ATTACHMENT A

PHASE 1 TECHNOLOGY EVALUATION AND FINAL TECHNICAL MEMORANDUM

AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com

781.246.5200 tel
781.245.6293 fax

Memorandum

To	Peter Rice, City Engineer	Page	1 of 34
CC	David Allen, Deputy Director and Paula Anania, Chief Operator		
Subject	Task 1.7 Technology Evaluation Final Technical Memorandum WWMP Piloting – Phase I Engineering Evaluation Peirce Island WWTF, Portsmouth, New Hampshire		
From	Terry Desmarais and Jon Pearson		
Date	September 26, 2011		

INTRODUCTION AND PURPOSE

The City of Portsmouth has been issued a Consent Decree by the US Environmental Protection Agency (EPA) to upgrade the existing Peirce Island WWTF to provide secondary treatment. As part of the first phase of the Wastewater Master Plan (WWMP) Piloting work, AECOM has prepared a conceptual level evaluation of eight potential treatment technologies for providing secondary and total nitrogen level treatment at the Peirce Island WWTF. The purpose of the evaluation was to identify the 2 to 3 most promising technologies for subsequent pilot testing. The eight technologies considered included:

1. Biological Aerated Filter (BAF)
2. Sequencing Batch Reactor (SBR) with BioMag
3. Conventional Activated Sludge (CAS) with BioMag
4. Moving Bed Bioreactor (MBBR) & ActiFlo
5. Moving Bed Bioreactor (MBBR) & CoMag
6. Moving Bed Bioreactor (MBBR) & DAF
7. Membrane Bioreactor (MBR)
8. Conventional Activated Sludge (CAS)

These technologies, with the exception of Conventional Activated Sludge, can be operated in a high rate mode and thus are compact secondary treatment technologies. It should be noted that some of these technologies are proprietary and/or patented. Each technology was evaluated for its ability to meet the required treatment standards as well as meet the City's goals for the project, which included the following:

1. Minimize capital and operations costs for secondary treatment
2. Minimize new construction outside of the existing filter building
3. Provide flexibility to upgrade the secondary treatment process to achieve future total nitrogen removal

Treatment levels evaluated included conventional secondary treatment (monthly average BOD_5 and TSS of less than 30 mg/L) and nitrogen removal to monthly average concentrations of less than 8, 5 and 3 mg/L. The approximate site layout and process configurations for each technology for each treatment level were determined. Preliminary opinions of probable construction costs, operation and maintenance costs and life cycle costs were developed for the secondary treatment level. Each technology was objectively compared to one another using a weighted evaluation matrix to rank the technologies. This technical memorandum presents the findings of the evaluation. This information was initially submitted to the City as a preliminary draft Technical Memorandum. The draft memorandum was followed by a workshop with City staff to review the results of the evaluation, obtain input on the evaluation criteria and ranking, and select the technologies for piloting in Phase 2.

In order to support the technology evaluation and Phase 2 piloting, the Phase 1 Engineering Evaluation also included a wastewater characterization program and an architectural, structural and electrical review of the constraints to the reuse of the existing Filter Building. The results of these efforts are also presented herein.

DRY WEATHER FLOW ANALYSIS

This evaluation expands on the concepts developed as part of the WWMP value engineering (VE) work completed in the fall of 2010 where the potential secondary treatment capacity that could be achieved by retrofitting the existing Filter Building was assessed. At that time, the sizing for the new facility was limited to retrofitting the existing 8 filter cells in the existing Filter Building for the new facilities. Flow to receive secondary treatment was based on average day and maximum day conditions where flow in excess of the maximum day rate would receive primary treatment and disinfection. The values used for preliminary sizing in the fall of 2010 were an assumed flow of 5 mgd average day flow and 7.5 mgd maximum day flow. For the current WWMP Piloting Phase I Engineering Evaluation work, AECOM reviewed three years of historical data (2008, 2009 and 2010) to more accurately parse out wet and dry flow days.

Methodology

AECOM used monthly operating report (MOR) data provided by the City and precipitation data from other sources to complete the evaluation. To classify days as “wet” or “dry”, AECOM developed a set of definitions which identified a finite number of days to be classified as “wet” following a specific precipitation event total depth. The definitions were based on a system response curve developed from the available data defining the number of days for WWTF flow rates to recede to the approximate pre-event flow rate. These definitions were applied to parse the flow data into a wet classification or dry classification. A memorandum summarizing the Dry Weather Flow Analysis is provided in Attachment A.

AECOM

Results

Based on the analysis, the following Secondary dry weather design flow rates were determined:

Table 1 - Design Flow Rates

Criteria	Flow (MGD)
Average Day Dry Weather Flow	4.30
90^{th} % Q	5.79
91.7^{th} % Q (represents maximum month)	5.99
95^{th} % Q	6.36
99^{th} % Q	7.33
99.7^{th} % Q (represents maximum day)	7.62
100^{th} % Q (represents max value)	7.73

Discussions with EPA

The City submitted the Dry Weather Flow Analysis Technical Memorandum to the EPA and the New Hampshire Department of Environmental Protection (DEP), and AECOM presented the results of the dry weather flow analysis to the NHDES and the Environmental Protection Agency (EPA) during a conference call on June 16, 2011. There was a subsequent meeting to discuss the results of the dry weather flow analysis at the EPA offices on June 23, 2011. At the meeting, EPA indicated that the proposed flow rates are lower than they expected and noted that a facility sized to meet a flow rate of approximately 5.8 MGD average day flow and 10.4 MGD was what they anticipated would be needed. There was additional discussion related to the City's overall Long Term Control Plan and specifically related to the reduction of infiltration and inflow as part of the ongoing sewer separation work and potential reduction of inflow as part of private inflow source removal efforts. EPA requested projections of what the effect of the sewer separation program will have on reducing the annual average flow to the Peirce Island WWTF. As a result of the ongoing discussions, the City is working with the engineering consultant that developed their sewer collection system model in an effort to quantify the benefits of the separation work and the true needs for wet weather and secondary treatment at Peirce Island. This modeling evaluation, along with subsequent discussions with EPA and DES, may revise the projected dry weather flows. However, for this evaluation the flows developed in Attachment A have been used to develop and compare the potential treatment technologies.

DRY WEATHER LOADING ANALYSIS

Loadings for the WWMP value engineering (VE) work completed in the fall of 2010 were based on effluent from the WWTF's existing chemically enhanced primary treatment (CEPT) system. These loadings were taken in part from the WWMP and were 65 to 75 mg/L BOD_5 and 55 to 65 mg/L TSS for the average day flows. For this analysis, AECOM calculated dry weather loadings from the same MOR data used to determine the dry weather flow rates. In addition, primary effluent (PE) load values were added because vendors were asked to include proposed sizing for treating both PE and CEPT loadings for the 2011 evaluation.

Methodology

The MOR data set was used as the basis to calculated raw, CEPT and PE loadings. AECOM used the parsed dry weather flow subset of data including the BOD_5 and TSS loadings to calculate the average dry weather loads. The City collects 24 hour flow composite samples for analysis of BOD_5 and TSS values twice weekly. Therefore the total number of load data points was less than the flow data points. From this data the average daily raw and CEPT TSS and BOD concentrations were determined.

For maximum month CEPT values, the full MOR data set (wet and dry) was used. AECOM modified the data set and truncated flows in excess of the proposed maximum day secondary flow rate to the maximum day flow rate of 7.62 MGD. The calculated loadings were plotted and the monthly moving average was determined. The maximum monthly average value for the 3 year record period was used to represent the maximum month load.

For the raw influent maximum month wastewater loads, the maximum day load shedding methodology (used for CEPT maximum month as described above) could not be applied because all influent flow will be treated in the primary clarifiers. AECOM applied an industry standard maximum month to average day peaking factor to the influent average day dry weather loads. To determine primary effluent load values, industry standard TSS and BOD_5 primary sedimentation removal efficiencies of 50% and 30%, respectively, were applied to the influent average day and maximum month load values.

A memorandum detailing the Loading Analysis is provided in Attachment B.

Results

The TSS and BOD_5 loadings conditions are as follows:

Table 2 - Average Raw Influent and CEPT Effluent TSS and BOD_5 Concentrations

Criteria	Average Concentration (mg/L)
Influent TSS	180.6
Effluent TSS	52.3
Influent BOD_5	186.7
Effluent BOD_5	106.6

The maximum month CEPT loadings were found to be 3,600 lb/d TSS and 4,900 lb/d BOD_5. Primary effluent TSS concentrations were calculated to be 91 mg/L for the average day flow and 84 mg/L for the maximum month flow condition. Primary effluent BOD concentrations were calculated to be 131 mg/L for the average day flow and 122 mg/L for the maximum month condition.

The following tables summarizes the flows and loads used as the basis of sizing:

Table 3 - 2011 Flow and Load Criteria

Parameter	Average Day	Maximum Month
Flow (mgd)	4.30	5.99
Influent TSS (mg/L)	181	169
Influent TSS (lb/d)	6,491	8,438
Influent BOD_5 (mg/L)	187	175
Influent BOD_5 (lb/d)	6,706	8,718
Primary Effluent TSS (mg/L)	91	84
Primary Effluent TSS (lb/d)	3,246	4,219
Primary Effluent BOD_5 (mg/L)	131	122
Primary Effluent BOD_5 (lb/d)	4,694	6,103
CEPT Effluent TSS (mg/L)	52	72
CEPT Effluent TSS (lb/d)	1,865	3,600
CEPT Effluent BOD_5 (mg/L)	107	98
CEPT Effluent BOD_5 (lb/d)	3,837	4,900

WASTEWATER CHARACTERIZATION PROGRAM

A wastewater characterization program was developed to provide data on the different components within Portsmouth's wastewater. The program included sampling and analysis of both the influent wastewater and the CEPT effluent (proposed secondary influent) and is being performed over an extended period of time to quantify seasonal changes in wastewater characteristics. Analysis parameters included temperature, dissolved oxygen, pH, alkalinity, fats, oils and grease (FOG), TSS, volatile suspended solids (VSS), chemical oxygen demand (COD), BOD_5, total Kjeldahl nitrogen (TKN), ammonia, nitrate and nitrite (NO_x), total phosphorous (TP) and phosphate. COD and BOD_5 were further analyzed to determine the soluble and particulate fractions of those components.

For the majority of the analysis parameters, a 24 hour flow proportional composite sample was used for analysis after lab blending and lab filtering as required for different types of analyses. A grab sample was taken and used for FOG and DO analysis. Additional data collected included the average daily flow and precipitation for the sampling day.

Sampling and analysis began on May 13, 2011 and extended through the period of this evaluation. The sampling and analysis parameters are summarized in Table 4.

Table 4 – Sampling and Analysis Summary

Sample Type	Temp	DO	pH	Alk	FOG	TSS	VSS	COD	BOD	TKN	NH_3-N	NOx-N	TP	PO_4-P
Raw Influent														
Not Filtered	X		X	X	X	X	X	X	X	X			X	
1.2 µm Filtered								X	X		X	X		X
0.45 µm Filtered								X						
Flocculated and 0.45 µm Filtered								X						
CEPT Effluent														
Not Filtered	X	X	X	X	X	X	X	X	X	X			X	
1.2 µm Filtered								X	X		X	X		X
0.45 µm Filtered								X						
Flocculated and 0.45 µm Filtered								X						

A summary of the averaged data for the period of May 15 through September 2, 2011 are provided in Table 5. The full set of data is provide in Attachment C. It should be noted that raw and CEPT No_x-N, TP and PO_4-P sampling and analysis provided the same results through the month of June and was discontinued at that time.

Table 5 – Intermediate Wastewater Characterization Results (5/14/11-9/2/11)

Sample Type	Temp (deg C)	DO (mg/l)	pH	Alk(mg/l as $CaCo_3$)	FOG (mg/l)	TSS (mg/l)	VSS (mg/l)	COD (mg/l)	BOD (mg/l)	TKN (mg/l-N)	NH_3-N (mg/l)	NOx-N (mg/l)	TP (mg/l)	PO_4-P (mg/l)
Raw Influent														
Not Filtered	19		6.6	166	35	243	181	455	123	31			9.5	
1.2 µm Filtered								207	105		17	<0.5		3.9
0.45 µm Filtered								155						
Flocculated and 0.45 µm Filtered								134						
CEPT Effluent														
Not Filtered	19	0.9	6.6	155	9.5	68	57	244	123	27			9.2	
1.2 µm Filtered								193	105		17	<0.5		3.6
0.45 µm Filtered								141						
Flocculated and 0.45 µm Filtered								128						

TECHNOLOGY EVALUATION

For each technology identified, AECOM developed process sizing, layouts, and estimated costs to allow the ability of each option to meet the City's objectives within the physical and other constraints on the island to be assessed.

Approach

A substantial amount of information including but not limited to sizing, process requirements/limitations, capital costs, and operation and maintenance costs was needed in order to evaluate each technology. AECOM began the data gathering work by reaching out to vendors of the proposed technologies. A memorandum was distributed summarizing the goals of the project, 2011 flows and loads, and vendor design constraints. Because there were significant differences between the proposed technologies, AECOM chose to provide three overall design concepts for the vendors to work within. The three concepts proposed, in order of preference, were as follows:

- S-1. Modify the existing filter building as necessary to accommodate the proposed technology within the limits of the existing 8 filter cells and, if feasible, the existing pump station at the east end of the building;
- S-2. Demolish the existing filter building and utilize only the foundation and exterior walls;
- S-3. Vendor developed concept for secondary treatment within the limit of the existing plant perimeter fence.

It was requested that the vendors review the 3 secondary treatment concepts outlined above in light of the capabilities of the secondary treatment technology that they proposed to provide, and provide recommendations, process sizing and layouts, and equipment costs for the concept that, in the vendor's judgment, best met the City's goals. Additional details were provided for each concept. These details are provided in the distributed memorandum, which has been included in Attachment D.

AECOM distributed and received proposals from the following vendors:

Table 6 - 2011 Vendor Summary

Technology	Vendors/Manufacturers
1. Biological Aerated Filter (BAF)	Infilco-Degremont Kruger
2. Sequencing Batch Reactor (SBR) with BioMag	Cambridge Water Technologies
3. Conventional Activated Sludge (CAS) with BioMag	Cambridge Water Technologies
4. Moving Bed Bioreactor (MBBR) & ActiFlo	Infilco-Degremont (MBBR) Kruger (MBBR & ActiFlo) World Water Works (MBBR)
5. Moving Bed Bioreactor (MBBR) & CoMag	See MBBR above Cambridge Water Technologies (CoMag)
6. Moving Bed Bioreactor (MBBR) & DAF	See MBBR above World Water Works (DAF)

Technology	Vendors/Manufacturers
7. Membrane Bioreactor (MBR)	Zenon/GE Ovivo Koch Poreflon (Layne Water Technologies)
8. Conventional Activated Sludge (CAS)	None

Although multiple vendors provided proposals for a single technology, based on a review of the proposals a single vendor that represented each technology was selected as the basis of developing process layout and capital costs estimates. This approach was not intended to imply preference toward a specific manufacturer, but rather to keep the number of scenarios evaluated to within project constraints. The selected vendor used as the basis of the evaluation was noted in the write-up of each technology below.

Using the information provided by the selected vendor, AECOM advanced the concept for each technology to a conceptual level design by developing a process flow schematic, site layout and process layout for the secondary treatment level. These items were used as the basis of developing the capital and operation and maintenance costs for the evaluation. A site layout was also developed for total nitrogen removal concepts provided by the vendors. The TN concept site layout was used as an indicator of the feasibility and flexibility of each process to be upgraded for future total nitrogen level treatment. For the purpose of this evaluation, the proposed process layout was optimized around the conventional secondary treatment option provided by the vendor. In certain cases, significant changes in the process layout to provide secondary treatment were needed to achieve nitrogen removal. As a result, the optimal layout for conventional secondary treatment would not be the recommended layout for planning a phased conversion from conventional secondary treatment to a total nitrogen level treatment layout. In addition, the TN layouts were developed using only the proposed technology and did not consider combinations of technologies that may minimize costs and/or footprint. For instance, a combination of the proposed conventional secondary treatment layouts with nitrification and a small footprint denitrification filter may reduce overall impact on the site. These items should be further considered for the selected treatment process during the engineering design phase.

Lastly, a comparison matrix to evaluate and rank the proposed technologies was prepared. The evaluation matrix was used to rank the technologies to assist in the decision of which technologies are the most promising, and will be selected by the City for subsequent piloting in Phase 2.

As noted above, a single vendor was chosen for the basis of layout and cost estimates. It was also decided that the basis of process sizing, layout, and costs would be the sizing necessary for treating primary effluent. This approach provides the most conservative layout because these loadings are higher than CEPT loadings, which results in a larger process footprint, and thus higher costs. This option would also allow the City to minimize the use of CEPT to only wet weather events, reducing the annual operating cost for chemicals and sludge disposal. Since the upgraded plant will provide secondary treatment to only dry weather flow, the evaluation was based on maintaining the existing clarifiers for wet weather treatment. The conversion of the primary clarifiers for secondary process reactor volume was not considered feasible. Only Option 8 – Conventional Activated Sludge impacts the use of the primary clarifiers. Under this option, the primary clarifiers are converted to secondary clarifiers and a new high rate wet weather treatment facility is proposed to treat the wet weather flow capacity.

Common Items

There were a number of unit processes common to multiple if not all of the proposed technologies. AECOM focused on each of the common elements and separated the costs for these facilities so that a direct comparison of the technology costs could be made. This section describes some of the common components.

Fine Screening and Pumping. Common to almost all technologies evaluated was the need for influent fine screening and pumping into the secondary treatment process. Option 2, 3 and 8, which are all conventional activated sludge based technologies, did not require fine screening of the secondary influent wastewater. A concept for a combined pumping station and fine screening building was developed. Fine screening requirements generally ranged from 2mm (sometimes 1mm preferred) for MBRs and BAFs to 6 mm for MBBRs. Requirements differed between manufacturers.

The proposed building to house both fine screens and the pump station would be located between the primary clarifier (PC) distribution box and the Filter Building (southeast of the Control Building). Overall dimensions are expected to be on the order of 45 feet by 35 feet and will include the following major components:

- Screen Room
    - Fine screens (2)
    - Washer compactor (1)
- Pump Room
    - Wet well
    - Submersible pumps (3 to handle range of flows)
- Odor control unit (1)
    - External pad mounted fan and carbon canister
- Electrical Room

TWAS Storage. A biological treatment process will require more capacity for sludge processing and storage, and there will be a need for sludge processing improvements and additional sludge storage. Previous work done as part of the WWMP identified the need for a sludge storage tank, but did not provide a proposed location or other specifics of the sludge type to be stored or its operations. AECOM reviewed the proposed footprint and determined that it could readily be located within the existing fence line. For the purposes of this evaluation, AECOM chose to size a thickened waste sludge storage tank. In this scenario, the waste sludge thickening process may need to be operated continuously or in batch mode as needed by the secondary process. This will minimize the sludge storage volume required and allow it to be located to the west of the existing Control Building. The TWAS storage tank will have its own process and control building to house blowers, pumps and electrical equipment.

Main Electrical Building and Standby Generator. The main electrical feed to the WWTF and the standby generator are located in the existing Filter Building (northeast). Under a retrofit concept (S-1), the existing electrical equipment and standby generator would be replaced in their existing location and arrangement and the appropriate costs were carried for this work. Any proposals that required demolition of the Filter Building (S-2 and S-3) required costs to replace the new Main Electrical Building and Standby Generator in a new location. The proposed building would be constructed in the area of the effluent metering structure and to the east of the Filter Building depending on the particular technology configuration and whether or not the parshall flume would be reused. The effluent metering structure also acts as the chlorine contact distribution box, so if a proposed building would impact this structure, it could only be partially demolished. For the purposes of the evaluation, it was assumed a new Main Electrical Building would be constructed and a new pad mounted generator with belly fuel tank and prefabricated enclosure would be provided.

The Wastewater Master Plan recommended a number of upgrades at the Peirce Island plant that would need to be implemented if the Filter Building were retrofitted to provide secondary treatment. Accordingly, AECOM carried the Wastewater Master Plan opinion of costs, but did not further develop the conceptual level concepts for Headworks (screens and grit), Sanitary Disinfection (pumping and UV), Biosolids Processing (rotary drum thickeners and inclined screw presses), and Additional Structures and Modifications (splitter boxes improvements).

Existing Filter Building Site Visit and Review of Constraints to Reuse

The evaluation of technologies to upgrade the Peirce Island WWTF was focused on reuse of the existing Filter Building (concept S-1) to house a secondary treatment process. In order to support the concept of a secondary retrofit, a multidisciplinary team including an architect, a structural engineer, and an electrical engineer visited the Filter Building on April 19, 2011 to assess constraints to upgrading the building. A memorandum that provides a summary of the major considerations identified by each discipline has been included as Attachment E.

There were no major considerations identified that would preclude retrofitting the existing Filter Building for a new treatment process. The majority of architectural, structural and electrical concerns noted as part of the site visit review were repairable, would likely be resolved as part of a retrofit project and would be expected for a facility of this type and age. Key considerations for a retrofit would be meeting local building code requirements for access in the existing Clearwell Gallery and the Mudwell Gallery, protection of the existing electrical service and standby generation systems during construction, construction phasing for replacement of electrical equipment and meeting national and local building code requirements for major structural modifications.

OPTION 1 - BIOLOGICAL AERATED FILTER

The BAF option is based on the BIOFOR® system manufactured by Infilco-Degremont.

Process Description

Upflow biological filters are attached growth processes, which act in a similar manner to packed filter beds. In these systems the media provides a surface for the organisms to attach themselves. The wastewater flows upward through the media. The media is retained in the filter while the treated effluent is discharged. The upward flow passing through the packed media provides a level of solids removal, eliminating the need for separate clarifiers.

The new upflow biological filters would be aerobic and provide removal of BOD and TSS. Multiple filters would be constructed in order to provide redundancy as well as accommodate backwash cycles. The BIOFOR system uses an expanded shale media which is heavier than water. The BIOFOR media is retained by gravity, and a concrete nozzle deck is provided at the bottom of the filter cells to support the media. The media depth would be approximately 12 feet. The system has flow nozzles to distribute the flow evenly across the filter area, and an aeration grid at the bottom of each cell.

Retrofit Details and Layout

Conventional Secondary Treatment (Concept S-1). The BIOFOR system would require the use of five existing filter cells to construct four new BAF filters and common backwash and effluent channels between the four filter cells. The four cells would have a total surface area of 1,920 square feet, a media depth of 12 feet and overall sidewater depth of 20.5 feet. In order to meet the required sidewater depth, new tanks would be constructed within the existing tanks extending approximately 4 feet higher than the original tanks (to elevation 30.0 – existing top of filter is at elevation 26.0), providing 2 feet of freeboard. The existing clear well would be used as a new wet well for pumping BAF effluent to disinfection. The remaining three unused existing filter cells and a portion of the existing wet well (below) would be used to store BAF effluent for use in the BAF backwashes. Pumps would be used to lift the BAF effluent from the new wetwell to the new clearwell. Finally a new mud well tank would be constructed in the existing pumping station to store the dirty backwash water for subsequent pumping back to the primary clarifiers.

The major components of the process include:

- Upflow biological filters (4 cells) including nozzle decks, process air distribution system, media and support gravel and media retention screens
- Common effluent and backwash channels between the filter cells
- Process piping to/from the process tanks
- Backwash pumps (2)
- Mudwell pumps (2)
- Clearwell lift pumps (2)
- Effluent pumps (3)
- Air distribution cleaning pump (1)
- Process air blowers (4)
- Air scour blower (2)
- Strainers
- Manual and automated valves
- Instrument air compressor (for system pneumatic valves)
- Controls and instrumentation

Additional work to support this treatment level included the following:

- Secondary influent pumping station and screen building southeast of the existing Control Building

A process flow schematic is attached as Figure 1-CST-PFS, a site layout is attached as Figure 1-CST-SL, and a process layout is attached as Figure 1-CST-PL.

Nitrogen Removal to TN < 8/5/3 mg/l (Concept S-2). This section describes an alternative to provide secondary treatment and nitrogen removal using the BAF technology in order to achieve a total nitrogen effluent limit. It should be noted that this alternative required that the entire limits of the filter building be used to accommodate the required filter area, or Concept S-2. Therefore, this alternative is not an add on alternative to the secondary treatment BAF option (Concept S-1) presented above.

In order to provide removal of carbon and nitrogen three BAF systems would be required in series. These include secondary (carbon removal) BAFs followed by nitrification BAFs followed by denitrification BAFs. An equal filter surface area would be required for the three proposed treatment levels of nitrogen removal. For a TN of less than 8 mg/l, the full surface area would be required, but no supplemental carbon addition would be necessary. For the TN treatment level of less than 5 or 3 mg/L, the same filter surface area would be required along with a supplemental carbon source. The supplemental carbon dosage rate would be greater for the less than 3 mg/l TN treatment level than the less than 5 mg/l TN treatment level. The specific filter surface area needed is summarized below:

- Secondary BAF – 4 filters at 480 square feet
- Nitrification BAF – 6 filters at 480 square feet
- Denitrification BAF – 4 filters at 274 square feet

Ancillary needs include a location to house the process blowers, pumps, electrical and other equipment, clearwell storage, mudwell storage, influent and effluent pumps, piping galleries and discharge and backwash channels.

Under this alternative (Concept S-2) only the existing exterior walls and base slab of the existing Filter Building would remain. New tanks would be constructed within the limits of the existing foundation and slab. A new building would be constructed on the west side of the existing Filter Building and a new clear well would be constructed on the outside perimeter on the north side and the west side of the existing Filter Building. The facility layout would be as follows:

Lower Level:

- The existing mudwell, clear well and wet well would be converted into one large mudwell tank for all filter cells with the exception of a small portion of this area in the northeast corner that would be converted into an effluent wet well.
- The west building addition would contain backwash pumps for the filter cells.
- The existing pumping station would contain effluent pumps and mudwell pumps that would discharge to the disinfection facility and primary settling tanks respectively.

Intermediate Level:

- The new BAF filter cells and associated pipe galleries would be located in the foot print of the existing filter cells and clearwell pipe gallery.

Upper Level:

- The west building addition would contain a Control Room as well as equipment rooms for the system blowers and air compressors.
- The east side of the building would house the required electrical rooms and other support systems.
- The tops of the filter cells would be located in the foot print of the existing filter cells and the area to the north of the filter cells. Similar to the BAF alternative for carbon removal the carbon oxidation and nitrification filters will be approximately 20 ft deep including freeboard and the denitrification filters would be approximately 3 ft shallower. As a result the top of the filter cells will be at an elevation of approximately 36.0 which is approximately 14 feet above existing grade.

Additional work to support this treatment level included the following:

- Main Electrical Building and Standby generator to replace the electrical systems in the existing Filter Building.
- Supplemental carbon addition facility for TN less than 5 mg/l and less than 3 mg/l level treatment.

A site layout of the BAF facilities to achieve a TN less than 8 is attached as Figure 1-TN8-SL, and a site layout of the BAF facilities to achieve a TN less than 5 is attached as Figure 1-TN53-SL.

OPTION 2 - SEQUENCING BATCH REACTOR WITH BIOMAG

Option 2 and Option 3 are based on the use of an iron ore ballasted biological process, BioMag, manufactured by Cambridge Water Technologies (CWT). The process description is provided in the following section for Option 3 – Conventional Activated Sludge with BioMag because the vendor would not recommend the SBR application of this technology. Although an SBR configuration could be constructed to meet conventional secondary treatment levels within the footprint of the existing building (Concept S-2), the SBR units would be limited by the hydraulic throughput because the required decant depths could not be achieved within the footprint constraint. As a result, the SBRs would have to be operated in a semi-storm mode even at the average day flow rate. The SBR in the semi-storm mode would continue to have influent flow into the reactor tanks during significant portions of the react and settle periods. CWT indicated that this configuration would leave little flexibility to meet future TN treatment levels and would not elaborate further on this option. As a result, this option has not been considered further.

OPTION 3 – CONVENTIONAL ACTIVATED SLUDGE WITH BIOMAG

Option 3 is based on the BioMag system manufactured by Cambridge Water Technologies.

Process Description

BioMag uses inert iron ore (magnetite) ballast in the aeration tank and clarifiers to increase secondary settling rates, which allows plants to operate with higher mixed liquor suspended solids concentrations in the aeration tanks. The magnetite has a specific gravity of 5.2 and when combined with biological floc increases settling rates. The ballasted floc is settled in the clarifiers and the majority of the magnetite ballasted floc is returned to the aeration tank in the return activated sludge (RAS) flow. Waste sludge is sent through a magnetite recovery process before being processed. Magnetite that is lost in the recovery process is processed with the WAS. Virgin magnetite is added to the recovered magnetite to replace the amount lost in the WAS and the recovered and virgin magnetite are returned to the aeration tank via RAS flow. The recovery process includes a shear device to split the ballast from the floc, and a magnetic recovery drum to recover the magnetite from the WAS.

BioMag uses conventional rectangular or circular secondary sedimentation tanks for clarification. Surface overflow rates and solid loading rates are higher than with conventional secondary sedimentation tanks.

Retrofit Details and Layout

Conventional Secondary Treatment (Concept S-2). CWT reviewed the potential arrangements and felt that the CAS and BioMag process and clarification fit best within the limits of the existing filter building slab and foundation walls (Concept S-2). The south side of the existing Filter Building would be converted to a conventional aeration tank with two aeration trains. The total aeration volume would be approximately 1,092,000 gallons. Each aeration tank would be approximately 81 ft by 30 ft and have 30 ft side water depth. Aeration effluent would discharge to center common effluent channel. This channel would flow to a common secondary clarifier influent channel on the north side of the existing Filter Building. Flow would be distributed from this channel to four rectangular clarifiers with a total surface area of 4,144 square feet. Effluent from the clarifiers would discharge by gravity to the existing parshall flume for subsequent disinfection.

The major components of the process include:

- Aeration tanks and fine bubble diffuser system
- Bioreactor supplemental tank mixers (4)
- Rectangular sedimentation tanks, chain and flight mechanism, scum skimmers/baffles
- Process piping to/from the process tanks
- Influent Pumps (3)
- RAS Pumps (3)
- Ballasted WAS Pumps (2)
- WAS Pumps (2)
- Process air blowers (3)
- Shear mills (2)
- Magnetic recovery drums (2)
- Ballast make-up tank (1)
- Ballast tank mixer (1)
- Virgin magnetite silo (1)
- Polymer Feed System (1)
- Compressor and dryer (1)
- Manual and automated valves
- Controls and instrumentation

Additional work to support this treatment level would include the following:

- Influent pumping station and blower building to the east of the existing Filter Building.
- Scum boxes for the clarifiers.
- RAS and WAS (ballasted and processed) pumping station north of the existing Filter Building adjacent to common center channel.
- Magnetite recovery building southeast of the existing Control Building.
- Main Electrical Building and Standby generator to replace the electrical systems in the existing Filter Building.

A process flow schematic is attached as Figure 3-CST-PFS, a site layout is attached as Figure 3-CST-SL, and a process layout is attached as Figure 3-CST-PL.

Nitrogen Removal to less than 8 mg/l (Concept S-2). To provide an effluent total nitrogen level of less than 8 mg/l, CWT proposed converting the first 30 percent of each aeration tank to an anoxic bioreactor. Internal nitrate recycle pumps, piping and appurtenances would be added to create a Modified Ludzack Ettinger (MLE) process arrangement for total nitrogen removal. The same clarifiers proposed for conventional secondary treatment would be used for clarification.

A site layout is attached as Figure 3-TN8-SL.

Nitrogen Removal to less than 5 mg/l or 3 mg/l (Concept S-2). To provide an effluent total nitrogen level of less than 5 mg/l or 3 mg/l, CWT proposed adding an additional 350,000 gallons of bioreactor volume (total volume of 1,443,000 gallons) and 4,440 square feet of secondary sedimentation tanks (total surface are of 8,580 square feet). Internal recycle pumps, piping and appurtenances, and supplemental carbon addition would be added to create a Four Stage Bardenpho process arrangement for total nitrogen removal. This arrangement cannot be added to the proposed TN less than 8 mg/l layout and requires construction of additional facilities outside the limits of the existing fence as shown on the site layout. The TN less than 5 and TN less than 3 mg/l treatment levels differ by the amount of supplemental carbon added to the process, which does not impact the overall footprint.

Additional work to support this treatment level would include the following:

- Supplemental carbon facility

A site layout is attached as Figure 3-TN53-SL. As indicated, this process has a large footprint which extends beyond the fence line. Alternatives to the vendor suggested process to achieve effluent total nitrogen levels of 5 mg/l or 3 mg/l would be a denitrification filter or a denitrification BAF. These processes would likely have a smaller footprint that the 4 stage Bardenpho process, and could be examined in more detail if this option is selected.

OPTION 4 - MOVING BED BIOREACTOR & ACTIFLO

Options 4, 5 and 6 were all based on the MBBR biological treatment process. These options differ by the solids separation process following the MBBR. Retrofit details for the MBBR will be described in detail in this option and is consistent with the biological component of Option 5 – MBBR & CoMag and Option 6 – MBBR & DAF.

The MBBR vendor selected for development of these layouts was Kruger's AnoxKaldnes system, and the solids separation process for Option 4 was based on Kruger's ActiFlo system.

Process Description

Moving bed biological reactors incorporate floating media with a high specific surface area in the aeration basin to increase treatment surface area, thereby reducing the footprint of tanks or increasing the capacity of existing tanks. The biomass that treats the wastewater is attached to the media and is retained in the reactor with no return sludge. The media is continuously agitated by the medium bubble aeration systems used to support biomass growth and treatment. The floating media is retained in the aerations tanks by retention screens at the outlets of the tanks. Clarification is still needed following the MBBR to remove solids that pass through the system and for removal of biomass that comes off the media. The level of treatment provided in an MBBR can be modified by the percentage of media in the reactor, which typically does not exceed 60 percent. The media does not require cleaning or backwashing.

The ActiFlo system following the MBBR is a ballast assisted settling technology that incorporates sand to provide surface area for floc formation and to assist settling by adding weight to the floc. The resulting floc settles much quicker than floc without ballast, allowing settling tanks to perform at much higher overflow rates and shorter detention times. The overall process consists of a coagulation step where pin flocs form, a maturation step where the floc forms and a settling step. The sand is introduced to the wastewater during the maturation step of the process and provides a foundation for a stable floc. Once the floc is formed, settling is significantly enhanced. The settled ballasted floc is pumped through a hydrocyclone to separate the sand and sludge. Sludge is wasted and the sand is reused for floc formation.

Retrofit Details

Conventional Secondary Treatment (Concept S-1). Kruger's AnoxKaldnes MBBR system will require the use of 8 existing filter cells. The 8 existing cells will be reconfigured to two aeration trains. The existing filter cell separation walls would be removed, two new aeration tanks constructed within the limits of the existing 8 filter cells with a center effluent channel. The basis of this arrangement includes a total aerobic reactor volume of 463,000 gallons (61,890 cubic feet) with a media fill of 25 percent for a total media volume of 15,466 cubic feet. Kruger's tanks would require a tank side water depth of 18 feet, so additional tank height is not required. This arrangement allows for clarification in the existing pump station. Alternatively, this arrangement could be modified to use 4 existing filter cells with an overall reduction in reactor volume, but an increase media fill to 50 percent.

Kruger's ActiFlo system includes two 5 MGD ActiFlo ballasted flocculation units each with a coagulation, maturation and settling tank. The layout included an influent and effluent channel. The overall footprint of the system is 47 feet by 33 feet. This footprint will fit within the area of the existing pumping station (66 feet by 33 feet). Effluent from the ActiFlo system will discharge to the existing clearwell, which will be converted to a new wetwell. Effluent will be pumped to the existing effluent channel in the Odor Control Room.

The major components of the process include:

Bioreactor

- Medium bubble aeration system for 8 existing cells converted to two aeration trains
- MBBR media and media retention screens
- Blowers for process air (4 – 1 duty and 1 standby per aeration train)

Clarification

- Process piping
- Effluent lift pumps (3)
- Coagulation mixers (2)
- Maturation mixers (2)
- Settling tank scrapers (2)
- Lamella settlers (2)
- Sand recirculation pump (4 - 1 duty and 1 standby per train)
- Hydrocyclones (4 - 1 duty and 1 standby per train)
- Waste sludge pumps (3)
- Controls and instrumentation

Additional work to support this treatment level would include the following:

- Secondary influent pump station and screening building to the southeast of the existing Control Building.

A process flow schematic is attached as Figure 4-CST-PFS, a site layout is attached as Figure 4-CST-SL, and a process layout is attached as Figure 4-CST-PL.

Nitrogen Removal to <8 mg/l (Concept S-2/3). To provide an effluent total nitrogen level of less than 8 mg/l, Kruger proposed two denitrification MBBR process trains. Each denitrification MBBR train would consist of 2 pre-anoxic reactors, 2 aerobic reactors, one deoxygenation zone, one post anoxic zone with carbon addition and one reaeration zone. This requires a total bioreactor volume of 929,000 gallons or 493,000 more gallons than the conventional secondary treatment level (based on an 8 existing cell arrangement). The layout to accommodate this reactor volume requires that the existing Filter Building be demolished and the pre-anoxic, aerobic, and deoxygenation tanks be constructed within the limits of the existing slab and foundation walls. New tanks would be constructed to the west of the existing Filter Building for the post anoxic and reaeration reactors and associated influent and effluent channels.

The ActiFlo clarifier dimensions would not change but the system would be constructed in a new location on the site. This would require a new ActiFlo control building adjacent to the reactor tanks to house pumps, electrical equipment and other accessories. This concept would expand beyond the limits of the existing fence.

Additional work to support this treatment level would include the following:

- Supplemental carbon source facility
- Effluent pumping station (to be housed in ActiFlo Control Building)

- Main Electrical Building and Standby generator to replace the electrical systems in the existing Filter Building.

A site layout is attached as Figure 4-TN8-SL.

Nitrogen Removal to <5/3 mg/l (Concept S-2/3). To provide an effluent total nitrogen level of less than 5 mg/l or 3 mg/l, Kruger proposed to add one post anoxic reactor to each denitrification MBBR train, and slightly modified the reactor volumes. The overall footprint would remain similar in the TN treatment level of less than 8 mg/l, with some modification to the side water depth. If a MBBR nitrogen removal configuration was the selected option, the tank layout could be optimized to most cost effectively plan construction to provide for all TN treatment levels discussed. The total bioreactor volume for a TN<5 mg/l treatment level was 969,000 gallons and for a TN<3 mg/l treatment level was 1,018,000 gallons.

The ActiFlo clarifier dimensions would not change but the system would be constructed in a new location on the site. This would require a new ActiFlo control building adjacent to the reactor tanks to house pumps, electrical equipment and other accessories. This concept would expand beyond the limits of the existing fence.

Additional work to support this treatment level would include the following:

- Supplemental carbon source facility
- Effluent pump station (to be housed in ActiFlo Control Building)
- Main Electrical Building and Standby generator to replace the electrical systems in the existing Filter Building.

A site layout is attached as Figure 4-TN53-SL.

OPTION 5 - MOVING BED BIOREACTOR & COMAG

The MBBR bioreactor configuration for Option 5 was the same as for Option 4 and 6. However, the separation unit process was a ballasted settling clarifier. AECOM consulted CWT, who manufactures the CoMag ballasted clarifier for solids separation for Option 5.

Process Description

The MBBR process description was provided in Option 4 described above.

CoMag uses an inert iron ore (magnetite) ballast to enhance settling of biological flocs as a separation process. The ballast is introduced during conventional coagulation and flocculation. The ballasted floc has a high specific gravity and when sent to the CoMag clarifier settles at a greater rate than non ballasted floc. This allows the separation process footprint to be smaller than conventional secondary clarification. The system consists of a flash mixing tank, a set of reaction tanks where coagulation and flocculation occur and the clarifier. A polymer is added just before clarification. The ballasted floc is settled in the clarifiers and the majority of the magnetite ballasted floc is returned to the reaction tanks to improve process performance. Waste sludge is sent through a magnetite recovery process before being processed. Magnetite that is lost in the recovery process is processed with the WAS. Virgin magnetite is added to the recovered magnetite to replace the amount lost in the

WAS and the recovered and virgin magnetite are returned to the reaction tanks. The recovery process includes a shear mixer to physically split the ballast form the floc and a magnetic recovery drum to separate the magnetite from the waste sludge and metal hydroxide.

Retrofit Details and Layout

Conventional Secondary Treatment (Concept S-1). Retrofit details for the MBBR for the proposed treatment level were provided in Option 4 described above.

CWT's CoMag system includes one flash mix tank and one train of reaction tanks for coagulation and flocculation (3 tanks total) and two rectangular clarifiers. The reaction tanks and clarifiers consume the entire footprint of the existing pump station. A portion of the existing mudwell had to be converted to accommodate the flash mix tank. In this configuration the effluent from the MBBR would flow out the south side of the effluent channel. The footprint of each CoMag clarifier was approximately 15 feet by 45 feet. The clarifiers would be separated and be placed on each side of the existing columns supporting the ceiling in the pump station. The footprint of the reaction tanks uses the remaining area of the existing pump station and Reaction Tank 1 is separated from Reaction Tanks 2 and 3 because of the existing column supporting the roof in this area. The effluent from the clarifiers would discharge to the existing clearwell, which would be converted to a new wetwell. The arrangement requires the effluent pumps be submersible located in the new wetwell. Sludge return and waste sludge pumps could not be accommodated within the limits of the existing pump station. Therefore, a new sludge pump station was proposed outside the Filter Building for return sludge and waste sludge pumps. The magnetite shear mill and magnetic drums would be located above the reaction tanks. Effluent would be pumped to the existing effluent channel in the Odor Control Room. The effluent piping arrangement from the existing effluent channel would need to be modified to because of the new sludge pump station.

The major components of the process include:

Bioreactor
- Component details for the MBBR for the proposed treatment level were provided in Option 4 described above.

Clarification
- Rectangular sedimentation tanks, chain and flight mechanism, scum skimmers/baffles
- Process piping to/from the process tanks
- Recycle Pumps (2)
- WAS Pumps (3)
- Shear mills (2)
- Magnetic recovery drums (2)
- Ballast make-up tank (1)
- Ballast tank mixer (1)
- Virgin magnetite silo (1)
- Polymer Feed System (1)
- Coagulant Feed System (1)
- Alkalinity feed system (1)
- Compressor and dryer (1)
- Controls and instrumentation

Additional work to support this treatment level would include the following:

- Additional work to support the proposed MBBR treatment level was provided in Option 4 described above.
- Sludge pump station located adjacent to the Filter Building.

A process flow schematic is attached as Figure 5-CST-PFS, a site layout is attached as Figure 5-CST-SL, and a process layout is attached as Figure 5-CST-PL.

Nitrogen Removal to <8/5/3 mg/l (Concept S-2/3). Retrofit details for the MBBR for the proposed treatment level was provided in Option 4 described above.

Under this level of nitrogen removal, the CoMag clarifier dimensions would not change but the system would be constructed in a new location on the site. This would require a new control building adjacent to the reactor tanks and clarifiers to house pumps, electrical equipment and other accessories. This concept would expand beyond the limits of the existing fence.

Additional work to support this treatment level would include the following:

- Additional work to support the proposed MBBR treatment level was provided in Option 4 described above.
- Effluent pump station (to be housed in CoMag Control Building)

A site layout for the <8 mg/l treatment level is attached as Figure 5-TN8–SL, and a site layout for the <5/3 mg/l level is attached as Figure 5-TN53-SL.

OPTION 6 - MOVING BED BIOREACTOR & DAF

The MBBR bioreactor configuration for Option 6 was the same as for Option 4 and 5. However, for this option the separation unit process is a dissolved air flotation (DAF) unit.

AECOM consulted World Water Works (WWW), who manufactures a DAF clarifier for solids separation for Option 6.

Process Description

The MBBR process description was provided in Option 4 described above.

DAF systems use microbubbles to float floc formations to the water surface for wasting. A typical system includes two stages of floc formation and in-line mixing upstream of the dissolved air section. Microbubbles are produced by a pressurized stream of clarified water and air. Clarified water passes under the surface float, which is wasted on a periodic basis

Retrofit Details and Layout

Conventional Secondary Treatment (Concept S-1). Retrofit details for the MBBR for the proposed treatment level were provided in Option 4 described above.

WWW's DAF clarifiers are premanufactured tanks with internal components and an in-line mixing system for polymer addition. The air pumps are provided loose and are typically located adjacent to the units. The proposed system consists of 2 DAFs where each can handle half of the peak flow. The proposed process flow path includes piping directly from the MBBR effluent channel to the DAF influent connection. Each premanufactured tank is approximately 20 feet by 12 feet and 15 feet high. The two tanks fit within the existing pump station while leaving adequate space for process pumps and access to the tanks. The overall footprint of the system including the two tanks, air pumps and surrounding grating for access to the DAFs is 34 feet by 33 feet. Effluent from the DAF system will discharge to the existing clearwell, which will be converted to a new wetwell. Effluent will be pumped to the existing effluent channel in the Odor Control Room.

The major components of the process include:

Bioreactor
- Component details for the MBBR for the proposed treatment level were provided in Option 4 described above.

Clarification
- DAF units with clarifier internals, air distribution piping and in-line mixer (2)
- Process piping
- Effluent lift pumps (3)
- Polymer make-up system
- Air pumps (2)
- Waste sludge pumps (3)
- Controls and instrumentation

Additional work to support this treatment level would include the following:

- Additional work to support the proposed MBBR treatment level was provided in Option 4 described above.
- No additional work required to support the DAF clarifier.

A process flow schematic is attached as Figure 6-CST-PFS, a site layout is attached as Figure 6-CST-SL, and a process layout is attached as Figure 6-CST-PL.

Nitrogen Removal to <8/5/3 mg/l (Concept S-2/3). Retrofit details for the MBBR for the proposed treatment level were provided in Option 4 described above.

The DAF clarifier dimensions would not change but the system would be constructed in a new location on the site. This would require a new building to house the DAFs and associated and electrical equipment and other accessories. This concept would expand beyond the limits of the existing fence.

Additional work to support this treatment level would include the following:

- Additional work to support the proposed MBBR treatment level was provided in Option 4 described above.
- Effluent pump station (to be housed in CoMag Control Building)

A site layout for the less than 8 mg/l treatment level is attached as Figure 6-TN8–SL, and a site layout for the <5/3 mg/l level is attached as Figure 6-TN5/3-SL.

OPTION 7 - MEMBRANE BIOREACTOR

The layout and sizing of the MBR option is based on the Zeeweed membrane system which is manufactured by Zenon Environmental Corporation (GE)

Process Description

Membrane bioreactor systems combine ultrafiltration technology with biological treatment for wastewater treatment and water reuse applications. Membrane bioreactor (MBR) systems replace conventional activated sludge treatment and combine clarification, aeration, and filtration into a single process. The Zeeweed MBR systems incorporate reinforced hollow fiber membranes into removable cassette arrangements. Membrane cassettes are submerged in the aeration tank and suction is applied to the membrane to filter water out of the mixed liquor suspended solids (MLSS). An MBR process is able to operate at MLSS concentrations as high as 8,000 – 10,000 mg/L, which significantly reduces the necessary footprint by concentrating treatment. The pores in the membranes typically range from 0.04 µm to 0.4 µm in size. The resulting effluent usually contains lower turbidity than tertiary effluent from sand bed filters.

Large recirculation rates are necessary to prevent the buildup of high MLSS concentrations around the membrane cassettes. Due to the high MLSS concentration, sludge can be wasted directly from the aeration basin without the use of clarifiers. It should also be noted the Zeeweed system presented in the conventional secondary treatment option is designed to provide both carbon oxidation and nitrification of the wastewater. While nitrification is not required to meet the secondary effluent permit limits Zenon has found nitrifying the wastewater offers advantages for reducing the fouling of their membranes. While the reduced fouling helps increase the flux of permeate through the membranes nitrifying of the wastewater requires additional process aeration.

Retrofit Details and Layout

Conventional Secondary Treatment (Concept S-1). The MBR option would use five membrane tanks and two aeration tanks. All membrane and aeration trains would act as activated sludge biological reactors however, the first two tanks would be conventional tanks with aeration systems only while the last five tanks would be aerated and have membrane cassettes in the activated sludge. The five membrane tanks would be located in five existing filter cells (cells 1-5 with a total volume of 323,000 gallons). The two aeration tanks would be located in the area of the remaining filter cells (cell 6-8) and a portion of the area to the east of filter cell No. 8, which is the existing pump station (total aeration volume of 300,000 gallons). No additional tank height would be needed for the membrane's side water depth requirement of 18 ft.

The membranes are scoured (by air) and backwashed with both clean water and chemical to prevent fouling. Membrane cassettes are approximately 11 feet high and require a minimum of approximately 13-15 feet of headroom to remove. This will require increasing the clear height of the building above the membrane trains for their removal and staging.

The membrane permeate pumps would pull effluent (permeate) through the membranes via suction and discharge the permeate to either the permeate back pulse tank or to disinfection. These permeate pumps also serve as back pulse pumps by reversing direction and pumping permeate (and sometimes chemical) back through the membranes to remove built up solids on the membrane fibers. The backpulse pumps, the back pulse tank, and the chemical storage tanks would be located in the area to the north of the existing filter cells (existing Clearwell Pipe Gallery). Mixed liquor recycle pumps would be located in the foot print of part of the existing mudwell adjacent and to the south of the membrane trains. The building over the membrane tanks would be extended at the raised height to include this area of the existing mudwell and reconfigured as a cassette staging area with RAS pump station below. A portion of the RAS flow would be wasted to the solids handing processes.

The major components of the process include:

- Membrane cassettes in 5 of the existing 8 tanks (6 cassettes per tank for 30 total cassettes)
- Coarse bubble aeration system for membrane tanks
- Fine bubble aeration for the two aeration tanks
- Permeate / back pulse pumps (5)
- Mixed liquor recycle pumps (5)
- WAS pumps (3)
- Membrane air scour blowers (6)
- Process aeration blowers (3)
- Process and air piping
- Manual and automated valves
- Bridge cranes (5)
- Instrument air compressor
- Controls and instrumentation

Additional work to support this treatment level would include the following:

- Influent pump station and screening building to the southeast of the existing Control Building.

A process flow schematic is attached as Figure 7-CST-PFS, a site layout is attached as 7-CST-SL, and a process layout is attached as 7-CST-PL.

Nitrogen Removal to < 8 mg/l (Concept S-1). To provide an effluent total nitrogen level of less than 8 mg/l, Zenon (GE) proposed maintaining the 5 tank membrane configuration for the Conventional Secondary Treatment level, increasing the aerobic zone from 300,000 gallons to 333,000 gallon and adding a 300,000 gallon anoxic bioreactor (total reactor volume of 633,000 gallons and membrane reactor volume of 323,000 gallons). This would require converting the entire existing pump station to anoxic and aeration volume. Internal nitrate recycle pumps, piping and appurtenances would be added to create a Modified Ludzack Ettinger (MLE) process arrangement for nitrogen removal.

Although this layout concept would provide for a retrofit of the existing Filter Building, conversion of the existing pump station to a tank would potentially require modification to the existing electrical systems, which are above the pump station and require conversion of a portion of the existing Controls area, loading dock and Odor Control Room to provide access to the anoxic and aerobic bioreactors.

A site layout is attached as Figure 7-TN8-SL.

Nitrogen Removal to <5/3 mg/l (Concept S-2). This section describes an alternative to provide secondary treatment and nitrogen removal using the MBR technology in order to achieve a total nitrogen effluent limit of less than 5mg/l or 3 mg/l. In order to achieve the required treatment level, a number of additional process reactors will be required for the MBR system. The overall process configuration is that of a conventional 4 stage Bardenpho process, including the following:

- Five pre anoxic process trains in the northwest portion of the building (existing Clearwell Pipe Gallery).
- Four aerobic process trains in the deeper east side of the building (existing pump station).
- Four post anoxic process trains in the footprint of existing filter cells numbers 6 through 8.
- Five membrane process trains would in the footprint of existing filter cells numbers 1 through 5.
- Permeate/back pulse pumps, the mixed liquor recycle pumps, and back pulse storage tank located in the footprint of the existing mudwell.
- A new aerobic effluent channel constructed to the east of the existing Filter Building.
- A building addition on the west side of the existing Filter Building to house the following:
    - Membrane chemical storage
    - Process and air scour blowers
    - Instrument air compressors
    - Control room
    - Electrical room
    - Support systems (HVAC, plumbing)

This layout would require the demolition of the existing Filter Building and construction within the limits of the existing foundation walls and slab (Concept S-2). In addition, this arrangement would require some channels and other structures constructed adjacent to the existing foundation walls.

Additional work to support this treatment level would include the following:

- Main Electrical Building and Standby generator to replace the electrical systems in the existing Filter Building.

A site layout is attached as Figure 7-TN53-SL

OPTION 8 - CONVENTIONAL ACTIVATED SLUDGE

AECOM completed preliminary process sizing for a conventional activated sludge system to meet the design criteria.

Process Description

For conventional secondary treatment, the activated sludge process generally consists of an aeration tank (or bioreactor) and a clarifier. Settled sludge from the clarifier, called return activated sludge, is returned to the flow stream entering the aeration tank. The mixture of the secondary influent flow stream (primary effluent) and the return sludge is termed mixed liquor suspended solids (MLSS). The biomass in the MLSS consumes incoming wastes. As the waste is removed more biomass is produced. This requires that sludge occasionally be wasted from the system to maintain the proper food to microorganism ratio and/or sludge age. Conventional secondary treatment removes carbonaceous BOD.

For nitrogen removal, the activated sludge process is modified to provide nitrification in the aerobic zone and to include a single, or a series, of alternating anoxic zones. Anoxic zones are reactors with no aeration diffuser system within the tank. In the modified Ludzack Ettinger (MLE) configuration, an anoxic zone precedes the aerobic zone. The aerobic zone is sized so that all ammonia is converted to nitrate, a process called nitrification. An internal nitrate recycle from the aeration tank returns nitrate rich wastewater from the aerobic zone to the anoxic zone. The nitrates mix with the RAS and the influent flow stream. The dominant type of bacteria in the anoxic zone breaks the bond between the nitrate and the oxygen to use the oxygen for cell growth. The nitrogen is released and leaves the system in the form of nitrogen gas. Internal recycle rates are such that total nitrogen is reduced. The MLE configuration can typically provide total nitrogen removal to less than 8 mg/L. Another common total nitrogen removal configuration is the 4 stage Bardenpho. In this configuration, the reactors would be pre-anoxic, aerobic, post anoxic and aerobic. This is essentially the MLE configuration with another anoxic and aerobic zone added to the end of the process before clarification. This arrangement can typically provide total nitrogen removal to less than 5 or 3 mg/L depending on the amount of supplemental carbon added. Supplemental carbon is required because the denitrifying microorganisms become carbon limited at the post anoxic stage and require a supplemental carbon source.

Retrofit Details and Layout

Conventional Secondary Treatment (Concept S-2). The CAS option needed the largest aeration treatment volume of all the scenarios to meet secondary treatment levels. This required the existing Filter Building be demolished and the limits of the existing foundation walls and slab be used for a new aeration tank. The proposed aeration tank would have a volume of approximately 1,900,000 gallons. The resulting tank has an overall footprint of 165 feet by 62 feet with a sidewater depth of 25 feet. The aeration system would be split into two aeration trains for maintenance purposes. This would require a new secondary influent pump station and blower building to the west of the existing Filter Building. The activated sludge process requires the use of conventional secondary sedimentation tanks because of the type of floc coming from the aeration tank. With the limited footprint, new secondary clarifiers could not be constructed. Therefore, this arrangement required the existing primary clarifiers be converted to secondary clarifiers. This requires the existing clarifier drive and rake mechanisms be replaced and sludge piping and pumps be modified. In addition, to meet acceptable clarifier overflow and solids loading rates, a third secondary clarifier (76 feet in diameter) would need to be constructed. The third clarifier would be constructed to the west of the existing clarifiers and would extend outside the exiting fence line. Because of the need to convert the existing primary clarifiers, a new wet weather facility was proposed to treat the flow in excess of secondary

treatment capacity, or 14.4 MGD. The high rate clarification process, ActiFlo was used as the basis of the wet weather treatment system. The ActiFlo process was described in Option 4 above.
The major components of the process include:

- Aeration tanks and fine bubble diffuser system
- Circular clarifier mechanisms, scum skimmers/baffles (3)
- Process piping to/from the process tanks
- Influent Pumps (3)
- RAS Pumps (3)
- WAS Pumps (4)
- Scum Pumps (4)
- Process air blowers (3)
- Controls and instrumentation

Additional work to support this treatment level would include the following:

- New effluent flow metering structure and meter.
- Main Electrical Building and Standby generator to replace the electrical systems in the existing Filter Building.
- Wet weather distribution box.

A process flow schematic is attached as Figure 8-CST-PFS, a site layout is attached as Figure 8-CST-SL, and a process layout is attached as Figure 8-CST-PL.

Nitrogen Removal to < 8 mg/l (Concept S-2/3). To provide an effluent total nitrogen level less than 8 mg/l, AECOM calculated the required anoxic volume to convert the Secondary Treatment Level configuration into an MLE configuration. This required another 950,000 gallons of reactor volume for the anoxic tank (total treatment volume of 2.86 million gallons). These tanks would be configured to be a two train system with internal recycle from the aeration tanks. The anoxic tanks would be provided with subsurface mixers. An effluent pump station would be constructed in an adjacent building. The anoxic tank and the effluent pump building would be located south of the new clarifier, which is outside the limits of the existing fence.

A site layout is attached as Figure 8-TN8-SL.

Nitrogen Removal to < 5 mg/l or 3 mg/l (Concept S-2/3). To provide an effluent total nitrogen level less than 5 mg/l or 3 mg/l, AECOM calculated the required volume to expand from the MLE configuration to the 4 stage Bardenpho configuration. An additional volume of 950,000 gallons (total treatment volume of 3.81 MG) was required for the post anoxic and aerobic reactors. These tanks would be configured to be a two train system. The post anoxic tanks would be provided with subsurface mixers. A supplemental carbon facility would be required and provisions for carbon addition would be added at the post anoxic tanks. The effluent pump station would be used to house the required aeration blowers for the aeration tanks. The post anoxic and aerobic tanks would be located south of the secondary effluent pump building, which is outside the limits of the existing fence.

A site layout for this option is attached as Figure 8-TN53-SL. As indicated, this process has a large footprint which extends beyond the fence line. Alternatives to the 4 stage Bardenpho process to achieve effluent total nitrogen levels of 5 mg/l or 3 mg/l would be a denitrification filter or a denitrification BAF. These processes would likely have a smaller footprint that the 4 stage Bardenpho process, and could be examined in more detail if this option is selected.

OPINION OF CAPITAL COSTS

Preliminary opinions of cost for the implementation of the potential technologies to achieve secondary treatment were developed. The opinion of cost developed for each option is provided in Attachment F and are summarized below. The estimates combine components of the Wastewater Master Plan opinions of cost and new opinions of cost developed for the conceptual treatment alternatives presented in this memorandum. The Wastewater Master Plan recommended a number of upgrades at the Peirce Island plant that would need to be implemented if the Filter Building were retrofitted to provide secondary treatment using one of the options previously discussed. Accordingly, AECOM carried the Wastewater Master Plan opinion of cost for Headworks, Sanitary Disinfection, Biosolids Processing, and parts of Additional Structures and Modifications from "Cost Estimate Scenario 1B – Peirce Island Alternative TN 8 – MBR Secondary Treatment at PI Site (6.2 MGD), PIT Site (1.7 MGD)" contained in Appendix I of the draft report. For the Wastewater Master Plan upgrade elements, the Wastewater Master Plan allowance percentages were used for yard piping, electrical, instrumentation and controls, and site work and landscaping. The Wastewater Master Plan allowances for engineering and contingency, which total 50 percent, were also used for the Wastewater Master Plan upgrade elements.

The Wastewater Master Plan cost estimates for work on Peirce Island also included an Island Construction Premium of 15 percent. In developing the updated opinions of cost for the secondary treatment options, AECOM discussed the applicability of this factor with two construction contractors that specialize in water and wastewater facilities, and who were familiar with the Peirce Island constraints. Based on their feedback, the 15 percent Island Construction Premium in the Wastewater Master Plan estimates was reduced to 3 percent.

The total estimated capital costs are preliminary planning level costs and have been developed based on a number of assumptions and may not represent the final project capital costs for the facilities once designed. The final costs could be higher or lower depending on what decisions are made during the design phase, how the final facilities are constructed, and when the final facilities are constructed.

Table 7 – Secondary Treatment Opinion of Capital Cost Summary

Option	Estimated Cost ($MM)
1. Biological Aerated Filter (BAF)	$33.0
2. Sequencing Batch Reactor (SBR) with BioMag	N/A
3. Conventional Activated Sludge (CAS) with BioMag	$37.0
4. Moving Bed Bioreactor (MBBR) & ActiFlo	$32.0
5. Moving Bed Bioreactor (MBBR) & CoMag	$34.0
6. Moving Bed Bioreactor (MBBR) & DAF	$32.0
7. Membrane Bioreactor (MBR)	$42.0
8. Conventional Activated Sludge (CAS)	$39.0

Based on the capital cost estimates, MBBR and ActiFlo (Option 4) and MBBR and DAF (Option 6) would be the least cost options for providing secondary treatment on Peirce Island.

Estimated Operations & Maintenance Costs

AECOM developed preliminary annual operation and maintenance costs for each candidate technology. The estimated annual operation and maintenance costs developed for each option are summarized below. These estimates reflect only the operation and maintenance costs to support the proposed technology and are not inclusive of other process at the Peirce Island WWTF. The estimates consist of annual costs for electricity, chemicals, labor and equipment replacement. Annual electricity costs were based on motor horsepower and an estimated annual runtime at an electricity cost of $0.13 per Kilowatt hour. Chemical costs were developed based on vendor provided and/or estimated chemical dosages and chemical costs. Required chemicals included polymers, coagulants, pH adjustment and membrane cleaning chemicals. Estimated labor costs were developed based on the *The Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants* prepared in November 2008 by the New England Interstate Water Pollution Control Commission (NEIWPCC). Equipment replacement costs were based on a percentage of raw equipment costs and were adjusted as needed based on vendor specifics.

Table 8 – Estimated Annual Secondary Treatment Operation and Maintenance Costs Summary

Item	Option 1 - BAF	Option 2 - SBR w/BioMag	Option 3 – CAS w/BioMag	Option 4 - MBBR & ActiFlo	Option 5 - MBBR & CoMag	Option 6 - MBBR & DAF	Option 7 - MBR	Option 8 - CAS
Electricity	$260,000	Not Feasible	$270,000	$230,000	$220,000	$260,000	$270,000	$230,000
Labor & Maintenance	$130,000		$140,000	$150,000	$160,000	$130,000	$170,000	$130,000
Chemicals	$0		$50,000	$130,000	$450,000	$10,000	$30,000	$70,000
Parts & Replacement	$60,000		$130,000	$60,000	$70,000	$50,000	$210,000	$40,000
Total	$450,000		$590,000	$570,000	$900,000	$450,000	$680,000	$470,000

Estimated Life Cycle Costs

AECOM estimated life cycle costs for each technology evaluated. The life cycle cost was estimated by summing the total capital cost and the present worth of the annual operation and maintenance costs. The present worth value of the operation and maintenance costs was developed using a period of 20 years and a present worth interest rate of 4.375 percent based on the United States Department of Agriculture's Natural Resources Conservation Service's discount rate for federal water projects. Table 9 summarizes the calculated life cycle costs.

Table 9 – Estimated Secondary Treatment Life Cycle Costs Summary ($MM)

Cost Item	Option 1 - BAF	Option 2 - SBR w/BioMag	Option 3 – CAS w/BioMag	Option 4 - MBBR & ActiFlo	Option 5 - MBBR & CoMag	Option 6 - MBBR & DAF	Option 7 - MBR	Option 8 - CAS
Capital	$33.00	Not Feasible	$37.00	$32.00	$34.00	$32.00	$42.00	$39.00
20 Year Present Worth O&M	$7.77		$9.71	$9.19	$13.37	$7.67	$11.32	$7.81
20 Year Life Cycle	$40.77		$46.71	$41.19	$47.37	$39.67	$53.32	$46.81

As indicated in Table 9, the 3 technologies with the lowest estimated life cycle costs for providing secondary treatment are MBBR and DAF (Option 6), BAF (Option 1) and MBBR and ActiFlo (Option 4).

NON-MONETARY FACTORS

In addition to evaluating the costs for the potential treatment technologies, AECOM developed a Criteria Evaluation Matrix as a tool to quantify the subjective aspects of the technologies. The criteria evaluation matrix provides a means to compare non-monetary factors that are important for meeting the City's needs and project goals. The non-monetary criteria used for the evaluation are summarized below:

Operational Track Record/Established Process. High rate treatment technologies are becoming increasingly popular because of the smaller footprint and the capability to increase treatment capacity within existing infrastructure. A number of these processes, however, have few operating facilities and in some cases those facilities have not been operating for an extended period of time. These processes received a less favorable score for this criterion.

Operability (No. of Processes/Complexity of Processes). The City has indicated a preference toward less complex treatment processes where the majority of process equipment can be maintained and operated by trained City staff. Some of the technologies involve the use of extensive process instrumentation and automation which would likely require the services of specialized contractors for maintenance, and these technologies receive a less favorable score.

Ability to Retrofit Conventional Secondary Treatment to Meet a TN Limit of 8 mg/l. The City is currently only required to implement secondary treatment at the Peirce Island WWTF. However, it is likely that the City will receive a future TN limit, but the timing of the requirement and the future limit is not known at this time. The future TN limit is expected be at least 8 mg/l, and may be lower, depending on the results of the ongoing efforts by the City and other surrounding communities to work with the EPA and DES to review the need and basis for the limits on total nitrogen. The ability to upgrade the proposed secondary process to achieve future nitrogen removal to a level of 8 mg/l is a significant consideration. Vendors were, therefore asked to provide recommendations, process sizing, and layouts of equipment/structures needed to retrofit the proposed secondary treatment concept to achieve an average monthly effluent total nitrogen concentration of 8 mg/l year round. Those technologies that can readily add to, or modify, the process layout for conventional secondary treatment to achieve a TN limit of 8 mg/l received a more favorable score than technologies that required a significantly different process layout for TN removal compared to conventional secondary treatment.

Ability to Retrofit Conventional Secondary Treatment to Meet a TN Limit of 5 mg/l or 3 mg/l. As noted above, the City is currently only required to implement secondary treatment at the Peirce Island WWTF. However, it is likely that the City will receive a future TN limit, but the timing of the requirement and the future limit is not known at this time. It is possible that the TN limit could be phased in, beginning with a limit of 8 mg/l, and progressing to a subsequent limit of 5 mg/l or 3 mg/l. The ability to upgrade the technology to achieve future nitrogen removal to a level of 5 mg/l or 3 mg/l is a significant consideration. Vendors were, therefore asked to provide recommendations, process sizing, and layouts of equipment/structures needed to retrofit the proposed secondary treatment concept to achieve an average monthly effluent total nitrogen concentration of 5 and 3 mg/l year round. Those technologies that can readily add to, or modify, the process layout for achieving a TN limit of 8 mg/l to a layout that can achieve 5 mg/l or 3 mg/l received a more favorable score than technologies that required a significantly different process layout for the lower TN removal limits compared to the 8 mg/l TN level.

Constructability. Construction of some of the proposed treatment technologies would require significant work for maintenance of existing plant operations during construction. This work may require extensive bypass pumping, construction of temporary facilities to support treatment operations during construction or other work necessary to provide treatment of wastewater flows during construction of the secondary facilities. These technologies received a less favorable score for this criterion.

Site Layout Hydraulic Complexity. Some of the proposed treatment technologies involve extensive routing of flows across the Peirce Island plant site, and some involve extensive pumping to achieve the required treatment levels. These technologies received a less favorable score for this criterion.

Ability to Stay Within Fence Line for Secondary Treatment. Vendors were asked to provide a proposal for the proposed concept (S-1, S-2 and S-3) that was optimal for the proposed technology and met the City's goals. The existing fence line is considered a hard limit and those technologies which required expansion or facilities beyond the fence line received an unfavorable score for this criterion.

Ability to Stay Within Fence Line for Future Nitrogen Removal. Minimizing the extent of plant facilities outside the fence line has been identified as a goal for the project. The existing fence line is considered a hard limit and those technologies which required expansion or facilities beyond the fence line received an unfavorable score for this criterion

Ability to Treat High FOG Levels. The City has noted that the fats, oils, and grease (FOG) concentrations increase dramatically during the summer seasons because of an increase in tourists visiting local restaurants and other sites. The proposed technology must be able to handle necessary FOG loads without excessive fouling or other deterioration in process performance. Alternatively, the process must be accompanied by a process to remove FOG upstream of the process, which will impact overall costs.

Technology Comparison & Ranking

For the criteria evaluation, a 2 step process was used to compare and rank the technologies. In the first step, the paired comparison technique was used to weigh the criteria noted above. In this technique, each pair of criteria were evaluated by the project team by deciding first which criterion is the more important one to consider and then its relative importance to the other criterion using a scale of 1 - 3 where:

> 1 - Indicates it is only slightly more important;
> 2 - Indicates its importance is somewhere between the extremes; and
> 3 - Indicates its importance is very much greater.

For example, when comparing Criterion A- Operational Track Record/Established Process to Criterion B- Operability (No. of Processes/Complexity of Processes), the team felt that Criterion A was slightly more important than Criterion B. As a result, in the box (cell) where Row A and Column B intersect, a score of A1 was given. The points accumulated by each criterion when compared to the other criteria were then summed to obtain a score and the scores normalized to 100 to create the weighting factors as shown in Table 10. The total score for each criterion is the sum of the points where each criterion was judged to be the more important of the two criteria compared. The Criterion H- Ability to Stay Within Fence Line for Future TN Treatment received a score of 0, which means that it was judged to be not more important than any of the other criteria considered and it was not considered further.

Table 10 – Criteria Evaluation Matrix

	B	C	D	E	F	G	H	I	Evaluation Criteria	Score	Weighting Factor
A	A 1	C 2	A 1	A 1	A 2	A 1	A 2	A 1	Operational Track Record/Established Process	9	18
	B	B 1	B 2	B 3	B 1	B 1	B 2	B 1	Operability (No. of Processes/Complexity of Processes)	11	22
		C	C 2	C 2	C 1	C 1	C 1	C 1	Ability to Retrofit Conv. Secondary Treatment Meet Future Nitrogen Limits of 8 mg/l	10	20
			D	E 1	F 2	G 2	D 1	I 2	Ability to Retrofit TN 8 to Meet Future Nitrogen Limits of 5/3 mg/l	1	2
				E	F 1	G 2	E 1	I 1	Constructability	2	4
					F	G 1	F 1	I 1	Site Layout Hydraulic Complexity	4	8
						G	G 2	I 1	Ability to Stay Within Fence Line for Secondary Treatment	7	14
							H	I 2	Ability to Stay Within Fence Line for Future TN Treatment	0	0
								I	Ability to Treat High FOG Levels	7	14
										Total	100

In the second step, these criteria were placed in the Option Evaluation Matrix, on the following page, where all the technology options are listed. The project team then determined how well each technology option met each criterion using a scale of 1 -5 where 5 indicates almost perfect conformance to the criterion and 1 indicates almost no compliance with the criterion. The points assigned to each for each criterion were then multiplied by the weighting factor, and the results summed to identify the non-monetary value points for each technology option. The estimated capital cost and life cycle cost of each option were added to the matrix and scores were divided by the costs (in millions) to obtain a value ratio.

AECOM

Table 11 – Option Evaluation Matrix

Evaluation Criteria	Weight	Option 1 - BAF		Option 2 - SBR w/ BioMag (Not Feasible)		Option 3 - CAS w/ BioMag		Option 4 - MBBR & ActiFlo		Option 5 - MBBR & CoMag		Option 6 - MBBR & DAF		Option 7 - MBR		Option 8 - Conventional Activated Sludge	
		Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Operational Track Record/Established Process	18	3	54			2	36	2	36	1	18	2	36	4	72	5	90
Operability (No. of Processes/Complexity of Processes)	22	3	66			3	66	2	44	2	44	3	66	2	44	4	88
Ability to Retrofit Conv. Secondary Treatment Meet Future Nitrogen Limits of 8 mg/l	20	1	20			5	100	1	20	1	20	1	20	3	60	4	80
Ability to Retrofit TN 8 to Meet Future Nitrogen Limits of 5/3 mg/l	2	5	10			3	6	4	8	4	8	4	8	2	4	4	8
Constructability	4	4	16			2	8	4	16	4	16	4	16	3	12	1	4
Site Layout Hydraulic Complexity	8	4	32			3	24	4	32	3	24	4	32	4	32	1	8
Ability to Stay Within Fence Line for Secondary Treatment	14	5	70			5	70	5	70	5	70	5	70	5	70	1	14
Ability to Stay Within Fence Line for Future TN Treatment		4				2		3		3		3		5		1	
Ability to Treat High FOG Levels	14	3	42			4	56	3	42	3	42	3	42	4	56	3	42
Total Weighted Criteria		310				366		268		242		290		350		334	
Capital Cost (estimated - in millions)		$33.0				$37.0		$32.0		$34.0		$32.0		$42.0		$39.0	
Value Ratio (criteria/capital cost)		**9.4**				**9.9**		**8.4**		**7.1**		**9.1**		**8.3**		**8.6**	
Life Cycle Cost (in millions)		$40.8				$46.7		$41.2		$47.4		$39.7		$53.3		$46.8	
Value Ratio (criteria/ life cycle cost)		**7.6**				**7.8**		**6.5**		**5.1**		**7.3**		**6.6**		**7.1**	

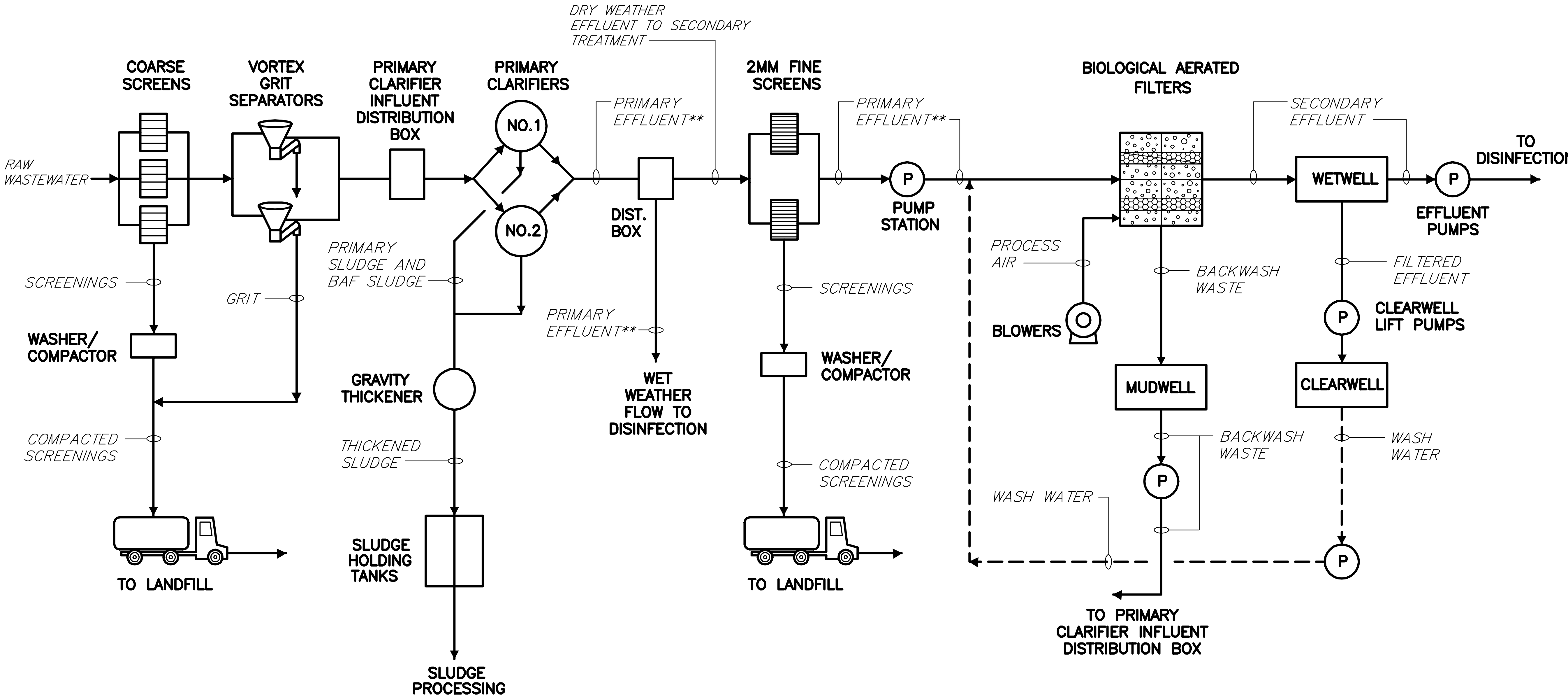
As indicated in Table 11, on a value ratio using the life cycle cost basis, the 3 highest ranked technologies are Conventional Activated Sludge with Biomag (Option 3), BAF (Option 1), and MBBR and DAF (Option 6).

SELECTION OF TECHNOLOGIES FOR PILOTING

AECOM and the City participated in a workshop on August 25, 2011 to review the information presented in the draft technical memorandum dated August 19, 2011. The project team collectively reviewed the non-monetary factors and weighting basis and finalized the ranking of the technologies to identify the technologies to be piloted as part of Phase 2 of this project. In light of the relatively small differences in estimated costs and the value ratios, piloting of 3 technologies for the intial piloting effort was recommended and it was agreed that piloting would be conducted for CAS with BioMag (Option 3), BAF (Option 1), and MBBR and DAF (Option 6).

List of Attachments

Attachment A – Memorandum, Task 1.3 Flow Evaluation, March 23, 2011
Attachment B – DRAFT Memorandum, Load Component of Task 1.3. Flow Evaluation, June 3, 2011
Attachment C – Wastewater Characterization Program Raw Data
Attachment D – Memorandum, Request for Preliminary Sizing and Cost Estimate, June 7, 2011
Attachment E – Memorandum, Task 1.4 Conduct Site Visit/Review Constraints on Filter Building Reuse, May 9, 2011
Attachment F – Opinion of Costs



** DURING WET WEATHER EVENTS, CLARIFIERS MAY BE OPERATED IN CHEMICALLY ENHANCED MODE.

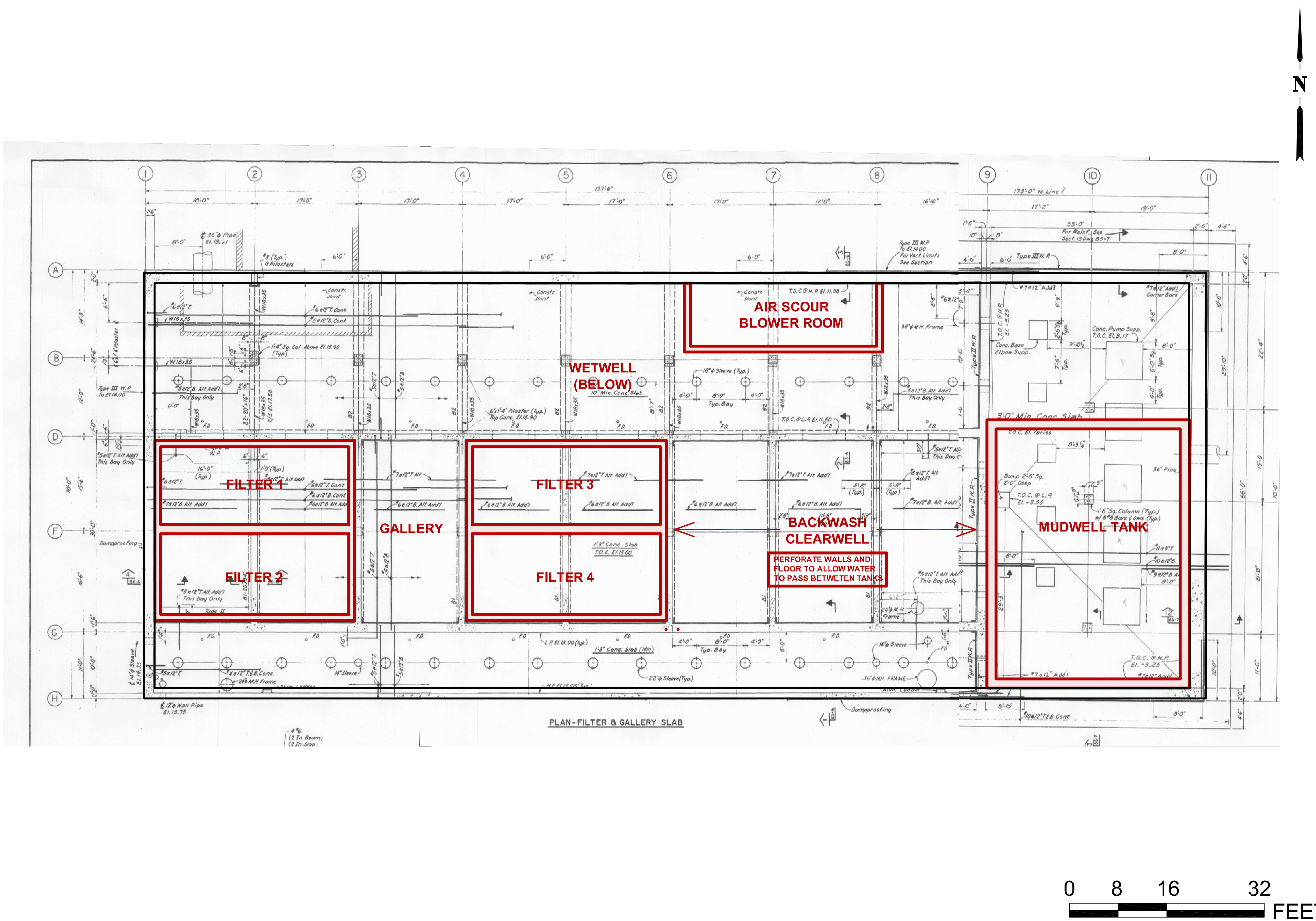
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

BAF
CONVENTIONAL SECONDARY TREATMENT

OPTION 1
FIG. 1-CST-PFS

PROCESS FLOW SCHEMATIC



AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

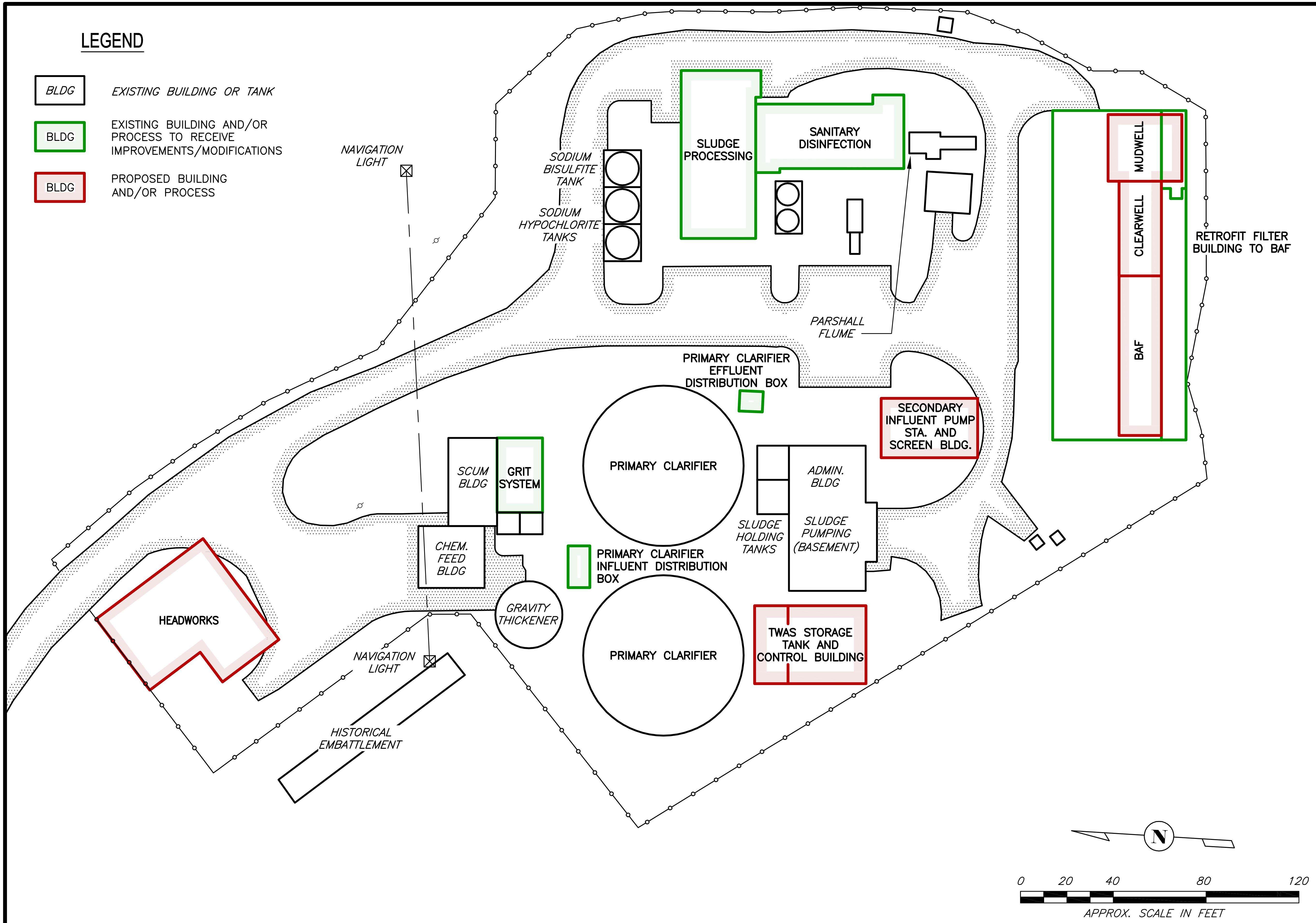
WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

BAF

CONVENTIONAL SECONDARY TREATMENT

OPTION 1
FIG. 1-CST-PL

PROCESS LAYOUT



AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

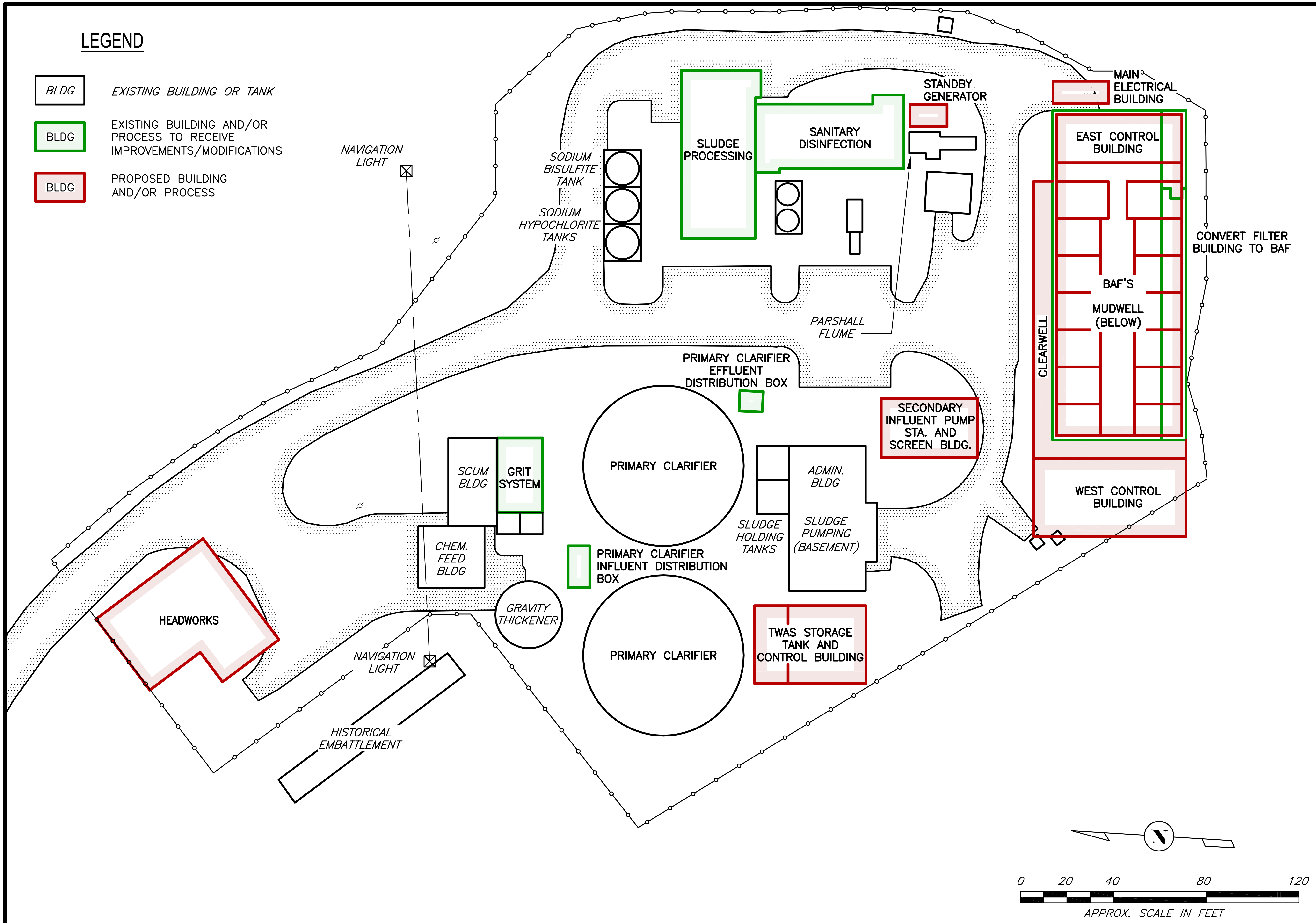
WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

BAF

CONVENTIONAL SECONDARY TREATMENT

OPTION 1
FIG. 1-CST-SL

SITE LAYOUT



AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

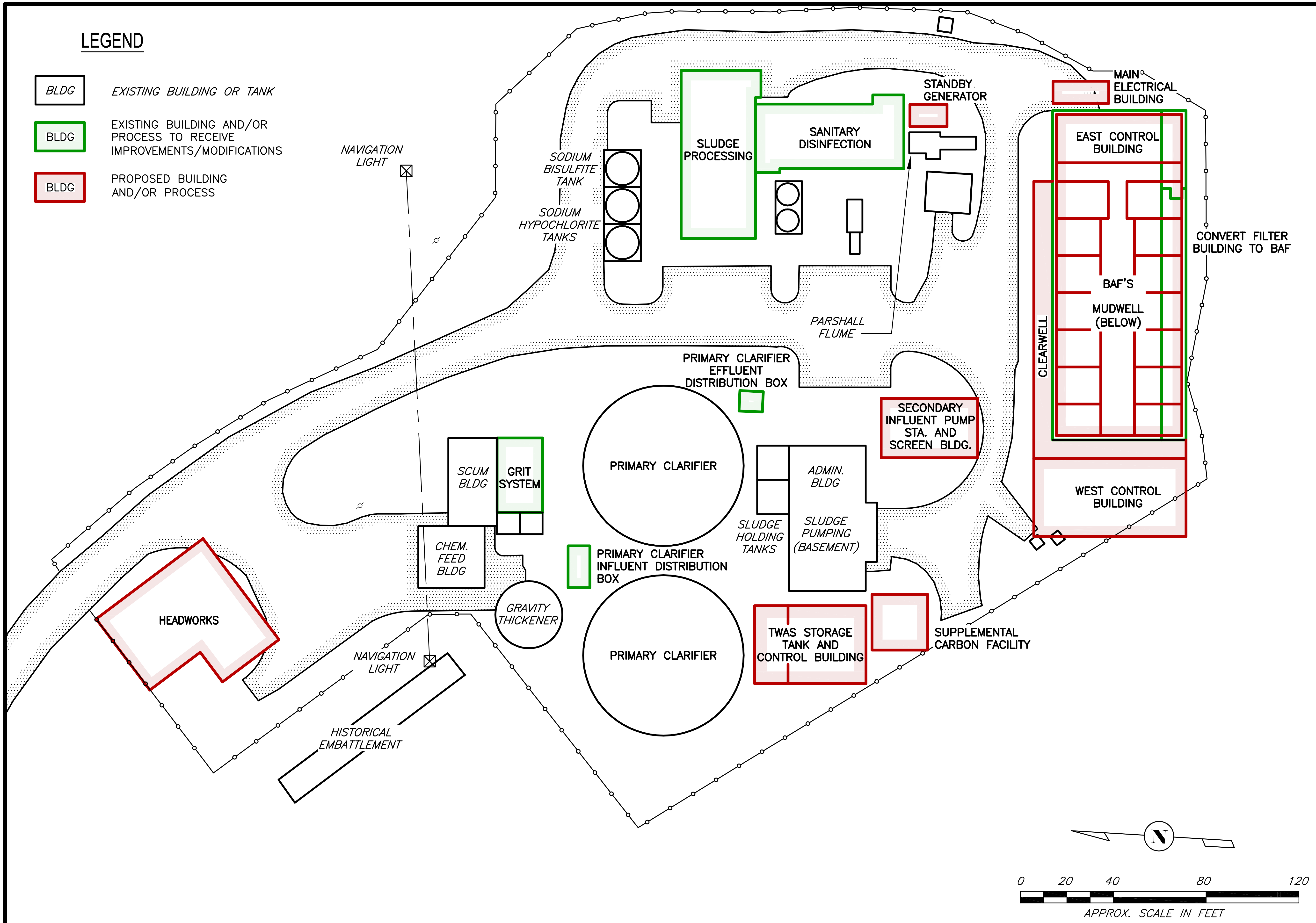
WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PIERCE ISLAND WWTF - PORTSMOUTH, NH

BAF

TOTAL NITROGEN < 8 Mg/L

OPTION 1
FIG. 1-TN8-SL

SITE LAYOUT

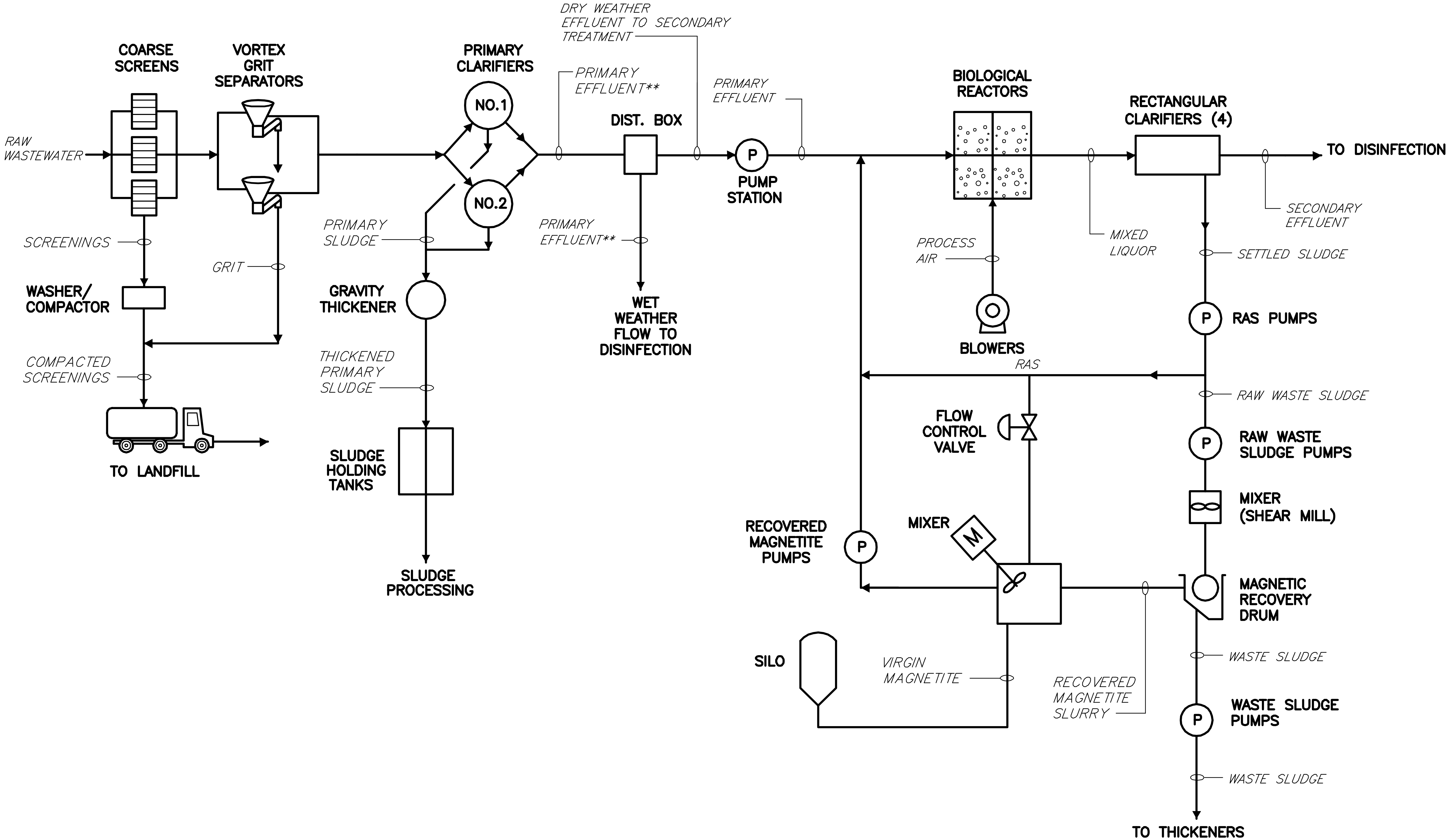


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
BAF
TOTAL NITROGEN < 5/3 Mg/L

OPTION 1
FIG. 1-TN53-SL

SITE LAYOUT



** DURING WET WEATHER EVENTS, CLARIFIERS MAY BE OPERATED IN CHEMICALLY ENHANCED MODE.

701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

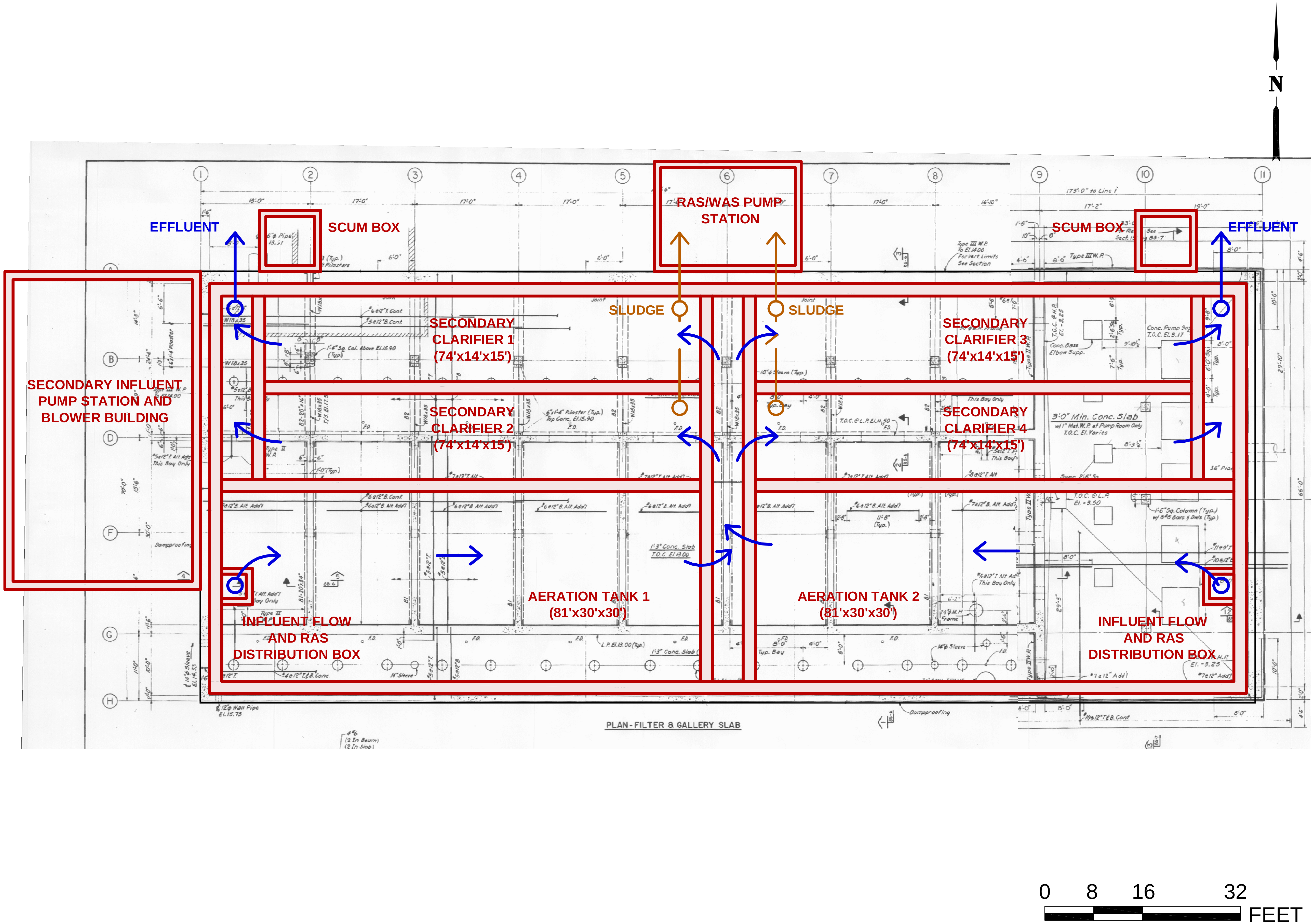
CAS WITH BIOMAG

CONVENTIONAL SECONDARY TREATMENT

OPTION 3

FIG. 3-CST-PFS

PROCESS FLOW SCHEMATIC



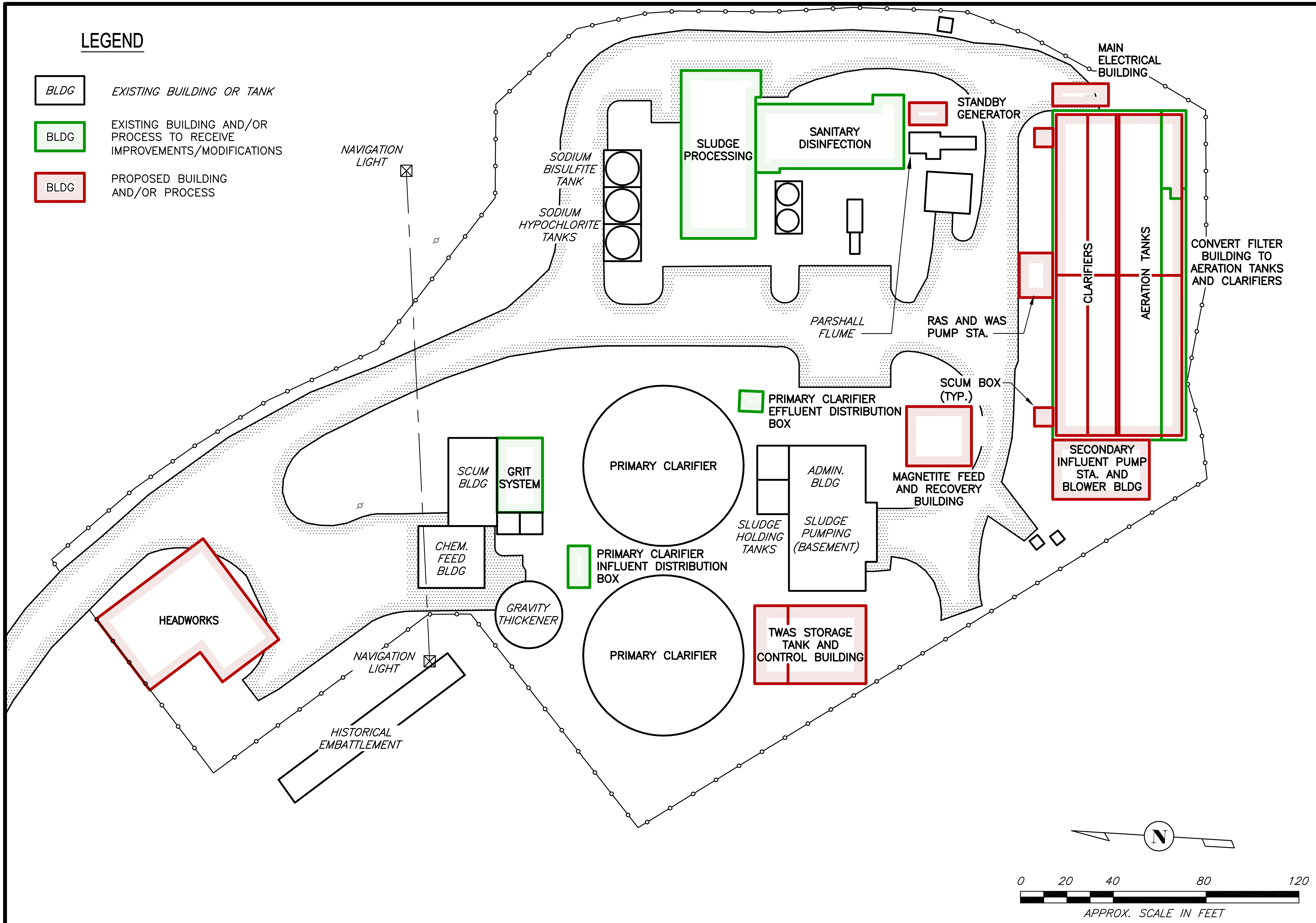
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

CAS WTIH BIOMAG
CONVENTIONAL SECONDARY TREATMENT

OPTION 3
FIG. 3-CST-PL

PROCESS LAYOUT

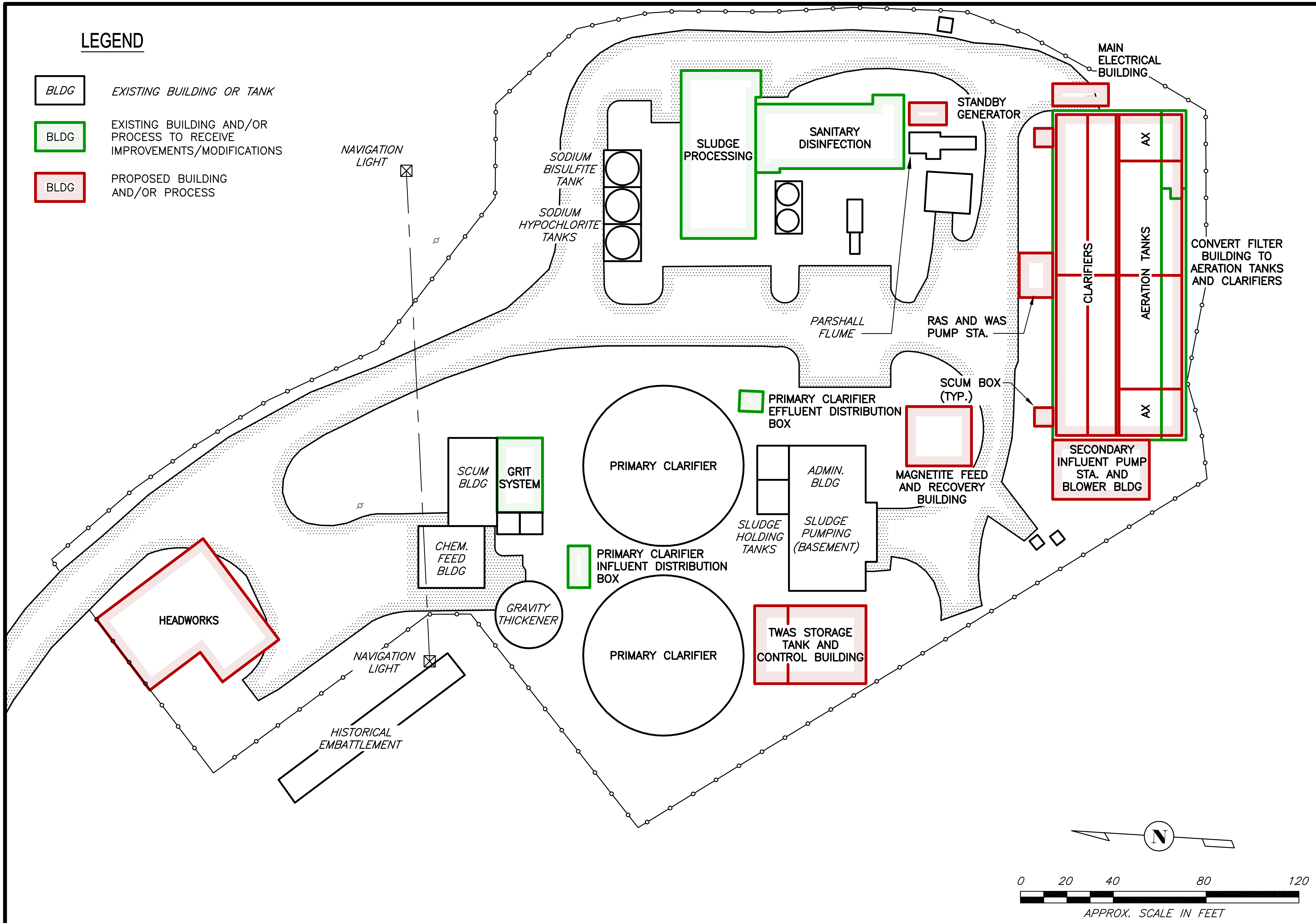


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
CAS WTIH BIOMAG
CONVENTIONAL SECONDARY TREATMENT

OPTION 3
FIG. 3-CST-SL

SITE LAYOUT

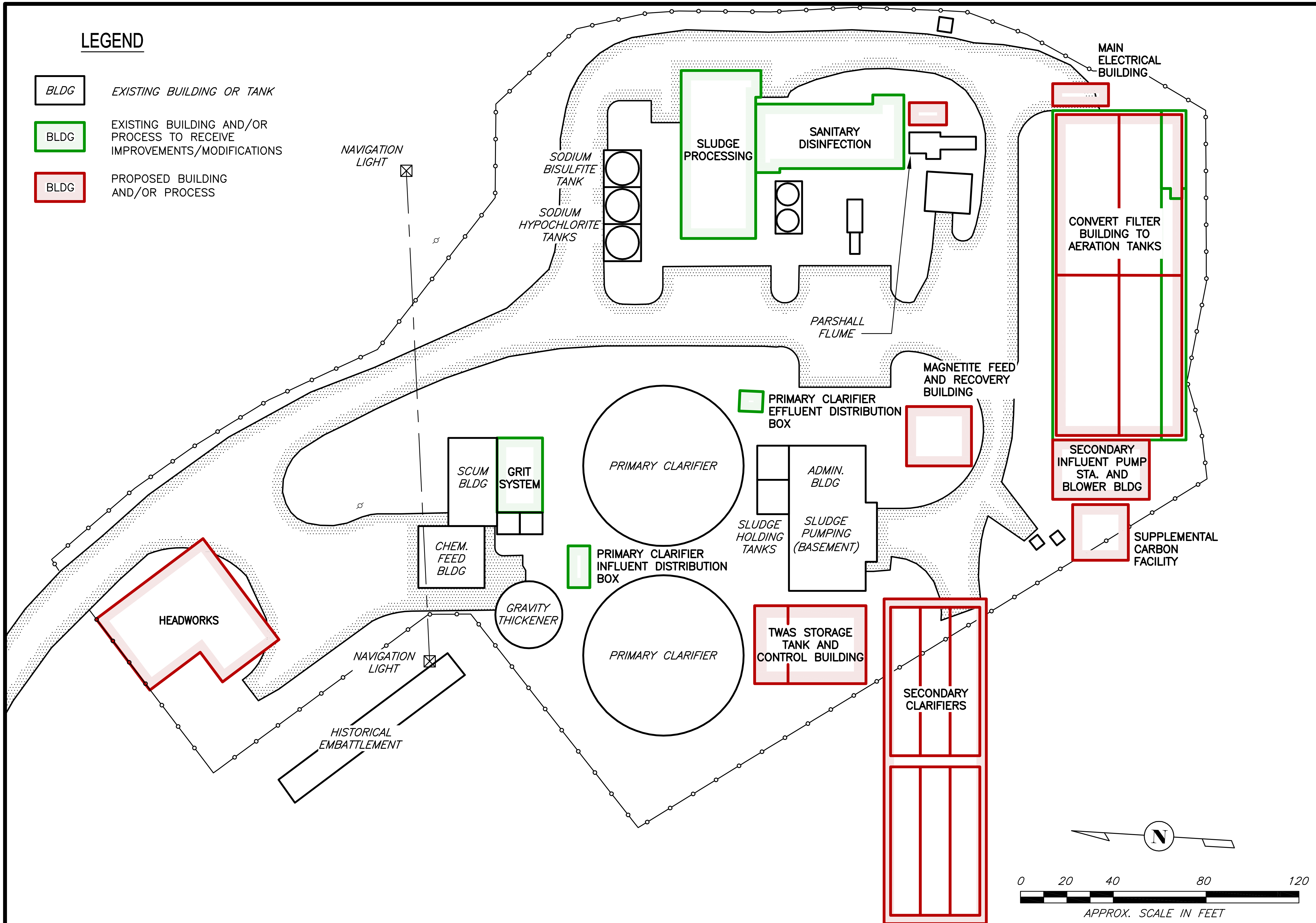


701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
CAS WTIH BIOMAG
TOTAL NITROGEN < 8 Mg/L

OPTION 3
FIG. 3-TN8-SL

SITE LAYOUT

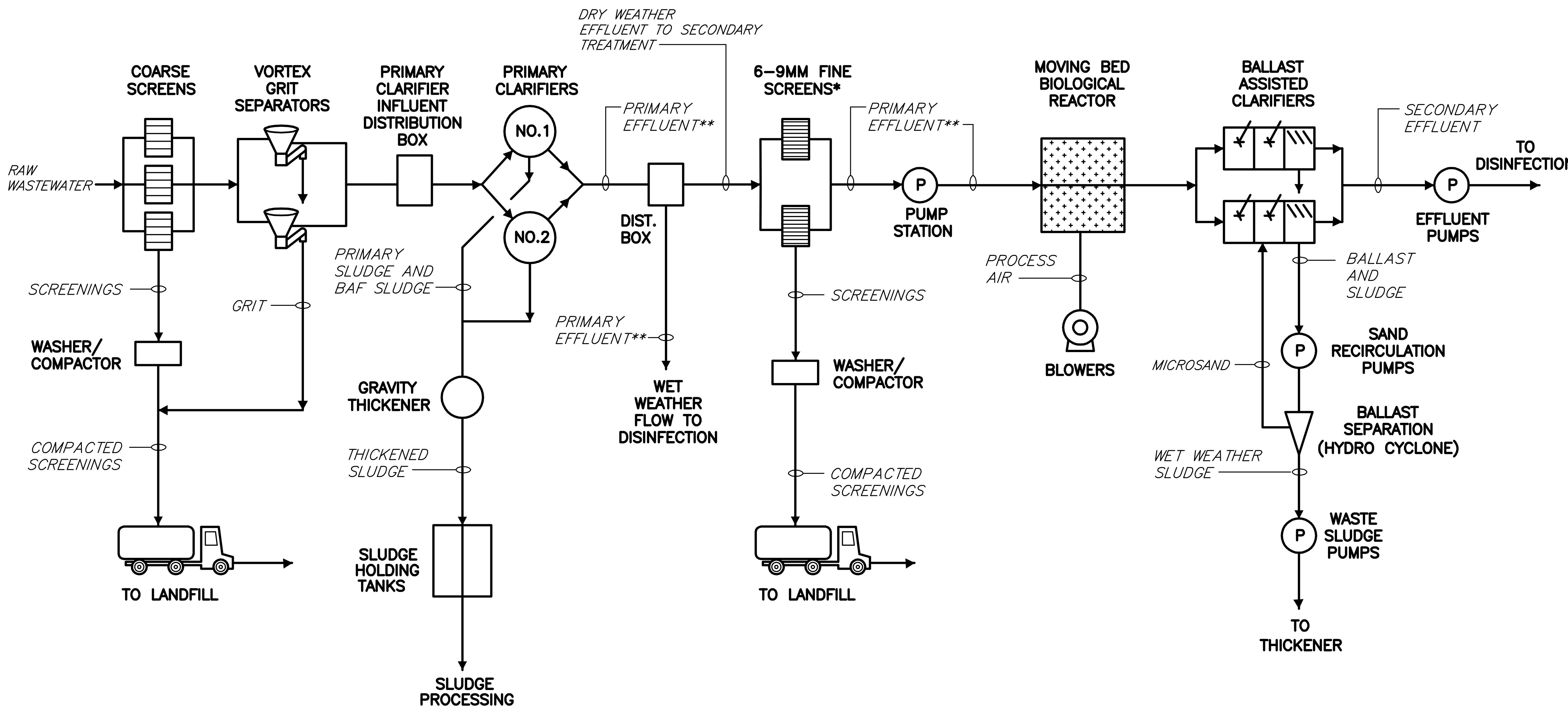


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
CAS WTIH BIOMAG
TOTAL NITROGEN < 5/3 Mg/L

OPTION 3
FIG. 3-TN53-SL

SITE LAYOUT



* SOME MANUFACTURERS MAY NOT REQUIRE SCREENS BEFORE MBBR IF PRIMARY CLARIFICATION IS PROVIDED.

** DURING WET WEATHER EVENTS, CLARIFIERS MAY BE OPERATED IN CHEMICALLY ENHANCED MODE.

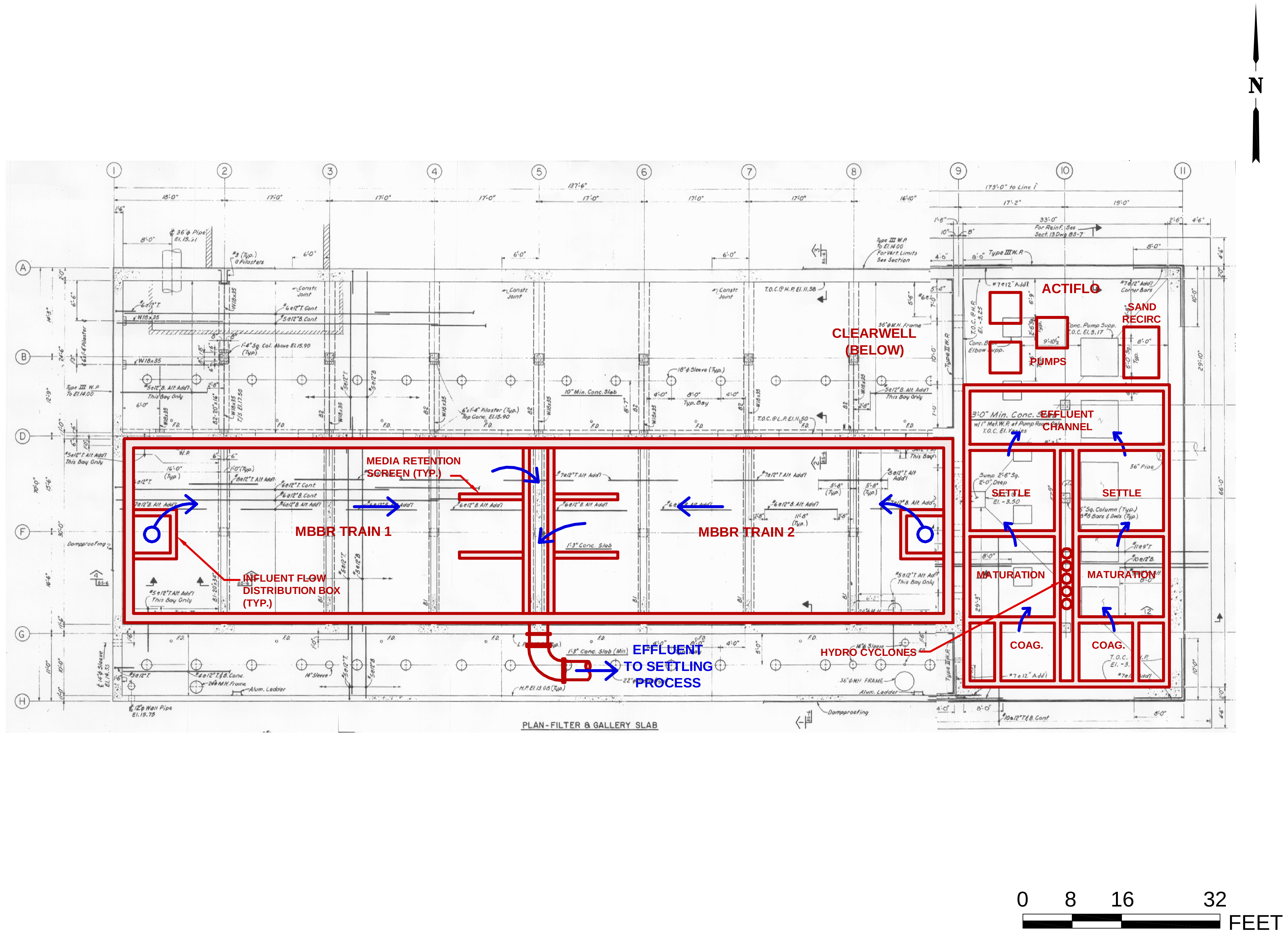
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

MBBR WITH ACTIFLO
CONVENTIONAL SECONDARY TREATMENT

OPTION 4
FIG. 4-CST-PFS

PROCESS FLOW SCHEMATIC



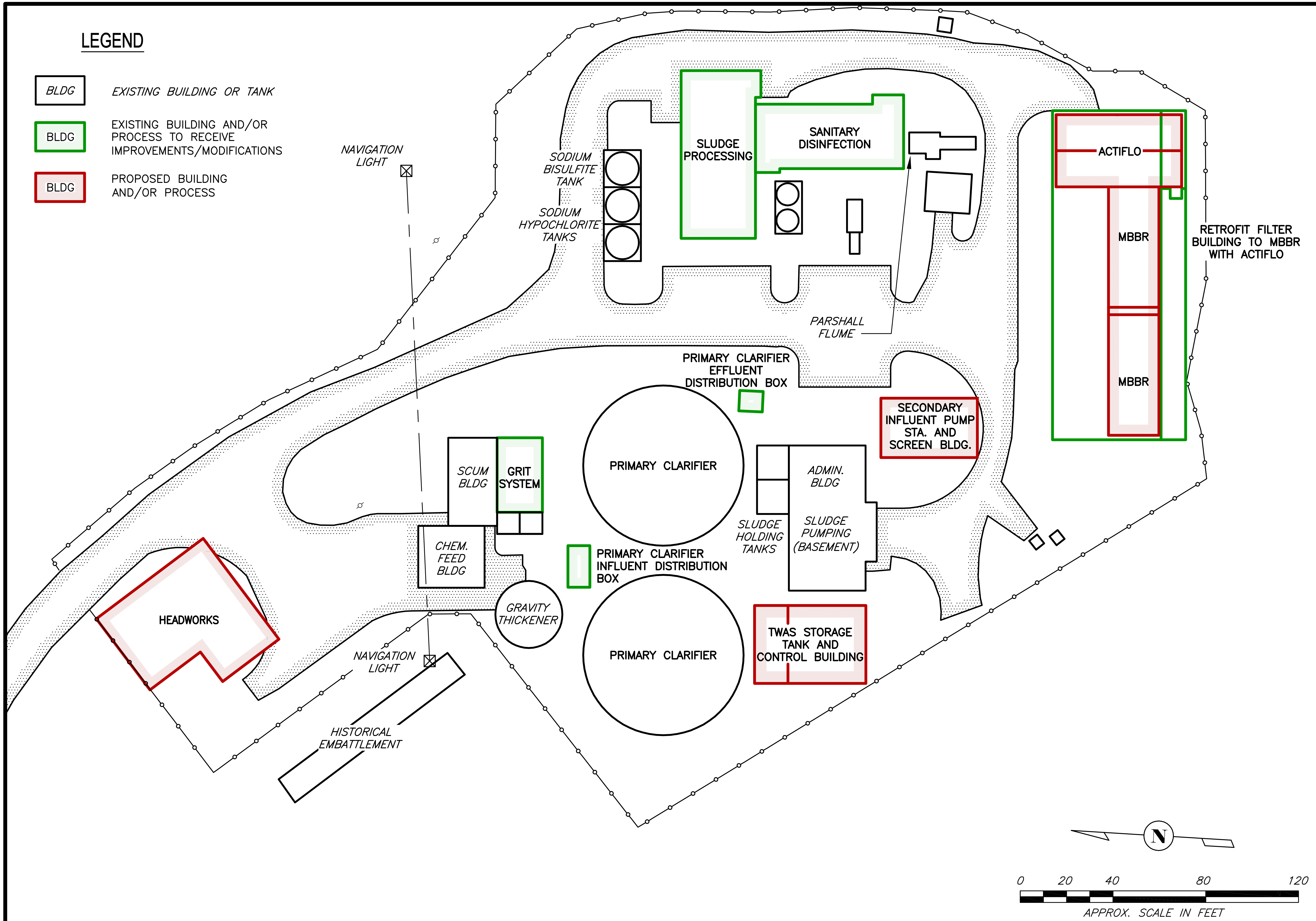
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

MBBR WITH ACTIFLO
CONVENTIONAL SECONDARY TREATMENT

OPTION 4
FIG. 4-CST-PL

PROCESS LAYOUT

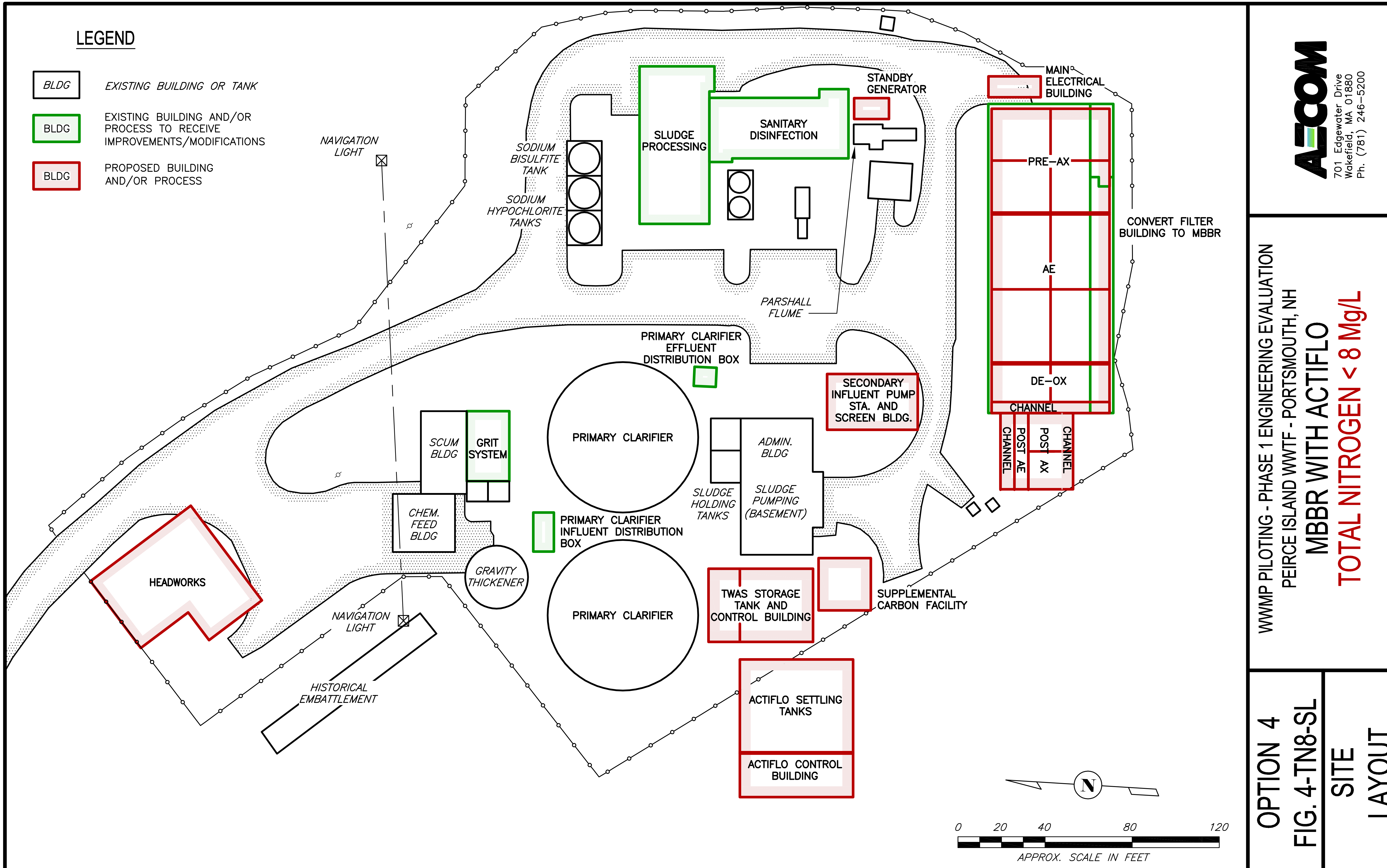


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

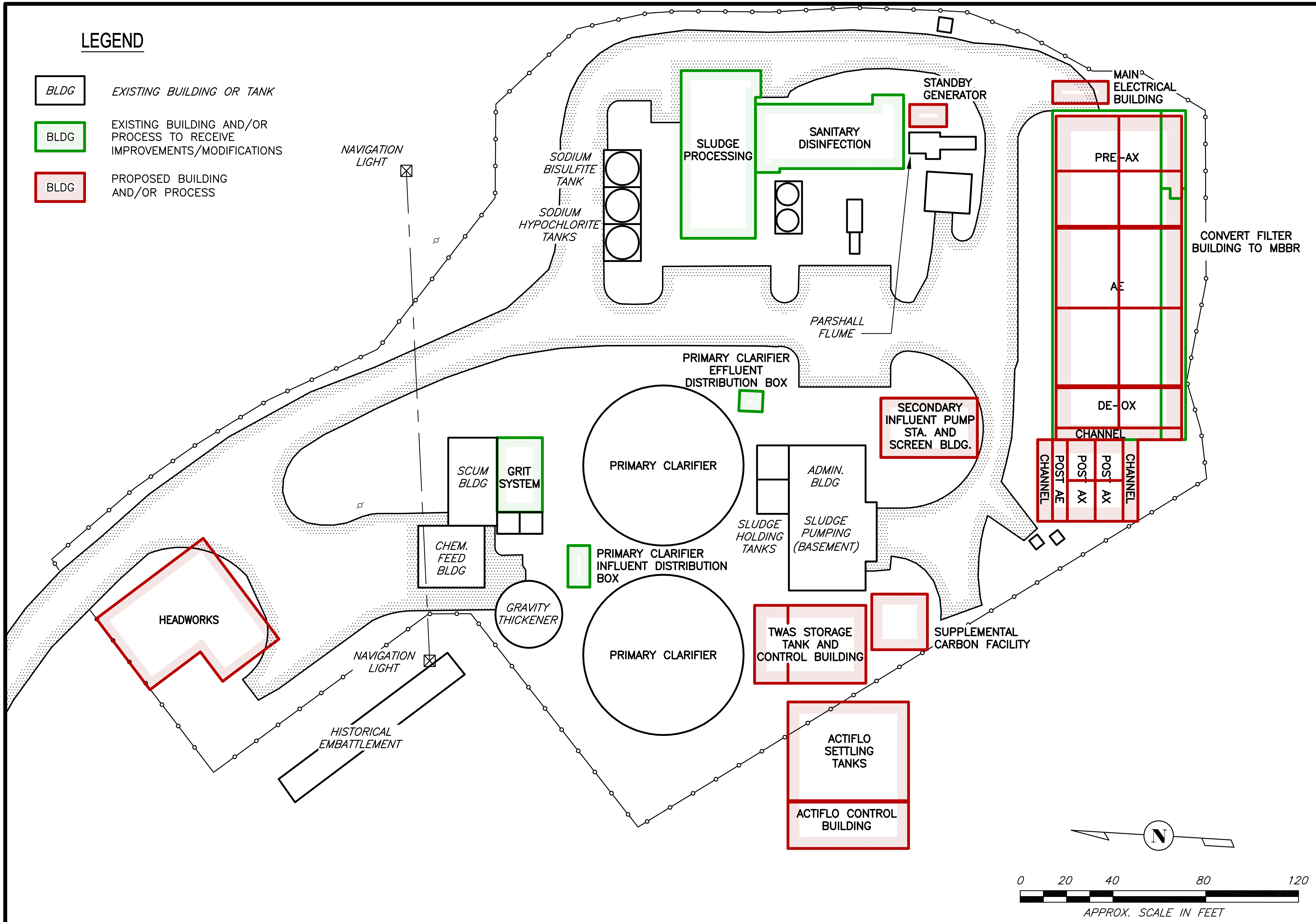
WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
MBBR WITH ACTIFLO
CONVENTIONAL SECONDARY TREATMENT

OPTION 4
FIG. 4-CST-SL

SITE LAYOUT



LEGEND
BLDG
EXISTING BUILDING OR TANK
BLDG
EXISTING BUILDING AND/OR PROCESS TO RECEIVE IMPROVEMENTS/MODIFICATIONS
BLDG
PROPOSED BUILDING AND/OR PROCESS
NAVIGATION LIGHT
SODIUM BISULFITE TANK
SODIUM HYPOCHLORITE TANKS
SLUDGE PROCESSING
SANITARY DISINFECTION
STANDBY GENERATOR
MAIN ELECTRICAL BUILDING
PRE-AX
AE
DE-OX
CHANNEL
CHANNEL
POST AE
POST AX
CHANNEL
CONVERT FILTER BUILDING TO MBBR
PARSHALL FLUME
PRIMARY CLARIFIER EFFLUENT DISTRIBUTION BOX
SECONDARY INFLUENT PUMP STA. AND SCREEN BLDG.
SCUM BLDG
GRIT SYSTEM
PRIMARY CLARIFIER
ADMIN. BLDG
SLUDGE PUMPING (BASEMENT)
SLUDGE HOLDING TANKS
CHEM. FEED BLDG
PRIMARY CLARIFIER INFLUENT DISTRIBUTION BOX
GRAVITY THICKENER
PRIMARY CLARIFIER
TWAS STORAGE TANK AND CONTROL BUILDING
SUPPLEMENTAL CARBON FACILITY
HEADWORKS
NAVIGATION LIGHT
HISTORICAL EMBATTLEMENT
ACTIFLO SETTLING TANKS
ACTIFLO CONTROL BUILDING
N
0 20 40 80 120
APPROX. SCALE IN FEET
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200
WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
MBBR WITH ACTIFLO
TOTAL NITROGEN < 8 Mg/L
OPTION 4
FIG. 4-TN8-SL
SITE LAYOUT



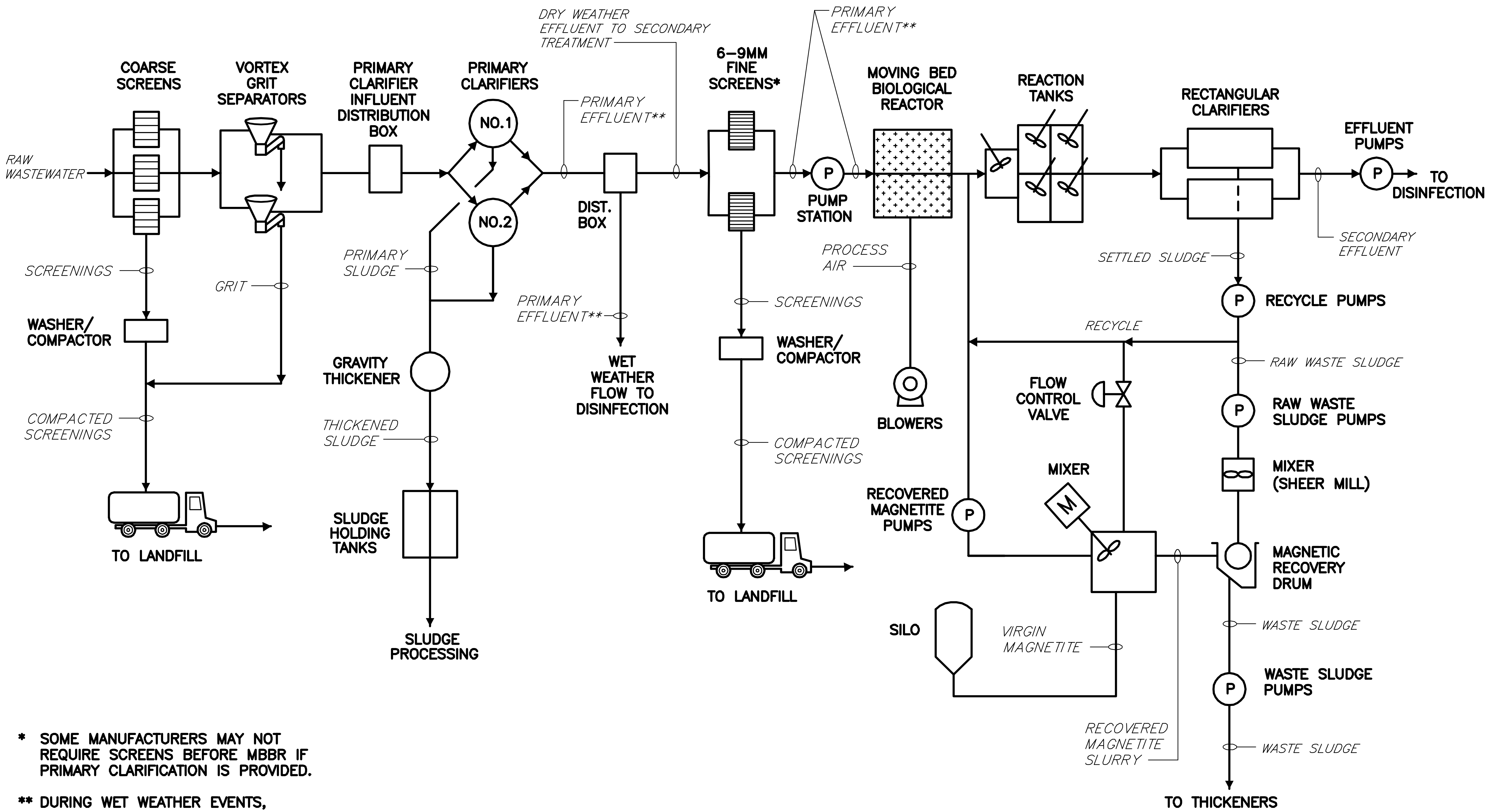
AECOM

701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
MBBR WITH ACTIFLO
TOTAL NITROGEN < 5/3 Mg/L

OPTION 4
FIG. 4-TN53-SL

SITE LAYOUT



* SOME MANUFACTURERS MAY NOT REQUIRE SCREENS BEFORE MBBR IF PRIMARY CLARIFICATION IS PROVIDED.

** DURING WET WEATHER EVENTS, CLARIFIERS MAY BE OPERATED IN CHEMICALLY ENHANCED MODE.

AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

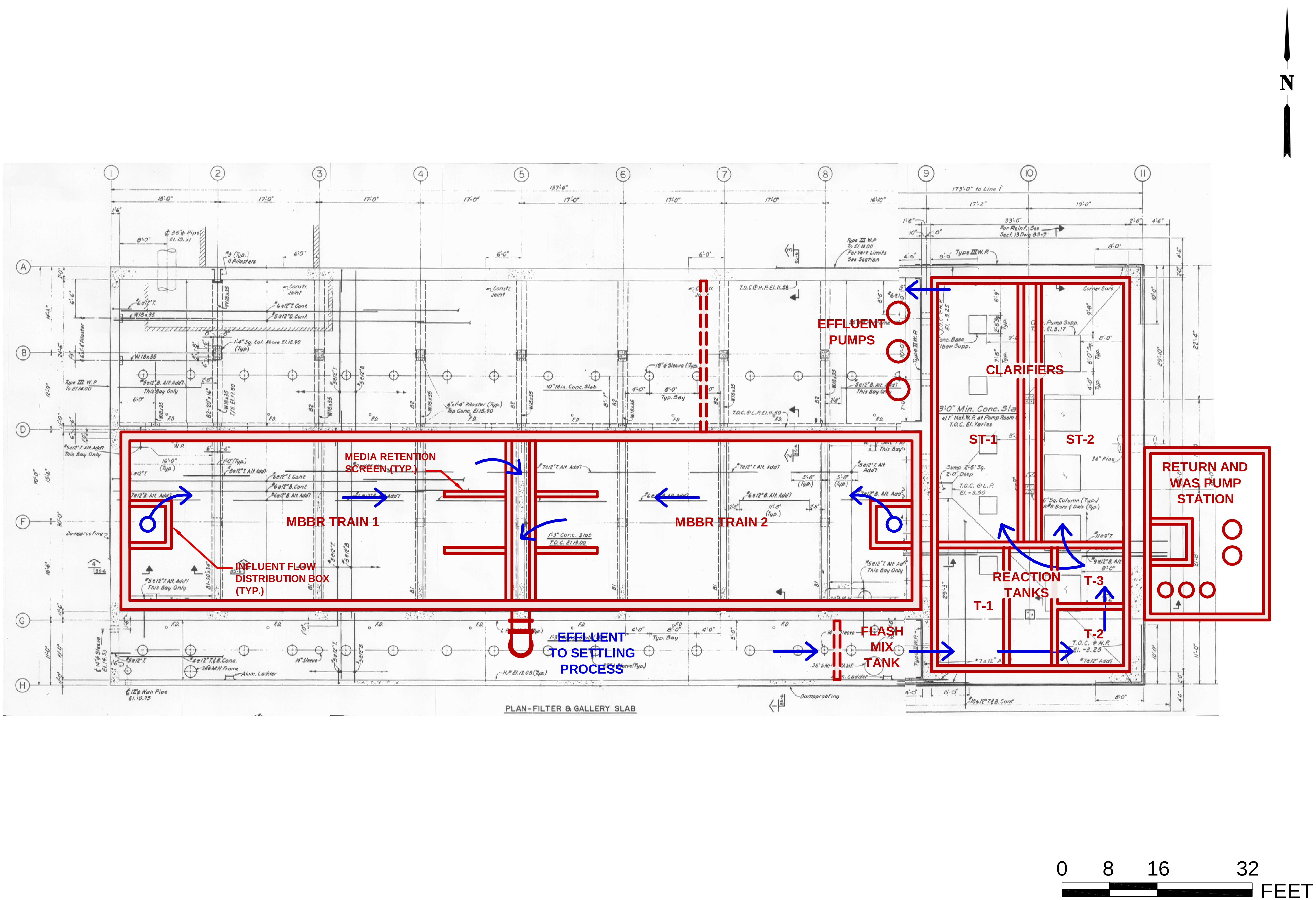
WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

MBBR WITH COMAG CONVENTIONAL SECONDARY TREATMENT

OPTION 5

FIG. 5-CST-PFS

PROCESS FLOW SCHEMATIC



AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

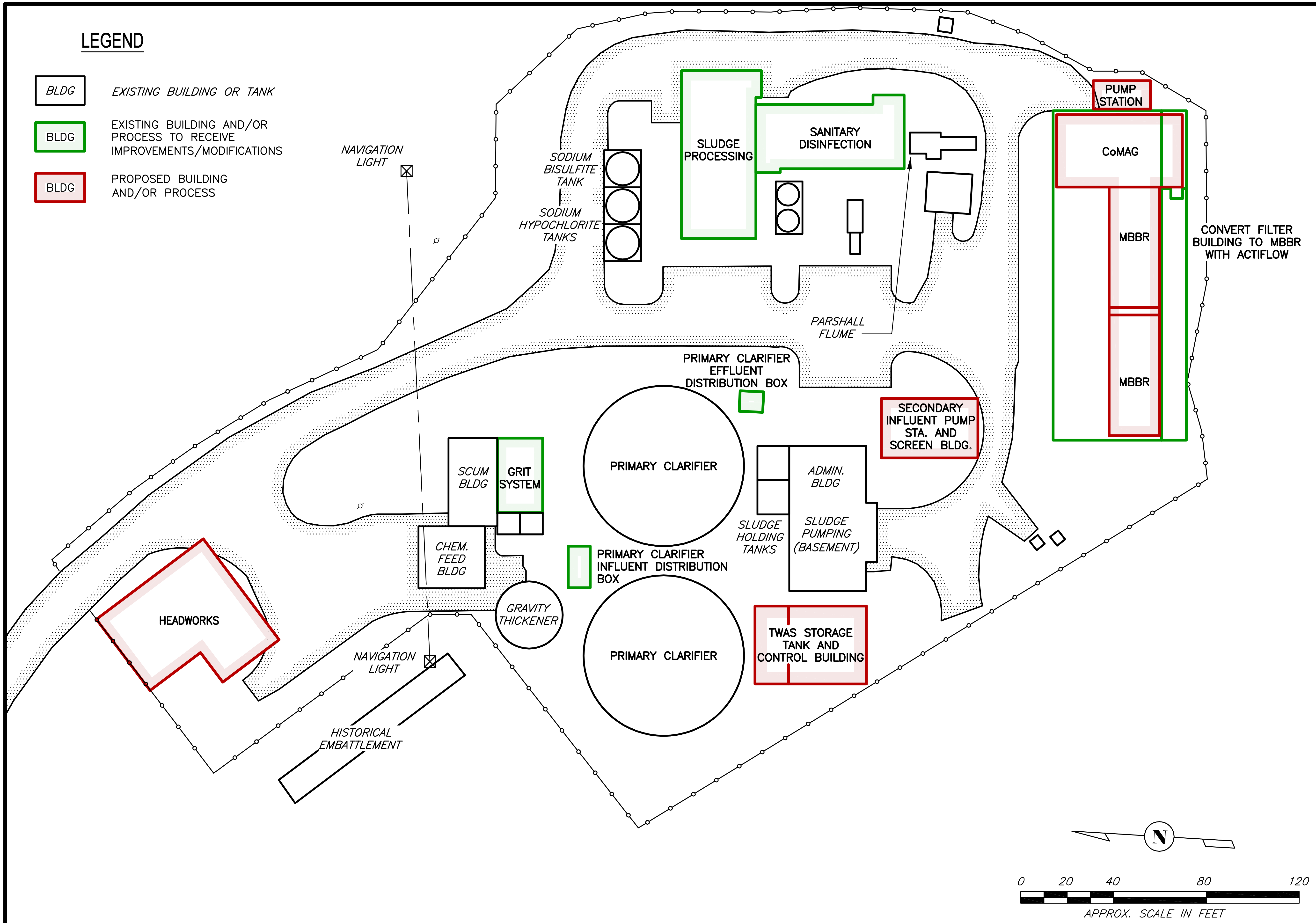
MBBR WITH CoMAG

CONVENTIONAL SECONDARY TREATMENT

OPTION 5

FIG. 5-CST-PL

PROCESS LAYOUT

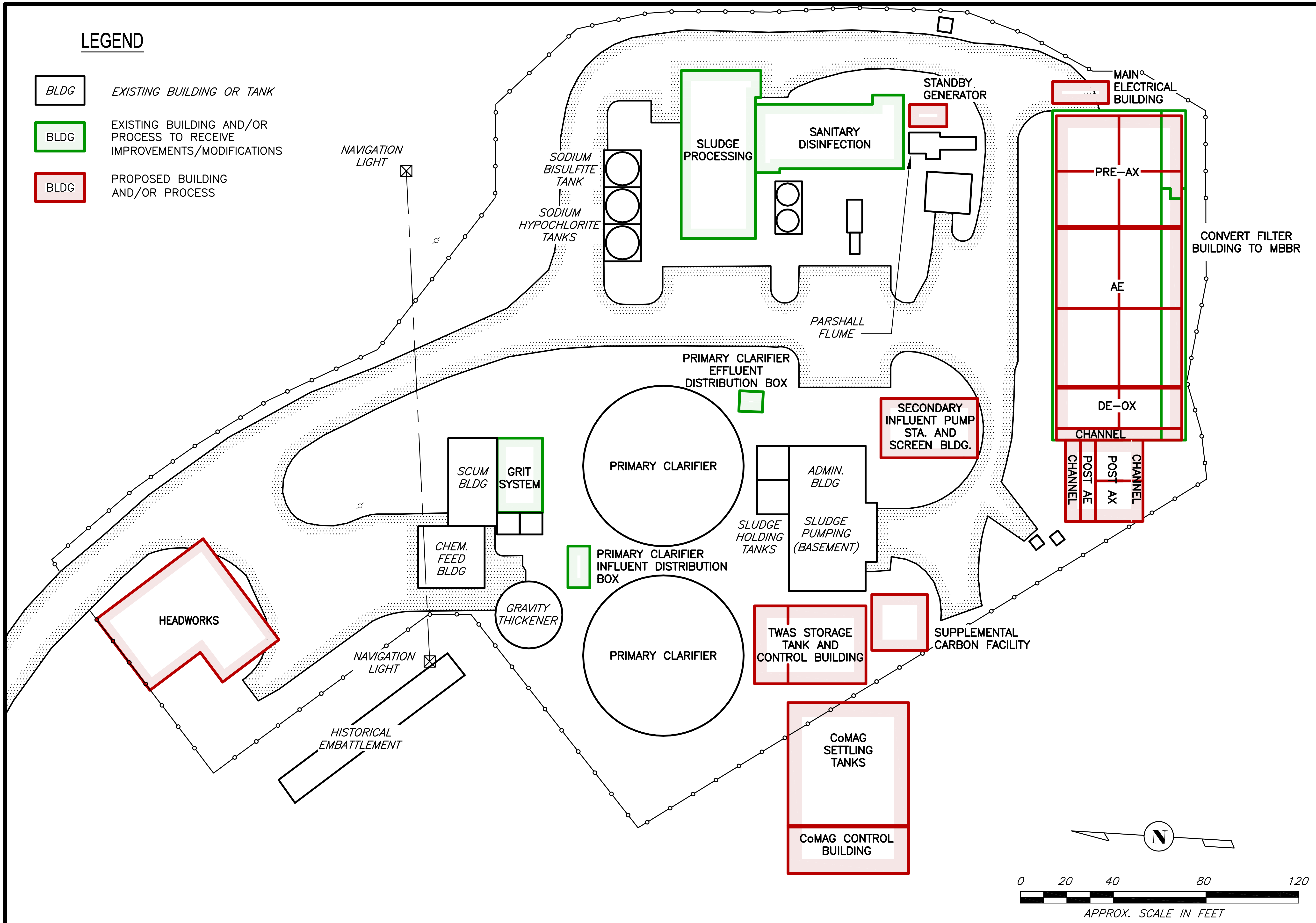


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
MBBR WITH CoMAG
CONVENTIONAL SECONDARY TREATMENT

OPTION 5
FIG. 5-CST-SL

SITE LAYOUT

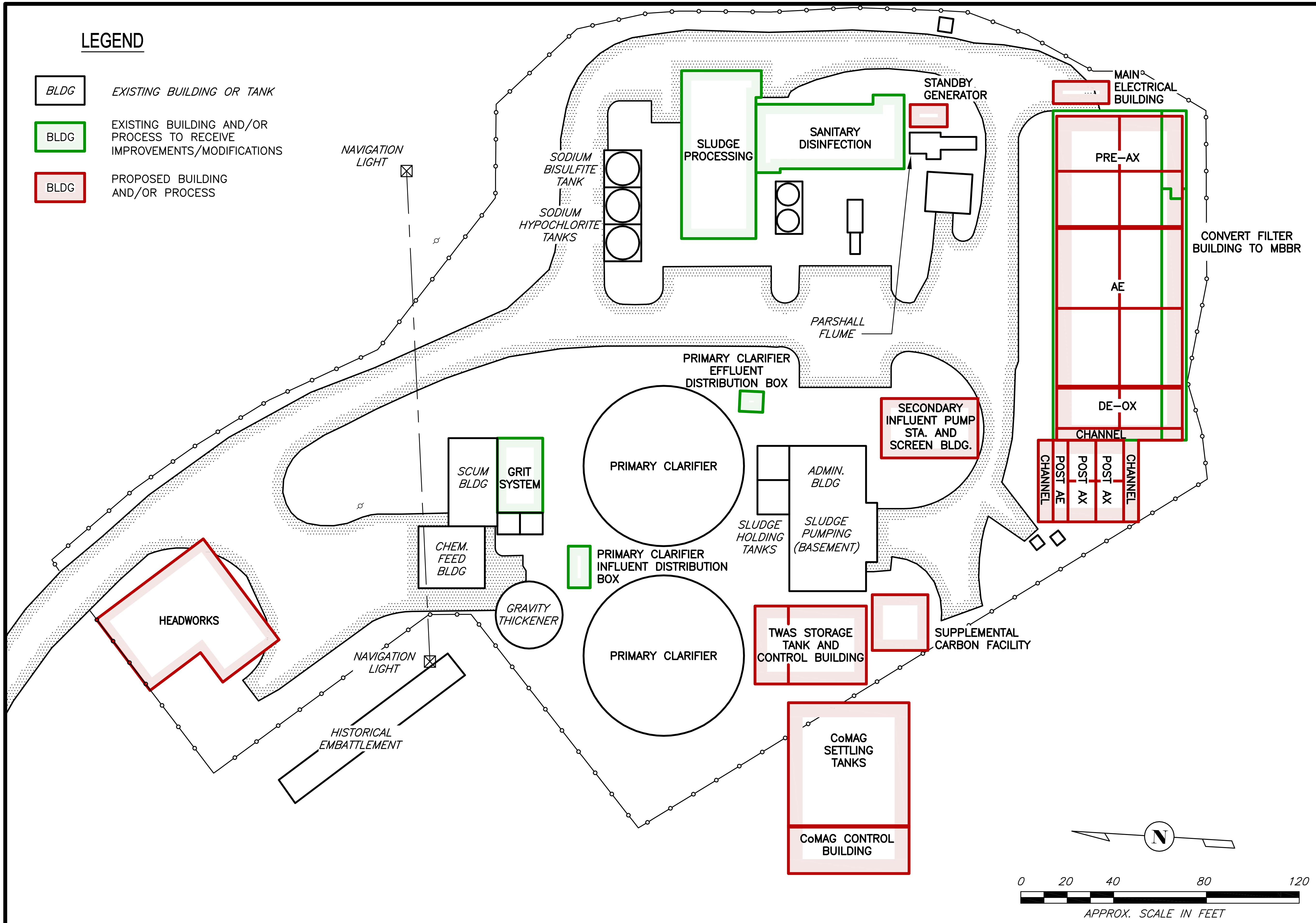


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
MBBR WITH CoMAG
TOTAL NITROGEN < 8 Mg/L

OPTION 5
FIG. 5-TN8-SL

SITE LAYOUT

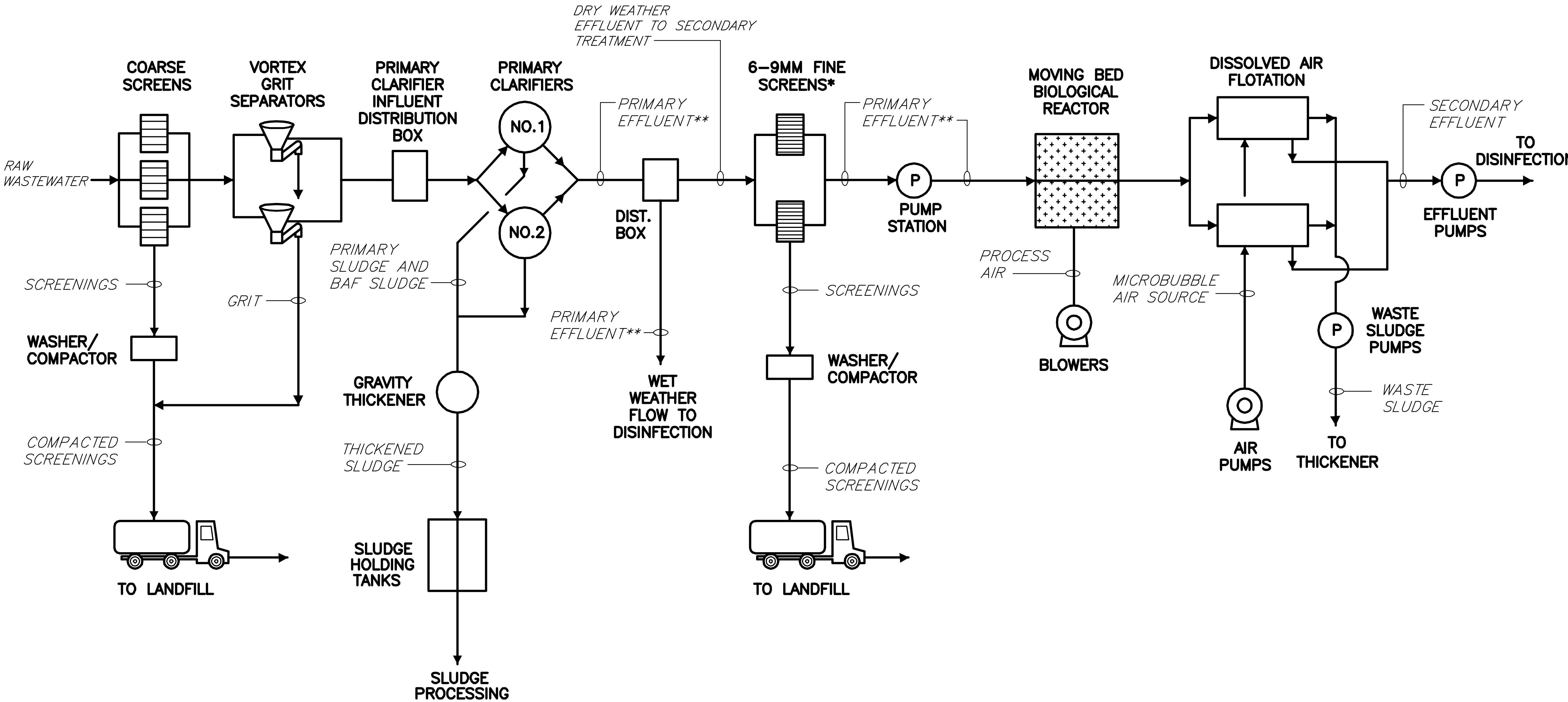


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
MBBR WITH CoMAG
TOTAL NITROGEN < 5/3 Mg/L

OPTION 5
FIG. 5-TN53-SL

SITE LAYOUT



* SOME MANUFACTURERS MAY NOT REQUIRE SCREENS BEFORE MBBR IF PRIMARY CLARIFICATION IS PROVIDED

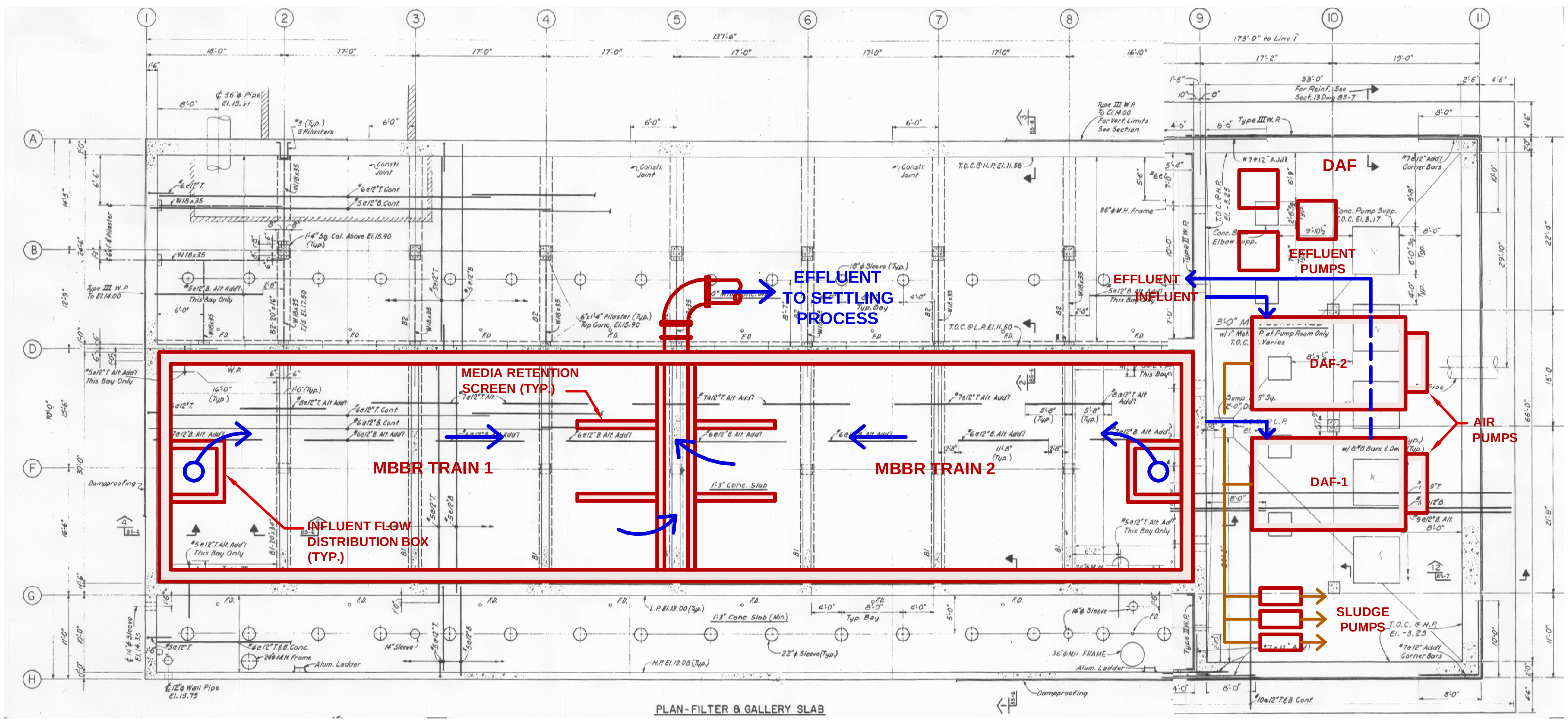
** DURING WET WEATHER EVENTS, CLARIFIERS MAY BE OPERATED IN CHEMICALLY ENHANCED MODE.

AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

MBBR WITH DAF
CONVENTIONAL SECONDARY TREATMENT

OPTION 6
FIG. 6-CST-PFS
PROCESS FLOW SCHEMATIC



N

0 8 16 32
FEET

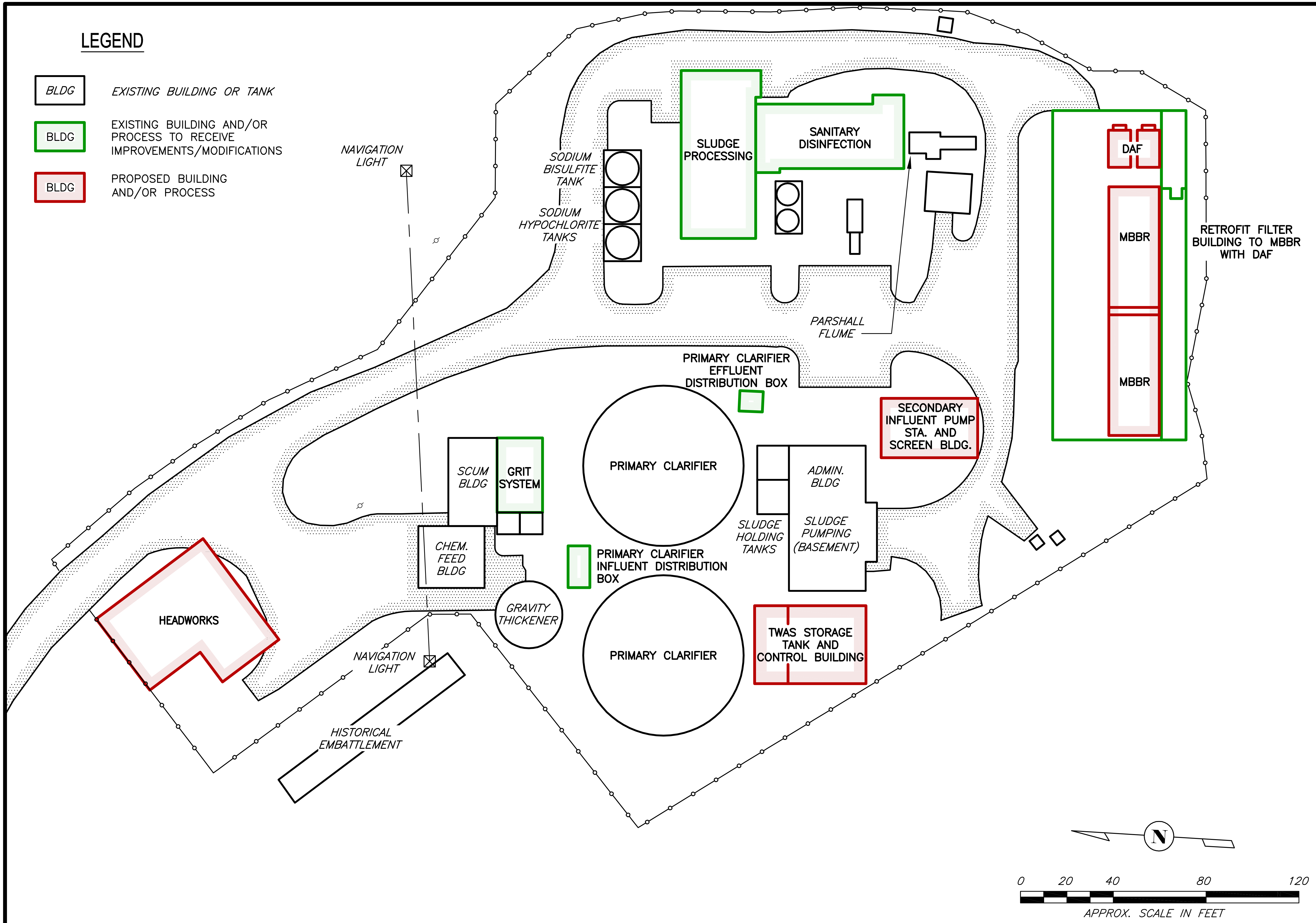
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

MBBR WITH DAF
CONVENTIONAL SECONDARY TREATMENT

OPTION 6
FIG. 6-CST-PL

PROCESS LAYOUT



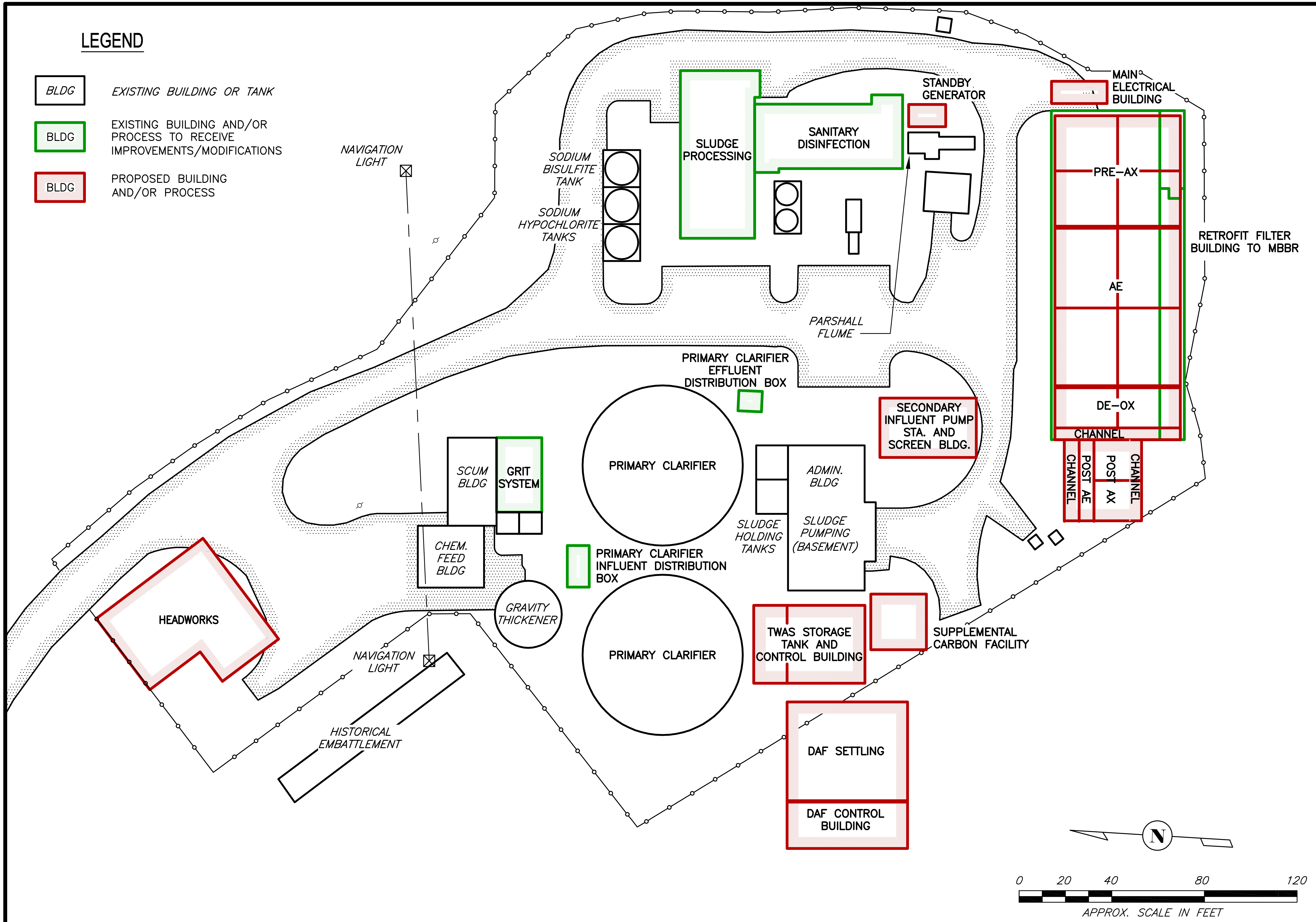
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

MBBR WITH DAF
CONVENTIONAL SECONDARY TREATMENT

OPTION 6
FIG. 6-CST-SL

SITE LAYOUT

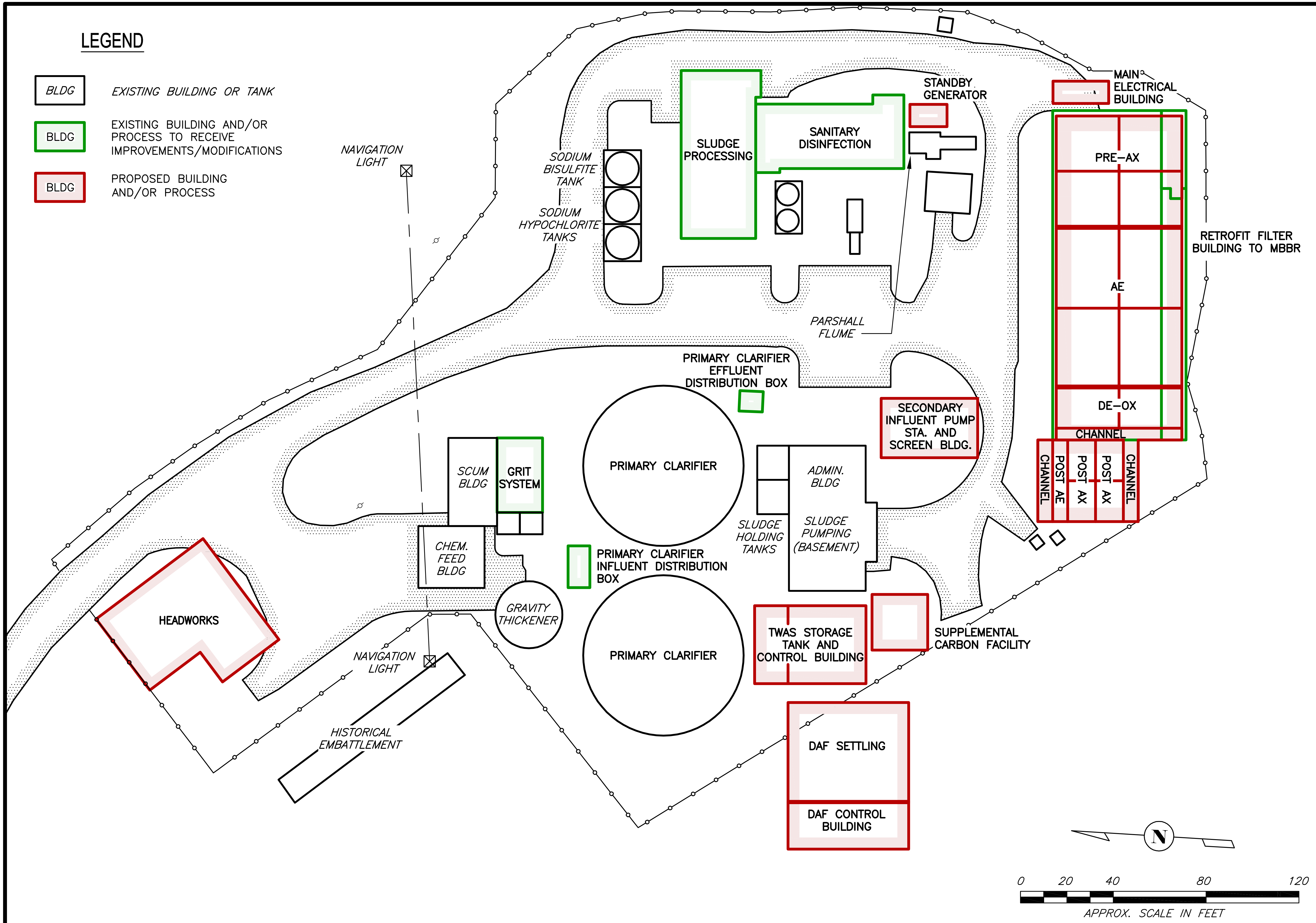


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
MBBR WITH DAF
TOTAL NITROGEN < 8 Mg/L

OPTION 6
FIG. 6-TN8-SL

SITE LAYOUT

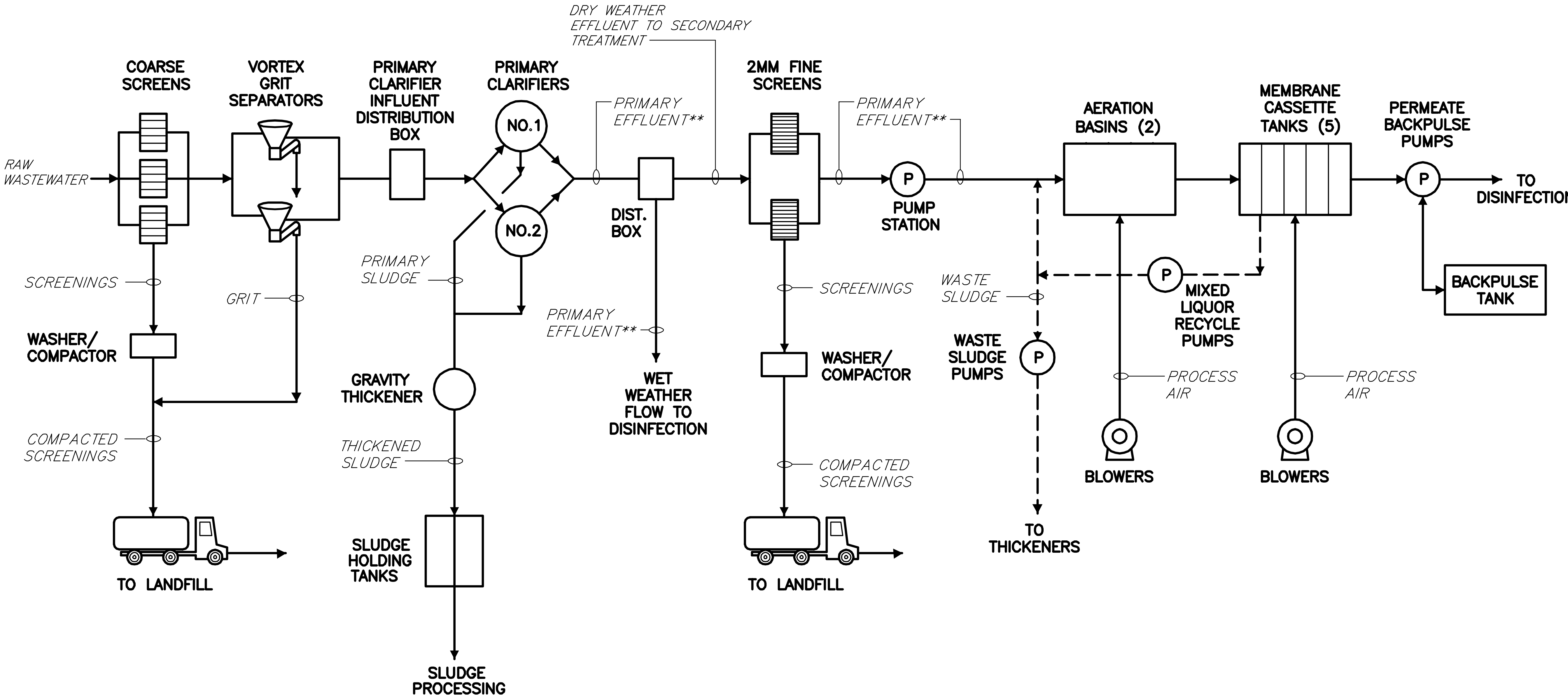


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246–5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
MBBR WITH DAF
TOTAL NITROGEN < 5/3 Mg/L

OPTION 6
FIG. 6-TN53-SL

SITE LAYOUT



** DURING WET WEATHER EVENTS, CLARIFIERS MAY BE OPERATED IN CHEMICALLY ENHANCED MODE.

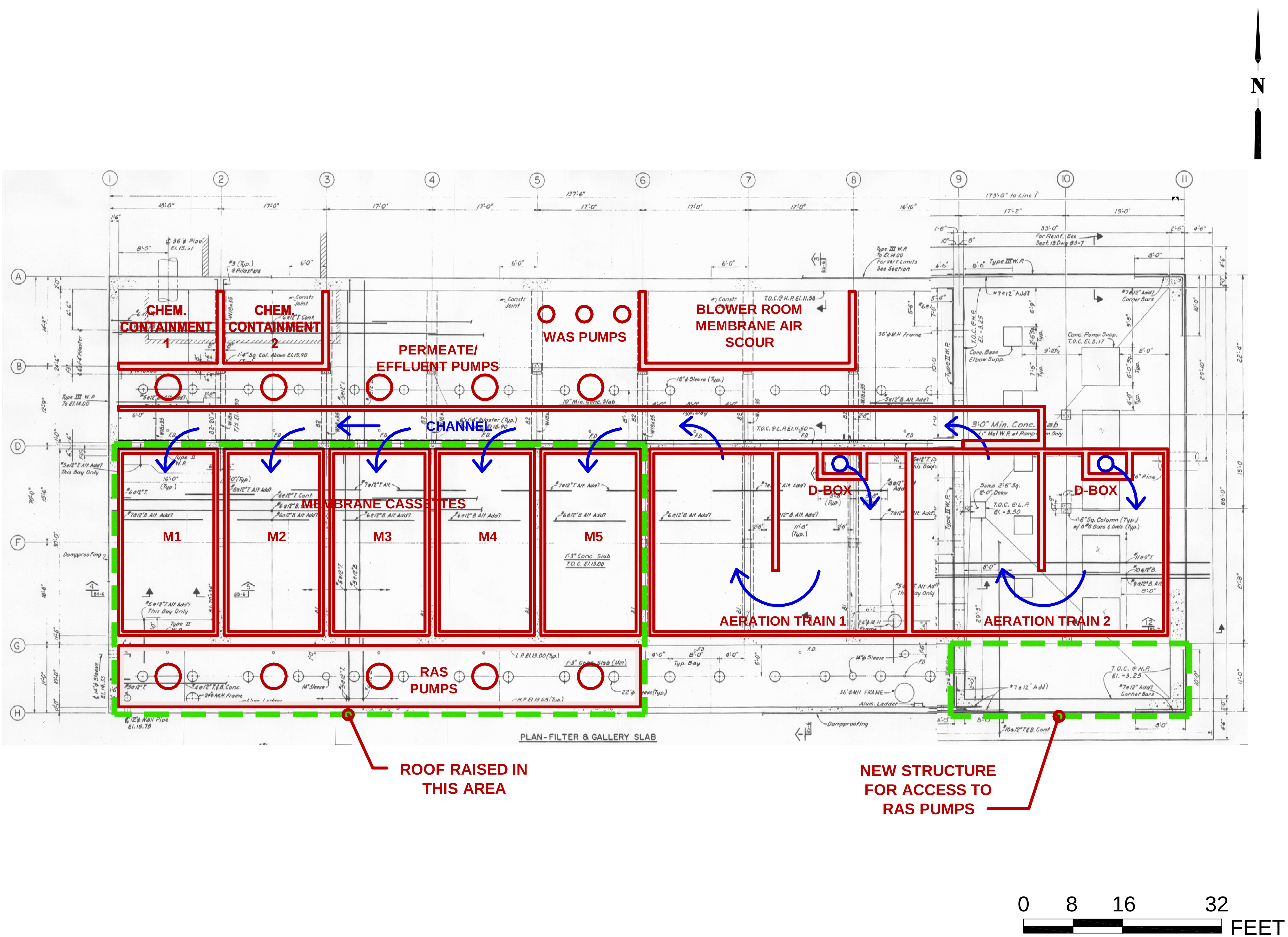
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

MBR
CONVENTIONAL SECONDARY TREATMENT

OPTION 7
FIG. 7-CST-PFS

PROCESS FLOW SCHEMATIC



AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

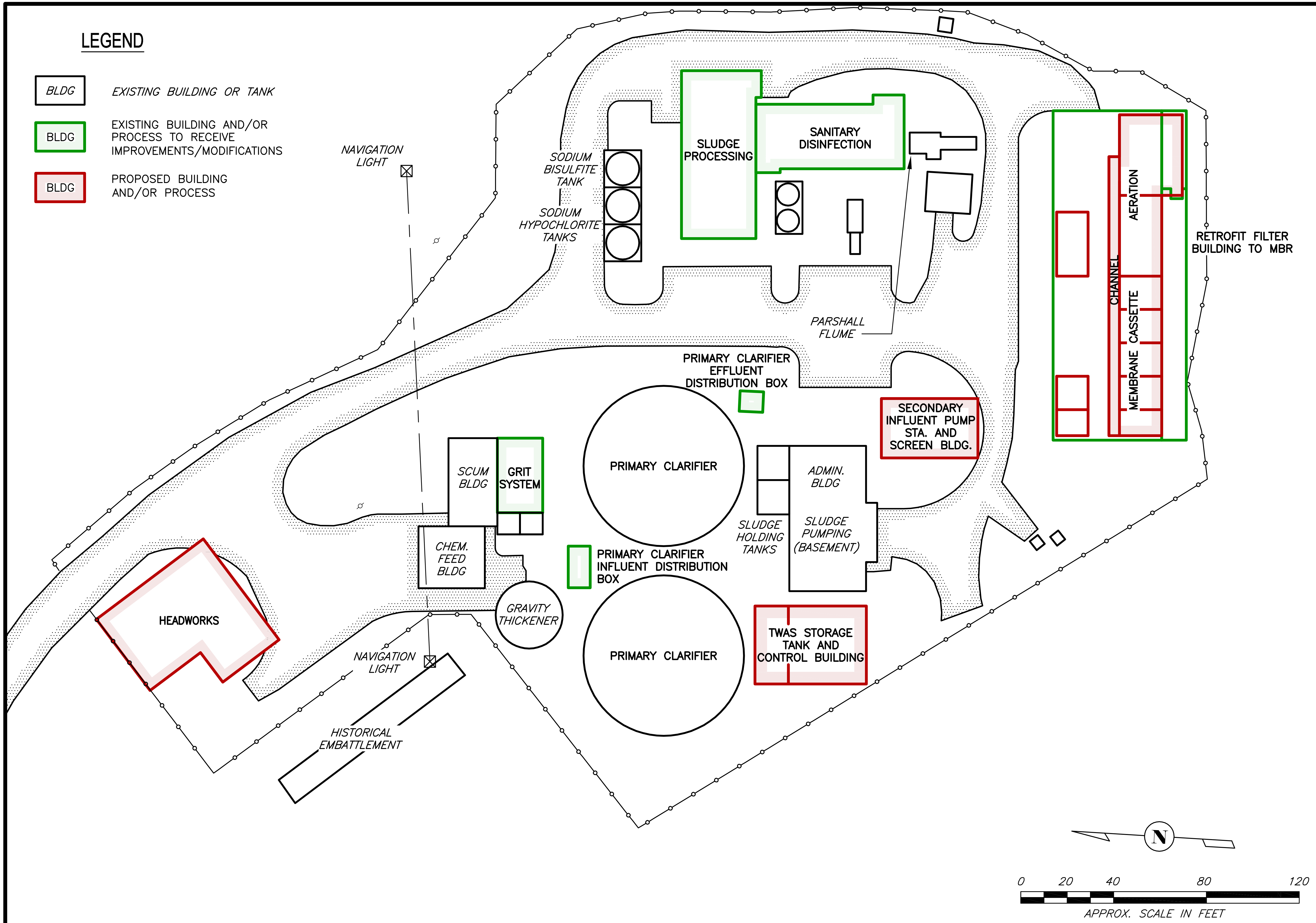
MBR

CONVENTIONAL SECONDARY TREATMENT

OPTION 7

FIG. 7-CST-PL

PROCESS LAYOUT



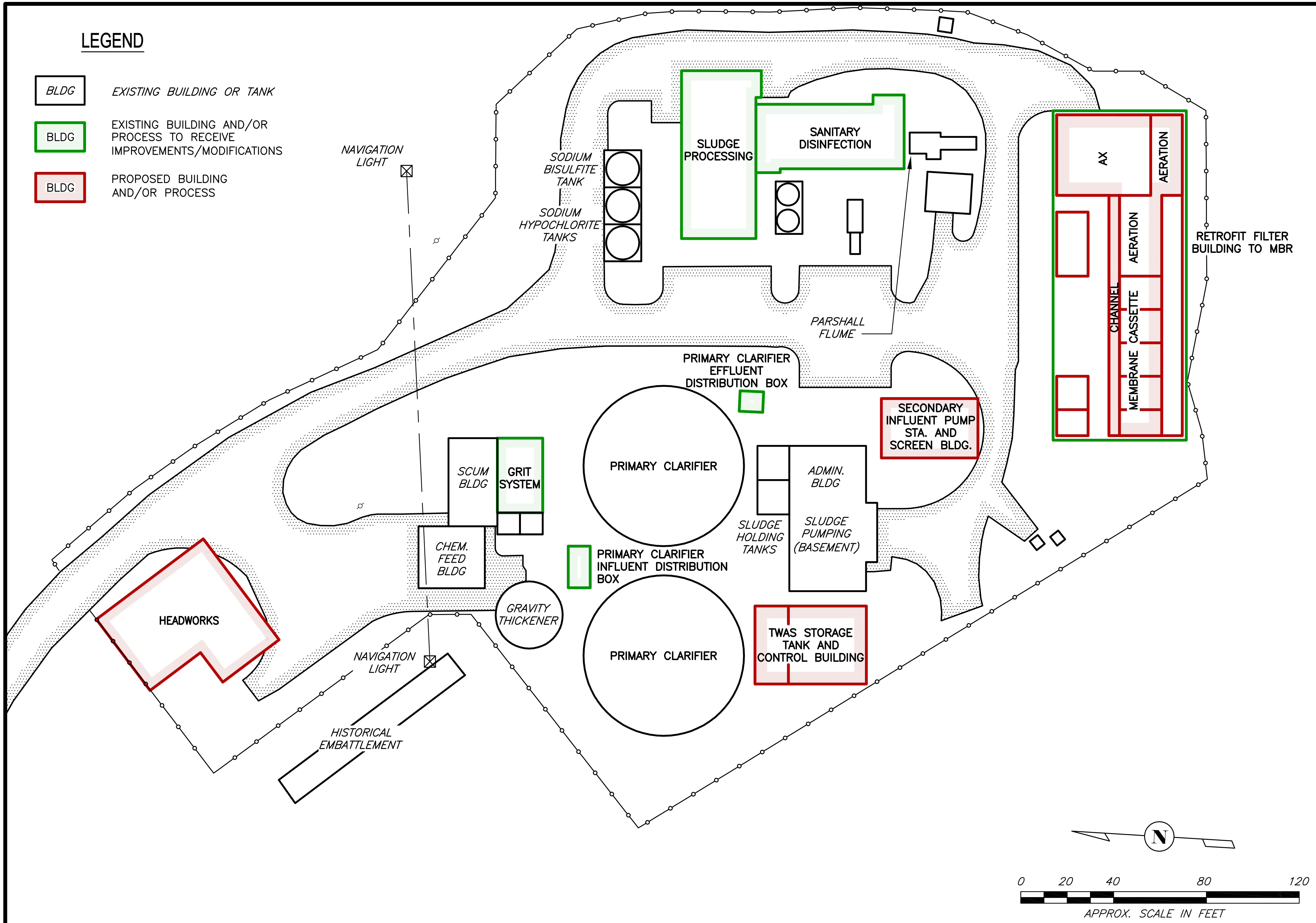
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

MBR
CONVENTIONAL SECONDARY TREATMENT

OPTION 7
FIG. 7-CST-SL

SITE LAYOUT



AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

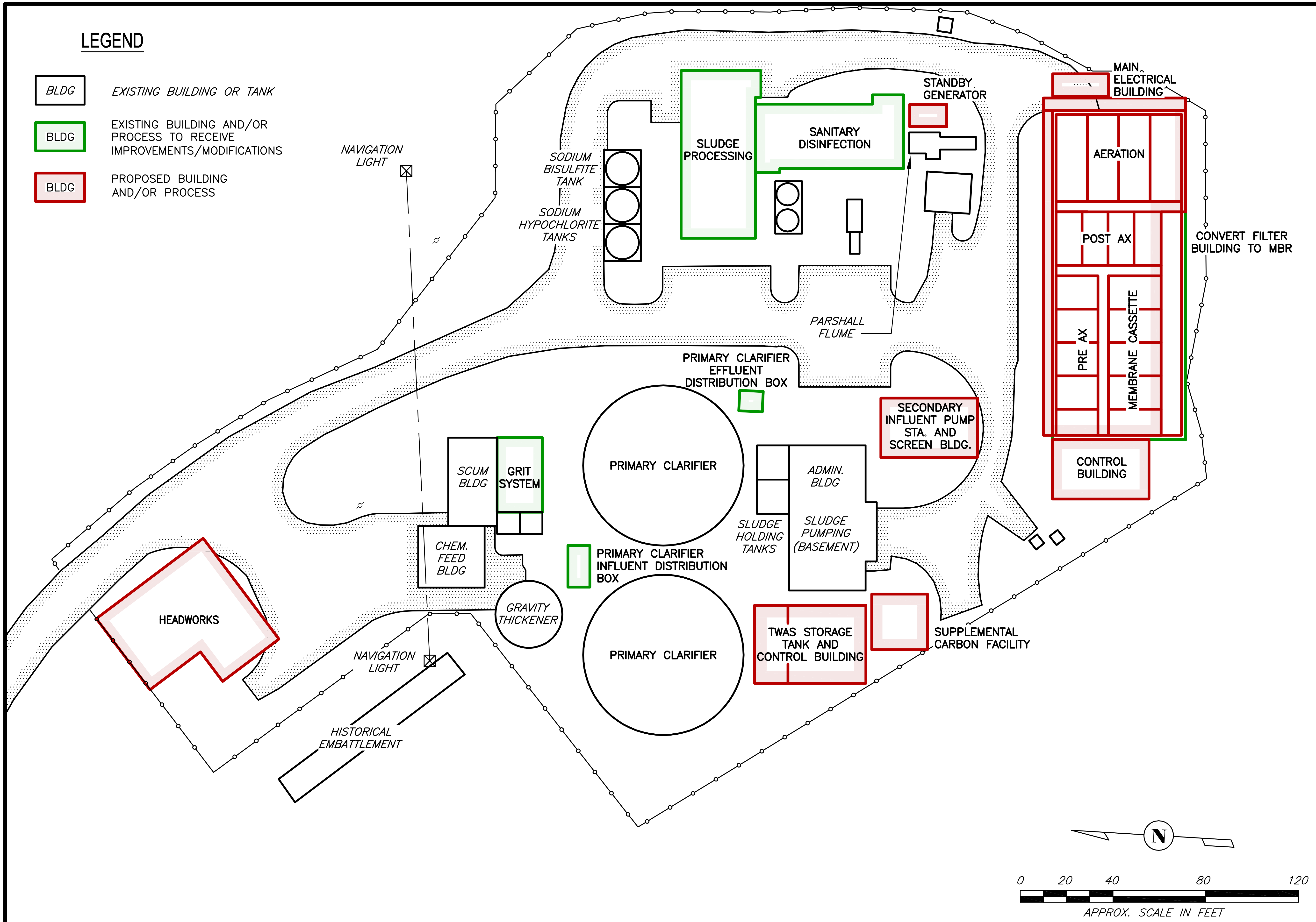
WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

MBR

TOTAL NITROGEN < 8 Mg/L

OPTION 7
FIG. 7-TN8-SL

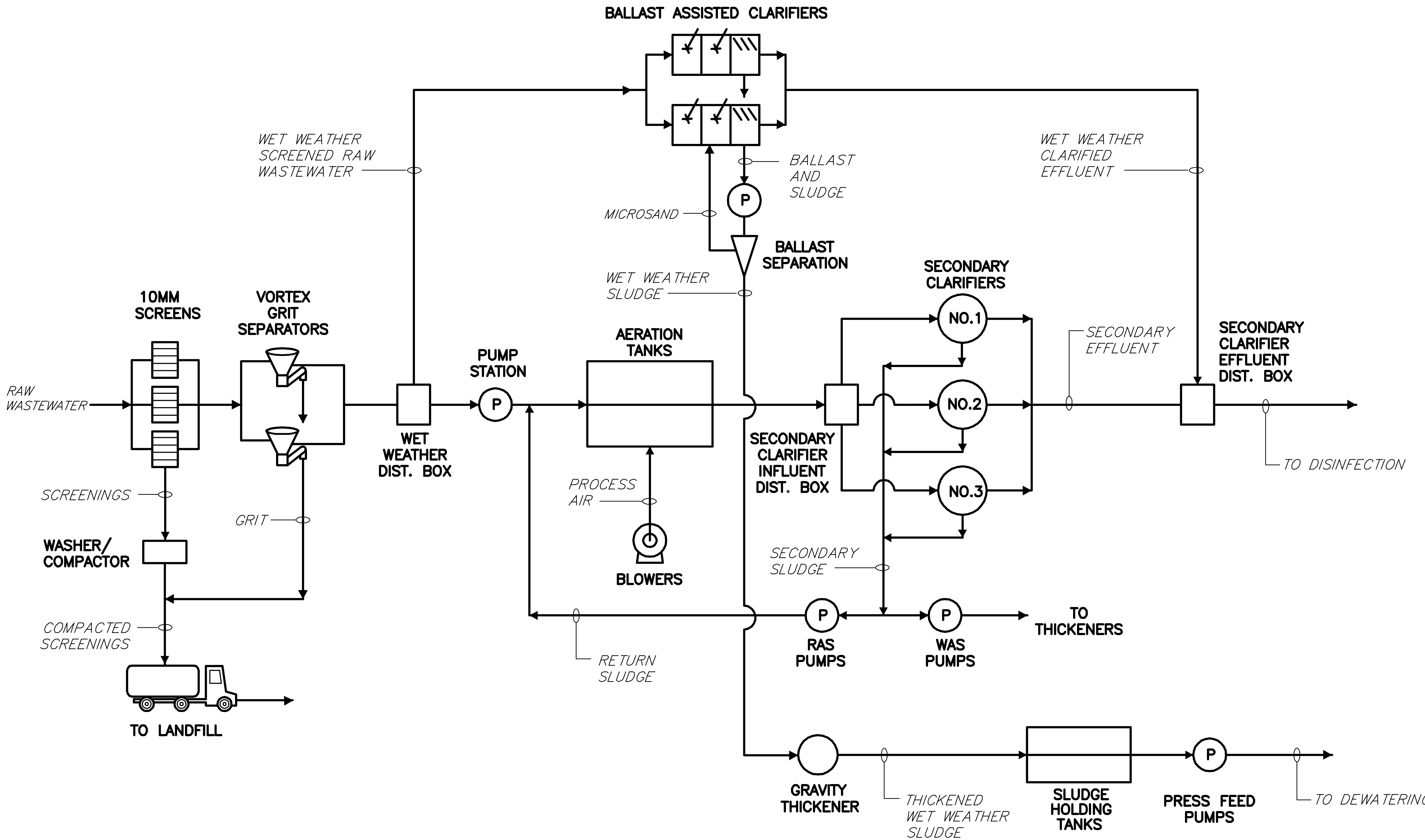
SITE LAYOUT



AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
MBR
TOTAL NITROGEN < 5/3 Mg/L

OPTION 7
FIG. 7-TN53-SL
SITE LAYOUT



701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

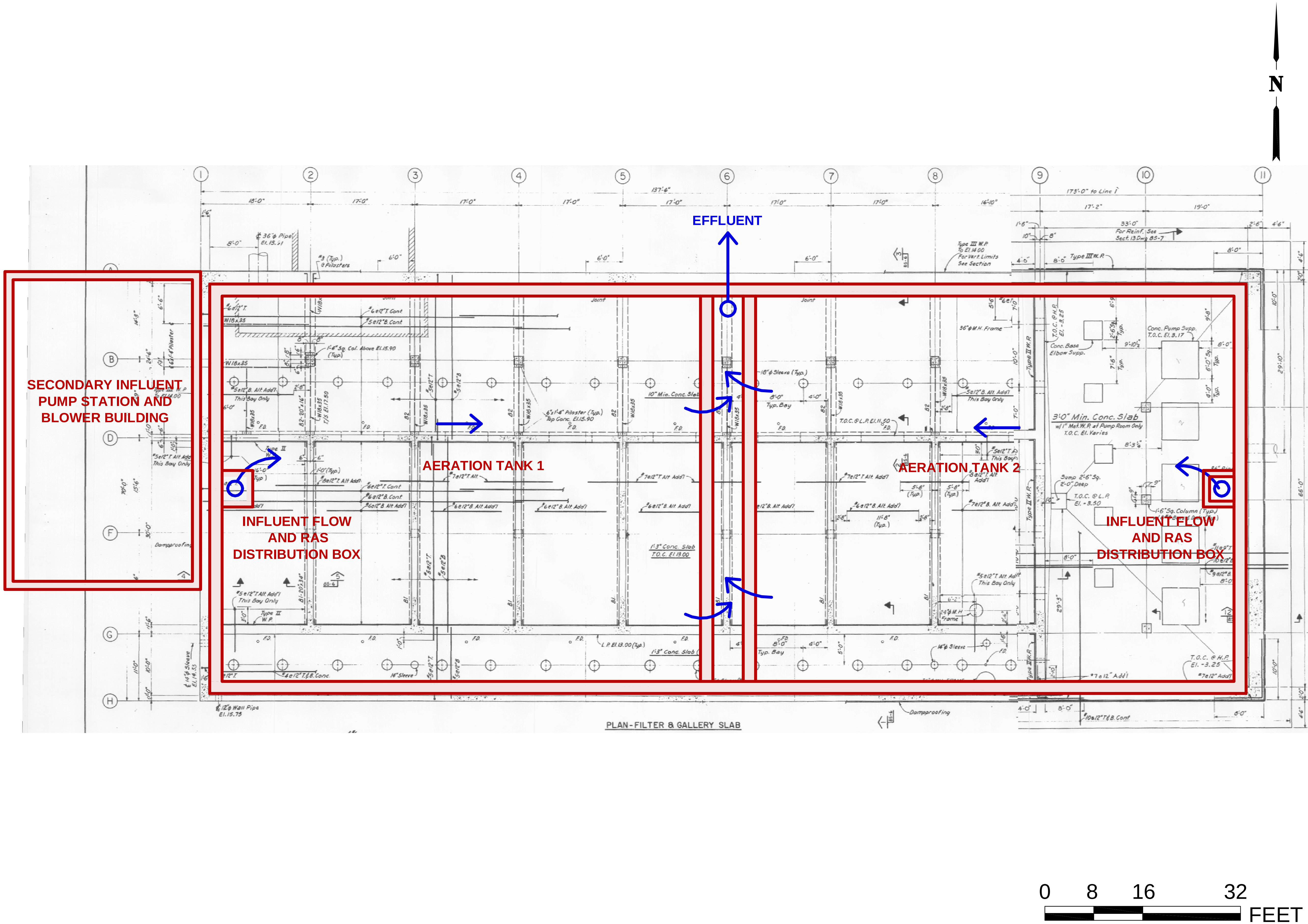
CONVENTIONAL ACTIVATED SLUDGE

CONVENTIONAL SECONDARY TREATMENT

OPTION 8

FIG. 8-CST-PFS

PROCESS FLOW SCHEMATIC



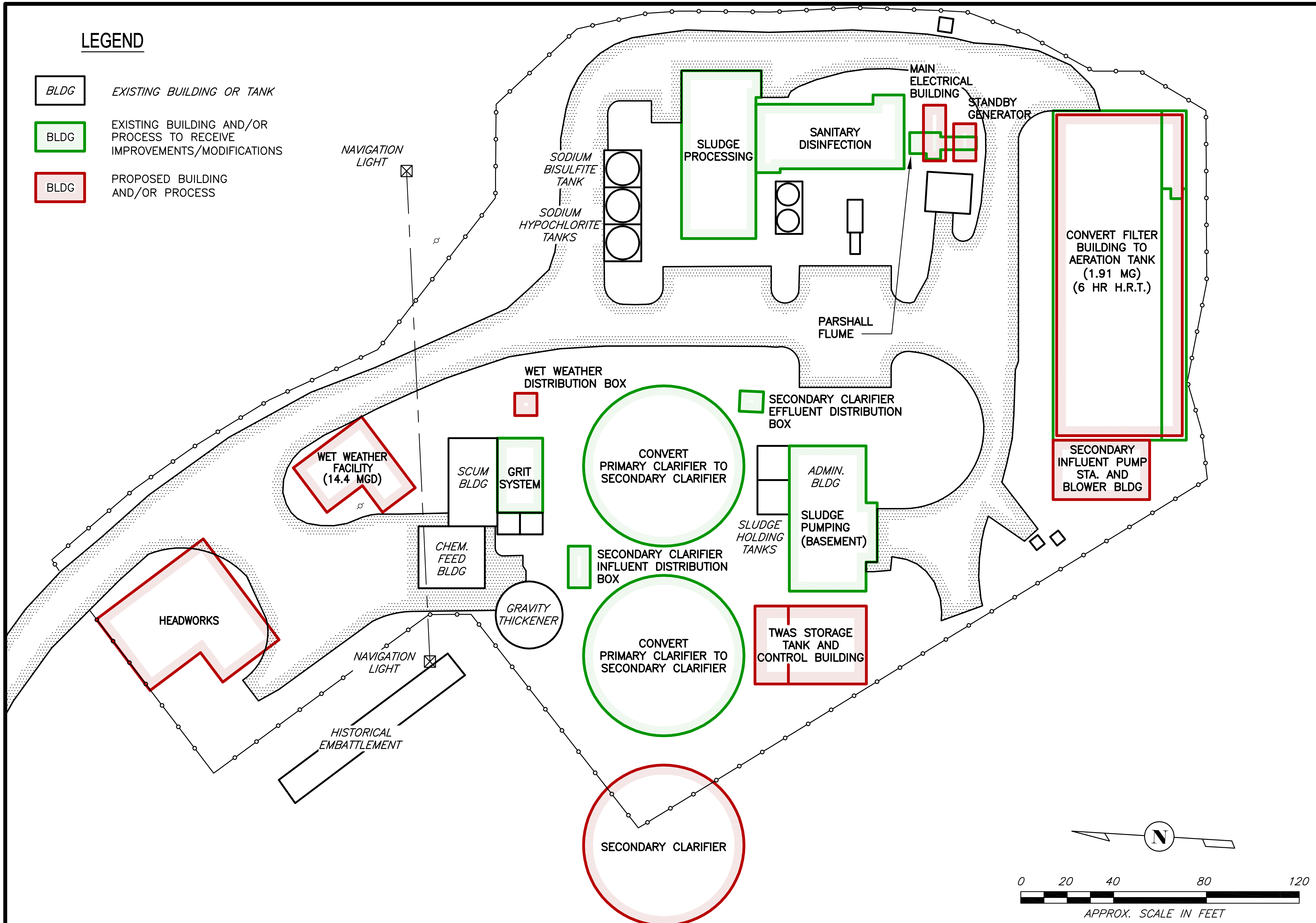
AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

CONVENTIONAL ACTIVATED SLUDGE
CONVENTIONAL SECONDARY TREATMENT

OPTION 8
FIG. 8-CST-PL

PROCESS LAYOUT

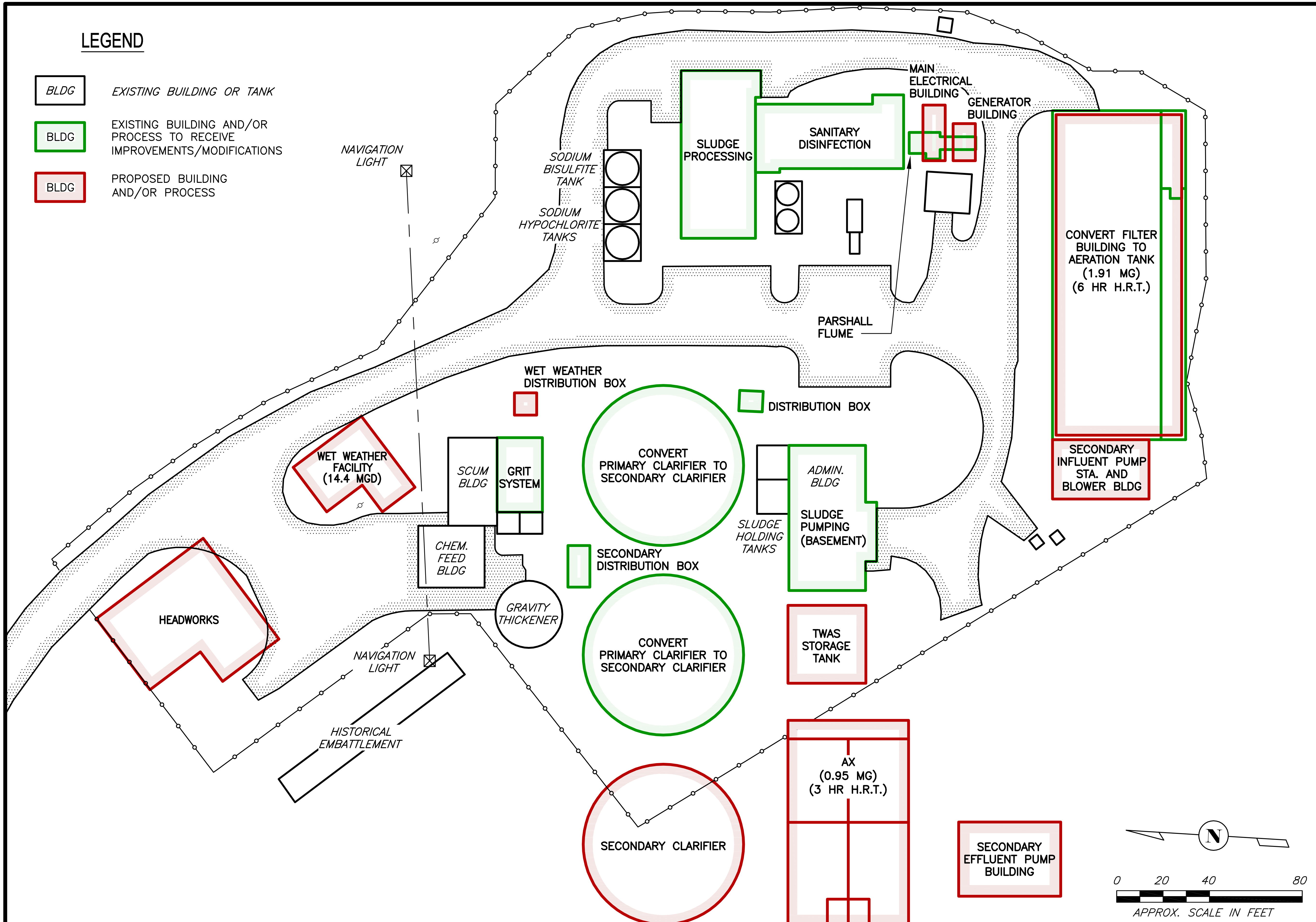


AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
CONVENTIONAL ACTIVATED SLUDGE
CONVENTIONAL SECONDARY TREATMENT

OPTION 8
FIG. 8-CST-SL

SITE LAYOUT



AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH

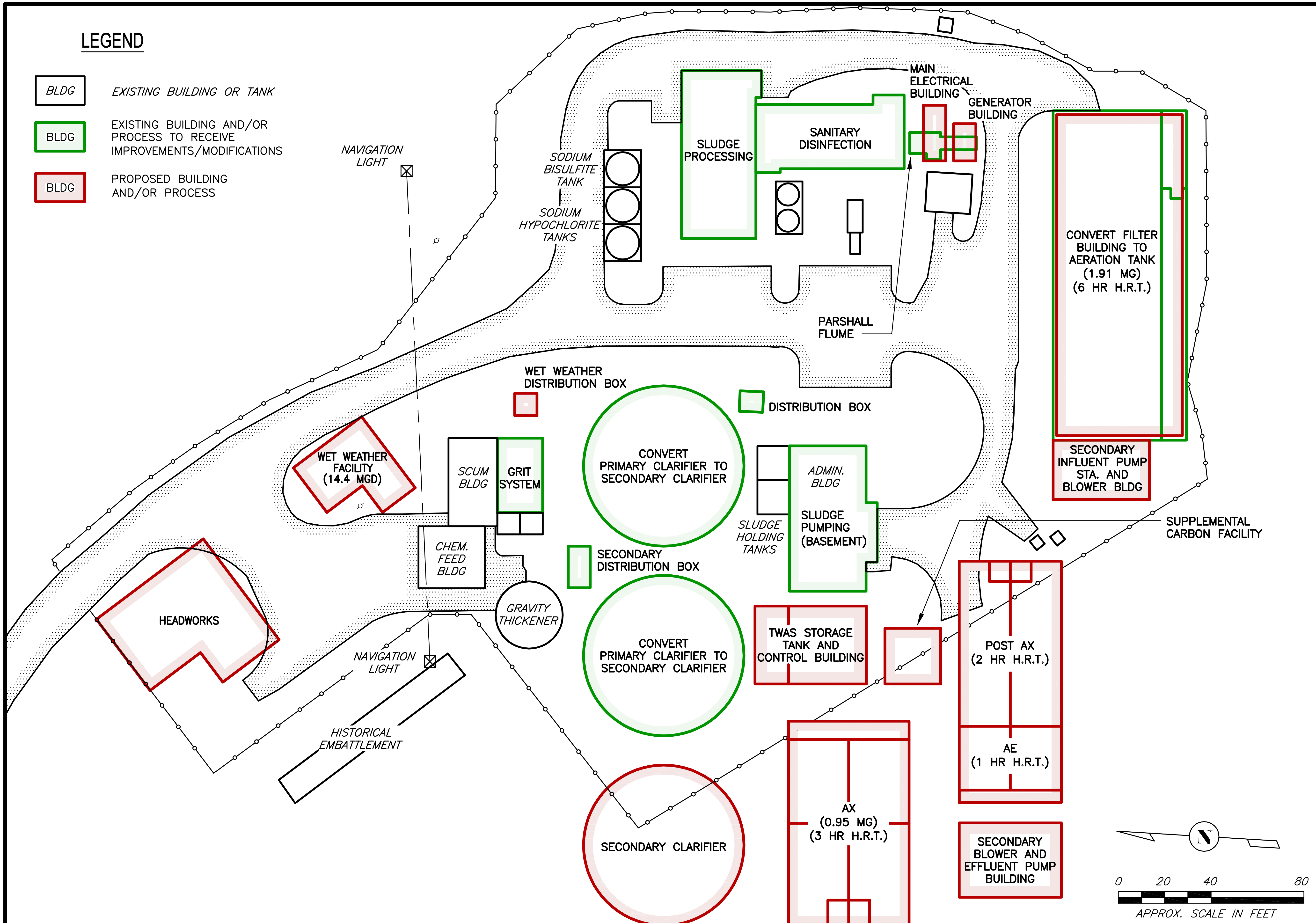
CONVENTIONAL ACTIVATED SLUDGE

TOTAL NITROGEN < 8 Mg/L

OPTION 8

FIG. 8-TN8-SL

SITE LAYOUT



AECOM
701 Edgewater Drive
Wakefield, MA 01880
Ph. (781) 246-5200

WWMP PILOTING - PHASE 1 ENGINEERING EVALUATION
PEIRCE ISLAND WWTF - PORTSMOUTH, NH
CONVENTIONAL ACTIVATED SLUDGE
TOTAL NITROGEN < 5/3 Mg/L

OPTION 8
FIG. 8-TN53-SL

SITE LAYOUT

Attachment A

Memorandum, Task 1.3 Flow Evaluation, March 23, 2011

AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com

781.246.5200 tel
781.245.6293 fax

Memorandum

To	Peter Rice, City Engineer	Page	1 of 32
CC	David Allen, Deputy Director and Paula Anania, Chief Operator		
Subject	Task 1.3. Flow Evaluation WWMP Piloting – Phase I Engineering Evaluation Pierce Island WWTF, Portsmouth, New Hampshire		
From	Terry Desmarais and Jon Pearson		
Date	May 23, 2011		

As part of the first phase of the Wastewater Master Plan Piloting work, AECOM completed an analysis of influent wastewater flows at the Peirce Island WWTF to quantify design dry weather flow rates. The values determined in this analysis as the average day, maximum day and maximum month dry weather flows will be used as the basis of evaluation for the proposed secondary treatment system technologies under evaluation as part of the engineering phase of the piloting effort.

Available Data

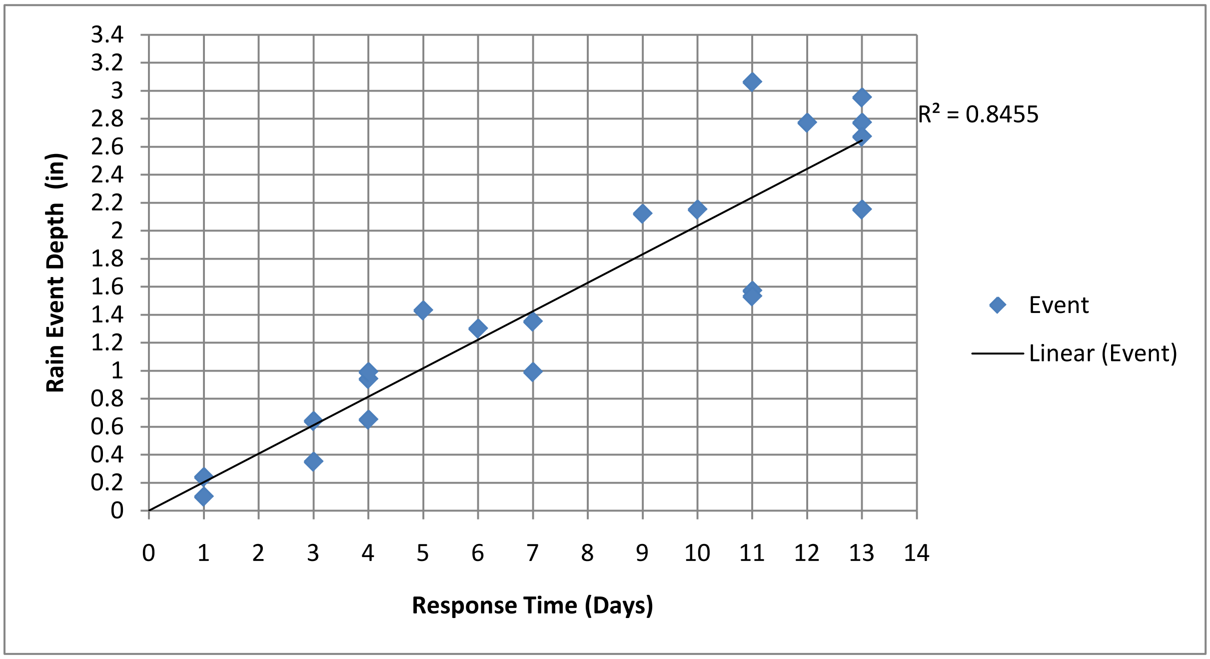
AECOM compiled three years (2008, 2009 and 2010) of available flow, precipitation, and temperature data from the following sources:

1. WWTF daily operating data from the City of Portsmouth from official Monthly Operating Reports (MORs)
2. Hourly and daily total precipitation from the City Hall rain gauge (heated) from the City of Portsmouth
3. Daily temperature data from NOAA Station ID 04743/PSM at the Pease International Tradeport Airport
4. Daily snow depth data from NOAA Stations in North Hampton, NH and Greenland, NH

Methodology

To classify days as "wet" or "dry", AECOM developed a set of definitions that were subsequently applied to parse the flow data into a wet classification or dry classification. Days were classified as wet based on precipitation event depth, the system response time resulting from rainfall events, and snow melt during times when snow pack existed. The precipitation based definitions were based on a response curve developed using the flow rate and precipitation data. The response time for selected events was estimated using the flow data, where response time was quantified as the number of days for flow rates to recede to the approximate pre-event flow rate. The response curve that was developed is shown on Figure 1 below. Figure 1 shows a best fit line developed using a linear regression analysis of the data points. As shown, the coefficient of determination for the line, R^2 is approximately 0.85, indicating good agreement between the line and the data.

Figure 1 - Precipitation Response Time



A precipitation event was defined as continuous or intermittent hourly precipitation that is not separated by more than 6 continuous hours. Precipitation separated by 6 or more hours was considered a separate event. The largest precipitation event in the period of record of 6.38-inches occurred from September 6, 2008 through September 7, 2008. This data point was not used in the precipitation response time developed above because it was significantly larger than any other event.

The definitions developed using this methodology are summarized below:

1. Classify any day with precipitation greater than 0.05 inches as wet;
2. Classify the next day following a precipitation day of 0.4 inches or greater as wet;
3. Classify the next 2 days following a precipitation day of 0.6 inches or greater as wet;
4. Classify the next 3 days following a precipitation day of 0.8 inches or greater as wet;
5. Classify the next 4 days following a precipitation day of 1.0 inches or greater as wet;
6. Classify the next 5 days following a precipitation day of 1.2 inches or greater as wet;
7. Classify the next 6 days following a precipitation day of 1.4 inches or greater as wet;
8. Classify the next 7 days following a precipitation day of 1.6 inches or greater as wet;
9. Classify the next 8 days following a precipitation day of 1.8 inches or greater as wet;
10. Classify the next 9 days following a precipitation day of 2.0 inches or greater as wet;
11. Classify the next 10 days following a precipitation day of 2.2 inches or greater as wet;
12. Classify the next 11 days following a precipitation day of 2.4 inches or greater as wet;
13. Classify the next 12 days following a precipitation day of 2.6 inches or greater as wet;
14. Classify any day with existing snow pack and temperature equal to or greater than 32 degrees F as wet;

Results
Based on the application of the definitions to the daily flow data, the following design flow rates were determined:

Table 1 - Design Flow Rates

Criteria	Flow (MGD)
Average Day Dry Weather Flow	4.30
90^{th} % Q	5.79
91.7^{th} % Q (represents maximum month)	5.99
95^{th} % Q	6.36
99^{th} % Q	7.33
99.7^{th} % Q (represents maximum day)	7.62
100^{th} % Q (represents max value)	7.73

The maximum day (99.7^{th} % Q) peaking factor is 1.70 and the total percentage of dry days in the data set is 40%. Figures 2, 3, and 4 attached show the average day flow and total daily precipitation for 2008, 2009, and 2010 respectively. Also shown on each figure is the average day dry weather flow indicating the data points used to calculate the values in the table above. Table 2, attached, shows the full set of data used in the analysis.

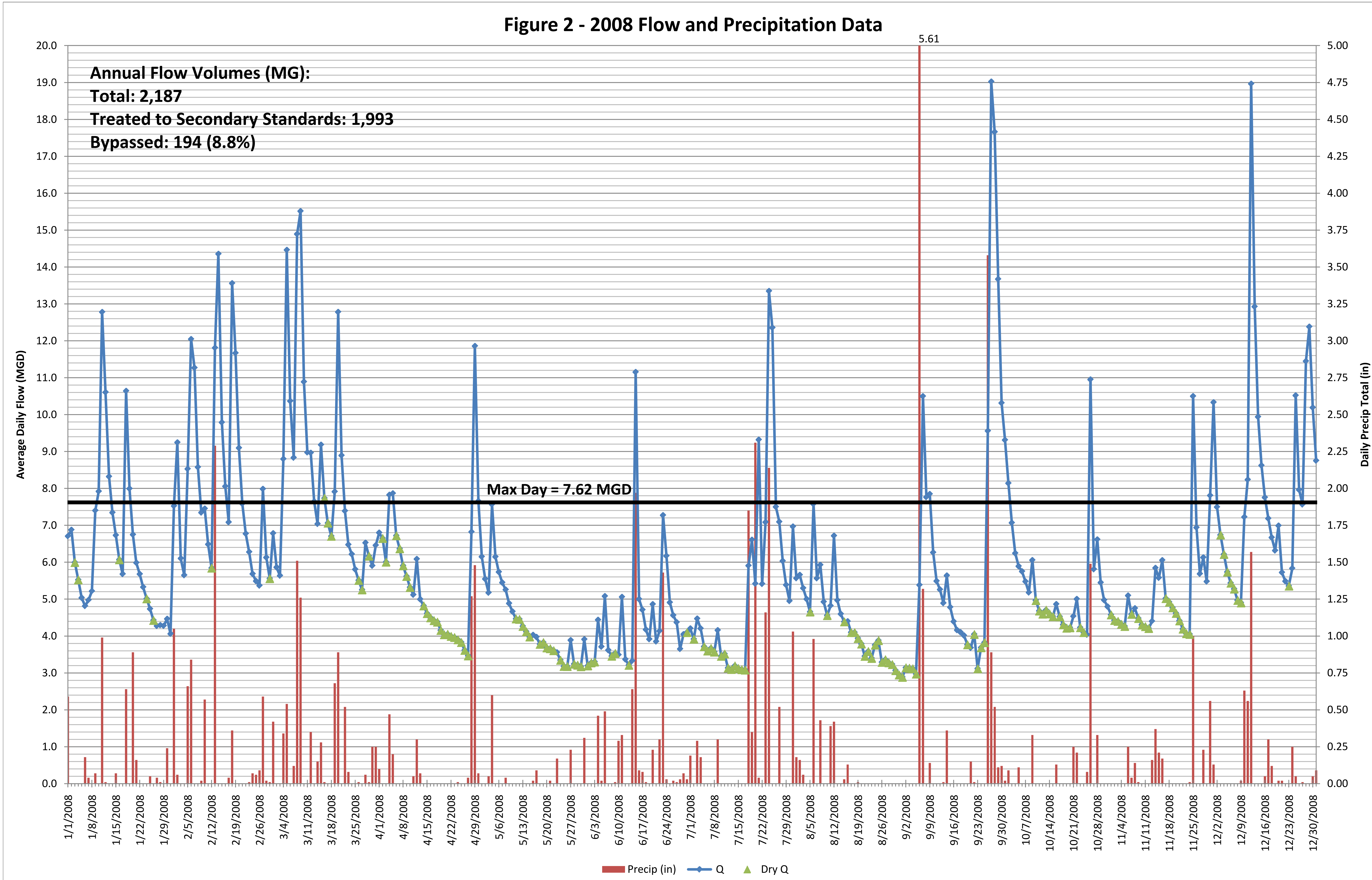


Figure 2 - 2008 Flow and Precipitation Data
Annual Flow Volumes (MG):
Total: 2,187
Treated to Secondary Standards: 1,993
Bypassed: 194 (8.8%)
Max Day = 7.62 MGD
5.61
Average Daily Flow (MGD)
Daily Precip Total (in)
Precip (in)
Q
Dry Q

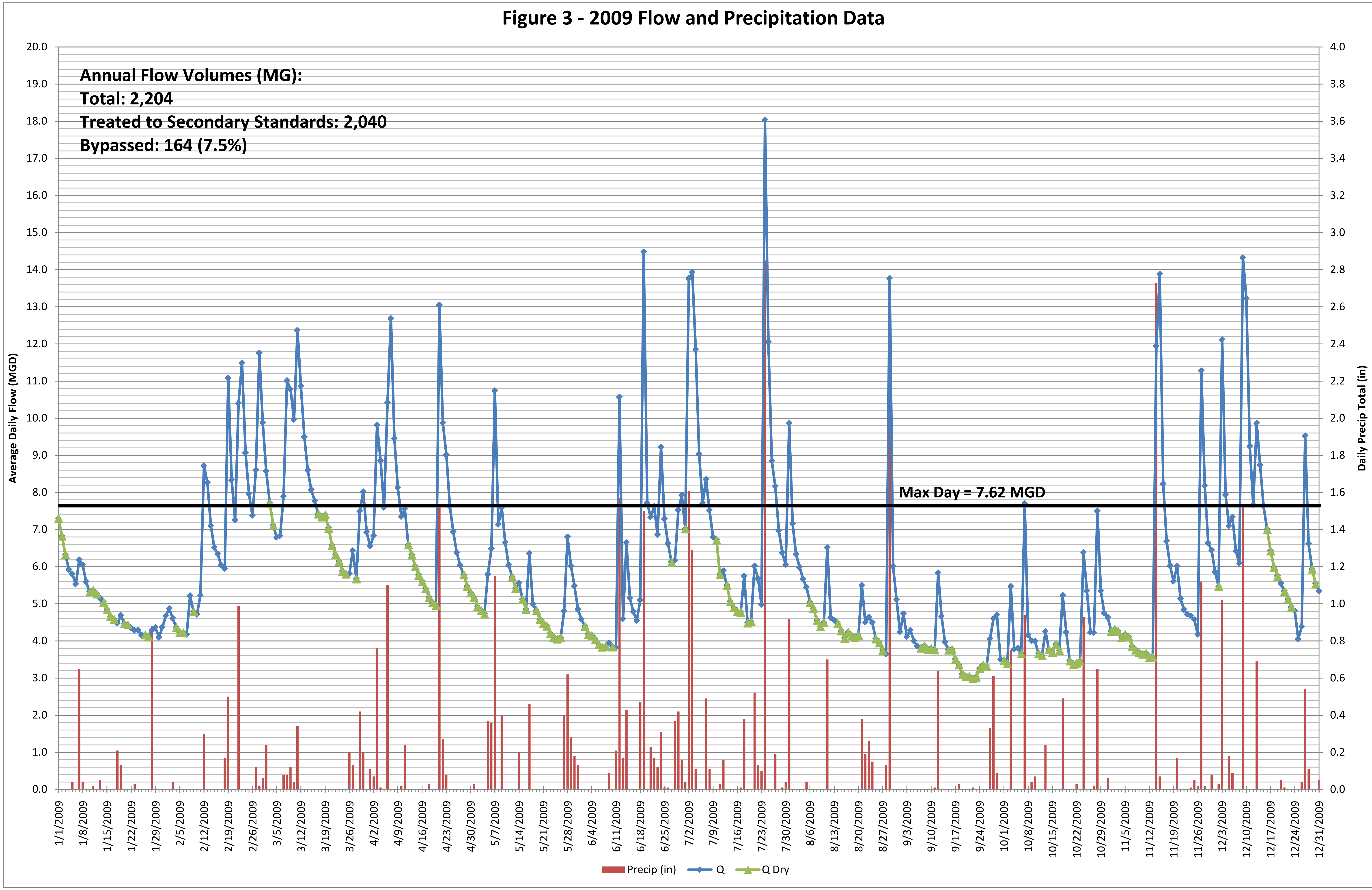


Figure 3 - 2009 Flow and Precipitation Data
Annual Flow Volumes (MG):
Total: 2,204
Treated to Secondary Standards: 2,040
Bypassed: 164 (7.5%)
Max Day = 7.62 MGD
Average Daily Flow (MGD)
Daily Precip Total (in)
Precip (in)
Q
Q Dry

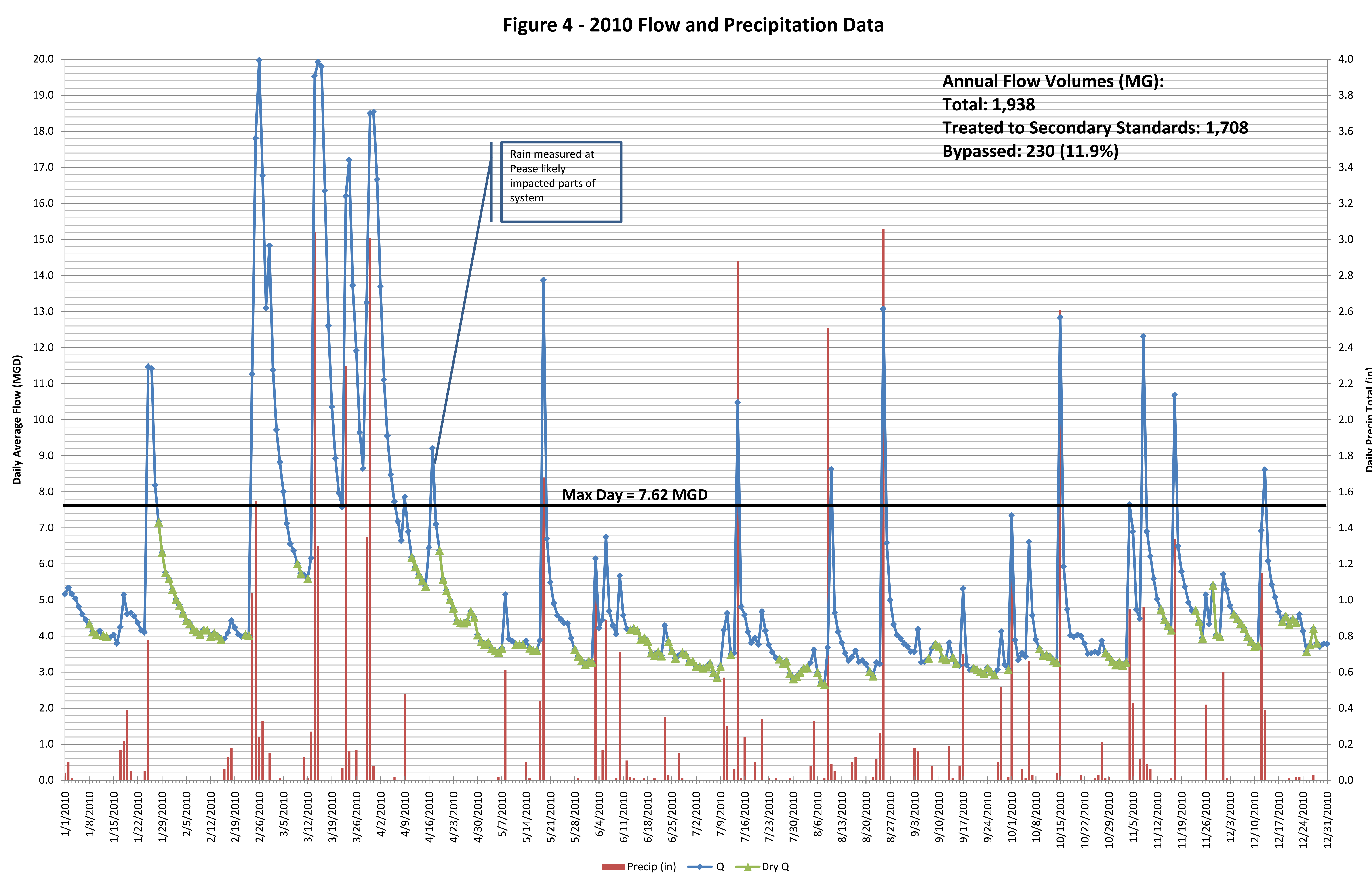


Figure 4 - 2010 Flow and Precipitation Data
Annual Flow Volumes (MG):
Total: 1,938
Treated to Secondary Standards: 1,708
Bypassed: 230 (11.9%)
Rain measured at Pease likely impacted parts of system
Max Day = 7.62 MGD
Daily Average Flow (MGD)
Daily Precip Total (in)
Precip (in)
Q
Dry Q

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
1/1/2008	6.705	0.59		37	6.705	
1/2/2008	6.875	0.00		31	6.875	
1/3/2008	5.995	0.00		12		5.995
1/4/2008	5.523	0.00		25		5.523
1/5/2008	5.035	0.00		34	5.035	
1/6/2008	4.812	0.18		39	4.812	
1/7/2008	4.972	0.04		48	4.972	
1/8/2008	5.214	0.00		60	5.214	
1/9/2008	7.399	0.07		59	7.399	
1/10/2008	7.918	0.00		47	7.918	
1/11/2008	12.777	0.99	5	41	12.777	
1/12/2008	10.603	0.01	4	47	10.603	
1/13/2008	8.320	0.00		41	8.32	
1/14/2008	7.343	0.00	9	37	7.343	
1/15/2008	6.729	0.07	12	33	6.729	
1/16/2008	6.069	0.00		31		6.069
1/17/2008	5.678	0.00		33	5.678	
1/18/2008	10.639	0.64		41	10.639	
1/19/2008	7.992	0.00			7.992	
1/20/2008	6.746	0.89			6.746	
1/21/2008	5.984	0.16		22	5.984	
1/22/2008	5.677	0.00		38	5.677	
1/23/2008	5.324	0.00		34	5.324	
1/24/2008	5.011	0.00		30		5.011
1/25/2008	4.734	0.05		28	4.734	
1/26/2008	4.427	0.00		31		4.427
1/27/2008	4.272	0.04	7	32	4.272	
1/28/2008	4.293	0.01	8	38	4.293	
1/29/2008	4.275	0.00		37	4.275	
1/30/2008	4.463	0.24		48	4.463	
1/31/2008	4.059	0.00		34	4.059	
2/1/2008	7.523	1.05		41	7.523	
2/2/2008	9.244	0.06		47	9.244	
2/3/2008	6.102	0.00		40	6.102	
2/4/2008	5.646	0.00		40	5.646	
2/5/2008	8.527	0.66	1	37	8.527	
2/6/2008	12.043	0.84		39	12.043	
2/7/2008	11.266	0.00	2	32	11.266	
2/8/2008	8.574	0.00	3	28	8.574	
2/9/2008	7.344	0.02	4	33	7.344	
2/10/2008	7.450	0.57	5	36	7.45	
2/11/2008	6.484	0.00	3	22	6.484	
2/12/2008	5.843	0.00	3	25		5.843

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
2/13/2008	11.807	2.29	8	36	11.807	
2/14/2008	14.353	0.00	6	36	14.353	
2/15/2008	9.787	0.00		42	9.787	
2/16/2008	8.055	0.00		25	8.055	
2/17/2008	7.082	0.04		37	7.082	
2/18/2008	13.557	0.36	5	57	13.557	
2/19/2008	11.665	0.00	1	43	11.665	
2/20/2008	9.095	0.00		30	9.095	
2/21/2008	7.582	0.00		27	7.582	
2/22/2008	6.772	0.00		28	6.772	
2/23/2008	6.276	0.01	6	32	6.276	
2/24/2008	5.683	0.07	4	38	5.683	
2/25/2008	5.488	0.06		39	5.488	
2/26/2008	5.365	0.09		37	5.365	
2/27/2008	7.984	0.59	4	37	7.984	
2/28/2008	6.127	0.02	6	26	6.127	
2/29/2008	5.558	0.01		25		5.558
3/1/2008	6.782	0.42	7	36	6.782	
3/2/2008	5.862	0.00		36	5.862	
3/3/2008	5.634	0.00		43	5.634	
3/4/2008	8.796	0.34		54	8.796	
3/5/2008	14.460	0.54	2	42	14.46	
3/6/2008	10.365	0.00	1	39	10.365	
3/7/2008	8.831	0.12		39	8.831	
3/8/2008	14.892	1.51	1	39	14.892	
3/9/2008	15.511	1.26	0	42	15.511	
3/10/2008	10.887	0.00		33	10.887	
3/11/2008	8.976	0.00			8.976	
3/12/2008	8.962	0.35		36	8.962	
3/13/2008	7.646	0.00			7.646	
3/14/2008	7.037	0.15		48	7.037	
3/15/2008	9.181	0.28		38	9.181	
3/16/2008	7.734	0.01		38		7.734
3/17/2008	7.062	0.00		44		7.062
3/18/2008	6.705	0.00		41		6.705
3/19/2008	7.910	0.68		39	7.91	
3/20/2008	12.779	0.89	0	41	12.779	
3/21/2008	8.891	0.00		36	8.891	
3/22/2008	7.388	0.52		42	7.388	
3/23/2008	6.475	0.08		40	6.475	
3/24/2008	6.216	0.00		39	6.216	
3/25/2008	5.805	0.00		34	5.805	
3/26/2008	5.510	0.01		55		5.51

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
3/27/2008	5.253	0.00		52		5.253
3/28/2008	6.526	0.06		39	6.526	
3/29/2008	6.166	0.01	3			6.166
3/30/2008	5.902	0.25			5.902	
3/31/2008	6.457	0.25		39	6.457	
4/1/2008	6.799	0.10	0	64	6.799	
4/2/2008	6.646	0.00	0	47		6.646
4/3/2008	6.005	0.00		53		6.005
4/4/2008	7.825	0.47	0	41	7.825	
4/5/2008	7.863	0.20		53	7.863	
4/6/2008	6.719	0.00		41		6.719
4/7/2008	6.366	0.00		45		6.366
4/8/2008	5.905	0.00		47		5.905
4/9/2008	5.618	0.00		49		5.618
4/10/2008	5.320	0.00				5.32
4/11/2008	5.116	0.05			5.116	
4/12/2008	6.085	0.30	0		6.085	
4/13/2008	4.995	0.07			4.995	
4/14/2008	4.819	0.00				4.819
4/15/2008	4.612	0.00				4.612
4/16/2008	4.497	0.00				4.497
4/17/2008	4.421	0.00				4.421
4/18/2008	4.380	0.00				4.38
4/19/2008	4.155	0.00				4.155
4/20/2008	4.039	0.00				4.039
4/21/2008	4.051	0.00				4.051
4/22/2008	3.994	0.00				3.994
4/23/2008	3.964	0.00				3.964
4/24/2008	3.902	0.01				3.902
4/25/2008	3.829	0.00				3.829
4/26/2008	3.616	0.00				3.616
4/27/2008	3.465	0.04				3.465
4/28/2008	6.820	1.27			6.82	
4/29/2008	11.856	1.48	0		11.856	
4/30/2008	7.654	0.07			7.654	
5/1/2008	6.148	0.00		56	6.148	
5/2/2008	5.546	0.00		49	5.546	
5/3/2008	5.172	0.05		46	5.172	
5/4/2008	7.564	0.60		49	7.564	
5/5/2008	6.145	0.00		64	6.145	
5/6/2008	5.734	0.00		67	5.734	
5/7/2008	5.447	0.00		72	5.447	
5/8/2008	5.254	0.04		78	5.254	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
5/9/2008	4.883	0.00		57	4.883	
5/10/2008	4.661	0.00		59	4.661	
5/11/2008	4.467	0.00		59		4.467
5/12/2008	4.455	0.00		51		4.455
5/13/2008	4.264	0.00		69		4.264
5/14/2008	4.120	0.00		63		4.12
5/15/2008	3.978	0.00		67		3.978
5/16/2008	4.028	0.02		62	4.028	
5/17/2008	3.972	0.09		66	3.972	
5/18/2008	3.780	0.00		69		3.78
5/19/2008	3.826	0.00		59		3.826
5/20/2008	3.682	0.00		67		3.682
5/21/2008	3.660	0.02		64		3.66
5/22/2008	3.607	0.00		60		3.607
5/23/2008	3.553	0.17		71	3.553	
5/24/2008	3.348	0.00		70		3.348
5/25/2008	3.181	0.00		72		3.181
5/26/2008	3.177	0.00		82		3.177
5/27/2008	3.886	0.23		83	3.886	
5/28/2008	3.241	0.00		67		3.241
5/29/2008	3.214	0.00		78		3.214
5/30/2008	3.172	0.00		58		3.172
5/31/2008	3.909	0.31		70	3.909	
6/1/2008	3.194	0.00		78		3.194
6/2/2008	3.276	0.00		75		3.276
6/3/2008	3.300	0.00		82		3.3
6/4/2008	4.436	0.46		60	4.436	
6/5/2008	3.708	0.02		63	3.708	
6/6/2008	5.078	0.49		56	5.078	
6/7/2008	3.616	0.00		84	3.616	
6/8/2008	3.457	0.00		92		3.457
6/9/2008	3.532	0.01		84		3.532
6/10/2008	3.488	0.29		90	3.488	
6/11/2008	5.057	0.33		83	5.057	
6/12/2008	3.368	0.00		78	3.368	
6/13/2008	3.211	0.00		81		3.211
6/14/2008	3.324	0.64		72	3.324	
6/15/2008	11.151	1.97		59	11.151	
6/16/2008	4.998	0.09		65	4.998	
6/17/2008	4.708	0.08		77	4.708	
6/18/2008	4.174	0.01		70	4.174	
6/19/2008	3.912	0.00		72	3.912	
6/20/2008	4.860	0.23		71	4.86	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
6/21/2008	3.851	0.00		74	3.851	
6/22/2008	4.134	0.30		78	4.134	
6/23/2008	7.271	1.43		70	7.271	
6/24/2008	6.168	0.03		79	6.168	
6/25/2008	4.908	0.00		81	4.908	
6/26/2008	4.559	0.02		78	4.559	
6/27/2008	4.370	0.01		84	4.37	
6/28/2008	3.648	0.03		64	3.648	
6/29/2008	4.047	0.07		71	4.047	
6/30/2008	4.097	0.03		85		4.097
7/1/2008	4.203	0.19		83	4.203	
7/2/2008	3.917	0.00		82		3.917
7/3/2008	4.470	0.29		87	4.47	
7/4/2008	4.203	0.18		73	4.203	
7/5/2008	3.713	0.00		71		3.713
7/6/2008	3.598	0.00		79		3.598
7/7/2008	3.667	0.00		86		3.667
7/8/2008	3.568	0.00		90		3.568
7/9/2008	4.155	0.30		91	4.155	
7/10/2008	3.455	0.00		82		3.455
7/11/2008	3.515	0.00		78		3.515
7/12/2008	3.136	0.00		75		3.136
7/13/2008	3.098	0.00		85		3.098
7/14/2008	3.194	0.00		80		3.194
7/15/2008	3.124	0.00		85		3.124
7/16/2008	3.093	0.00		84		3.093
7/17/2008	3.081	0.00		84		3.081
7/18/2008	5.906	1.85		85	5.906	
7/19/2008	6.606	0.35		90	6.606	
7/20/2008	5.417	2.31		74	5.417	
7/21/2008	9.318	0.04		73	9.318	
7/22/2008	5.410	0.00		75	5.41	
7/23/2008	7.083	1.16		70	7.083	
7/24/2008	13.347	2.14		79	13.347	
7/25/2008	12.352	0.00		79	12.352	
7/26/2008	7.499	0.00		83	7.499	
7/27/2008	7.093	0.52		80	7.093	
7/28/2008	6.032	0.00		83	6.032	
7/29/2008	5.384	0.00		83	5.384	
7/30/2008	4.948	0.00		81	4.948	
7/31/2008	6.964	1.03		81	6.964	
8/1/2008	5.565	0.18		78	5.565	
8/2/2008	5.654	0.16		72	5.654	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
8/3/2008	5.296	0.06		76	5.296	
8/4/2008	5.000	0.00		80	5	
8/5/2008	4.654	0.00		69		4.654
8/6/2008	7.574	0.98		65	7.574	
8/7/2008	5.563	0.00		69	5.563	
8/8/2008	5.924	0.43		72	5.924	
8/9/2008	4.926	0.00		76	4.926	
8/10/2008	4.557	0.00		75		4.557
8/11/2008	4.817	0.39		67	4.817	
8/12/2008	6.715	0.42		72	6.715	
8/13/2008	4.968	0.00		78	4.968	
8/14/2008	4.596	0.00		76	4.596	
8/15/2008	4.388	0.03		76		4.388
8/16/2008	4.396	0.13		76	4.396	
8/17/2008	4.099	0.00		82		4.099
8/18/2008	4.096	0.00		85		4.096
8/19/2008	3.937	0.01		72		3.937
8/20/2008	3.787	0.00		74		3.787
8/21/2008	3.454	0.00		79		3.454
8/22/2008	3.584	0.00		81		3.584
8/23/2008	3.397	0.00		80		3.397
8/24/2008	3.757	0.00		74		3.757
8/25/2008	3.879	0.00		84		3.879
8/26/2008	3.291	0.00		74		3.291
8/27/2008	3.362	0.00		77		3.362
8/28/2008	3.278	0.00		74		3.278
8/29/2008	3.231	0.00		73		3.231
8/30/2008	3.067	0.00		81		3.067
8/31/2008	2.950	0.00		80		2.95
9/1/2008	2.885	0.00		84		2.885
9/2/2008	3.143	0.00		78		3.143
9/3/2008	3.131	0.00		75		3.131
9/4/2008	3.117	0.00		87		3.117
9/5/2008	2.973	0.00		77		2.973
9/6/2008	5.381	5.61		77	5.381	
9/7/2008	10.495	1.32		76	10.495	
9/8/2008	7.762	0.00		77	7.762	
9/9/2008	7.845	0.14		72	7.845	
9/10/2008	6.262	0.00		69	6.262	
9/11/2008	5.488	0.00		67	5.488	
9/12/2008	5.258	0.00		65	5.258	
9/13/2008	4.890	0.01		74	4.89	
9/14/2008	5.637	0.36		74	5.637	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
9/15/2008	4.779	0.00		80	4.779	
9/16/2008	4.391	0.00		63	4.391	
9/17/2008	4.159	0.00		66	4.159	
9/18/2008	4.101	0.00		67	4.101	
9/19/2008	4.014	0.00		56	4.014	
9/20/2008	3.766	0.00		63		3.766
9/21/2008	3.677	0.15		74	3.677	
9/22/2008	4.046	0.01		60		4.046
9/23/2008	3.117	0.00		60		3.117
9/24/2008	3.686	0.00		65		3.686
9/25/2008	3.824	0.00		65		3.824
9/26/2008	9.557	3.58		63	9.557	
9/27/2008	19.021	0.89		67	19.021	
9/28/2008	17.656	0.52		67	17.656	
9/29/2008	13.670	0.11		71	13.67	
9/30/2008	10.313	0.12		62	10.313	
10/1/2008	9.310	0.02		62	9.31	
10/2/2008	8.139	0.09		62	8.139	
10/3/2008	7.066	0.00		60	7.066	
10/4/2008	6.242	0.00		59	6.242	
10/5/2008	5.890	0.11		61	5.89	
10/6/2008	5.749	0.00		56	5.749	
10/7/2008	5.476	0.00		66	5.476	
10/8/2008	5.178	0.00		68	5.178	
10/9/2008	6.054	0.33		73	6.054	
10/10/2008	4.964	0.00		70		4.964
10/11/2008	4.681	0.00		68		4.681
10/12/2008	4.597	0.00		67		4.597
10/13/2008	4.705	0.00		60		4.705
10/14/2008	4.602	0.00		63		4.602
10/15/2008	4.529	0.00		60		4.529
10/16/2008	4.862	0.13		63	4.862	
10/17/2008	4.524	0.00		60		4.524
10/18/2008	4.307	0.00		53		4.307
10/19/2008	4.217	0.00		48		4.217
10/20/2008	4.227	0.00		59		4.227
10/21/2008	4.534	0.25		59	4.534	
10/22/2008	5.001	0.21		46	5.001	
10/23/2008	4.230	0.00		50		4.23
10/24/2008	4.097	0.00		59		4.097
10/25/2008	4.034	0.08		57	4.034	
10/26/2008	10.949	1.49		65	10.949	
10/27/2008	5.808	0.00		64	5.808	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
10/28/2008	6.614	0.33		54	6.614	
10/29/2008	5.446	0.00		44	5.446	
10/30/2008	4.973	0.00		44	4.973	
10/31/2008	4.797	0.00		61	4.797	
11/1/2008	4.576	0.00		55		4.576
11/2/2008	4.426	0.00		45		4.426
11/3/2008	4.401	0.00		48		4.401
11/4/2008	4.321	0.00		62		4.321
11/5/2008	4.263	0.00		62		4.263
11/6/2008	5.094	0.25		59	5.094	
11/7/2008	4.592	0.04		60		4.592
11/8/2008	4.749	0.14		60	4.749	
11/9/2008	4.478	0.01		57		4.478
11/10/2008	4.302	0.00		51		4.302
11/11/2008	4.258	0.00		46		4.258
11/12/2008	4.207	0.00		47		4.207
11/13/2008	4.399	0.16		49	4.399	
11/14/2008	5.843	0.37		55	5.843	
11/15/2008	5.575	0.21		66	5.575	
11/16/2008	6.052	0.17		64	6.052	
11/17/2008	5.018	0.00		46		5.018
11/18/2008	4.918	0.00		39		4.918
11/19/2008	4.768	0.00		33		4.768
11/20/2008	4.617	0.00		32		4.617
11/21/2008	4.414	0.00		33		4.414
11/22/2008	4.191	0.00		28		4.191
11/23/2008	4.068	0.00		31		4.068
11/24/2008	4.048	0.01		42		4.048
11/25/2008	10.497	1.00	0	52	10.497	
11/26/2008	6.938	0.00		44	6.938	
11/27/2008	5.684	0.00		45	5.684	
11/28/2008	6.128	0.23		43	6.128	
11/29/2008	5.476	0.00	0	44	5.476	
11/30/2008	7.807	0.56		43	7.807	
12/1/2008	10.331	0.13	0	45	10.331	
12/2/2008	7.494	0.00		47	7.494	
12/3/2008	6.739	0.00		43		6.739
12/4/2008	6.213	0.00		48		6.213
12/5/2008	5.735	0.00		38		5.735
12/6/2008	5.436	0.00		34		5.436
12/7/2008	5.275	0.00		33		5.275
12/8/2008	4.969	0.00		19		4.969
12/9/2008	4.900	0.02		51		4.9

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
12/10/2008	7.223	0.63		61	7.223	
12/11/2008	8.235	0.56	0	37	8.235	
12/12/2008	18.963	1.57		36	18.963	
12/13/2008	12.924	0.00		27	12.924	
12/14/2008	9.938	0.00		38	9.938	
12/15/2008	8.620	0.00		62	8.62	
12/16/2008	7.753	0.05	0	61	7.753	
12/17/2008	7.184	0.30	3	28	7.184	
12/18/2008	6.668	0.12	4	36	6.668	
12/19/2008	6.315	0.00		26	6.315	
12/20/2008	6.989	0.02	13	15	6.989	
12/21/2008	5.721	0.02		24	5.721	
12/22/2008	5.484	0.00	12	25	5.484	
12/23/2008	5.356	0.00		25		5.356
12/24/2008	5.831	0.25		50	5.831	
12/25/2008	10.517	0.05		51	10.517	
12/26/2008	7.962	0.00		33	7.962	
12/27/2008	7.563	0.01	6	41	7.563	
12/28/2008	11.446	0.00	4	58	11.446	
12/29/2008	12.380	0.00		44	12.38	
12/30/2008	10.189	0.05	1	39	10.189	
12/31/2008	8.751	0.09		22	8.751	
1/1/2009	7.301	0.00		13		7.301
1/2/2009	6.828	0.00		27		6.828
1/3/2009	6.325	0.00		29		6.325
1/4/2009	5.923	0.00		33	5.923	
1/5/2009	5.801	0.04	1	37	5.801	
1/6/2009	5.527	0.00		33	5.527	
1/7/2009	6.185	0.65		36	6.185	
1/8/2009	6.043	0.04		35	6.043	
1/9/2009	5.593	0.00		26	5.593	
1/10/2009	5.326	0.00		25		5.326
1/11/2009	5.358	0.02		24		5.358
1/12/2009	5.269	0.00	10	27		5.269
1/13/2009	5.147	0.05		36	5.147	
1/14/2009	5.047	0.00		31		5.047
1/15/2009	4.843	0.00		15		4.843
1/16/2009	4.662	0.00		16		4.662
1/17/2009	4.585	0.00		18		4.585
1/18/2009	4.467	0.21		22	4.467	
1/19/2009	4.686	0.13	17	30	4.686	
1/20/2009	4.466	0.00		28		4.466
1/21/2009	4.437	0.00		24		4.437

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
1/22/2009	4.342	0.00		35	4.342	
1/23/2009	4.282	0.03		35	4.282	
1/24/2009	4.284	0.00		39	4.284	
1/25/2009	4.156	0.00		24		
1/26/2009	4.166	0.00		22		4.166
1/27/2009	4.115	0.00		26		4.115
1/28/2009	4.280	0.88		35	4.28	
1/29/2009	4.363	0.00	16	33	4.363	
1/30/2009	4.095	0.00		36	4.095	
1/31/2009	4.370	0.00		27	4.37	
2/1/2009	4.670	0.00		33	4.67	
2/2/2009	4.870	0.00		40	4.87	
2/3/2009	4.610	0.04		35	4.61	
2/4/2009	4.360	0.00	16	24		4.36
2/5/2009	4.234	0.00		15		4.234
2/6/2009	4.222	0.00		27		4.222
2/7/2009	4.162	0.00		41	4.162	
2/8/2009	5.218	0.00		50	5.218	
2/9/2009	4.792	0.00		31		4.792
2/10/2009	4.713	0.00		33	4.713	
2/11/2009	5.223	0.00		55	5.223	
2/12/2009	8.719	0.30		46	8.719	
2/13/2009	8.262	0.00		40	8.262	
2/14/2009	7.099	0.00		38	7.099	
2/15/2009	6.515	0.00		37	6.515	
2/16/2009	6.339	0.00		36	6.339	
2/17/2009	6.038	0.00		35	6.038	
2/18/2009	5.942	0.17		35	5.942	
2/19/2009	11.080	0.50		39	11.08	
2/20/2009	8.331	0.00		28	8.331	
2/21/2009	7.252	0.00		35	7.252	
2/22/2009	10.403	0.99		39	10.403	
2/23/2009	11.486	0.00	10	31	11.486	
2/24/2009	9.065	0.00		31	9.065	
2/25/2009	7.960	0.00		34	7.96	
2/26/2009	7.374	0.00		44	7.374	
2/27/2009	8.599	0.12		57	8.599	
2/28/2009	11.756	0.02	5	49	11.756	
3/1/2009	9.880	0.06		23	9.88	
3/2/2009	8.572	0.24	15	24	8.572	
3/3/2009	7.712	0.00		26		7.712
3/4/2009	7.113	0.00		29		7.113
3/5/2009	6.790	0.00		38	6.79	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
3/6/2009	6.828	0.00		48	6.828	
3/7/2009	7.894	0.08		56	7.894	
3/8/2009	11.013	0.08		54	11.013	
3/9/2009	10.777	0.12	2	39	10.777	
3/10/2009	9.962	0.04		43	9.962	
3/11/2009	12.371	0.34		50	12.371	
3/12/2009	10.862	0.00		37	10.862	
3/13/2009	9.494	0.00		32	9.494	
3/14/2009	8.597	0.00		51	8.597	
3/15/2009	8.071	0.00		51	8.071	
3/16/2009	7.768	0.00		37	7.768	
3/17/2009	7.422	0.00		43		7.422
3/18/2009	7.342	0.00		61		7.342
3/19/2009	7.398	0.00		48		7.398
3/20/2009	7.042	0.00		37		7.042
3/21/2009	6.581	0.00		40		6.581
3/22/2009	6.330	0.00		47		6.33
3/23/2009	6.151	0.00		31		6.151
3/24/2009	5.879	0.00		45		5.879
3/25/2009	5.806	0.00		50		5.806
3/26/2009	5.805	0.20		49	5.805	
3/27/2009	6.430	0.13		53	6.43	
3/28/2009	5.673	0.00		44		5.673
3/29/2009	7.494	0.42	0	41	7.494	
3/30/2009	8.018	0.20		43	8.018	
3/31/2009	6.929	0.00	0	50	6.929	
4/1/2009	6.552	0.11		42	6.552	
4/2/2009	6.827	0.07		56	6.827	
4/3/2009	9.817	0.76		48	9.817	
4/4/2009	8.854	0.01		52	8.854	
4/5/2009	7.595	0.00		57	7.595	
4/6/2009	10.417	1.10		47	10.417	
4/7/2009	12.684	0.00	0	50	12.684	
4/8/2009	9.450	0.00		45	9.45	
4/9/2009	8.128	0.00		59	8.128	
4/10/2009	7.346	0.02		63	7.346	
4/11/2009	7.555	0.24		46	7.555	
4/12/2009	6.590	0.00	0	43		6.59
4/13/2009	6.317	0.00		53		6.317
4/14/2009	6.008	0.00		54		6.008
4/15/2009	5.775	0.00		41		5.775
4/16/2009	5.601	0.00		49		5.601
4/17/2009	5.408	0.00		68		5.408

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
4/18/2009	5.172	0.03		58		5.172
4/19/2009	5.031	0.00		52		5.031
4/20/2009	4.967	0.00		49		4.967
4/21/2009	13.049	1.53	0	52	13.049	
4/22/2009	9.869	0.27	0	64	9.869	
4/23/2009	9.010	0.08	0	56	9.01	
4/24/2009	7.623	0.00		70	7.623	
4/25/2009	6.939	0.00		87	6.939	
4/26/2009	6.382	0.00		82	6.382	
4/27/2009	6.037	0.00	0	58	6.037	
4/28/2009	5.784	0.00		93		5.784
4/29/2009	5.478	0.00		58		5.478
4/30/2009	5.297	0.00		64		5.297
5/1/2009	5.177	0.03		69		5.177
5/2/2009	4.932	0.00		68		4.932
5/3/2009	4.820	0.00		63		4.82
5/4/2009	4.730	0.00		67		4.73
5/5/2009	5.791	0.37		52	5.791	
5/6/2009	6.481	0.36		64	6.481	
5/7/2009	10.740	1.15		58	10.74	
5/8/2009	7.134	0.00		74	7.134	
5/9/2009	7.594	0.40		71	7.594	
5/10/2009	6.650	0.00		66	6.65	
5/11/2009	6.042	0.00		58	6.042	
5/12/2009	5.725	0.00		61		5.725
5/13/2009	5.420	0.00		67		5.42
5/14/2009	5.560	0.20		61	5.56	
5/15/2009	5.123	0.00		74		5.123
5/16/2009	4.855	0.00		58		4.855
5/17/2009	6.361	0.46		64	6.361	
5/18/2009	4.988	0.00		53	4.988	
5/19/2009	4.823	0.00		63		4.823
5/20/2009	4.586	0.00		74		4.586
5/21/2009	4.477	0.00		90		4.477
5/22/2009	4.402	0.00		89		4.402
5/23/2009	4.203	0.00		65		4.203
5/24/2009	4.103	0.00		75		4.103
5/25/2009	4.055	0.00		76		4.055
5/26/2009	4.086	0.00		56		4.086
5/27/2009	4.804	0.40		50	4.804	
5/28/2009	6.800	0.62		48	6.8	
5/29/2009	6.023	0.28		59	6.023	
5/30/2009	5.477	0.18		77	5.477	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
5/31/2009	4.848	0.13		76	4.848	
6/1/2009	4.579	0.00		70	4.579	
6/2/2009	4.399	0.00		76		4.399
6/3/2009	4.186	0.00		73		4.186
6/4/2009	4.145	0.00		70		4.145
6/5/2009	4.043	0.00		64		4.043
6/6/2009	3.903	0.00		66		3.903
6/7/2009	3.839	0.00		76		3.839
6/8/2009	3.856	0.00		71		3.856
6/9/2009	3.946	0.09		58	3.946	
6/10/2009	3.841	0.00		61		3.841
6/11/2009	3.814	0.21		59	3.814	
6/12/2009	10.570	1.57		77	10.57	
6/13/2009	4.589	0.17		72	4.589	
6/14/2009	6.651	0.43		59	6.651	
6/15/2009	5.152	0.00		61	5.152	
6/16/2009	4.785	0.00		67	4.785	
6/17/2009	4.549	0.00		75	4.549	
6/18/2009	5.098	0.47		63	5.098	
6/19/2009	14.480	1.50		68	14.48	
6/20/2009	7.711	0.00		76	7.711	
6/21/2009	7.334	0.23		66	7.334	
6/22/2009	7.621	0.17		64	7.621	
6/23/2009	6.861	0.12		66	6.861	
6/24/2009	9.221	0.31		68	9.221	
6/25/2009	7.283	0.01		77	7.283	
6/26/2009	6.623	0.01		83	6.623	
6/27/2009	6.126	0.00				6.126
6/28/2009	6.165	0.37			6.165	
6/29/2009	7.525	0.42		64	7.525	
6/30/2009	7.925	0.16		66	7.925	
7/1/2009	7.022	0.04		60		7.022
7/2/2009	13.761	1.61		59	13.761	
7/3/2009	13.929	1.29		74	13.929	
7/4/2009	11.853	0.11		78	11.853	
7/5/2009	9.037	0.00		79	9.037	
7/6/2009	7.710	0.00		77	7.71	
7/7/2009	8.348	0.49		60	8.348	
7/8/2009	7.520	0.11		61	7.52	
7/9/2009	6.800	0.00		68	6.8	
7/10/2009	6.723	0.00		76		6.723
7/11/2009	5.787	0.03		77		5.787
7/12/2009	5.893	0.16		80	5.893	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
7/13/2009	5.498	0.00		77		5.498
7/14/2009	5.068	0.00		73		5.068
7/15/2009	4.898	0.00		79		4.898
7/16/2009	4.801	0.00		79		4.801
7/17/2009	4.772	0.01		80		4.772
7/18/2009	5.746	0.38		80	5.746	
7/19/2009	4.487	0.00		80		4.487
7/20/2009	4.516	0.00		78		4.516
7/21/2009	6.017	0.52		66	6.017	
7/22/2009	5.678	0.13		75	5.678	
7/23/2009	4.975	0.10		70	4.975	
7/24/2009	18.039	2.85		67	18.039	
7/25/2009	12.053	0.00		80	12.053	
7/26/2009	8.845	0.00		82	8.845	
7/27/2009	8.164	0.19		85	8.164	
7/28/2009	6.966	0.00		87	6.966	
7/29/2009	6.375	0.01		85	6.375	
7/30/2009	6.048	0.04		84	6.048	
7/31/2009	9.860	0.92		79	9.86	
8/1/2009	7.159	0.00		82	7.159	
8/2/2009	6.330	0.00		74	6.33	
8/3/2009	5.986	0.00		83	5.986	
8/4/2009	5.664	0.00		82	5.664	
8/5/2009	5.446	0.04		86	5.446	
8/6/2009	5.044	0.00		77		5.044
8/7/2009	4.879	0.00		78		4.879
8/8/2009	4.553	0.00		74		4.553
8/9/2009	4.384	0.00		77		4.384
8/10/2009	4.495	0.00		87		4.495
8/11/2009	6.513	0.70		79	6.513	
8/12/2009	4.622	0.00		73	4.622	
8/13/2009	4.555	0.00		70	4.555	
8/14/2009	4.475	0.00		82		4.475
8/15/2009	4.274	0.00		89		4.274
8/16/2009	4.076	0.00		88		4.076
8/17/2009	4.239	0.00		90		4.239
8/18/2009	4.140	0.00		93		4.14
8/19/2009	4.097	0.00		90		4.097
8/20/2009	4.149	0.00		80		4.149
8/21/2009	5.492	0.38		89	5.492	
8/22/2009	4.498	0.19		82	4.498	
8/23/2009	4.636	0.26		86	4.636	
8/24/2009	4.490	0.15		81	4.49	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
8/25/2009	4.057	0.00		79		4.057
8/26/2009	3.951	0.00		85		3.951
8/27/2009	3.751	0.00		74		3.751
8/28/2009	3.641	0.13		68	3.641	
8/29/2009	13.769	2.02		59	13.769	
8/30/2009	6.003	0.00		71	6.003	
8/31/2009	5.112	0.00		71	5.112	
9/1/2009	4.240	0.00		72	4.24	
9/2/2009	4.734	0.00		76	4.734	
9/3/2009	4.111	0.00		78	4.111	
9/4/2009	4.287	0.00		77	4.287	
9/5/2009	3.997	0.00		80	3.997	
9/6/2009	3.861	0.00		65	3.861	
9/7/2009	3.810	0.00		68		3.81
9/8/2009	3.871	0.00		77		3.871
9/9/2009	3.768	0.00		70		3.768
9/10/2009	3.799	0.00		64		3.799
9/11/2009	3.762	0.01		62		3.762
9/12/2009	5.835	0.64		62	5.835	
9/13/2009	4.662	0.00		79	4.662	
9/14/2009	3.962	0.00		74	3.962	
9/15/2009	3.758	0.00		75		3.758
9/16/2009	3.769	0.00		61		3.769
9/17/2009	3.509	0.00		61		3.509
9/18/2009	3.360	0.03		72		3.36
9/19/2009	3.110	0.00		63		3.11
9/20/2009	3.039	0.00		73		3.039
9/21/2009	3.046	0.00		70		3.046
9/22/2009	2.981	0.01		74		2.981
9/23/2009	3.024	0.00		82		3.024
9/24/2009	3.261	0.00		77		3.261
9/25/2009	3.352	0.00		65		3.352
9/26/2009	3.319	0.00		59		3.319
9/27/2009	4.059	0.33		64	4.059	
9/28/2009	4.602	0.61		74	4.602	
9/29/2009	4.699	0.09		68	4.699	
9/30/2009	3.500	0.00		60	3.5	
10/1/2009	3.479	0.00		54		3.479
10/2/2009	3.395	0.00		59		3.395
10/3/2009	5.467	0.75		62	5.467	
10/4/2009	3.773	0.00		65	3.773	
10/5/2009	3.805	0.00		65	3.805	
10/6/2009	3.660	0.00		65		3.66

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
10/7/2009	7.700	0.94		66	7.7	
10/8/2009	4.163	0.00		61	4.163	
10/9/2009	4.003	0.04		60	4.003	
10/10/2009	3.986	0.07		64	3.986	
10/11/2009	3.663	0.00		58		3.663
10/12/2009	3.603	0.00		55		3.603
10/13/2009	4.256	0.24		50	4.256	
10/14/2009	3.765	0.00		51		3.765
10/15/2009	3.689	0.00		42		3.689
10/16/2009	3.909	0.00		45		3.909
10/17/2009	3.744	0.00		50		3.744
10/18/2009	5.226	0.49		41	5.226	
10/19/2009	4.235	0.00		56	4.235	
10/20/2009	3.465	0.00		63		3.465
10/21/2009	3.360	0.00		65		3.36
10/22/2009	3.405	0.03		56		3.405
10/23/2009	3.461	0.00		46		3.461
10/24/2009	6.386	0.93		64	6.386	
10/25/2009	5.348	0.00		63	5.348	
10/26/2009	4.232	0.00		59	4.232	
10/27/2009	4.219	0.02		52	4.219	
10/28/2009	7.498	0.65		48	7.498	
10/29/2009	5.344	0.00		51	5.344	
10/30/2009	4.746	0.00		53	4.746	
10/31/2009	4.634	0.06		73	4.634	
11/1/2009	4.266	0.00		60		4.266
11/2/2009	4.312	0.00		50		4.312
11/3/2009	4.256	0.00		56		4.256
11/4/2009	4.092	0.00		49		4.092
11/5/2009	4.173	0.00		45		4.173
11/6/2009	4.112	0.00		47		4.112
11/7/2009	3.855	0.00		48		3.855
11/8/2009	3.758	0.00		66		3.758
11/9/2009	3.695	0.00		69		3.695
11/10/2009	3.648	0.00		65		3.648
11/11/2009	3.668	0.00		50		3.668
11/12/2009	3.564	0.00		50		3.564
11/13/2009	3.571	0.00		49		3.571
11/14/2009	11.945	2.73	0	54	11.945	
11/15/2009	13.883	0.07	0	61	13.883	
11/16/2009	8.231	0.00		57	8.231	
11/17/2009	6.686	0.00		50	6.686	
11/18/2009	6.027	0.00		52	6.027	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
11/19/2009	5.605	0.00		60	5.605	
11/20/2009	6.012	0.17		64	6.012	
11/21/2009	5.132	0.00		59	5.132	
11/22/2009	4.843	0.00		48	4.843	
11/23/2009	4.718	0.00		47	4.718	
11/24/2009	4.674	0.01	0	50	4.674	
11/25/2009	4.574	0.05		47	4.574	
11/26/2009	4.176	0.02	0	47	4.176	
11/27/2009	11.280	1.12		45	11.28	
11/28/2009	8.173	0.02	0	49	8.173	
11/29/2009	6.637	0.00	0	53	6.637	
11/30/2009	6.442	0.08		48	6.442	
12/1/2009	5.853	0.00		42	5.853	
12/2/2009	5.470	0.03		50		5.47
12/3/2009	12.116	1.02		68	12.116	
12/4/2009	7.931	0.00		53	7.931	
12/5/2009	7.096	0.18		41	7.096	
12/6/2009	7.334	0.09		35	7.334	
12/7/2009	6.418	0.00	4	34	6.418	
12/8/2009	6.087	0.00	2	38	6.087	
12/9/2009	14.324	1.52	0	45	14.324	
12/10/2009	13.225	0.00	0	42	13.225	
12/11/2009	9.243	0.00	0	28	9.243	
12/12/2009	7.664	0.00	0	31	7.664	
12/13/2009	9.865	0.69		41	9.865	
12/14/2009	8.737	0.00		42	8.737	
12/15/2009	7.629	0.00		46	7.629	
12/16/2009	7.001	0.00		35		7.001
12/17/2009	6.427	0.00		19		6.427
12/18/2009	5.993	0.00		26		5.993
12/19/2009	5.748	0.00		29		5.748
12/20/2009	5.547	0.05	5	24	5.547	
12/21/2009	5.342	0.01	5	29		5.342
12/22/2009	5.117	0.00	5	29		5.117
12/23/2009	4.914	0.00	4	22		4.914
12/24/2009	4.803	0.00	3	44	4.803	
12/25/2009	4.048	0.00	3	34	4.048	
12/26/2009	4.379	0.04	4	43	4.379	
12/27/2009	9.526	0.54	0	50	9.526	
12/28/2009	6.614	0.11	0	41	6.614	
12/29/2009	5.940	0.00	0	29		5.94
12/30/2009	5.539	0.00	0	24		5.539
12/31/2009	5.339	0.05	1	28	5.339	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
1/1/2010	5.160	0.04	1	33	5.16	
1/2/2010	5.338	0.10	5	27	5.338	
1/3/2010	5.161	0.01	8	32	5.161	
1/4/2010	5.039	0.00	7	32	5.039	
1/5/2010	4.816	0.00	7	33	4.816	
1/6/2010	4.596	0.00	6	32	4.596	
1/7/2010	4.455	0.00	5	36	4.455	
1/8/2010	4.340	0.00	5	25		4.34
1/9/2010	4.121	0.00	5	23		4.121
1/10/2010	4.051	0.00	4	26		4.051
1/11/2010	4.143	0.00	4	33	4.143	
1/12/2010	4.021	0.00	4	28		4.021
1/13/2010	3.986	0.00	3	27		3.986
1/14/2010	3.950	0.00	3	32	3.95	
1/15/2010	4.029	0.00	2	43	4.029	
1/16/2010	3.796	0.00	2	47	3.796	
1/17/2010	4.250	0.17	2	38	4.25	
1/18/2010	5.148	0.22	5	33	5.148	
1/19/2010	4.615	0.39	8	32	4.615	
1/20/2010	4.641	0.05		34	4.641	
1/21/2010	4.543	0.00	10	35	4.543	
1/22/2010	4.369	0.00	10	34	4.369	
1/23/2010	4.153	0.00	10	34	4.153	
1/24/2010	4.103	0.05	9	38	4.103	
1/25/2010	11.472	0.78	2	51	11.472	
1/26/2010	11.421	0.00	0	46	11.421	
1/27/2010	8.179	0.00	0	44	8.179	
1/28/2010	7.164	0.00	0	35		7.164
1/29/2010	6.321	0.00	0	18		6.321
1/30/2010	5.760	0.00	0	22		5.76
1/31/2010	5.592	0.00	0	28		5.592
2/1/2010	5.297	0.00	0	34		5.297
2/2/2010	5.024	0.00	0	31		5.024
2/3/2010	4.862	0.00	0	31		4.862
2/4/2010	4.639	0.00	0	30		4.639
2/5/2010	4.429	0.00	0	33		4.429
2/6/2010	4.353	0.00	0	24		4.353
2/7/2010	4.197	0.00	0	30		4.197
2/8/2010	4.126	0.00	0	31		4.126
2/9/2010	4.054	0.00	0	41		4.054
2/10/2010	4.176	0.00	0	34		4.176
2/11/2010	4.169	0.00	0	42		4.169
2/12/2010	3.990	0.00	0	39		3.99

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
2/13/2010	4.089	0.00	0	39		4.089
2/14/2010	4.003	0.00	0	38		4.003
2/15/2010	3.915	0.00	0	42		3.915
2/16/2010	3.923	0.06	6	36	3.923	
2/17/2010	4.084	0.13	8	37	4.084	
2/18/2010	4.433	0.18	6	45	4.433	
2/19/2010	4.237	0.00	4	39	4.237	
2/20/2010	4.051	0.00	3	47	4.051	
2/21/2010	3.984	0.00	2	38	3.984	
2/22/2010	4.039	0.00	0	45		4.039
2/23/2010	4.013	0.00	0	38		4.013
2/24/2010	11.262	1.04	0	41	11.262	
2/25/2010	17.804	1.55	0	43	17.804	
2/26/2010	19.966	0.24	0	43	19.966	
2/27/2010	16.772	0.33	1	37	16.772	
2/28/2010	13.095	0.00	0	38	13.095	
3/1/2010	14.824	0.15	0	48	14.824	
3/2/2010	11.378	0.00	0	44	11.378	
3/3/2010	9.717	0.00	0	37	9.717	
3/4/2010	8.818	0.01	0	37	8.818	
3/5/2010	8.002	0.00		48	8.002	
3/6/2010	7.121	0.00		57	7.121	
3/7/2010	6.557	0.00		58	6.557	
3/8/2010	6.363	0.00		57	6.363	
3/9/2010	6.007	0.00		49		6.007
3/10/2010	5.743	0.00		46		5.743
3/11/2010	5.686	0.13		44	5.686	
3/12/2010	5.592	0.01		41		5.592
3/13/2010	6.155	0.27		42	6.155	
3/14/2010	19.530	3.04		40	19.53	
3/15/2010	19.927	1.30		45	19.927	
3/16/2010	19.800	0.00		55	19.8	
3/17/2010	16.351	0.00		65	16.351	
3/18/2010	12.603	0.00		64	12.603	
3/19/2010	10.355	0.00		62	10.355	
3/20/2010	8.927	0.00		71	8.927	
3/21/2010	7.963	0.00		49	7.963	
3/22/2010	7.576	0.07		44	7.576	
3/23/2010	16.201	2.30		43	16.201	
3/24/2010	17.203	0.16	0	46	17.203	
3/25/2010	13.726	0.00		62	13.726	
3/26/2010	11.913	0.17		46	11.913	
3/27/2010	9.649	0.00		35	9.649	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
3/28/2010	8.642	0.00		42	8.642	
3/29/2010	13.250	1.35		51	13.25	
3/30/2010	18.495	3.01		48	18.495	
3/31/2010	18.532	0.08		48	18.532	
4/1/2010	16.663	0.00		61	16.663	
4/2/2010	13.695	0.00		61	13.695	
4/3/2010	11.106	0.00		72	11.106	
4/4/2010	9.550	0.00		76	9.55	
4/5/2010	8.474	0.00		68	8.474	
4/6/2010	7.726	0.02		65	7.726	
4/7/2010	7.180	0.00	0	87	7.18	
4/8/2010	6.644	0.00		59	6.644	
4/9/2010	7.855	0.48		50	7.855	
4/10/2010	6.898	0.00	0	58	6.898	
4/11/2010	6.190	0.00		67		6.19
4/12/2010	5.925	0.00		58		5.925
4/13/2010	5.705	0.00	0	52		5.705
4/14/2010	5.542	0.00		65		5.542
4/15/2010	5.386	0.00		56		5.386
4/16/2010	6.453	0.00		43	6.453	
4/17/2010	9.211	0.00	0	40	9.211	
4/18/2010	7.098	0.00	0	50	7.098	
4/19/2010	6.373	0.00	0	60		6.373
4/20/2010	5.580	0.00		68		5.58
4/21/2010	5.268	0.00		68		5.268
4/22/2010	5.005	0.00		69		5.005
4/23/2010	4.778	0.00		60		4.778
4/24/2010	4.427	0.00		63		4.427
4/25/2010	4.374	0.00		60		4.374
4/26/2010	4.368	0.00		58		4.368
4/27/2010	4.414	0.00		48		4.414
4/28/2010	4.681	0.00		45		4.681
4/29/2010	4.516	0.00	0	57		4.516
4/30/2010	4.034	0.00		72		4.034
5/1/2010	3.855	0.00		74		3.855
5/2/2010	3.779	0.00		76		3.779
5/3/2010	3.832	0.00		82		3.832
5/4/2010	3.666	0.00		80		3.666
5/5/2010	3.589	0.00		77		3.589
5/6/2010	3.558	0.02		75		3.558
5/7/2010	3.662	0.00		68		3.662
5/8/2010	5.152	0.61		54	5.152	
5/9/2010	3.919	0.00		52	3.919	

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
5/10/2010	3.865	0.00		56	3.865	
5/11/2010	3.766	0.00		56		3.766
5/12/2010	3.764	0.00		57		3.764
5/13/2010	3.760	0.00		68		3.76
5/14/2010	3.866	0.10		64	3.866	
5/15/2010	3.671	0.01		68		3.671
5/16/2010	3.600	0.00		73		3.6
5/17/2010	3.600	0.00		72		3.6
5/18/2010	3.876	0.44		64	3.876	
5/19/2010	13.874	1.68		56	13.874	
5/20/2010	6.695	0.00		82	6.695	
5/21/2010	5.485	0.00		67	5.485	
5/22/2010	4.905	0.00		66	4.905	
5/23/2010	4.574	0.00		66	4.574	
5/24/2010	4.463	0.00		80	4.463	
5/25/2010	4.357	0.00		87	4.357	
5/26/2010	4.350	0.00		92	4.35	
5/27/2010	3.935	0.00		74	3.935	
5/28/2010	3.632	0.00		70		3.632
5/29/2010	3.446	0.01		79		3.446
5/30/2010	3.327	0.00		78		3.327
5/31/2010	3.207	0.00		68		3.207
6/1/2010	3.306	0.00		81		3.306
6/2/2010	3.270	0.00		68		3.27
6/3/2010	6.151	1.21		84	6.151	
6/4/2010	4.218	0.00		78	4.218	
6/5/2010	4.442	0.17		85	4.442	
6/6/2010	6.744	0.89		71	6.744	
6/7/2010	4.691	0.00		73	4.691	
6/8/2010	4.298	0.00		69	4.298	
6/9/2010	4.050	0.01		71	4.05	
6/10/2010	5.671	0.71		56	5.671	
6/11/2010	4.570	0.00		68	4.57	
6/12/2010	4.199	0.11		65	4.199	
6/13/2010	4.175	0.02		61		4.175
6/14/2010	4.208	0.01		72		4.208
6/15/2010	4.163	0.00		77		4.163
6/16/2010	3.910	0.00		71		3.91
6/17/2010	3.955	0.01		70		3.955
6/18/2010	3.855	0.00		87		3.855
6/19/2010	3.533	0.00		86		3.533
6/20/2010	3.471	0.01		87		3.471
6/21/2010	3.564	0.00		86		3.564

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
6/22/2010	3.449	0.00		79		3.449
6/23/2010	4.292	0.35		80	4.292	
6/24/2010	3.851	0.03		87		3.851
6/25/2010	3.591	0.00		82		3.591
6/26/2010	3.384	0.00		81		3.384
6/27/2010	3.457	0.15		75	3.457	
6/28/2010	3.545	0.01		88		3.545
6/29/2010	3.483	0.00		87		3.483
6/30/2010	3.310	0.00		76		3.31
7/1/2010	3.301	0.00		73		3.301
7/2/2010	3.163	0.00		76		3.163
7/3/2010	3.150	0.00		88		3.15
7/4/2010	3.113	0.00		93		3.113
7/5/2010	3.146	0.00		91		3.146
7/6/2010	3.238	0.00		97		3.238
7/7/2010	2.992	0.00		85		2.992
7/8/2010	2.848	0.00		84		2.848
7/9/2010	3.161	0.00		87		3.161
7/10/2010	4.165	0.57		84	4.165	
7/11/2010	4.633	0.30		81	4.633	
7/12/2010	3.487	0.00		82		3.487
7/13/2010	3.514	0.06		84	3.514	
7/14/2010	10.479	2.88		74	10.479	
7/15/2010	4.814	0.01		81	4.814	
7/16/2010	4.582	0.24		82	4.582	
7/17/2010	4.116	0.00		91	4.116	
7/18/2010	3.808	0.00		89	3.808	
7/19/2010	3.952	0.10		86	3.952	
7/20/2010	3.763	0.00		79	3.763	
7/21/2010	4.682	0.34		83	4.682	
7/22/2010	4.144	0.00		82	4.144	
7/23/2010	3.753	0.01		80	3.753	
7/24/2010	3.551	0.00		79	3.551	
7/25/2010	3.402	0.01		87	3.402	
7/26/2010	3.368	0.00		82		3.368
7/27/2010	3.241	0.00		88		3.241
7/28/2010	3.312	0.00		89		3.312
7/29/2010	2.968	0.01		89		2.968
7/30/2010	2.812	0.00		79		2.812
7/31/2010	2.870	0.00		72		2.87
8/1/2010	2.991	0.00		76		2.991
8/2/2010	3.112	0.00		78		3.112
8/3/2010	3.129	0.00		85		3.129

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
8/4/2010	3.251	0.08		92	3.251	
8/5/2010	3.623	0.33		85	3.623	
8/6/2010	2.985	0.00		85		2.985
8/7/2010	2.712	0.00		74		2.712
8/8/2010	2.658	0.01		85		2.658
8/9/2010	3.681	2.51		92	3.681	
8/10/2010	8.625	0.09		86	8.625	
8/11/2010	4.641	0.05		78	4.641	
8/12/2010	4.117	0.00		73	4.117	
8/13/2010	3.819	0.00		74	3.819	
8/14/2010	3.519	0.00		78	3.519	
8/15/2010	3.310	0.00		77	3.31	
8/16/2010	3.415	0.10		78	3.415	
8/17/2010	3.590	0.13		85	3.59	
8/18/2010	3.286	0.00		82	3.286	
8/19/2010	3.326	0.00		80	3.326	
8/20/2010	3.218	0.00		81	3.218	
8/21/2010	3.014	0.00		75		3.014
8/22/2010	2.890	0.02		70		2.89
8/23/2010	3.267	0.12		66	3.267	
8/24/2010	3.220	0.26		68	3.22	
8/25/2010	13.073	3.06		64	13.073	
8/26/2010	6.577	0.00		83	6.577	
8/27/2010	4.994	0.00		76	4.994	
8/28/2010	4.325	0.00		82	4.325	
8/29/2010	4.026	0.00		92	4.026	
8/30/2010	3.930	0.00		90	3.93	
8/31/2010	3.789	0.00		94	3.789	
9/1/2010	3.709	0.00		92	3.709	
9/2/2010	3.568	0.00		94	3.568	
9/3/2010	3.558	0.18		84	3.558	
9/4/2010	4.184	0.16		82	4.184	
9/5/2010	3.276	0.00		73	3.276	
9/6/2010	3.289	0.00		77	3.289	
9/7/2010	3.383	0.00		84		3.383
9/8/2010	3.651	0.08		82	3.651	
9/9/2010	3.781	0.00		73		3.781
9/10/2010	3.713	0.00		71		3.713
9/11/2010	3.393	0.00		69		3.393
9/12/2010	3.352	0.00		63		3.352
9/13/2010	3.815	0.19		65	3.815	
9/14/2010	3.411	0.01		73		3.411
9/15/2010	3.249	0.00		67		3.249

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
9/16/2010	3.171	0.08		67	3.171	
9/17/2010	5.314	0.70		66	5.314	
9/18/2010	3.200	0.00		67	3.2	
9/19/2010	3.065	0.00		70	3.065	
9/20/2010	3.121	0.00		70		3.121
9/21/2010	3.068	0.00		70		3.068
9/22/2010	3.012	0.00		84		3.012
9/23/2010	2.971	0.00		69		2.971
9/24/2010	3.118	0.00		86		3.118
9/25/2010	3.012	0.00		86		3.012
9/26/2010	2.928	0.00		63		2.928
9/27/2010	3.063	0.10		58	3.063	
9/28/2010	4.125	0.52		74	4.125	
9/29/2010	3.207	0.00		81	3.207	
9/30/2010	3.076	0.02		74		3.076
10/1/2010	7.347	1.38		77	7.347	
10/2/2010	3.886	0.00	0	64	3.886	
10/3/2010	3.333	0.00		58	3.333	
10/4/2010	3.526	0.06		59	3.526	
10/5/2010	3.427	0.01		60	3.427	
10/6/2010	6.612	0.66		57	6.612	
10/7/2010	4.570	0.03	0	63	4.57	
10/8/2010	3.901	0.00		73	3.901	
10/9/2010	3.649	0.00		58		3.649
10/10/2010	3.462	0.00		65		3.462
10/11/2010	3.484	0.00		65		3.484
10/12/2010	3.438	0.00		61		3.438
10/13/2010	3.317	0.00		60		3.317
10/14/2010	3.266	0.04		59		3.266
10/15/2010	12.834	2.61	0	59	12.834	
10/16/2010	5.927	0.00		57	5.927	
10/17/2010	4.739	0.00		63	4.739	
10/18/2010	4.024	0.00		57	4.024	
10/19/2010	3.975	0.00		57	3.975	
10/20/2010	4.028	0.00		60	4.028	
10/21/2010	3.995	0.03		57	3.995	
10/22/2010	3.788	0.00		45	3.788	
10/23/2010	3.508	0.00		53	3.508	
10/24/2010	3.523	0.00		45	3.523	
10/25/2010	3.560	0.01		55	3.56	
10/26/2010	3.530	0.03	0	67	3.53	
10/27/2010	3.869	0.21		72	3.869	
10/28/2010	3.544	0.01	0	72		3.544

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
10/29/2010	3.431	0.02		55		3.431
10/30/2010	3.304	0.00		54		3.304
10/31/2010	3.203	0.00		53		3.203
11/1/2010	3.280	0.00		50		3.28
11/2/2010	3.186	0.00		48		3.186
11/3/2010	3.268	0.00		47		3.268
11/4/2010	7.649	0.95		50	7.649	
11/5/2010	6.893	0.43	0	59	6.893	
11/6/2010	4.730	0.00		47	4.73	
11/7/2010	4.478	0.12		44	4.478	
11/8/2010	12.317	0.96	0	48	12.317	
11/9/2010	6.899	0.09	0	54	6.899	
11/10/2010	6.213	0.06		49	6.213	
11/11/2010	5.584	0.00	0	54	5.584	
11/12/2010	5.020	0.00		59	5.02	
11/13/2010	4.742	0.00		65		4.742
11/14/2010	4.465	0.00		49		4.465
11/15/2010	4.300	0.00		51		4.3
11/16/2010	4.168	0.01	0	52		4.168
11/17/2010	10.684	1.34	0	61	10.684	
11/18/2010	6.486	0.00	0	51	6.486	
11/19/2010	5.784	0.00		43	5.784	
11/20/2010	5.366	0.00		52	5.366	
11/21/2010	4.932	0.00		37	4.932	
11/22/2010	4.711	0.00		47	4.711	
11/23/2010	4.711	0.00	0	49		4.711
11/24/2010	4.419	0.00		46		4.419
11/25/2010	3.941	0.00		38		3.941
11/26/2010	5.149	0.42	0	40	5.149	
11/27/2010	4.327	0.00		42	4.327	
11/28/2010	5.409	0.00		44		5.409
11/29/2010	4.037	0.00		44		4.037
11/30/2010	3.986	0.00		47		3.986
12/1/2010	5.710	0.60		51	5.71	
12/2/2010	5.292	0.01		51	5.292	
12/3/2010	4.842	0.00		40	4.842	
12/4/2010	4.615	0.00		40		4.615
12/5/2010	4.485	0.00		32		4.485
12/6/2010	4.357	0.00		32		4.357
12/7/2010	4.221	0.00		34		4.221
12/8/2010	3.994	0.00		31		3.994
12/9/2010	3.861	0.00		27		3.861
12/10/2010	3.716	0.00		25		3.716

Table 2
Flow and Precipitation Data

Date	Daily Flow (MGD)	City Hall Precip (in)	NOAA Snow Pack Depth (in)	NOAA Max of Dry Bulb Temp (F)2	Parsed Wet Weather Daily Flow (MGD)	Parsed Dry Weather Daily Flow (MGD)
12/11/2010	3.746	0.00		44		3.746
12/12/2010	6.923	1.15		52	6.923	
12/13/2010	8.615	0.39		52	8.615	
12/14/2010	6.084	0.00		37	6.084	
12/15/2010	5.429	0.00		21	5.429	
12/16/2010	5.072	0.00		30	5.072	
12/17/2010	4.671	0.00		34	4.671	
12/18/2010	4.410	0.00		36		4.41
12/19/2010	4.558	0.00		35		4.558
12/20/2010	4.329	0.01	0	30		4.329
12/21/2010	4.471	0.00	0	43		4.471
12/22/2010	4.381	0.02	0	35		4.381
12/23/2010	4.600	0.02	1	40	4.6	
12/24/2010	4.136	0.00	1	38	4.136	
12/25/2010	3.566	0.00	1	30		3.566
12/26/2010	3.756	0.00	1	26		3.756
12/27/2010	4.207	0.03	8	31		4.207
12/28/2010	3.808	0.00	8	31		3.808
12/29/2010	3.705	0.00	8	37	3.705	
12/30/2010	3.782	0.00	7	42	3.782	
12/31/2010	3.781	0.00	7	50	3.781	
Average	5.78				6.77	4.30
90^{th} %	9.216					5.787
91.7^{th} %	9.941					5.994
95^{th} %	11.819					6.366
99^{th} %	17.226					7.326
99.7^{th} %	19.385					7.619
100^{th} %	19.966					7.734
Count	1096				654	441

Attachment B

DRAFT Memorandum, Load Component of Task 1.3. Flow Evaluation, June 3, 2011

AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com

781.246.5200 tel
781.245.6293 fax

DRAFT Memorandum

To	Peter Rice, City Engineer	Page	1 of 13
CC	David Allen, Deputy Director and Paula Anania, Chief Operator		
Subject	Load Component of Task 1.3. Flow Evaluation WWMP Piloting – Phase I Engineering Evaluation Peirce Island WWTF, Portsmouth, New Hampshire		
From	Terry Desmarais and Jon Pearson		
Date	June 3, 2011		

In the Memorandum titled "Task 1.3 Flow Evaluation" dated May 23, 2011, AECOM presented the results of a flow evaluation to identify the dry weather design flows for the secondary treatment upgrade as part of our agreement and for the purpose of discussion with regulatory authorities. This memorandum supplements the flow analysis with the dry weather total suspended solids (TSS) and 5-day biochemical oxygen demand (BOD_5) loadings. The results of the flow and the load analysis are presented in this memorandum along with the loading analysis methodology.

Available Data

A 24-hour flow proportional composite sample of the influent and effluent is collected twice a week at the WWTF for TSS and BOD_5 analysis. The results are reported in the WWTF Monthly Operating Reports (MORs). AECOM used the load data available from the compiled MORs for the period of record in the flow analysis of 2008, 2009 and 2010.

Methodology

For the flow analysis, AECOM parsed dry weather days from the three year data set as described in the flow analysis memorandum. The resulting dry day data set including available influent and effluent TSS and BOD_5 concentrations was used as the basis of this analysis to determine average day loads. It should be noted that because the dry day data set was parsed from a larger database and because TSS and BOD_5 concentrations are only measured twice weekly, there were fewer TSS and BOD_5 data points than dry weather flow data points. The number of data points are presented in the results section of this memorandum.

For maximum month values, The MOR data was used to determine the chemically enhanced primary treatment (CEPT) effluent loadings. This was done by using the entire data set (wet weather and dry weather) and computing loadings based on the daily flow rate and pollutant concentration. For wet weather days where the proposed system would be in a bypass condition around secondary, AECOM computed loads with a maximum flow rate of 7.62 million gallons per day (mgd), the maximum day flow computed in the flow analysis. This essentially sheds load around the secondary system, which is the proposed mode of operation for the system under consideration at the Peirce Island WWTF. The computed loads for the record period were plotted and the monthly moving average was computed. The maximum monthly average value for the record period was used to represent the maximum month load. For the influent raw maximum month wastewater loads, the maximum day load shedding methodology (used for CEPT maximum month as described above) could not be applied because all influent flow will be treated in the primary clarifiers. This will be the case once the plant is upgraded for secondary treatment. Therefore, AECOM used a different methodology to determine the influent maximum month load values. A textbook maximum month to average day peaking factor was applied to the influent average day dry weather loads. For the primary effluent load values, textbook TSS and BOD_5 primary sedimentation removal efficiencies were applied to the influent average day and maximum month load values.

Results

The entire record data set consisted of 1096 points. Of the 1096 data points, 314 TSS and BOD_5 load concentration data points were available. The dry day flow data set consisted of 442 flow data points, which was 40% of the record data set. Of the 442 dry day flow data points, 142 TSS and BOD_5 load concentration data points were available to calculate the average load concentrations. One hundred and forty two (142) data points represents 32% of the dry day flow data set or 13% of the record data set. The full set of data is attached as Table 3 Selected MOR Data. Calculated average concentrations from the dry day data set are shown in the following table:

Table 1 – Average TSS and BOD_5 Concentrations

Criteria	Average Concentration (mg/L)
Influent TSS	180.6
Influent BOD_5	186.7
Effluent TSS	52.3
Effluent BOD_5	106.6

Figure 1, attached, shows the results of the CEPT maximum month computations indicating a maximum month TSS load of 3,600 lb/d and a BOD_5 load of 4,900 lb/d.

For the Peirce Island WWTF, which provides chemically enhanced primary treatment (CEPT), the effluent concentrations represent the chemically enhanced primary treatment wastewater characteristics. Influent wastewater characteristics represent the raw influent. The effluent concentrations, therefore, will be used as the basis for loading calculations to size a proposed secondary treatment system. For certain proposed technologies, chemical addition for enhanced settling may be eliminated. To estimate primary effluent wastewater characteristics (non-CEPT), AECOM used textbook primary clarifier removal efficiencies of 50% for TSS and 30% for BOD_5. The resulting primary effluent average loading concentrations were estimated to be 90 mg/L TSS and 131 mg/L BOD_5.

With the flow rates previously determined, the TSS and BOD_5 loadings conditions are as follows:

Table 2 – Design Flows and Loads

Parameter	Average Day	Max Month PF	Removal Efficiency, %	Max Month
Flow (mgd)	4.30	**1.39**		5.99
Influent TSS (mg/L)	181			**169**
Influent TSS (lb/d)	**6,491**	1.3		**8,438**
Influent BOD_5 (mg/L)	187			**175**
Influent BOD_5 (lb/d)	**6,706**	1.3		**8,718**
Primary Effluent TSS (mg/L)	**91**			**84**
Primary Effluent TSS (lb/d)	**3,246**		50	**4,219**
Primary Effluent BOD_5 (mg/L)	**131**			**122**
Primary Effluent BOD_5 (lb/d)	**4,694**		30	**6,103**
CEPT Effluent TSS (mg/L)	52			**72**
CEPT Effluent TSS (lb/d)	**1,865**			3,600
CEPT Effluent BOD_5 (mg/L)	107			**98**
CEPT Effluent BOD_5 (lb/d)	**3,837**			4,900

Note: Values shown in bold were calculated for this table. Flow and load values not shown in bold were developed from MOR data. Peaking factors not shown in bold were taken from Figures 5-6(a) and 5-6(b) of "Wastewater Engineering Treatment, Disposal and Reuse", 3rd Edition, p. 161, Metcalf & Eddy, 1991. Removal efficiencies not shown bold were based on published removal efficiencies from "Wastewater Engineering Treatment, Disposal and Reuse", 3rd Edition, Metcalf & Eddy, 1991.

Secondary reactor and aeration sizing will be based on the average day and maximum monthly loading conditions.

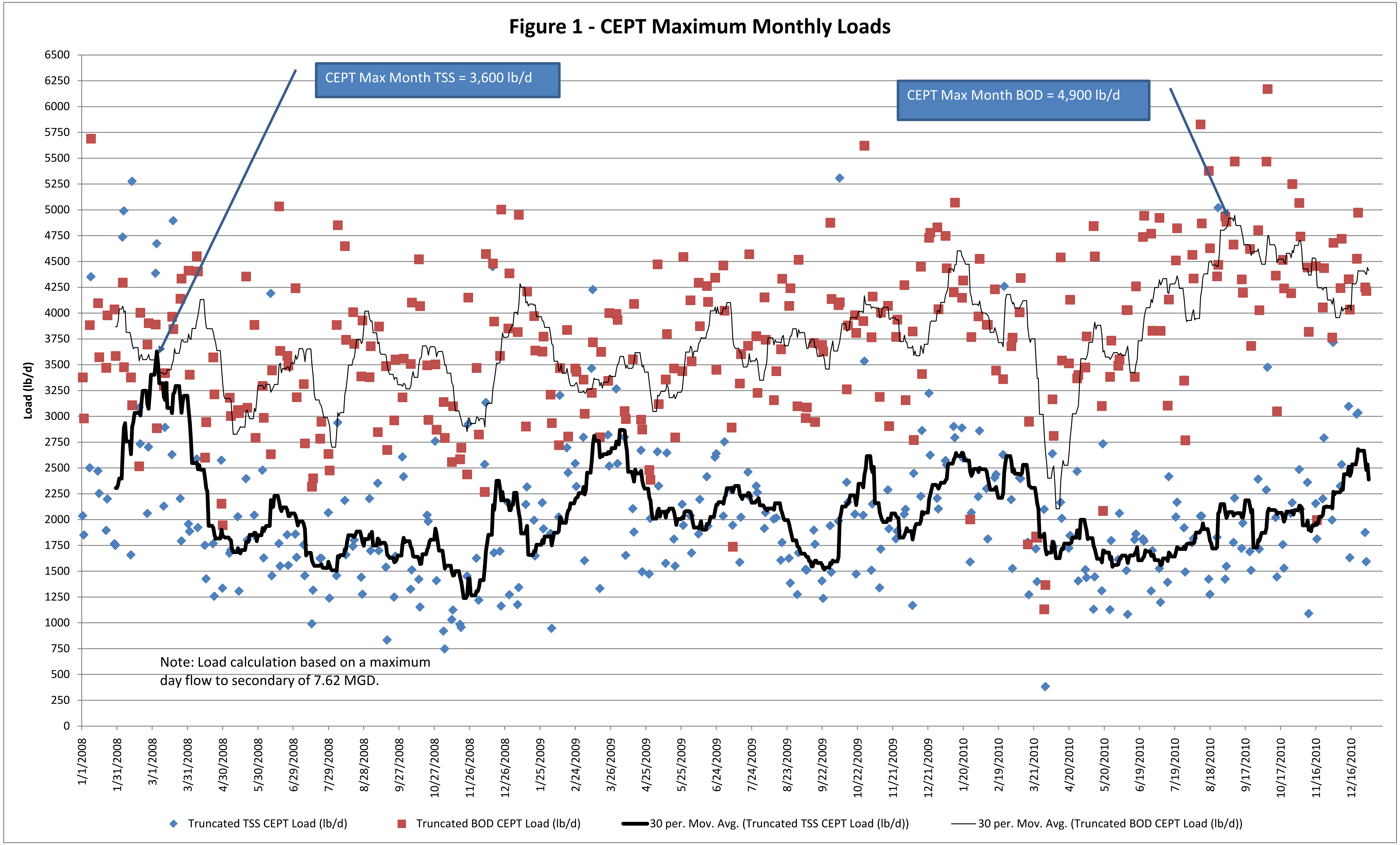


Figure 1 - CEPT Maximum Monthly Loads
CEPT Max Month TSS = 3,600 lb/d
CEPT Max Month BOD = 4,900 lb/d
Load (lb/d)
6500
6250
6000
5750
5500
5250
5000
4750
4500
4250
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
Note: Load calculation based on a maximum
day flow to secondary of 7.62 MGD.
1/1/2008
1/31/2008
3/1/2008
3/31/2008
4/30/2008
5/30/2008
6/29/2008
7/29/2008
8/28/2008
9/27/2008
10/27/2008
11/26/2008
12/26/2008
1/25/2009
2/24/2009
3/26/2009
4/25/2009
5/25/2009
6/24/2009
7/24/2009
8/23/2009
9/22/2009
10/22/2009
11/21/2009
12/21/2009
1/20/2010
2/19/2010
3/21/2010
4/20/2010
5/20/2010
6/19/2010
7/19/2010
8/18/2010
9/17/2010
10/17/2010
11/16/2010
12/16/2010
Truncated TSS CEPT Load (lb/d)
Truncated BOD CEPT Load (lb/d)
30 per. Mov. Avg. (Truncated TSS CEPT Load (lb/d))
30 per. Mov. Avg. (Truncated BOD CEPT Load (lb/d))

Table 3
Selected MOR Data

Date	Parsed Dry Flow Data (MGD)	Parsed Dry Influent TSS (mg/L)	Parsed Dry Effluent TSS (mg/L)	Parsed Dry Influent BOD (mg/L)	Parsed Dry Effluent BOD (mg/L)
1/3/2008	5.995	120.0	37.0	141.3	59.6
1/4/2008	5.523				
1/16/2008	6.069	88.5	44.5	118.7	70.6
1/24/2008	5.011				
1/26/2008	4.427				
2/12/2008	5.843	110.5	34.0	121.9	69.3
2/29/2008	5.558				
3/16/2008	7.734				
3/17/2008	7.062				
3/18/2008	6.705	96.0	47.0	112.1	70.9
3/26/2008	5.51	117.5	39.0	148.6	94.3
3/27/2008	5.253				
3/29/2008	6.166				
4/2/2008	6.646	85.5	34.0	106.8	61.4
4/3/2008	6.005				
4/6/2008	6.719				
4/7/2008	6.366				
4/8/2008	5.905	113.5	52.5	141.3	92.4
4/9/2008	5.618	114.0	41.0	145.5	94.0
4/10/2008	5.32				
4/14/2008	4.819				
4/15/2008	4.612	125.5	45.5	130.1	67.6
4/16/2008	4.497	128.5	38.0	148.5	78.5
4/17/2008	4.421				
4/18/2008	4.38				
4/19/2008	4.155				
4/20/2008	4.039				
4/21/2008	4.051				
4/22/2008	3.994	159.5	53.0	184.0	107.2
4/23/2008	3.964	160.5	38.0	205.6	97.2
4/24/2008	3.902				
4/25/2008	3.829				
4/26/2008	3.616				
4/27/2008	3.465				
5/11/2008	4.467				
5/12/2008	4.455				
5/13/2008	4.264	178.5	57.0	188.1	86.1
5/14/2008	4.12	138.5	38.0	180.9	88.2
5/15/2008	3.978				
5/18/2008	3.78				
5/19/2008	3.826				
5/20/2008	3.682	200.5	78.0	246.5	141.8
5/21/2008	3.66	165.5	59.0	238.8	101.0
5/22/2008	3.607				
5/24/2008	3.348				
5/25/2008	3.181				
5/26/2008	3.177				
5/28/2008	3.241	209.0	68.0	247.2	103.3
5/29/2008	3.214				
5/30/2008	3.172				
6/1/2008	3.194				

Table 3
Selected MOR Data

Date	Parsed Dry Flow Data (MGD)	Parsed Dry Influent TSS (mg/L)	Parsed Dry Effluent TSS (mg/L)	Parsed Dry Influent BOD (mg/L)	Parsed Dry Effluent BOD (mg/L)
6/2/2008	3.276				
6/3/2008	3.3	228.5	90.0	248.3	119.7
6/8/2008	3.457				
6/9/2008	3.532				
6/13/2008	3.211				
6/30/2008	4.097				
7/2/2008	3.917	170.0	50.0	159.0	97.5
7/5/2008	3.713				
7/6/2008	3.598				
7/7/2008	3.667				
7/8/2008	3.568	218.0	59.0	220.4	111.3
7/10/2008	3.455				
7/11/2008	3.515				
7/12/2008	3.136				
7/13/2008	3.098				
7/14/2008	3.194				
7/15/2008	3.124	263.0	38.0	247.2	89.0
7/16/2008	3.093	234.5	51.0	231.8	93.0
7/17/2008	3.081				
8/5/2008	4.654	155.5	37.5	174.0	100.1
8/10/2008	4.557				
8/15/2008	4.388				
8/17/2008	4.099				
8/18/2008	4.096				
8/19/2008	3.937	182.0	53.0	205.9	122.1
8/20/2008	3.787	178.0	57.0	213.2	117.2
8/21/2008	3.454				
8/22/2008	3.584				
8/23/2008	3.397				
8/24/2008	3.757				
8/25/2008	3.879				
8/26/2008	3.291	187.5	52.5	223.8	123.4
8/27/2008	3.362	156.5	45.5	241.0	140.1
8/28/2008	3.278				
8/29/2008	3.231				
8/30/2008	3.067				
8/31/2008	2.95				
9/1/2008	2.885				
9/2/2008	3.143	214.5	84.0	246.1	128.9
9/3/2008	3.131	210.0	65.0	293.2	140.9
9/4/2008	3.117				
9/5/2008	2.973				
9/20/2008	3.766				
9/22/2008	4.046				
9/23/2008	3.117	180.5	48.0	214.1	113.9
9/24/2008	3.686	173.0	53.5	221.6	115.5
9/25/2008	3.824				
10/10/2008	4.964				
10/11/2008	4.681				
10/12/2008	4.597				
10/13/2008	4.705				

Table 3
Selected MOR Data

Date	Parsed Dry Flow Data (MGD)	Parsed Dry Influent TSS (mg/L)	Parsed Dry Effluent TSS (mg/L)	Parsed Dry Influent BOD (mg/L)	Parsed Dry Effluent BOD (mg/L)
10/14/2008	4.602	182.5	37.0	183.9	117.8
10/15/2008	4.529	155.0	30.5	203.1	107.7
10/17/2008	4.524				
10/18/2008	4.307				
10/19/2008	4.217				
10/20/2008	4.227				
10/23/2008	4.23				
10/24/2008	4.097				
11/1/2008	4.576				
11/2/2008	4.426				
11/3/2008	4.401				
11/4/2008	4.321	137.5	25.5	175.7	87.1
11/5/2008	4.263	141.5	21.0	204.0	78.5
11/7/2008	4.592				
11/9/2008	4.478				
11/10/2008	4.302				
11/11/2008	4.258	148.0	29.0	213.3	72.0
11/12/2008	4.207	149.0	32.0	204.9	88.3
11/17/2008	5.018				
11/18/2008	4.918	128.5	24.0	152.3	63.0
11/19/2008	4.768	109.5	24.0	158.6	67.8
11/20/2008	4.617				
11/21/2008	4.414				
11/22/2008	4.191				
11/23/2008	4.068				
11/24/2008	4.048	126.5	43.0	128.4	72.2
12/3/2008	6.739				
12/4/2008	6.213	40.5	23.5	88.0	54.5
12/5/2008	5.735				
12/6/2008	5.436				
12/7/2008	5.275				
12/8/2008	4.969				
12/9/2008	4.9	156.0	62.0	168.4	55.5
12/23/2008	5.356	137.0	26.0	150.5	112.0
1/1/2009	7.301				
1/2/2009	6.828				
1/3/2009	6.325				
1/10/2009	5.326				
1/11/2009	5.358				
1/12/2009	5.269				
1/14/2009	5.047	129.0	55.0	166.8	100.0
1/15/2009	4.843				
1/16/2009	4.662				
1/17/2009	4.585				
1/20/2009	4.466	155.0	53.5	193.7	106.6
1/21/2009	4.437	164.5	44.5	185.9	98.3
1/25/2009	4.156				
1/26/2009	4.166				
1/27/2009	4.115	173.0	63.0	214.1	105.7
2/4/2009	4.36	146.0	26.0	150.0	80.7
2/5/2009	4.234				

Table 3
Selected MOR Data

Date	Parsed Dry Flow Data (MGD)	Parsed Dry Influent TSS (mg/L)	Parsed Dry Effluent TSS (mg/L)	Parsed Dry Influent BOD (mg/L)	Parsed Dry Effluent BOD (mg/L)
2/6/2009	4.222				
2/9/2009	4.792				
3/3/2009	7.712	92.0	44.0	94.3	52.8
3/4/2009	7.113	81.0	27.0	105.8	51.0
3/17/2009	7.422	88.0	21.5	96.5	45.2
3/18/2009	7.342	101.5	45.5	106.3	59.2
3/19/2009	7.398				
3/20/2009	7.042				
3/21/2009	6.581				
3/22/2009	6.33				
3/23/2009	6.151				
3/24/2009	5.879	155.5	57.5	160.3	68.2
3/25/2009	5.806	169.0	52.0	139.0	82.6
3/28/2009	5.673				
4/12/2009	6.59				
4/13/2009	6.317				
4/14/2009	6.008	98.0	42.0	121.7	70.9
4/15/2009	5.775	122.0	39.0	134.0	84.9
4/16/2009	5.601				
4/17/2009	5.408				
4/18/2009	5.172				
4/19/2009	5.031				
4/20/2009	4.967				
4/28/2009	5.784	186.0	30.5	161.3	51.4
4/29/2009	5.478	106.0	44.0	124.5	52.2
4/30/2009	5.297				
5/1/2009	5.177				
5/2/2009	4.932				
5/3/2009	4.82				
5/4/2009	4.73				
5/12/2009	5.725	133.0	33.0	131.6	70.3
5/13/2009	5.42	122.5	58.5	141.7	84.0
5/15/2009	5.123				
5/16/2009	4.855				
5/19/2009	4.823	152.5	45.0	153.2	86.1
5/20/2009	4.586	144.0	40.5	151.0	73.1
5/21/2009	4.477				
5/22/2009	4.402				
5/23/2009	4.203				
5/24/2009	4.103				
5/25/2009	4.055				
5/26/2009	4.086	188.5	63.0	175.1	100.9
6/2/2009	4.399	158.5	55.5	191.4	112.4
6/3/2009	4.186	202.0	48.0	199.4	101.2
6/4/2009	4.145				
6/5/2009	4.043				
6/6/2009	3.903				
6/7/2009	3.839				
6/8/2009	3.856				
6/10/2009	3.841	193.0	68.5	115.3	120.9
6/27/2009	6.126				

Table 3
Selected MOR Data

Date	Parsed Dry Flow Data (MGD)	Parsed Dry Influent TSS (mg/L)	Parsed Dry Effluent TSS (mg/L)	Parsed Dry Influent BOD (mg/L)	Parsed Dry Effluent BOD (mg/L)
7/1/2009	7.022	112.0	47.0	119.0	68.7
7/10/2009	6.723				
7/11/2009	5.787				
7/13/2009	5.498				
7/14/2009	5.068	136.0	37.5	123.2	78.5
7/15/2009	4.898	160.5	49.5	157.3	88.2
7/16/2009	4.801				
7/17/2009	4.772				
7/19/2009	4.487				
7/20/2009	4.516				
8/6/2009	5.044				
8/7/2009	4.879				
8/8/2009	4.553				
8/9/2009	4.384				
8/10/2009	4.495				
8/14/2009	4.475	146.0	54.0	148.4	92.1
8/15/2009	4.274				
8/16/2009	4.076				
8/17/2009	4.239				
8/18/2009	4.14	191.0	46.5	194.7	105.7
8/19/2009	4.097	177.5	52.0	171.9	126.8
8/20/2009	4.149				
8/25/2009	4.057	214.0	48.0	219.2	120.3
8/26/2009	3.951	244.5	42.0	217.9	128.7
8/27/2009	3.751				
9/7/2009	3.81				
9/8/2009	3.871	170.5	47.0	175.7	92.4
9/9/2009	3.768	158.0	48.0	165.3	98.2
9/10/2009	3.799				
9/11/2009	3.762				
9/15/2009	3.758	217.5	60.5	193.3	118.4
9/16/2009	3.769	172.5	56.0	151.5	93.7
9/17/2009	3.509				
9/18/2009	3.36				
9/19/2009	3.11				
9/20/2009	3.039				
9/21/2009	3.046				
9/22/2009	2.981	205.0	56.5	226.7	148.5
9/23/2009	3.024	170.0	49.0	215.8	143.9
9/24/2009	3.261				
9/25/2009	3.352				
9/26/2009	3.319				
10/1/2009	3.479				
10/2/2009	3.395				
10/6/2009	3.66	264.0	65.0	222.0	133.6
10/11/2009	3.663				
10/12/2009	3.603				
10/14/2009	3.765	227.0	69.0	192.2	123.6
10/15/2009	3.689				
10/16/2009	3.909				
10/17/2009	3.744				

Table 3
Selected MOR Data

Date	Parsed Dry Flow Data (MGD)	Parsed Dry Influent TSS (mg/L)	Parsed Dry Effluent TSS (mg/L)	Parsed Dry Influent BOD (mg/L)	Parsed Dry Effluent BOD (mg/L)
10/20/2009	3.465	191.0	71.0	208.9	137.7
10/21/2009	3.36	191.0	52.5	184.8	135.9
10/22/2009	3.405				
10/23/2009	3.461				
11/1/2009	4.266				
11/2/2009	4.312				
11/3/2009	4.256	205.5	42.5	192.2	106.1
11/4/2009	4.092	198.5	63.0	186.8	121.9
11/5/2009	4.173				
11/6/2009	4.112				
11/7/2009	3.855				
11/8/2009	3.758				
11/9/2009	3.695				
11/10/2009	3.648	192.0	44.0	188.5	104.8
11/11/2009	3.668	185.5	56.0	199.0	130.9
11/12/2009	3.564				
11/13/2009	3.571				
12/2/2009	5.47	160.0	46.0	134.4	69.2
12/16/2009	7.001	110.0	49.0	101.1	58.4
12/17/2009	6.427				
12/18/2009	5.993				
12/19/2009	5.748				
12/21/2009	5.342				
12/22/2009	5.117	195.0	75.5	165.4	110.8
12/23/2009	4.914	169.0	64.0	163.1	116.6
12/29/2009	5.94	117.0	44.5	146.4	97.5
12/30/2009	5.539	141.0	45.5	130.6	87.4
1/8/2010	4.34				
1/9/2010	4.121				
1/10/2010	4.051				
1/12/2010	4.021	212.0	86.5	185.7	125.3
1/13/2010	3.986	603.0	84.0	383.7	152.5
1/28/2010	7.164				
1/29/2010	6.321				
1/30/2010	5.76				
1/31/2010	5.592				
2/1/2010	5.297				
2/2/2010	5.024	134.0	53.0	153.1	94.7
2/3/2010	4.862	154.0	70.5	155.6	111.6
2/4/2010	4.639				
2/5/2010	4.429				
2/6/2010	4.353				
2/7/2010	4.197				
2/8/2010	4.126				
2/9/2010	4.054	216.0	68.0	194.5	115.0
2/10/2010	4.176	181.0	52.0	198.6	111.6
2/11/2010	4.169				
2/12/2010	3.99				
2/13/2010	4.089				
2/14/2010	4.003				
2/15/2010	3.915				

Table 3
Selected MOR Data

Date	Parsed Dry Flow Data (MGD)	Parsed Dry Influent TSS (mg/L)	Parsed Dry Effluent TSS (mg/L)	Parsed Dry Influent BOD (mg/L)	Parsed Dry Effluent BOD (mg/L)
2/22/2010	4.039				
2/23/2010	4.013	236.5	78.5	180.9	100.4
3/9/2010	6.007	220.0	48.0	145.7	80.0
3/10/2010	5.743	167.0	50.0	126.2	90.6
3/12/2010	5.592				
4/11/2010	6.19				
4/12/2010	5.925				
4/13/2010	5.705	113.0	45.5	120.1	95.4
4/14/2010	5.542	136.5	43.5	115.5	76.6
4/15/2010	5.386				
4/19/2010	6.373				
4/20/2010	5.58	143.0	37.0	130.0	75.5
4/21/2010	5.268	115.0	42.0	99.8	94.0
4/22/2010	5.005				
4/23/2010	4.778				
4/24/2010	4.427				
4/25/2010	4.374				
4/26/2010	4.368				
4/27/2010	4.414	142.0	67.0	140.7	91.5
4/28/2010	4.681	167.0	36.0	119.6	87.1
4/29/2010	4.516				
4/30/2010	4.034				
5/1/2010	3.855				
5/2/2010	3.779				
5/3/2010	3.832				
5/4/2010	3.666	162.5	49.5	186.7	113.6
5/5/2010	3.589	178.5	48.0	192.5	126.1
5/6/2010	3.558				
5/7/2010	3.662				
5/11/2010	3.766	186.0	36.0	205.1	154.2
5/12/2010	3.764	245.5	46.0	270.4	144.9
5/13/2010	3.76				
5/15/2010	3.671				
5/16/2010	3.6				
5/17/2010	3.6				
5/28/2010	3.632				
5/29/2010	3.446				
5/30/2010	3.327				
5/31/2010	3.207				
6/1/2010	3.306	178.0	58.5	213.7	126.6
6/2/2010	3.27	196.5	75.5	247.7	130.3
6/13/2010	4.175				
6/14/2010	4.208				
6/15/2010	4.163	186.5	52.0	167.2	97.4
6/16/2010	3.91	192.0	57.0	202.1	130.6
6/17/2010	3.955				
6/18/2010	3.855				
6/19/2010	3.533				
6/20/2010	3.471				
6/21/2010	3.564				
6/22/2010	3.449	390.5	63.0	300.9	164.7

Table 3
Selected MOR Data

Date	Parsed Dry Flow Data (MGD)	Parsed Dry Influent TSS (mg/L)	Parsed Dry Effluent TSS (mg/L)	Parsed Dry Influent BOD (mg/L)	Parsed Dry Effluent BOD (mg/L)
6/24/2010	3.851				
6/25/2010	3.591				
6/26/2010	3.384				
6/28/2010	3.545				
6/29/2010	3.483	241.5	45.0	247.2	164.2
6/30/2010	3.31	219.0	61.5	226.3	138.7
7/1/2010	3.301				
7/2/2010	3.163				
7/3/2010	3.15				
7/4/2010	3.113				
7/5/2010	3.146				
7/6/2010	3.238	287.5	56.5	286.5	182.3
7/7/2010	2.992	242.5	48.0	266.0	153.4
7/8/2010	2.848				
7/9/2010	3.161				
7/12/2010	3.487				
7/26/2010	3.368				
7/27/2010	3.241	235.0	71.0	201.5	123.8
7/28/2010	3.312	253.0	54.0	217.6	100.2
7/29/2010	2.968				
7/30/2010	2.812				
7/31/2010	2.87				
8/1/2010	2.991				
8/2/2010	3.112				
8/3/2010	3.129	276.5	68.0	296.4	174.9
8/6/2010	2.985				
8/7/2010	2.712				
8/8/2010	2.658				
8/21/2010	3.014				
8/22/2010	2.89				
9/7/2010	3.383	221.0	63.0	213.3	165.3
9/9/2010	3.781				
9/10/2010	3.713				
9/11/2010	3.393				
9/12/2010	3.352				
9/14/2010	3.411	181.5	60.5	216.0	152.1
9/15/2010	3.249	229.5	72.5	248.4	154.9
9/20/2010	3.121				
9/21/2010	3.068	209.5	66.0	239.7	180.6
9/22/2010	3.012	226.0	60.0	226.5	146.6
9/23/2010	2.971				
9/24/2010	3.118				
9/25/2010	3.012				
9/26/2010	2.928				
9/30/2010	3.076				
10/9/2010	3.649				
10/10/2010	3.462				
10/11/2010	3.484				
10/12/2010	3.438				
10/13/2010	3.317	208.5	73.0	231.4	157.7
10/14/2010	3.266	208.5	53.0	232.5	111.9

Table 3
Selected MOR Data

Date	Parsed Dry Flow Data (MGD)	Parsed Dry Influent TSS (mg/L)	Parsed Dry Effluent TSS (mg/L)	Parsed Dry Influent BOD (mg/L)	Parsed Dry Effluent BOD (mg/L)
10/28/2010	3.544				
10/29/2010	3.431				
10/30/2010	3.304				
10/31/2010	3.203				
11/1/2010	3.28				
11/2/2010	3.186	298.0	93.5	303.7	190.7
11/3/2010	3.268	317.5	77.0	282.6	174.0
11/13/2010	4.742				
11/14/2010	4.465				
11/15/2010	4.3				
11/16/2010	4.168	264.5	62.0	216.0	128.2
11/23/2010	4.711	251.0	71.0	208.7	112.9
11/24/2010	4.419				
11/25/2010	3.941				
11/28/2010	5.409				
11/29/2010	4.037				
11/30/2010	3.986	320.0	60.0	289.3	113.2
12/4/2010	4.615				
12/5/2010	4.485				
12/6/2010	4.357				
12/7/2010	4.221	332.5	66.0	290.8	120.5
12/8/2010	3.994	267.5	76.0	243.3	141.7
12/9/2010	3.861				
12/10/2010	3.716				
12/11/2010	3.746				
12/18/2010	4.41				
12/19/2010	4.558				
12/20/2010	4.329				
12/21/2010	4.471	195.0	81.0	195.4	121.4
12/22/2010	4.381	172.0	83.0	177.0	136.1
12/25/2010	3.566				
12/26/2010	3.756				
12/27/2010	4.207				
12/28/2010	3.808	174.0	59.0	231.4	133.8
Average	**4.30**	**180.6**	**52.3**	**186.7**	**106.6**

Attachment C

Wastewater Characterization Program Raw Data

WWMP Pilot
Wastewater Characterization Data
Peirce Island WWTF, Portsmouth, NH

Sample ID	Average	13-May	20-May	27-May	3-Jun	10-Jun	17-Jun	24-Jun	1-Jul	8-Jul	15-Jul	22-Jul	29-Jul	5-Aug	12-Aug	19-Aug	26-Aug	2-Sep
Average Flow (MGD)	4.81	4.67	10.57	5.56	4.48	4.82	4.37	6.14	4.55	4.108	4.009	3.507	3.344	3.031	3.959	4.192	5.012	4.178
Precipitation (in)	0.11	0.00	0.38	0.00	0.00	0.34	0.00	0.35	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.63	0.00
Raw Temp (deg C)	19.14	14.9	14.6	16.6	16	18.9	19.2	18.3	20.2	19.3	20.3	21.2	21.1	20.5	21.5	0.6321.3	22.1	20.2
Raw pH	6.57	6.28	6.68	5.92	6.58	6.76	6.61	6.71	6.4	6.65	6.31	6.83	6.66	6.58	6.68	6.5	6.64	6.62
Raw Alkalinity (mg/L as $CaCO_3$)	165.88	150	110	160	150	170	150	160	180	180	170	190	180	210	170	180	140	170
Raw FOG (mg/L)	35.29	35	10	35	25	61	57	44	78	19	48	37	19	14	40	24	31	23
Raw TSS (mg/L)	242.53	190	80	140	63	350	160	160	160	200	200	240	220	240	800	220	390	310
Raw VSS (mg/L)	181.24	180	73	120	58	270	150	140	140	170	190	220	200	220	180	190	300	280
Raw BOD_{XX} (mg/L)	178.06	130	87	200	120	160	190	140	130	200	240	190	240	260	160	190	180	210
Raw BOD_{GF} (mg/L)	112.88	100	38	120	71	110	110	93	99	150	140	130	170	140	95	96	97	160
Raw COD_{XX} (mg/L)	454.71	420	200	350	230	570	400	370	420	520	590	460	530	550	400	440	620	660
Raw COD_{GF} (mg/L)	206.82	210	86	200	180	220	210	160	180	270	290	210	260	230	210	200	170	230
Raw COD_{XM} (mg/L)	154.53	150	67	150	120	150	150	110	140	200	220	160	200	180	160	150	130	190
Raw Floc COD (mg/L) or sCOD	133.65	130	56	120	110	130	130	96	110	160	200	130	160	230	130	120	100	160
Raw TKN (mg/L-N)	31.41	27	13	23	23	31	30	30	28	37	36	41	40	42	33	32	33	35
Raw NH_3-N (mg/L-N)	17.28	14	6.7	13	14	15	16	15	15	18	22	24	26	27	17	18	15	18
Raw NO_x-N (mg/L-N)	#DIV/0!	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Raw TP (mg/L-P)	9.46	8.5	4.2	12	7.8	13	7.7	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Raw PO_4-P (mg/L-P)	3.90	3.8	1.6	4.5	3.4	6	3.4	4.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CEPT Temp (deg C)	18.92	14.8	14.2	15.6	15.7	18.3	18	18.5	18.6	19.3	20.8	21.4	21.1	20.9	21.2	21.1	20.8	20.9
CEPT DO (mg/L)	0.86	<0.1	5.7	<0.1	0.2	<1	0.2	0.1	0.2	0.2	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.2
CEPT pH	6.56	6.38	6.52	6.52	6.5	6.53	6.6	6.58	6.62	6.61	6.74	6.62	6.55	6.48	6.55	6.46	6.58	6.62
CEPT Alkalinity (mg/L as CaCO3)	155.29	150	110	140	160	160	150	130	160	160	170	180	170	190	160	160	130	160
CEPT FOG (mg/L)	9.53	8	5	8	7	10	6	9	7	9	13	14	10	16	9	10	10	11
CEPT TSS (mg/L)	68.35	60	48	54	130	69	53	49	60	65	77	71	66	87	71	68	70	64
CEPT VSS (mg/L)	56.82	58	48	44	120	57	42	30	48	51	74	57	49	67	57	58	58	48
CEPT BOD_{XX} (mg/L)	123.12	100	46	100	140	140	110	87	100	130	160	160	160	140	120	130	120	150
CEPT BOD_{GF} (mg/L)	105.12	100	34	90	100	100	90	56	92	120	140	130	160	130	110	96	89	150
CEPT COD_{XX} (mg/L)	244.12	250	110	210	370	270	240	210	230	250	320	260	260	250	220	200	240	260
CEPT COD_{GF} (mg/L)	193.24	210	85	140	200	210	220	180	190	200	270	210	220	210	190	170	180	200
CEPT COD_{XM} (mg/L)	140.65	140	61	100	140	150	160	140	130	150	180	150	170	160	140	130	130	160
CEPT Floc COD (mg/L) or sCOD	127.94	130	54	91	130	140	150	120	120	130	180	140	150	140	130	110	120	140
CEPT TKN (mg/L-N)	26.65	27	12	19	26	25	26	23	25	28	32	35	36	35	28	25	24	27
CEPT NH_3-N (mg/L-N)	17.22	15	6.8	12	15	16	17	14	16	16	22	24	25	26	17	17	16	18
CEPT NO_x-N (mg/L-N)	#DIV/0!	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CEPT TP (mg/L-P)	9.20	9.2	5.3	10	9.5	13	7.7	9.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CEPT PO_4-P (mg/L-P)	3.57	3.3	1.3	3	4	6.6	3.2	3.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Legend:

XX - raw blended sample

GF - glass fiber filtered (1.2µm)

XM - membrane filtered (0.45µm)

Floc -flocculated and membrane filtered (0.45µm)

Date - date of collection

Average Flow (MGD) and Precipitation (in) is data for day 24 hour composite sample began

N/A - Sampling and analysis for parameter was discontinued

Attachment D

Memorandum, Request for Preliminary Sizing and Cost Estimate, June 7, 2011

AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com

781.246.5200 tel
781.245.6293 fax

Memorandum

To	Selected Vendor	No. Pages	5
CC	Jon Pearson, Peter Rice		
Subject	Request for Preliminary Sizing and Cost Estimate WWMP Pilot – Phase I Engineering Evaluation Peirce Island WWTF, Portsmouth, New Hampshire		
From	Terry Desmarais		
Date	June 7, 2011		

AECOM is working with Portsmouth, NH to review options to upgrade the Peirce Island WWTF. This is a follow-up to work completed in the fall of 2010. At the end of this evaluation phase, AECOM will work with the City to shortlist two to three technologies to be subsequently piloted at the Peirce Island WWTF. The target date to have an operational pilot is late August or early September 2011.

As part of the current phase of work, AECOM is revisiting the preliminary process sizing based on revised flows and loads after evaluating three years of historical data and in more detail than was completed in 2010. This memorandum summarizes the flow and load criteria and proposed concepts under consideration for sizing the treatment technology.

Previous Work in Fall 2010

This work follows a preliminary evaluation completed in the fall of 2010, where vendors were asked to provide preliminary sizing for facilities. At that time, the sizing was limited to retrofitting the existing 8 filter cells in the Filter Building for the new facilities. Flow was based on average and max day conditions where flow in excess of the maximum day rate would be bypassed around secondary treatment. Loadings for the 2010 criteria were based on effluent from the WWTF's existing chemically enhanced primary treatment (CEPT) system, so loads were less than conventional primary clarified effluent. A summary of the flow and load conditions provided for preliminary sizing in the fall of 2010 is provided in the following table:

Table 1. 2010 Secondary Flow and Load Criteria

Criteria	Average Day	Max Day
Flow (MGD)	5	7.5
CEPT Effluent BOD_5 (mg/L)	65 to 75	Not provided
CEPT Effluent TSS (mg/L)	55 to 65	Not provided

AECOM

2011 Flow and Load Criteria

AECOM reviewed three years of historical data and parsed out wet and dry flow days. Primary effluent (PE) has been added because as part of the evaluation the benefits of treating conventional (not chemically enhanced) primary effluent will be reviewed. Scenarios under consideration are described in detail later in this memorandum. Based on our analysis, the following flows and loads will be used as the basis of sizing:

Table 2. 2011 Flow and Load Criteria

Parameter	Average Day	Max Month PF	Removal Efficiency, %	Max Month	Max Day
Flow (mgd)	4.30	**1.39**		5.99	7.62
Influent TSS (mg/L)	181			**169**	
Influent TSS (lb/d)	**6,491**	1.3		**8,438**	
Influent BOD_5 (mg/L)	187			**175**	
Influent BOD_5 (lb/d)	**6,706**	1.3		**8,718**	
Primary Effluent TSS (mg/L)	**91**			**84**	
Primary Effluent TSS (lb/d)	**3,246**		50	**4,219**	
Primary Effluent BOD_5 (mg/L)	**131**			**122**	
Primary Effluent BOD_5 (lb/d)	**4,694**		30	**6,103**	
CEPT Effluent TSS (mg/L)	52			**72**	
CEPT Effluent TSS (lb/d)	**1,865**			3,600	
CEPT Effluent BOD_5 (mg/L)	107			**98**	
CEPT Effluent BOD_5 (lb/d)	**3,837**			4,900	
Primary/CEPT Effluent TKN (mg/L)	35			35	
Primary/CEPT Effluent TKN (lb/d)	**1,255**			**1,748**	

Note: Items shown bold were calculated and non-bold items were obtained from MOR data or are textbook values.

Project Goals

The City of Portsmouth is looking to upgrade the existing Peirce Island WWTF to provide secondary treatment with the following goals for the project:

1. Minimize capital and operations costs for secondary treatment
2. Minimize new construction outside of the existing filter building
3. Provide maximum flexibility to upgrade the secondary treatment process to achieve future total nitrogen removal

The basis of sizing shall initially provide treatment to secondary standards to meet an effluent permit limit of 30 mg/L BOD_5 and TSS.

Treatment Sizing Concepts

Three overall concepts have been developed for secondary treatment and are presented below in order of most desirable to least desirable:

S-1. Modify the existing filter building as necessary to accommodate the proposed technology within the limits of the existing 8 filter cells and, if feasible, the existing pump station at the east end of the building;
S-2. Demolish the existing building and utilize only the foundation and exterior walls;
S-3. Vendor developed concept for secondary treatment within the limit of the existing plant perimeter fence.

Vendors are requested to review the 3 secondary treatment concepts outlined above in light of the capabilities of the secondary treatment technology(ies) that they propose to provide, and provide recommendations, process sizing and layouts, and equipment costs for the concept that, in the vendor's judgment, best meets the City's goals for the project. Additional details for consideration of these alternatives are as follows:

S-1. Modify Existing Building:

The existing 8 filter cells are located in the filter room of the building. Each cell measures 16-ft wide by 30-ft long with a 1-ft wide separation wall between cells. The cells extend from a top of concrete elevation of 26.0 to the bottom of the cell at elevation 13.0. The bottom of the cell is a false floor separating the filter cells and a wetwell below. The floor separating the two is 1'-3" thick. The wetwell floor is sloped from a high point at elevation 6.5 to a elevation 5.0. Nearest the pumping station, the wetwell floor slopes sharply to elevation -3.25. These overall dimensions of the exiting filter area is 30-ft by 134.5-ft. The false floor can be removed and the separation walls extended to elevation -6.5, creating 8 individual cells with a maximum tank height of 19.5-ft. With 1-ft freeboard, this would provide a maximum SWD of 18.5-ft. Alternatively, the existing separation walls can be removed and the false floor removed and new tank configurations constructed within the limits of the existing 8 filter cells. This allows for a higher SWD by constructing new tanks walls within the limits of the existing tank walls. The maximum additional wall height is limited structurally to 4-ft or elevation 30.0, providing a tank height of 23.5-ft. With 1-ft freeboard, this would provide a maximum SWD of 22.5-ft.

Hydraulically, flow must be pumped into or out of the proposed secondary/advanced treatment system. The original configuration of the filter building used gravity flow through the filter and filtered effluent was pumped to a parshall flume adjacent to the chlorine contact tank. The pump station is located at the east end of the facility. If necessary the proposed treatment technology could utilize the area of the existing pump station for treatment capacity. The existing pump station area measures 33-ft wide (west to east) by 66-ft long (north to south) and extends downward to the floor at elevation -3.25. If the vendor chooses to take advantage of this area, it must be clearly noted so that AECOM can account for the costs of a pumping station appropriately.

S-2. Demolish the Existing Building:

The concept of demolishing the existing building would minimize the constraints of the existing filter building layout and allow for construction of new tanks or other facilities within the limits of the exiting Filter Building footprint. The existing building foundation/slab and exterior walls would be maintained and all structural and other components within the limits of this area would be demolished. This would result in an outside of wall dimension of 70-ft by 173-ft and an overall inside of walls dimensions of approximately 66-ft by 169-ft. The foundation extends from top of existing floor at elevation 26.0 down to the wetwell floor, which slopes from a high point at the west end of the facility to the pumping station at the east end of the facility. Starting at the west end of the wetwell at the high point at elevation 6.5, the floor slopes to elevation 5.0 over 104.42 (104'-5") horizontal feet, then from elevation 5.0 to elevation -3.25 over 8.25 (8'-3") horizontal feet and then remains at elevation -3.25 to the east end of the facility.

S-3. Vendor Concept for Treatment within Limits of Existing Fence:

The Peirce Island WWTF is located on a very restricted site. Immediately to the west of the facility is a historically significant resource (Fort Washington) and the WWTF is sited very close to the edge of the waterline. The existing fence line is a hard limit. There are some areas available for additional facilities within the limits of the existing fence. It must be noted that although the exiting fence line is a hard limit, the City is interested in the most cost effective treatment solution, so significant changes will likely be uneconomical and eliminated. A new headworks and a secondary treatment screening building will be necessary for most proposed technologies and these facilities have not yet been sited.

Selected site, structural and mechanical record drawings have been provided. Additional drawings will be provided upon request.

Important Considerations

The sewer system contributing to the Peirce Island WWTF is a combined system and during storm events flow to the WWTF increases rapidly from the average day flow to the max day flow of 22 MGD. Flow to the facility is regulated by the Mechanic Street pumping station. All flow passes through the existing primary clarifiers. For the proposed secondary facility, flow in excess of the maximum day rate identified in the 2011 criteria will bypass the secondary treatment system and undergo primary or enhanced primary treatment before blending with the secondary treated effluent for disinfection.

The City has noted that the fats, oils, and grease (FOG) concentrations increase dramatically during the summer seasons because of an increase in tourists visiting local restaurants and other sites. The proposed technology should be able to handle an increase in FOG load or indicate a need to control FOG upstream of the process. FOG concentrations will be measured as part of a wastewater characterization program that is ongoing during this evaluation and future pilot phases.

The WWTF currently adds ferric chloride and polymer to improve settling in its primary clarifiers. It has been estimated that the cost for the chemicals for CEPT is on the order of $170,000 annually. As part of this evaluation AECOM plans to investigate the potential of not utilizing chemical addition during dry weather. In developing your secondary treatment concept please provide recommendations, process sizing and layouts, and equipment costs for both secondary influent loading conditions; CEPT and primary effluent (non-CEPT).

The majority of the proposed technologies require fine screening of the influent wastewater. Fine screening will be included and will be sized to only handle peak hour flows to the secondary treatment system. The screening will likely be located between the Filter Influent D-box and the Filter Building.

Flow will have to be pumped into or out of the Filter Building. The existing arrangement pumps out of the existing Filter Building. This may not be the case for certain technologies depending upon the maximum water surface elevation and layout condition.

Future Nitrogen Removal

The City is currently only required to implement secondary treatment at the Peirce Island WWTF. However, it is likely that the City will receive a future TN limit, but the timing of the requirement and the future limit is not known at this time. As noted above under Project Goals, the ability to upgrade the secondary process to achieve future nitrogen removal is a significant consideration. For the secondary treatment concept that you select to best meet the City's goals for the project, you are requested to provide recommendations, process sizing, layouts of equipment/structures, and equipment costs needed to retrofit the proposed secondary treatment concept to achieve an average monthly effluent total nitrogen (TN) concentration of 8 mg/l, 5 mg/L and 3 mg/L year round. We would expect that there will be different additional/modified facilities necessary to achieve the 3 different levels of TN removal.

Requested Information

The vendor is asked to provide the following information:

1. Provide recommendations, preliminary sizing and layout for secondary treatment concept S-1, S-2, or S-3 that, in the vendors' judgment, best meets the City's goals for the project.
2. Provide recommendations, preliminary sizing and layouts for upgrade/expansion/addition or add-on processes for your recommended secondary treatment process needed to meet annual monthly average TN concentrations of 8 mg/L, 5 mg/L and 3 mg/L. (3 separate conditions)
3. Provide Items 1 and 2 sized both for CEPT effluent and Non-CEPT Effluent
4. Provide equipment capital costs and O&M requirements for all concepts. At a minimum, O&M requirements should include anticipated maintenance labor hours, spare parts, power consumption, and chemical consumption on a annual basis.
5. Identify constraints or considerations for the concepts and/or identify concepts that are not feasible.

Please provide this information no later than Wednesday June 22, 2011.

The requested information will be used in the engineering evaluation of the potential processes, and will result in the selection of 2-3 processes to be piloted. The primary focus of the evaluation will be on secondary treatment, but the ability to upgrade/modify the proposed secondary treatment process for nitrogen removal will also be an important factor in the evaluation.

We are available to meet and discuss existing conditions and proposed concepts. AECOM will complete any necessary structural or other evaluations as applicable. Please call Terry Desmarais at 207-541-2007 with any questions.

Attachment E

Memorandum, Task 1.4 Conduct Site Visit/Review Constraints on Filter Building Reuse

May 9, 2011

AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com

781.246.5200 tel
781.245.6293 fax

Memorandum

To	Peter Rice, City Engineer	Page	1 of 3
CC	David Allen, Deputy Director and Paula Anania, Chief Operator		
Subject	Task 1.4 Conduct Site Visit/Review Constraints on Filter Building Reuse WWMP Piloting – Phase I Engineering Evaluation Peirce Island WWTF, Portsmouth, New Hampshire		
From	Terry Desmarais and Jon Pearson		
Date	May 9, 2011		

The upgrade of the Peirce Island WWTF is focused on reuse of the existing Filter Building to house a secondary treatment process. A multidisciplinary team including an architect, a structural engineer, and an electrical engineer visited the Filter Building on April 19, 2011 to assess constraints to upgrading the building. This memorandum provides a summary of the major concerns or considerations identified by each discipline. Architectural and structural items noted are preceded by a description of the applicable discipline (e.g. “A:” for architectural and “S:” for structural). Electrical considerations are described following the architectural and structural items. The full report of each discipline has been attached to this memorandum.

Architectural and Structural:

Exterior:
- No major concerns or considerations. See detailed reports.

Control Area:
- No major concerns or considerations. See detailed reports.

Blower Room:
- No major concerns or considerations. See detailed reports.

Boiler Room:
- No major concerns or considerations. See detailed reports.

Storage Room:
- Not evaluated. Room was temporarily inaccessible.

Electrical Room:
- No major concerns or considerations. See detailed reports.

Generator Room:
- No major concerns or considerations. See detailed reports.

Dock:

- A: Loading dock cannot be readily accessed because of site constraints with existing fence and access would be improved by a 10-15 foot extension to the east
- A: Exterior door at the loading dock does not meet the minimum code requirement of 2’-8” for a single leaf entrance
- A: Loading dock roof hatch did not align properly at leaf intersection resulting in leakage and had excessive deflection when walked on

Odor Control Room:

- No major concerns or considerations. See detailed reports.

Filter Room:

- A: Hardware for Filter Room doors (two doors) was in poor operating condition and some components were missing
- A: Finish of the top rail of filter cell railings was damaged along north side of cells
- A: Filter Room railing system chains do not meet OSHA requirements
- S: Pre-cast roof plank in center of room cracked down the middle from interior wall shared with Control Area to the exterior Filter Room wall.

Clearwell Gallery:

- A: Clearwell Gallery stairs to Control Area are not enclosed with fire rated walls
- A: An additional stairwell may be required to meet building code requirements for egress from the lower levels (e.g. Clearwell Gallery, Pump Room, etc.)
- A,S: Staining, paint deterioration and concrete corrosion at interior wall adjacent to stairwell from leaking pipe joints and corroded pipes along wall
- S: Area of delamination in the cast-in-place concrete floor surface at the interior wall shared with the filter cells
- S: Signs of cracks in cast-in-place concrete interior wall shared with the filter cells that cannot be evaluated until the wall is impacted by water pressure in filled filter cells

Clearwell:

- No major concerns or considerations. See detailed reports.

Pump Room:

- A,S: Interior wall and concrete roof slab staining, paint deterioration and concrete corrosion at roof drain locations resulting from corroded roof drain pipes
- A: Floor supports for the ladder at the south end of the Pump Room raised platform were deteriorated

Mudwell Gallery:

- A: The Mudwell Gallery as currently configured with access to the Pump Room and two hatches (one near the Pump Room door and one at the far end) may be considered a confined space. A new door may be required if this space is reconfigured for new mechanical process use.
- A: Roof hatches in Mudwell Gallery were not aligned properly and were leaking
- S: Active leaks and signs of previous leaks in cast-in-place roof slab

Mudwell:

- No major concerns or considerations. See detailed reports.

Electrical

General:

- The majority of equipment and systems has reached a near end of life condition due to corrosion from exposure to moisture
- In the case of a building retrofit, significant consideration should be given to protecting the existing service and standby power systems during construction and phasing the work to replace electrical equipment as necessary. Consideration should also be given to relocating the equipment to a new location outside the limits of the existing Filter Building.

Facility Service (into Electrical Room):

- No major concerns. See detailed reports.

Generator and ATS:

- No major concerns or considerations. See detailed reports.

MCCs:

- No major concerns or considerations. See detailed reports.

Low Voltage Distribution:

- Low voltage control panels show signs of corrosion
- Raceway systems in the Mudwell Gallery, Filter Room and Mudwell Gallery showed signs of corrosion

Lighting:

- Lighting equipment showed signs of corrosion on all unpainted surfaces and was particularly severe on aluminum surfaces
- Emergency lights with battery backup were not operable

Fire Alarms:

- The hardwired fire alarm system was not operable due to impacts from corrosion.

Instrumentation:

- Instruments were no longer in operation.

Summary

There are no major concerns or considerations that would eliminate the potential of retrofitting the existing Filter Building for a new treatment process. The majority of architectural, structural and electrical concerns noted are repairable, would likely be resolved as part of a retrofit project, and would be expected of a facility of this age. Key considerations for a retrofit will be meeting local building code requirements for access in the Clearwell Gallery and the Mudwell Gallery, protection of the existing electrical service and standby generation systems during construction, and construction phasing for replacement of electrical equipment.

AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com

781.246.5200 tel
781.245.6293 fax

Memorandum

To	Terry Desmarais and Jon Pearson	Page	1
CC	Bill Shosho and Anthony Catalano		
Subject	Architectural Task 1.4 Conduct Site Visit/Review Constraints on Filter Building Reuse WWMP Piloting – Phase I Engineering Evaluation Peirce Island WWTF, Portsmouth, New Hampshire		
From	Brian Norton		
Date	April 26, 2011		

INTRODUCTION

On April 19, 20011, AECOM participated in a site visit at Peirce Island Waste Water Treatment Plant in Portsmouth, New Hampshire. This memorandum provides the Architectural observations and conditions assessment of the existing Filter Building.

Building Exterior

The building roof consists of single-ply membrane with river bed stone ballast over precast concrete planks. This membrane roof system is original and was therefore installed approximately 21 years ago. Due to the stone ballast on the roof, only selected areas were observed where the stone ballast was temporarily removed or exposed adjacent to curbed openings. The membrane was in good condition however the treatment plant staff mentioned that there is leaking at the roof drains. It should also be noted that the typical life span of a single ply membrane roof system is approximately 20 years. Flashings at rooftop HVAC equipment, roof vents and chimney appeared to be in good condition. The metal roof coping is in good condition but some minor adjustments are required at the panel joints.






The brick façade, mortar joints and sealants on the building exterior are in very good condition. The anodized aluminum window units are double pane type and in good condition. The louvers are aluminum with anodized finish and are also in good condition. The windows, louvers and the aluminum storefront at the entrance require cleaning and the entrance door will require some minor hardware adjustments. The exterior door at the Odor Control Room has been pad locked in the closed position and is in fair condition, the hardware for this door will need to be replaced. The exterior door at the loading dock does not meet the minimum code requirement of 2’-8” for a single door leaf width and should be replaced.



AECOM

Dock:

	Material	Condition	Comments
Walls	Brick	Good	
Floor	Concrete	Good	
Ceiling	Concrete panel	Good	
Door	Aluminum	Good	
Dock	Concrete	Good	Dock area does not function efficiently due to insufficient truck access. A 10-15 foot extension of the dock is recommended.
Hatches	Aluminum	Fair	Intersection at hatch leafs are not aligned and the hatch cover deflection was excessive when walked on.



Building Interior:

The interior spaces, finishes and openings such as doors, windows and louvers are generally in good condition for a facility of this age. This can be attributed to the limited use at the facility. A detailed description of each room, materials and condition is as follows:

Blower Room:

	Material	*Condition*	*Comments*
Walls	Insulated wall panels	Good	
Floor	Concrete	Good	
Ceiling	Insulated wall panels	Good	
Door	Aluminum	Good	Hardware is in good operating condition, door opening has 2 - 2'-6" doors

Boiler Room:

	Material	*Condition*	*Comments*
Walls	CMU painted	Good	
Floor	Concrete	Good	
Ceiling	Concrete panel painted	Good	
Door	Steel, painted and fire rated	Good	Hardware is in good operating condition, door opening has 2 - 2'-6" doors

Electrical Room:

	Material	*Condition*	*Comments*
Walls	CMU painted	Good	
Floor	Concrete	Good	
Ceiling	Concrete panel painted	Good	
Door	Aluminum	Good	Hardware is in good operating condition, one door opening has 2 - 2'-6" doors, one door is single 3'-0"

Generator Room:

	Material	*Condition*	*Comments*
Walls	Insulated wall panels	Good	
Floor	Concrete	Good	
Ceiling	Insulated wall panels	Good	
Door	Aluminum	Good	Hardware is in good operating condition, door opening has 2 - 2'-6" doors
Louvers	Aluminum	Good	Large operable louver connected to generator operation

Odor Control Room:

	Material	*Condition*	*Comments*
Walls	CMU painted	Good	
Floor	Concrete	Good Fair	 Flooring at containment area is cracking and in poor condition
Ceiling	Concrete panel painted	Good	
Door	Aluminum	Fair	Hardware is in poor operating condition and some components are missing.



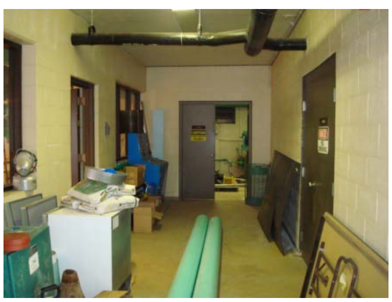
Filter Room:

	Material	*Condition*	*Comments*
Walls	CMU painted	Good	
Floor	Concrete	Good	
Ceiling	Concrete panel painted	Good	
Doors	Aluminum	Fair	Hardware is in poor operating condition and some components are missing.
Railing	Aluminum	Good	2-Rail guard rail system generally in good condition but top rail finish is damaged by basket removal process at north side and chains need to be replaced with rails or gates to meet OSHA
Windows	Aluminum	Good	Interior windows are single pane, exterior windows are double pane



Control Area:

	Material	*Condition*	*Comments*
Walls	CMU painted	Good	
Floor	Concrete with finish	Good	Floor has slip resistant coating in good condition
Ceiling	Concrete panel painted	Good	

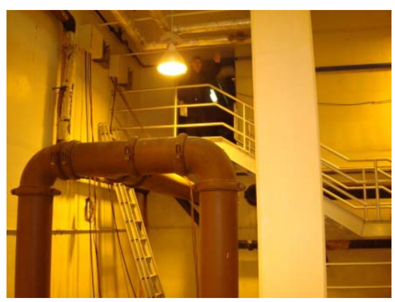


Pump Room:

	Material	*Condition*	*Comments*
Walls	Concrete painted	Good	
Floor	Concrete	Good	Leaking was observed at southeast corner
Ceiling/Roof	Concrete panel painted	Good	Drains are leaking and rusting
Grating Platform	Aluminum	Good	Some minor pitting but generally in good condition. Ladder at south end will require new supports at the floor level


Mudwell Gallery:

	Material	*Condition*	*Comments*
Walls	Concrete	Good	Some leaking observed along wall
Floor	Concrete	Good	
Ceiling	Concrete	Good	Some leaking observed at concrete roof
Roof Hatches	Aluminum	Fair	Both roof hatches are not aligned properly and are leaking
The gallery as currently configured with access on one end (door) only and hatches at the other may be considered a confined space. A new door may be required if this space is reconfigured for new mechanical process use.			



Clearwell Gallery:

	Material	*Condition*	*Comments*
Walls	CMU, painted	Good	
Floor	Concrete, no finish	Good	Some shallow spalling concrete observed near joint with Filter Cell walls
Ceiling	Concrete, painted	Good	
Stair	Steel, painted	Good	Stair is not enclosed with fire rated walls
Additional stair may be required to meet building code requirements for egress from the lower levels			

Sodium Hydroxide Containment Area (Clearwell Gallery):

	Material	*Condition*	*Comments*
Walls	CMU, painted	Good	
Floor	Concrete, coating	Good	Floor and curbs have a protective coating
Ceiling	Concrete, painted	Good	

AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com

781.246.5200 tel
781.245.6293 fax

Memorandum

To	Terry Desmarais; Jon Pearson	Page	1
CC	Bill Shosho; Brian Norton; Ron Fiore		
Subject	Structural Task 1.4 Conduct Site Visit/Review Constraints on Filter Building Reuse WWMP Piloting – Phase I Engineering Evaluation Peirce Island WWTF, Portsmouth, New Hampshire		
From	Anthony Catalano Jr.		
Date	April 26, 2011		

Introduction

On April 19, 20011, AECOM conducted a site visit at the Peirce Island Waste Water Treatment Plant in Portsmouth, New Hampshire. This memorandum provides the Structural observations, condition assessments, and recommendations for the existing Filter Building.

Background

The Filter Building's design was completed in September of 1989 and the construction and record drawings were completed in September of 1993. The substructure of the building is made up of cast in place concrete walls, slabs, and foundation mats with wet and dry areas. The superstructure of the building is made up of load bearing CMU and brick walls and a precast hollow core concrete plank roof acting as a shear diaphragm.

Condition Assessment

Clearwell and Mudwell:

Although confined space entries of the mudwell and clearwell were not performed, visual inspections of the areas through a manhole opening were performed and the cast in place concrete walls and foundation mat seemed to be in good condition (See Photo 1). Both the mudwell and clearwell were partially filled with water. The plant operator informed AECOM personnel that the water was from the roof drains, therefore the water was clean and clear and the concrete walls and foundation mat below the water surface were easily viewed. There was no visible deterioration of the concrete surfaces above or below the water surface in either the mudwell or clearwell.

Pump Room

The Pump Room was in good condition overall, other than the cast in place concrete roof slab had areas of corrosion due to leaking roof drains, and the cast in place concrete walls had areas of corrosion due to leaking pipe joints and corroded pipes running along the walls. There were spots of rust and spalling of the concrete roof surface (See Photo 2), and there were spots of rust stains and corrosion of the concrete wall surface (See Photo 3).

Mudwell Gallery

The Mudwell Gallery was in fair condition. There were areas with cracks having efflorescence leaching from the cast in place roof slab (See Photo 4), and other areas with cracks having active leaks in the cast in place roof slab (See Photo 5).

Clearwell Gallery

The Clearwell Gallery was in fairly good condition. There were areas of delamination of the cast in place concrete floor slab next to the interior wall (See Photo 6). There were also areas of cracks with efflorescence in the interior cast in place concrete wall surfaces (See Photo 7). There was no way to determine whether or not the wall cracks were actively leaking, since the filter cells were empty on the other side of the wall. The cast in place concrete floor slab had some areas of minor spider cracks that were most likely due to shrinkage (See Photo 8). There were some areas where chemical lines running along the walls had leaked and caused corrosion and/or stripping of the paint off the concrete (See Photo 9).

Filter Room

The Filter Room was in good condition structurally. The concrete walls in the filter cells seemed to be in good condition with no signs of deterioration or spalling. There were some areas that had minor efflorescence that most likely was caused by water pressure from the exterior ground water (See Photo 10). The Filter Room precast hollow core concrete roof planks were all in good condition, except for the concrete plank near the middle of the building that had a straight crack down the middle, most likely traveling down the hollow core portion with no reinforcement (See Photo 11). There were no signs of deterioration in this crack and it was most likely caused by thermal expansion and contraction of the building.

Control Area

The Control Area was in good condition other than one area where the precast hollow core concrete plank roof joint was damaged and showed some signs of deterioration. The damage does not appear to be a structural deficiency other than signs of minor corrosion.

Summary and Recommendations

Since the Filter Building's structure is in good condition, there will not be many structural modifications needed to satisfy the serviceability of the building, but there will be many structural modifications needed to satisfy the process functionality of the building. This report is intended to highlight the structural modifications needed to only satisfy the serviceability of the building.

The cast in place concrete roof slab and walls in the Pump Room should be cleaned and/or repaired and any corroded material that previously caused the corrosion of the slab and walls should be removed and/or replaced to reduce future corrosion.

The cracks in the Mudwell Gallery roof slab should be injected with hydrophilic grout where there are signs of active leaks. The cracks with only efflorescence that are not actively leaking are not structural or serviceable deficiencies and therefore are not recommended to be injected or repaired.

The delamination of the cast in place concrete floor slab in the Clearwell Gallery is usually caused by the rusting of the reinforcement steel and therefore the concrete in this area should be repaired to protect the reinforcement steel from further deterioration. The spider cracks in the floor are not structural or serviceable deficiencies and therefore are not recommended to be injected or repaired. Since the areas of the wall in the Clearwell Gallery that are showing signs of efflorescence cannot be checked for leaks, it is unknown whether or not the cracks should be repaired. Once the structure is put into service, if the walls show signs of active leaks, they should to be injected with hydrophilic grout. The walls that showed signs of corrosion due to chemical lines and corroded material should be cleaned and/or repaired and any corroded material that previously caused the corrosion of the walls should be removed and/or replaced to reduce future corrosion of the concrete. The damage to the precast hollow core concrete planks in the Control Area needs to be repaired to reduce the chance that further corrosion will occur.

The above recommendations highlight the structural modifications needed to satisfy the serviceability of the building. If the process selection yields the need for major modifications to the building shell to satisfy the process functionality of the building, additional structural modifications will be needed along with structural analysis to assure the building can resist the additional vertical and horizontal loads. Note that a structural modification of the building may also require bringing the entire structure into compliance with the seismic provisions of the International Building Code 2009.

Photo 1: Clearwell opening.

Photo 2: Pump Room Cast in Place Concrete Roof Slab Surface.

Photo 3: Pump Room Cast in Place Concrete Wall Surface.

Photo 4: Mudwell Gallery Non-leaking Cast in Place Concrete Roof Surface.

Photo 5: Mudwell Gallery Leaking Cast in Place Concrete Roof Surface.

Photo 6: Clearwell Gallery Delaminated Floor Surface.

Photo 7: Clearwell Gallery Wall Surface with Efflorescence.

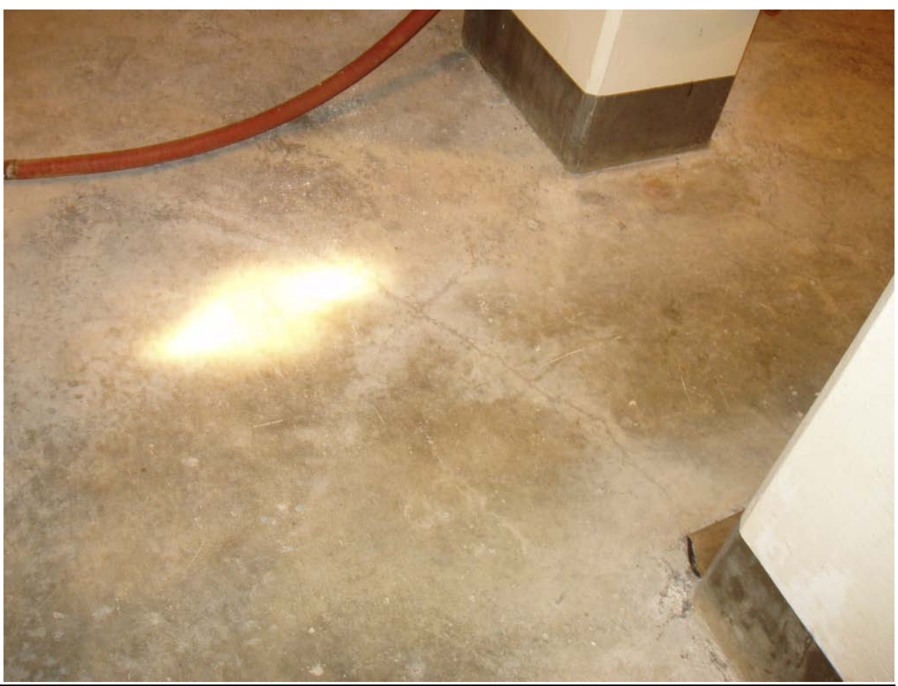


Photo 8: Clearwell Gallery Spider Cracks in Floor Surface.

Photo 9: Clearwell Gallery Wall Surface with Chemical Corrosion.

Photo 10: Filter Room, Filter Cell Wall Surface.

Photo 11: Filter Room Precast Hollow Core Concrete Roof Plank Crack.

Photo 12: Control Area Precast Hollow Core Concrete Roof Plank Joint Deterioration.

AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com

781.246.5200 tel
781.245.6293 fax

Memorandum

To	Terry Desmarais; Jon Pearson	Page	1
CC	Brian Norton; Ron Fiore; Anthony Catalano Jr, Yasser Rizk		
Subject	Electrical Task 1.4 Conduct Site Visit/Review Constraints on Filter Building Reuse WWMP Piloting – Phase I Engineering Evaluation Peirce Island WWTF, Portsmouth, New Hampshire		
From	Bill Shosho		
Date	May 2, 2011		

Introduction

On April 19, 20011, AECOM participated in a site visit at Peirce Island Waste Water Treatment Plant in Portsmouth, New Hampshire. This memorandum provides the Electrical system observations, condition assessments, and recommendations for the existing Filter Building.

Background

The design of the Filter Building's design dates back to 1989 and the construction and record drawings were completed in September of 1993. A Cutler Hammer main switchboard and a Caterpillar standby generator are located within separate rooms in the Filter Building and power the Filter Building as well as the other structures at the WWTF.

Condition Assessment

Facility Electrical Incoming Service

An overhead primary utility service is routed to a pole adjacent to a utility oil-filled padmount transformer near the Filter Building. Multiple 4-inch ducts are routed underground from the transformer secondary to a manhole just outside the building and then to a pullbox on an interior wall at the Filter Building lower level below the location of the Main Switchboard in the Electrical Room (Clearwell Gallery). The 480 Y/277 V 3-phase, 4-wire service enters the 1200 amp main circuit breaker switchboard section from below. The switchboard is a Westinghouse Pow-L-Line C style, dated 09/90, model no. BS39001, and all equipment and sections are provided within a NEMA 1 type enclosure.

The main breaker is rated 1200 amps and is a Westinghouse Type SPB100 electrically operated circuit breaker with a Digitrip RMS 500 trip unit. The main breaker is provided with long time, short time, instantaneous and ground fault protection. The main switchboard incoming section includes a Westinghouse IQ Data Plus II electric power meter. At the time of inspection, approximately 125 amperes was measured on Phase A.

The load side cables from the main breaker are cabled to one side of a Westinghouse 1200 amp dual breaker style automatic transfer switch (ATS) section. The standby power cables are routed to the other end of the ATS via top entry into the switchboard from a 600 kW standby generator in the adjacent room (Generator Room). The load side connection of the ATS power is directly connected to the switchboard distribution bus which consists of 800A frame Westinghouse Type SPB100 electrically operated circuit breakers with Digitrip RMS 500 trip units. These electrically operated circuit breakers feed the following loads:

- MCC-1 in the Control Building
- MCC-2 in the Scum Concentrator Building
- MCC-3 in the Sludge Processing Building
- MCC-8 in the Filter Building.

All MCC feeder breakers are provided with long time, instantaneous and ground fault protection.

Motor Control Centers and Low Voltage Distribution

Motor Control Center (MCC) MCC-8 and MCC-8A are located in the Filter Building Electrical Room with the main wwitchboard. A pair of MCCs can be found at each MCC building location. The primary MCC at each building feeds all process loads. A second MCC at each building is fed from the primary MCC and powers HVAC type loads. The original contract drawings showed the second MCC fed via an under-voltage shunt trip breaker so as to prevent the standby generator from powering the second MCC when the generator first assumes load after a utility outage. The shunt trip breakers were not evident by inspection and talking with the staff it was learned that the feeder breakers to these second MCCs do not have to be reclosed after an outage. Apparently, the shunt–trip main breaker design was modified after the Contract Drawings were issued.

Low voltage panelboards show signs of corrosion.

In the Filter Building Electrical Room are three older style Robicon variable frequency drives that were once used for the [plant effluent pumps.

Electric heat in the Electrical Room was operational with a thermostat set at 50 degrees F.

Associated raceways systems were rigid galvanized steel (RGS) type and painted. In heated areas they appeared to be in good condition, while those raceways installed in wet areas showed evidence of extreme corrosion. Several newer RGS raceways had been installed in the Electrical Room and along the walls of the Clearwell Gallery as part of the SCADA system and chemical pacing system.

Generator System

Within the Generator Room is a Caterpillar 600 kW/750 kVA, 480/277V diesel generator system with a diesel day tank. The generator keep warm system was in operation and the battery terminals were clean. In general, the equipment appeared to be well maintained. It was reported by staff that the city’s generator systems are maintained by one generator maintenance shop on an annual contract basis.

Miscellaneous Systems

Fire Alarm: The Filter Building was equipped with hard wired smoke detectors, heat detectors and visual / audible notification appliances with pull stations. However, the Filter Building fire alarm system is not operational as is the fire alarm system in all buildings at the WWTF with the exception of the Control Building. Due to corrosion, false alarms were prevalent and the fire alarm systems in the remote buildings were disconnected in 2007 from the Control Building Master Fire Alarm Control Panel, which is a relatively new Simplex Model 41000 system panel.

SCADA: A facility SCADA system is installed and maintained by Electrical Installations, Inc (EII) of Moultonboro, NH and is presently in use. PLC – 6 with an HMI was found to be operational in the Filter Building electrical room, and monitoring influent flow and providing a pacing signal to one chemical pump in the Filter Building Clearwell Gallery.

Lighting: The lighting systems were in general found to be operational but exhibited surface corrosion on all un-painted metal surfaces. Severe oxidation was encountered on aluminum surfaces. High intensity discharge (HID) lighting was located in the process areas and fluorescent fixtures were installed in the small equipment rooms. Emergency lighting heads were connected to battery packs that were no longer operable.

Instrumentation: In general most instruments were no longer functioning, including gas detection in the Filter Room and bubbler systems at the access manholes of the Clearwell and Mudwell. Filter control panels are abandoned in place.

Summary and Recommendations:

In general, the various electrical systems installed at the Filter Building have reached a near end of life condition due to their age and corrosion from exposure to moisture.

Although the electrical distribution system and associated generator are amply sized for the facility electrical loads, the main switchboard, MCC-8 and MCC-8A are found to be in average condition. There is evidence of dirt and heavy dust, surface rusting at the edges of the enclosures, and corrosion at locations such as fuse barrels and terminals within the enclosures. There is no indication that the Main Switchboard circuit breaker Digitrip sensors have been tested or calibrated since their original installation date and that surge protection has been provided at the electrical system buses. A new 1200 amp 480/277V switchboard with electrically operated main and generator breakers for transfer control should be considered. Consideration should also be given to the replacing the existing generator. Grounding systems should be tested and upgraded as required due to the evidence of equipment corrosion in various structures and the facility location near seawater. A new fire alarm and detection system should be provided at each building with fiber optic (FO) cables routed between buildings. The use of FO cables would reduce the likelihood of future failures due to underground cable corrosion.

The electrical equipment and associated raceways in the Filter Building should be demolished and replaced in kind if the building will be reused. Significant consideration should be given to protection of existing and/or new facilities during construction of a new secondary treatment system in the existing building. In addition, improvements should be incorporated into the existing electrical rooms (e.g. climate controlled environment) to prevent future damage due to corrosion. Another possible option would be to relocate the electrical distribution system, MCCs and standby generator to a new location as part of a secondary treatment system upgrade. This could be adjacent to the existing Chlorine Contact Tanks and/or Control Building as space constraints allow.

Photos:

Photo 1: Utility Riser Pole and Transformer

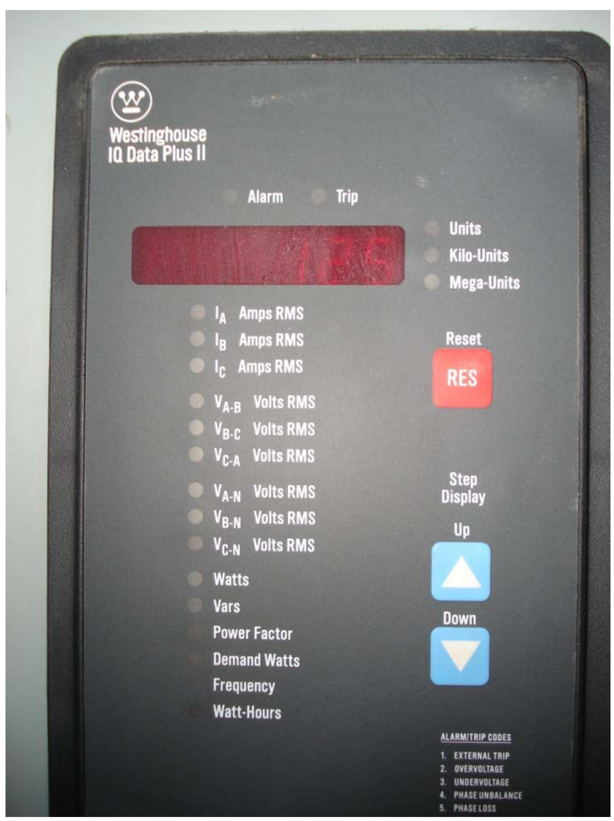


Photo 2: Switchboard Power Monitor

Photo 3: Motor Control Center Data Nameplate

Photo 4: Robicon VFD for Effluent Pumps

Photo 4: Filter Building SCADA System Panel

Photo 5: Control Building Main Fire Alarm Panel

Photo 6: Filter Building Raceway Corrosion

Photo 7: Filter Building Smoke Detector Corrosion

Photo 8: Filter Building Lighting Panel Corrosion

Attachment F
Opinion of Costs

Opinion of Cost - Option 1 BAF
Secondary Treatment at Peirce Island Site (4.3 MGD)

PEIRCE ISLAND CAPITAL COST ESTIMATE						
SOURCE	**ITEM**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**AMOUNT**	**Subtotal**
Portions of Wastewater Master Plan, June 2010, Cost Estimate Scenario 1B - Peirce Island Alternative TN 8, MBR Secondary Treatment at PI Site (6.2 MGD), PIT Site (1.7 MGD)	**Headworks**					
	Structure	2500	SF	$ 300	$ 750,000	
	Equipment:					
	Odor Control	1	EA	$ 60,000	$ 87,000	
	Bar Screens	2	EA	$ 250,000	$ 725,000	
	Screenings Washer & Compactor	2	EA	$ 50,000	$ 145,000	
	Grit Pumps	3	EA	$ 35,000	$ 152,250	
	Vortex Grit Removal	2	EA	$ 75,000	$ 217,500	
	Grit Classifier & Washer	2	EA	$ 40,000	$ 116,000	
						$ 2,192,750
	Sanitary Disinfection					
	Equipment:					
	Pump System	1	EA	$ 100,000	$ 100,000	
	UV Disinfection	1	EA	$ 200,000	$ 200,000	
						$ 300,000
	Biosolids Processing					
	Structure					
	Rehab Existing Process Building	1	EA	$ 350,000	$ 350,000	
	Equipment:					
	Carbon Odor Control	1	EA	$ 60,000	$ 87,000	
	Rotary Drum Thickener	2	EA	$ 150,000	$ 435,000	
	Dewatering Screw Press	2	EA	$ 400,000	$ 1,160,000	
	Conveyors	2	EA	$ 50,000	$ 145,000	
						$ 2,177,000
	Additional Structures and Modifications					
	Structure					
	PE Splitter - Upstream - Rehab Existing	1	EA	$ 500,000	$ 500,000	
	PE Splitter - Downstream	2200	SF	$ 300	$ 660,000	
						$ 1,160,000
	SUBTOTAL					**$ 5,829,750**
	Yard Piping (12%)					$ 699,570
	Electrical (22%)					$ 1,282,545
	Instrumentation and Controls (6%)					$ 349,785
	Site Work and Landscaping (7%)					$ 408,083
	SUBTOTAL					**$ 8,569,733**
	Island Construction Premium (3%)					$ 257,092
	Engineering (20%)					$ 1,713,947
	Contingency (30%)					$ 2,570,920
	SUBTOTAL FROM WASTEWATER MASTER PLAN ESTIMATES					**$ 13,111,691**

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
AECOM WWMP Pilot - Phase 1 Engineering Evaluation, August 2011	**Secondary Pump Station (Fine Screens and Lift Station)**					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 150,000	$ 150,000	
	Yard Piping	1	LS	$ 53,000	$ 53,000	
	Structure	1	LS	$ 959,000	$ 959,000	
	Process Piping and Appurtenances	1	LS	$ 133,000	$ 133,000	
	Equipment:					
	Odor Control	1	EA	$ 131,000	$ 131,000	
	Fine Screens, Washer and Compactor and Container	2	EA	$ 316,500	$ 633,000	
	Secondary Influent Pumps	3	EA	$ 100,000	$ 300,000	
	Instrumentation and Controls	1	LS	$ 83,000	$ 83,000	
	Electrical	1	LS	$ 119,000	$ 119,000	
						$ 2,561,000
	Demolition of Filter Building For Reuse (Main Electrical and Standby Generator to Remain)					
	Demolition	1	LS	$ 296,000	$ 296,000	
	Site Work	1	LS	$ 157,000	$ 157,000	
	Yard Piping	1	LS	$ -	$ -	
	Structure (Remove and Replace HVAC and Elec)	1	LS	$ 1,277,000	$ 1,277,000	
	Electrical (Replace Electrical Equipment)	1	LS	$ 350,000	$ 350,000	
						$ 2,080,000
	BAF Secondary Treatment Retrofit of Filter Building					
	Demolition	1	LS	$ 256,000	$ 256,000	
	Site Work and Landscaping	1	LS	$ 36,000	$ 36,000	
	Yard Piping	1	LS	$ 10,000	$ 10,000	
	Structure	1	LS	$ 1,103,000	$ 1,103,000	
	Process Piping and Appurtenances	1	LS	$ 804,000	$ 804,000	
	Equipment:					
	BAF Vendor (IDI)	1	EA	$ 3,573,000	$ 3,573,000	
	Effluent Pumps	3	EA	$ 42,667	$ 128,000	
	Mudwell Pumps	2	EA	$ 24,500	$ 49,000	
	Clearwell Lift Pumps	2	EA	$ 24,500	$ 49,000	
	Instrumentation and Controls	1	LS	$ 92,000	$ 92,000	
	Electrical	1	LS	$ 1,141,000	$ 1,141,000	
						$ 7,241,000
	TWAS Storage Tank and Control Building					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 38,000	$ 38,000	
	Yard Piping	1	LS	$ 94,000	$ 94,000	
	Structure	1	LS	$ 568,000	$ 568,000	
	Process Piping and Appurtenances	1	LS	$ 189,000	$ 189,000	
	Equipment:				$ -	
	TWAS Press Feed Pumps and Grinders	3	EA	$ 58,333	$ 175,000	
	Aeration Blowers	3	EA	$ 32,667	$ 98,000	
	Aeration Diffusers	1	EA	$ 50,000	$ 50,000	
	Instrumentation and Controls	1	LS	$ 37,000	$ 37,000	
	Electrical	1	LS	$ 124,000	$ 124,000	
						$ 1,373,000
	SUBTOTAL					**$ 13,255,000**
	Island Construction Premium (3%)					$ 397,650
	Engineering and Contingency (40%)					$ 5,302,000
	SUBTOTAL FROM AECOM					**$ 18,954,650**

OPINION OF CONSTRUCTION COST	**$ 32,066,341**
OPINION OF PROJECT COST (Rounded)	**$ 33,000,000**

Opinion of Cost - Option 3 Conventional Activated Sludge & BioMag

Secondary Treatment at Peirce Island Site (4.30 MGD)

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
Portions of Wastewater Master Plan, June 2010, Cost Estimate Scenario 1B - Peirce Island Alternative TN 8, MBR Secondary Treatment at PI Site (6.2 MGD), PIT Site (1.7 MGD)	**Headworks**					
	Structure	2500	SF	$ 300	$ 750,000	
	Equipment:					
	Odor Control	1	EA	$ 60,000	$ 87,000	
	Bar Screens	2	EA	$ 250,000	$ 725,000	
	Screenings Washer & Compactor	2	EA	$ 50,000	$ 145,000	
	Grit Pumps	3	EA	$ 35,000	$ 152,250	
	Vortex Grit Removal	2	EA	$ 75,000	$ 217,500	
	Grit Classifier & Washer	2	EA	$ 40,000	$ 116,000	
						$ 2,192,750
	Sanitary Disinfection					
	Equipment:					
	Pump System	1	EA	$ 100,000	$ 100,000	
	UV Disinfection	1	EA	$ 200,000	$ 200,000	
						$ 300,000
	Biosolids Processing					
	Structure					
	Rehab Existing Process Building	1	EA	$ 350,000	$ 350,000	
	Equipment:					
	Carbon Odor Control	1	EA	$ 60,000	$ 87,000	
	Rotary Drum Thickener	2	EA	$ 150,000	$ 435,000	
	Dewatering Screw Press	2	EA	$ 400,000	$ 1,160,000	
	Conveyors	2	EA	$ 50,000	$ 145,000	
						$ 2,177,000
	Additional Structures and Modifications[1]					
	Structure					
	PE Splitter - Upstream - Rehab Existing	1	EA	$ 500,000	$ 500,000	
	PE Splitter - Downstream	2200	SF	$ 300	$ 660,000	
						$ 1,160,000
	SUBTOTAL					**$ 5,829,750**
	Yard Piping (12%)					$ 699,570
	Electrical (22%)					$ 1,282,545
	Instrumentation and Controls (6%)					$ 349,785
	Site Work and Landscaping (7%)					$ 408,083
	SUBTOTAL					**$ 8,569,733**
	Island Construction Premium (3%)					$ 257,092
	Engineering (20%)					$ 1,713,947
	Contingency (30%)					$ 2,570,920
	SUBTOTAL FROM WASTEWATER MASTER PLAN ESTIMATES					**$ 13,111,691**
AECOM WWMP Pilot - Phase 1 Engineering Evaluation, August 2011	**Secondary Influent Pumping Station and Blower Building**					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 33,000	$ 33,000	
	Yard Piping	1	LS	$ 30,000	$ 30,000	
	Structure	1	LS	$ 883,000	$ 883,000	
	Process Piping and Appurtenances	1	LS	$ 518,000	$ 518,000	
	Equipment:					
	Influent Pumps	3	EA	$ 42,667	$ 128,000	
	Aeration Tank Blowers	3	EA	$ 105,000	$ 315,000	
	Odor Control	1	EA	$ 131,000	$ 131,000	
	Instrumentation and Controls	1	LS	$ 28,000	$ 28,000	
	Electrical	1	LS	$ 200,000	$ 200,000	
						$ 2,266,000
	Demolish Filter Building including Main Electrical Facilities					
	Demolition	1	LS	$ 1,354,000	$ 1,354,000	
	Site Work and Landscaping	1	LS	$ 491,000	$ 491,000	
						$ 1,845,000
	Convert Filter Building to Aeration Tanks and Clarifiers					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ -	$ -	
	Yard Piping	1	LS	$ 190,000	$ 190,000	
	Structure	1	LS	$ 2,862,000	$ 2,862,000	
	Process Piping and Appurtenances	1	LS	$ 629,000	$ 629,000	
	Equipment:					
	Fine Bubble Aeration and Clarifiers	1	LS	$ 921,000	$ 921,000	
	Instrumentation and Controls	1	LS	$ 28,000	$ 28,000	
	Electrical	1	LS	$ 89,000	$ 89,000	
						$ 4,719,000

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
AECOM WWMP Pilot - Phase 1 Engineering Evaluation, August 2011	**RAS and WAS Pump Station**					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 21,000	$ 21,000	
	Yard Piping	1	LS	$ 60,000	$ 60,000	
	Structure	1	LS	$ 308,000	$ 308,000	
	Process Piping and Appurtenances	1	LS	$ 397,000	$ 397,000	
	Equipment:					
	RAS Pumps	3	EA	$ 42,667	$ 128,000	
	Raw WAS Pumps	2	EA	$ 24,500	$ 49,000	
	WAS Pumps	2	EA	$ 24,500	$ 49,000	
	Scum Pumps	3	EA	$ 12,333	$ 37,000	
	Instrumentation and Controls	1	LS	$ 46,000	$ 46,000	
	Electrical	1	LS	$ 125,000	$ 125,000	
						$ 1,220,000
	Magnetite Recovery and Feed Building					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 33,000	$ 33,000	
	Yard Piping	1	LS	$ 21,000	$ 21,000	
	Structure	1	LS	$ 332,000	$ 332,000	
	Process Piping and Appurtenances	1	LS	$ 88,000	$ 88,000	
	Equipment:					
	Magnetite Recovery and Feed Equipment (CWT)	1	EA	$ 2,842,000	$ 2,842,000	
	Recovered ballast make-up tank	1	EA	$ 24,000	$ 24,000	
	Polymer System	1	EA	$ 176,000	$ 176,000	
	Alkalinity System	1	EA	$ 21,000	$ 21,000	
	Instrumentation and Controls	1	LS	$ 46,000	$ 46,000	
	Electrical	1	LS	$ 691,000	$ 691,000	
						$ 4,274,000
	TWAS Storage Tank					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 38,000	$ 38,000	
	Yard Piping	1	LS	$ 94,000	$ 94,000	
	Structure	1	LS	$ 568,000	$ 568,000	
	Process Piping and Appurtenances	1	LS	$ 189,000	$ 189,000	
	Equipment:				$ -	
	TWAS Press Feed Pumps and Grinders	3	EA	$ 58,333	$ 175,000	
	Aeration Blowers	3	EA	$ 32,667	$ 98,000	
	Aeration Diffusers	1	EA	$ 50,000	$ 50,000	
	Instrumentation and Controls	1	LS	$ 37,000	$ 37,000	
	Electrical	1	LS	$ 124,000	$ 124,000	
						$ 1,373,000
	Main Electrical Building and Standby Generator					
	Demolition	1	LS	$ 5,000	$ 5,000	
	Site Work and Landscaping	1	LS	$ 15,000	$ 15,000	
	Electrical Conduit	1	LS	$ 217,000	$ 217,000	
	Structure	1	LS	$ 168,000	$ 168,000	
	Process Piping and Appurtenances	1	LS	$ -	$ -	
	Equipment:					
	Electrical (Switchboard, MCB, ATS)	1	EA	$ 122,000	$ 122,000	
	Standby Generator	1	EA	$ 347,000	$ 347,000	
	Instrumentation and Controls	1	LS	$ -	$ -	
	Electrical	1	LS	$ -	$ -	
						$ 874,000
	SUBTOTAL					**$ 16,571,000**
	Island Construction Premium (3%)					$ 497,130
	Engineering and Contingency (40%)					$ 6,628,400
	SUBTOTAL FROM AECOM					**$ 23,696,530**

OPINION OF CONSTRUCTION COST	**$ 36,808,221**
OPINION OF PROJECT COST (Rounded)	**$ 37,000,000**

Opinion of Cost - Option 4 MBBR & ActiFlo
Secondary Treatment at Peirce Island Site (4.30 MGD)

PEIRCE ISLAND CAPITAL COST ESTIMATE						
SOURCE	**ITEM**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**AMOUNT**	**Subtotal**
Portions of Wastewater Master Plan, June 2010, Cost Estimate Scenario 1B - Peirce Island Alternative TN 8, MBR Secondary Treatment at PI Site (6.2 MGD), PIT Site (1.7 MGD)	**Headworks**					
	Structure	2500	SF	$ 300	$ 750,000	
	Equipment:					
	Odor Control	1	EA	$ 60,000	$ 87,000	
	Bar Screens	2	EA	$ 250,000	$ 725,000	
	Screenings Washer & Compactor	2	EA	$ 50,000	$ 145,000	
	Grit Pumps	3	EA	$ 35,000	$ 152,250	
	Vortex Grit Removal	2	EA	$ 75,000	$ 217,500	
	Grit Classifier & Washer	2	EA	$ 40,000	$ 116,000	
						$ 2,192,750
	Sanitary Disinfection					
	Equipment:					
	Pump System	1	EA	$ 100,000	$ 100,000	
	UV Disinfection	1	EA	$ 200,000	$ 200,000	
						$ 300,000
	Biosolids Processing					
	Structure					
	Rehab Existing Process Building	1	EA	$ 350,000	$ 350,000	
	Equipment:					
	Carbon Odor Control	1	EA	$ 60,000	$ 87,000	
	Rotary Drum Thickener	2	EA	$ 150,000	$ 435,000	
	Dewatering Screw Press	2	EA	$ 400,000	$ 1,160,000	
	Conveyors	2	EA	$ 50,000	$ 145,000	
						$ 2,177,000
	Additional Structures and Modifications					
	Structure					
	PE Splitter - Upstream - Rehab Existing	1	EA	$ 500,000	$ 500,000	
	PE Splitter - Downstream	2200	SF	$ 300	$ 660,000	
						$ 1,160,000
	SUBTOTAL					**$ 5,829,750**
	Yard Piping (12%)					$ 699,570
	Electrical (22%)					$ 1,282,545
	Instrumentation and Controls (6%)					$ 349,785
	Site Work and Landscaping (7%)					$ 408,083
	SUBTOTAL					**$ 8,569,733**
	Island Construction Premium (3%)					$ 257,092
	Engineering (20%)					$ 1,713,947
	Contingency (30%)					$ 2,570,920
	SUBTOTAL FROM WASTEWATER MASTER PLAN ESTIMATES					**$ 13,111,691**

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
AECOM WWMP Pilot - Phase 1 Engineering Evaluation, August 2011	**Secondary Pump Station (Fine Screens and Lift Station)**					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 150,000	$ 150,000	
	Yard Piping	1	LS	$ 53,000	$ 53,000	
	Structure	1	LS	$ 959,000	$ 959,000	
	Process Piping and Appurtenances	1	LS	$ 133,000	$ 133,000	
	Equipment:					
	Odor Control	1	EA	$ 131,000	$ 131,000	
	Fine Screens, Washer and Compactor and Container	2	EA	$ 316,500	$ 633,000	
	Secondary Influent Pumps	3	EA	$ 100,000	$ 300,000	
	Instrumentation and Controls	1	LS	$ 83,000	$ 83,000	
	Electrical	1	LS	$ 119,000	$ 119,000	
						$ 2,561,000
	Demolition of Filter Building For Reuse (Main Electrical and Standby Generator to Remain)					
	Demolition	1	LS	$ 296,000	$ 296,000	
	Site Work	1	LS	$ 157,000	$ 157,000	
	Yard Piping	1	LS	$ -	$ -	
	Structure (Remove and Replace HVAC and Elec)	1	LS	$ 1,277,000	$ 1,277,000	
	Electrical (Replace Electrical Equipment	1	LS	$ 350,000	$ 350,000	
						$ 2,080,000
	MBBR Secondary Treatment Retrofit of Filter Building					
	Demolition	1	LS	$ 227,000	$ 227,000	
	Site Work and Landscaping	1	LS	$ 41,000	$ 41,000	
	Yard Piping	1	LS	$ 26,000	$ 26,000	
	Structure	1	LS	$ 454,000	$ 454,000	
	Process Piping and Appurtenances	1	LS	$ 714,000	$ 714,000	
	Equipment:					
	MBBR Vendor (Kruger)	1	EA	$ 1,636,000	$ 1,636,000	
	Instrumentation and Controls	1	LS	$ 92,000	$ 92,000	
	Electrical	1	LS	$ 305,000	$ 305,000	
						$ 3,495,000
	ActiFlo Settling and Effluent Pump Station (in existing Pump Station)					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ -	$ -	
	Yard Piping	1	LS	$ 14,000	$ 14,000	
	Structure	1	LS	$ 388,000	$ 388,000	
	Process Piping and Appurtenances	1	LS	$ 731,000	$ 731,000	
	Equipment:					
	Effluent Pumps	3	EA	$ 42,667	$ 128,000	
	Mudwell Pumps	2	EA	$ 18,000	$ 36,000	
	Polymer Make-up and Feed System	1	EA	$ 111,000	$ 111,000	
	ActiFlo Vendor Equipment	1	EA	$ 1,597,000	$ 1,597,000	
	Instrumentation and Controls	1	LS	$ 92,000	$ 92,000	
	Electrical	1	LS	$ 481,000	$ 481,000	
						$ 3,578,000.00
	TWAS Storage Tank and Control Building					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 38,000	$ 38,000	
	Yard Piping	1	LS	$ 94,000	$ 94,000	
	Structure	1	LS	$ 568,000	$ 568,000	
	Process Piping and Appurtenances	1	LS	$ 189,000	$ 189,000	
	Equipment:				$ -	
	TWAS Press Feed Pumps and Grinders	3	EA	$ 58,333	$ 175,000	
	Aeration Blowers	3	EA	$ 32,667	$ 98,000	
	Aeration Diffusers	1	EA	$ 50,000	$ 50,000	
	Instrumentation and Controls	1	LS	$ 37,000	$ 37,000	
	Electrical	1	LS	$ 124,000	$ 124,000	
						$ 1,373,000
	SUBTOTAL					**$ 13,087,000**
	Island Construction Premium (3%)					$ 392,610
	Engineering and Contingency (40%)					$ 5,234,800
	SUBTOTAL FROM AECOM					**$ 18,714,410**

OPINION OF CONSTRUCTION COST	**$ 31,826,101**
OPINION OF PROJECT COST (Rounded)	**$ 32,000,000**

Opinion of Cost - Option 5 MBBR & CoMag

Secondary Treatment at Peirce Island Site (4.30 MGD)

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
Portions of Wastewater Master Plan, June 2010, Cost Estimate Scenario 1B - Peirce Island Alternative TN 8, MBR Secondary Treatment at PI Site (6.2 MGD), PIT Site (1.7 MGD)	**Headworks**					
	Structure	2500	SF	$ 300	$ 750,000	
	Equipment:					
	Odor Control	1	EA	$ 60,000	$ 87,000	
	Bar Screens	2	EA	$ 250,000	$ 725,000	
	Screenings Washer & Compactor	2	EA	$ 50,000	$ 145,000	
	Grit Pumps	3	EA	$ 35,000	$ 152,250	
	Vortex Grit Removal	2	EA	$ 75,000	$ 217,500	
	Grit Classifier & Washer	2	EA	$ 40,000	$ 116,000	
						$ 2,192,750
	Sanitary Disinfection					
	Equipment:					
	Pump System	1	EA	$ 100,000	$ 100,000	
	UV Disinfection	1	EA	$ 200,000	$ 200,000	
						$ 300,000
	Biosolids Processing					
	Structure					
	Rehab Existing Process Building	1	EA	$ 350,000	$ 350,000	
	Equipment:					
	Carbon Odor Control	1	EA	$ 60,000	$ 87,000	
	Rotary Drum Thickener	2	EA	$ 150,000	$ 435,000	
	Dewatering Screw Press	2	EA	$ 400,000	$ 1,160,000	
	Conveyors	2	EA	$ 50,000	$ 145,000	
						$ 2,177,000
	Additional Structures and Modifications					
	Structure					
	PE Splitter - Upstream - Rehab Existing	1	EA	$ 500,000	$ 500,000	
	PE Splitter - Downstream	2200	SF	$ 300	$ 660,000	
						$ 1,160,000
	SUBTOTAL					**$ 5,829,750**
	Yard Piping (12%)					$ 699,570
	Electrical (22%)					$ 1,282,545
	Instrumentation and Controls (6%)					$ 349,785
	Site Work and Landscaping (7%)					$ 408,083
	SUBTOTAL					**$ 8,569,733**
	Island Construction Premium (3%)					$ 257,092
	Engineering (20%)					$ 1,713,947
	Contingency (30%)					$ 2,570,920
	SUBTOTAL FROM WASTEWATER MASTER PLAN ESTIMATES					**$ 13,111,691**

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
AECOM WWMP Pilot - Phase 1 Engineering Evaluation, August 2011	**Secondary Pump Station (Fine Screens and Lift Station)**					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 150,000	$ 150,000	
	Yard Piping	1	LS	$ 53,000	$ 53,000	
	Structure	1	LS	$ 959,000	$ 959,000	
	Process Piping and Appurtenances	1	LS	$ 133,000	$ 133,000	
	Equipment:					
	Odor Control	1	EA	$ 131,000	$ 131,000	
	Fine Screens, Washer and Compactor and Container	2	EA	$ 316,500	$ 633,000	
	Secondary Influent Pumps	3	EA	$ 100,000	$ 300,000	
	Instrumentation and Controls	1	LS	$ 83,000	$ 83,000	
	Electrical	1	LS	$ 119,000	$ 119,000	
						$ 2,561,000
	Demolition of Filter Building For Reuse (Main Electrical and Standby Generator to Remain)					
	Demolition	1	LS	$ 296,000	$ 296,000	
	Site Work	1	LS	$ 157,000	$ 157,000	
	Yard Piping	1	LS	$ -	$ -	
	Structure (Remove and Replace HVAC and Elec)	1	LS	$ 1,277,000	$ 1,277,000	
	Electrical (Replace Electrical Equipment	1	LS	$ 350,000	$ 350,000	
						$ 2,080,000
	MBBR Secondary Treatment Retrofit of Filter Building					
	Demolition	1	LS	$ 227,000	$ 227,000	
	Site Work and Landscaping	1	LS	$ 41,000	$ 41,000	
	Yard Piping	1	LS	$ 26,000	$ 26,000	
	Structure	1	LS	$ 454,000	$ 454,000	
	Process Piping and Appurtenances	1	LS	$ 714,000	$ 714,000	
	Equipment:					
	MBBR Vendor (Kruger)	1	EA	$ 1,636,000	$ 1,636,000	
	Instrumentation and Controls	1	LS	$ 92,000	$ 92,000	
	Electrical	1	LS	$ 305,000	$ 305,000	
						$ 3,495,000
	CoMag Settling, Effluent Pump Station (in existing Pump Station), Sludge Pump Station (New)					
	Demolition	1	LS	$ 4,000	$ 4,000	
	Site Work and Landscaping	1	LS	$ 10,000	$ 10,000	
	Yard Piping	1	LS	$ 28,000	$ 28,000	
	Structure	1	LS	$ 937,000	$ 937,000	
	Process Piping and Appurtenances	1	LS	$ 564,000	$ 564,000	
	Equipment:					
	Effluent Pumps	3	EA	$ 42,667	$ 128,000	
	Sludge Recycle Pumps	2	EA	$ 24,500	$ 49,000	
	Waste Sludge Pumps	3	EA	$ 24,667	$ 74,000	
	Polymer Make-up System	1	EA	$ 158,000	$ 158,000	
	CoMag Vendor Equipment	1	EA	$ 2,281,000	$ 2,281,000	
	Instrumentation and Controls	1	LS	$ 23,000	$ 23,000	
	Electrical	1	LS	$ 460,000	$ 460,000	
						$ 4,716,000.00
	TWAS Storage Tank and Control Building					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 38,000	$ 38,000	
	Yard Piping	1	LS	$ 94,000	$ 94,000	
	Structure	1	LS	$ 568,000	$ 568,000	
	Process Piping and Appurtenances	1	LS	$ 189,000	$ 189,000	
	Equipment:				$ -	
	TWAS Press Feed Pumps and Grinders	3	EA	$ 58,333	$ 175,000	
	Aeration Blowers	3	EA	$ 32,667	$ 98,000	
	Aeration Diffusers	1	EA	$ 50,000	$ 50,000	
	Instrumentation and Controls	1	LS	$ 37,000	$ 37,000	
	Electrical	1	LS	$ 124,000	$ 124,000	
						$ 1,373,000
	SUBTOTAL					**$ 14,225,000**
	Island Construction Premium (3%)					$ 426,750
	Engineering and Contingency (40%)					$ 5,690,000
	SUBTOTAL FROM AECOM					**$ 20,341,750**

OPINION OF CONSTRUCTION COST	**$ 33,453,441**
OPINION OF PROJECT COST (Rounded)	**$ 34,000,000**

Opinion of Cost - Option 6 MBBR & DAF
Secondary Treatment at Peirce Island Site (4.30 MGD)

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
Portions of Wastewater Master Plan, June 2010, Cost Estimate Scenario 1B - Peirce Island Alternative TN 8, MBR Secondary Treatment at PI Site (6.2 MGD), PIT Site (1.7 MGD)	**Headworks**					
	Structure	2500	SF	$ 300	$ 750,000	
	Equipment:					
	Odor Control	1	EA	$ 60,000	$ 87,000	
	Bar Screens	2	EA	$ 250,000	$ 725,000	
	Screenings Washer & Compactor	2	EA	$ 50,000	$ 145,000	
	Grit Pumps	3	EA	$ 35,000	$ 152,250	
	Vortex Grit Removal	2	EA	$ 75,000	$ 217,500	
	Grit Classifier & Washer	2	EA	$ 40,000	$ 116,000	
						$ 2,192,750
	Sanitary Disinfection					
	Equipment:					
	Pump System	1	EA	$ 100,000	$ 100,000	
	UV Disinfection	1	EA	$ 200,000	$ 200,000	
						$ 300,000
	Biosolids Processing					
	Structure					
	Rehab Existing Process Building	1	EA	$ 350,000	$ 350,000	
	Equipment:					
	Carbon Odor Control	1	EA	$ 60,000	$ 87,000	
	Rotary Drum Thickener	2	EA	$ 150,000	$ 435,000	
	Dewatering Screw Press	2	EA	$ 400,000	$ 1,160,000	
	Conveyors	2	EA	$ 50,000	$ 145,000	
						$ 2,177,000
	Additional Structures and Modifications					
	Structure					
	PE Splitter - Upstream - Rehab Existing	1	EA	$ 500,000	$ 500,000	
	PE Splitter - Downstream	2200	SF	$ 300	$ 660,000	
						$ 1,160,000
	SUBTOTAL					**$ 5,829,750**
	Yard Piping (12%)					$ 699,570
	Electrical (22%)					$ 1,282,545
	Instrumentation and Controls (6%)					$ 349,785
	Site Work and Landscaping (7%)					$ 408,083
	SUBTOTAL					**$ 8,569,733**
	Island Construction Premium (3%)					$ 257,092
	Engineering (20%)					$ 1,713,947
	Contingency (30%)					$ 2,570,920
	SUBTOTAL FROM WASTEWATER MASTER PLAN ESTIMATES					**$ 13,111,691**

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
AECOM WWMP Pilot - Phase 1 Engineering Evaluation, August 2011	**Secondary Pump Station (Fine Screens and Lift Station)**					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 150,000	$ 150,000	
	Yard Piping	1	LS	$ 53,000	$ 53,000	
	Structure	1	LS	$ 959,000	$ 959,000	
	Process Piping and Appurtenances	1	LS	$ 133,000	$ 133,000	
	Equipment:					
	Odor Control	1	EA	$ 131,000	$ 131,000	
	Fine Screens, Washer and Compactor and Container	2	EA	$ 316,500	$ 633,000	
	Secondary Influent Pumps	3	EA	$ 100,000	$ 300,000	
	Instrumentation and Controls	1	LS	$ 83,000	$ 83,000	
	Electrical	1	LS	$ 119,000	$ 119,000	
						$ 2,561,000
	Demolition of Filter Building For Reuse (Main Electrical and Standby Generator to Remain)					
	Demolition	1	LS	$ 296,000	$ 296,000	
	Site Work	1	LS	$ 157,000	$ 157,000	
	Yard Piping	1	LS	$ -	$ -	
	Structure (Remove and Replace HVAC and Elec)	1	LS	$ 1,277,000	$ 1,277,000	
	Electrical (Replace Electrical Equipment	1	LS	$ 350,000	$ 350,000	
						$ 2,080,000
	MBBR Secondary Treatment Retrofit of Filter Building					
	Demolition	1	LS	$ 227,000	$ 227,000	
	Site Work and Landscaping	1	LS	$ 41,000	$ 41,000	
	Yard Piping	1	LS	$ 26,000	$ 26,000	
	Structure	1	LS	$ 454,000	$ 454,000	
	Process Piping and Appurtenances	1	LS	$ 714,000	$ 714,000	
	Equipment:					
	MBBR Vendor (Kruger)	1	EA	$ 1,636,000	$ 1,636,000	
	Instrumentation and Controls	1	LS	$ 92,000	$ 92,000	
	Electrical	1	LS	$ 305,000	$ 305,000	
						$ 3,495,000
	DAF Settling and Effluent Pump Station (in existing Pump Station)					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ -	$ -	
	Yard Piping	1	LS	$ 28,000	$ 28,000.00	
	Structure	1	LS	$ 70,000	$ 70,000.00	
	Process Piping and Appurtenances	1	LS	$ 495,000	$ 495,000.00	
	Equipment:					
	Effluent Pumps	3	EA	$ 42,667	$ 128,000.00	
	Waste Sludge Pumps	2	EA	$ 120,500	$ 241,000.00	
	Polymer Make-up and Feed System	1	EA	$ 111,000	$ 111,000.00	
	DAF Vendor Equipment	1	EA	$ 1,673,000	$ 1,673,000.00	
	Instrumentation and Controls	1	LS	$ 28,000	$ 28,000.00	
	Electrical	1	LS	$ 451,000	$ 451,000.00	
						$ 3,225,000.00
	TWAS Storage Tank and Control Building					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 38,000	$ 38,000	
	Yard Piping	1	LS	$ 94,000	$ 94,000	
	Structure	1	LS	$ 568,000	$ 568,000	
	Process Piping and Appurtenances	1	LS	$ 189,000	$ 189,000	
	Equipment:				$ -	
	TWAS Press Feed Pumps and Grinders	3	EA	$ 58,333	$ 175,000	
	Aeration Blowers	3	EA	$ 32,667	$ 98,000	
	Aeration Diffusers	1	EA	$ 50,000	$ 50,000	
	Instrumentation and Controls	1	LS	$ 37,000	$ 37,000	
	Electrical	1	LS	$ 124,000	$ 124,000	
						$ 1,373,000
	SUBTOTAL					**$ 12,734,000**
	Island Construction Premium (3%)					$ 382,020
	Engineering and Contingency (40%)					$ 5,093,600
	SUBTOTAL FROM AECOM					**$ 18,209,620**

OPINION OF CONSTRUCTION COST	**$ 31,321,311**
OPINION OF PROJECT COST (Rounded)	**$ 32,000,000**

Opinion of Cost - Option 7 MBR
Secondary Treatment at Peirce Island Site (4.30 MGD)

PEIRCE ISLAND CAPITAL COST ESTIMATE						
SOURCE	**ITEM**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**AMOUNT**	**Subtotal**
Portions of Wastewater Master Plan, June 2010, Cost Estimate Scenario 1B - Peirce Island Alternative TN 8, MBR Secondary Treatment at PI Site (6.2 MGD), PIT Site (1.7 MGD)	**Headworks**					
	Structure	2500	SF	$ 300	$ 750,000	
	Equipment:					
	Odor Control	1	EA	$ 60,000	$ 87,000	
	Bar Screens	2	EA	$ 250,000	$ 725,000	
	Screenings Washer & Compactor	2	EA	$ 50,000	$ 145,000	
	Grit Pumps	3	EA	$ 35,000	$ 152,250	
	Vortex Grit Removal	2	EA	$ 75,000	$ 217,500	
	Grit Classifier & Washer	2	EA	$ 40,000	$ 116,000	
						$ 2,192,750
	Sanitary Disinfection					
	Equipment:					
	Pump System	1	EA	$ 100,000	$ 100,000	
	UV Disinfection	1	EA	$ 200,000	$ 200,000	
						$ 300,000
	Biosolids Processing					
	Structure					
	Rehab Existing Process Building	1	EA	$ 350,000	$ 350,000	
	Equipment:					
	Carbon Odor Control	1	EA	$ 60,000	$ 87,000	
	Rotary Drum Thickener	2	EA	$ 150,000	$ 435,000	
	Dewatering Screw Press	2	EA	$ 400,000	$ 1,160,000	
	Conveyors	2	EA	$ 50,000	$ 145,000	
						$ 2,177,000
	Additional Structures and Modifications					
	Structure					
	PE Splitter - Upstream - Rehab Existing	1	EA	$ 500,000	$ 500,000	
	PE Splitter - Downstream	2200	SF	$ 300	$ 660,000	
						$ 1,160,000
	SUBTOTAL					**$ 5,829,750**
	Yard Piping (12%)					$ 699,570
	Electrical (22%)					$ 1,282,545
	Instrumentation and Controls (6%)					$ 349,785
	Site Work and Landscaping (7%)					$ 408,083
	SUBTOTAL					**$ 8,569,733**
	Island Construction Premium (3%)					$ 257,092
	Engineering (20%)					$ 1,713,947
	Contingency (30%)					$ 2,570,920
	SUBTOTAL FROM WASTEWATER MASTER PLAN ESTIMATES					**$ 13,111,691**

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
AECOM WWMP Pilot - Phase 1 Engineering Evaluation, August 2011	**Secondary Pump Station (Fine Screens and Lift Station)**					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 150,000	$ 150,000	
	Yard Piping	1	LS	$ 53,000	$ 53,000	
	Structure	1	LS	$ 959,000	$ 959,000	
	Process Piping and Appurtenances	1	LS	$ 133,000	$ 133,000	
	Equipment:					
	Odor Control	1	EA	$ 131,000	$ 131,000	
	Fine Screens, Washer and Compactor and Container	2	EA	$ 316,500	$ 633,000	
	Secondary Influent Pumps	3	EA	$ 100,000	$ 300,000	
	Instrumentation and Controls	1	LS	$ 83,000	$ 83,000	
	Electrical	1	LS	$ 119,000	$ 119,000	
						$ 2,561,000
	Demolition of Filter Building For Reuse (Main Electrical and Standby Generator to Remain)					
	Demolition	1	LS	$ 296,000	$ 296,000	
	Site Work	1	LS	$ 157,000	$ 157,000	
	Yard Piping	1	LS	$ -	$ -	
	Structure (Remove and Replace HVAC and Elec)	1	LS	$ 1,277,000	$ 1,277,000	
	Electrical (Replace Electrical Equipment	1	LS	$ 350,000	$ 350,000	
						$ 2,080,000
	MBR Secondary Treatment Retrofit of Filter Building					
	Demolition	1	LS	$ 327,000	$ 327,000.00	
	Site Work and Landscaping	1	LS	$ 179,000	$ 179,000.00	
	Yard Piping	1	LS	$ 182,000	$ 182,000.00	
	Structure	1	LS	$ 1,435,000	$ 1,435,000.00	
	Process Piping and Appurtenances	1	LS	$ 1,901,000	$ 1,901,000.00	
	Equipment:					
	RAS Pumps	5	EA	$ 36,400	$ 182,000.00	
	WAS Pumps	3	EA	$ 24,667	$ 74,000.00	
	Aeration Blowers	3	EA	$ 105,000	$ 315,000.00	
	Aeration Tank Diffusers	1	EA	$ 112,000	$ 112,000.00	
	Hoisting Equipment	5	EA	$ 70,600	$ 353,000.00	
	Vendor (GE/Zenon)	1	EA	$ 7,147,000	$ 7,147,000.00	
	Instrumentation and Controls	1	LS	$ 277,000	$ 277,000.00	
	Electrical	1	LS	$ 1,390,000	$ 1,390,000.00	
						$ 13,874,000
	TWAS Storage Tank and Control Building					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 38,000	$ 38,000	
	Yard Piping	1	LS	$ 94,000	$ 94,000	
	Structure	1	LS	$ 568,000	$ 568,000	
	Process Piping and Appurtenances	1	LS	$ 189,000	$ 189,000	
	Equipment:				$ -	
	TWAS Press Feed Pumps and Grinders	3	EA	$ 58,333	$ 175,000	
	Aeration Blowers	3	EA	$ 32,667	$ 98,000	
	Aeration Diffusers	1	EA	$ 50,000	$ 50,000	
	Instrumentation and Controls	1	LS	$ 37,000	$ 37,000	
	Electrical	1	LS	$ 124,000	$ 124,000	
						$ 1,373,000
	SUBTOTAL					**$ 19,888,000**
	Island Construction Premium (3%)					$ 596,640
	Engineering and Contingency (40%)					$ 7,955,200
	SUBTOTAL FROM AECOM					**$ 28,439,840**

OPINION OF CONSTRUCTION COST	**$ 41,551,531**
OPINION OF PROJECT COST (Rounded)	**$ 42,000,000**

Opinion of Cost - Option 8 Conventional Activated Sludge
Secondary Treatment at Peirce Island Site (4.30 MGD)

PEIRCE ISLAND CAPITAL COST ESTIMATE						
SOURCE	**ITEM**	**QUANTITY**	**UNIT**	**UNIT PRICE**	**AMOUNT**	**Subtotal**
Portions of Wastewater Master Plan, June 2010, Cost Estimate Scenario 1B - Peirce Island Alternative TN 8, MBR Secondary Treatment at PI Site (6.2 MGD), PIT Site (1.7 MGD)	**Headworks**					
	Structure	2500	SF	$ 300	$ 750,000	
	Equipment:					
	Odor Control	1	EA	$ 60,000	$ 87,000	
	Bar Screens	2	EA	$ 250,000	$ 725,000	
	Screenings Washer & Compactor	2	EA	$ 50,000	$ 145,000	
	Grit Pumps	3	EA	$ 35,000	$ 152,250	
	Vortex Grit Removal	2	EA	$ 75,000	$ 217,500	
	Grit Classifier & Washer	2	EA	$ 40,000	$ 116,000	
						$ 2,192,750
	Sanitary Disinfection					
	Equipment:					
	Pump System	1	EA	$ 100,000	$ 100,000	
	UV Disinfection	1	EA	$ 200,000	$ 200,000	
						$ 300,000
	Biosolids Processing					
	Structure					
	Rehab Existing Process Building	1	EA	$ 350,000	$ 350,000	
	Equipment:					
	Carbon Odor Control	1	EA	$ 60,000	$ 87,000	
	Rotary Drum Thickener	2	EA	$ 150,000	$ 435,000	
	Dewatering Screw Press	2	EA	$ 400,000	$ 1,160,000	
	Conveyors	2	EA	$ 50,000	$ 145,000	
						$ 2,177,000
	Additional Structures and Modifications[1]					
	Structure					
	PE Splitter - Upstream - Rehab Existing[2]	1	EA	$ 500,000	$ 500,000	
	PE Splitter - Downstream	2200	SF	$ 300	$ 660,000	
	Primary Clarifier Drive Replacement	2	EA	$ 175,000	$ 350,000	
						$ 1,510,000
	SUBTOTAL					**$ 6,179,750**
	Yard Piping (12%)					$ 741,570
	Electrical (22%)					$ 1,359,545
	Instrumentation and Controls (6%)					$ 370,785
	Site Work and Landscaping (7%)					$ 432,583
	SUBTOTAL					**$ 9,084,233**
	Island Construction Premium (3%)					$ 272,527
	Engineering (20%)					$ 1,816,847
	Contingency (30%)					$ 2,725,270
	SUBTOTAL FROM WASTEWATER MASTER PLAN ESTIMATES					**$ 13,898,876**
AECOM WWMP Pilot - Phase 1 Engineering Evaluation, August 2011	**Wet Weather Facility**					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 33,000.00	$ 33,000.00	
	Yard Piping	1	LS	$ 109,000.00	$ 109,000.00	
	Structure	1	LS	$ 1,390,000.00	$ 1,390,000.00	
	Process Piping and Appurtenances	1	LS	$ 235,000.00	$ 235,000.00	
	Equipment:					
	Vendor (Kruger ActiFlo)	1	EA	$ 2,105,000.00	$ 2,105,000.00	
	Polymer makeup system	1	EA	$ 111,000.00	$ 111,000.00	
	Odor Control	1	EA	$ 206,000.00	$ 206,000.00	
	Instrumentation and Controls	1	LS	$ 231,000.00	$ 231,000.00	
	Electrical	1	LS	$ 589,000.00	$ 589,000.00	
						$ 5,009,000
	Secondary Influent Pump Station and Blower Building					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 33,000.00	$ 33,000.00	
	Yard Piping	1	LS	$ 179,000.00	$ 179,000.00	
	Structure	1	LS	$ 886,000.00	$ 886,000.00	
	Process Piping and Appurtenances	1	LS	$ 539,000.00	$ 539,000.00	
	Equipment:					
	Influent Pumps	3	EA	$ 42,666.67	$ 128,000.00	
	Aeration Tank Blowers	3	EA	$ 105,000.00	$ 315,000.00	
	Odor Control	1	EA	$ 131,000.00	$ 131,000.00	
	Electrical	1	LS	$ 28,000.00	$ 28,000.00	
	Instrumentation and Controls	1	LS	$ 149,000.00	$ 149,000.00	
						$ 2,388,000
	Demolish Filter Building including Main Electrical Facilities					
	Demolition	1	LS	$ 1,354,000	$ 1,354,000	
	Site Work and Landscaping	1	LS	$ 491,000	$ 491,000	
						$ 1,845,000
	Convert Filter Building to Aeration Tank					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 41,000.00	$ 41,000.00	
	Yard Piping	1	LS	$ -	$ -	
	Structure	1	LS	$ 1,993,000.00	$ 1,993,000.00	
	Process Piping and Appurtenances	1	LS	$ 124,000.00	$ 124,000.00	
	Equipment:					
	Fine Bubble Aeration	1	EA	$ 119,000.00	$ 119,000.00	
	Instrumentation and Controls	1	LS	$ 46,000.00	$ 46,000.00	
	Electrical	1	LS	$ 167,000.00	$ 167,000.00	
						$ 2,490,000

PEIRCE ISLAND CAPITAL COST ESTIMATE

SOURCE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	Subtotal
AECOM WWMP Pilot - Phase 1 Engineering Evaluation, August 2011	**Primary Clarifier Conversion and New Secondary Clarifier**					
	Demolition	1	LS	$ 6,000.00	$ 6,000.00	
	Site Work and Landscaping	1	LS	$ 48,000.00	$ 48,000.00	
	Yard Piping	1	LS	$ 115,000.00	$ 115,000.00	
	Structure	1	LS	$ 739,000.00	$ 739,000.00	
	Process Piping and Appurtenances	1	LS	$ 56,000.00	$ 56,000.00	
	Equipment:					
	SC Drive to Replace Existing Primary (see Additional Structures and Modifications)					
	SC Drive (same as costs for PC Drive Replacement under Additional Structures and Modifications)	1	EA	$ 175,000.00	$ 175,000.00	
	Instrumentation and Controls	1	LS	$ 14,000.00	$ 14,000.00	
	Electrical	1	LS	$ 55,000.00	$ 55,000.00	
						$ 1,208,000.00
	Sludge Pump and Scum Pump Improvements (Admin Building Basement)					
	Demolition	1	LS	$ 15,000	$ 15,000	
	Site Work and Landscaping	1	LS	$ 6,000	$ 6,000	
	Yard Piping	1	LS	$ 117,000	$ 117,000	
	Structure	1	LS	$ 2,000	$ 2,000	
	Process Piping and Appurtenances	1	LS	$ 715,000	$ 715,000	
	Equipment:				$ -	
	RAS Pumps	3	EA	$ 42,667	$ 128,000	
	WAS Pumps	4	EA	$ 13,750	$ 55,000	
	TPS Press Feed Pumps	3	EA	$ 58,333	$ 175,000	
	Scum Pumps	4	EA	$ 12,500	$ 50,000	
	Instrumentation and Controls	1	LS	$ 28,000	$ 28,000	
	Electrical	1	LS	$ 56,000	$ 56,000	
						$ 1,347,000
	TWAS Storage Tank					
	Demolition	1	LS	$ -	$ -	
	Site Work and Landscaping	1	LS	$ 38,000	$ 38,000	
	Yard Piping	1	LS	$ 94,000	$ 94,000	
	Structure	1	LS	$ 568,000	$ 568,000	
	Process Piping and Appurtenances	1	LS	$ 189,000	$ 189,000	
	Equipment:				$ -	
	TWAS Press Feed Pumps and Grinders	3	EA	$ 58,333	$ 175,000	
	Aeration Blowers	3	EA	$ 32,667	$ 98,000	
	Aeration Diffusers	1	EA	$ 50,000	$ 50,000	
	Instrumentation and Controls	1	LS	$ 37,000	$ 37,000	
	Electrical	1	LS	$ 124,000	$ 124,000	
						$ 1,373,000
	Main Electrical Building and Standby Generator					
	Demolition	1	LS	$ 5,000	$ 5,000	
	Site Work and Landscaping	1	LS	$ 15,000	$ 15,000	
	Electrical Conduit	1	LS	$ 217,000	$ 217,000	
	Structure	1	LS	$ 168,000	$ 168,000	
	Process Piping and Appurtenances	1	LS	$ -	$ -	
	Equipment:					
	Electrical (Switchboard, MCB, ATS)	1	EA	$ 122,000	$ 122,000	
	Standby Generator	1	EA	$ 347,000	$ 347,000	
	Instrumentation and Controls	1	LS	$ -	$ -	
	Electrical	1	LS	$ -	$ -	
						$ 874,000
	Maintenance of Operations During Construction/Construction Phasing					
	Maintenance of Operations During Construction	1	LS	$ 500,000	$ 500,000	
						$ 500,000
	SUBTOTAL					**$ 17,034,000**
	Island Construction Premium (3%)					$ 511,020
	Engineering and Contingency (40%)					$ 6,813,600
	SUBTOTAL FROM AECOM					**$ 24,358,620**

OPINION OF CONSTRUCTION COST	**$ 38,257,496**
OPINION OF PROJECT COST (Rounded)	**$ 39,000,000**