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REGIONAL WASTEWATER TREATMENT CONSOLIDATION STUDY

Technical Memorandum 4: Regional Wastewater Alternatives Short List Development

B&V PROJECT NO. 198910

PREPARED FOR

Naugatuck Valley Council of Governments

23 December 2020

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1.0 BACKGROUND AND PURPOSE

This technical memorandum (TM) No. 4 is a continuation of the regional wastewater treatment consolidation study being carried out by the Naugatuck Valley Council of Governments (NVCOG). The Task 2 work within this Phase 2 effort resulted in a total of seven regional alternatives to be carried forward into this Task 3, with an end goal of identifying the preferred alternative(s). The seven short-listed regional alternatives are identified below.

Table 1-1 Short List of Regional Wastewater Alternatives

No.	Alternative Description
3	Derby to Ansonia
4	Derby to Ansonia, Effluent Pumped to Housatonic River
5	Derby and Seymour to Ansonia
5b	Derby and Seymour to Ansonia, Effluent Pumped to Housatonic River
8	Ansonia to Derby
9	Seymour and Ansonia to Derby

This TM summarizes the work carried out in Task 3. The work effort is essentially synthesized in the following statements. The report is also organized to follow this structure.

1. More detailed development of the regional alternatives. The short-list regional alternatives have undergone more detailed analysis and development along with the 'base case' alternatives where each of the communities would continue to handle, treat and discharge their wastewater as they are currently doing. Treatment facility and wastewater conveyance systems infrastructure requirements are more fully defined. The collection systems are also addressed.
2. Budgetary cost development. Budgetary capital costs were assigned to each of the shortlisted regional alternatives and base case scenarios. Operations and maintenance (O&M) costs were also assigned for the regional alternatives and base case facilities.
3. Cost evaluation/analysis of the regional alternatives and base case facilities. This analysis will allow for a comparison of the regional alternatives and base case scenarios on both a capital cost and life cycle (present worth) basis. The present worth analysis allows for the capital and O&M costs to be converted, allowing for the alternatives to be compared on a present worth dollar basis.
4. Recommended alternatives. The forgoing information will allow for the preferred alternative(s) to be identified on a cost analysis basis. While other factors will contribute to the final decision, that is not part of this existing work task.

2.0 WASTEWATER TREATMENT PLANT DEVELOPMENT

2.1 INTRODUCTION

The technical study and engineering detail at the wastewater treatment plants was expanded further to define the planning level infrastructure needs associated with the short-listed regional alternatives and base case scenarios. Task 2 development efforts focused on wastewater process engineering on the parts of the plant that are traditionally more land intensive (i.e. primary and secondary treatment). Process related engineering and planning was continued in this task for each of the regional plants and base case facilities. This allowed for confirmation associated with the identified infrastructure needs (e.g. tanks) and the operating requirements for these systems (e.g. energy, chemical usage) that would be used in the present worth comparison of alternatives.

In addition, other critical parts of the plants that had not been addressed in Task 2 development were also better defined. These included: influent and effluent pumping systems, preliminary treatment (screenings and grit removal), effluent disinfection, sludge processing, treatment and disposal, plant administration facilities/buildings, and other major systems (e.g. electrical and SCADA).

General process considerations and data updates applying to the plants are described in Appendix A. Sludge management applying to the plant is described in Appendix B.

2.2 BASE CASES PLANTS

The base case wastewater treatment plant requirements for Derby, Ansonia and Seymour documented in Phase 1 and in Task 2 deliverables were developed further in this task. The resultant work has allowed for a more complete picture of the infrastructure needs at these plants and allowed for the associated upgrade costs to be established.

2.2.1 Derby

2.2.1.1 Performance

The historic effluent N loads at Derby are shown in Figure 2-1 below alongside the N General Permit waste load allocation (WLA). What this shows is that in some years the WLA is exceeded, and N credits must be purchased from the state, while in some other years the WLA is met. As established above, at current flows Derby would need to achieve an effluent TN of 6.0 mg/L-N on average in order to meet the WLA. With the current modified Ludzack-Ettinger process configuration, meeting this WLA is challenging during all months of the year and at various loadings. As the flows and loads increase during the study period, the required effluent concentration will decrease accordingly to approximately 5.0 mg/L-N. As this happens, either N credits will need to be purchased more frequently, or process upgrades such as the addition of a post-anoxic zone and supplemented carbon feed system will be required.

The addition of a post-anoxic zone would allow the facility to more consistently meet the N WLA even as flow increases in the future. Additionally, these post anoxic zones should be set up as swing zones, allowing the plant to operate these as:

- Unaerated anoxic zones with carbon dosed for greater removal of N during warmer periods, and

- Aerated during colder months as needed in order to retain capacity.

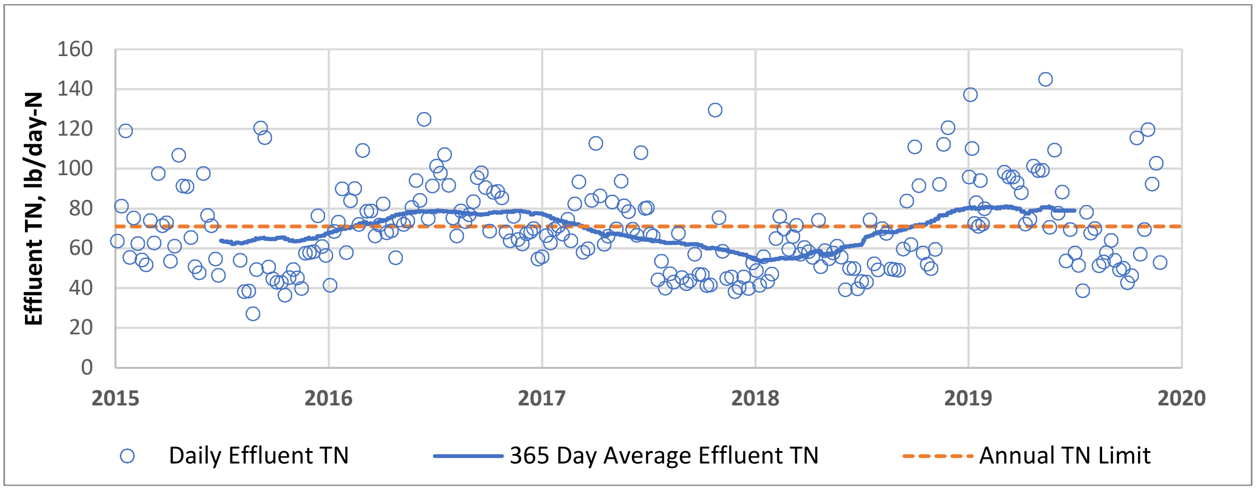


Figure 2-1 Derby Effluent N Loads

2.2.1.2 Capacity

In the previous Task, it was determined that to meet primary treatment capacity requirement at 2040 design conditions, additional primary clarifiers would not likely be needed; however, it was noted that there may be some reduction in primary solids removal performance as flows increase.

In the previous Task, it was determined that to meet secondary capacity requirements, the third aeration basin, which has not been upgraded to an MLE process for nitrogen removal as of 2020, would need to be upgraded to meet 2040 requirements. With the lower growth projections from the recent Derby Facility Plan (resulting in an annual average flow of 1.59 mgd), the need for this upgrade was reevaluated. The upgrade of the third basin is still recommended as it will meet capacity requirements without the need for step feeding. The facility plan recommends that an additional structure be built as a common reaeration zone. We believe that a 4-stage process with swing post-anoxic zones and reaerations zones can be incorporated into the footprint of the three existing aeration basins and that this additional external tankage is not necessary.

The facility plan also recommends the construction of two new deeper secondary clarifiers with the construction of a mixed liquor flow splitting structure and RAS pumping station. Additionally, the plan calls for the rehabilitation of one existing secondary clarifier and the demolition of the other. While newer and deeper secondary clarifiers would improve performance and add redundancy, we believe improving sludge settleability to be more important to achieve capacity and performance. The "addition" of the third aeration basin (upgrade of existing inoperable basin) should be adequate to meet the increase in loading with similar performance as is currently achieved. The additional aerobic volume along with settling rate enhancements and refurbishment of the existing secondary clarifiers, mixed liquor splitter, and RAS pumping system will allow the plant to achieve similar performance as it has historically at the projected future flow. Table 2-1 summarizes capacity parameters at Derby in 2040 based on the suggested upgrades.

Table 2-1 Derby Capacity Parameters in 2040

Facility Requirements and Capacities	2040 Annual Average (1)	2040 Max Month
Additional Primary Clarifiers	**0**	**0**
Primary Clarifier SOR, gal/day/ft^2	550	850
Additional Aeration Basins (2)	**1**	**1**
Additional Secondary Clarifiers	**0**	**0**
Aeration Basin Total HRT, hrs	20.3	13.2
Aeration Basin MLSS, mg/L	1870	3430
Secondary Clarifier SOR, gal/day/ft^2	560	430
Secondary Clarifier SLR, lb/day/ft^2	15.6	24.9

(1) With one secondary clarifier offline at average loading conditions.
(2) Derby has two existing aeration basins that are operable and one aeration basin that is inoperable. In the process evaluation, it was assumed that the inoperable basin would be upgraded to meet additional aeration basin needs.

This subsection and the one proceeding it have addressed the need for additional primary and secondary liquid stream unit processes. In addition to the upgrades identified to these two process areas to increase capacity for 2040 flow and load conditions, there are numerous capital improvements required at other areas of the Derby plant. These are required to address poor condition, age/usefulness, inefficiencies and treatment bottlenecks throughout the plant and are highlighted in the next subsection.

2.2.1.3 Other Needed Upgrades

Table 2-2 lists the upgrades needed at the Derby wastewater plant based on the condition assessment performed as a part of Phase 1 and additional investigations conducted since that time. These upgrades, which cover both existing structures and equipment were identified as being needed from observations made during site visits and from information corroborated by Derby plant staff. These upgrades are required for the Derby base case; they were also carried into regional alternatives as applicable.

Table 2-2 Derby Facility Upgrades Needed

Area/Facility	Upgrades Required
Raw wastewater Screening Facility and Influent Pump Station	• Replace manually cleaned trash racks with two mechanical screens for greatly improved process performance and redundancy. Include screenings washer/grinder compactor system • Replace existing ventilation system with improved HVAC. Include odor control systems to remove H_2S gas and other influent odorous compounds • Replace influent pumps, piping, valves, electrical components, VFDs and controls • Repair damaged concrete, reconfigure intermediate platforms
Grit Removal Facility	• Demolish existing aerated grit facility • Construct new vortex grit removal facility
Primary Clarifiers	• Replace mechanisms • Remove channel mounted comminutor • Repair damaged concrete
Aeration Basins	• Replace air piping, diffusers, MLR pumps, mixers, valves, gates, and instrumentation for all three aeration basins (refer also to requirements described above)
Secondary Control Building	• Replace blowers, aeration piping, and valves • Replace RAS and WAS pumps, piping, and valves • Partition sludge pumps off from blowers and upgrade HVAC system to protect blowers and controls from corrosive wastewater gases
Secondary Clarifiers	• Replace mechanisms • Upgrade flow splitter box to improve hydraulic balance between clarifiers
Disinfection	• Upgrade sodium hypochlorite and sodium bisulfite chemical feed systems
Sludge Handling Facility	• Demolish aerobic digesters • Demolish sludge belt filter press and polymer feed system • Construct new sludge handling facility to process thickened sludge for ultimate disposal (refer to appendix for detail)
Primary Control Building	• Upgrade control building with remodeled interior and new HVAC system
Electrical and Control Systems	• Replace all motor control centers and power/lighting panels • Add a new plant supervisory control and data acquisition (SCADA) system
General	• Add grating or platforms above water surfaces where needed • Plant-wide structural concrete repairs • Replace plant water system • Replace underground process piping as needed

A brief description of some of the more significant facility upgrades in the above table is provided below

2.2.1.3.1 New Facilities and Reconfigured Existing Facilities

New facilities proposed for the Derby base case include a Grit Removal Facility and Sludge Handling Facility. Existing facilities that will undergo a major upgrade include the Influent Pump Station. Preliminary layouts of these facilities were developed for capital cost development. The reconfigured Raw Wastewater Screening Facility and Influent Pump Station is shown in Figure 2-2 and the new Grit Removal Facility is shown in Figure 2-3 (note that two vortex grit chambers are indicated, which applies to regional plants described later in this chapter; one vortex grit chamber is assumed for the Base Case); the new Sludge Handling Facility is shown in Figure B 1 in Appendix B.

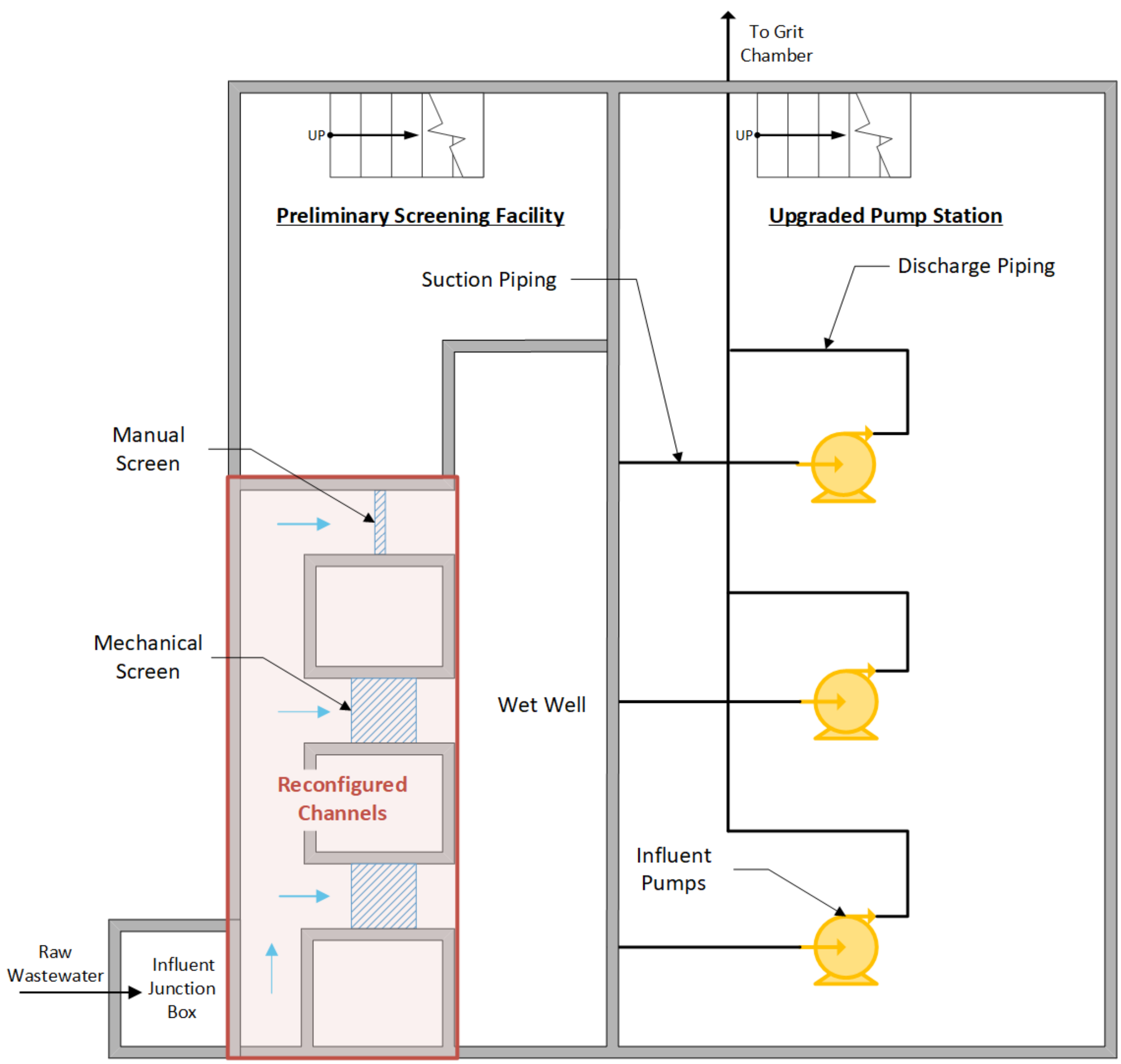


Figure 2-2 Preliminary Screening and Influent Pump Station for Derby

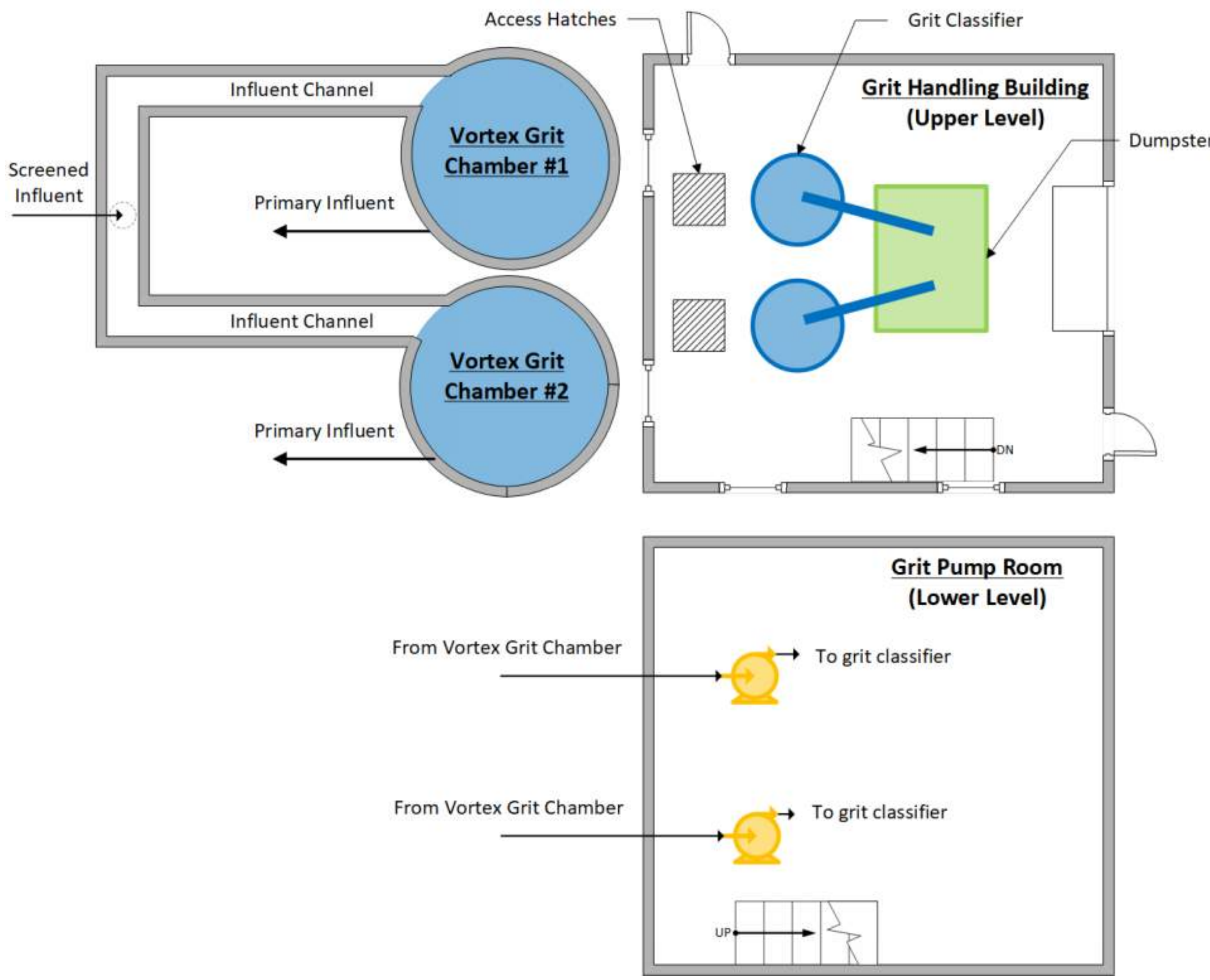


Figure 2-3 New Grit Removal Facility for Derby

Derby Base Case Site LayoutFigure 2-4 shows the conceptual site layout of the Derby WPCF base case.

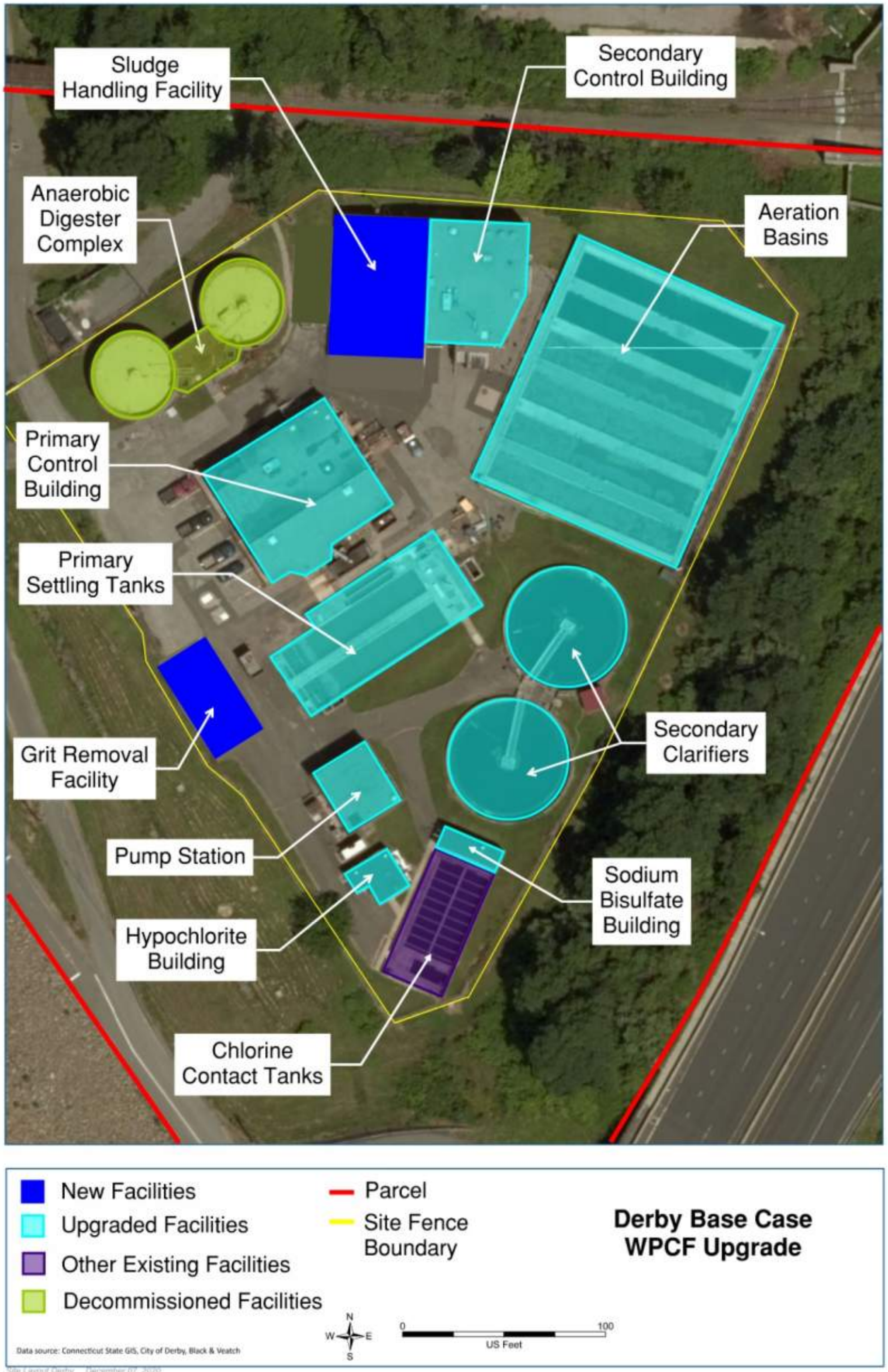


Figure 2-4 Derby Base Case Site Layout

2.2.2 Ansonia

2.2.2.1 Performance

The historic effluent N loads at Ansonia are shown in Figure 2-5 below alongside the N General Permit waste load allocation (WLA). The effluent N load is generally less than half of the WLA meaning that Ansonia is consistently a seller of N credits to the state credit trading program. As stated above, Ansonia's target effluent N concentration to meet the WLA is higher than those at Derby or Seymour with the average effluent TN to meet the load limit being 7.2 mg/L-N at 2040 flows. Despite the higher limits, Ansonia performs very well with average effluent TN of 3.3 mg/L-N. This is almost certainly due to the oxidation ditch configuration which operates at lower dissolved oxygen levels and achieves simultaneous nitrification and denitrification. Additionally, the facility has a 4-stage process, which has pre- and post-anoxic zones upstream and downstream of the oxidation ditch.

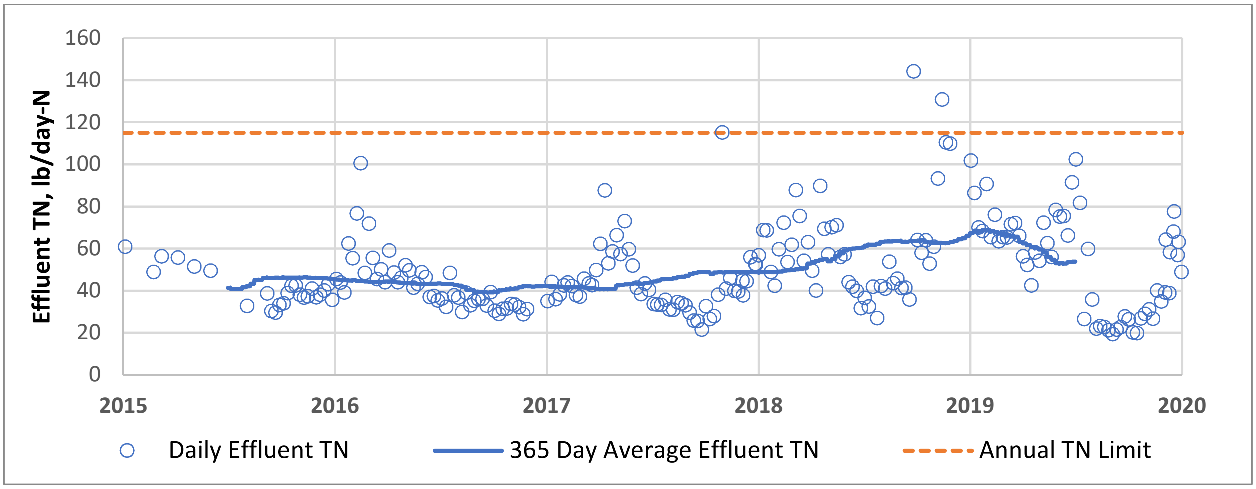


Figure 2-5 Ansonia Effluent N Loads

Ansonia is required to meet a seasonal phosphorus load limit of 11.92 lb/day from April through October. Based on average flows, this requires the facility to achieve a concentration of approximately 0.8 mg/L-P on average during that period, though the actual concentration required is greater than 0.9 mg/L-P as flows in the summer months are lower. Based on 2040 flows the requirement decreases to approximately 0.75 mg/L-P on average. These concentrations can be achieved through the dosage of chemical coagulant to the secondary process which has already been implemented at Ansonia.

2.2.2.2 Capacity

In the previous Task, it was determined that to meet primary treatment capacity requirements at 2040 design conditions, additional primary clarifiers will not likely be needed. Additionally, secondary capacity was determined to not be limiting at Ansonia in 2040. In this task, the capacity at Ansonia was revisited based on the refinements to the capacity and performance evaluation. Growth projection at Ansonia have not changed and CEPT is not necessary.

Based on biokinetic modeling, a more conservative SRT was selected for Ansonia. Additionally, a more thorough review of SVI data indicated that higher SVIs, corresponding to worse settling, should be assumed. If maximum month SVIs of approximately 200 mL/g is assumed, state point analysis still indicates that there should be no issues in meeting the 2040 capacity requirements. Table 2-3 summarizes capacity parameters at Ansonia in 2040 without any additional primary and secondary treatment upgrades.

Table 2-3 Ansonia Capacity Parameters in 2040

Facility Requirements and Capacities	2040 Annual Average (1)	2040 Max Month
Additional Primary Clarifiers	0	0
Primary Clarifier SOR, gal/day/ft^2	390	680
Additional Aeration Basins	**0**	**0**
Additional Secondary Clarifiers	**0**	**0**
Aeration Basin Total HRT, hrs	38.1	21.9
Aeration Basin MLSS, mg/L	900	1,500
Secondary Clarifier SOR, gal/day/ft^2	5.0	7.8
Secondary Clarifier SLR, lb/day/ft^2	340	290
(1) With one secondary clarifier offline at average loading conditions.		

This subsection and the one proceeding it have addressed the need for additional primary and secondary liquid stream unit processes. In addition to the upgrades identified for these two process areas to increase capacity for 2040 flow and load conditions, there are capital improvements required at other areas of the Ansonia plant. These are required to address poor condition, age or usefulness, inefficiencies and treatment bottlenecks throughout the plant and are highlighted in the next subsection.

2.2.2.3 Other Needed Upgrades

Table 2-4 lists the upgrades needed at the Ansonia wastewater plant based on the condition assessment performed as a part of Phase 1 of this study and additional investigations conducted since that time. These upgrades, which cover both existing structures and equipment were identified as being needed from observations made during site visits and from information corroborated by Ansonia plant staff. These upgrades are required for the Ansonia base case; they were also carried into regional alternatives as applicable.

Table 2-4 Ansonia Facility Upgrades Needed

Area/Facility	Upgrades Required
Headworks	• Add second mechanical screen for added redundancy and ability to bypass the existing single screen • Replace ventilation and odor control system for headworks area to improve air quality and reduce corrosive H_2S gas concentrations
Disinfection	• Build new UV disinfection channel for added redundancy and ability to bypass the existing single UV channel
Effluent Pump Station	• Upgrade effluent pumps to meet peak flows (current system limited to 7 mgd)
Sludge Handling Facility	• Demolish existing sludge holding tanks • Build new sludge handling facility to process thickened sludge (refer to Appendix for details)
General	• Demolish non-functioning soda ash storage and feed system • Plant-wide structural concrete repairs

2.2.2.3.1 New Facilities and Reconfigured Existing Facilities

New facilities proposed for the Ansonia base case include a Sludge Handling Facility, shown in Figure B 1 in Appendix B. While no significant or large-scale facility retrofits are proposed for the Ansonia base case, as noted above, a number of moderate ones have been identified as being needed.

2.2.2.4 Ansonia Base Case Site Layout

Figure 2-6 shows the conceptual site layout of the Ansonia WPCF base case.

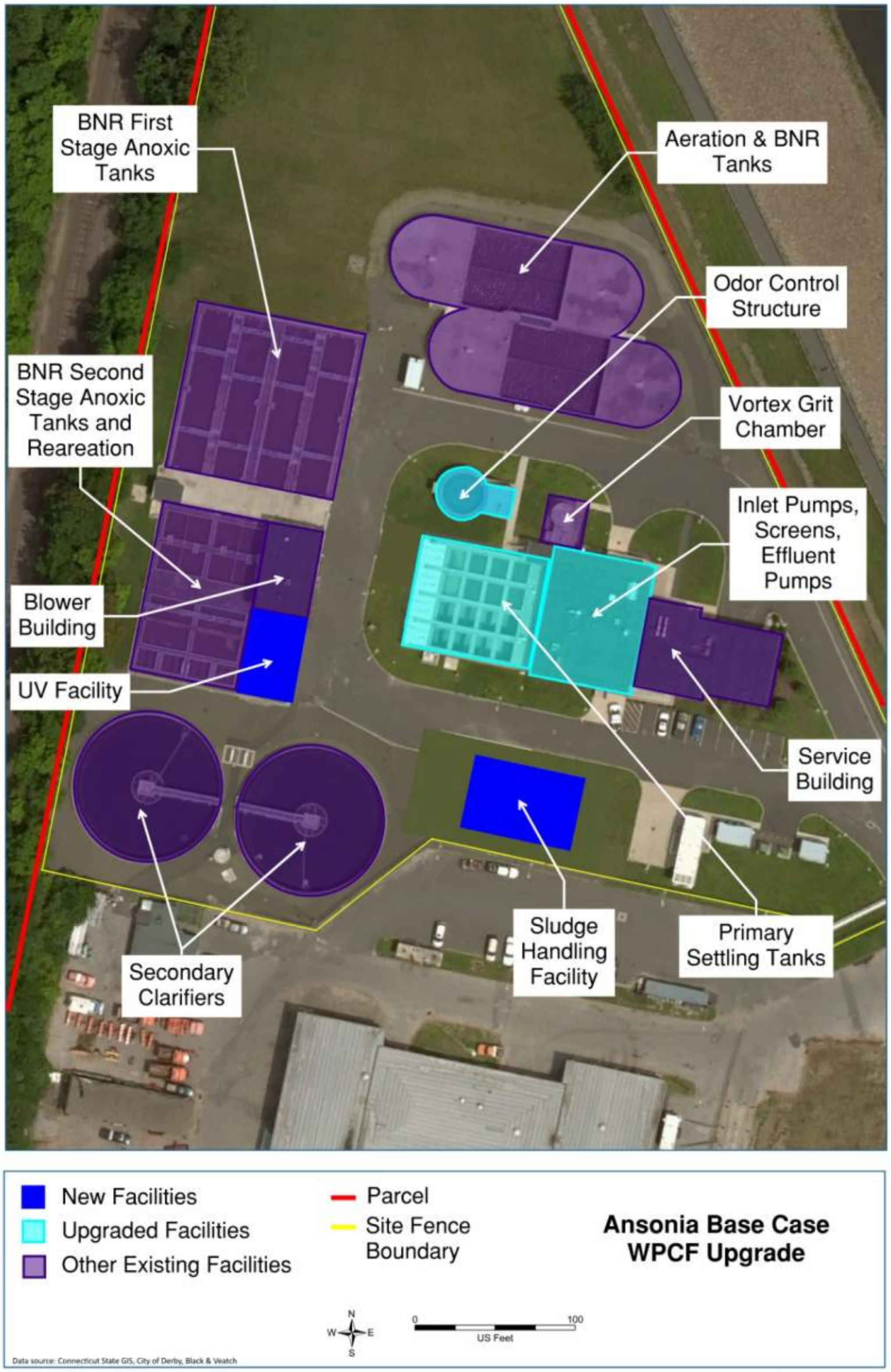


Figure 2-6 Ansonia Base Case Site Layout

2.2.3 Seymour

2.2.3.1 Performance

The historic effluent N loads at Seymour are shown in Figure 2-7 below alongside the N General Permit waste load allocation (WLA). What this shows is that in some years the WLA is exceeded, and N credits must be purchased from the state, while in some years the limits are met. As established above, at current flows Seymour would need to achieve an effluent TN of approximately 7.5 mg/L-N on average in order to meet the WLA. To meet this WLA, the current modified Ludzack-Ettinger process should be adequate provided that MLR pump system and anoxic zones are properly sized and that adjustments are made to improve the environment in the anoxic zone such that the process is more efficient. In addition to design, the influent C:N ratio impacts N removal performance, and the lower than average C:N ratio in the influent at this facility may be one of the issues to Seymour meeting its N target during various times of the year. Meeting this WLA will become more challenging as the flow and loads increase, with the required effluent concentration to meet the limit at 2040 flows being approximately 5.6 mg/L-N. As this happens, either N credits will need to be purchased more frequently or process upgrades will need to be explored. This could include increasing the MLR pump system size and adding a supplemental carbon feed system, or it could also mean the addition of a post-anoxic zone to create a 4-stage process as recommended at Derby. In summary, due to the relatively small scale of Seymour, and our observations at the plant, operational based changes with more moderate capital investment should be investigated to improve the system's N removal capability. If this is found to be effective, the Town, if needed, should expect to buy N credits when certain conditions arise when operational changes are not adequate to meet the N General Permit load allocation.

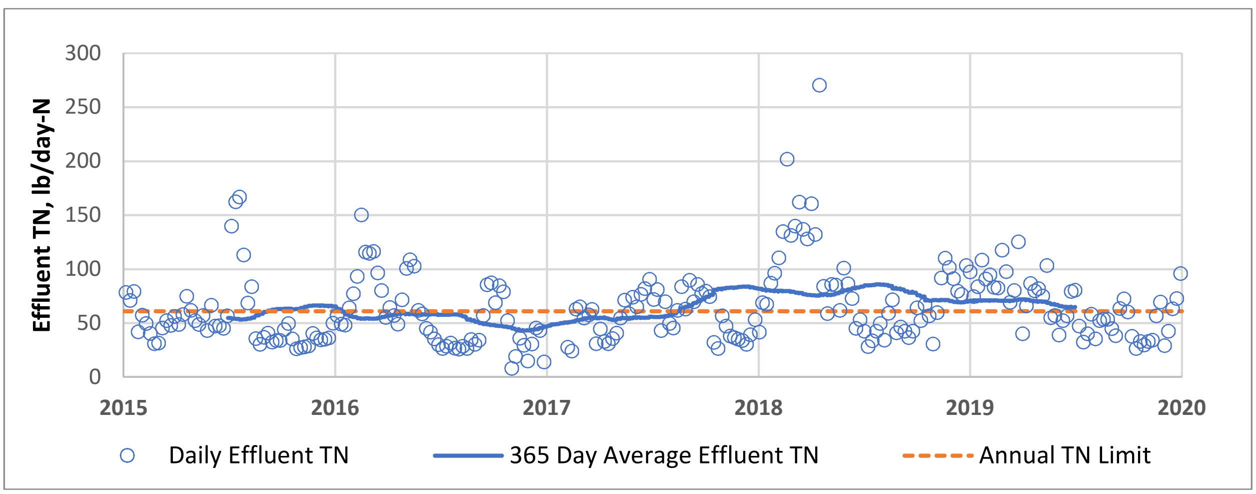


Figure 2-7 Seymour Effluent N Loads

With the recent permit renewal, Seymour is required to meet a seasonal phosphorus load limit of 7.54 lb/day from April through October. Based on annual average flows this requires the facility to achieve a concentration of approximately 0.9 mg/L-P on average during that period; however, the actual required concentration may be greater than 1.0 mg/L-P because plant records indicate that flows in the summer months are typically lower. Based on 2040 flow projections, the requirement decreases to approximately 0.7 mg/L-P on average. These concentrations can be achieved through the dosage of chemical coagulant to the secondary process which has already been implemented at Seymour.

2.2.3.2 Capacity

In the previous Task, it was determined that to meet primary treatment capacity requirement at 2040 design conditions, additional primary clarifiers will not likely be needed. Additionally, secondary capacity was determined to not be limiting at Seymour under 2040 conditions. Our analysis during that Task also found that if the Seymour plant was to accept Beacon Falls wastewater flow then, process improvements to enhance settleability at Seymour would need to be implemented. However, because this long-list regional alternative (Beacon Falls to Seymour) was eliminated in Task 2, an additional settling tank at Seymour is not required. In this task, the capacity at Seymour was revisited based on the refinements to the capacity and performance evaluation. Growth projection at Seymour has not changed and CEPT is not necessary and so the conclusion for the Seymour base case remains largely the same as had been reported in Task 2. Table 2-5 summarizes capacity parameters at Seymour in 2040 without any additional upgrades to secondary treatment.

Table 2-5 Seymour Capacity Parameters in 2040

Facility Requirements and Capacities	2040 Annual Average (1)	2040 Max Month
Additional Primary Clarifiers	**0**	**0**
Primary Clarifier SOR, gal/day/ft^2	490	970
Additional Aeration Basins	**0**	**0**
Additional Secondary Clarifiers	**0**	**0**
Aeration Basin Total HRT, hrs	16.7	8.4
Aeration Basin MLSS, mg/L	1,420	2,370
Secondary Clarifier SOR, gal/day/ft^2	390	390
Secondary Clarifier SLR, lb/day/ft^2	10.0	16.6
(1) With one secondary clarifier offline at average loading conditions.		

This subsection and the one proceeding it have addressed the need for additional primary and secondary liquid stream unit processes. In addition to the upgrades identified for these two process areas to increase capacity for 2040 flow and load conditions, there are numerous capital improvements required at other areas of the Seymour plant. These are required to address poor condition, age/usefulness, inefficiencies and treatment bottlenecks throughout the plant and are highlighted in the next subsection.

2.2.3.3 Other Needed Upgrades

Table 2-6 lists the upgrades needed at the Seymour wastewater plant based on the condition assessment performed as a part of Phase 1 of this study and additional investigations conducted since that time. These upgrades, which cover both existing structures and equipment were identified as being needed from observations made during site visits and from information corroborated by Seymour plant staff. These upgrades are required for the Seymour base case; they were also carried into regional alternatives as applicable.

Table 2-6 Seymour Facility Upgrades Needed

Area/Facility	Upgrades Required
Headworks	• Complete refurbishment of the preliminary treatment system which includes screening and grit removal • Replace mechanical screen and add redundant unit. Add washer grinder compactor • Replace grit removal equipment • Add enclosure structure, ventilation (with odor control) to improve operations and maintenance during all seasons of the year
Influent Pump Station	• Replace pumps, piping, valves and electrical components, VFDs and controls
Primary Clarifiers	• Replace mechanisms; modify for more efficient operation
Aeration Basins	• Replace air piping, diffusers, MLR pumps, mixers, valves, gates, and instrumentation
Old Digester Complex	• Add one additional aeration turbo blower for redundancy • Demolish existing multi-stage centrifugal blowers
Control Building	• Replace RAS and WAS pumps • Demolish rotary drum thickener, belt filter press, and polymer system • Add new gravity belt thickeners and associated systems to manage sludge as a thickened liquid • Upgrade HVAC and odor control systems to improve air quality and remove H2S produced by sludge processing
Secondary Clarifiers	• Replace mechanisms (feed well, scrapers, skimmers, scum collector, baffles and weirs). Inspect bridge to determine need for refurbishment or replacement
Sludge Handling Facility	• Demolish aerobic digesters • Demolish sludge belt filter press and polymer feed system • Build new sludge handling facility to process thickened sludge (refer to Appendix for details)
Primary Control Building	• Upgrade/refurbish control building interior
Electrical and Control Systems	• Replace switchgear, motor control centers and power/lighting panels predating the early 1990s upgrade • Add a new plant supervisory control and data acquisition (SCADA) system
General	• Plant-wide structural concrete repairs

2.2.3.3.1 New Facilities and Reconfigured Existing Facilities

Major new/or significantly upgraded facility for the Seymour base case includes the sludge handling system to manage sludge as a thickened liquid instead of dewatered cake. This process configuration is depicted in Figure B 1 in Appendix B. Other significant upgrades involve the influent pump station, the preliminary treatment systems (both screening and grit removal), and new equipment at the primary clarifiers, the secondary clarifiers, and modifications at the aeration basins. Major upgrade is also needed on the plant electrical power system. A new SCADA system is also required.

Seymour Base Case Site Layout

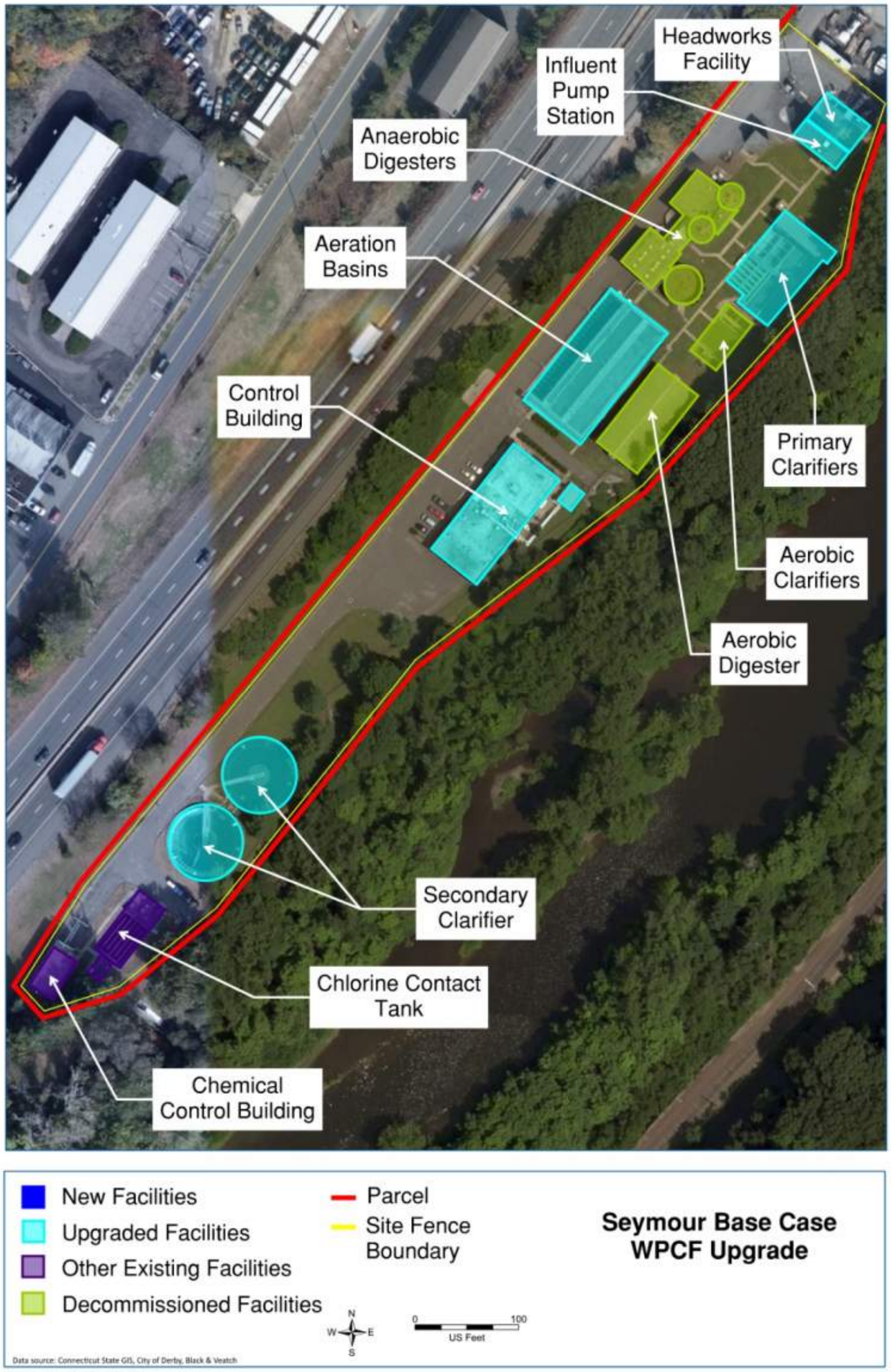


Figure 2-8 shows the conceptual site layout of the Seymour WPCF base case.

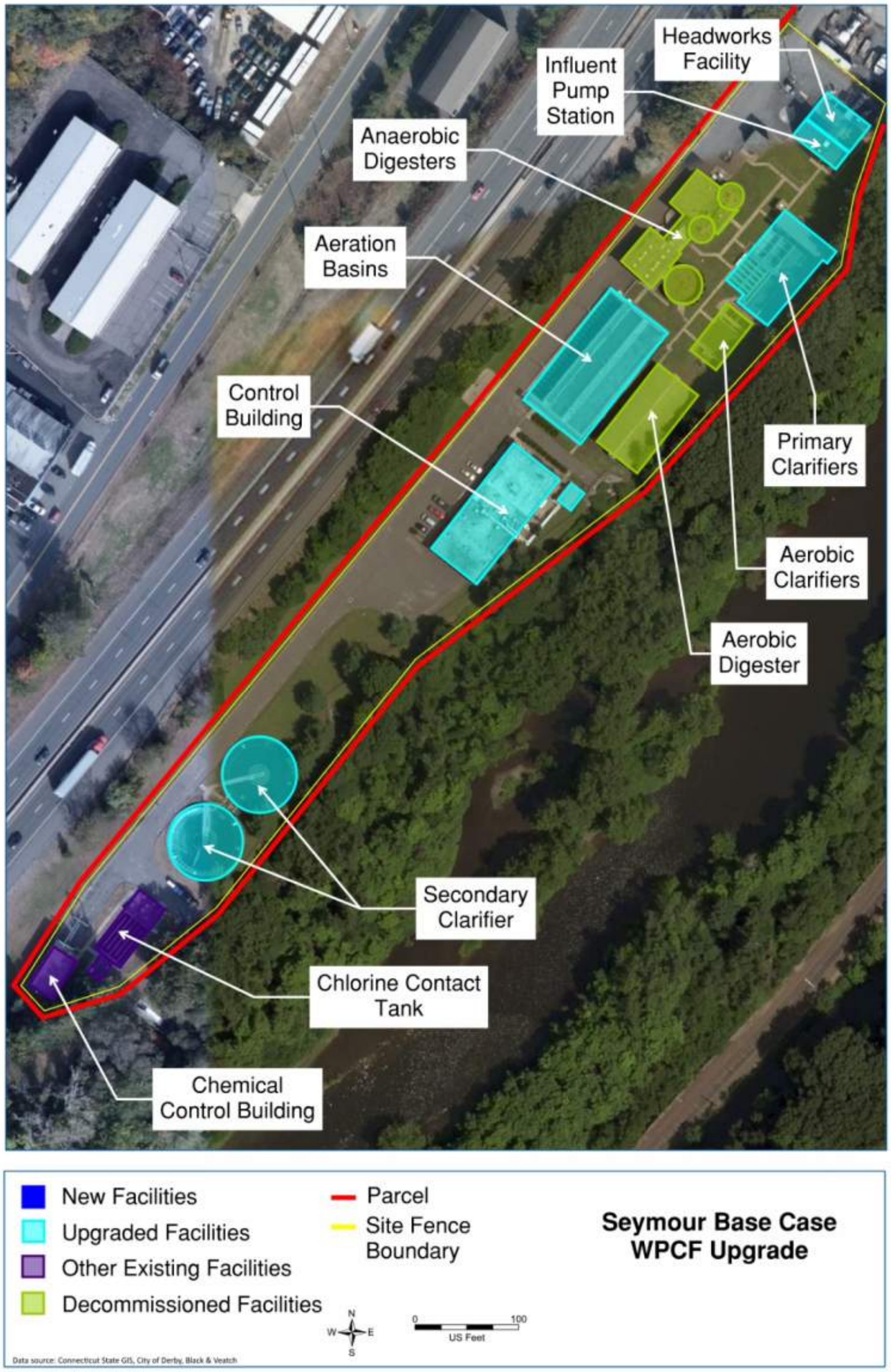


Figure 2-8 Seymour Base Case Site Layout

2.3 DERBY REGIONAL ALTERNATIVES

2.3.1 Issues

Task 2 evaluations of major unit processes for primary and secondary treatment indicated that regionalization at Derby was possible. However, due to the constrained site, both new treatment facilities and intensification technologies are required to treat the flows and loads associated with regionalization. For primary treatment, CEPT negates the need for additional primary settling tanks and reduces the loading to secondary treatment. Two intensification alternatives evaluated in Task 2 were assessed in greater detail; ballasted sedimentation and integrated fixed-film activated sludge (IFAS). These processes were evaluated in greater detail in this Task and with the load reduction associated with CEPT factored in by using Biokinetic modeling. This also allowed for estimation of planning level operational related costs. An advantage of regionalization at Derby is that discharge will be into the Housatonic. This discharge location does not have phosphorus limits associated with it and, as a result, does not require tertiary treatment which is in contrast to some of the regionalization alternatives at Ansonia.

2.3.2 Facilities

2.3.2.1 Ballasted Sedimentation Based Upgrades

Ballasted Activated Sludge enhances process capacity through the addition of high-density ballasting particles to the activated sludge process to increase the settling rate of the activated sludge flocs. The most widely adopted of this is the BioMag™ process by Evoqua in which magnetite is added and recovered through a magnetic recovery process. This enhances the settling rate and secondary sludge thickening characteristics allowing for an increased capacity both in terms of flow and loading.

Broadly, required equipment can be separated into two categories, the first being the equipment necessary for the feeding and recovery of magnetite which is generally part of the technology vendor scope of supply. Figure 2-9 shows how this equipment is incorporated into the activated sludge process. Specifically, magnetite feeding and recovery equipment includes:

- A magnetite storage silo
- A dry magnetite feeder and associated equipment
- A shear mill to separate magnetite from the floc
- A magnetic magnetite recovery drum
- A mix tank to incorporate recovered/make-up magnetite into a RAS slip-stream

The second concern with mechanical equipment is related to provisions made to prevent the settling of the ballasted mixed liquor in the process basins and channels, which is generally addressed during design. These considerations include:

- Supplemental mixing may be needed in aerated zones with efficient fine bubble diffusers (or alternately, coarse bubble diffusers can be utilized instead of fine bubble diffusers)
- Mixers in unaerated zones will require about twice the power as would be required for unaerated zones in conventional activated sludge systems
- Mixed liquor channels may need supplemental aeration or mixing to prevent settling

- Even with these provisions, more frequent cleaning of aeration basins should be accounted for by allowing for a basin to be offline at any time of operation

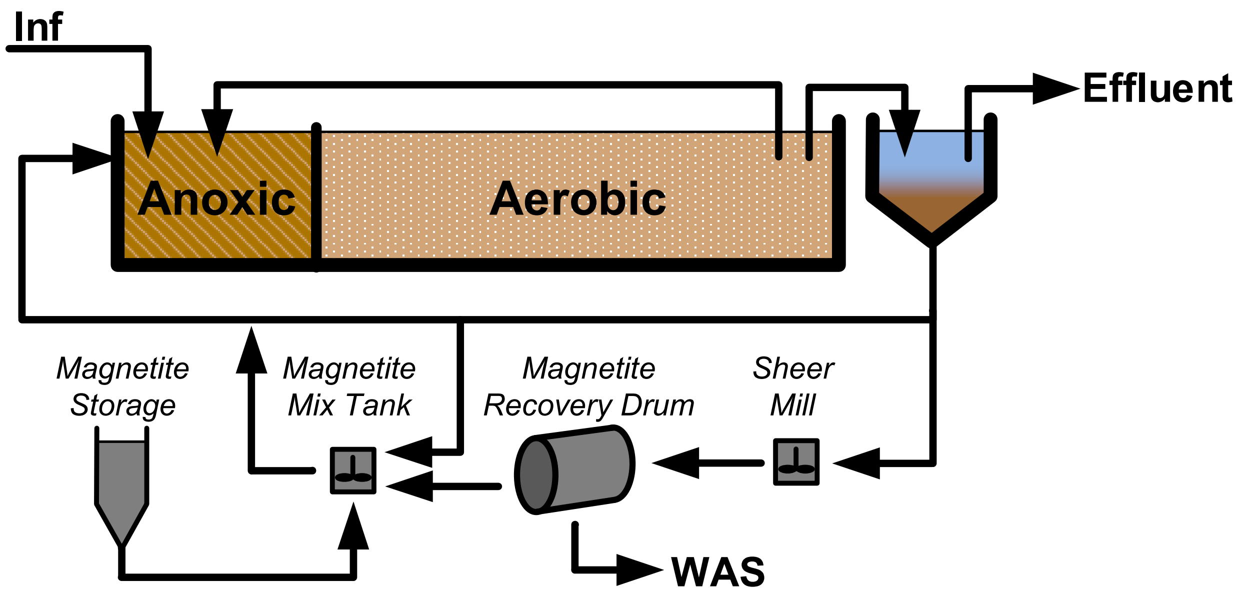


Figure 2-9 Magnetite Ballasted Sedimentation

Regionalization alternatives relying on BioMag were assessed in Task 2. These assessments have been further refined in this Task by accounting for lower loadings due to CEPT and the revised and lower Derby growth projections, which are counteracted by a higher design SRT and operational considerations.

As in Task 2, the capacity of the ballasted activated sludge process was assessed using clarifier loading rate guidelines from published design regulations. This includes that the SOR should not exceed 1,500 gpd/ft^2 on a Max Month basis or 2,500 gpd/ft^2 on a peak hour basis, and that the SLR should be limited to 75 lb/day/ft^2 on a Max Month basis or 100 lb/day/ft^2 on a Peak Hour basis (excluding ballast). Because the peak hour to peak day peaking factor is estimated to be around 1.5 to 1.7 in the regionalization alternatives, the peak day SOR and SLR were limited to 1,500 gpd/ft^2 and 70 lb/day/ft^2, respectively.

With this additional definition of system requirements, the capacity was again checked using yields resulting from biokinetic modeling. Based on these yields and the additional definition, the ballasted flocculation alternative would need one fewer aeration basin than indicated in Task 2 to meet the capacity requirements. However, due to the recommendation that the facility be able to operate with one basin offline if using BioMag, the same number of aeration basins are recommended for the regionalization alternatives. In the case of Derby treating Ansonia, two additional aeration basins and no additional secondary clarifiers are needed. In the full regionalization alternative of Derby treating Ansonia and Seymour, three additional aeration basins and one additional secondary clarifier is needed. Table 2-7 shows that the clarifier loadings meet the maximum limits for BioMag with one aeration basin offline.

Table 2-7 Recommended Capacity Parameters for Derby Regionalization Alternatives using BioMag

Facility Requirements and Capacities (1)	Derby + Ansonia	Derby + Ansonia + Seymour
Additional Aeration Basins (2)	**2**	**3**
Additional Secondary Clarifiers	**0**	**1**
Design HRT, hrs	5.8	5.4
Design MLSS, mg/L	4,900	4,600
Peak Day SOR, gpd/ft^2	1,540	1,350
Peak Day SLR, ppd/ft^2	82.8	68.2

(1) Secondary clarifier capacities assume one aeration basin offline.
(2) Derby has two existing aeration basins that are operable and one aeration basin that is inoperable. In the process evaluation, it was assumed that the inoperable basin would be upgraded to meet additional aeration basin needs.

Aeration requirements and energy were also determined for the BioMag process based on planning level biokinetic modeling results for process oxygen requirements and Black & Veatch's gas transfer model. Because of the higher sludge density, BioMag process requires either supplemental mixing to aerobic zones with fine bubble diffusers or coarse bubble diffusers. To estimate airflow requirements and aeration energy requirements it was assumed that coarse bubble diffusers would be used.

2.3.2.1.1 Performance

The results of biokinetic modeling are shown in Table 2-8. The model was configured to reflect the proposed upgrades and operation. However, detailed influent characterization and model calibration were not undertaken, meaning that there is some uncertainty with regards to the nitrogen removal performance results of the model. The results however do confirm that the process has the capacity to effectively nitrify and denitrify to the required levels, though the amount of supplemental carbon needed will likely vary from the amounts projected. In this case, the average TN limits were met without the need for supplemental carbon. Based on historic N removal performance without CEPT, it is possible that this is an over prediction of N removal performance, however, as mentioned above, detailed influent characterization and model calibration were not undertaken.

Table 2-8 Biokinetic Modeling Results for Derby Regionalization Alternatives Using BioMag

	Derby + Ansonia	Derby + Ansonia + Seymour
Average NHx, mg/L-N	0.26	0.20
Max Month NHx, mg/L-N	1.00	0.58
Average NOx, mg/L-N	2.11	2.90
Max Month NOx, mg/L-N	2.64	4.39
Average TN, mg/L-N	3.76	4.48
Max Month TN, mg/L-N	5.21	6.44

2.3.2.2 Integrated Fixed-Film Activated Sludge Upgrade

Integrated Fixed-Film Activated Sludge (IFAS) is a hybrid suspended growth and fixed film technology. IFAS incorporates all the elements of conventional activated sludge but with the addition of the carrier media and retention sieves in order to increase the biomass inventory. Media is generally added to the aerobic zone though it can also be added to the anoxic zone as necessary. As with conventional activated sludge, the MLSS operates at 2,000 to 4,000 mg/L in IFAS. However, because of the fixed film biomass inventory associated with the media, the process can achieve the same inventory at a lower MLSS concentration, thereby increasing capacity, and/or achieving a higher inventory at the same MLSS concentration, thereby improving treatment. This makes IFAS a popular technology for retrofitting existing activated sludge processes which need to increase capacity and/or achieve stricter effluent nutrient limits. Figure 2-10 shows a schematic view of the IFAS process set-up. Generally, the technology vendor scope of supply includes the following:

- Plastic Biofilm Carrier Media
- Media Retention Sieves
- Diffuser Aeration System
- Scum Removal Systems

Additionally, the design must make the following considerations when designing for an IFAS system.

- Blowers must be sized for lower transfer efficiency due to the high DO operation associated with IFAS and the lower efficiency associated with coarse bubble diffusers
- The hydraulic grade line through the mainstream of the facility must account for the increased head loss through the IFAS process due to the media and media screens
- Screening at the influent must be fine enough to remove material that may blind the media retention screens

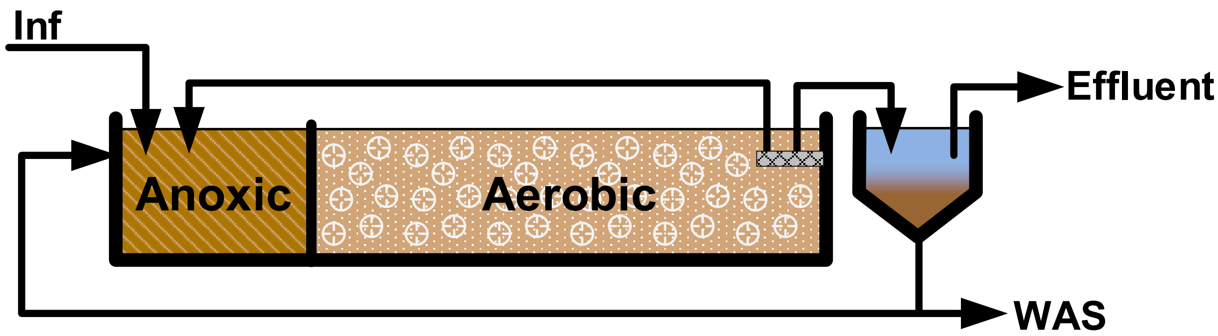


Figure 2-10 Integrated Fixed-Film Activated Sludge Process

Regionalization alternatives relying on IFAS were assessed in Task 2. These assessments have been further refined in this Task by accounting lower loadings due to CEPT and revised and lower Derby growth projections, which are counteracted by a higher design SRT and operational considerations. Performance and capacity were confirmed in this task using biokinetic models of the IFAS process with the revised secondary loadings. The resulting MLSS was used with state point analysis (SPA) to confirm clarifier capacity. One difference is that a closer examination of SVI has shown that SVI at Derby is routinely in the 150 to 200 mL/g range. There is no reason to expect that settleability will be markedly improved with the implementation of the IFAS process. The recommended number of new aeration basins, aeration basin fill fractions, number of secondary clarifiers, and clarifier loadings are summarized in Table 2-9 below.

Table 2-9 Recommended Capacity Parameters for Derby Regionalization Alternatives using IFAS

	Derby + Ansonia	Derby + Ansonia + Seymour
Additional Aeration Basins (1)	**1**	**2**
Additional Secondary Clarifiers	**1**	**2**
Media Fill, % (2)	40	40
Design HRT, hrs	5.8	5.4
Design MLSS, mg/L (3)	2,200	2,080
Peak Day SOR, gpd/ft^2	1,020	1,010
Peak Day SLR, ppd/ft^2 (3)	27.9	25.7

(1) Derby has two existing aeration basins that are operable and one aeration basin that is inoperable. In the process evaluation, it was assumed that the inoperable basin would be upgraded to meet additional aeration basin needs.
(2) Media characteristics assumed were consistent with Kaldnes K1 media and are as follows;

- Specific surface area: 500 m^2/m^3
- Void ratio: 84%
- Maximum fill fraction: 65%

(3) Suspended only

Aeration requirements and energy were also determined for the IFAS process based on biokinetic modeling results for process oxygen requirements and Black & Veatch's gas transfer model. The IFAS process uses coarse bubble diffusers and so it was assumed that coarse bubble diffusers would be used when determining airflow and aeration energy requirements.

2.3.2.2.1 Performance

The results of biokinetic modeling are shown in Table 2-10. The model was configured to reflect the proposed upgrades and operation. However, detailed influent characterization and model calibration were not undertaken, meaning that there is some uncertainty with regards to the nitrogen removal performance results of the model. The results however do confirm that the process has the capacity to effectively nitrify and denitrify to the required levels, though the amount of supplemental carbon needed will likely vary from the amounts projected. In this case the average TN limits were met without the need for supplemental carbon. Based on historic N removal performance without CEPT, it is possible that this is an over prediction of N removal performance, however, as mentioned above, detailed influent characterization and model calibration were not undertaken.

Table 2-10 Biokinetic Modeling Results for Derby Regionalization Alternatives Using IFAS

	Derby + Ansonia	Derby + Ansonia + Seymour
Average NHx, mg/L-N	0.18	0.18
Max Month NHx, mg/L-N	0.62	0.73
Average NOx, mg/L-N	3.9	4.1
Max Month NOx, mg/L-N	3.5	4.8
Average TN, mg/L-N	5.8	5.9
Max Month TN, mg/L-N	5.8	7.3

2.3.2.3 New Facilities and Reconfigured Existing Facilities

Table 2-11 summarizes new and reconfigured existing facilities required for the Derby regional alternatives.

Table 2-11 New and Reconfigured Facilities for Derby Regional Alternatives

	Derby + Ansonia (BioMag)	Derby + Ansonia (IFAS)	Derby + Ansonia + Seymour (BioMag)	Derby + Ansonia + Seymour (IFAS)
Reconfigured Raw Wastewater Screening Facility and Influent Pump Station	Yes	Yes	Yes	Yes
New Grit Removal Facility	Yes	Yes	Yes	Yes
New Aeration Basin	Yes	No	Yes	Yes
Extension to Existing Aeration Basins	No	No	Yes	No
New Secondary Clarifier	No	No	Yes	Yes (2x)
New Sludge Handling Facility	Yes	Yes	Yes	Yes
New Ultraviolet Disinfection Facility	Yes	Yes	Yes	Yes

Preliminary layouts of these facilities were developed for the planning level capital costs. The new Sludge Handling Facility is shown in Figure B 1 in Appendix B. The reconfigured Raw Wastewater Screening Facility and Influent Pump Station, and new Grit Removal Facility are shown in Figure 2-2 and Figure 2-3, respectively, earlier in this chapter. The reconfigured aeration basin area with one new basin is shown in Figure 2-11; the reconfigured aeration basin area with one new basin and basin extension is shown in Figure 2-12. It is noted that the existing chlorine contact tank system currently in use at Derby will not be sufficient for the regionalization alternatives. With limited space to construct an additional chlorine contact tank, it will be necessary to replace chlorine disinfection and dechlorination with a new UV system for the regional alternatives at Derby. The new UV Disinfection Facility is shown in Figure 2-13.

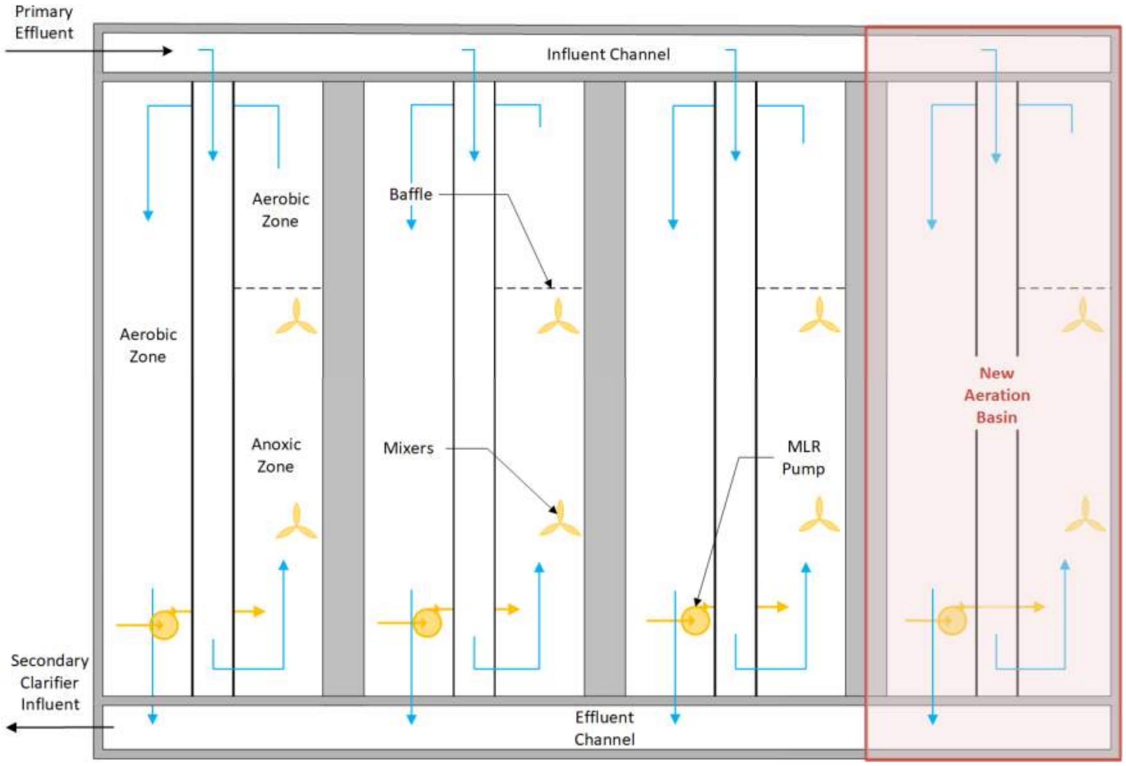


Figure 2-11 Reconfigured Derby Aeration Basins with One New Basin

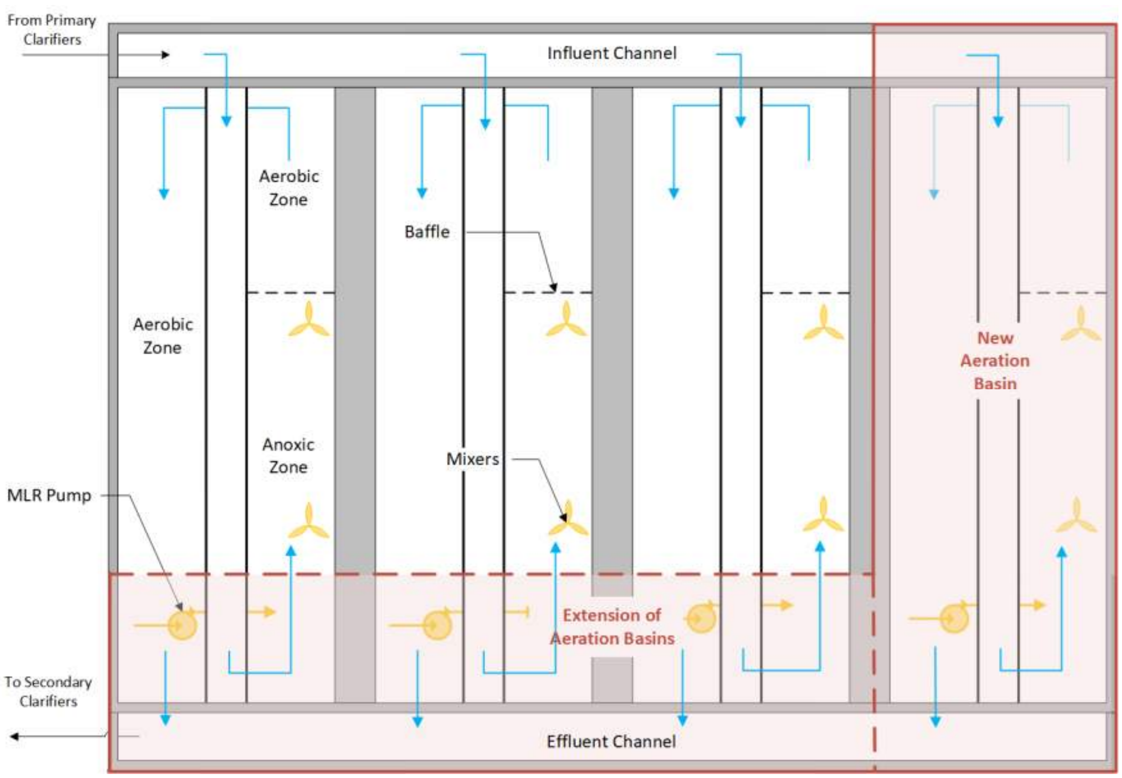


Figure 2-12 Reconfigured Derby Aeration Basins with One New Basin and Basin Extension

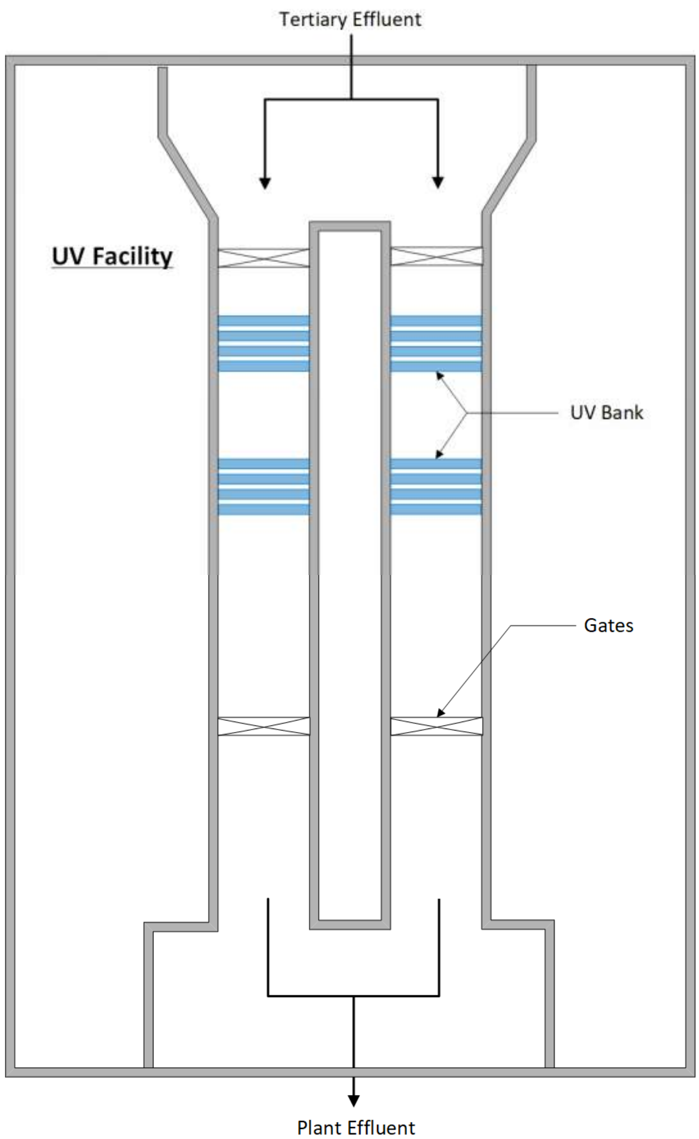


Figure 2-13 New UV Disinfection Facility

2.3.2.4 Derby Regional Alternative Layouts

Conceptual site layouts for the Derby regional alternatives are shown in Figure 2-14, Figure 2-15, Figure 2-16, and Figure 2-17.

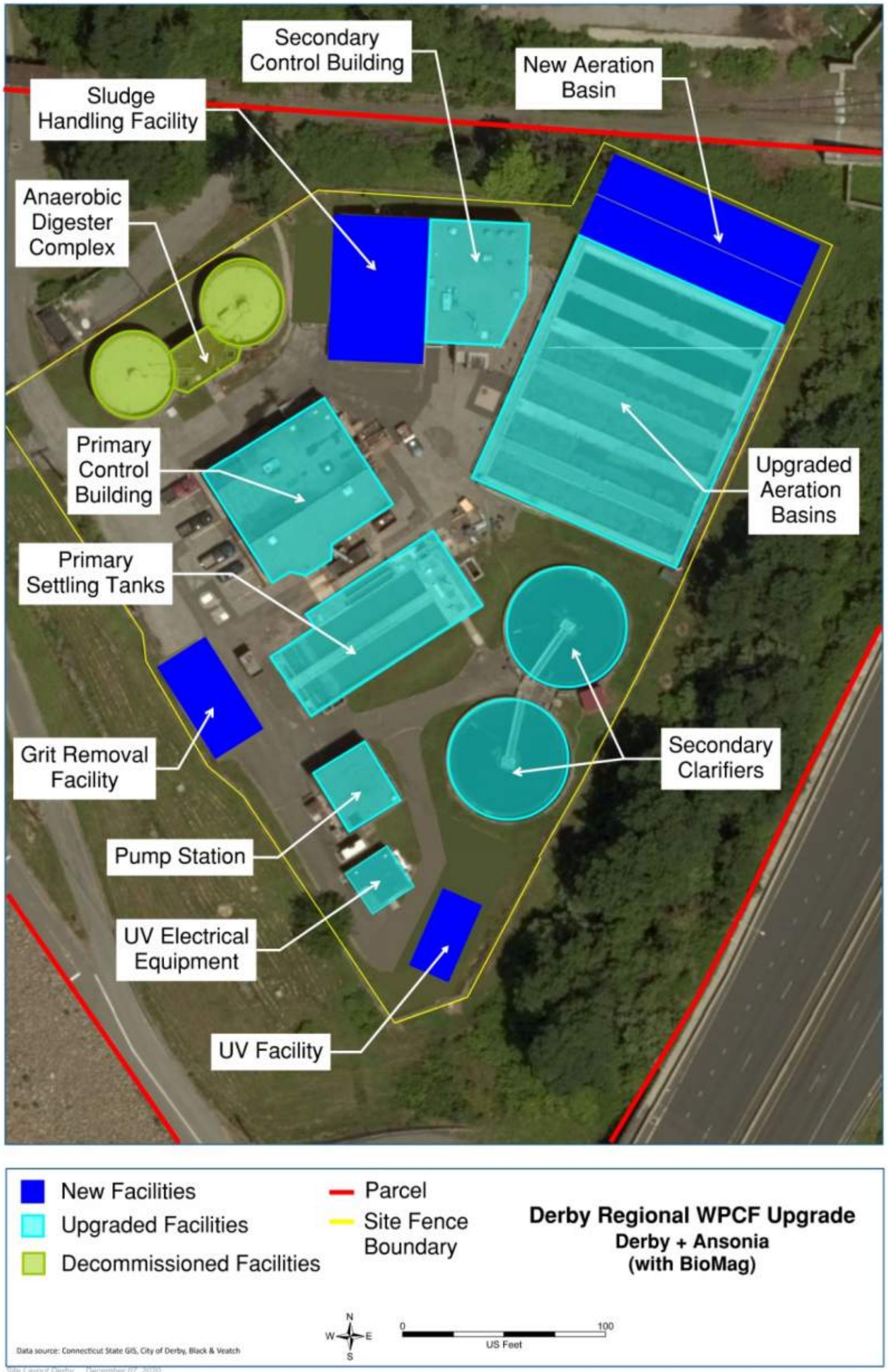


Figure 2-14 Derby Plus Ansonia with BioMag Site Layout

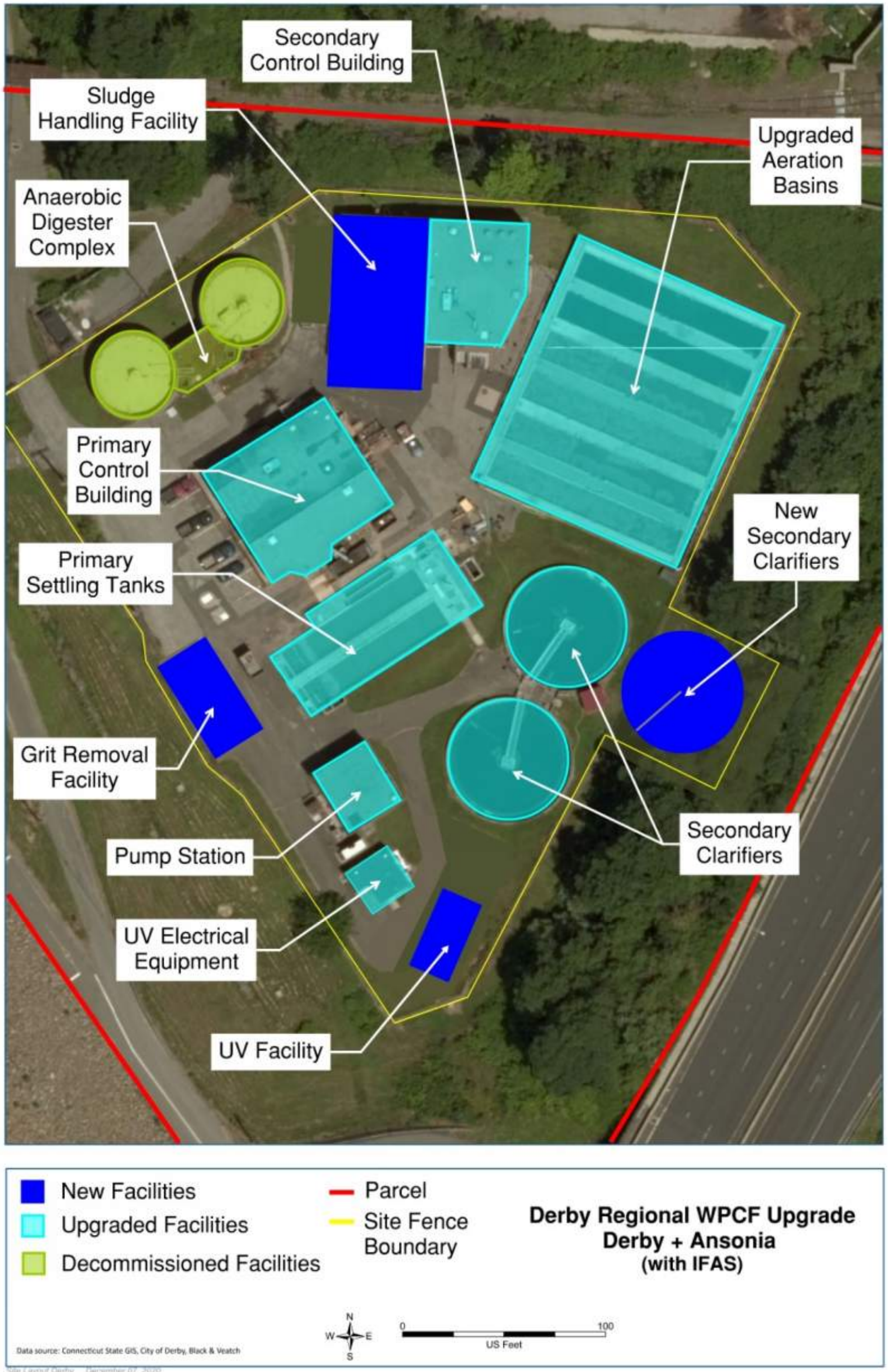


Figure 2-15 Derby Plus Ansonia with IFAS Site Layout

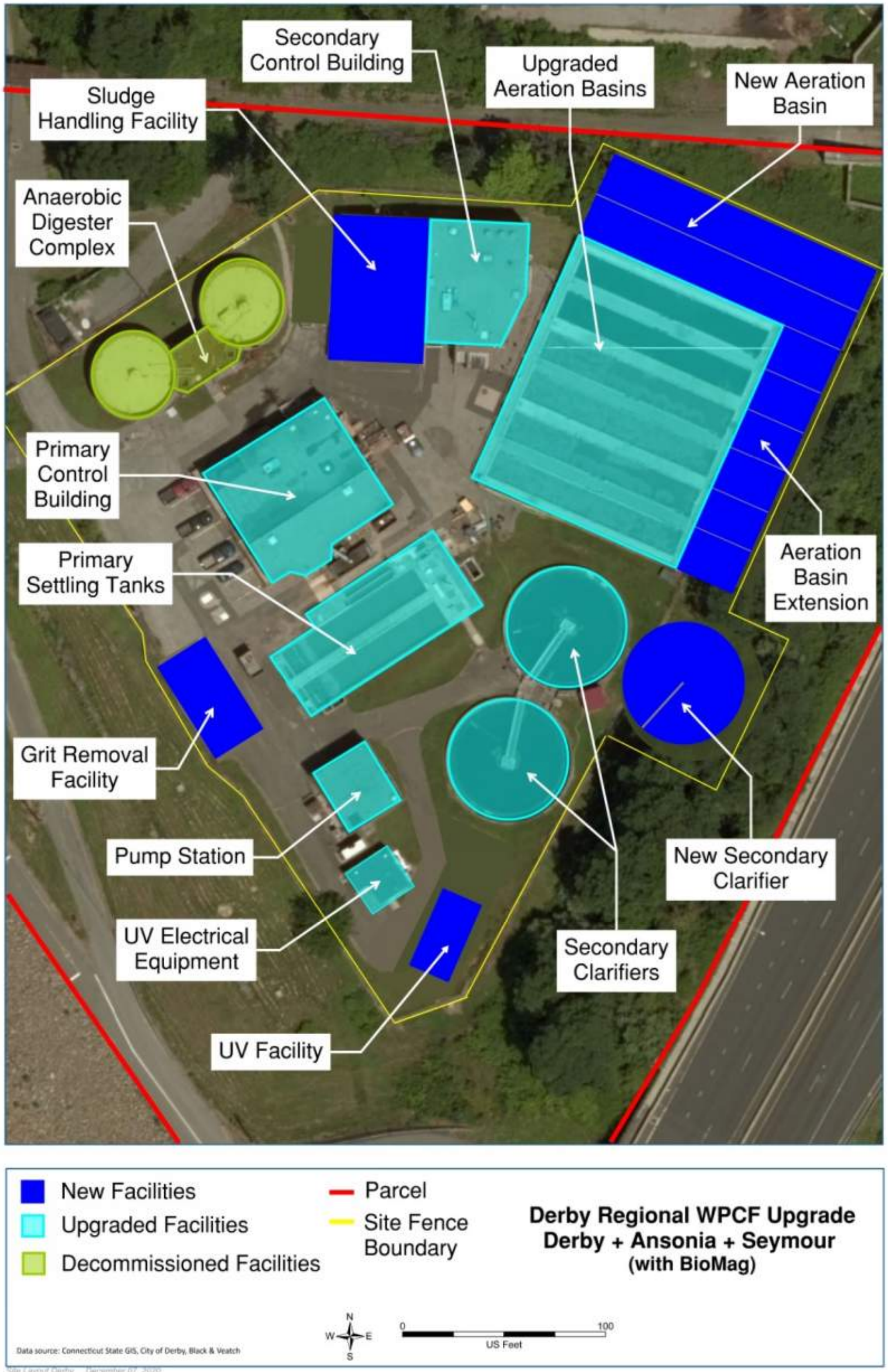


Figure 2-16 Derby Plus Ansonia and Seymour with BioMag Site Layout

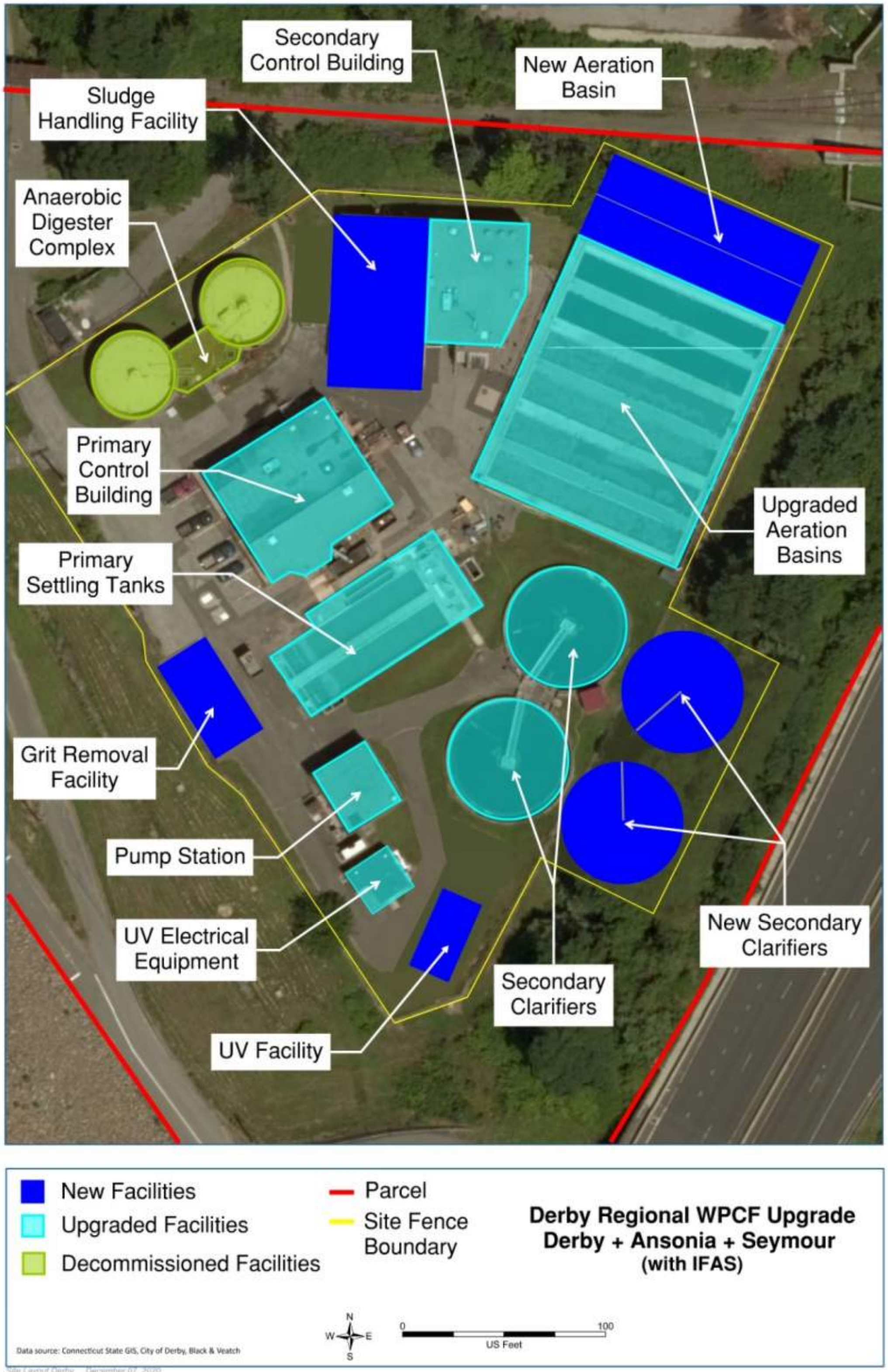


Figure 2-17 Derby Plus Ansonia and Seymour with IFAS Site Layout

2.4 ANSONIA REGIONAL ALTERNATIVES

2.4.1 Issues

Relative to Derby, the facilities at Ansonia have a higher safety factor in terms of treating the rated flows and loads. Additionally, the site is less constrained with more room to add major process units if needed. As a result, the previous task determined the regionalization alternatives were possible without using secondary process intensification, though primary settling tanks may require the ability to operate in CEPT at higher flows in some regionalization alternatives. The previous task also determined that, for regionalization alternatives in which Derby flows and loads are treated at Ansonia, tertiary treatment for phosphorus removal may be required. An alternative to this is secondary treatment and disinfection at Ansonia, with discharge at the Derby facility's outfall to the Housatonic (which currently has no phosphorus limits). Considering these issues, biokinetic modeling was used to provide additional planning level definition for the treatment upgrades required to meet capacity. This also allowed for estimation of planning level operational related costs for the regionalization alternatives at Ansonia, factoring in increased primary removals due to CEPT in the appropriate cases.

2.4.2 Facilities

Regionalization alternatives for Ansonia were assessed in Task 2. These assessments have been further refined in this Task by accounting for lower loadings due to CEPT and revised Derby growth projections which were decreased and, which are counteracted by a higher design SRT and operational considerations. Performance and capacity were confirmed in this task using biokinetic models with the revised secondary loadings. The resulting MLSS was used with SPA to confirm clarifier capacity. A closer examination of SVI has shown that while SVI at Ansonia average 130 mL/g, it routinely increases to approximately 200 mL/g in the spring. Based on these revisions to the design basis, it is still the case that no upgrades are needed if just regionalizing with Derby but that one additional secondary clarifier is necessary for a regionalization alternative involving Ansonia treating Derby and Seymour. The recommended number of new aeration basins, number of secondary clarifiers, and clarifier loadings are summarized in Table 2-12 below.

Table 2-12 Recommended Capacity Parameters for Ansonia Regionalization Alternatives

	Ansonia + Derby	Ansonia+ Derby+ Seymour
Additional Aeration Basins	**0**	**0**
Additional Secondary Clarifiers	**0**	**1**
Design HRT, hrs	12.7	9.0
Design MLSS, mg/L	2,670	2,950
Peak Day SOR, gpd/ft^2	790	690
Peak Day SLR, ppd/ft^2	25.0	25.1

The results of biokinetic modeling are shown in Table 2-13. The model was configured to reflect the proposed upgrades and operation. However, detailed influent characterization and model calibration were not undertaken, meaning that there is some uncertainty with regards to the nitrogen removal performance results of the model. In general, the model predicts lower N removal than observed historically. Again, this is likely due to the model not fully accounting for the SND occurring. In the model the average TN limits, which vary between 6.0 to 6.5 mg/L-N for the Ansonia regionalization alternatives, were met without the need for supplemental carbon which is likely to be the case at full scale.

Table 2-13 Biokinetic Modeling Results for Ansonia Regionalization Alternatives

	Ansonia + Derby	Ansonia + Derby + Seymour
Average NHx, mg/L-N	0.55	0.56
Max Month NHx, mg/L-N	0.43	0.36
Average NOx, mg/L-N	2.64	2.74
Max Month NOx, mg/L-N	4.48	6.06
Average TN, mg/L-N	4.32	4.48
Max Month TN, mg/L-N	6.36	7.89

As established in the previous task, there is some uncertainty regarding phosphorus limits in the Ansonia regionalization alternatives. If assuming that the load limits for P discharge into the Naugatuck River move with the facilities' share of the wastewater being treated, then when Seymour flows are treated and discharged at Ansonia, the effluent P concentrations for compliance are not substantially different; thus, tertiary phosphorus treatment is not needed to meet P limits. However, because Derby doesn't currently discharge into the Naugatuck River and therefore has no P load allocation to the Naugatuck River, incorporating Derby into the Ansonia regionalization alternatives substantially impacts the concentrations which must be achieved to meet P load limits in those alternatives. Table 2-14 summarizes these concentrations and shows that the alternatives with Derby being treated and discharged at Ansonia's outfall, the effluent TP would need to be less than approximately 0.5 mg/L-P for compliance. The concentration that can typically be expected to be achieved with chemical P removal in the secondary process is generally 0.5 mg/L-P. Lower values can be attained with good secondary clarifier performance (i.e. low effluent TSS) as is currently achieved at Ansonia. However, there will likely be some increase in effluent solids at higher loading rates and so at this stage of planning, it should be assumed that tertiary filtration is required to meet the P limits in the Ansonia regionalization alternatives which include Derby. At these effluent levels, the tertiary process is only needed for solids separation, i.e. chemical coagulant dosage to the tertiary process is not necessary. Given the limited footprint and process requirements, cloth media filters have been identified as an appropriate filtration technology, with the recommended filter requirements highlighted in Table 2-14.

Table 2-14 Effluent TP Loads and Filter Requirements for Ansonia Regionalization Alternatives

	Ansonia + Derby	Ansonia + Derby + Seymour
Seasonal P Load Limit, lb/day-P	11.92	19.46
2040 Annual Average Flow, mgd	3.49	4.79
Low Effluent P Required, mg/L-P	0.41	0.49
High Effluent P Required, mg/L-P (1)	0.44	0.52
Tertiary Treatment Required?	Likely (2)	Possibly (2)
Firm Cloth Filter Area Requirement, ft^2	1600	2200
Tertiary Filter Facility Requirements	2x15 Filter Discs (3)	2x20 Filter Discs (3)

(1) Assuming April-October Average flow is 94% of annual average flow (based on historical averages).
(2) Depends on effluent TSS achieved at higher flows. Need for tertiary filtration could be reevaluated after regionalization but before design conditions are reached.
(3) Assuming the use of Aqua Aerobics Mega-Disc Filters.

2.4.2.1 New Facilities and Reconfigured Existing Facilities

Table 2-15 summarizes new and reconfigured existing facilities required for the Ansonia regional alternatives.

Table 2-15 New and Reconfigured Facilities for Ansonia Regional Alternatives

	Ansonia + Derby	Ansonia + Derby (Effluent to Housatonic)	Ansonia + Derby + Seymour	Ansonia + Derby + Seymour (Effluent to Housatonic)
Additional Grit Removal Unit	Yes	Yes	Yes	Yes
New Primary Clarifier	Yes	Yes	Yes	Yes
New Secondary Clarifier	No	No	Yes	Yes
New Phosphorus Removal Facility	Yes	No	Yes	No
Additional UV Channel	Yes	Yes	Yes	Yes
New Sludge Handling Facility	Yes	Yes	Yes	Yes

Preliminary layouts of these facilities were developed for the planning level capital costs. The new Sludge Handling Facility is shown in Figure B 1 in Appendix B. The new phosphorus removal facility is shown in Figure 2-18 (upper level) and Figure 2-19 (lower level).

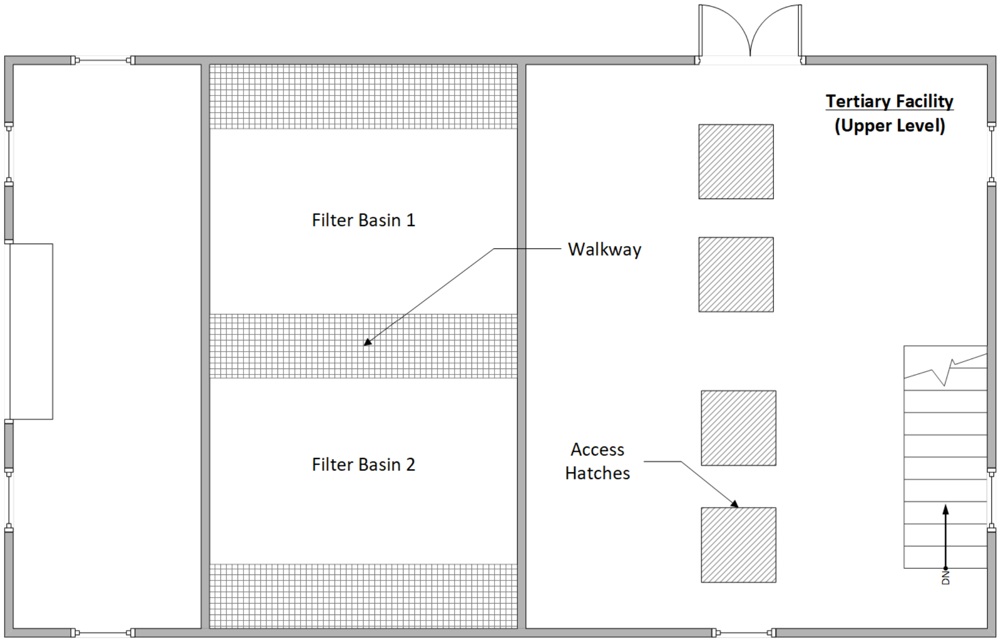


Figure 2-18 New Phosphorus Removal Facility (Upper Level)

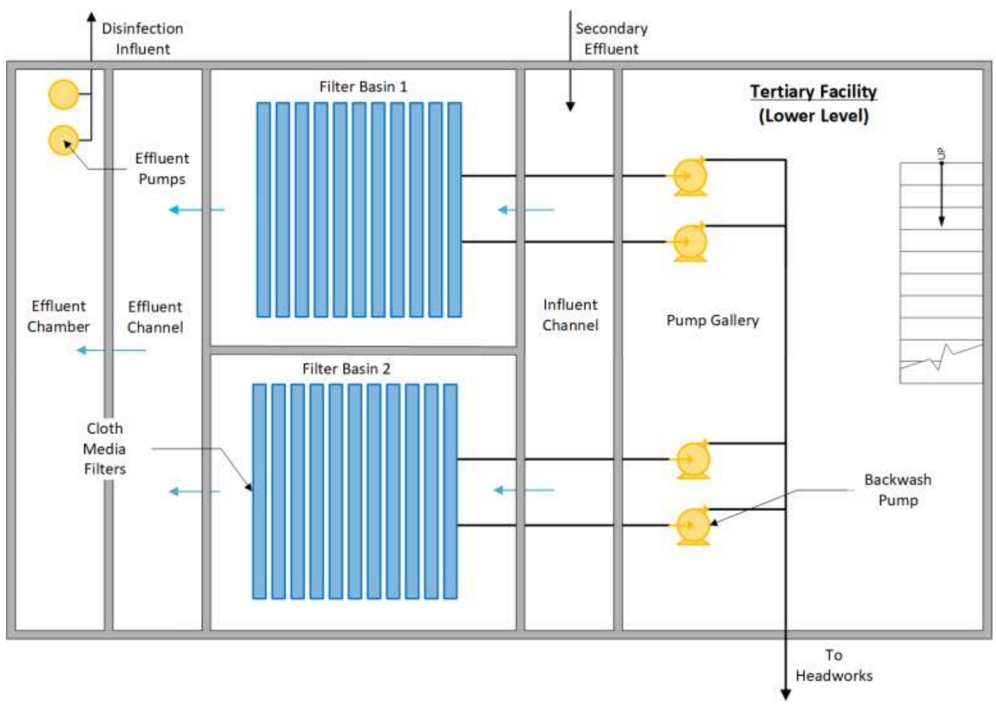


Figure 2-19 New Phosphorus Removal Facility (Lower Level)

2.4.2.2 Ansonia Regional Alternative Layouts

Conceptual site layouts for the Ansonia regional alternatives are shown in Figure 2-20, Figure 2-21, Figure 2-22, and Figure 2-23.

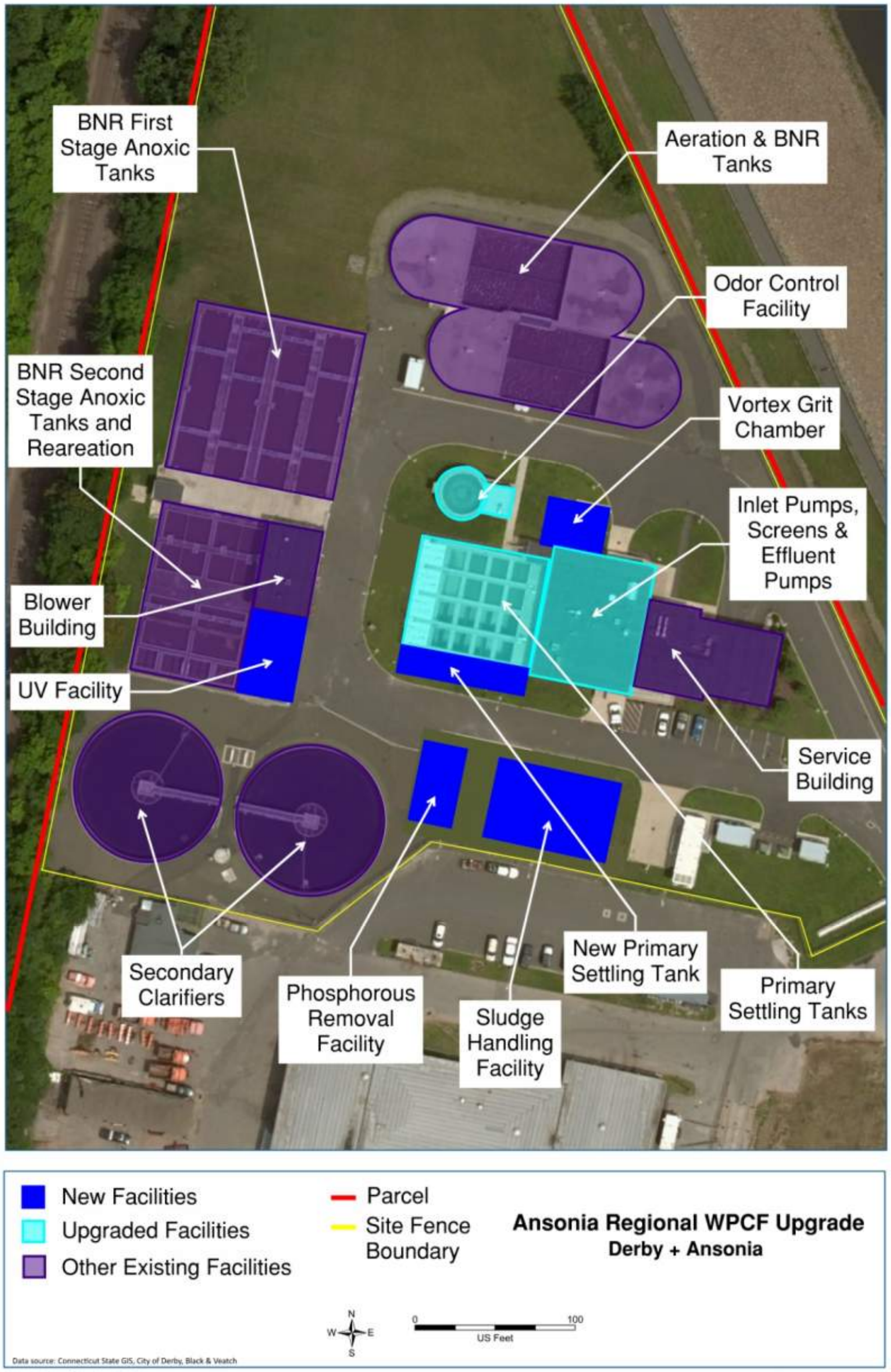


Figure 2-20 Ansonia Plus Derby Site Layout

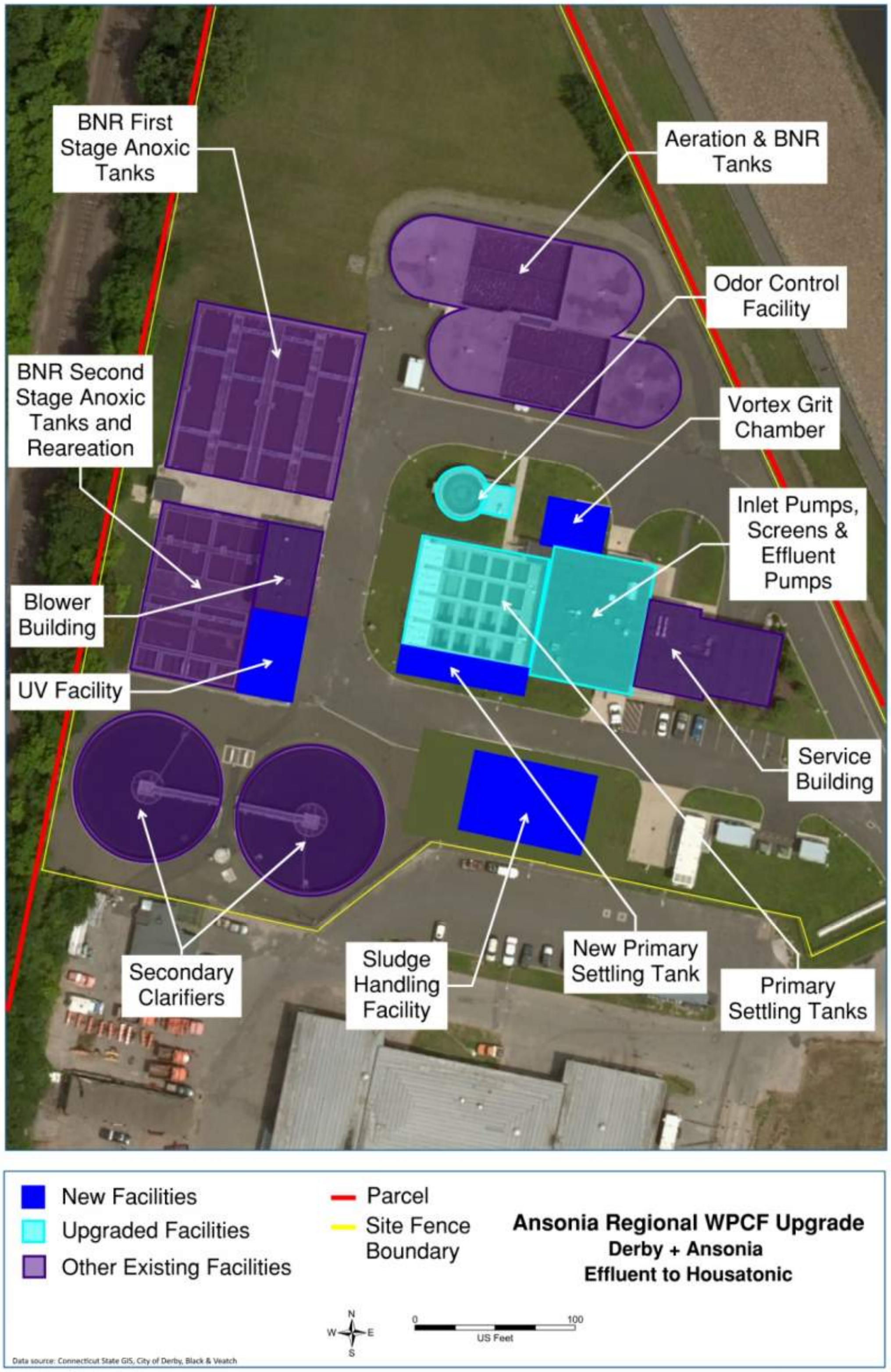


Figure 2-21 Ansonia Plus Derby with Effluent Pumped to the Housatonic Site Layout

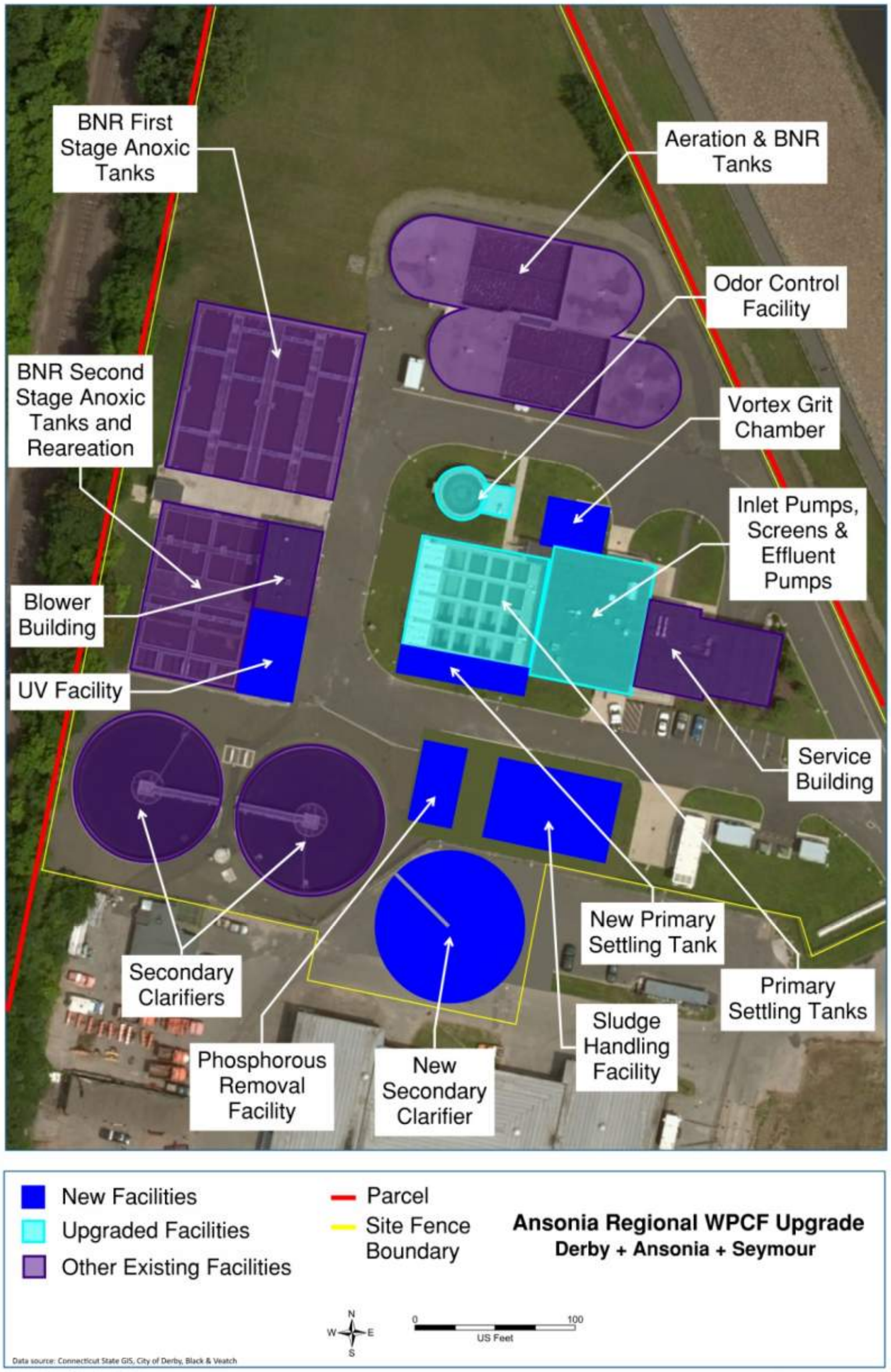


Figure 2-22 Ansonia Plus Derby and Seymour Site Layout

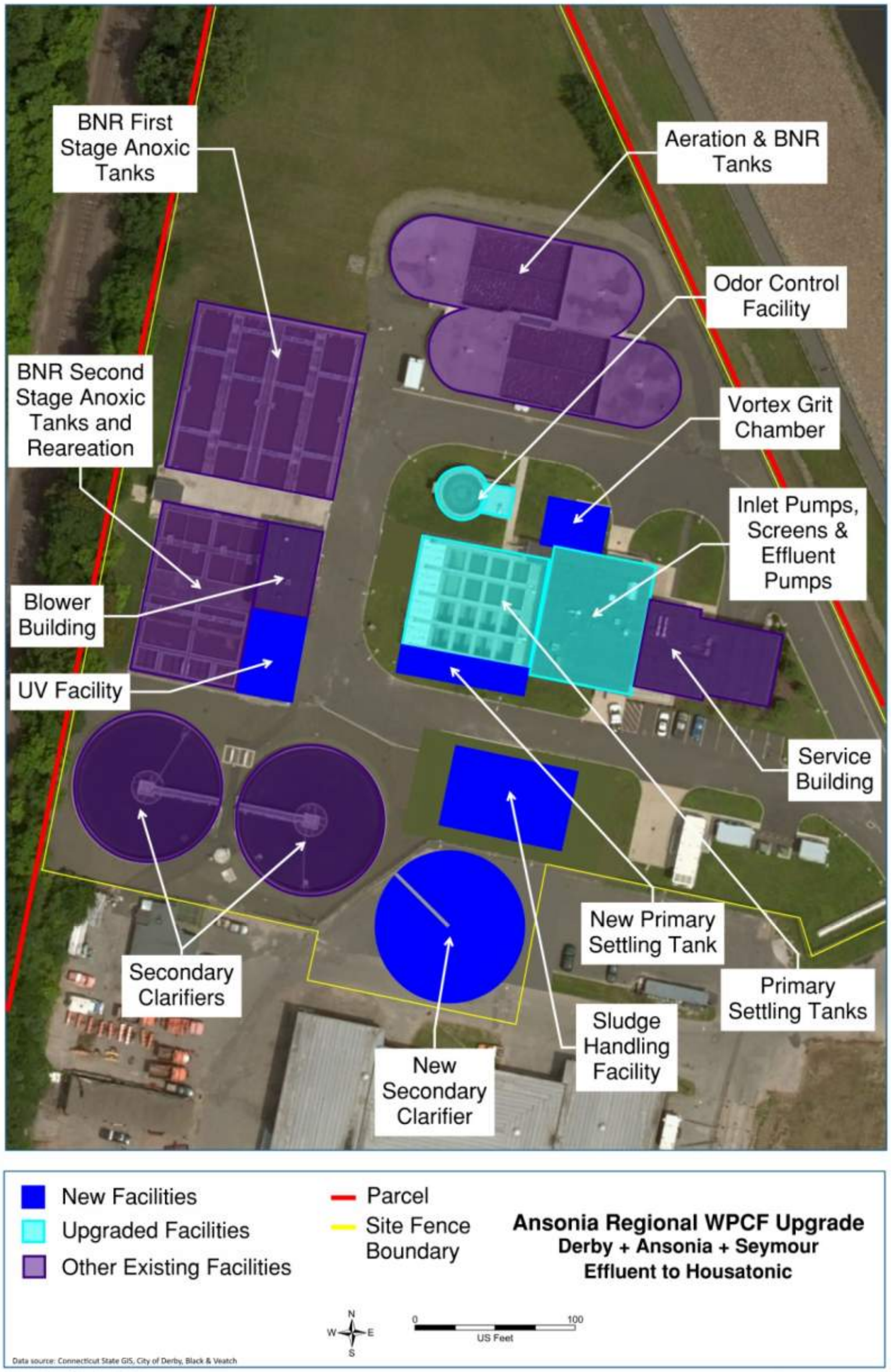


Figure 2-23 Ansonia Plus Derby and Seymour with Effluent Pumped to the Housatonic Site Layout

3.0 CONVEYANCE PIPELINES AND PUMPING

3.1 BACKGROUND

In Task 2, the wastewater conveyance corridors were developed on an initial basis and the alignments that were the least likely to be implemented (i.e. ones along river banks, railroad and/or state highway right-of-way) were removed from further consideration. The more attractive routes were carried forward into this Task where they were defined further in terms of general physical attributes, environmental concerns, easements/right of way issues, and pumping requirements. It is also noted that based on the short-listed alternatives resulting from Task 2, only the Derby to/from Ansonia and Seymour to Ansonia conveyance systems would receive focused study as part of this Task.

3.2 REGIONAL CONVEYANCE

The conveyance corridors between Derby and Ansonia and between Ansonia and Seymour were evaluated using the State of Connecticut GIS data, aerial imagery, and by on-site investigations of the streets where these corridors would be aligned. To mitigate the topographical challenges, variations to the routes were also investigated so as to minimize pumping.

A conceptual design of the pipelines based on flow rates, general topography, and associated pumping head requirements was developed; this included general characteristics of pipe diameters, pipeline lengths, and pump horsepower requirements. Requirements to screen and de-grit the raw wastewater prior to conveyance was also considered. This level of conceptual planning and design allowed for budgetary level capital costs to be identified for the conveyance pipelines associated with the short-listed regional alternatives.

3.2.1 General Considerations

3.2.1.1 Pipeline Routing

Pipeline routes were established based on environmental constraints and topography. Using Connecticut GIS, and to the extent possible, the routes were set outside flood plains, wetland buffers, and protected areas. Both conveyance corridors (the one from Seymour to Ansonia and the one that connects Derby and Ansonia) are routed along city streets and private property. At this level of planning, existing utility maps were not obtained/reviewed, but it is assumed that actual conveyance pipeline alignments can be adjusted to minimize impacts on existing buried utilities, highway structures (e.g. bridge abutments), or other existing infrastructure along the pipeline routes. Although the pipelines as depicted in this report are identified on specific streets and routing, it needs to be made clear that there are, in many reaches, two and even more alternate streets that the actual conveyance pipelines can be located in. The exact locations and property that pipelines will be routed through will be determined as part of a subsequent preliminary design where a more detailed analysis of existing utilities and land parcels would be performed.

While the conveyance corridors will not be located within the right-of-way (ROW) of the railroad or Route 8, they will cross these ROWs at different locations. ConnDOT allows transverse utility installations if they are underground, and any supporting structures are outside non-access highway lines and do not obstruct line of sight. To comply with these construction requirements, trenchless construction methods will need to be used for these segments of the routes.

Microtunneling was initially considered as a trenchless technology method where the conveyance corridor routes crossed the state highway or the railroad. Microtunneling requires, a microtunnel boring machine (MTBM) that is driven from a launch shaft to a receiving shaft. Excavated materials are carried to ground surface while lengths of pipe are added as the machine moves forward. Microtunneling is used when soil geology varies and long lengths need to be excavated. However, the lengths of these crossings are significantly shorter than for typical microtunneling projects and thus would be, cost prohibitive. Therefore, microtunneling at the crossings was dropped from further consideration and study.

Pipe jacking was also studied. In pipe jacking, casing sections are pushed using a boring machine while spoils inside the casing are simultaneously removed. Two jacking pits are required, and this method can be used in varying geological conditions for drives up to 1,000 feet. This method was determined to be a feasible and a cost-effective trenchless construction method for locations where these sections of the conveyance corridor pipelines crossed either the state highway or railroad ROWs.

3.2.1.2 Pumping Systems and Preliminary Treatment

Given the varying topography of the conveyance corridor routes, certain sections of the pipelines will flow by gravity while at others, the flow will need to be pumped. For all routes, the first leg of the conveyance pipeline will be pumped. This initial pump station would be located at the WPCF site where the wastewater flow will emanate. Existing influent pump stations would be upgraded and repurposed as wastewater conveyance pump stations. Due to the length and topographical extremes along the route from Seymour to Ansonia, an intermediate lift station will be required for that pipeline to convey flow to the Ansonia plant.

Before pumping, wastewater will be screened to minimize solids deposition and obstructions in the pipelines. Screening of the raw wastewater will also be required to better assure that pumps will not clog and serve reliably. Screening facilities at the plants will be upgraded as in the base case scenarios to remove debris prior to conveyance pumping. In addition to screening, it is ideal to remove grit prior to conveyance to minimize the potential for grit build up in the pipelines. Grit facilities require considerable space on the site to operate effectively, which is challenging when the hydraulic grade line is low at the plant influent. This is typically the case at the end of collection system. At Derby and Ansonia, implementing grit removal prior to pumping into the conveyance pipeline would be cost prohibitive and impractical for operations and maintenance given the deep hydraulic grade lines at those plants. Seymour has a shallower hydraulic grade line and grit removal upstream of the influent pumps; therefore, grit removal should be maintained ahead of raw wastewater being pumped into the conveyance pipeline.

Table 3-1 summarizes the upgrades required at current influent pump stations and screening and grit removal facilities to be converted into conveyance pump stations. These upgrades are comparable to the upgrades required for each of the plant Base Case scenarios.

Table 3-1 Required Upgrades to Convert Influent Pump Stations to Conveyance Pump Stations

	Derby	Ansonia	Seymour
Influent Pump Station	Replace pumps, piping, VFDs, and valves	Replace pumps, piping, VFDs, and valves (to meet hydraulic requirements)	Replace pumps, piping, VFDs, and valves
Screenings Facility	Reconfigure raw wastewater screening facility	Fix current mechanical screen and add a second mechanical screen	Replace mechanical screen and add second mechanical screen
Grit Removal	NA (grit removed at receiving plant)	NA (grit removed at receiving plant)	Replace equipment and upgrade grit aeration chamber
Miscellaneous	Pump station concrete repair, controls upgrade, and electrical equipment replacement	Headworks area odor control	Controls upgrade and electrical equipment replacement

An intermediate booster pump station will be required to convey flow from Seymour to Ansonia, shown schematically in Figure 3-1. This pump station would be located approximately two miles from the Seymour WPCF. Figure 3-2 identifies parcels where the pump station could be located. Exact location of the booster pump station would be determined in a later, more detailed engineering design phase if this regionalization alternative is selected.

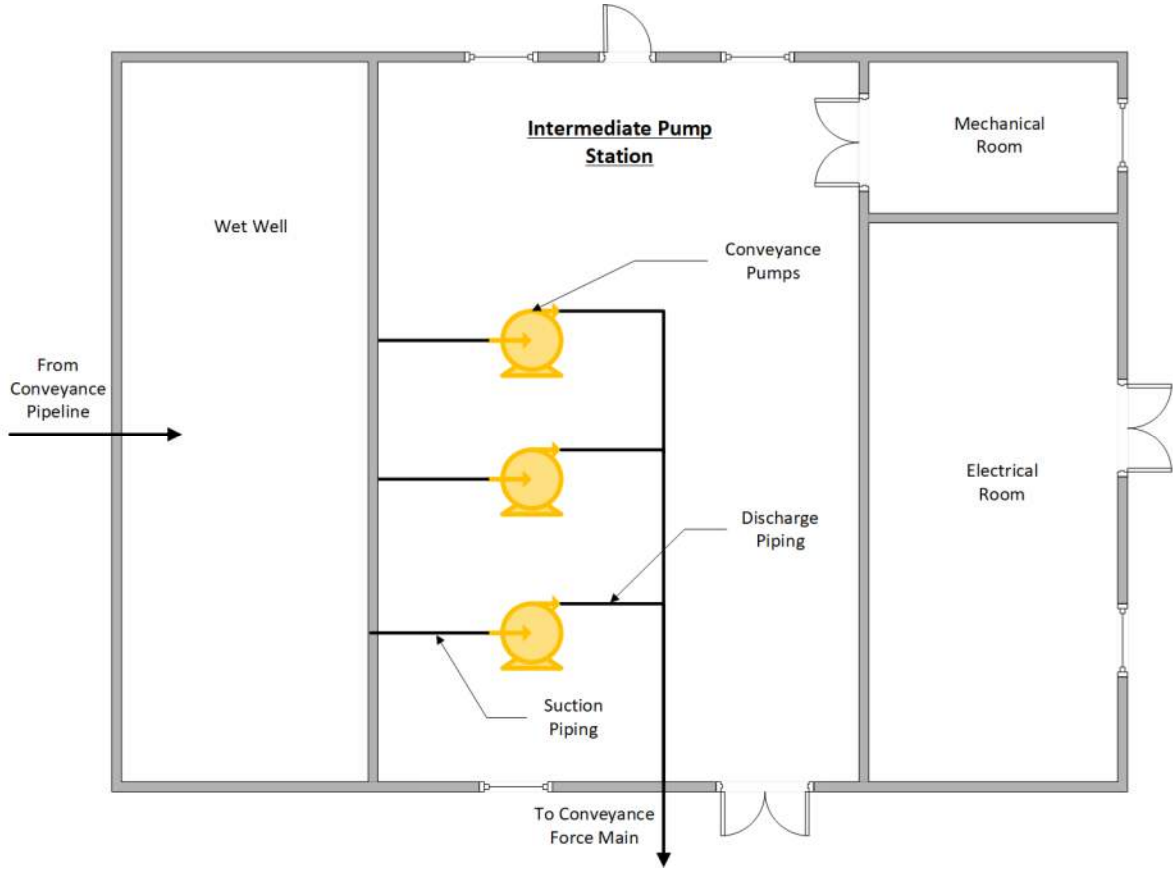


Figure 3-1 Seymour to Ansonia Intermediate Pump Station Schematic

Figure 3-2 Seymour to Ansonia Booster Pump Station Possible Site Locations

3.2.2 Derby to/from Ansonia

Figure 3-3 shows the conveyance corridor that will connect Ansonia and Derby. A route variation along North Division St was identified but at this point of the study, no decision could be made about which route is more optimal until further investigation on existing utilities and easements is undertaken as part of a subsequent preliminary design phase, if this regional alternative is selected.

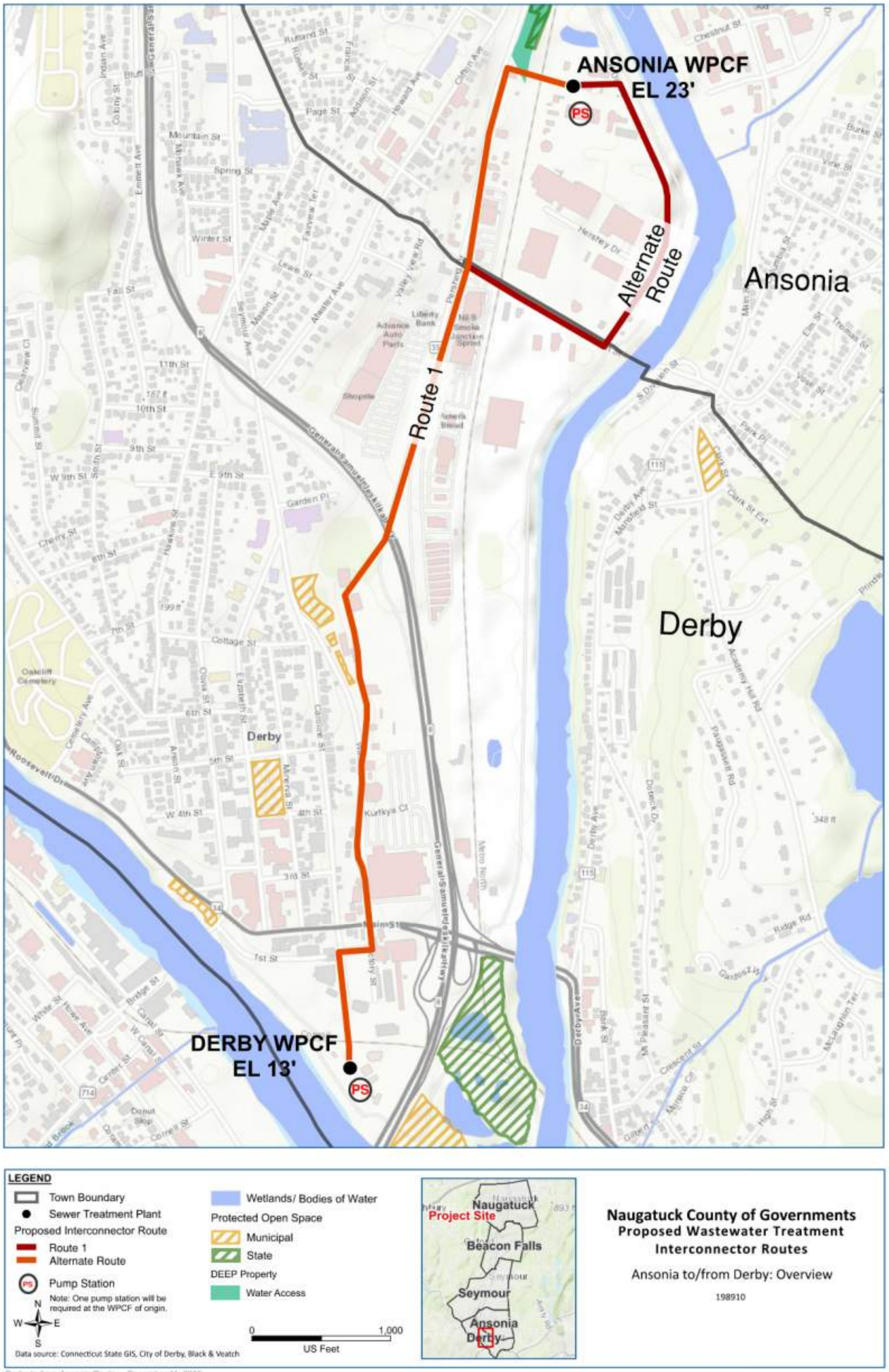


Figure 3-3 Ansonia to/from Derby Conveyance Pipeline Route

The elevation difference between Derby WPCF (13 feet) and Ansonia WPCF (23 feet) is 10 feet with the highest elevation along the route at 37 feet. The elevation profiles from Derby to Ansonia and Ansonia to Derby can be seen in Figure 3-4 and Figure 3-5, respectively.

Figure 3-4 Derby to Ansonia Conveyance Pipeline Profile

Figure 3-5 Ansonia to Derby Conveyance Pipeline Profile

The existing influent pump station at the WPCF of origin will need to be upgraded as described in section 3.2.1.2 to convey wastewater. The conveyance corridor will be a combination of force main and gravity sewer trunk line. The pipeline will be routed along city streets and private property. Based on conceptual planning and design, the physical attributes of the conveyance corridor pipelines are summarized in Table 3-2.

Table 3-2 Derby to/from Ansonia Conveyance Pipeline Characteristics

	Derby to Ansonia	Ansonia to Derby	Ansonia + Seymour to Derby
Length (ft)	8,100		
Diameter (in)	14 and 20	14 and 21	16 and 24
Pump Stations	1		
High point elevation (ft)	37		
Private land taking	20% of route crosses private parcels		

Approximately 20% of the pipeline would be routed along private properties both in Derby and Ansonia. Through these properties, the preferred construction method will be open cut construction. The following parcels would be within the alignment of the conveyance corridor:

1. **205 Water St, 151 Water St, 139 Water St:** Between Water St and Route 8 ramp, the conveyance corridor will be routed for approximately 1,500 feet along the driveway of three businesses: Suburban Propane, Silktown Roofing, Inc., and A Quick Pick Crane & Rigging Services as seen in Figure 3-6.

Figure 3-6 Derby to/from Ansonia Conveyance Pipeline Property Crossings Near Derby WPCF

2. **112 Pershing Drive, 120 Pershing Drive, or 200 Pershing Drive:** Between Pershing Dr and Ansonia WPCF, the pipeline will either be routed along the driveway of an existing commercial building in 112 Pershing Drive, or through the empty vegetated lot of 120 Pershing Drive or 200 Pershing Drive as shown in Figure 3-7.

Figure 3-7 Derby to/from Ansonia Conveyance Pipeline Property Crossings Near Ansonia WPCF

3. **Waterbury Branch of the Metro North Railroad Crossing**: Leaving/going into Ansonia WPCF the pipeline will cross the railroad for approximately 75 feet as seen in Figure 3-7. This crossing will be constructed using pipe jacking with a pit at Ansonia WPCF and another pit in a private property on Pershing Avenue.

Additionally, the pipeline will cross several busy road areas that will require significant planning and traffic control. The preferred construction method through these intersections will be open-cut construction.

1. **Intersection between Factory Street/Water Street and Main Street**: This is an 85 feet long crossing through a four-way intersection in Derby. Main Street is just off Route 8 and is part of Route 34, a length of state highway that connects Newtown and New Haven. The intersection is shown in Figure 3-8.

Figure 3-8 Derby to/from Ansonia Conveyance Pipeline Intersection Crossing at Factory/Water and Main

2. **Merge ramp from Pershing Drive to Route 8:** The pipeline will be routed along a merge ramp in the southwest direction onto Route 8 for approximately 900 feet as shown in Figure 3-9.

Figure 3-9 Derby to/from Ansonia Conveyance Pipeline Route 8 Crossing Along Merge Ramp

3. **Intersection between Pershing Drive and Division Street:** This is a 120 feet long four-way intersection in Ansonia. Division street is a five-lane, two-way street and Pershing Drive is a five-lane, two-way commercial and residential street that is part of Ansonia's State Route 727. The intersection is shown in Figure 3-10.

Figure 3-10 Derby to/from Ansonia Conveyance Pipeline Intersection Crossing at Pershing Dr and Division St

3.2.3 Seymour to Ansonia

Figure 3-11 shows the conveyance corridor that will connect Seymour and Ansonia. The conveyance corridor to connect these two communities, crosses Route 8 twice and is situated along a combination of town/city streets and private property.

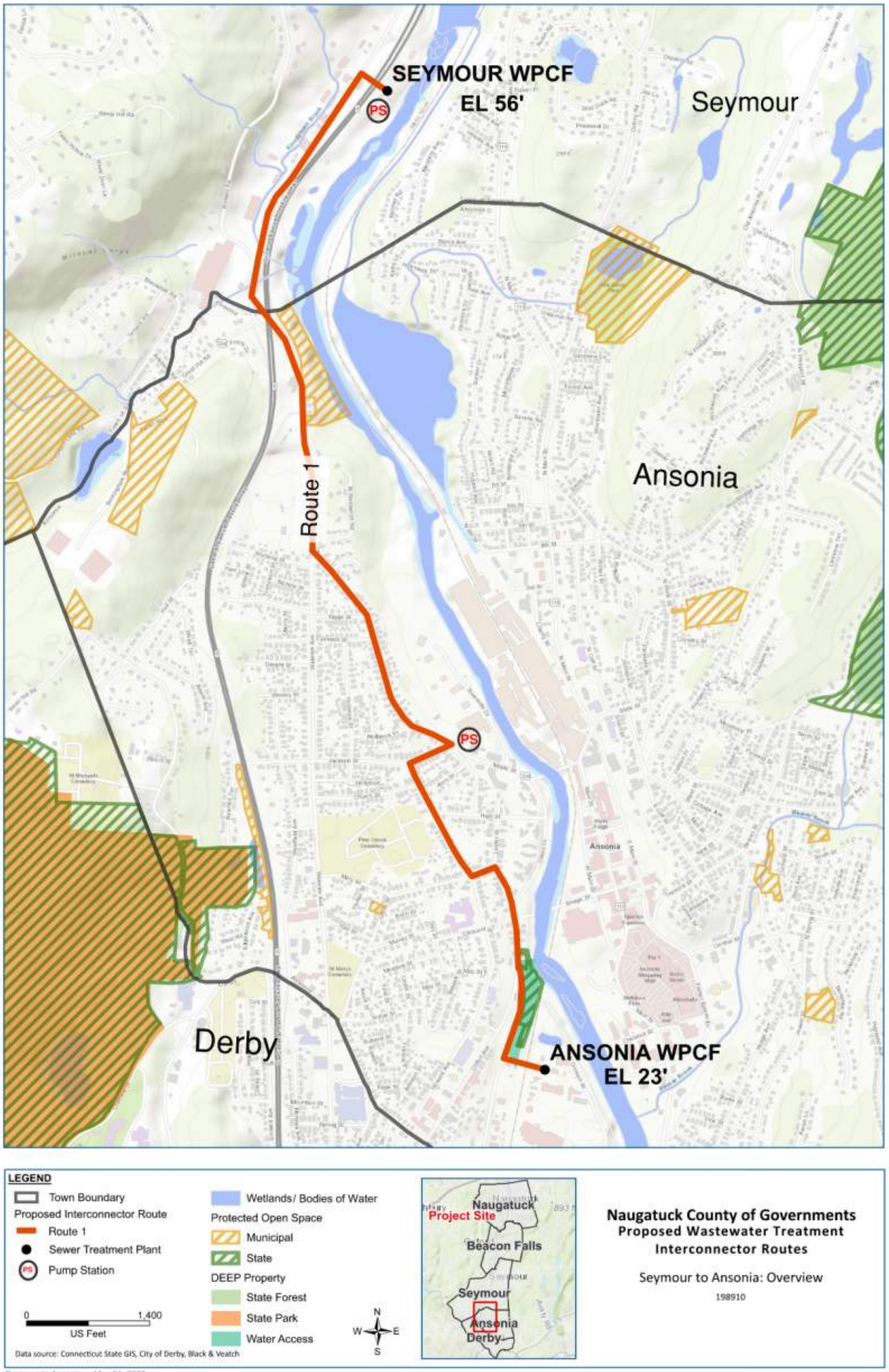


Figure 3-11 Seymour to Ansonia Conveyance Pipeline Route

Figure 3-12 shows the elevation profile of this route from Seymour WPCF to Ansonia WPCF. The elevation difference between Seymour WPCF (56 feet) and Ansonia WPCF (23 feet) is 33 feet with the highest elevation along the route at 135 feet. Route variations along different city streets were considered, with the route selected optimized based on length and topographical challenges. Due to the irregular topography, two pump stations will be required; one pump station will be located at Seymour WPCF and the other one will be a booster station along the pipeline route in Ansonia.

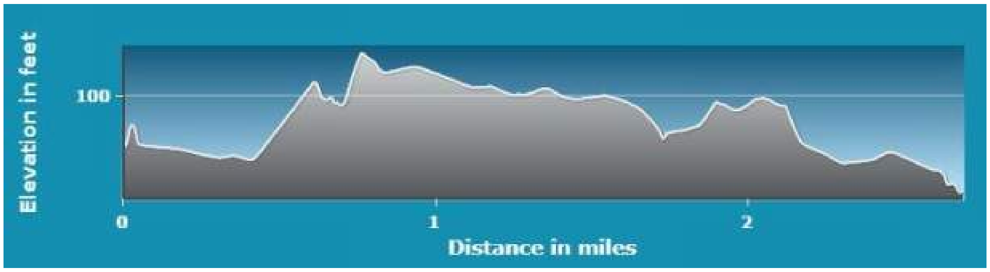


Figure 3-12 Seymour to Ansonia Conveyance Pipeline Profile

The pipeline will have different segments of force main and gravity sewer. Based on conceptual design, the physical attributes of the conveyance pipeline are summarized in Table 3-3.

Table 3-3 Seymour to Ansonia Conveyance Pipeline Characteristics

	Seymour to Ansonia
Length (ft)	14,200
Diameter (in)	14 and 20
Pump Stations	2
High point elevation (ft)	135
Private land taking	10% of route crosses private parcels

This conveyance corridor will cross Route 8 twice. At these locations pipe jacking will be required. The following segments of the wastewater conveyance pipeline will cross Route 8:

1. **From Seymour WPCF to Derby Avenue:** Figure 3-13 shows the approximately 200 feet long crossing from Seymour WPCF to Derby Avenue. One pit will be located at Seymour WPCF and the second pit at a private parcel on Derby Avenue.

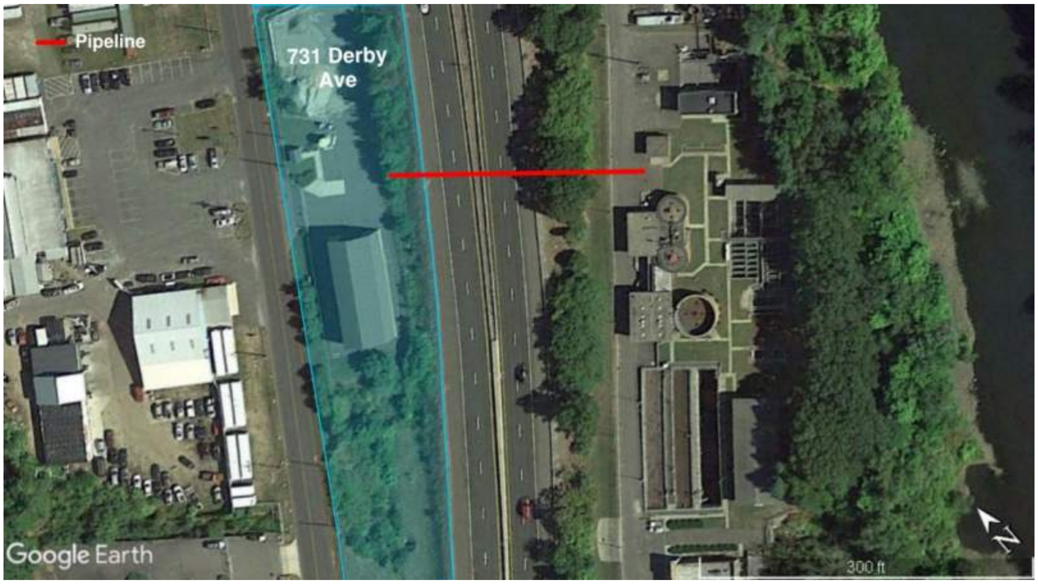


Figure 3-13 Seymour to Ansonia Conveyance Pipeline Route 8 Crossing from WWTP

2. **From Derby Avenue to Wakelee Avenue:** Figure 3-14 shows the first crossing from Derby Avenue to Wakelee Avenue. Because of the length and topographical changes, this crossing will have to be completed in two drives of approximately 600 feet each, requiring a launch pit, an intermediate pit, and a retrieval pit. The first drive will be from Derby Avenue to the median between Wakelee Avenue, Route 8, and merge ramp. The second drive will be from the median to a private parcel on Wakelee Avenue.

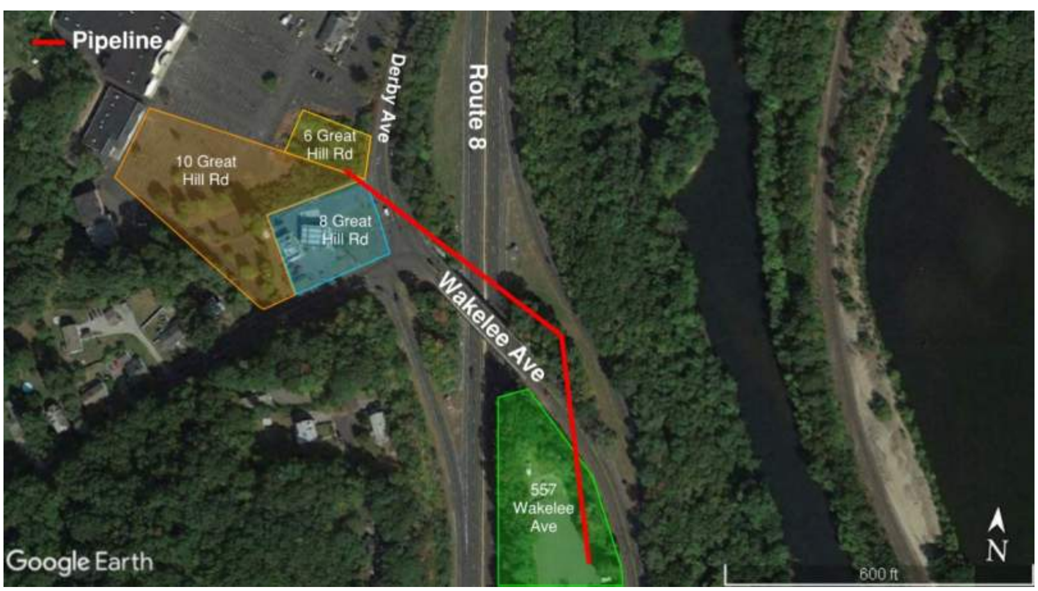


Figure 3-14 Seymour to Ansonia Conveyance Pipeline Route 8 Crossing near Wakelee Ave

Approximately 10% of the pipeline would be routed along private properties in Seymour and Ansonia. Through these properties, the preferred construction method will be open cut construction. The following parcels will be within the alignment of the conveyance corridor:

1. **731 Derby Avenue:** After crossing Route 8, the pipeline will cross 731 Derby Avenue, a property owned by the State of Connecticut shown in Figure 3-15.

Figure 3-15 Seymour to Ansonia Conveyance Pipeline 731 Derby Ave Crossing

2. **112 Pershing Drive, 120 Pershing Drive, or 200 Pershing Drive:** Between Pershing Dr and Ansonia WPCF, the pipeline will either be routed along the driveway of an existing commercial building in 112 Pershing Drive, or through the empty vegetated lot of 120 Pershing Drive or 200 Pershing Drive as shown in Figure 3-7 earlier in this chapter describing the Derby to/from Ansonia pipeline route.

3. **Waterbury Branch of the Metro North Railroad Crossing:** Leaving/going into Ansonia WPCF the pipeline will cross the railroad for approximately 75 feet as seen in Figure 3-7 earlier in this chapter describing the Derby to/from Ansonia pipeline route. This crossing will be constructed using pipe jacking with a pit at Ansonia WPCF and another pit in a private property on Pershing Avenue.

Most of the pipeline will be routed along busy city streets in Ansonia that will require significant planning and traffic control. The following intersections will need to be evaluated:

1. **Wakelee Avenue and Franklin Street:** Figure 3-16 shows the approximate 100 feet long three-way intersection in Ansonia. Wakelee Avenue and Westwood Road are both two-way residential streets. Franklin Street is a two-way residential street that is part of Route 334 in Connecticut, a state highway that runs from Seymour to Ansonia.

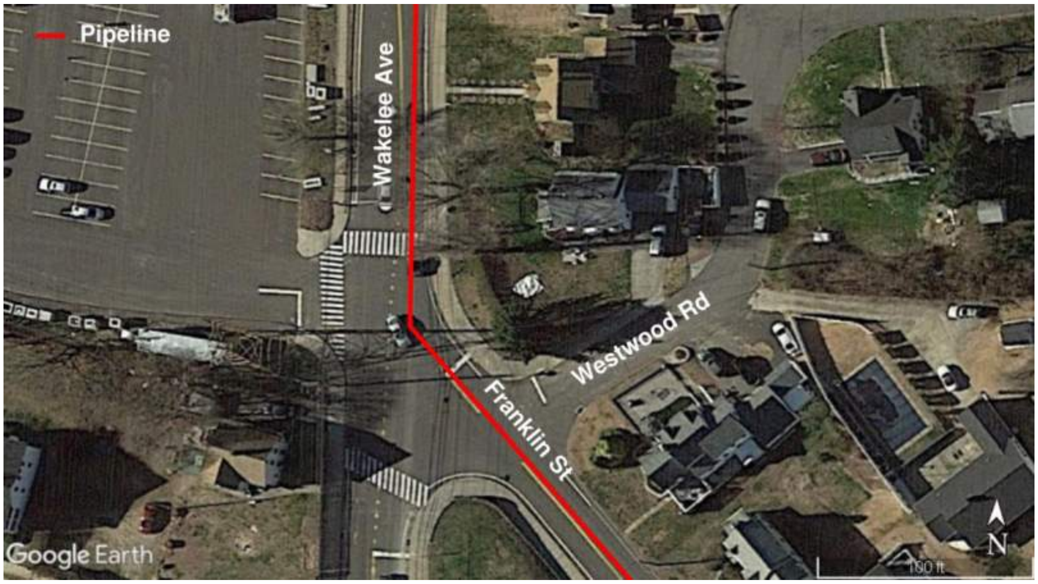


Figure 3-16 Seymour to Ansonia Conveyance Pipeline Intersection Crossing at Wakelee Ave and Franklin St

2. **Franklin Street/Maple Street and Jackson Street:** Figure 3-17 shows the approximate 100 feet long three-way intersection in the City of Ansonia. Franklin St (northeast) and Maple St are two-way streets both part of Route 334; Maple St and Franklin St (southwest) are both two-way residential streets.

Figure 3-17 Seymour to Ansonia Conveyance Pipeline Intersection Crossing at Franklin and Jackson St

3. **Lester Street/Pershing Drive and Olson Drive/Crescent Street and Bridge Street:** Figure 3-18 shows the approximate 300 feet long intersection in Ansonia. Lester Street and Olson Drive are two-way residential streets; Crescent Street is a one-way residential street; Pershing Drive is a two-way, five-lane commercial and residential street that is part of Ansonia's State Route 727; Bridge Street is a two-way street and is one of the main bridges connecting East and West Ansonia over the Naugatuck river.

Figure 3-18 Seymour to Ansonia Conveyance Pipeline Intersection Crossing at Pershing Dr and Bridge St

3.2.4 Effluent Discharge to Housatonic

Regionalization at Ansonia will require a new phosphorus removal facility to meet phosphorus discharge limits in the Naugatuck River. Regional alternatives 4 and 5b consider conveying and discharging fully treated secondary effluent from the regional plant in Ansonia to the Housatonic River at the Derby plant's existing outfall. The corridor for the effluent conveyance pipeline would be virtually the same as the regional conveyance pipeline from Derby to Ansonia for those alternatives, with two pipes installed in parallel, one from Derby conveying raw wastewater to Ansonia for treatment and the other from Ansonia conveying fully treated secondary effluent back to Derby. The physical attributes of the effluent discharge pipeline will be comparable to what is identified in Table 3-2. In these alternatives, the Ansonia effluent pump station would be modified to become a conveyance pump station; this only adds nominal costs as the effluent pumps at Ansonia would need to be upgraded in any case.

It is likely that the pipes will have to be installed at differing elevations to avoid interference with existing utilities. Moreover, installing two parallel pipes will result in longer construction times, wider easements, and increased traffic control requirements.

4.0 COLLECTION SYSTEMS

4.1 INFLOW AND INFILTRATION REDUCTION IN COLLECTION SYSTEMS

Infiltration and Inflow (I/I) is extraneous, undesired flow in the sewer system. It is typically relatively clean groundwater or storm water runoff that enters the collection system, potentially overwhelming pipe, pump, or treatment capacity, as well as increasing treatment and pumping costs. Defects resulting from aging, structural failure, lack of proper maintenance, and poor construction and design practices in sanitary sewer systems are the most common source of I/I. Defects can include conditions such as broken pipes; leaking joints; manhole lids with holes and/or poor sealing; and root infested sewer laterals. These conditions can compromise the structural integrity and contribute to excessive I/I during and after precipitation events, which can then lead to sewer surcharging and system overflows.

Each one of the five community plants included in this study will need improvements regardless of changes in flows and wastewater characteristics associated with regionalization. It is recommended that community-wide I/I programs be undertaken in all five of the communities, realizing that some of these are already underway. The results of these programs need to be regularly monitored. This will allow the communities to reevaluate the need and degree to implement aggressive I/I mitigation measures.

4.1.1 I/I Program Development

I/I programs are a standard part of wastewater management and are cost-effective at managing flows to the wastewater treatment plant over time. Implementation of an I/I program typically takes place in phases and over time – it is not uncommon that 10 or more years is required to fully implement community-wide I/I program, and I/I removal activities then continue indefinitely. I/I control results can be elusive due to the wide range of potential sources and environmental conditions, as well as the variety of control measures that can be implemented. Therefore, a strong commitment by the municipality to stay with the program is required. This is particularly the case as guideline assumptions of I/I removal may be optimistic, depending on the circumstances, and additional control may be required. This may occur for a variety of reasons, such as:

- Monitoring and SSES activities may not have identified all sources of inflow and infiltration, e.g. due to drier-than-normal conditions.
- Construction methods may not adequately seal the pipes, manholes, and related structures in the collection system to prevent I/I, or leaks that were sealed as part of the program may migrate to other cracks that were not producing leaks initially;
- Private I/I sources can be difficult to identify and control, and they may contribute a greater proportion of I/I than original estimates.

For these reasons and more, post-rehabilitation monitoring is important. The results characterize the effectiveness of I/I removal efforts and provide a basis for projecting future results. The results of post monitoring may also re-prioritize the capital plan and/or require additional testing prior to more implementation.

4.1.2 Flow Monitoring

The first step to controlling I/I is understanding the magnitude (how much flow), extent (where is it coming from), and nature (rapid inflow vs. gradual infiltration) of the problem. There are many different potential sources and patterns of I/I, ranging from discrete, identifiable sources to diffuse infiltration system-wide. The more widespread the problem is, the more expensive it will be to address. Flow monitoring is typically the first step in I/I management because it is cost-effective at characterizing each of the factors identified above. Having flow monitoring data from high groundwater periods and during storm events provides the ability to develop a strategy for successful I/I control.

Flow monitors were installed in eight locations in Ansonia, Derby, and Seymour from April 15 to May 28, 2020 as part of this regionalization study. Overall during this monitoring, flows were fairly typical for late-spring flows, with average flows moderately high compared with other times of the year. However, flow rates declined steadily throughout the monitoring period, indicating the drawdown of the water table throughout the study area. A total of 3.23 inches of rainfall was recorded during the monitoring period, using a rain gauge at the Ansonia treatment plant. Most of the rain fell as isolated, small, low intensity events with no significant change in flow. The two largest events were recorded on April 21 (0.25 inches) and April 30-May 1 (1.0 inches). These storm events are presented in more detail in subsequent discussion. Although ideal storm events were not recorded, given declining flows and lack of storm events, monitors were pulled on May 28, 2020 because significant storm responses were not expected.

Following are brief findings for each of the three monitored communities.

4.1.2.1 Derby Flow Monitoring

Flow rates from the monitoring period were compared with historical monthly operating report (MOR) flow data dating to 2015, as shown in Figure 4-1. The MOR data showed that flows in the monitoring period, while representing a high for 2020, were also substantially lower than prior years, like Seymour. Average flow during the monitoring period declined fairly rapidly over the course of the monitoring period.

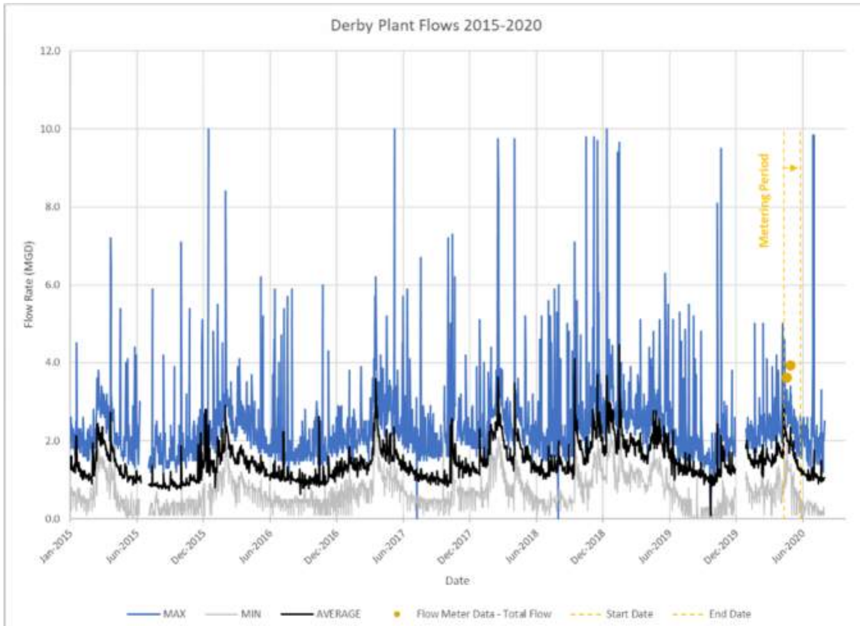
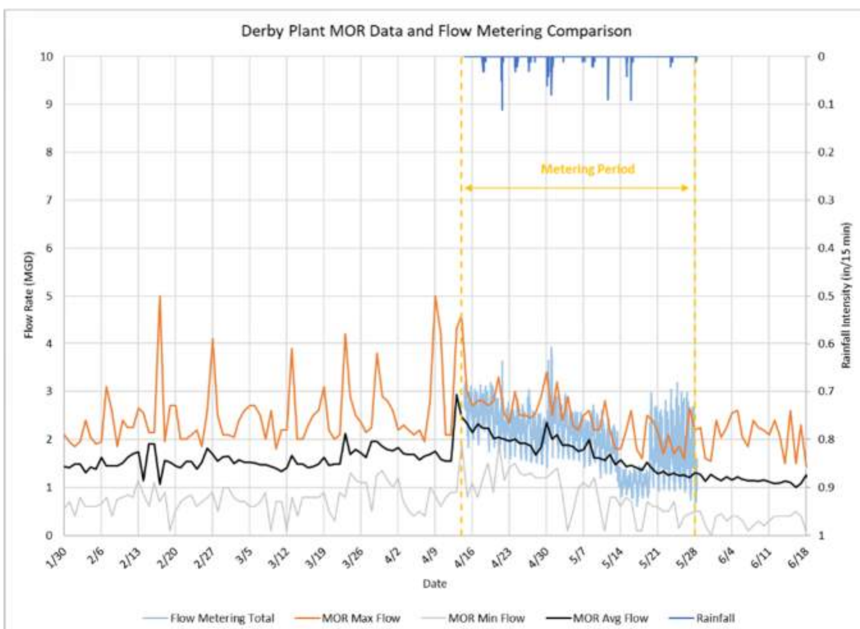
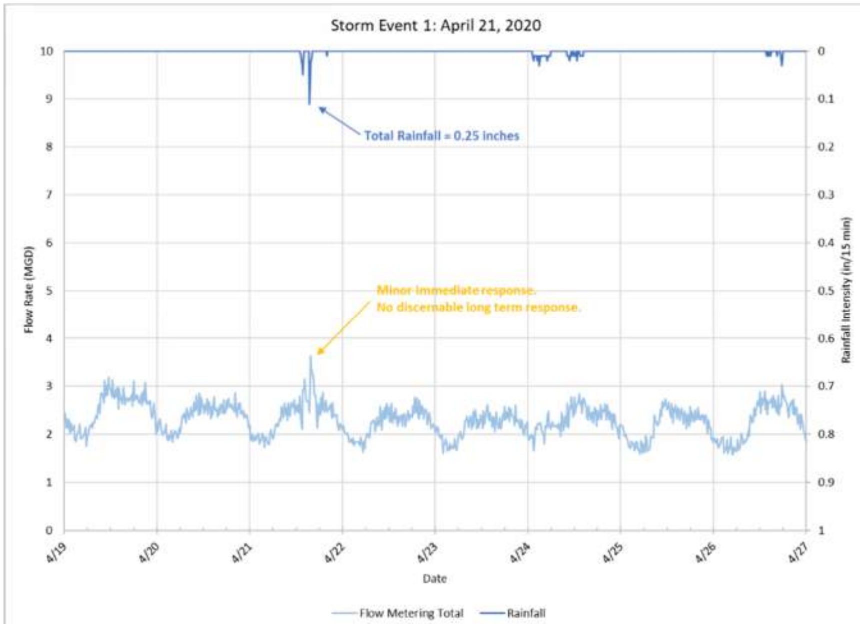
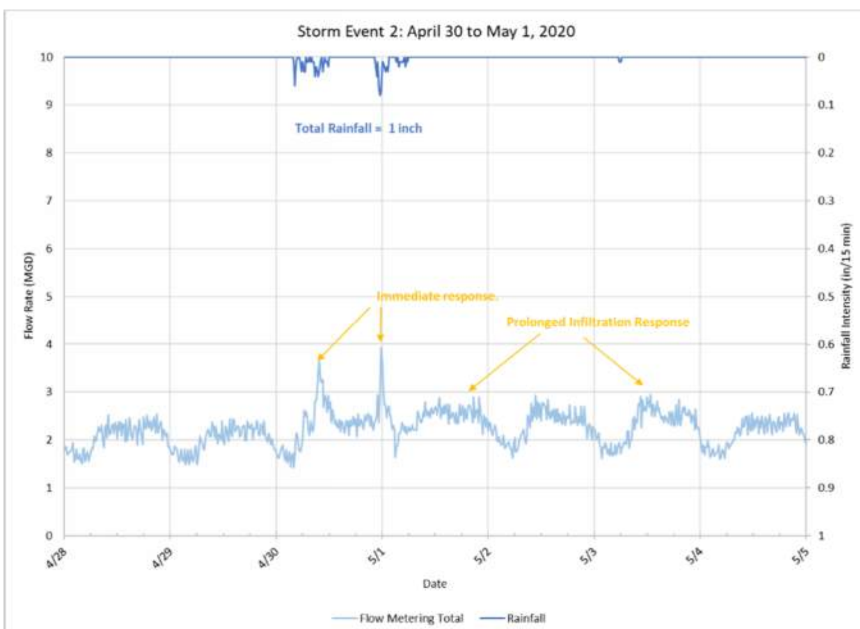
	The metering period is shown in the context of extended MOR data to contextualize the observed flows in the context of long-term flows. It shows that the metering period captures a moderately high average flow period. However, the peak flows were not comparable to higher flows earlier in spring 2020 and were far from observed recurring peak flows near 10 mgd.
	Flow meter data is shown superimposed on more recent plant MOR data to contextualize flows. Overall, observed flow metering flows were fairly consistently above average flows, and daily peak flows were consistently above MOR peak flows. Observed flows declined steadily through the monitoring period, indicating the impact of declining groundwater infiltration from a declining water table.

Figure 4-1 Derby Plant MOR Data and Flow Metering Data Comparison

Flow responses during the two storm events are presented in Figure 4-2, which shows that although there was an observable rainfall response, the response during larger storm events can be much larger than observed, as indicated by the frequency of events between 9 and 10 mgd since 2015. Further flow monitoring is recommended during wetter conditions before arriving at any conclusions regarding the low level of I/I observed in the system. Initially, it was surmised that recent I/I removal activities had reduced the peak flows, but on July 3, a high peak flow was recorded again, indicating that there is still significant I/I.



There was a discernable inflow response following the peak rainfall. However, this response (approximately 25% increase in flow) was still a minor response when compared with typical I/I inflow responses during significant storm events.



As with event #1, there was a discernable inflow response following the peak rainfall. Despite lower rainfall intensity, the response was greater than event #1. Additionally, there was a minor longer-term infiltration response. This event depicted something closer to an expected I/I response.

Figure 4-2 Derby Flow Metering Storm Event Observations

4.1.2.2 Ansonia Flow Monitoring

Figure 4-3 and Figure 4-4 present the MOR and flow meter comparisons and the storm event graphs, respectively. Like Derby, the average flow declined significantly during the monitoring period. Like Seymour, little to no storm response was observed in the monitoring period. Further flow monitoring is recommended during wetter conditions before arriving at any conclusions regarding the low level of I/I observed in the system.

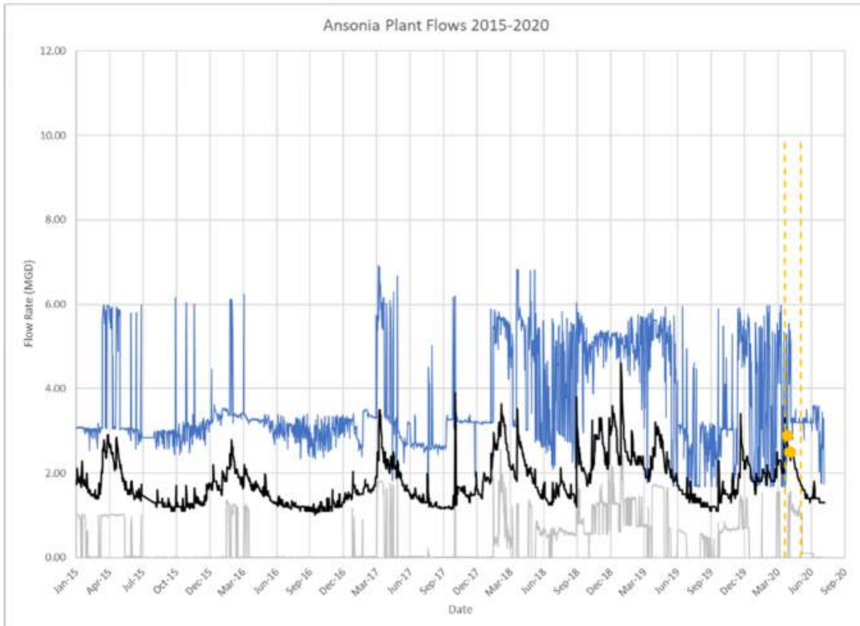
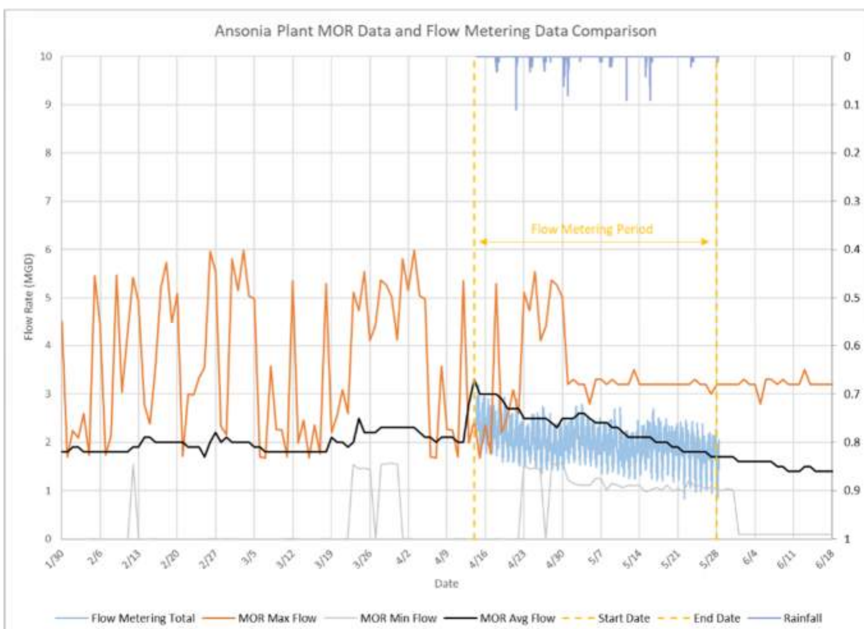
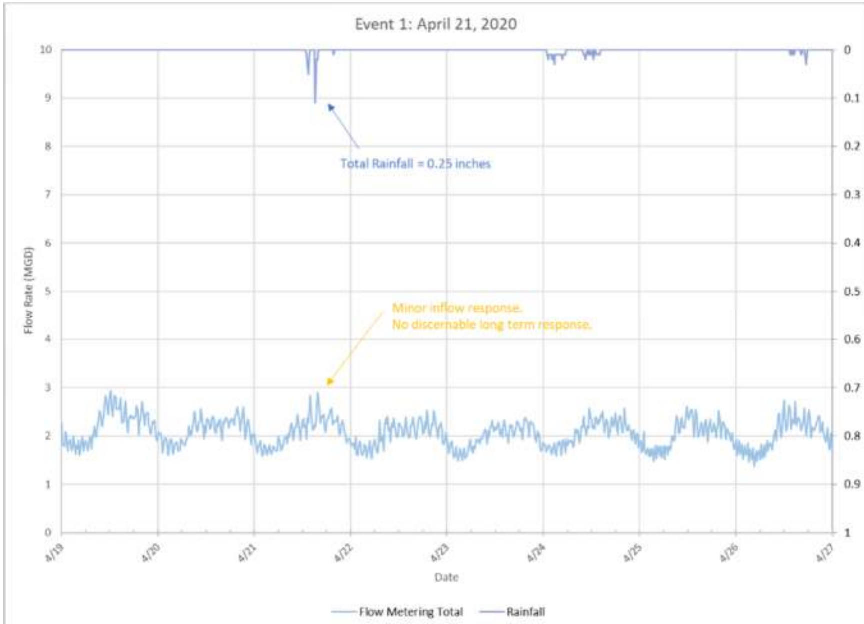
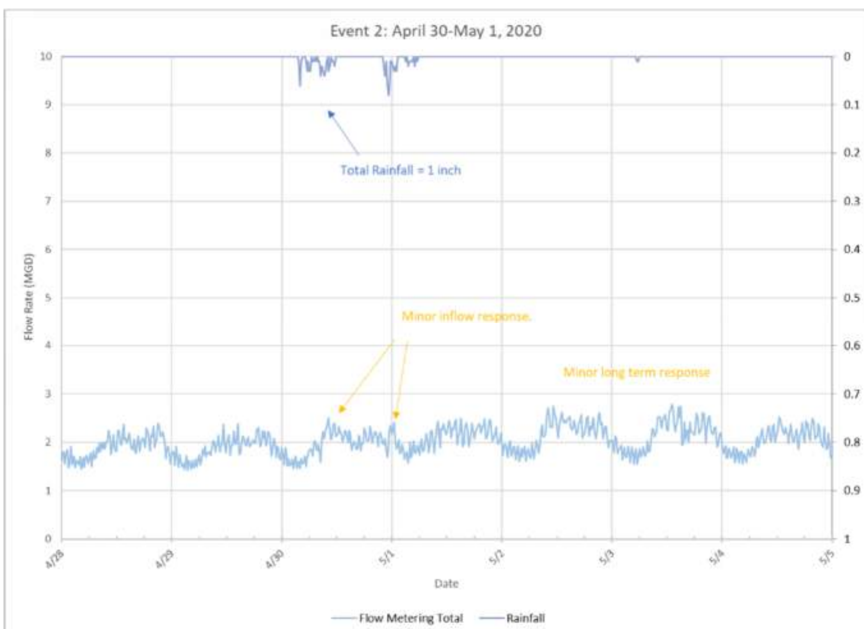
	The metering period is shown in the context of extended MOR data to contextualize the observed flows in the context of long-term flows. It shows that the metering period captures a moderately high average flow period. Peak flows are not comparable in Ansonia due to pump effects.
	Flow meter data is shown superimposed on more recent plant MOR data to contextualize flows. Overall, observed flow metering flows were fairly consistently below average flows, and daily peak flows were near average MOR flows. Observed flows declined steadily through the monitoring period, indicating the impact of declining groundwater infiltration from a declining water table.

Figure 4-3 Ansonia Plant MOR Data and Flow Metering Data Comparison

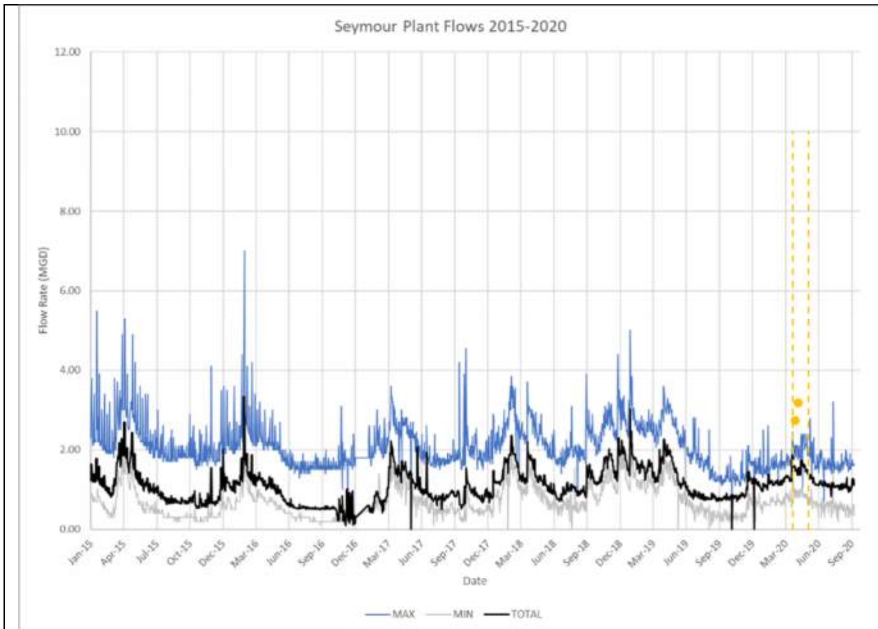
<table>
<tr>
<td>
</td>
<td>Very minor inflow response was observed following the peak rainfall intensity. This response is smaller than the peak dry weather flow observed two days earlier.</td>
</tr>
<tr>
<td>
</td>
<td>Very minor inflow response was observed following the peak rainfall intensity. This response is less than 5% greater than the peak dry weather flow observed one day earlier.

A minor increase (approximately 10%) in average flow was noted for several days following the event.</td>
</tr>
</table>

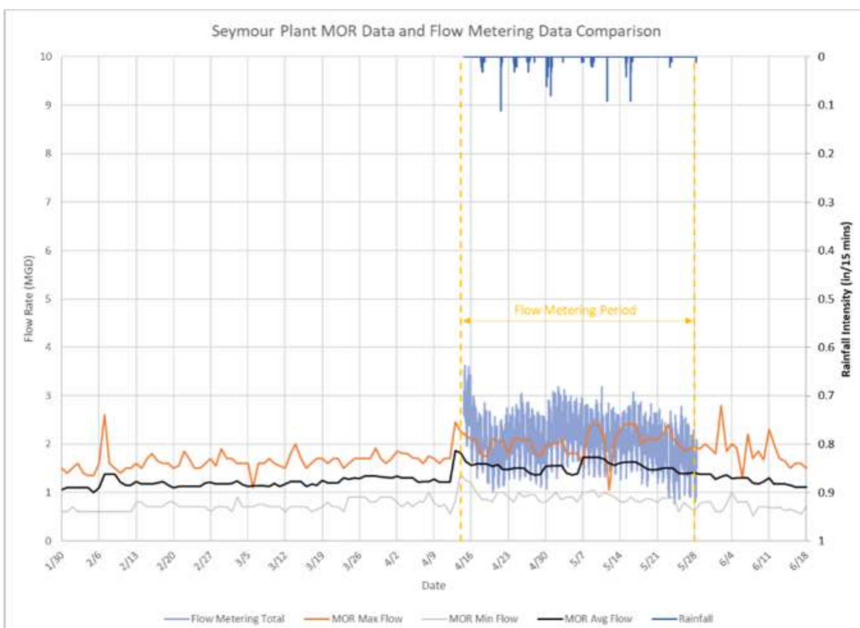
Figure 4-4 Ansonia Flow Metering Storm Event Observations

4.1.2.3 Seymour Flow Monitoring

Flow rates from the monitoring period were compared with historical monthly operating report (MOR) flow data dating to 2015, as shown in Figure 4-5. The MOR data showed that flows in the monitoring period, while representing a high for 2020, were substantially lower than prior years. Data during the monitoring period were quite consistent. Flow responses during the two storm events are presented in Figure 4-6, which shows that there was little to no observable rainfall response in the system. Further flow monitoring is recommended during wetter conditions before arriving at any conclusions regarding the low level of I/I observed in the system.

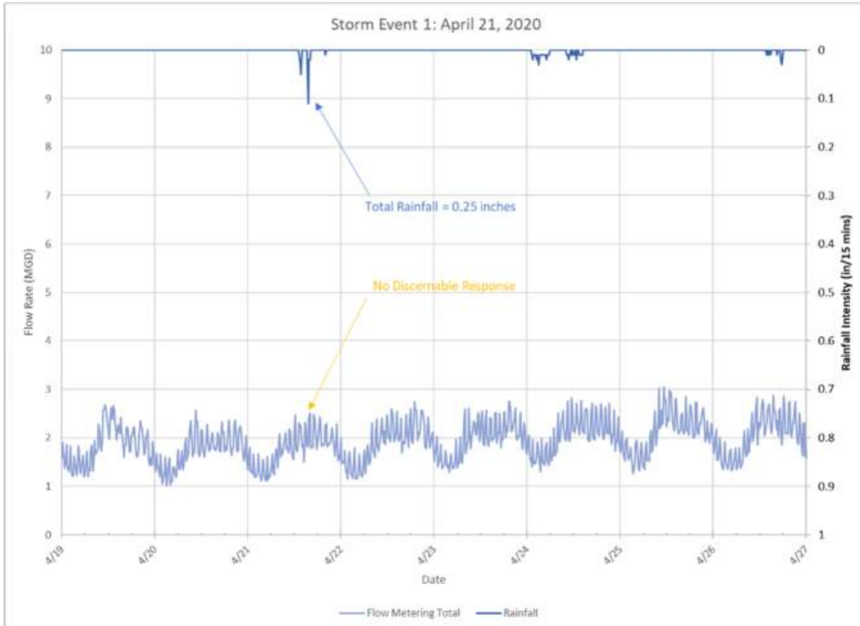


The metering period is shown in the context of extended MOR data to contextualize the observed flows in the context of long-term flows. It shows that the metering period captures a moderately high average flow period, with lower than average peak flows and no major peaks greater than 4 mgd, such as observed in 2015-2018.

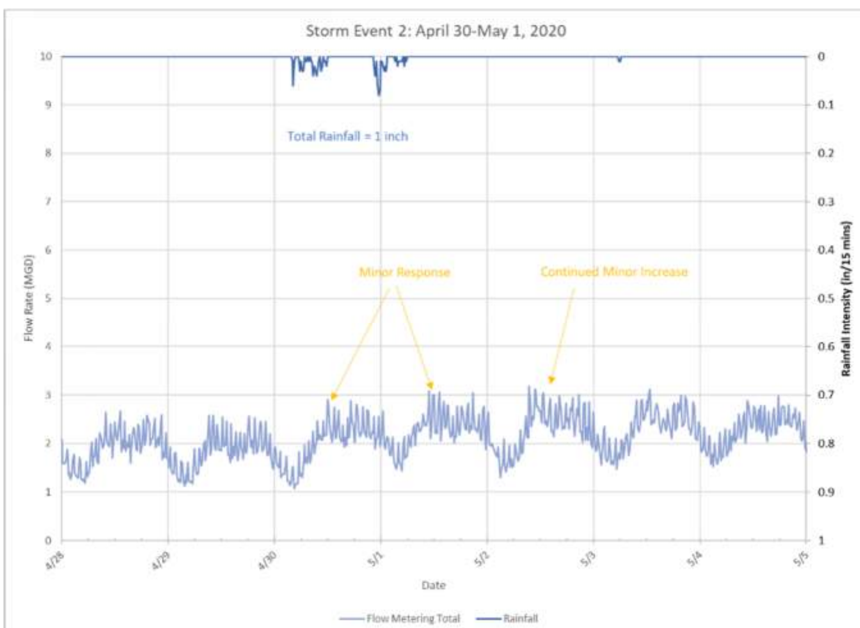


Flow meter data is shown superimposed on more recent plant MOR data to contextualize flows. Overall, observed flow metering flows were fairly consistently above average flows, and daily peak flows were consistently above MOR peak flows. Observed flows were quite consistent despite some rainfall events.

Figure 4-5 Seymour Plant MOR Data and Flow Metering Data Comparison



Despite a moderately high short-term rainfall intensity, there was no discernable rainfall response during the first storm event.



Despite a moderate rainfall volume, rainfall response was limited. A minor increase in short term response as well as long-term (multiple day response was noted). These increases of approximately 10% are minor compared with typical I/I responses during significant rainfall events.

Figure 4-6 Seymour Flow Metering Storm Event Observations

4.1.3 Major Inflow Sources

Inflow sources typically provide very rapid response to rainfall, with a source of direct entry to the sewer system. These flows can lead to very high peaks that quickly overwhelm a sewer system. Where significant inflow is identified, it is typically the most cost-effective and beneficial approach to remove those sources. However, inflow sources are also frequently over-emphasized.

Solving these problems will reduce I/I, but there are many other sources as well. Therefore, it will not reduce I/I to desired levels but will be the first step in I/I control. Common contributors of inflow include legal and illegal sources, including:

- Sump pumps
- Roof leaders
- Surface drainage to manholes
- Cross connections to storm sewers or catch basins

4.1.4 Infiltration Sources

Infiltration of various sorts are typically the predominant sources of I/I in most systems, especially when major sources of inflow have already been removed. Infiltration can be long term infiltration due to high groundwater in parts of the system, or it can be storm infiltration, which can be very rapid or gradual, depending on system defects as well as soil and surface characteristics. Infiltration is typically more difficult and more costly to manage than inflow.

4.1.5 Sewer System Evaluation Surveys

A sewer system evaluation survey (SSES) is used to identify potential sources of I/I and target appropriate repairs. The most common elements of SSES are identified below. There are multiple methods of inspection that vary in cost and precision.

- Smoke testing,
- Dye testing,
- Flow isolation monitoring,
- Manhole inspections, and
- Pipe inspections.

5.0 COSTS

5.1 CAPITAL COSTS

While budgetary in scope, capital costs were estimated using standard industry methods and cost data. The estimated capital costs are considered AACE Class 4 with an accuracy range of ±30%. Wherever possible, unit prices used for the capital costs were standardized to ensure consistency between the base case and regional alternatives.

Costs for wastewater plant facilities and upgrades, conveyance pipelines, and conveyance pump stations were estimated based on planning level quantities for comparative purposes and include equipment, construction installation, and startup. The costs also include general requirements, contractor overhead and profit, a 40% contingency, and a 20% allowance for engineering, legal, administration, and associated services during design and construction. These costs were escalated at a fixed rate of 3.5% through the anticipated midpoint of construction periods based on recent industry trends.

Costs for programmed collection system improvements were estimated on a set cost per linear foot of the collection systems, inflated at a fixed annual rate of 2% across the planning period based on historical trends.

5.1.1 Wastewater Treatment Plants

5.1.1.1 Base Cases

Plant upgrade capital costs for the base cases are summarized in Table 5-1, represented at the midpoint of anticipated construction.

Table 5-1 Plant Upgrade Capital Costs for Base Cases

Facility/Area	Derby	Ansonia	Seymour
Headworks and Influent Pumping	$11,600,000	$2,400,000	$9,300,000
Primary Clarifiers	$2,600,000	NA	$1,500,000
BNR Process Upgrades	$14,600,000	NA	$4,100,000
Secondary Clarifiers	$1,200,000	NA	$2,200,000
Disinfection	$900,000	$2,200,000	NA
Effluent Pumps	NA	$1,900,000	NA
Primary & Secondary Control Building Upgrades	$4,200,000	NA	NA
Sludge Handling Facilities	$8,700,000	$8,700,000	$2,500,000
Sitewide Electrical and Controls	$5,300,000	NA	$4,400,000
Sitework	$1,400,000	$900,000	$400,000
General Upgrades/Miscellaneous	$1,200,000	$400,000	$500,000
Total	**$51,700,000**	**$16,500,000**	**$24,900,000**

5.1.1.2 Derby Regional Alternatives

Plant upgrade capital costs for the Derby regional alternatives are summarized in Table 5-2, represented at the midpoint of anticipated construction.

Table 5-2 Plant Upgrade Capital Costs for Derby Regional Alternatives

Facility/Area	Derby + Ansonia (BioMag)	Derby + Ansonia (IFAS)	Derby + Ansonia + Seymour (BioMag)	Derby + Ansonia + Seymour (IFAS)
Influent Pump Station and Screening	$6,600,000	$6,600,000	$6,600,000	$6,600,000
New Grit Removal Facility	$7,600,000	$7,600,000	$7,600,000	$7,600,000
Primary Clarifiers	$2,600,000	$2,600,000	$2,600,000	$2,600,000
BNR Process Upgrade and Fitout	$26,200,000	$30,700,000	$27,200,000	$34,200,000
New BNR Tankage	$6,300,000	NA	$10,400,000	$6,300,000
New Secondary Clarifier	NA	$4,700,000	$4,700,000	$8,400,000
Existing Secondary Clarifiers	$1,200,000	$1,200,000	$1,200,000	$1,200,000
New UV Disinfection Facility	$4,100,000	$4,100,000	$4,100,000	$4,100,000
Primary Control Building	$2,700,000	$2,700,000	$2,700,000	$2,700,000
Secondary Control Building	$1,500,000	$1,500,000	$1,500,000	$1,500,000
New Sludge Handling Facility	$9,100,000	$9,100,000	$9,500,000	$9,500,000
Sitewide Electrical And I&C	$5,300,000	$5,300,000	$5,300,000	$5,300,000
Sitework	$1,600,000	$1,600,000	$1,600,000	$1,600,000
General Upgrades/Miscellaneous	$1,200,000	$1,200,000	$1,200,000	$1,200,000
Total	**$76,000,000**	**$78,900,000**	**$86,200,000**	**$92,800,000**

5.1.1.3 Ansonia Regional Alternatives

Plant upgrade capital costs for the Ansonia regional alternatives are summarized in Table 5-3, represented at the midpoint of anticipated construction.

Table 5-3 Plant Upgrade Capital Costs for Ansonia Regional Alternatives

Facility/Area	Ansonia + Derby	Ansonia + Derby (Effluent to Housatonic)	Ansonia + Derby + Seymour	Ansonia + Derby + Seymour (Effluent to Housatonic)
Influent Screening	$1,600,000	$1,600,000	$1,700,000	$1,700,000
New Grit Removal Facility	$4,100,000	$4,100,000	$4,100,000	$4,100,000
Headworks Odor Control	$800,000	$800,000	$900,000	$900,000
New Primary Clarifier and CEPT	$3,400,000	$3,400,000	$4,300,000	$4,300,000
New Secondary Clarifier	NA	NA	$7,500,000	$7,500,000
Influent and Effluent Pumps	$3,800,000	$3,800,000	$3,900,000	$3,900,000
New Sludge Handling Facility	$9,200,000	$9,200,000	$9,600,000	$9,600,000
New Phosphorus Treatment Facility	$14,200,000	NA	$15,100,000	NA
UV Disinfection Facility	$2,200,000	$2,200,000	$2,200,000	$2,200,000
Sitework	$900,000	$900,000	$1,000,000	$1,000,000
General Upgrades/Miscellaneous	$500,000	$500,000	$500,000	$500,000
Total	**$40,700,000**	**$26,500,000**	**$50,800,000**	**$35,700,000**

5.1.2 Conveyance Pipelines and Pump Stations

Capital costs for the regional conveyance systems are summarized in Table 5-4, represented at the midpoint of anticipated construction.

Table 5-4 Regional Conveyance Pipeline Capital Costs

	Ansonia to Derby	Ansonia Plus Seymour to Derby	Ansonia Plus Seymour to Derby (Effluent to Housatonic)	Derby to Ansonia	Derby to Ansonia (Effluent to Housatonic)	Seymour to Ansonia
Conveyance Pipeline	$13,600,000	$14,000,000	$21,400,000	$12,600,000	$19,400,000	$20,200,000
Pump Stations, Screenings, Grit Removal	$4,200,000	$4,300,000	$4,300,000	$6,600,000	$6,600,000	$11,400,000
Total	**$17,800,000**	**$18,300,000**	**$25,700,000**	**$19,200,000**	**$26,000,000**	**$31,600,000**

5.1.3 Collection Systems

Capital costs for programmatic collection system improvements are summarized in Table 5-5, represented at the midpoint of the study period. These capital improvements costs are the same between the base cases and the different regional alternatives, as the existing collection systems will not change based on regionalization; however, it is imperative that these improvements are accounted for and implemented.

Table 5-5 Collection System Capital Costs

	Derby	Ansonia	Seymour
Collection System Length (miles)	41.2	65.3	63.0
System replacement rate (yr 1-5)	2.5%	2%	2%
System replacement rate (yr 6-25)	1.2%	1%	0.75%
System replacement cost (yr 1-5)	$2,860,000	$3,620,000	$3,500,000
System replacement cost (yr 6-25)	$7,030,000	$9,280,000	$6,720,000
Pump station replacement cost	$4,380,000	$3,150,000	$2,100,000
Total	**$14,300,000**	**$16,100,000**	**$12,300,000**

5.2 OPERATION AND MAINTENANCE COSTS

Relevant operational and maintenance (O&M) costs were estimated for the following key categories where O&M cost differences were anticipated between base cases and the regional alternatives: energy, chemicals, sludge disposal, disinfection, and labor. These costs were calculated based on unit costs applied to estimated O&M unit quantities. Unit costs were based on actual O&M cost data obtained from Derby, Ansonia, and Seymour plant staff for categories where cost information was readily available. To a limited extent, the unit costs from available market data were also reviewed. The calculated unit costs were escalated at a fixed annual rate of 2% across the planning period based on historical trends. Unit costs were standardized for all O&M costs to ensure consistency in analysis between the base case and regional alternatives. O&M unit costs are summarized in Table 5-6, represented at the midpoint of the study period.

Table 5-6 O&M Unit Costs

O&M Category	Unit Cost
Energy	$0.18/kWh
Ferric	$1.15/gallon
Polymer	$19.21/gallon
Magnetite ballast	$0.45/pound
Thickened sludge disposal, 4.5% solids	$32.80/wet ton
Labor, superintendent	$98.54/hr
Labor, O&M staff (blended)	$69.38/hr

Startup factors were applied to totalized O&M costs to account for projected growth and associated increases to plant flows and loads over time. The startup factors are weighted averages of current 2020 loading to projected 2040 loading for each base case and alternative. O&M costs were totalized for 25 years, accounting for project implementation and startup within the first five years; for regional alternatives, base case O&M costs were carried for the first five years and the regional alternative O&M costs were carried for the subsequent 20 years.

Black & Veatch conducted an O&M staff evaluation to determine staff structures for the base cases and regional alternatives. This evaluation is discussed in Appendix C.

5.2.1 Base Cases

O&M costs associated with energy, relevant chemicals, disinfection, sludge disposal, and operations staff for the base cases are shown in Table 5-7, Table 5-8, Table 5-9, Table 5-10, and Table 5-11 below. Labor includes O&M costs of the plants and collection systems. A summary of annual and 25-year total O&M costs is shown in Table 5-12. Quantities were calculated based on the projected 2040 flows and loads; annual costs are expressed at the midpoint of the study period.

Table 5-7 O&M Energy Costs for Ansonia, Derby, and Seymour Base Case

	Ansonia	Derby	Seymour
Aeration Energy, hp	142	38.8	27.9
Influent Pump Energy, hp	19.1	19.3	13
RAS Pump Energy, hp	3.3	3.4	2.3
MLR Pump Energy, hp	9.5	9.6	6.5
Mixing Energy, hp	20	6	6
Fixed Energy Costs, hp	83.1	53.6	38.7
Total Energy, hp	277	130.7	94.4
Annual Energy Usage, kWh/yr	1,810,700	854,400	617,100
Startup Factor	0.92	0.89	0.75
Annual Electricity Costs	$313,500	$145,600	$97,000
25-year Electricity Costs	**$7,838,000**	**$3,639,000**	**$2,424,000**

Table 5-8 O&M Chemical Costs for Ansonia, Derby, and Seymour Base Case

	Ansonia	Derby	Seymour
Coagulant Dosage CEPT, gal/d	0	101	0
Coagulant Dosage P Removal, gal/d	225	0	127
Polymer Dosage CEPT, gal/d	0	4	0
Startup Factor	0.92	0.89	0.75
Annual Chemical Costs	$90,900	$66,700	$46,600
25-year Chemical Costs	**$2,273,000**	**$1,668,000**	**$1,164,000**

Table 5-9 O&M Disinfection Costs for Ansonia, Derby, and Seymour Base Case

	Ansonia	Derby	Seymour
Startup Factor	0.92	0.89	0.75
Annual UV Disinfection Costs	$24,000	$0	$0
Annual Chemical Disinfection Costs	$0	$8,300	$8,300
25-year Disinfection Costs	**$601,000**	**$208,000**	**$208,000**

Table 5-10 O&M Sludge Disposal Costs for Ansonia, Derby, and Seymour Base Case

	Ansonia	Derby	Seymour
Total Sludge Production, dry tons/year	541	361	359
Thickened Sludge Production, wet tons/year (1)	12,018	8,019	7,980
Startup Factor	0.92	0.89	0.75
Annual Sludge Disposal Costs	$379,200	$249,000	$228,500
25-year Sludge Disposal Costs	**$9,481,000**	**$6,224,000**	**$5,713,000**
(1) Assumes a 4.5% solids concentration			

Table 5-11 O&M Labor Costs for Ansonia, Derby, and Seymour Base Case

	Ansonia	Derby	Seymour
Plant Superintendent, FTE	1.0	1.0	1.0
Plant Operations and Maintenance, FTE	4.0	5.0	4.0
Collection System O&M, FTE	2.0	2.0	2.0
Annual Labor Cost	$1,070,800	$1,215,100	$1,070,800
25-year Labor Costs	**$26,771,000**	**$30,378,000**	**$26,771,000**

Table 5-12 Total O&M Costs for Ansonia, Derby, and Seymour Base Case

	Ansonia	Derby	Seymour
Total Annual O&M Costs	$1,878,000	$1,685,000	$1,451,000
25-year O&M Costs	**$47,000,000**	**$42,100,000**	**$36,300,000**

5.2.2 Derby Regional Alternatives O&M Costs

O&M costs associated with energy, relevant chemicals, disinfection, sludge disposal, and operations staff for the Derby regional alternatives are shown in Table 5-13, Table 5-14, Table 5-15, Table 5-16, and Table 5-17 below. Labor includes O&M costs of the plants, conveyance systems, and collection systems. A summary of annual and 25-year total O&M costs is shown in Table 5-18. Quantities were calculated based on the projected 2040 flows and loads; annual costs are expressed at the midpoint of the study period. Associated base case O&M costs were carried for the first five years to account for project implementation and startup.

Table 5-13 O&M Energy Costs for Derby Regional Alternatives

	Derby + Ansonia (BioMag)	Derby + Ansonia (IFAS)	Derby + Ansonia + Seymour (BioMag)	Derby + Ansonia + Seymour (IFAS)
Aeration Energy, hp	147.8	147.8	200.6	200.6
Influent Pump Energy, hp	38.3	38.3	51.4	51.4
RAS Pump Energy, hp	6.7	3.4	9	4.5
MLR Pump Energy, hp	19.2	19.2	25.7	25.7
Mixing Energy, hp	8	6	10	8
Fixed Energy Costs, hp	129.2	126.1	146.1	142.9
BioMag Recovery Energy, hp	33	NA	41	NA
Conveyance Pumping Energy, hp	8	8	60	60
Total Energy, hp	390.2	348.8	543.8	493.1
Annual Energy Usage, kWh/yr	2,550,700	2,280,000	3,554,700	3,223,300
Startup Factor	0.91	0.91	0.81	0.81
Annual Electricity Costs, /yr	$438,000	$391,500	$579,700	$525,700
25-year Electricity Costs	**$11,055,000**	**$10,126,000**	**$14,374,000**	**$13,293,000**

Table 5-14 O&M Chemical Costs for Derby Regional Alternatives

	Derby + Ansonia (BioMag)	Derby + Ansonia (IFAS)	Derby + Ansonia + Seymour (BioMag)	Derby + Ansonia + Seymour (IFAS)
Coagulant Dosage CEPT, gal/d	202	202	270	270
Polymer Dosage CEPT, gal/d	7	7	9	9
Polymer Dosage BioMag, gal/d	30	NA	42	NA
Ballast Usage, lb/d	174	NA	224	NA
Startup Factor	0.91	0.91	0.81	0.81
Annual Chemical Costs, $/yr	$355,900	$127,800	$460,300	$160,000
25-year Chemical Costs, $M	**$7,906,000**	**$3,344,000**	**$10,227,000**	**$4,220,000**

Table 5-15 O&M Disinfection Costs for Derby Regional Alternatives

	Derby + Ansonia (BioMag)	Derby + Ansonia (IFAS)	Derby + Ansonia + Seymour (BioMag)	Derby + Ansonia + Seymour (IFAS)
Startup Factor	0.91	0.91	0.81	0.81
Annual UV Disinfection Costs	$38,300	$38,300	$42,800	$42,800
25-year Disinfection Costs	**$928,000**	**$928,000**	**$1,059,000**	**$1,059,000**

Table 5-16 O&M Sludge Disposal Costs for Derby Regional Alternatives

	Derby + Ansonia (BioMag)	Derby + Ansonia (IFAS)	Derby + Ansonia + Seymour (BioMag)	Derby + Ansonia + Seymour (IFAS)
Total Sludge Production, dry tons/year	902	902	1,261	1,261
Thickened Sludge Production, wet tons/year (1)	20,038	20,038	28,018	28,018
Startup Factor	0.91	0.91	0.81	0.81
Annual Sludge Disposal Costs	$627,000	$627,000	$832,600	$832,600
25-year Sludge Disposal Costs	**$15,681,000**	**$15,681,000**	**$20,935,000**	**$20,935,000**
(1) Assumes a 4.5% solids concentration				

Table 5-17 O&M Labor Costs for Derby Regional Alternatives

	Derby + Ansonia (BioMag)	Derby + Ansonia (IFAS)	Derby + Ansonia + Seymour (BioMag)	Derby + Ansonia + Seymour (IFAS)
Plant Superintendent, FTE	1.0	1.0	1.0	1.0
Plant Operations and Maintenance, FTE	5.0	5.0	5.0	5.0
Collection System O&M, FTE	4.0	4.0	6.0	6.0
Annual Labor Cost	$1,503,800	$1,503,800	$1,792,400	$1,792,400
25-year Labor Costs	**$41,505,000**	**$41,505,000**	**$52,631,000**	**$52,631,000**

Table 5-18 Total O&M Costs for Derby Regional Alternatives

	Derby + Ansonia (BioMag)	Derby + Ansonia (IFAS)	Derby + Ansonia + Seymour (BioMag)	Derby + Ansonia + Seymour (IFAS)
Total Annual O&M Costs	$5,648,000	$5,377,000	$7,282,000	$6,950,000
25-year O&M Costs	**$77,100,000**	**$71,600,000**	**$99,200,000**	**$92,100,000**

5.2.3 Ansonia Regional Alternatives O&M Costs

O&M costs associated with energy, relevant chemicals, disinfection, sludge disposal, and operations staff for the Ansonia regional alternatives are shown in Table 5-19, Table 5-20, Table 5-21, Table 5-22, and Table 5-23 below. Labor includes O&M costs of the plants, conveyance systems, and collection systems. A summary of annual and 25-year total O&M costs is shown in Table 5-24. Quantities were calculated based on the projected 2040 flows and loads; annual costs are expressed at the midpoint of the study period. Associated base case O&M costs were carried for the first five years to account for project implementation and startup.

Table 5-19 O&M Energy Costs for Ansonia Regional Alternatives

	Ansonia + Derby	Ansonia + Derby (Effluent to Housatonic)	Ansonia + Derby + Seymour	Ansonia + Derby + Seymour (Effluent to Housatonic)
Aeration Energy, hp	239	239	331	331
Influent Pump Energy, hp	38.3	38.3	51.4	51.4
RAS Pump Energy, hp	6.7	6.7	9	9
MLR Pump Energy, hp	19.2	19.2	25.7	25.7
Mixing Energy, hp	20	20	20	20
Fixed Energy Costs, hp	113.6	113.6	123.3	123.3
Tertiary Facility Energy, hp	4	NA	4	NA
Conveyance Pumping Energy, hp	8	16	50	68
Total Energy, hp	448.8	452.8	614.4	628.4
Annual Energy Usage, kWh/yr	2,933,700	2,959,900	4,016,200	4,107,700
Startup Factor	0.91	0.91	0.81	0.81
Annual Electricity Costs, /yr	$503,800	$508,300	$655,000	$669,900
25-year Electricity Costs	**$12,371,000**	**$12,461,000**	**$15,880,000**	**$16,178,000**

Table 5-20 O&M Chemical Costs for Ansonia Regional Alternatives

	Ansonia + Derby	Ansonia + Derby (Effluent to Housatonic)	Ansonia + Derby + Seymour	Ansonia + Derby + Seymour (Effluent to Housatonic)
Coagulant Dosage CEPT, gal/d	202	202	270	270
Coagulant Dosage P Removal, gal/d	80	0	108	0
Polymer Dosage CEPT, gal/d	7	7	9	9
Startup Factor	0.91	0.91	0.81	0.81
Annual Chemical Costs, $/yr	$159,900	$127,800	$201,100	$160,000
25-year Chemical Costs, $M	**$3,985,000**	**$3,344,000**	**$5,042,000**	**$4,220,000**

Table 5-21 O&M Disinfection Costs for Ansonia Regional Alternatives

	Ansonia + Derby	Ansonia + Derby (Effluent to Housatonic)	Ansonia + Derby + Seymour	Ansonia + Derby + Seymour (Effluent to Housatonic)
Startup Factor	0.91	0.91	0.81	0.81
Annual UV Disinfection Costs	$38,300	$38,300	$42,800	$42,800
25-year Disinfection Costs	**$928,000**	**$928,000**	**$1,059,000**	**$1,059,000**

Table 5-22 O&M Sludge Disposal Costs for Ansonia Regional Alternatives

	Ansonia + Derby	Ansonia + Derby (Effluent to Housatonic)	Ansonia + Derby + Seymour	Ansonia + Derby + Seymour (Effluent to Housatonic)
Total Sludge Production, dry tons/year	902	902	1,261	1,261
Thickened Sludge Production, wet tons/year (1)	20,038	20,038	28,018	28,018
Startup Factor	0.91	0.91	0.81	0.81
Annual Sludge Disposal Costs	$627,000	$627,000	$832,600	$832,600
25-year Sludge Disposal Costs	**$15,681,000**	**$15,681,000**	**$20,935,000**	**$20,935,000**
(1) Assumes a 4.5% solids concentration				

Table 5-23 O&M Labor Costs for Ansonia Regional Alternatives

	Ansonia + Derby	Ansonia + Derby (Effluent to Housatonic)	Ansonia + Derby + Seymour	Ansonia + Derby + Seymour (Effluent to Housatonic)
Plant Superintendent, FTE	1.0	1.0	1.0	1.0
Plant Operations and Maintenance, FTE	5.0	5.0	5.0	5.0
Collection System O&M, FTE	4.0	4.0	6.0	6.0
Annual Labor Cost	$1,503,800	$1,503,800	$1,792,400	$1,792,400
25-year Labor Costs	**$41,505,000**	**$41,505,000**	**$52,631,000**	**$52,631,000**

Table 5-24 Total O&M Costs for Ansonia Regional Alternatives

	Ansonia + Derby	Ansonia + Derby (Effluent to Housatonic)	Ansonia + Derby + Seymour	Ansonia + Derby + Seymour (Effluent to Housatonic)
Total Annual O&M Costs	$6,191,000	$6,185,000	$7,944,000	$7,995,000
25-year O&M Costs	**$74,500,000**	**$73,900,000**	**$95,500,000**	**$95,000,000**

5.2.4 Conveyance Systems and Collection Systems

Labor and conveyance energy O&M costs associated with the conveyance systems and collection systems are carried under the plant O&M costs in the tables above.

5.3 PRESENT WORTH ANALYSIS

A common approach to comparing alternatives is to use a present worth (PW) analysis. The PW method allows for monetary costs associated with capital expenditures and O&M costs over the planning period to be expressed as a present equivalent value. The PW analysis allows for these costs to be expressed in common units enabling a comparison of distinct alternatives. The alternative with the lowest present worth cost is the most favorable as compared to the others. The PW analysis is often also referred to as a lifecycle analysis, which acknowledges the useful lives of assets in the investment along with the impact on operations and maintenance (O&M) costs for the duration of the analysis.

A common approach to evaluating alternatives is to start the assessment with a high-level analysis of multiple alternatives and systematically reduce the number of alternatives through increasingly rigorous technical and financial review. For this study, there were 23 alternatives initially explored in Phase 1 and, through the subsequent analysis conducted in Task 2, these were reduced to six short-list regional alternatives. Using the present worth method, a detailed cost analysis was performed as part of this task to further reduce the short-listed alternatives down to the preferred ones to carry forward.

For this detailed cost analysis, inflation and escalation rates were applied to capital and O&M costs as noted previously in this chapter, calculated as averages across assumed PW durations. Table 5-25 shows the duration and timing of costs assumed for the present worth analysis. An annual interest rate of 2.2% was assumed over the 25-year evaluation period based on loans available through the CT DEEP Clean Water Fund program.

Table 5-25 Present Worth Analysis Time Assumptions

Present Worth Cost Category	Present Worth Start Year	Present Worth Duration
Derby and Seymour base case plant upgrades	3	Three years
Ansonia base case plant upgrades	4	Two years
Regional alternative plant upgrades	3	Three years
Conveyance pipelines and pumping	4	Two years
Collection system improvements	0	25 years (planning period)
Base case O&M costs (1)	0	25 years (planning period)
Regional alternative O&M costs (1)	6	20 years
(1) O&M costs for base cases associated with the regional alternative were carried for the first five years of the planning period.		

This analysis did not incorporate value of assets, salvage value or funding sources including cash, bonds, or grants. It is assumed that these values are comparable for each base case and regional alternative for the purposes of consistent evaluation. We also believe that these items will not change the results of the PW evaluation performed as part of this Task 3 work.

Table 5-26 summarizes the base case present worth costs and Table 5-27 summarizes the regional alternative present worth costs.

Table 5-26 Base Case Present Worth Costs

Base Case	Capital Present Worth Costs (1)	O&M Present Worth Costs	Total Present Worth Costs
Derby	$58,400,000	$32,100,000	**$90,500,000**
Ansonia	$27,300,000	$35,800,000	**$63,100,000**
Seymour	$32,400,000	$27,700,000	**$60,100,000**
(1) Costs include wastewater treatment plant and collection system improvements.			

Table 5-27 Regional Alternative Present Worth Costs

No.	Regional Alternative	Capital Present Worth Costs (1)	O&M Present Worth Costs	Total Present Worth Costs
	Ansonia Regional Alternatives			
3	Derby to Ansonia	$78,200,000	$57,500,000	**$135,700,000**
4	Derby to Ansonia, Effluent Pumped to Housatonic River	$71,100,000	$57,100,000	**$128,200,000**
5	Derby and Seymour to Ansonia	$125,800,000	$74,200,000	**$200,000,000**
5b	Derby and Seymour to Ansonia, Effluent Pumped to Housatonic River	$117,600,000	$73,800,000	**$191,400,000**
	Derby Regional Alternatives	$109,200,000	$59,300,000	**$168,500,000**
8a	Ansonia to Derby (BioMag)	$111,900,000	$55,400,000	**$167,300,000**
8b	Ansonia to Derby (IFAS)	$157,200,000	$76,800,000	**$234,000,000**
9a	Seymour and Ansonia to Derby (BioMag)	$163,300,000	$71,700,000	**$235,000,000**
9b	Seymour and Ansonia to Derby (IFAS)	$78,200,000	$57,500,000	**$135,700,000**
(1) Costs include wastewater treatment plant, conveyance systems, and collection system improvements.				

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 BASE CASE AND REGIONAL ALTERNATIVES COMPARISON

Table 6-1 shows the comparison of regional alternative and base case present worth costs.

Table 6-1 Base Case and Regional Alternatives Comparison

No.	Regional Alternative	Regional Alternative Costs (millions)			Base Cases	Base Case Costs (millions)			Present Worth Difference (millions)
		Capital	O&M	Total		Capital	O&M	Total	
	Ansonia Regional Alternatives								
3	Derby to Ansonia	$78.2	$57.5	**$135.7**	Derby + Ansonia	$85.7	$67.9	**$153.6**	**$17.9**
4	Derby to Ansonia, Effluent Pumped to Housatonic River	$71.1	$57.1	**$128.2**	Derby + Ansonia	$85.7	$67.9	**$153.6**	**$25.4**
5	Derby + Seymour to Ansonia	$125.8	$74.2	**$200.0**	Derby + Ansonia + Seymour	$118.1	$95.6	**$213.7**	**$13.7**
5b	Derby + Seymour to Ansonia, Effluent Pumped to Housatonic River	$117.6	$73.8	**$191.4**	Derby + Ansonia + Seymour	$118.1	$95.6	**$213.7**	**$22.3**
	Derby Regional Alternatives								
8a	Ansonia to Derby (BioMag)	$109.2	$59.3	**$168.5**	Derby + Ansonia	$85.7	$67.9	**$153.6**	**($14.9)**
8b	Ansonia to Derby (IFAS)	$111.9	$55.4	**$167.3**	Derby + Ansonia	$85.7	$67.9	**$153.6**	**($13.7)**
9a	Seymour + Ansonia to Derby (BioMag)	$157.2	$76.8	**$234.0**	Derby + Ansonia + Seymour	$118.1	$95.6	**$213.7**	**($20.3)**
9b	Seymour + Ansonia to Derby (IFAS)	$163.3	$71.7	**$235.0**	Derby + Ansonia + Seymour	$118.1	$95.6	**$213.7**	**($21.3)**

6.2 RECOMMENDED ALTERNATIVES

Based on the present worth cost comparison, the Ansonia regional alternatives are financially more attractive than both the Derby regional alternatives and the base case scenarios. The Ansonia regional alternatives that convey treated secondary effluent back to Derby for discharge to the Housatonic River (4 and 5b) are the two most financially attractive alternatives and are recommended to be carried forward for final development in Task 4 and potential implementation.

Of these two preferred regional alternatives—*Derby to Ansonia, Effluent Pumped to Housatonic River*—is the more financially attractive; however, the other alternative that also includes Seymour—*Derby + Seymour to Ansonia, Effluent Pumped to Housatonic River*—has the added advantage of eliminating two wastewater treatment plant discharges completely.

These two regional alternatives benefit all participating communities; however, it is noted that the benefit is proportional to the current improvements needed at the respective plants.

6.2.1 Additional Notes

As noted in the present worth analysis summary, project funding has not been included in the cost analysis. Grants through the CT DEEP Clean Water Fund program are available for qualifying wastewater plant projects. These grants are prioritized for regional authorities; therefore, it is anticipated that more grant funds would be available for a regional alternative plant and related systems as compared to base case plants.

6.3 TASK 4 LOOK AHEAD

This TM summarizes the work conducted in Task 3 to develop the short list of NVCOG regional wastewater alternatives and define the recommended alternatives for final investigations. These conclusions and recommendations will be reviewed in a workshop (Workshop No. 2) with the NVCOG stakeholders where concurrence will be reached on the recommended alternatives. After Workshop No. 2 is complete, Task 4 activities will advance to further develop the recommended alternatives and the preparation of final technical report.

APPENDIX A

GENERAL PROCESS CONSIDERATIONS AND DATA UPDATES

APPENDIX A GENERAL PROCESS CONSIDERATIONS AND DATA UPDATES

A.1 Introduction

Several key assumptions and analysis methods were adopted as part of the added process evaluations conducted in this Task 3. These generally apply to each of the plants. These considerations are described below.

A.2 Chemically Enhanced Primary Treatment

An outcome of Task 2 was that the most practical way to maintain primary treatment capacity in the regionalization alternatives was to utilize chemically enhanced primary treatment (CEPT), as expanding primary clarifiers is challenging due to footprint constraints. This will result in additional removal of solids at primary treatment even at the higher loadings. In Task 2, primary TSS and BOD removals of 60% and 30% were assumed, which is typical of conventional primary treatment and supported by the MOR data at the facilities. In this task, Task 3, primary TSS and BOD removals of 75% and 37.5% will be assumed which are typical or even conservative for CEPT.

As a result of increased primary removal efficiencies, the secondary treatment capacity is increased. This was not fully accounted for during Task 2 evaluations of secondary processes as unit processes were being considered separately at that time. In this evaluation, the effect of CEPT on secondary capacity was evaluated. However, based on preliminary modeling it was decided that the nitrification safety factor for aerobic solids retention time (SRT) should be increased, which decreases capacity and mostly offsets the gains in secondary capacity resulting from CEPT.

A drawback of CEPT on secondary treatment is the detrimental impact on biological nutrient removal (BNR) process performance, which can be anticipated. This is accounted for in the present evaluation by assessing the performance through biokinetic modeling.

A.3 Flows and Loads

Wastewater flows and loads data was confirmed during Task 2 for the Derby, Ansonia, and Seymour plants. The Ansonia and Seymour flows and loads data is still current for this evaluation. New flows and loads data for the Derby plant was published in the City of Derby WPCA 2020 Wastewater Facilities Plan Supplement to the 2014 Wastewater Facilities Plant, dated June 2020. This information was reviewed against the process evaluations conducted to date, including coordination directly with the City and their engineer to confirm key assumptions. As a result of this data update, the wastewater flows and loads were reevaluated and adjusted as necessary, resulting in some changes to the Derby flows and loads. Flows and loads data is summarized for the Derby, Ansonia, and Seymour plants in Table A 1, Table A 2, and Table A 3, respectively.

Table A 1 Derby Current and Design Influent Flows and Loads

	Flow, MGD	BOD, mg/L	BOD lb/day	TSS, mg/L	TSS, lb/day	TKN, mg/L	TKN, lb/day
Current Influent							
Annual Average	1.42	221	2,621	197	2,333	28	335
Maximum Month	2.19	260	4,749	240	4,384	33	610
Peak Day	4.10	-	-	-	-	-	-
Peak Hour	10	-	-	-	-	-	-
Design Influent							
Annual Average	1.69	221	3,119	197	2,776	28	399
Maximum Month	2.61	260	5,651	240	5,216	33	726
Peak Day	4.88	-	-	-	-	-	-
Peak Hour	10	-	-	-	-	-	-

Table A 2 Ansonia Current and Design Influent Flows and Loads

	Flow, MGD	BOD, mg/L	BOD lb/day	TSS, mg/L	TSS, lb/day	TKN, mg/L	TKN, lb/day
Current Influent							
Annual Average	1.76	204	2,988	184	2,695	45	656
Maximum Month	3.06	187	4,772	191	4,874	41	1,046
Peak Day	4.60	-	-	-	-	-	-
Peak Hour	9	-	-	-	-	-	-
Design Influent							
Annual Average	1.90	204	3,236	184	2,919	45	711
Maximum Month	3.31	187	5,167	191	5,278	41	1,133
Peak Day	4.98	-	-	-	-	-	-
Peak Hour	9	-	-	-	-	-	-

Table A 3 Seymour Current and Design Influent Flows and Loads

	Flow, MGD	BOD, mg/L	BOD lb/day	TSS, mg/L	TSS, lb/day	TKN, mg/L	TKN, lb/day
Current Influent							
Annual Average	0.97	140	1,133	146	1,181	33	269
Maximum Month	1.93	93	1,497	99	1,594	22	356
Peak Day	3.34	-	-	-	-	-	-
Peak Hour	7.0	-	-	-	-	-	-
Design Influent							
Annual Average	1.30	140	1,518	146	1,583	33	361
Maximum Month	2.59	112	2,424	133	2,863	27	576
Peak Day	4.48	-	-	-	-	-	-
Peak Hour	9.4	-	-	-	-	-	-

A.4 Nitrogen Load Allocations

Total Nitrogen Annual Discharge Limits are currently dictated by the General Permit for Nitrogen Discharges. These limits are 115, 71, and 61 lb/day-N for Ansonia, Derby, and Seymour respectively, values which have not changed between the 2016-2018 General Permit and the current Proposed General Permit (2019-2023). Based on these annual limits, and the current and projected future annual average flows, target TN concentrations can be calculated as shown in Table A 4.

Table A 4 Target Effluent Nitrogen Concentrations for Base Case and Regionalization Alternatives

	Ansonia	Derby	Seymour	Ansonia + Derby	Ansonia + Derby + Seymour
Annual TN Limit, lb/day-N	115	71	61	186	247
Current Annual Avg Flow, mgd	1.76	1.42	0.97	3.17	3.89
Current Effluent N Target, mg/L-N	7.85	6.00	7.54	7.04	7.61
2040 Annual Avg Flow, mgd	1.90	1.69	1.30	3.59	4.89
2040 Effluent N Target, mg/L-N	7.25	5.04	5.63	6.21	6.05

Ansonia is consistently significantly below the load-based TN Discharge Limit, while Derby and Seymour have both been below the limit in some years and above the limit in others requiring these facilities to purchase nitrogen credits. Ansonia typically meets its limits as the concentrations required to meet the limit are >7.5 mg/L-N on average, because influent carbon to nitrogen is adequate, and because the facility has a 4-stage process with an oxidation ditch that is well suited to remove nitrogen. To avoid buying credits, Derby would need to achieve TN concentration of <6.0 mg/L-N and has a modified Ludzack-Ettinger (MLE) process which is not as well equipped to meet these limits consistently. Derby's recently completed facility plan recommends an upgrade to a 4-stage process which will have more anoxic and aerobic volume overall which will help it to meet its limits more consistently. Seymour needs to achieve <7.0 mg/L-N to meet its load-based limits, however it also operates an MLE process. The reason why the limit is not always met is likely due to the MLE process but could also be made worse by carbon-to-nitrogen (C:N) ratios which are on average lower at Seymour than the other facilities based on influent MOR data.

APPENDIX B

SLUDGE MANAGEMENT

APPENDIX B SLUDGE MANAGEMENT

B.1 Sludge Management

Sludge is currently managed for disposal differently at each of the plants. Prior to disposal, Derby and Seymour dewater their sludge and Ansonia thickens their sludge only. Sludge processing is summarized in Table B 1.

Table B 1 Existing Sludge Processing

Facility	Sludge Processing	Typical Solids Concentration
Derby WPCF	Dewatering	15%-17%
Ansonia WPCF	Thickening	3.5%-4.5%
Seymour WWTP	Dewatering	19%-21%

It is generally more cost effective to thicken sludge only instead of thickening and dewatering for wastewater treatment plants in the size range of the base case plants and the regional alternatives plants. This also takes into account the disposal and transport costs charged by area incinerator merchant plants. We have found that sludge dewatering clearly becomes cost effective at significantly larger plants than at any of the three base case facilities or the regional treatment facilities associated with the short-listed alternatives.

Sludge treatment and handling was evaluated on a planning level basis for the base cases and regional alternatives to determine what strategies were more cost effective for each of the plants. It was determined that sludge thickening only would be the most cost-effective strategy in every case, therefore this was carried forward for the regional alternatives and the base case scenarios. Figure B 1 shows a schematic depiction of a new sludge thickening facility that is envisioned for all three base case plants and the regional facilities at Derby and Ansonia.

Review of the existing sludge treatment/handling facilities at Derby indicated that these systems are old and inefficient and need to be replaced with systems as shown in Figure B 1. Additionally, the plant should cease using its aerobic digester when the new facilities are built. While the sludge treatment/handling systems at Ansonia are in better condition, they are not efficient. Therefore, on a planning basis, the sludge facilities at Ansonia are identified for replacement; this includes the base case regional alternatives plants. There may be opportunities to maximize the use of the existing sludge storage system at Ansonia in lieu of full replacement; this could be reviewed later for viability by others including if regionalization is agreed upon and selected.

The sludge treatment/handling facilities for Seymour are old, inefficient and in need of replacement. Per the planning level review noted above, the base case for Seymour calls for sludge thickening only with new facilities as shown in Figure B 1. It is noted that for Seymour, the new sludge facilities would be located within the existing sludge thickening and dewatering building.

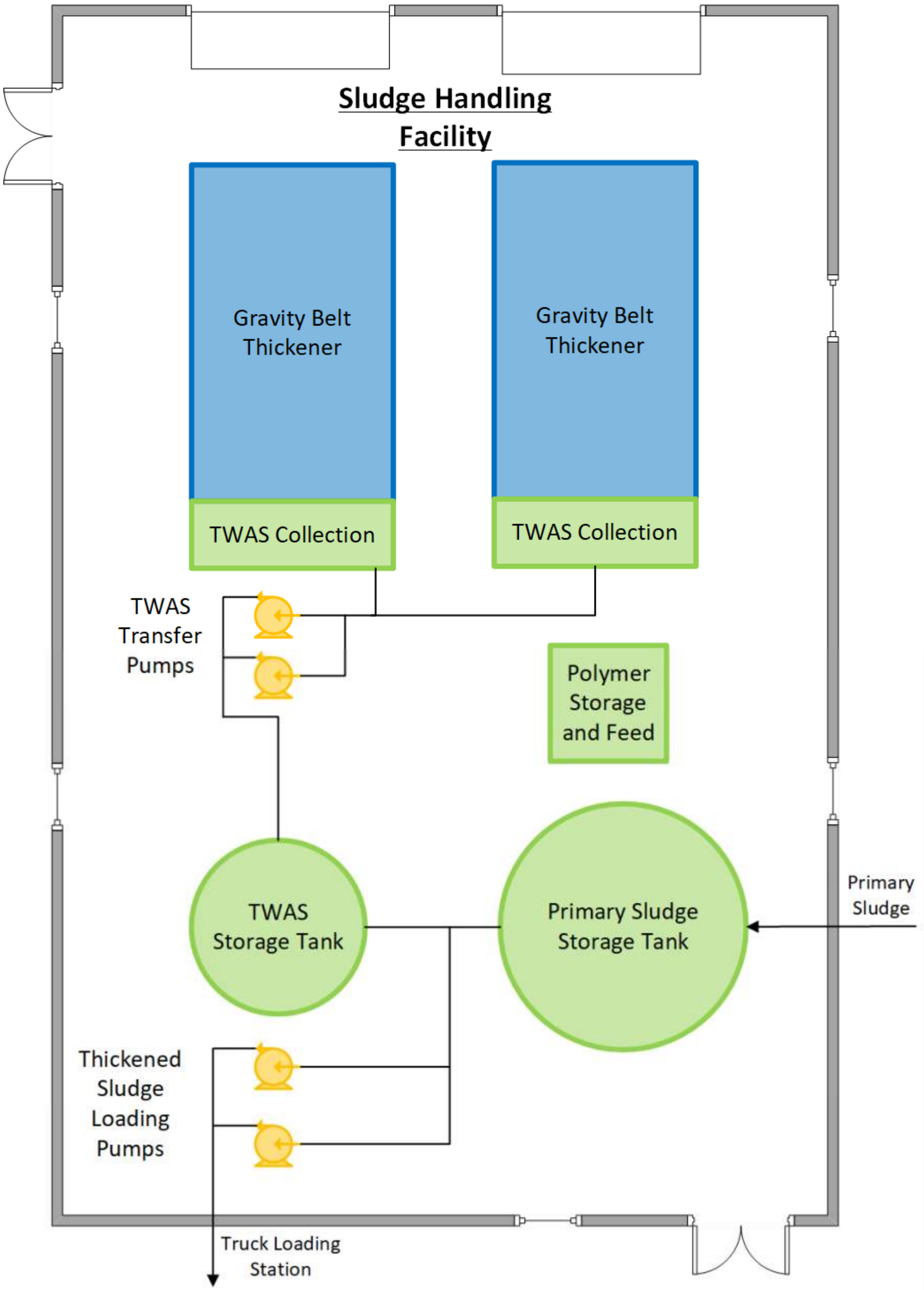


Figure B 1 New Sludge Handling Facility for Derby and Ansonia Plants

APPENDIX C

OPERATIONS AND MAINTENANCE STAFFING

APPENDIX C OPERATIONS AND MAINTENANCE STAFFING

C.1 Introduction

Staffing is a critical part of long-term operations and maintenance (O&M) of wastewater facilities and systems. A planning level O&M staffing assessment was conducted to determine staff needs across the study communities and establish comparable staff structures for the base cases and regional alternatives.

C.2 Current O&M Staffing

Staff structures, roles, and responsibilities were reviewed with Derby, Ansonia, and Seymour. All three plants operate on a basic single-shift, Monday through Friday schedule. Table C 1 summarizes the current wastewater facility staffing for the plants and collection systems.

Table C 1 Current Wastewater Facility Staffing

Facility	Plant O&M Full-Time Equivalencies (1)	Collection System O&M Full-Time Equivalencies
Derby WPCF	6	2
Ansonia WPCF	5	0 (2)
Seymour WWTP	5	0 (2)(3)

(1) Includes superintendent.
(2) Plant staff at Ansonia and Seymour attend to pump stations in the collection system.
(3) Plant staff at Seymour address problematic areas (“hot spots”) and handle emergencies in the collection system.

C.3 Staffing Development

Black & Veatch relied on the expertise of our own O&M specialists to evaluate current staff structures and establish recommended staff structures for each of the base cases and regional alternatives for this evaluation. We also reviewed the New England Interstate Water Pollution Control Commission (NEIWPCC) Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants to confirm our conclusions.

C.4 Conclusions

Table C 2 shows the recommended staff structure for the base case plants and Table C 3 shows the recommended staff structure for the regional alternatives. All operations would remain on a single-shift, Monday through Friday schedule.

Table C 2 Base Case Wastewater Facility Staffing

Facility	Plant O&M Full-Time Equivalencies (1)	Collection System O&M Full-Time Equivalencies
Derby WPCF	6	2
Ansonia WPCF	5	2
Seymour WWTP	5	2
(1) Includes superintendent.		

Table C 3 Regional Alternative Wastewater Facility Staffing

Regional Alternatives	Plant O&M Full-Time Equivalencies (1)	Collection System O&M Full-Time Equivalencies
Derby plus Ansonia	6	4
Derby plus Ansonia plus Seymour	6	6
Ansonia plus Derby	6	4
Ansonia plus Derby plus Seymour	6	6
(1) Includes superintendent.		

There may be opportunity to reduce the recommended staff by as much as 25% overall; however, we believe the staff numbers in the tables above are appropriate for comparison of the alternatives. A more in-depth study would need to be conducted on staffing after the planning has advanced beyond the scope of this initial study with both technical engineering studies and when the regional authority and structure is better defined.