade of the pump station and rehabilitation including architectural, structural, process mechanical, HVAC, electrical, and controls upgrades.	Assets in this project are in a reasonable condition and expected to last another 5-10 years.
WTP_09	Oxygen Reactor Controls Improvement	$1.6	Modifications to improve operation of the Oxygen Reactors, including the effluent weir modifications, oxygen piping modifications, oxygen control valves, oxygen flow meters, headspace pressure sensors, reactor level sensors, and general instrumentation and controls upgrades.	Improvements to plant operations and energy efficiency provided by this project.
WTP_10	Oxygen Reactor and Gallery Upgrades	$6.5	Condition-based rehabilitation of the Oxygen Reactor and Gallery and assets within the area including architectural, structural, mechanical, HVAC, plumbing, electrical, and controls upgrades. Includes mixer/aerator gearbox replacement. Does not include the controls improvements in the Oxygen Reactor Controls Improvement project (WTP_10).	Assets in this project are in a reasonable condition and expected to last another 5-10 years.
WTP_11	Selective Wasting	$5.2	Implementation of selective wasting.	Improvements to plant operations possible, including improving issues with high effluent TSS at high flows. Needs to be completed after the selective wasting pilot and contact stabilization study (ADM_04)
WTP_12	Contact Stabilization	$3.4	Implementation of contact stabilization.	Improvements to plant operations possible, including improving issues with high effluent TSS at high flows. Needs to be completed after the selective wasting pilot and contact stabilization study (ADM_04)
WTP_13	Secondary Clarifiers and Buildings and Odor C	$16.3	Condition-based rehabilitation of the Secondary Clarifiers and Buildings and assets within the buildings including architectural, structural, mechanical, HVAC, plumbing, electrical, and controls upgrades. Includes collector replacement, sprocket misalignment correction, etc. Includes condition-based rehabilitation of Odor C. Excludes the RAS system, WAS pumps, tank drain pumps, scum	Assets in this project are in a reasonable condition and expected to last another 5-10 years.

Project ID	Project Element Title	Estimated Cost (Millions of 2024 dollars)[1]	Major Components	Tier Rational
			removal, effluent visibility/monitoring, and hydraulics improvements.	
WTP_14	Grit Building Upgrade (Condition)	$12.7	Condition-based upgrade of the Grit Building and equipment inside including architectural, structural, mechanical, HVAC, plumbing, electrical, and controls upgrades. Does not include the demolition of the existing bridge crane and existing grit removal system.	Assets in this project are in a reasonable condition and expected to last another 5-10 years.
WTP_15	Grit Building Upgrade (Process)	$5.1	Demolition of the existing bridge crane and manual grit removal system and construction of a new grit removal system with grit screws at the bottom of each chamber, grit pumps, and grit washers.	Improvements to plant operations possible and assets in this project being in a reasonable condition and expected to last another 5-10 years.
WTP_16	Operations Building	$43.0	Condition-based rehabilitation of the Operations Building and assets within the building including architectural, structural, mechanical, HVAC, plumbing, electrical, and controls upgrades. Includes new sludge blanket detectors. Does not include dewatering equipment, thickening equipment, and cake storage upgrades.	Assets in this project are in a reasonable condition and expected to last another 5-10 years.
WTP_17	Primary Clarifiers Buildings	$9.4	Condition-based upgrade of the Primary Clarifier Buildings and equipment inside including architectural, structural, mechanical, HVAC, plumbing, electrical, and controls upgrades. This excludes the sludge blanket detectors in the clarifiers and the scum blending tanks rehab.	Assets in this project are in a reasonable condition and expected to last another 5-10 years.
Tier 3 (10-15 yrs)				
PSU_08	Beverly Pump Station Resiliency Upgrades	$11.3	Construction of a perimeter flood protection barrier for the pump station.	Flood elevations that are driving this project are not likely to be reached for 10+ years.
WTP_18	Odor B and G Upgrades	$33.4	Condition-based rehabilitation of the Odor B and G systems and assets within the areas including architectural, structural, mechanical, HVAC, plumbing, electrical, and controls upgrades. Odor B upgrades would consist of a replacement in kind of the existing wet scrubbers and carbon vessels. Odor G upgrades would consist of demolition of the caustic and acid wet scrubbers and replacement in kind of the hypochlorite wet scrubber and carbon vessels.	Assets in this project are in reasonable condition and expected to last another 10-15 years. Needs to be completed after the odor control studies (ADM_05 and ADM_06).
WTP_19	Odor Control (A, E, and Salem Neck)	$18.3	Condition-based rehabilitation of the Odor A, E, and Salem Neck systems and assets within the areas including architectural, structural, mechanical, HVAC, plumbing, electrical, and controls upgrades. Odor A upgrades consist of the replacement in kind of wet scrubbers and carbon vessels. Odor E upgrades consist of the demolition of the mist wet scrubber and the replacement in kind of	Assets in this project are in a reasonable condition and expected to last another 10-15 years. Needs to be completed after the odor control studies (ADM_05 and ADM_06).

Project ID	Project Element Title	Estimated Cost (Millions of 2024 dollars)[1]	Major Components	Tier Rational
			the carbon vessels. Salem Neck Odor Control Facility upgrades consist of the replacement in kind of the carbon vessels.	
WTP_20	Oxygen Generation Upgrade	$16.5	Replacement of the PSA system with a new VPSA system. Also includes condition-based rehabilitation of the Oxygen Generation Building including structural, HVAC, plumbing, electrical, and controls upgrades.	Assets in this project are in a reasonable condition and expected to last another 10-15 years.
Tier 4 (15-20 yrs)				
PSU_05	Danvers Pump Station Upgrade	$23.5	Complete replacement of the pump station and installation of flood protection measures.	Assets in this project are in a reasonable condition and expected to last another 5-10 years.
WTP_21	Chlorination Building	$2.7	Condition-based rehabilitation of the Chlorination Building and assets within the area including architectural, structural, mechanical, HVAC, plumbing, electrical, and controls upgrades.	Assets in this project are in a reasonable condition and expected to last another 10-15 years.
WTP_22	Effluent Pump Station	$8.7	Condition-based rehabilitation of the Effluent Pump Station and assets within the area including architectural, structural, mechanical, HVAC, plumbing, electrical, and controls upgrades. Includes replacement of the low head pumps.	Assets in this project are in a reasonable condition and expected to last another 10-15 years.
WTP_23	Administration and Maintenance Buildings	$13.3	Condition-based rehabilitation of the Administration and Maintenance Buildings and assets within the buildings including architectural, structural, HVAC, plumbing, fire protection, electrical, and controls upgrades.	Assets in this project are in a reasonable condition and expected to last another 10-15 years.
WTP_24	Electrical Building + Medium Voltage Distribution System	$12.3	Condition-based rehabilitation of the Main Electrical Building and assets within the buildings including structural, HVAC, electrical, and controls upgrades.	Assets in this project are in a reasonable condition and expected to last another 10-15 years.
WTP_25	Site Improvements	$1.2	Site improvements including site paving, sidewalks improvements, and landscaping improvements.	Assets in this project are in a reasonable condition and expected to last another 10-15 years.

Project ID Definitions: ADM – Administrative Projects; PSU – Pump Station Upgrades; RES – Residuals Upgrades; WTP – Wastewater Treatment Plant Upgrades

(1) Estimated costs are the estimated construction costs for the project and include contractor overhead and profit, an allowance for final design elements, engineering costs, and construction contingency

9.2 RECOMMENDED PLAN

SESD compiled the results from the CSCIP as well as the WFMP into an integrated District-wide Capital Improvement Plan. In order to develop this plan, SESD conducted the following additional steps.

- Individual projects associated with the wastewater treatment facilities were grouped together into larger construction project consisting of multiple project elements that are related and/or physically located close to each other to minimize the need to return to the space for future work or to complete similar work at a similar time at one or more locations.
- Costs generated by AECOM and CDM Smith in the studies, which were in 2024 dollars, were separated into priority tiers (or tranches). Estimated durations for each project were identified and the projects were scheduled out over a specific span of time within the time span of each Tier. An inflation rate of 3% per year was also incorporated into the capital expenditures estimate.
- Based on this scheduling work and inflationary adjustment, the District developed an estimate of the capital expenditures for each year of the twenty-year plan.
- Additional costs were incorporated into the capital expenditures plan associated with Program Implementation Technical Support.

Table 55 summarizes the District-Wide Capital Improvement Plan and associated cost estimates.

The District-Wide Recommended Capital Improvement Plan provided in Table 55 was prepared to provide a path forward to resolve the needs identified. The costs to implement this District-Wide Recommended Capital Improvement Plan are substantial, and it is important to consider that it may be necessary to modify portions of the plan based on the available financial resources of SESD's member communities. The District-Wide Recommended Capital Improvement Plan will likely need to be adjusted and modified over time based on financing and other changing conditions.

Table 55: District-Wide Recommended Capital Improvement Plan

Project Number	Construction Contract Name	Project Element Name	Priority Tier	Tier 1 Project Costs	Tier 2 Project Costs	Tier 3 Project Costs	Tier 4 Project Costs
ADM_07	Program Implementation Technical Support	Program, Project Management, Construction Oversight & OPM Support	N/A Program Cost	$5,218,000	$7,972,000	$6,323,000	$5,778,000
ADM_01	Residuals Management Studies	Dewatering Pilot	1	$515,000			
ADM_02	Residuals Management Studies	Co-settling Demonstration	1	$1,569,000			
ADM_03	Secondary Treatment Process Optimization Study Phase I	Secondary Treatment Process Optimization Study Phase 1	1	$515,000			
ADM_04	Secondary Treatment Process Study Phase 2	Secondary Treatment Process Study Phase 2 Selective Wasting Pilot and Contact Stab Study	1	$1,045,000			
ADM_05	Odor Control Study	Odor Control Study Phase I	1	$515,000			
ADM_08	Beverly Beach Interceptor Assessment	Assessment + Alternatives Analysis	1	$164,000			
CSC_01	Bass River Siphon Upgrade Phase 1	Bass River Siphon Chambers	1	$5,324,000			
CSC_02	Marblehead Force Main Upgrades	Marblehead Force Main	1	$32,537,000			
CSC_03	Beverly Force main Upgrade Phase 1	Beverly Harbor Force Main	1	$30,398,000			
CSC_13	Peabody Salem Interceptor Rehabilitation Phase 1	Peabody Salem Interceptor Heavy Cleaning	1	$2,420,000			
PSU_01	Screening Upgrades	Pump Station Screening Upgrades	1	$4,738,000			
PSU_02	Influent Pump Station Upgrade Phase 1	Influent Pump Station High Priority	1	$16,067,000			
RES_01	Residuals Process Upgrade	Cake Storage	1	$12,024,000			
RES_02	Residuals Process Upgrade	Dewatering Upgrade	1	$16,089,000			
RES_03	Residuals Process Upgrade	Thickening upgrade or WAS co-settling	1	$6,103,000			
WTP_01	Secondary Process Upgrade Phase 1	Scum Removal Improvements	1	$10,165,000			
WTP_02	Secondary Process Upgrade Phase 1	Secondary Clarifiers Improvements - effluent visibility and monitoring	1	$1,913,000			
WTP_03	Secondary Process Upgrade Phase 1	Secondary Clarifiers Improvements - baffle/weir modifications	1	$3,826,000			
WTP_04	Secondary Process Upgrade Phase 1	Static Mixer Removal	1	$2,733,000			
WTP_05	RV Dump Station Relocation	RV Dump Station	1	$431,000			
ADM_06	Odor Control Study	Odor Control Study Phase 2	2		$1,212,000		

ADM_09	Danvers Collection System Assessment	Danvers Collection System Assessment	2		$2,424,000		
CSC_04	Beverly Force main Upgrade Phase 2	Beverly Force Main (landbased portion)	2		$23,867,000		
CSC_05	Bass River Siphon Upgrade Phase 2	Bass River Siphon Barrels	2		$6,766,000		
CSC_06	Beverly Water Street Interceptor Rehabilitation	Beverly Water Street Interceptor	2		$6,889,000		
CSC_07	Danvers Doty Avenue Sewer Rehabilitation	Danvers Doty Avenue Gravity Sewer	2		$12,302,000		
PSU_03	Influent Pump Station Upgrade Phase 2	Influent Pump Station	2		$5,211,000		
PSU_04	Beverly Pump Station Upgrade	Beverly Pump Station	2		$16,860,000		
PSU_06	Marblehead Pump Station Upgrade	Marblehead Pump Station	2		$11,664,000		
PSU_07	Peabody Metering Pump Station Upgrade	Peabody Metering Station	2		$1,576,000		
WTP_06	Secondary Process Upgrades Phase 2	RAS System Improvements	2		$6,369,000		
WTP_07	Secondary Process Upgrades Phase 2	Beverly Metering Station	2		$364,000		
WTP_08	Secondary Process Upgrades Phase 2	Salem Neck Pump Station	2		$2,830,000		
WTP_09	Secondary Process Upgrades Phase 2	Oxygen Reactor Controls Improvement	2		$1,968,000		
WTP_10	Secondary Process Upgrades Phase 2	Oxygen Reactor and Gallery Upgrades	2		$7,997,000		
WTP_11	Secondary Process Upgrades Phase 2	Selective Wasting	2		$6,397,000		
WTP_12	Secondary Process Upgrades Phase 2	Contact Stabilization	2		$4,183,000		
WTP_13	Secondary Process Upgrades Phase 2	Secondary Clarifiers and Buildings and Odor C	2		$20,666,000		
WTP_14	Plant Facilities Upgrades Phase I	Grit Building Upgrade (Condition)	2		$15,861,000		
WTP_15	Plant Facilities Upgrades Phase I	Grit Building Upgrade (Process)	2		$6,274,000		
WTP_16	Plant Facilities Upgrades Phase I	Operations Building	2		$54,519,000		
WTP_17	Plant Facilities Upgrades Phase I	Primary Clarifiers Buildings	2		$11,564,000		
CSC_08	Peabody Walnut Street Sewer Rehabilitation	Peabody Walnut Street Gravity Sewer	3			$6,884,000	
CSC_09	Peabody Salem Interceptor Rehabilitation Phase 2	Peabody Salem Interceptor	3			$53,684,000	
CSC_10	Salem Derby Street Sewer Rehabilitation	Salem Derby Street Gravity Sewer	3			$4,145,000	
PSU_08	Beverly Pump Station Resiliency Upgrades	Beverly Pump Station Resiliency Upgrades	3			$16,116,000	

WTP_18	Odor Control Upgrades	Odor G and B Upgrades	3			$49,092,000	
WTP_19	Odor Control Upgrades	Odor A and E Upgrades	3			$26,494,000	
WTP_20	Oxygen Generation Upgrade	Oxygen Generation	3			$24,252,000	
CSC_11	Danvers Doty Avenue Force main Rehabilitation	Danvers Doty Avenue Force Main	4				$32,736,000
CSC_12	WWTP Outfall Force main Upgrade	WWTP Outfall Force Main (Land Based Portion)	4				$20,572,000
CSC_14	Beverly Beach Interceptor Rehabilitation	SESD Portion of Beverly Beach Interceptor	4				$8,267,000
PSU_05	Danvers Pump Station Upgrade	Danvers Pump Station	2				$39,442,000
WTP_21	Plant Facilities Upgrades Phase 2	Chlorination Building	4				$4,464,000
WTP_22	Plant Facilities Upgrades Phase 2	Effluent Pump Station	4				$14,384,000
WTP_23	Plant Facilities Upgrades Phase 2	Admin and Maintenance Buildings	4				$22,322,000
WTP_24	Plant Facilities Upgrades Phase 2	Electrical Building + Medium Voltage Distribution System	4				$20,958,000
WTP_25	Plant Facilities Upgrades Phase 2	Site Improvements	4				$1,955,000
	TOTAL			$154,310,000	$235,740,000	$186,990,000	$170,880,000

Total of all four tranches - $747,900,000

9.3 Environmental Impacts and Regulatory Considerations

9.3.1 Watershed Management Program Impacts

There are not expected to be any impacts to watershed management program administered by the DEP. The District already has an NPDES permit. The changes to the District systems and the work proposed by the CWMP are not expected to impact the existing NPDES permit conditions. In fact, several of the proposed projects are expected to improve treatment, particularly during wet weather events while almost the entire program is being undertaken to improve overall system reliability and reduce the chance of system failure and release of untreated or partially treated wastewater into the environment.

9.3.2 Other Water Resources and Wastewater Planning Impacts

There are not expected to be any impacts to state, regional, or local non-point source or water resource management plans since no work is proposed that will impact non-point sources. Further, the recommended upgrades will literally protect healthy waters, which is a direct goal of these plans.

9.3.3 Massachusetts Environmental Policy Act Impacts

The SESD CWMP envisions a series of upgrade projects over the next 20 years to sustain our infrastructure and provide reliable ongoing wastewater collection and treatment. There are no significant changes in the capacity, configuration, or treatment that, in our opinion, are defined as "major and complicated." Thus we do not see a benefit from incorporating the MEPA process into the wastewater planning effort.

SESD does anticipate that some projects will trigger MEPA review, for instance the construction of a new Beverly Harbor Force Main. In these instances, the MEPA process will be undertaken as part of the design and permitting of these individual projects. Additional discussion on the applicability of MEPA for the recommended Collection System Improvements, Pumping Station Improvements, and WWTP Improvements are described in detail and included in CWMP Section 5.4, 6.4 and 7.4.

9.3.4 Other Environmental Permits and Impacts

The environmental impacts and environmental permitting requirements for the recommended collection system improvements, pumping station improvements, and WWTP Improvements are described in detail and included in CWMP Section 5.4, 6.4 and 7.4. In addition, the temporary, and direct and indirect impacts of the recommended improvements are also discussed in those sections.

9.4 Institutional Impacts

The primary institutional impact, one that may impact the District for 50 years, is that the District will be required to borrow significant funds to capitalize the District-wide CIP. This will impact on the debt structure and future financial obligations of the District. The repayment of the debt will need to be included into future District Budgets until it has been repaid.

No additional long-term institutional impacts to District organization or mission are expected as a result of the recommendations in the CWMP.

9.5 FINANCING PLAN

The District engaged the University of Massachusetts Boston's Edward J. Collins Jr Center for Public Management to develop a financial model and assess different funding mechanisms for the combined WWTP, Remote Pump Stations, and Collection System CIPs. The annualized capital spending projections summarized in Table 55 were provided to the Collins Center for their model.

9.5.1 Project Funding Mechanisms

There are several funding mechanisms for the combined WWTP, Remote Pump Stations, and Collection System costs that were investigated by the Collins Center and the District staff. Four debt scenarios were investigated for implementation of the four tranches (or priority tiers). The tranches or project priority groupings are broken into four separate five year long phases and include four debt borrowings. The debt scenarios that were modeled were as follows:

- 100% General Obligation (GO) Bonds at Market Rates
- 49% State Revolving Loan Fund (SRF) and 51% General Obligation Bonds
- 100% State Revolving Loan Fund Financing
- 49% Water Infrastructure Financing Act (WIFIA) and 51% State Revolving Loan Fund

The details of the principal, interest rates and debt service payments are included in the Capital Finance Presentation Overview Memorandum prepared by the Collins Center (attached).

9.5.2 Summary of Financial Consultant Recommendations

Estimates for the total debt service payments paid over a more than 50-year total time for the total estimated capital expenditure for the 20-year WWTP, Remote Pump Stations, and Collection System CIP were prepared for the four different funding mechanisms and are summarized in Table 56 (Collins Center Memo Table 2). Please note, the numbers presented in Table 56 are outdated because the cost of the capital program has increased since the completion of the Collins Center Memo due to movement of a project and the addition of several new studies and projects. The Collins Center Memo is in the process of being updated.

Table 56: Total Debt Service Estimates by Funding Scenario

Project Funding Mechanism	Total Debt Service Payments (Millions of Dollars)
100% GO Bonds	$1,288
49% SRF Loan + 51% GO Bonds	$1,135
100% SRF Loan	$938
49% WIFIA Loan + 51% SRF Loan	$1,010

Due to the magnitude of these numbers, it could be a challenge to authorize and implement such a large capital program at one time. Further, due to the uncertainty of forecasting costs beyond 10 years into the future and the outsized impacts of financing the total cost of the CIP, financial modeling performed focused on the first two tranches (10 years) of the CIP program. This modeling was completed using a 49% SRF / 51% GO bond split. The total costs to the District for the first 10 years of the CIP program, including both principal and financing costs, are presented in Table 57 (Collins Center Memo Table 3). Please note, the numbers presented in Table 57 are outdated because the cost of Priority Tier 1 and Tier 2 projects in the capital program has changed since the completion of the Collins Center Memo due to the movement of a project and the addition of several new studies and projects. The Collins Center Memo is in the process of being updated. This section of the report will be updated once the updated Collins Center Memo is received.

Table 57: Principal and Interest Payment Estimates for Priority Tiers 1 and 2

Project Funding Mechanism	Priority Tier 1	Priority Tier 2	Total
SRF Principal (49%)	$74,320,000	$130,488,000	$204,809,000
SRF Interest	$11,995,000	$20,982,000	$32,977,000
General Obligation Bond Principal (51%)	$77,353,000	$135,815,000	$213,168,000
General Obligation Bond Interest	$33,279,000	$69,328,000	$102,607,000
Total Principal	$151,674,000	$266,304,000	$417,978,000
Total Debt Service Payments	$196,948,000	$356,614,000	$553,562,000

As the table shows, the SRF interest payments are substantially lower than the interest payments for General Obligation bonds, reflecting how critical SRF financing support is to SESD and its ratepayers.

Finally, the Collins Center created a financial model that provides an estimate of the assessment increases for each of our member communities. This model looked at Operating costs, current debt costs, and the costs of debt for the recommended work. The model estimates that the total assessment for our member communities is expected to increase from $27.1 million in 2026 to $62.4 million in 2036. This is roughly equivalent to an annual assessment increase of 9.75% per year for ten years.

The District does not charge rates as a wholesale service provider. We assess the communities and the communities then assess rates on their rate payers. The District does not participate in the rate-setting work of our member communities. Regardless, such a large increase in annual assessments will impact the rate payers including residents and industrial and commercial customers. In a simplistic way to assess impacts, given a service population of 188,000 people, this represents an increase of $190 per person over the ten-year period noted above. This increase will certainly be felt by low-income residents in the district service area and by our commercial and industrial users. Therefore, it is critical that the District find additional funding sources, whether it be SRF 0 percent interest loans or principal forgiveness.

Additional recommendations included in the Collins Center Memorandum are as follows:

- Reach out to lending programs and verify assumptions and limitations on the scenarios proposed
- Assess the capital program size based on board feedback
- Continue discussions on the complicating factor of proposition 2-1/2 and approach to relief from that requirement
- Evaluate options for "smoothing" assessments or rate increases
- Explore additional grant funds or opportunities for principal forgiveness

The implementation of the CWMP will have a substantial impact to the District's budget. The District has been looking for and will continue to search for grant funding, which is quite limited. Further, SRF principal forgiveness for the District is also anticipated to be limited due to the per capita income of our service area.

9.6 IMPLEMENTATION PLAN

9.6.1 Staffing Assessment

A staffing assessment of the Districts Operations, Maintenance and Administrative personnel was prepared based on the New England Interstate Water Pollution Control Commission (NEIWPCC) Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants.

The guide includes a bottom-up approach to estimating annual operations and maintenance hours based on the size, process complexity and the number of physical units that are within an individual wastewater treatment plant.

The staffing guide includes seven categories to develop the staffing assessment:

1. Basic and Advanced Treatment (Liquid Processes)
2. Maintenance
3. Laboratory Operations
4. Biosolids/Sludge Handling
5. Yardwork
6. Automation and Supervisory Control and Data Acquisition (SCADA)
7. Considerations for Additional Plant Staffing

Based on the NEIWPCC guidance document, the SESD WWTP requires 70,000 worker-hours annually to maintain the Districts' management, operations, and maintenance activities for their WWTP and collection system. This is approximately 66 full-time staff including administration and management staff.

The District currently has 60 permanent full-time staff positions grouped into four divisions. This staff is responsible for the operation and maintenance of their WWTP, pump stations, and collection system. District staff is also responsible for administration, finance, and engineering support. The staffing assessment indicates that the District is slightly understaffed and approximately 6 additional staff are estimated to be needed. This assessment aligns with the District's experience as staff are noted to be frequently overworked and often have to focus their

time on high priority tasks, letting lower priority tasks remain unaddressed. As the District implements the CIP, their staffing needs may shift. However, it is not expected that a significant change in the labor required to operate and maintain their WWTP, pump stations, and collection system would be realized through the CIP implementation.

It is anticipated that the District would not have sufficient engineering staff to support a major CIP implementation and would need external support such as program management support or additional engineering support.

9.6.2 Operations Practices Assessment

The implementation of the CIP is not expected to significantly change the District's operations practices at their WWTP or pump stations as no major process changes are recommended in the WWTP and Remote Pump Station CIP. Many of the proposed upgrade projects were recommended in part to improve operations and reduce the operational labor required. For example, the proposed upgrades to the WWTP instrumentation and SCADA system are expected to streamline and automate WWTP operations as the District primarily operates the WWTP manually. These improvements are not expected to significantly change the number of staff required for operations but are expected to reduce the workload on the operations staff, freeing up time for less critical activities that can improve the operation and control of the plant.

9.6.3 Maintenance Practices Assessment

The implementation of the CIP is not expected to significantly change the total labor required for maintenance at the District's WWTP or pump stations. However, the replacement of aging equipment in the CIP will likely reduce the labor required for unplanned maintenance related to fixing older equipment. Maintenance practices would likely make a shift towards performing more preventative maintenance. Some of the proposed upgrade projects in the CIP would add more equipment to improve the operation of the plant, therefore resulting in more labor required to maintain the additional equipment. The upgrades proposed to the WWTP SCADA system will also require additional labor to maintain. As a whole, the changes in maintenance requirements with the WWTP and Pump Station CIP implementation are not expected to significantly change the maintenance staffing requirements for the District.

9.6.4 Asset Management Assessment

The CIP implementation would replace a large portion of the District's assets while adding some new assets that will need to be managed. The District currently has an asset management system that has allowed them to effectively manage their assets. The proposed upgrades to the WWTP and Pump Stations are not expected to necessitate the need for a new asset management system. However, the proposed upgrades present an opportunity to update and improve the District asset database as proposed projects are completed, and the new assets can be added or replace those already in the database while the equipment documentation is readily available through the construction documentation. It is recommended that the District standardize the entry of the new assets into the database including considering if the data entry of the new assets will be performed internally by District staff or by a consultant who would perform all of the data entry for different upgrade projects as they occur.

10 PUBLIC PARTICIPATION

10.1 SUMMARY OF PUBLIC OUTREACH

The District has been actively increasing its public outreach efforts over the past two years in anticipation of the upcoming implementation of the recommended work. Efforts taken to date include the following:

- Development of a new District logo, branding approach, tag line (Wastewater Treatment for a Cleaner Environment) – which culminated with the launch of a new website showcasing these efforts in September 2024.
- Development of a partnership with Salem Sound Coastwatch, including participating with them in school education programs at schools within the District. Further, the executive director participated in a Salem Sound evening lecture series with a presentation focused on the importance of wastewater treatment in March 2025.
- Creation of a new education program called Pipe Detectives – aimed as school age children to educate them about what they (and their parents) should and should not flush. See Figure 6 below for the Pipe Detective rack card we have developed.
- Outreach to aligned environmental organizations including Salem Sound Coastwatch, Salem Chamber of Commerce, Salem Alliance for the Environment, and Change is Simple, including plant tours with employees and volunteers.
- Development of a booth and participation in several environmental themed festivals in the Service Area including the Salem Green Living Expo, Division of Marine Fisheries Marine Quest Festival, and Beverly Harbord Days – where we promote the importance of wastewater treatment and the work we do to protect the environment.

There is more work and promotion to do, but the District and the Board understand the importance of communicating the about how the services we provide are essential. This understanding is critical for the District to gain public support for our upcoming work.



Figure 6: Pipe Patrol Rack Card

10.2 Summary of Public Participation

The District has been coordinating with AECOM and will be conducting a Public Hearing in the winter of 2025 / 2026. The District is aware this is a requirement of the CWMP process and it was in AECOM's initial scope to complete the WFMP. The intent is to schedule this meeting once the draft CWMP is completed and has been reviewed by the Massachusetts DEP for completeness. A meeting will be advertised and a summary report prepared after the public hearing.