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SUPPLEMENTAL ALTERNATIVE TECHNOLOGY EVALUATION

PSNH MERRIMACK STATION UNITS 1 & 2 BOW, NEW HAMPSHIRE

Prepared for
Public Service Company of New Hampshire

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EXECUTIVE SUMMARY

Public Service Company of New Hampshire's (PSNH) Merrimack Station electrical generating facility in Bow, New Hampshire (Station) is seeking a renewal of its existing National Pollutant Discharge Elimination System (NPDES) permit (NPDES Permit NH0001465). In July 2007, the United States Environmental Protection Agency (EPA) issued an information request letter to PSNH under Section 308 of the Clean Water Act (CWA) regarding CWA §316(a) and §316(b), 33 U.S.C. §§1326(a) and 1326(b) (§308 Letter). In the §308 Letter, EPA requested certain technology and aquatic information from PSNH to support EPA's development of the renewal NPDES permit for the Station. PSNH submitted a response (§308 Response Report) prepared by Enercon Services, Inc. (ENERCON) and Normandeau Associates, Inc. (Normandeau).

Following a meeting with PSNH, Normandeau, and ENERCON regarding the §308 Response Report in December 2008, EPA requested that PSNH further evaluate the following technologies in more detail and submit a supplement to the §308 Response Report:

- **Option 1** - Seasonal deployment of wedgewire screens in front of the Station's existing cooling water intake structures.
- **Option 2** - Seasonal deployment of an Aquatic Filter Barrier in front of the Station's existing intake structures.
- **Option 3** - Installation of fine mesh traveling screens to replace the Station's existing coarse mesh traveling screens.

This Supplemental Alternative Technology Evaluation responds to the EPA's request by evaluating, on a conceptual basis, the following for each technology option:

- **Conceptual Design** - Lists the major components and major modifications that would be required to retrofit Merrimack Station with each technology option, using preliminary site layouts.
- **Operational Features and Maintenance Requirements** - Describes the general operational and preventative maintenance requirements associated with each conceptual technology option.
- **Construction Factors** - Develops a conceptual planning schedule that includes an estimate for any outages due to construction activities.
- **Cost Estimates** - Determines projected initial costs (capital costs and lost generation costs), annual operational and maintenance (O&M) costs (including contingencies), and estimated useful life for major equipment associated with each conceptual technology option.
- **Impingement Mortality/Entrainment Reduction Assessment** - Determines the potential reduction of impingement mortality and entrainment from baseline that would result from the implementation of each conceptual technology option.
- **Environmental Considerations** - Evaluates each conceptual technology option's potential impact on the use of the Merrimack River, aesthetics, and greenspace / potential habitat.

Each of the three conceptual technology options was ranked using its projected initial and O&M costs and the results of its impingement/entrainment reduction assessment. For the reasons detailed below, the preferred conceptual technology option identified through this ranking was seasonal operation of wedgewire screens in combination with the use of upgraded fish return systems with the existing intake structures. The initial capital cost for this technology option would range from approximately \$8,508,000 to approximately \$8,816,000, depending on the optimal slot size determined as the result of the recommended site-specific study (see below). Annual costs were estimated at approximately \$86,000. Some construction activities associated with the installation of wedgewire screens would likely require an outage, but it is possible that these activities could be scheduled to coincide with a routine maintenance outage. If these activities were unable to be scheduled during a routine maintenance outage, a forced construction outage would be required, resulting in increased costs due to loss of energy generation.

The preferred conceptual technology option – seasonal operation of wedgewire screens in combination with the use of upgraded fish return systems – is expected to satisfy CWA §316(b) with regard to impingement mortality and entrainment as follows:

- Reduce impingement mortality by approximately 84% from baseline.
- Reduce entrainment from baseline ranging from approximately 73% for 9 mm wedgewire screens to approximately 79% for 1.5 mm wedgewire screens.

Any wedgewire screens used at Merrimack Station would need to maximize biological benefits while maintaining the consistent intake flow required for cooling. Typically, smaller slot size screens minimize entrainment to a greater degree than larger slot size screens but are more susceptible to fouling. In order to minimize both entrainment and fouling, a range of slot sizes from 9 mm to 1.5 mm was selected for evaluation in this Report. The lowest slot size in this range is smaller, and thus potentially more protective of aquatic organisms, than the 1.75 mm slot size of EPA's identified compliance technology for the Station. Nonetheless, due to the significant potential for screen fouling in the Merrimack River at Merrimack Station, on-site physical testing of different slot sizes through a site-specific study would be required to evaluate the optimal slot size for the Station. Contingent on the results of this site-specific testing, seasonal use of wedgewire screens with upgraded fish return systems for the existing cooling water intake structures is recommended as the "best technology available" (BTA) for minimizing adverse environmental impact for Merrimack Station.

1 Background, Introduction, and Scope

1.1 Background and Introduction

Public Service Company of New Hampshire's (PSNH) Merrimack Station electrical generating facility in Bow, New Hampshire (Station) is seeking a renewal of its existing National Pollutant Discharge Elimination System (NPDES) permit (NPDES Permit NH0001465). In July 2007, the United States Environmental Protection Agency (EPA) issued an information request letter to PSNH under Section 308 of the Clean Water Act (CWA) regarding CWA §316(a) and §316(b), 33 U.S.C. §§1326(a) and 1326(b) (§308 Letter). In the §308 Letter, EPA requested certain technology and aquatic information from PSNH to support EPA's development of the renewal NPDES permit for the Station. PSNH submitted a response (§308 Response Report) prepared by Enercon Services, Inc. (ENERCON) and Normandeau Associates, Inc. (Normandeau).

Following a meeting with PSNH, Normandeau, and ENERCON regarding the §308 Response Report in December 2008, EPA requested that PSNH further evaluate the following technologies in more detail and submit a supplement to the §308 Response Report:

- **Option 1 -** Seasonal deployment of wedgewire screens in front of the Station's cooling water intake structures (CWISs).
- **Option 2 -** Seasonal deployment of an Aquatic Filter Barrier (AFB) in front of the Station's existing intake structures.
- **Option 3 -** Installation of fine mesh traveling screens to replace the Station's existing coarse mesh traveling screens.

1.2 Scope

This Supplemental Alternative Technology Evaluation (Report) presents the additional information that EPA asked PSNH to provide following its review of the §308 Response Report (Ref. 7.1) and its December 2008 meeting with PSNH, ENERCON, and Normandeau. This Report discusses and compares the following alternative CWIS technology options:

- **Option 1 -** Seasonal deployment of wedgewire screens in front of the Station's existing CWISs, with operation of the existing traveling screens and upgraded fish return systems during the months the wedgewire screens are not operating.
- **Option 2 -** Seasonal deployment of an AFB in front of the Station's existing CWISs, with operation of the existing traveling screens and upgraded fish return systems during the months the AFB is not operating.
- **Option 3 -** Replacement of the Station's existing coarse mesh traveling screens with fine mesh traveling screens.

In particular, this Report responds to EPA's request by evaluating, on a conceptual basis, the following for each technology option:

- **Conceptual Design** - Lists the major components and major modifications that would be required to retrofit Merrimack Station with each technology option, using preliminary site layouts.
- **Operational Features and Maintenance Requirements** - Describes the general operational and preventative maintenance requirements associated with each conceptual technology option. Site-specific operational issues are anticipated, but must be confirmed.
- **Construction Factors** - Develops a conceptual planning schedule that includes an estimate for any outages due to construction activities.
- **Cost Estimates** - Determines projected initial costs (capital costs and lost generation costs), annual operational and maintenance (O&M) costs (including contingencies), and estimated useful life for major equipment associated with each conceptual technology option.
- **Impingement Mortality/Entrainment Reduction Assessment** - Determines the potential reduction of impingement mortality and entrainment (IM&E) from the established baseline that would result from implementation of each conceptual technology option.
- **Environmental Considerations** - Evaluates each conceptual technology option's potential impact on the use of the Merrimack River, aesthetics, and greenspace / potential habitat.

2 Option 1 - Seasonal Deployment of Wedgewire Screens and Upgraded Fish Return Systems

2.1 Conceptual Design

Wedgewire screen systems are passive systems that provide a reliable and robust physical barrier separating aquatic organisms and debris from water withdrawn from a source waterbody for cooling. Due to the cylindrical shape of a wedgewire screen, the velocity pulling organisms toward the screen is quickly dissipated, making it easier for fish to swim away before becoming impinged. EPA has previously identified wedgewire screens (i.e., the "[a]ddition of passive fine-mesh screen system (cylindrical wedgewire) near shoreline with mesh width of 1.75 mm") as "the most appropriate [CWA §316(b)] compliance technology" for Merrimack Station (Ref. 7.14).

As directed by EPA Region 1, this Report refines the initial assessment of wedgewire screens from the §308 Response Report for Merrimack Station (Ref. 7.1) in order to evaluate whether this technology, implemented and seasonally operated as described below, represents the "best technology available for minimizing adverse environmental impact" (BTA) from the Station's CWISs. The results of this focused evaluation support EPA's conclusion that wedgewire screens constitute "the most appropriate compliance technology" for Merrimack Station (Ref. 7.14). In short, the evaluated wedgewire screen sizing and axial orientation, in combination with the natural current of the Merrimack River, would aid organisms in bypassing the Station's CWIS intakes during the time period with the highest observed levels of entrainment (late May through late June) (Ref. 7.2). Additionally, as a result of the evaluated sizing and associated surface area of the screens, the through-slot velocity would be less than 0.5 fps, which EPA has determined would reduce impingement mortality by approximately 80-95% (Ref. 7.14) and thereby satisfy CWA §316(b) with regard to impingement mortality.

There are several considerations with respect to the use of wedgewire screens at Merrimack Station, summarized below:

- Wedgewire screens are susceptible to damage and clogging due to ice formation on the screens during the winter months (Ref. 7.1; Ref. 7.6). Therefore, in order to avoid damage and any operational impacts resulting from the formation of frazil ice (discussed in Section 2.2.1), wedgewire screens could only safely be used at Merrimack Station from April through November.
- Wedgewire screens require a minimum axial velocity from a waterbody of 1 fps to move the debris and silt from the screen surfaces (Ref. 7.3). The flow velocity of the Merrimack River slows in late summer and, therefore, there would not always be sufficient axial flow to remove debris and silt. During these periods of low flow, wedgewire screens could be susceptible to fouling or clogging, which could block the flow of water to the Station. Therefore, in order to minimize such fouling and clogging, wedgewire screens would only be used at Merrimack Station from April through July. Moreover, PSNH would use an automatic air cleaning system to help keep the screens clean of debris and silt.

- Any wedgewire screens used at Merrimack Station would need to maximize biological benefits while maintaining the consistent intake flow required for cooling. Typically, smaller slot size screens minimize entrainment to a greater degree than larger slot size screens but are more susceptible to fouling. In order to minimize both entrainment and fouling, a range of slot sizes from 9 mm to 1.5 mm was selected for evaluation in this Report. The lowest slot size in this range is smaller, and thus potentially more protective of aquatic organisms, than the 1.75 mm slot size of EPA's identified compliance technology for the Station (Ref. 7.14). Nonetheless, due to the significant potential for screen fouling in the Merrimack River at Merrimack Station, on-site physical testing of different slot sizes through a site-specific study would be required to evaluate the optimal slot size for the Station.
- Wedgewire screens are susceptible to damage from ice floes and could potentially become damaged by navigational activities on the Merrimack River (i.e., dropping anchors, low boat hulls, boating, etc.). Therefore, in order to avoid damage and any operational impacts resulting from ice floes, engineered measures to protect the wedgewire screens would be explored during detailed design.
- At low water levels, the use of wedgewire screens at Merrimack Station would be limited by the submergence requirements of the circulating water pumps. Submergence is required to prevent air intrusion into the circulating water pumps, and submergence margin is employed to buffer against this occurrence. The resistance of the wedgewire screens (assumed clear of fouling or clogging) and the associated piping systems would reduce the water elevation within the CWISs and, therefore, the submergence of the circulating water pumps. As fouling or clogging of the wedgewire screens occurred, resistance through the screens would increase, causing additional water level drop in the pump bay and reduced margin for each pump. Prior to completion of the detailed design, operation of the circulating water pumps during low water level conditions would have to be thoroughly evaluated. As a result of this evaluation wedgewire screen operation could be limited to times in which adequate submergence is present.

During the months the wedgewire screens would not be operating (August through March), Merrimack Station's existing coarse mesh traveling screens would be used in combination with upgraded fish return systems (i.e., improved fish return sluices with low pressure spray wash systems). The existing coarse mesh traveling screens and upgraded fish return systems would be run continuously from August through November (Ref. 7.15). Consistent with the Station's current operating procedures, the existing coarse mesh traveling screens and upgraded fish return systems would be run intermittently from December through March as there would be personnel safety issues associated with maintaining the fish return systems when ice is present.

A typical wedgewire screen is shown in Figures 2-1 and 2-2. A typical installation of wedgewire screens is depicted in Figure 2-3.

Figure 2-1: Hendrick Wedgewire Intake Screen (Attachment D1)

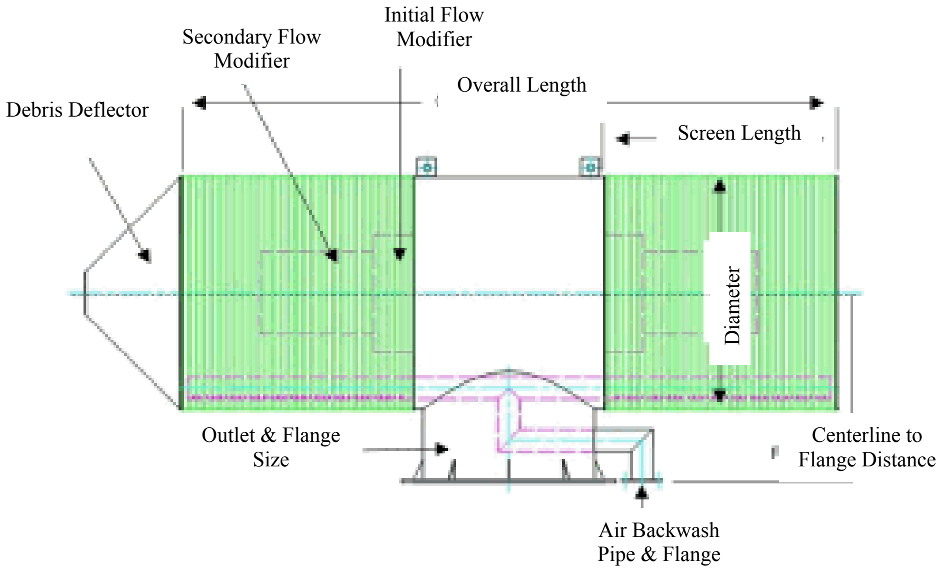

Figure 2-2: Basic Diagram of Wedgewire Screen from Johnson Screens Website (www.johnsonscreens.com)

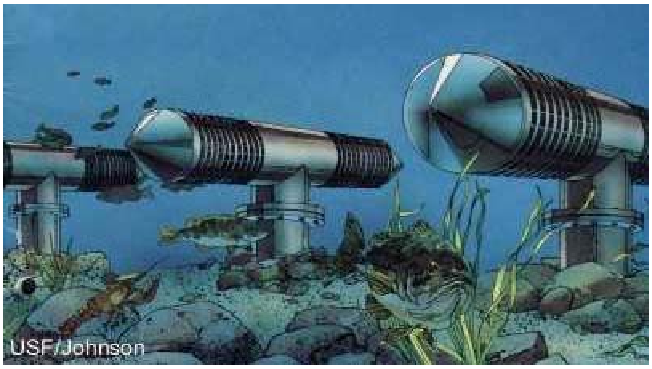

Figure 2-3: Drawing of Wedgewire Screens on the Bottom of a Water Body (Ref. (Ref. 7.4)

The two vendors listed below were contacted to obtain information on the sizing, placement, and costs of implementing wedgewire screens at Merrimack Station:

- Eimco Water Technologies, LLC (Eimco) (www.glv.com)
- Johnson Screens (www.johnsonscreens.com)

The basic design requirements for the wedgewire screens and upgraded fish return systems evaluated in this Report are detailed in Table 2-1.

Table 2-1: Basic Design Considerations for the Wedgewire Screens and Upgraded Fish Return Systems Evaluated for Merrimack Station

Item	Design Criteria	Specific Design Criteria	Recommendation
Slot Width	Desired for entrainment reduction and fouling minimization	1.5 mm (0.06 in) – 9 mm (0.35 in)	Normandeau (Ref. 7.15)
Diameter	Maximum screen diameter should be half the water depth at the lowest extreme water level (preferably no more than one-third depth)	2 ft	US EPA website (http://www.waterintake.com/intakescreenstyles.htm) Eimco and Johnson Screens (Attachment D1)
Length	Provide necessary surface area to reduce through-slot velocity ≤ 0.5 fps	80 in	Johnson Screens (Attachment D1)
Quantity Unit 1	Provide necessary surface area to reduce through-slot velocity ≤ 0.5 fps	13 - 24	Johnson Screens (Attachment D1)
Quantity Unit 2	Provide necessary surface area to reduce through-slot velocity ≤ 0.5 fps	31 - 52	Johnson Screens (Attachment D1)
Material	Corrosion proof and resist organism growth (i.e., zebra snails, filamentous algae, etc.)	304 SS	Normandeau, Eimco (Attachment D1)
Distance from River Bottom	Minimum of ½ diameter	1 ft	Johnson Screens and Eimco (Attachment D1)
Distance from other screens	Minimum of ½ diameter	Minimum of 2 ft	Johnson Screens and Eimco (Attachment D1)
Air Cleaning System	Reduce clogging during operation	Recommended	Johnson Screens and Eimco (Attachment D1)

Item	Design Criteria	Specific Design Criteria	Recommendation
Fish Slide/Sluice	Smooth and gently sloped and curved to return fish to river when wedgewire screens not in use Removable Cover	Required	Normandeau (Attachment E) (Ref. 7.1 and Ref. 7.7)
Slide Water Velocity	3 - 5 fps	3 - 5 fps	Normandeau (Ref. 7.1)
Minimum Water Depth in Fish Slide	4 - 6 in	4 - 6 in	Normandeau (Ref. 7.1)
Slope of Fish Slide	Optimal 1/16 ft drop/linear ft (LF)	1 ft drop/16 LF	Eimco (Attachment D3)
Low Pressure Spray System	Gently recover impinged organisms from screen ≤ 15 psi and maintain depth in slide 4 - 6 in	5 - 15 psi	Normandeau (Ref. 7.15) (Ref. 7.1 and Ref. 7.7)

2.1.1 Major Components

Major components for the evaluated wedgewire screen installations and upgraded fish return systems are detailed in Table 2-2 and Attachment D1.

Table 2-2: Major Components for the Wedgewire Screen Installations and Upgraded Fish Return Systems Evaluated for Merrimack Station

Component	Quantity	Description	Size	Slot Size	Material
Unit 1					
Wedgewire Screens	13-24	Passive screens	24 in diameter x 80 in long	1.5 mm (0.06 in.) – 9 mm (0.35 in)	304 SS
Compressor	2	Rotary Screw	15 hp		
Receiver	1	Vertical receiver	400 gallon, ASME 200 psig		

Component	Quantity	Description	Size	Slot Size	Material
Control Panel	1	3-modes of operation (manual, auto and remote)			
Butterfly Valve	2	Manually Operated	36 in		304 SS
Fish Slide	1	300 ft			
Low Pressure Spray System	2	Fish Removal Spray			
Spray Wash Pump	1	Pump for Fish Removal Spray	400 gpm at 80 psi		
Wedgewire Header Piping	200 - 250 LF	Large Diameter ASTM 778 Austenitic Steel Piping	OD 24 in to 36 in		304 SS
Unit 2					
Wedgewire Screens	31 - 52	Passive screens	24 in diameter by 80 in long	1.5 mm (0.06 in) – 9 mm (0.35 in)	304 SS
Butterfly Valve	2	Manually Operated	54 in		304 SS
Compressor	2	Rotary Screw	15 hp		
Receiver	1	Vertical receiver	400 gallon, ASME 200 psig		
Control Panel	1	3-modes of operation (manual, auto and remote)			
Fish Slide	1	100 ft			
Spray Wash Pump	1	Pump for Fish Removal Spray	400 gpm at 80 psi		

Component	Quantity	Description	Size	Slot Size	Material
Low Pressure Spray System	2	Fish Removal Spray			
Wedgewire Header Piping	300 - 400 LF	Large Diameter ASTM 778 Austenitic Steel Piping	OD 48 in to 54 in		304 SS

2.1.2 Site Layout

Sketches conceptually depicting the implementation of the evaluated wedgewire screen installations at Merrimack Station are included in Attachment A. The conceptual placement of the wedgewire screens seeks both to minimize the distance the screens would extend into the Merrimack River, and to maximize the submergence of the screens in order to reduce potential impacts on boating activities. Additionally, the wedgewire screens would have to be placed at a sufficient distance from the existing CWISs to leave room for dredging activities. Detailed bathymetry of the river depth in the vicinity of Merrimack Station would be required during detailed design to refine the placement of the wedgewire screens. The details for the screens used in these conceptual sketches were obtained from Johnson Screens (Attachment D1) and are summarized as follows:

- Total Number of Screens
    - Unit 1: 13 - 24
    - Unit 2: 31 - 52
- Diameter of Screens: 24 in
- Length of Screens: 80 in
- Distance Protruding into River
    - Unit 1: 60 - 90 ft
    - Unit 2: 65 - 95 ft
- Distance from the River Bed: 1 ft

The wedgewire screens would be tied into the existing system after the bar racks, as shown in sketches PSNH004-SK-001 and PSNH004-SK-002. Sketches PSNH004-SK-003 and PSNH004-SK-004 show the tie-ins to the existing cooling water systems via piping and manually operated butterfly valves. Aerial views of the evaluated wedgewire screen systems are also shown in sketches PSNH004-SK-001 or PSNH004-SK-002.

2.2 Operational Features and Maintenance Requirements

2.2.1 Operations

The operational period for wedgewire screens at Merrimack Station would be limited to the months of April through July, for the reasons discussed below.

The granular ice crystals formed in turbulent, supercooled water are referred to as 'frazil ice'. Supercooled water occurs when the water temperature begins to drop and passes through the 32°F point. At a temperature of less than 32°F, tiny particles of ice form quickly and uniformly through the water mass. Frazil ice is extremely adhesive and will stick to any solid metallic object, such as a screen, that is at or below the freezing point (Ref. 7.6). Currently, Merrimack Station uses operational measures to manage frazil ice on its existing bar racks and traveling screens.

Wedgewire screens are very susceptible to formation of ice on the screens, as documented by the U.S. Army Corps of Engineers (Ref. 7.12). Therefore, the wedgewire screens could only safely be used at Merrimack Station from April through November to avoid damage and operational impacts from frazil ice that forms during the winter months.

In addition, wedgewire screens require a minimum axial velocity from the intake source waterbody of 1 fps to move debris and silt from the screen surfaces (Ref. 7.3 and Attachment D1). Utilizing historical (1984 - 2004) daily river flow rate data provided by PSNH and available bathymetry data for the vicinity of Merrimack Station (Ref. 7.13), approximate daily axial velocities for the Merrimack River were developed for the 1984 – 2004 period. These data indicate that there is not always sufficient axial velocity (>1 fps) from the river to prevent screen surface fouling by debris and silt during the months of August through November. However, according to Normandeau, the time period with the highest observed levels of entrainment is late May through late June (Ref. 7.2), and there are very few organisms in the Merrimack River from August through November that are capable of becoming entrained (Ref. 7.15).

In sum, wedgewire screens would be used at Merrimack Station during the months of April through July to achieve the biological benefit of minimizing total annual entrainment and the operational benefits of avoiding frazil ice and screen surface fouling. An automatic air cleaning system would be used to help keep the screens clean of debris via air bursts. This air cleaning system would use a control system to rotate the cleaning of the wedgewire screens by piping trains. To minimize impingement mortality during the months when wedgewire screens could not be operated (August through March), Merrimack Station's existing coarse mesh traveling screens would be used in combination with upgraded fish return systems. The existing coarse mesh traveling screens and upgraded fish return systems would be run continuously from August through November (Ref. 7.15). Consistent with the Station's current operating procedures, the existing coarse mesh traveling screens and upgraded fish return systems would be run intermittently from December through March as there would be personnel safety issues associated with maintaining the fish return systems when ice is present.

2.2.2 Maintenance

The evaluated wedgewire screens would have minimal O&M requirements, as summarized in Table 2-3. The O&M estimates for these screens are in addition to the present O&M requirements for the existing CWISs. The maintenance estimates are for preventative/routine maintenance and do not include repair or replacement time. When debris accumulates on the screen body, the screens would be cleaned with an airburst system. The frequency of cleaning would need to be determined by operations after installation in order to account for conditions specific to the Merrimack River.

Table 2-3: Operation and Maintenance Requirements for the Wedgewire Screens Evaluated for Merrimack Station

Duration	Task Description	Group	Personnel (#)	Task Estimated Duration (hours)	Total Annual Time (man-hours)
Weekly (April-July) (17 Weeks)	Check air cleaning system[2]	Operations	1	0.5	8.5
Weekly (August-March) (35 Weeks)	Activate air cleaning system to clean wedgewire screens when not operating [2]	Operations	1	2	70
Monthly	Check/ lubricate butterfly valves	Operations	1	4	48
Monthly (March, June, August)	Inspect wedgewire screen system using divers or cameras[2]	Sub-contractor	4	16	192
Annually (March)	Manually brush and/or hydroclean wedgewire screens[2]	Sub-contractor	4	40	160
Annually (April)	Open manually operated butterfly valves Set automatic control for air cleaning system	Operations	2	4	8
Annually (July)	Close manually operated butterfly valves Set automatic control for air cleaning system	Operations	2	4	8
Total Estimated O&M[1] Time					**494.5**

Notes:

1. Preventative/routine maintenance estimates only; does not include repair or replacement time. Does not include testing of the large 304 SS conveyance piping every 20 years. The O&M estimates are in addition to the present requirements for the existing CWISs.
2. Recommendation from Eimco Water Technologies via telephone conversation (Attachment D1).

2.3 Construction Factors

2.3.1 Schedule

A detailed schedule for implementation of the evaluated wedgewire screen options (including upgraded fish return systems) is included in Attachment B1. A site-specific data acquisition study would be required before design or construction. This study would have two primary purposes: (1) to obtain information regarding the potential effects of various site-specific parameters (e.g., river velocity, silting, debris, fouling) on the performance of wedgewire screens installed at Merrimack Station, and (2) to verify the levels of IM&E reductions that could be achieved by the operation of such screens at the Station. According to Normandeau (Attachment E), due to the seasonal and annual variability of conditions on and in the Merrimack River, this site-specific study would need to cover approximately three years of seasonal cycles to ensure that the data collected is representative of most conditions expected in the river.

The design and construction of the evaluated wedgewire screen systems is estimated to take approximately 26 months following the completion of the site-specific study. The design phase would take approximately 13 months, during which the design would be completed using the optimal cleaning frequency, mesh sizing, and material information obtained from the site-specific study.

The construction phase would last approximately 13 months and include the following construction activities:

- Mobilization
    - Placement of construction trailers and construction site layout, including hooking up temporary power.
    - Inspection and delivery of wedgewire screens.
- General Site Modifications
    - Marking and protecting construction area.
    - Installation of dock required for underwater construction activities.
    - Construction of cofferdams around each CWIS (a temporary structure used to avoid underwater construction by creating a dry work area) and dewatering of excavation and tie-in area.
- Unit 2 Construction Activities
    - Excavation for underwater trenching required for new piping.
    - Installation of new conveyance piping and butterfly valves.
    - Installation of wedgewire screens.
    - Installation of air cleaning system, including piping, compressor, receiver, and controls.
    - Upgrade fish return system.

- Commissioning of installed equipment, including inspection of equipment for compliance with design requirements, and basic testing such as flow, leak and pressure.
- Tie-in to existing Unit 2.
- Start-up of system with river water.
- Validation of system.

- Unit 1 Construction Activities
  - Excavation for underwater trenching required for new piping.
  - Installation of new conveyance piping and butterfly valves.
  - Installation of wedgewire screens.
  - Installation of air cleaning system, including piping, compressor, receiver, and controls.
  - Upgrade fish return system
  - Commissioning of installed equipment, including inspection of equipment for compliance with design requirements, and basic testing such as flow, leak and pressure.
  - Tie-in to existing Unit 1.
  - Start-up of system with river water.
  - Validation of system.
- Demobilization
  - Clean-up of construction site.
  - Removal of dock.
  - Restoration of construction site.

The trenching, piping, and installation of the wedgewire screen systems would need to be accomplished between April and November to avoid icing conditions. The tie-in of the wedgewire piping to the existing CWISs would be scheduled, to the extent practicable, to coincide with the scheduled Unit outages. Due to the need for construction to coincide with such scheduled outages, minor delays in the completion of any phase could result in additional delays or require forced construction outages at each Unit, resulting in increased costs, including loss of electricity generation.

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2.4 Cost Estimates

2.4.1 Initial Capital Costs

The initial capital costs for the evaluated wedgewire screen option (including upgraded fish return systems) include design, procurement, implementation, and startup activities, based on the conceptual design identified and discussed in Section 2.1. The costs associated with permitting this option are not included in this estimate. The estimating focused on soliciting the various assets capable of providing real world solutions. Vendors were contacted for quotations on the major equipment and material components, while established construction cost estimating tools were utilized in developing the labor, equipment, and scheduling, including the following:

- RS Means (Factored Construction Cost Data)

  The RS Means catalogue is one of the nation's most respected guidelines for estimating construction related cost of building (Ref. 7.9). When other resources were unclear or not available, the typical factored cost per commodity for the portion of work provided in the RS Means catalogue was used.

- National Heavy Construction Estimator (Craftsman Book Company)

  The National Heavy Construction Estimator is a heavy construction cost estimating database that provides detailed cost estimates for the construction industry including piping, concrete, industrial equipment, and electrical systems.

The capital cost estimates for the wedgewire screen option are detailed in Attachment C1. Vendor data and budgetary cost estimates for major equipment components are included in Attachment D1. Each cost estimate involves two cost multipliers:

- Recommended Minimum Contingency (25%)
- PSNH Corporate Overheads and Work In Progress Cost (AFUDC) (12%)

The current stage of development of the various conceptual designs provides a sound basis for estimating the associated overall design, procurement, and construction costs. However, the full scope of work will not be fully captured unless a final detailed design is completed. For this reason, a Recommended Minimum Contingency of 25% was added to all cost estimates. Additionally, PSNH routinely applies a cost multiplier of 12% to all major capital projects; this multiplier captures both corporate overhead and the cost of carrying the associated funding (i.e., a Corporate Overheads and Work In Progress Cost).

As shown in Attachment C, the total estimated capital cost for the evaluated wedgewire screen option (Option 1 - Seasonal Deployment of Wedgewire Screens and Upgraded Fish Return Systems) would range from $8,508,000 for wedgewire screens with 9 mm slot sizes to $8,816,000 for wedgewire screens with 1.5 mm slot sizes.

2.4.2 O&M Costs

O&M costs are summarized in Table 2-4 and are based on the following:

- Additional labor required to operate and maintain the wedgewire screen systems, as detailed in Table 2-3.

- O&M labor cost includes wages and benefits.

- Additional maintenance required for running the existing traveling screens continuously from August through November (Ref. 7.1, Section 8.1.1.1).

Table 2-4: Option 1 - Estimated Annual Operation and Maintenance Cost for the Wedgewire Screen Systems Evaluated for Merrimack Station

	Cost	Units	#	Cost
Unit 1 and Unit 2				
Labor PSNH Personnel[2]	$ 60	per hr	143	$ 8,600
Labor Subcontractor[3]	$ 2,800	per day	11	$ 30,800
Continuous Operation of Existing Screens[4]	$ 6,700	per month	4	$ 26,800
TOTAL Annual O&M Costs[1]				**$ 66,200**

Notes:

1. Cost is for 1st Quarter 2009 in $U.S. Preventative/routine maintenance estimates only; does not include repair or replacement cost.
2. Labor cost includes wages and benefits for 2009 (Attachment D5).
3. Two man dive team is estimated at $2800 per day (Attachment D5).
4. From §308 Response Report (Ref. 7.1, Section 8.1.1.1) estimate in 2007 Dollars converted to 2009 Dollars using Cost Index 100/91.1 (Ref. 7.9).

2.4.3 Parasitic Losses (Costs)

Parasitic power losses due to operation of the evaluated wedgewire screen systems are based on the following:

- Parasitic power losses are based on a 2009 market value of $98 MW-hr (Attachment D5).

- Estimated power requirements for operating the air cleaning system are based on the following conservative assumptions for running the compressor motor:
  - Compressor motors would run 24 hours per day from April to July.
  - Compressor motors would run once per week for 4 hours from August to March.

- Additional power requirements for continuous operation of the existing coarse mesh traveling screens and upgraded fish return systems are based on the following conservative assumptions:
  - The traveling screens and spray wash pumps would be continuously run from August through November.

- o The power requirements for the existing traveling screens and spray wash pumps running intermittently from August through November are negligible.

Based on these assumptions, the additional parasitic losses associated with the operation of the evaluated wedgewire screens and upgraded fish return systems would be approximately 202 MW-hr per year. The corresponding annual cost associated with this power loss would be $19,800.

2.4.4 Lost Generating Capacity during Implementation

As discussed in Section 2.3.2, the tie-in would take approximately three weeks for each Unit and could likely be scheduled during a routine maintenance outage for each Unit. Therefore, there would be no expected cost associated with lost generating capacity during implementation of the evaluated wedgewire screen options. If the tie-in was unable to be scheduled during a scheduled outage, a forced construction outage would be required, resulting in increased costs due loss of energy generation. The cost associated with this power loss would be approximately $746,000 per week for Unit 1 and approximately $2,176,000 per week for Unit 2, based on a 2009 replacement power cost of $37 MW-hr (Attachment D5).

2.4.5 Water Treatment Costs

No additional water treatment costs would be anticipated for operation of the evaluated wedgewire screen options.

2.4.6 Estimated Useful Life of Major Equipment

As shown in Attachment D1, the estimated useful life for wedgewire screens is 30+ years.

2.5 Environmental Considerations

2.5.1 Waterway Impact

The water depth of the Merrimack River in front of Merrimack Station ranges from 6-10 ft and the evaluated wedgewire screens would be located underwater approximately 1 ft above the river bottom. The placement of the screens would need to be a minimum of 1 ft above the river bottom to ensure design flow is unrestricted, but the screens may have to be further raised to minimize silt build-up around the slots. The optimal location above the river bottom would be determined based on data collected during the site specific study.

The main piping train for the wedgewire screens would be trenched below the river bottom. The U.S. Army Corps of Engineers (COE) and any other applicable regulatory agencies would have to be contacted regarding the permit restrictions associated with the use of the evaluated wedgewire screens and any impacts resulting from their implementation.

The main water traffic on the Merrimack River is for recreational purposes (i.e., skiing, boating, and fishing). In the event that the evaluated wedgewire screens would not have sufficient water cover, the area in which they would be located would have to buoyed off and declared a hazard zone using Coast Guard-approved hazard buoys and floating polyethylene rope to exclude boaters and skiers. The impacted surface area would be approximately 25,000 ft^2 in front of the CWISs.

2.5.2 Aesthetic Impact

The evaluated wedgewire screen systems would be installed underwater. Therefore, little negative visual impact would be expected from the screens themselves; however, if the evaluated screens would not have sufficient water cover, the area in which they would be located would have to buoyed off using Coast Guard-approved hazard buoys and floating polyethylene rope to exclude boaters and skiers.

2.5.3 Wildlife Habitat and Greenspace Impact

The evaluated wedgewire screen systems would be passive systems. Therefore, no adverse impacts would be expected on aquatic organisms other than those estimated entrainment and impingement mortality impacts detailed in Section 2.6. The evaluated system would not reduce greenspace; therefore, no impact on land species would be expected. Any applicable regulatory agencies would have to be contacted regarding the permit restrictions associated with the use of the evaluated wedgewire screens and any impacts resulting from their implementation.

Normandeau has been authorized to complete a fisheries habitat survey of the entire Hooksett Pool during the low water period in the summer of 2009 (Normandeau, Attachment D5). This survey will enable Normandeau to quantify the affected physical habitat that would be impacted by the evaluated wedgewire screen systems.

2.6 Impingement Mortality/Entrainment Reduction Assessment

To respond to EPA's request for further evaluation of the three identified alternative CWIS technologies, Normandeau undertook additional analysis to determine the expected biological performance of seasonally deployed wedgewire screens of different slot sizes at Merrimack Station. More specifically, using data from the 2005-2007 Merrimack Station impingement and entrainment study (Ref. 7.2), Normandeau estimated the potential monthly and annual IM&E reductions from the installation and seasonal operation of wedgewire screens with slot sizes ranging from 1.0 mm to 9 mm at the Station (Ref. 7.15). Normandeau's analysis was based on four basic premises supported by peer-reviewed and published technical studies relating to entrainment and impingement of fish exposed to wedgewire screens: (1) the ability of a wedgewire screen to exclude impinged and entrained fish is affected by the width of the screen's slot openings, (2) additional entrainment reduction can result from active avoidance of wedgewire screens by larvae too small to be physically excluded, (3) wedgewire screens can achieve 80 to 90% or greater reduction in entrainment, and reduce impingement mortality by 99% or greater, compared with conventional once-through traveling screens, and (4) impingement mortality in months when wedgewire screens are not in use will include not only the mortality resulting from impingement of fish against the existing screens, but also the additional mortality of impinged fish during passage through a state-of-the-art fish return system. Normandeau conservatively assumed a zero percent entrainment survival rate for the baseline scenario and all evaluated wedgewire screen scenarios. In addition, it based its analysis on certain criteria regarding flow rates through Merrimack Station, months of operation of wedgewire screens and an upgraded fish return system, and mortality rates.

The results of Normandeau's analysis are summarized in Table 2-5 in terms of percent reductions for annual impingement mortality, annual entrainment, and annual adult equivalent losses for the following scenarios: (1) current operation, (2) wedgewire screen operation during April through July and operation of a new state of the art fish return system during August through November, and (3) wedgewire screen operation during April through November, with no fish return system operation at any time during the year.

Overall, the results of Normandeau's analysis show that the Phase II §316(b) Rule's performance standards of a 60-90% reduction in entrainment and an 80-95% reduction in impingement mortality could be attained at Merrimack Station by installing wedgewire screens with any of five slot sizes evaluated (1.5 mm through 9 mm) at both Unit 1 and Unit 2, operating them from April through July of each year, and installing and operating a state-of-the-art fish return sluice (in combination with the existing traveling screens) during August through November. Because the installation and operation of wedgewire screens with smaller slot sizes (i.e., <1.5 mm) is expected to result in fouling sufficiently significant to negatively affect Station operations and, therefore, reliability of the Station, the installation of wedgewire screens with a 1 mm slot size was not further evaluated. This is consistent with EPA's determination in the Phase II §316(b) Rule that wedgewire screens with a 1.75 mm slot size constitute "the most appropriate [CWA §316(b)] compliance technology" for Merrimack Station (Ref. 7.14).

Table 2-5: Potential for Reduction in Impingement Mortality and Entrainment Under Various Scenarios Using Wedgewire Screens

Scenario	Slot Width (mm)	Impingement Mortality Reduction	Entrainment Reduction[1]			Adult Equivalent Loss Reduction[1,2]		
			P_a=0	P_a=0.3	P_a=f(L)	P_a=0	P_a=0.3	P_a=f(L)
Current Operation	N/A	18%	17%	17%	17%	17%	17%	17%
Wedgewire Screens (April – July) and Fish Return Systems (August – November)	1.5	84%	49%	64%	79%	56%	68%	81%
	2.0	84%	30%	51%	74%	38%	55%	78%
	3.0	84%	19%	43%	73%	21%	43%	76%
	6.0	84%	17%	42%	73%	18%	42%	76%
	9.0	84%	17%	42%	73%	18%	42%	76%
Wedgewire Screens (April – November)	1.5	88%	49%	65%	79%	56%	68%	82%
	2.0	88%	30%	51%	75%	38%	56%	78%
	3.0	88%	19%	44%	73%	21%	44%	77%
	6.0	88%	17%	42%	73%	19%	42%	77%
	9.0	88%	17%	42%	73%	19%	42%	77%

Notes:

1. The three alternative assumptions for larval avoidance of Wedgewire Screens are described by Normandeau (Ref. 7.15) and are labeled "P_a=0" for no avoidance, "P_a=0.3" for 30% of larvae avoidance, and "P_a=f(L)" for avoidance modeled as a function of larval length.
2. Adult equivalent losses are the losses resulting from both impingement and entrainment combined.

Installation of cylindrical wedgewire screens at both Units and operation from April through November of each year would provide the largest reduction in entrainment and impingement mortality. However, as discussed in Section 2.2.1, there are operational issues (i.e., fouling concerns) that would prohibit the operation of wedgewire screens from August through November. By operating wedgewire screens with a 1.5 mm slot size from April to July and the existing coarse mesh traveling screens with upgraded fish return systems from August through November, an up to 79% reduction in entrainment and an 84% reduction in impingement mortality could be attained. By operating wedgewire screens with a 9 mm slot size from April to July and the existing coarse mesh traveling screens with upgraded fish return systems from August through November, an up to 73% reduction in entrainment and an 84% reduction in impingement mortality could be attained. Reductions in adult equivalent losses for IM&E combined were predicted to range from 76% for the 3 mm through 9 mm slot size wedgewire screens to 81% for the 1.5 mm slot size wedgewire screens.

These results show that the reductions in entrainment would increase with the reduction in slot size. However, because of the significant potential for screen fouling in the Merrimack River at Merrimack Station, a three year site-specific study is recommended to evaluate wedgewire screens with slot sizes ranging from 1.5 mm to 9 mm, in order to evaluate the magnitude of the expected fouling and establish the optimum slot size and operational period of the wedgewire screens at the Station.

3 Option 2 - Seasonal Deployment of Aquatic Filter Barrier and Upgraded Fish Return Systems

3.1 Conceptual Design

The Aquatic Filter Barrier (AFB) is a relatively new fish protection technology for use at CWISs (Ref. 7.5). While the AFB is permeable to water, it is relatively impermeable to fish, shellfish and ichthyoplankton and, therefore, is one of only a few technologies capable of reducing both impingement and entrainment of aquatic organisms (Ref. 7.5). Gunderboom® has a patented full-water-depth filter curtain composed of polyethylene or polypropylene fabric that is supported by flotation billets at the surface of the water and anchored to the bottom of the water body (Ref. 7.2). This AFB system is referred to as the Gunderboom® Marine Life Exclusion System™ (MLES™). The MLES™ completely surrounds an intake structure, preventing organisms from entering the cooling water intake. Since the surface area of an MLES™ is large compared to the surface area of the intake structure's traveling screens, through-screen water velocity can be reduced to below 0.5 fps, thereby enabling even small fish and larvae to swim or drift away from the filter curtain.

Gunderboom® supplied information on the recommended sizing and placement of an MLES™ for Merrimack Station. According to Gunderboom®, the MLES™ for Merrimack Station would be deployed along the shore, similar to the deployments depicted in Figures 3-1 and 3-2. The MLES™ would need to be approximately 3500 ft in length, varying from 6 to 10 ft in depth, and would need to surround both of the Station's existing CWISs in order to have sufficient surface area to reduce the water velocity through the MLES™ to below 0.5 fps.

Figure 3-1: Gunderboom® Marine Life Exclusion System™ Deployed at an Existing Intake Structure (Attachment D2)

Figure 3-2: Aerial View of a Gunderboom® Marine Life Exclusion System™ Around an Existing Intake Structure (Attachment D2)

Similar to wedgewire screens, there are several considerations with respect to the use of AFBs at Merrimack Station, summarized below:

- AFBs are susceptible to damage from ice floes and ice formation on the fabric panels during the winter months (Ref. 7.6). Therefore, in order to avoid damage and any operational impacts resulting from ice floes or the formation of frazil ice, an AFB could only be used at Merrimack Station from April through November.
- Due to fouling concerns, an automatic AirBurst™ cleaning system, shown in Figures 3-3 through 3-5, would be used to routinely remove deposits on the fabric panel. In tests conducted for the Electric Power Research Institute (EPRI), this cleaning system effectively cleaned various AFB intake configurations after one to three cleaning cycles (Ref. 7.5).
- AFBs could potentially become damaged by navigational activities on the Merrimack River (i.e., dropping anchors, low boat hulls, boating, etc.) or overtopping of the AFB. Therefore, in order to avoid damage and any operational impacts resulting from ice floes, engineered measures to protect the AFB would be explored during detailed design.

During the months the MLES™ would not be operating (August through March), Merrimack Station's existing coarse mesh traveling screens would be used in combination with upgraded fish return systems. The existing coarse mesh traveling screens and upgraded fish return systems would be run continuously from August through November (Ref. 7.15). Consistent with the Station's current operating procedures, the existing coarse mesh traveling screens and upgraded fish return systems would be run intermittently from December through March as there would be personnel safety issues associated with maintaining the fish return systems when ice is present.

Figure 3-3: Gunderboom® Automatic AirBurst™ Cleaning System
(www.gunderboom.com)

Figure 3-4: Inner Workings for the Gunderboom® Automatic AirBurst™ Cleaning System
(www.gunderboom.com)

Figure 3-5: Deployment of the Gunderboom® Automatic AirBurst™ Cleaning System (www.gunderboom.com)

The basic design requirements for the MLES™ and upgraded fish return systems evaluated in this Report are detailed in Table 3-1.

Table 3-1: Basic Design Considerations for the MLES™ and Upgraded Fish Return Systems Evaluated for Merrimack Station

Item	Design Criteria	Specific Design Criteria	Recommendation
Height of curtain	Full water depth	6 - 10 ft	Gunderboom® (Attachment D2)
Length	Maximize surface area to reduce through-mesh velocity ≤ 0.5 fps	3500 ft	Gunderboom® (Attachment D2)
Surface Area	As required to provide 5 - 15 gpm/ft^2	9 gpm/ft^2 (20,000 ft^2)	Gunderboom® (Attachment D2)
Maximum instantaneous CWIS flow	179,500 gpm (258.5 MGD)	200,000 gpm (288 MGD)	Gunderboom® (Attachment D2)
Material of Curtain	Patented treated fabric two-layer curtain	Patented treated fabric two layer curtain	Gunderboom® (Attachment D2)
Mooring System	Anchor curtain to floor of river minimizing gaps	Anchor curtain to floor of river minimizing gaps	Gunderboom® (Attachment D2)
Air Cleaning System	Reduce clogging during operation	Recommended	Gunderboom® (Attachment D2)

Item	Design Criteria	Specific Design Criteria	Recommendation
Fish Slide/Sluice	Smooth and gently sloped and curved to return fish to river Removable Cover	Required	Normandeau (Ref. 7.1 and Ref. 7.7)
Slide Water Velocity	3 - 5 fps	3 - 5 fps	Normandeau (Ref. 7.1)
Minimum Water Depth in Fish Slide	4 - 6 in	4 - 6 in	Normandeau (Ref. 7.1)
Slope of Fish Slide	Optimal 1/16 ft drop/linear ft (LF)	1 ft drop/16 LF	Eimco (Attachment D3)
Low Pressure Spray System	Gently recover impinged organisms from screen ≤ 15 psi and maintain depth in slide 4 to 6 in	5 - 15 psi	Normandeau (Ref. 7.15) (Ref. 7.1 and Ref. 7.7)

3.1.1 Major Components

Major components for the evaluated MLES™ installation and upgraded fish return systems are detailed in Table 3-2 and Attachment D2.

Table 3-2: Major Components for the MLES™ Installation and Upgraded Fish Return Systems Evaluated for Merrimack Station

Component	Unit	Quantity	Description	Size	Material
AFB	1 & 2	1	Passive screens	3500 ft long by depth of water (6-10 ft)	Patented by Gunderboom®
Mooring System	1 & 2	1	Anchoring to floor of river and side of banks		
AirBurst System	1 & 2	2 (1 duty/ 1 spare)	Automatic Cleaning System	200 hp	
Control Panel	1 & 2	1	Control For AirBurst System		

Component	Unit	Quantity	Description	Size	Material
Monitoring Sensors	1& 2	TBD	Monitors pressure across MLES™	TBD	
Communication System	2	1	Communications between sensors and AirBurst Cleaning System		
Fish Slide	1	1	300 ft		
Fish Slide	2	1	100 ft		
Spray Wash Pump	1	1	Pump for Fish Removal Spray	400 gpm at 80 psi	
Spray Wash Pump	2	1	Pump for Fish Removal Spray	400 gpm at 80 psi	
Low Pressure Spray System	1	1	Fish Removal Spray and maintain water in slide		
Low Pressure Spray System	2	1	Fish Removal Spray and maintain water in the slide		

3.1.2 Site Layout

Sketches conceptually depicting the implementation of the evaluated MLES™ at Merrimack Station are included in Attachment A. The MLES™ could be placed around both existing intakes as shown in sketch PSNH004-SK-005. The estimated length of the MLES™ is 3500 ft, assuming a varying river depth of 6 to 10 ft. The MLES™ curtain would extend from the river surface to the riverbed so that the river would not spill over the screen. Detailed bathymetry of the river depth around the Merrimack Station would be required to refine the length and placement of the MLES™ curtain during detailed design.

3.2 Operational Features and Maintenance Requirements

3.2.1 Operations

The deployment period for the evaluated MLES™ at Merrimack Station would be limited to the months of April through July, for the reasons discussed below.

The fabric used in the MLES™ would be very susceptible to formation of ice. Therefore, the MLES™ would only be used from April through November in order to avoid damage from both frazil ice and other ice that forms in the Merrimack River during the winter months, as detailed in Section 2.2.1. The MLES™ would require removal from the river during December through March. In addition, similar to the wedgewire screen option detailed in Section 2.2.1, fouling concerns would be present for the low river flow conditions that occur during the late summer months. Since, according to Normandeau, the time period with the highest observed levels of entrainment is late May through late June (Ref. 7.2), and there are very few organisms in the Merrimack River from August through November that are capable of becoming entrained, the optimum deployment period for the evaluated MLES™ at Merrimack Station would be April through July.

During deployment of the MLES™, an automatic air cleaning system would be utilized to keep the MLES™ free of fouling due to silt and biological mass accumulation. This air cleaning system would use information relayed from monitoring sensors via a communications system to a control system to determine the airburst timing. The required cycling, duration, and effectiveness of the air cleaning system are site-specific; therefore a site-specific study would need to be conducted to optimize effectiveness of the air cleaning system.

To minimize impingement mortality during the months when the MLES™ could not be deployed (August through March), Merrimack Station's existing coarse mesh traveling water screens would be used with upgraded fish return systems. The existing coarse mesh traveling screens and upgraded fish return systems would be run continuously from August through November (Ref. 7.15). Consistent with the Station's current operating procedures, the existing coarse mesh traveling screens and upgraded fish return systems would be run intermittently from December through March, as there would be personnel safety issues associated with maintaining the fish return systems when ice is present.

3.2.2 Maintenance

The evaluated MLES™'s O&M requirements are summarized in Table 3-3.

Table 3-3: Operation and Maintenance Requirements for the MLES™ Evaluated for Merrimack Station

Duration	Task Description[2]	Group	Personnel (#)	Task Estimated Duration (hours)	Total Annual Time (man-hours)
Weekly (April-July) (17 Weeks)	Check air cleaning system via boat	Operations	2	8	272
Bi-monthly (April-July) (8 Total)	Clean MLES™ using power wash system via boat deployment	Operations	2	8	128
Annually (March)	Deploy MLES™	Subcontractor	-	-	Note 3

Duration	Task Description[2]	Group	Personnel (#)	Task Estimated Duration (hours)	Total Annual Time (man-hours)
Annually (August)	Retrieve MLES™	Subcontractor	-	-	Note 3
Annually	Inspect MLES™ while deployed in river	Subcontractor	-	-	Note 3
Annually	Repair MLES™ after removal from river	Subcontractor	-	-	Note 3
Total Estimated O&M[1] Time					**400**

Notes:

1. Preventative/routine maintenance estimates only; does not include repair or replacement time. The O&M requirements are in addition to the present CWIS O&M.
2. Information supplied by Gunderboom® (Attachment D2).
3. Sub-contractor labor provided in Attachment D2 and summarized in Table 3-4.

3.3 Construction Factors

3.3.1 Schedule

A detailed schedule for implementation of the evaluated MLES™ option (including upgraded fish return systems) is included in Attachment B2. A site-specific data acquisition study would be required before design or construction. This study would have two primary purposes: (1) to obtain information regarding the potential effects of various site-specific parameters (e.g., river velocity, silting, debris, fouling) on the performance of an MLES™ installed at Merrimack Station, and (2) to verify the level of IM&E reduction that could be achieved by the operation of an MLES™ at the Station. According to Normandeau (Attachment E), due to the seasonal and annual variability of conditions on and in the Merrimack River, this site-specific study would need to cover approximately three years of seasonal cycles to ensure that data collected is representative of most conditions expected in the Merrimack River (Attachment D5).

The design and construction of the evaluated MLES™ is estimated to take approximately 8 months following the completion of the site-specific study, and would be finalized using the optimal cleaning frequency and mesh sizing information obtained from the site-specific study. Fabrication time for an MLES™ typically takes between four and six months (Attachment D).

The construction phase would include the following construction activities:

- Mobilization
    - Placement of construction trailers and construction site layout including hooking up temporary power.

  - Inspection and delivery of MLES™ components.
- General Site Modifications
  - Marking and protecting construction area.
  - Installation of permanent dock required for installation and retrieval of MLES™ both during construction and semi-annually thereafter.
- Unit 1 & 2 Construction Activities
  - Deployment of MLES™.
  - Installation of MLES™ mooring system.
  - Installation of automatic air cleaning system, including control, monitoring and communications.
  - Upgrade fish return systems.
  - Commissioning of installed equipment, including inspection of equipment for compliance with design requirements and basic testing such as flow, leak, and pressure.
  - Start-up of system with river water.
  - Validation of system.
- Demobilization
  - Clean-up of construction site.
  - Restoration of construction site.

The installation of the MLES™ mooring system would need to take place between April and November in order to avoid ice.

3.3.2 Outage Duration and Timing

The installation of the MLES™ should not interfere with normal operations of Merrimack Station. In order to avoid interfering with Station operation, the installation of the MLES™ would be recommended, but not required, to coincide with the scheduled maintenance for either Unit 1 or Unit 2.

3.4 Cost Estimates

Gunderboom® could provide an MLES™ through one of the following:

1. PSNH's purchase of an AFB system.
2. PSNH's rental of an AFB system from Gunderboom®.

The rental arrangement would likely be governed by a "Gunderboom® BOOM contract" (Attachment D2). Under the standard BOOM contract, Gunderboom® builds, owns, operates and maintains the MLES™, providing the exclusion of fish, fish eggs, and larvae as a service with a monthly fee.

3.4.1 Initial Capital Costs

The initial capital costs for the evaluated MLES™ option (including upgraded fish return systems) include design, procurement, implementation, and startup activities, based on the conceptual design identified and discussed in Section 3.1. The costs associated with permitting this option are not included in this estimate. The initial capital cost estimates for this option were developed in the same manner as those for the evaluated wedgewire screen options, utilizing (1) vendor quotations for the major equipment and material components, (2) established construction cost estimating tools for labor, equipment, and scheduling costs, and (3) a Recommended Minimum Contingency of 25% and a routine PSNH cost multiplier of 12%. As shown in Attachment C2, the total estimated capital cost for Option 2 (Seasonal Deployment of Aquatic Filter Barrier and Upgraded Fish Return Systems) is $9,955,000. Vendor data and budgetary cost estimates for major equipment components are included in Attachment D2.

3.4.2 O&M Costs

O&M costs for purchase of the MLES™ are summarized in Table 3-4 and are based on the following:

- Additional labor required to operate and maintain the MLES™, as detailed in Table 3-3, and including the seasonal removal and installation cost estimate provided by the vendor.
- O&M labor cost includes wages and benefits.
- Additional maintenance required for running the existing traveling screens continuously from August through November (Ref. 7.1, Section 8.1.1.1).

Table 3-4: Option 2 - Estimated Annual Operation and Maintenance Cost for the AFB

	Cost	Units	#	Cost
Unit 1 and Unit 2				
Labor PSNH Personnel[2]	$ 60	per hr	400	$ 24,000
Labor Subcontractor for Deployment/Retrieval[3]	$405,000	per year	Annual	$405,000
Continuous Operation of Existing Screens[4]	$ 6,700	per month	4	$ 26,800
TOTAL Annual O&M Costs[1]				**$ 455,800**

Notes:
1. Cost is for 1st Quarter 2009 in $U.S. Preventative/routine maintenance estimates only; does not include repair or replacement cost.
2. Labor cost includes wages and benefits for 2009 (Attachment D5).
3. Annual cost for labor provided by Gunderboom® (Attachment D2).
4. From §308 Response Report (Ref. 7.1, Section 8.1.1.1) estimate in 2007 Dollars converted to 2009 Dollars using Cost Index 100/91.1 (Ref. 7.9).

If the rental option were selected, the contract would likely be a multi-year (e.g., five-year) term with payments on a monthly basis and could also incorporate the performance requirements and assumptions detailed in Attachment D2. Gunderboom®'s estimated monthly rental cost for an MLES™ at Merrimack ranges from approximately $125,000 to $250,000 for the first five years. For the following five years the monthly payments could drop off to be an estimated $60,000 to $100,000.

3.4.3 Parasitic Losses (Costs)

Parasitic power losses due to operation of the evaluated MLES™ option are based on the following:

- Parasitic power losses are based on a 2009 market value of $98 MW-hr (Attachment D5).
- Estimated power requirements for operating the air cleaning system based on the conservative assumption that the compressor motors would run 4 hours per day from April to July.
- Additional power requirements for continuous operation of the existing coarse mesh traveling screens and upgraded fish return systems are based on the following conservative assumptions:
    - The traveling screens and spray wash pumps would be continuously run from August through November.
    - The power requirements for the existing traveling screens and spray wash pumps running intermittently from August through November are negligible.

Based on these assumptions, the additional parasitic losses associated with the operation of the evaluated MLES™ option would be approximately 204 MW-hr per year. The corresponding annual cost associated with this power loss would be $20,000.

3.4.4 Lost Generating Capacity during Implementation

As discussed in Section 3.3.2, the tie-in would be recommended, but not required, to coincide with the scheduled maintenance outage for either Unit 1 or Unit 2. Therefore, there would be no expected cost associated with lost generating capacity during implementation of the evaluated MLES™ option.

3.4.5 Water Treatment Costs

No additional water treatment costs would be anticipated for operation of the evaluated MLES™ option.

3.4.6 Estimated Useful Life of Major Equipment

Gunderboom® provided the estimated useful life for each of the major components of the AFB as follows (see Attachment D2):

- Anchoring – 30 years
- Mooring Hardware – 8 to 12 years
- MLES™ Load Bearing Components – 8 to12 years
- Replaceable Filters – 3 to 5 years
- Mooring Line, Flexible Air Hoses – 3 to 5 years
- AirBurst Electronics – 5 to 8 years
- Air Supply Equipment – 15 to 20 years

3.5 Environmental Considerations

3.5.1 Waterway Impact

The MLES™ would be up to 3500 ft in length and would surround both Units' CWISs, substantially protruding into the Merrimack River, as shown in Attachment A, PSNH004-SK-005. The MLES™ would also extend from the surface to the bed of the river. The main water traffic on the Merrimack River is for recreational purposes (i.e., skiing and fishing). The MLES™ would be deployed each April and would be removed from the river each August. Up to 952,000 ft^2 of the waterway would be impacted by the MLES™. As shown in Attachment A, PSNH004-SK-005, if the MLES™ were deployed in the river, the potential river width used for recreational purposes would be reduced by approximately 50% for a length of up to 3500 ft adjacent to Merrimack Station.

In order to implement the evaluated MLES™ option, the applicable regulatory agencies would have to be contacted regarding the permit restrictions associated with the use of an MLES™ and any impacts resulting from its implementation. As discussed in Section 8.2.3 of the §308 Response Report, a typical MLES™ is generally much shorter than the MLES™ evaluated for Merrimack Station. Since the Merrimack River is only 6 to 10 ft deep in the vicinity of the Station, scaling from what is usually a 20 ft tall curtain down to a 6 to 10 ft tall curtain would require an increase in length of the curtain deployed to up to 3500 ft long. It is likely that the use of such a long curtain in the Merrimack River would be difficult to permit due to the space limitations at Merrimack Station and the impairment of other uses in the Merrimack River.

3.5.2 Aesthetic Impact

The majority of the MLES™ would be located underwater. However, the buoys used to suspend the MLES™ would be visible.

3.5.3 Wildlife Habitat and Greenspace Impact

The MLES™ would be a passive system that would span a significant area of the Merrimack River adjacent to Merrimack Station. The impact of the MLES™ across the aquatic habitat area is unknown, and further study would be required to research the following (Normandeau, Attachment D5):

- Potential effects of the MLES™ substrate and enclosure on upstream and downstream migration of fish during the annual deployment period.
- Potential effects of the MLES™ substrate and enclosure on aquatic habitat and aquatic communities within the enclosure during the annual deployment period.
- Whether the habitat that would be enclosed by the MLES™ would be limiting in any way, by quantifying the amount and types of fisheries habitat enclosed by the MLES™ in comparison to the total habitat of each type found elsewhere within Hooksett Pool.

Normandeau has been authorized to complete a fisheries habitat survey of the entire Hooksett Pool during the low water period in the summer of 2009 (Normandeau, Attachment D5). This survey will enable Normandeau to quantify the affected physical habitat surface area and volume that would be surrounded by the MLES™, and compare the habitat affected as percentage of the total available within Hooksett Pool.

The MLES™ would not reduce greenspace and, therefore, no impact on land species would be expected.

3.6 Impingement Mortality/Entrainment Reduction Assessment

A Gunderboom® MLES™ was deployed at Lovett Generating Station from May through August of each year 2004, 2005, 2006 and 2007 to estimate its effectiveness in excluding Hudson River fish eggs and larvae (i.e., "ichthyoplankton") from entrainment. The MLES™ installed and tested at the 42,200 gpm design flow cooling water intake system at Lovett Station Unit 3 was approximately 500 ft long, varied in depth between 20 ft and 35 ft as it followed the river bottom while enclosing the intake, and was made from two panels of non-woven fabric. Normandeau used the biological effectiveness reports for the Lovett Station MLES™ to estimate the biological effectiveness of an MLES™ deployed at Merrimack Station (Ref. 7.15).

The MLES™ system installed and operated at Lovett Station during 2004 through 2007 exhibited an average exclusion effectiveness of 79% for all species and life stages of ichthyoplankton combined, with inter-annual variation ranging from a low of 40% in 2004 to a high of 95% in 2007. According to Normandeau (Ref. 7.15), the 79% overall average percent effectiveness and the absence of size selectivity both suggest that performance of the Lovett MLES™ is directly related to its deployment, the proportion of the total intake flow drawn directly through the filtration mesh, and the density of ichthyoplankton in the volume of unfiltered water drawn into the intake when deployment fails.

Similar to its evaluation of the conceptual wedgewire screen option discussed in Section 2.6, Normandeau undertook additional analysis to determine the expected biological performance of an AFB at Merrimack Station. More specifically, using data from the 2005-2007 Merrimack Station impingement and entrainment study (Ref. 7.2), Normandeau estimated the potential monthly and annual IM&E reductions from the installation and seasonal operation of an AFB to encircle Merrimack Station Unit 1 and Unit 2 (Ref. 7.15). Its analysis was based on the following model conditions: (1) the AFB would be 79% effective in excluding fish from impingement and entrainment during its deployment period, (2) the AFB would deployed to protect both Unit 1 and Unit 2 during the months of April through July or April through November of each year, (3) all fish excluded by the AFB would escape impingement and entrainment and survive, and (4) the existing traveling screens at the Station would be operated intermittently during the period from December through March, without the use of the state-of-the-art fish return system, due to ice cover on Hooksett Pool, resulting in 100% impingement mortality during this time period. Normandeau conservatively made certain assumptions about total impingement mortality and post-impingement mortality, as well as assumed a zero percent entrainment survival rate for the baseline scenario and all evaluated AFB scenarios. In addition, it based its analysis on certain criteria regarding flow rates through Merrimack Station, months of operation of wedgewire screens and an upgraded fish return system, and mortality rates.

The results of the analysis are summarized in Table 3-5 for percent reductions for annual impingement mortality, annual entrainment, and annual adult equivalent losses for (1) current operation, (2) for the AFB deployed during April through July, with the existing traveling screens and an upgraded fish return system operation during April through November, and (3) for the AFB deployed during April through November, with the existing traveling screens and upgraded fish return system operation during April through November, but no fish return system operation at any other time during the year.

Table 3-5: Potential for Reduction in Impingement Mortality and Entrainment Using an MLES™ Deployed at Merrimack Station

Scenario	Impingement Mortality Reduction	Entrainment Reduction	Adult Equivalent Loss Reduction
Current Operation	18%	17%	17%
MLES™ (April – July) and Fish Return Systems (August – November)	78%	82%	80%
MLES™ (April – November)	82%	83%	81%

As shown in Table 3-5, deployment of an AFB around both Units from April through November of each year would provide the largest reduction in impingement mortality. However, as discussed in Section 3.2.1, there are operational issues (i.e., fouling concerns) that would prohibit the operation of an AFB from August through November. By deploying an AFB around both Units from April to July (the peak entrainment season), an 82% reduction in entrainment and a 78% reduction in impingement mortality could be attained if the existing coarse mesh traveling screens were used with upgraded fish return systems. Under this scenario, however, deployment of an AFB at Merrimack Station would not be able to satisfy CWA §316(b) with respect to impingement mortality.

4 Option 3 - Fine Mesh Traveling Screens and Upgraded Fish Handling and Return Systems

4.1 Conceptual Design

Fine mesh traveling screens are designed to improve the survivability of impinged fish through a capture and release design, and reduce entrainment by screening eggs, larvae, and juvenile fish from the cooling water intake flow. The concept of using fine mesh screens for exclusion of eggs, larvae, and juvenile fish relies on gentle impingement on the screen's surface or retention within screening baskets, low-pressure washing of the screen panels or baskets, transferring the organisms to a sluiceway, and then sluicing the organisms back to the source water body (Ref. 7.3). The effectiveness of an installation using fine mesh traveling screens is contingent on the application of satisfactory handling and recovery facilities to allow safe return of impinged organisms to the aquatic environment (Ref. 7.3).

At Merrimack Station, the following features of fine mesh traveling screens and upgraded fish handling and return systems could improve the survivability of impinged fish and reduce entrainment:

- Continuous operation of the traveling screens and associated fish return from April through November to minimize impingement time. Consistent with the Station's current operating procedures, the traveling screens and associated fish returns would be run intermittently from December through March as there would be personnel safety issues associated with maintaining the fish return systems when ice is present.

- Low through-screen velocity so that if there is any impingement of eggs, larvae, or juvenile fish on the screens, it is gentle enough not to result in damage or mortality for most organisms.

- Fine mesh screening (1.5 mm was selected for evaluation in this Report) to reduce entrainment by collecting eggs, larvae, and juvenile fish and returning them to the river.

- Alternative fish bucket configurations that would include provisions to minimize damage to the fish upon entering the fish bucket, while inside the fish bucket and when transported from the fish bucket, and to keep the fish from escaping from the safety of the fish bucket.

- Low-pressure spray wash (5 to 15 psi) to gently remove any impinged fish before the high-pressure spray is used to clean debris off the screens.

- A sluiceway (i.e., fish return) that would provide smooth flow and avoid areas of high turbulence or rough areas that could damage delicate organisms. The sluiceway would be covered to protect fish from predators while in transport to the river.

Nonetheless, there are several considerations with respect to the installation and operation of fine mesh traveling screens at the Station, summarized below:

- New, expanded CWISs would be needed to accommodate fine mesh traveling screens. In particular, expanded CWISs would be required to maintain an acceptable head loss across the screens and provide a through-screen velocity of less than 0.5 fps.
- Fine mesh traveling screens are susceptible to damage and clogging due to ice formation on the screens during the winter months (Ref. 7.6). Clogging of the fine mesh screens could also lead to separation of the fine mesh panels from the screen housing. To avoid damage and any operational impacts resulting from the formation of frazil ice, a de-icing recirculation system similar to that used at the Station's existing CWISs would be used during periods where the temperature is below freezing.
- Fine mesh traveling screens would be susceptible to fouling and would require high-pressure sprays for cleaning as well as periodic cleaning throughout the year. Fouling of the fine mesh screens could lead to separation of the fine mesh panels from the screen housing. Based on the results of a three year site-specific study, a sodium hypochlorite system could also be required to limit biological growth and fouling.
- Any fine mesh traveling screens used at Merrimack Station would need to maximize biological benefits while maintaining the consistent intake flow required for cooling. Typically, smaller mesh size screens minimize entrainment to a greater degree than larger mesh size screens, but are more susceptible to fouling. In order to minimize both entrainment and fouling, a mesh size of 1.5 mm was selected for evaluation in this Report. Nonetheless, on-site physical testing would be required to determine the optimal mesh size for Merrimack Station.

In this Report, two types of fine mesh traveling screens, dual flow and MultiDisc®, were evaluated for Merrimack Station.

Dual flow traveling screens (shown in Figures 4-1 and 4-2) are essentially through flow systems turned 90°, putting the screen surfaces parallel to the intake flow. This configuration doubles the effective screening area, reduces possible down-stream debris carryover (Ref. 7.6) and in certain situations allows for finer screen meshes without increasing through-screen velocity.

Figure 4-1: Dual Flow Traveling Screens (www.siemens.com)

Figure 4-2: Dual Flow Traveling Screen Installation (www.siemens.com)

A dual flow system typically uses a low-pressure wash followed by a high-pressure wash to protect organisms and remove debris. A fish sluice is used to transport the fish, larvae, and eggs back to the river via a covered, smooth fish trough, as seen in Figure 4-3.

Figure 4-3: Traveling Screens with Fish Sluiceway (www.glv.com)

The two vendors listed below were contacted to obtain information on the sizing, placement, and costs of implementing dual flow screens at Merrimack Station:

- Eimco Water Technologies, LLC (Eimco) (www.glv.com)
- Siemens Water Technologies (Siemens) (www.siemens.com)

MultiDisc® screens were also examined for potential use at Merrimack Station. Like the dual flow screens, the MultiDisc® screens prevent down-stream debris carryover. MultiDisc® screens typically use fine mesh panels equipped with fish buckets to capture and retain fish and a fish sluiceway for returning fish to river, as depicted in Figure 4-4.

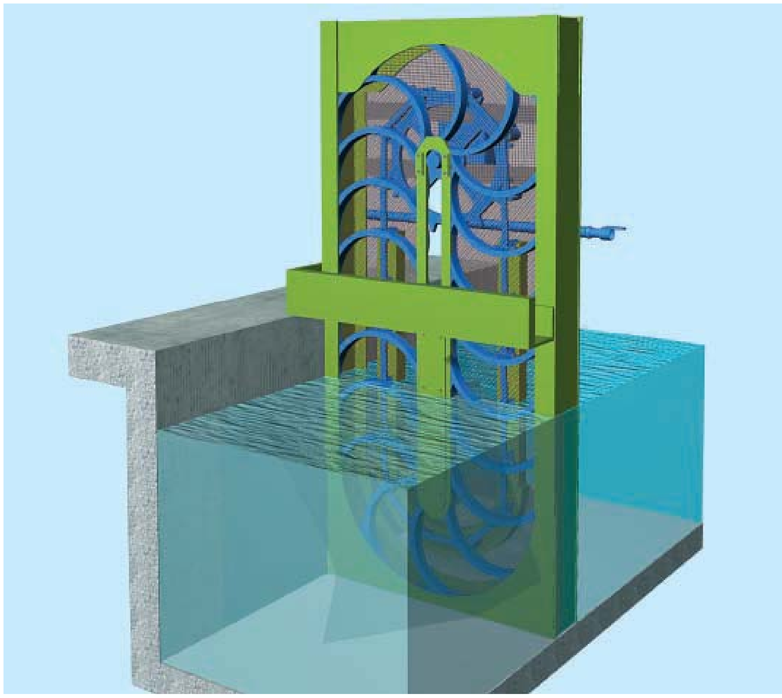


Figure 4-4: MultiDisc® System (www.passavant-geiger.com)

A low-pressure spray wash is used to recover impinged organisms from the screen surface into the buckets. As each screen panel turns to return down for another cleaning cycle, the retained water and fish are emptied into the debris trough located at the upstream side.

Presently, one vendor, Passavant-Geiger, supplies this system. Passavant-Geiger was contacted for information on sizing, placement, and costs of implementing MultiDisc® screens at Merrimack Station.

In order to maintain an acceptable head loss across the screens and provide a through-screen velocity of less than 0.5 fps, the size of Merrimack Station's existing CWISs would need to be greatly expanded to accommodate either dual flow or MultiDisc® fine mesh traveling screens. This is due to the fact that a much larger fine mesh screen area would be required to provide the same total open area as the existing coarse mesh screens. Both of the fine mesh screens evaluated in this Report would require the construction of new CWISs (or extensive modifications to the existing CWISs) to house the additional screens required, as well as the installation of new circulating water pumps similar to the existing circulating water pumps. In addition, both of the evaluated fine mesh screens would require bar racks to remove large debris that could damage them. By replacing the existing circulating water pumps instead of relocating them, the majority of the construction for the new CWISs could take place while the existing CWISs were still operating, thus avoiding the cost of extended/forced outages.

The basic design requirements for the two types of fine mesh traveling screens, and the upgraded fish return systems, evaluated in this Report are detailed in Table 4-1.

Table 4-1: Basic Design Considerations for Fine Mesh Traveling Screens and Upgraded Fish Return Systems Evaluated for Merrimack Station

Item	Design Criteria	Specific Design Criteria	Recommendation
Bar Rack	Remove large debris that could damage fine mesh screens	Required	Siemens (Attachment D3),
Stop Gate	To block off flow to intake channel for maintenance of fine mesh screens	Recommended	Siemens (Attachment D3),
Mesh Width	Optimize for entrainment reduction and fouling minimization	1.5 mm (0.06 in)	Normandeau (Ref. 7.15).
Through–Screen Velocity	≤ 0.5 fps	0.46-0.5 fps	Normandeau (Ref. 7.1 and Ref. 7.7), Siemens (Attachment D3), Passavant Geiger (Attachment D4)
Number of Screens New Unit 1	Provide surface area to reduce through-flow velocity ≤ 0.5 fps	6	Siemens (Attachment D3), Passavant Geiger (Attachment D4)
Number of Screens New Unit 2	Provide surface area to reduce through-slot velocity ≤ 0.5 fps	14	Siemens (Attachment D3), Passavant Geiger (Attachment D4)
Screen Type	Minimize new intake size/reduce debris into clean water side	Dual Flow; MultiDisc®	Eimco and Siemens (Attachment D3), Passavant Geiger (Attachment D4)
Low Pressure Spray System	Gently recover impinged organisms from screen ≤ 15 psi	5-15 psi	Normandeau (Ref. 7.1)
Fish Buckets	Capture organisms to return to water body	Required	Normandeau (Ref. 7.1)
Fish Slide/Sluice	Smooth and gently sloped and curved to return fish to river Removable Cover	Required	Normandeau (Ref. 7.1 and Ref. 7.7)
Slide Water Velocity	3 - 5 fps	3 - 5 fps	Normandeau (Ref. 7.1)

Item	Design Criteria	Specific Design Criteria	Recommendation
Minimum Water Depth in Fish Slide	4 - 6 in	4 - 6 in	Normandeau (Ref. 7.1 and Ref. 7.15)
Slope of Fish Slide	Optimal 1/16 ft drop/linear ft (LF)	1 ft drop/16 LF	Eimco (Attachment D3)
High Pressure Wash	Reduce clogging from debris during operation (60-100 psi)	60-100 psi	Eimco and Siemens (Attachment D2), Passavant Geiger (Attachment D4)

4.1.1 Major Components

Major components for the evaluated fine mesh additions and upgraded fish return systems are detailed in Tables 4-2 and 4-3 and Attachments D3 and D4.

Table 4-2: Major Components for the Dual Flow Fine Mesh Traveling Screens and Upgraded Fish Handling and Return Systems Evaluated for Merrimack Station (Option 3a)

Component	Quantity	Description	Size	Slot Size	Material
Unit 1					
Fine Mesh Traveling Screens	4	Dual Flow, Ristroph type	8 ft wide by 38 ft high; Net screen porosity 43.8%	1.5 mm (0.06 in.)	Epoxy coated carbon steel with 316 SS mesh
Local Control Panels	4	Start/Jog/Stop			
Drive Unit	4	Two speeds	3 hp/1.5 hp		
Ultra-Sonic Differential Panel	4	Includes motor starter			
Bar Racks	4	Manually cleaned 15° incline; anchored to channel walls	11 ft wide by 38 ft high	3 in clear openings	Epoxy Coated Carbon Steel

Component	Quantity	Description	Size	Slot Size	Material
Stop Logs	4	Solid with guides and lifting beams	11 ft wide by 38 ft high		Epoxy Coated Carbon Steel
Circulating Water Pumps	2	Vertical-Centrifugal Wet well	29,500 gpm; 28.5 ft TDH		
Spray Wash Pump	2	Pump for Fish Removal Spray	400 gpm at 80 psi		
Low Pressure Spray System	4	Fish removal spray	7 - 15 psi		
Fish Buckets	TBD	Ristroph type			
Fish Return Slide	1	Smooth and gently sloped and curved to return fish to river	500 ft		
High Pressure Wash	4	Debris removal	87 psi		
Unit 2					
Fine Mesh Traveling Screens	8	Dual Flow, Ristroph type	10 ft wide by 38 ft high; Net screen porosity 43.8%	1.5 mm (0.06 in.)	Epoxy coated carbon steel with 316 SS mesh
Local Control Panels	8	Start/Jog/Stop			
Drive Unit	8	Two speeds	5 hp/2.5 hp		
Ultra-Sonic Differential Panel	8	Includes motor starter			
Bar Racks	8	Manually cleaned; 15° incline; anchored to channel walls	12 ft wide by 38 ft high	3 in clear openings	Epoxy Coated Carbon Steel

Component	Quantity	Description	Size	Slot Size	Material
Stop Logs	8	Solid with guides and lifting beams	12 ft wide by 38 ft high		Epoxy Coated Carbon Steel
Circulating Water Pumps	2	Vertical-Centrifugal Wet well	70,000 gpm 24.5 ft TDH		
Spray Wash Pump	2	Pump for Fish Removal Spray	400 gpm at 80 psi		
Low Pressure Spray System	8	Fish removal spray	7 - 15 psi		
Fish Buckets	TBD	Ristroph type			
Fish Return Slide	1	Smooth and gently sloped and curved to return fish to river	100 ft		
High Pressure Wash	8	Debris removal	87 psi		

Table 4-3: Major Components for the MultiDisc® Fine Mesh Traveling Screens and Upgraded Fish Handling and Return Systems Evaluated for Merrimack Station (Option 3b)

Component	Quantity	Description	Size	Slot Size	Material
Unit 1					
Fine Mesh Traveling Screens	6	MultiDisc®, equipped with fish buckets	10 ft-8in wide by 36ft-9in high; Net screen porosity 46.5%	1.5 mm (0.06 in.)	304 SS
Power and Control Panel	6	Frequency Converter, VFD Operator Panel (SLOW-FAST-WATER LEVEL); MCB for VFD protection and terminals for motor control	Supply Voltage-460V, 60 Hz Control Voltage-24 VDC Signal- 4-20 mA		NEMA 4X 304 SS
Drive Unit	6	Frequency convertor motor (SLOW-FAST-WATER LEVEL)	7.5 kW		
Bar Racks	6	Manually cleaned; 15° Inclined; anchored to channel walls	12 ft wide by 37 ft high	3 in clear openings	Epoxy Coated Carbon Steel
Stop Logs	6	Solid with guides and lifting beams	12 ft wide by 37 ft high		Epoxy Coated Carbon Steel
Circulating Water Pumps	2	Vertical-Centrifugal Wet well	29,500 gpm 28.5 ft TDH		
Spray Wash Pump	2	Pump for Fish Removal Spray	400 gpm at 80 psi		
Low Pressure Spray System	6	Fish removal spray	5 - 15 psi		
Fish Buckets	40 per screen	TBD			

Component	Quantity	Description	Size	Slot Size	Material
High Pressure Wash	6	Debris removal	87 psi		
Fish Return Slide	1	Smooth and gently sloped and curved to return fish to river	500 ft		
Unit 2					
Fine Mesh Traveling Screens	14	MultiDisc®, equipped with fish buckets	10 ft-8 in wide by 36 ft-9 in high; Net screen porosity 46.5%	1.5 mm (0.06 in.)	304 SS
Power and Control Panel	14	Frequency Converter, VFD Operator Panel (SLOW-FAST-WATER LEVEL); MCB for VFD protection and terminals for motor control	Supply Voltage-460V, 60 Hz Control Voltage - 24 VDC Signal- 4 - 20 mA		NEMA 4X 304 SS
Drive Unit	14	Frequency convertor motor (SLOW-FAST-WATER LEVEL)	9.2 kW		
Bar Racks	14	Manually cleaned ; 15° Inclined; anchored to channel walls	12 ft wide by 37 ft high	3 in clear openings	Epoxy Coated Carbon Steel
Stop Logs	14	Solid with guides and lifting beams	12 ft wide by 37 ft high		Epoxy Coated Carbon Steel
Circulating Water Pumps	2	Vertical-Centrifugal Wet well	70,000 gpm 24.5 ft TDH		
Spray Wash Pump	2	Pump for Fish Removal Spray	400 gpm at 80 psi		
Fish Return Slide	1	Smooth and gently sloped and curved to return fish to river	100 ft		

Component	Quantity	Description	Size	Slot Size	Material
Low Pressure Spray System	14	Fish removal spray	5 - 15 psi		
Fish Buckets	40 per screen	TBD			
High Pressure Wash	14	Debris removal	87 psi		

4.1.2 Site Layout

Sketches conceptually depicting the implementation of the evaluated fine mesh screens at Merrimack Station are included in Attachment A. New intakes for both units would be required to house the fine mesh screens, as shown in sketches PSNH004-SK-006 and PSNH004-SK-007. A conceptual plan and section view for the new intakes are included in sketches PSNH004-SK-008 and PSNH004-SK-009, which shows the minimum space required to fit the dual flow and MultiDisc® fine mesh screens, respectively. The final design could require the screens to have a larger distance allowance between the screen surface and the channel width to account for flow patterns. Therefore, the actual footprints for the intakes could be larger after incorporating flow modeling.

The details for the dual screens conceptually presented in these sketches were obtained from Johnson Screens (Attachment D3) and are summarized as follows:

- Total Number of Dual Flow Screens and Channels
  - Unit 1: 4
  - Unit 2: 8
- Screen Width
  - Unit 1: 8 ft
  - Unit 2: 10 ft
- Channel Width
  - Unit 1: 11 ft
  - Unit 2: 12 ft
- Height of Screens: 38 ft
- Distance into River: 50 ft
- Estimated Width of CWIS:
  - Unit 1: 62 ft
  - Unit 2: 129 ft

The details for the MultiDisc® screens were obtained from Passavant-Geiger (Attachment D4) and are summarized as follows:

- Total Number of MultiDisc® Screens and Channels
  - Unit 1: 6
  - Unit 2: 14
- Screen width: 8 ft - 10 in
- Channel width: 12 ft
- Height of screens: 37 ft
- Distance into River: 50 ft
- Estimated width of CWIS:
  - Unit 1: 88 ft
  - Unit 2: 202 ft

4.2 Operational Features and Maintenance Requirements

4.2.1 Operations

The evaluated fine mesh traveling screens would replace the Station's existing coarse mesh traveling screens and would be operated continuously from April through November to minimize impingement time. Consistent with the Station's current operating procedures, the traveling screens and associated fish returns would be run intermittently from December through March as there would be personnel safety issues associated with maintaining the fish return systems when ice is present. O&M requirements are detailed in Table 4-4. The cost and manhours required for operation of the fine mesh screens would be expected to increase from the present operational requirements by a factor corresponding to the additional number of screens. Presently, each CWIS has a total of four coarse mesh screens and two bar racks to maintain. The new systems would have between three (dual flow) and five (MultiDisc®) times the number of traveling screens to operate and maintain. In addition, the number of bar racks would increase by a factor of six (dual flow) and ten (MultiDisc®) compared to the current number. Therefore, the increase in operations is expected to be 3 to 10 times that required by the existing CWISs. The number of circulating water pumps would remain the same, two for each unit. Therefore, pump operations and maintenance would remain the same as for the existing CWISs.

Fine mesh traveling screens are susceptible to damage and clogging due to ice formation on the screens during the winter months (Ref. 7.6). In order to avoid damage and any operational impacts resulting from the formation of frazil ice, a de-icing recirculation system similar to that used at the existing CWISs would be used during periods when the temperature is below freezing. In addition, the fine mesh traveling screens would be susceptible to fouling and would require high pressure sprays for cleaning as well as periodic cleaning throughout the year. Based on the results of a three year site-specific study, a sodium hypochlorite system could also be required to limit fouling.

4.2.2 Maintenance

Since there would be 8 (dual flow) to 16 (MultiDisc®) additional traveling screens and 8 (dual flow) to 16 (MultiDisc®) additional bar racks, both dual flow and MultiDisc® fine mesh screens would require significantly more maintenance than the existing systems. O&M for the existing CWIS is estimated to take 1050 hours per year, not including dredging which is subcontracted (Attachment D5).

O&M requirements for dual flow fine mesh screens are summarized in Table 4-4 and include preventative/routine maintenance, not repair or replacement time. The dual flow fine mesh screens would be operated year round except for during scheduled outage times.

Table 4-4: Operation and Maintenance Requirements for Dual Flow Fine Mesh Traveling Screens Evaluated for Merrimack Station

Duration	Task Description[2]	Group	Personnel (#)	Task Estimated Duration (hours)	Total Annual Time (man-hours)
Daily (365 Days)	Check spray pattern and cleaning action Check reducer, motor and coupling for excessive noise, vibration or heat build up	Operations/ Maintenance	2	4	2920
Weekly (52 Weeks)	Lubricate tray chain; capstan nut; take-up screws[3] Inspect Trays & Screen Cloths Inspect Seal Plates Tighten or Replace Loose or Missing Tray Chain Bolts Operate valves and controls	Operations/ Maintenance	2	8	832
Monthly (12 Months)	Lubricate/purge gear reducer (initial purge after 1000 hours)[3]	Operations/ Maintenance	2	32	768

Duration	Task Description[2]	Group	Personnel (#)	Task Estimated Duration (hours)	Total Annual Time (man-hours)
Periodically (3-6 months) (2-4 Total)	Lubricate/Purge Spherical Roller Headshaft Bearing[3] Inspect/Replace Worn Screen Chain Joints Inspect/Replace worn tooth inserts	Operations/ Maintenance	2	16	96
Periodically (6-12 months) (1-2 Total)	Lubricate Motor[3] Lubricate/Purge Gear Reducer[3] Inspect/Replace Worn Headshaft Bearing Turnover/ Replace UHMW Thrust Strips Touch-up or Repaint any damaged or rusting surface	Operations Maintenance	2	24	72
Annually	Clean Bar Racks	Operations Subcontractor	4	24	160
Total Estimated O&M[1] Time					**4848**

Notes:

1. Preventative/routine maintenance estimates only; does not include repair or replacement time. Pump O&M for the new system should follow the same schedule and duration as the existing CWIS and is not included in this table.
2. See Attachment D3 for recommended O&M for Dual Flow Screens.
3. See Attachment D3 for Traveling Screen Lubrication Chart and Location Drawing.

Since MultiDisc® traveling screens would require many more screens and mechanical parts, the O&M requirements would be expected to be significantly higher than the O&M requirements detailed for dual flow screens. The fine mesh MultiDisc® traveling screens would be operated year round except for during scheduled outage times.

O&M requirements for MultiDisc® fine mesh screens are summarized in Table 4-5 and include preventative/routine maintenance, not repair or replacement time. The dual flow fine mesh screens would be operated year round except for during scheduled outage times.

Table 4-5: Operation and Maintenance Requirements for MultiDisc® Fine Mesh Traveling Screens Evaluated for Merrimack Station

Duration	Task Description	Group	Personnel (#)	Task Estimated Duration (hours)[2]	Total Annual Time (man-hours)
Daily (365 Days)	Check spray pattern and cleaning action Check reducer, motor and coupling for excessive noise, vibration or heat build up	Operations/ Maintenance	2	6	4380
Weekly (52 Weeks)	Inspect Discs Inspect Seal Plates Operate valves and controls	Operations/ Maintenance	2	12	1248
Monthly (12 Months)	Lubricate gear (initial purge after 1000 hours)	Operations/ Maintenance	2	54	1296
Periodically (3-6 months) (2-4 Total)	Inspect/Replace damaged discs	Operations/ Maintenance	2	28	168
Periodically (6-12 months) (1-2 Total)	Lubricate Motor Touch-up or Repaint any damaged or rusting surface	Operations Maintenance	2	40	120
Annually	Clean Bar Racks	Operations Subcontractor	4	60	240
Total Estimated O&M[1] Time					**7452**

Notes:

1. Preventative/routine maintenance estimates only; does not include repair or replacement time. Pump O&M for the new system should follow the same schedule and duration as the existing CWIS and is not included in this table.
2. Estimated to be approximately 1.5 to 1.7 times the dual flow screen tasks due to the larger number of screens.

4.3 Construction Factors

4.3.1 Schedule

A detailed schedule for the implementation of the evaluated dual flow and MultiDisc® fine mesh screen options (including upgraded fish handling and return systems) are included in

Attachment B3 and B4, respectively. A site specific data acquisition study would be scheduled before design or construction of either fine screen option. This study would have two primary purposes: (1) to obtain information regarding the potential effects of various site-specific parameters (e.g., silting, debris, fouling) on the performance of the fine mesh screens installed at Merrimack Station, and (2) to verify the levels of IM&E reductions that could be achieved by the operation of such fine mesh screens at the Station. According to Normandeau (Attachment E), due to the seasonal and annual variability of conditions expected on and in the Merrimack River, this site-specific study would need to cover approximately three years of seasonal cycles to ensure that the data collected is representative of most conditions expected in the river.

The design and construction of the dual flow fine mesh screen option would take a total of approximately 36 months, following the completion of the site-specific study. The design and construction of the MultiDisc® fine mesh screen option would take a total of approximately 46 months, following the completion of the site-specific study.

The design phase for both the dual flow and MultiDisc® fine mesh screens would have some overlap into the construction phase and would be completed using the optimal cleaning frequency, mesh sizing and material information obtained from the site specific study. The total design phase would take approximately 24 months for the dual flow fine mesh screens and 26 months for the MultiDisc® fine mesh.

The construction phases for the new CWISs would be expected to last approximately 20 months for the dual flow option and 28 months for the MultiDisc® option and would include the following construction activities:

- Mobilization
  - Placement of construction trailers and construction site layout to include hooking up temporary power.
  - Inspection and delivery of the dual flow or MultiDisc® system components.
- General Site Modifications
  - Preparing the site for construction to include clearing, grubbing, fencing and storm water run-off protection.
  - Construction of cofferdam.
  - Pumping dry area for new intakes.
  - Installation of sheet piles.
  - Excavation and preparation of foundation and subgrade.
- Unit 1 and 2 Construction Activities
  - Set rebar and pour concrete for foundations, lower walls, elevated slabs, and building walls.
  - Set bar joist and metal beds for roof; install roof.

- Install new equipment (i.e., bar racks, fine mesh screens, stop gates, centrifugal pumps, etc.).
- Construct fish return troughs.
- Commissioning of installed equipment, which includes making sure equipment meets the design requirements and includes basic testing such as flow, leak, and pressure.
- Tie-in to existing circulating water piping.
- Start-up of system with river water.
- Validation of system.
- Abandon and leave in place the existing Unit 1 and 2 CWISs.

- Demobilization
  - Clean-up of construction site.
  - Restoration of construction site.

4.3.2 Outage Duration

The following activities should be completed before tie-in of the new CWISs to the existing circulating water piping systems and should not require either Unit to be offline:

- Excavation and exposure to circulation piping tie-in point.
- Completion of construction of all new intake structure to include new circulating water pumps and the piping up to the tie-in point.
- Commissioning of all installed equipment to include fine mesh screens and components, and centrifugal pumps.

After the above preparations, the actual tie-in from the new CWISs to the existing circulating water piping is estimated to take approximately 8 weeks (4 weeks of scheduled outage with an additional 4 weeks of forced construction outage) for each Unit. If the tie-in was unable to be scheduled during a scheduled outage, a forced construction outage would be required for the entire duration of the tie-in, resulting in increased costs due loss of energy generation.

4.4 Cost Estimates

4.4.1 Initial Capital Costs

The initial capital costs for the evaluated fine mesh traveling screen options (including upgraded fish return systems) include design, procurement, implementation, and startup activities, based on the conceptual designs identified and discussed in Section 4.1. The costs associated with permitting this option are not included in this estimate. The initial capital cost estimates for this option were developed in the same manner as those for the evaluated wedgewire screen options, utilizing (1) vendor quotations for the major equipment and material components, (2) established construction cost estimating tools for labor, equipment, and scheduling costs, and (3) a Recommended Minimum Contingency of 25% and a routine PSNH cost multiplier of 12%.

4.4.1.1 Dual Flow

As shown in Attachment C3, the total estimated capital cost for Option 3a, dual flow fine mesh (1.5 mm) traveling screens with upgraded fish handling and return systems, is $42,922,000. Vendor data and budgetary cost estimates for major equipment components are included in Attachment D3.

4.4.1.2 MultiDisc

As shown in Attachment C4, the total estimated capital cost for Option 3b, MultiDisc® fine mesh (1.5 mm) traveling screens with upgraded fish handling and return systems, is approximately $59,697,000. Vendor data and budgetary cost estimates for major equipment components are included in Attachment D4.

4.4.2 Operation and Maintenance Costs

4.4.2.1 Dual Flow

O&M costs are summarized in Table 4-6 and are based on the following:

- Additional labor required to operate and maintain the dual flow system, as detailed in Table 4-4.
- O&M labor costs include wages and benefits.
- O&M costs for the new circulating water pumps would be the same as the O&M costs for the existing circulating water pumps.

Table 4-6: Option 3a - Estimated Annual Operation and Maintenance Cost for the Dual Flow Fine Mesh Traveling Screen System

	Cost	Units	#	Cost
Unit 1 and Unit 2 Labor PSNH Personnel[2]	$ 60	per hr	4,848	$ 290,900
TOTAL Annual O&M Costs[1]				**$ 290,900**

Notes:
1. Cost is for 1st Quarter 2009 $U.S. Total annual cost does not include maintenance time for the circulation water pumps. Preventative/routine maintenance estimates only; does not include repair or replacement cost.
2. Labor cost includes wages and benefits for 2009 (Attachment D5).

4.4.2.2 MultiDisc®

O&M costs are summarized in Table 4-7 and are based on the following:

- Additional labor required to operate and maintain the MultiDisc® system is expected to be approximately1.7 times that required for the dual flow system.
- Operation and maintenance labor costs include wages and benefits.
- O&M costs for the new circulating water pumps would run continuously would be the same as the O&M costs for the existing circulating water pumps.

Table 4-7: Option 3b - Estimated Annual Operation and Maintenance Cost for the MultiDisc® Fine Mesh Traveling Screen System

	Cost	Units	#	Cost
Unit 1 and Unit 2				
Labor PSNH Personnel[2]	$ 60	per hr	7,452	$ 447,200
TOTAL Annual O&M Costs[1]				**$ 447,200**

Notes:

1. Cost is for 1st Quarter 2009 $U.S. Total annual cost does not include maintenance time for the pumps. Preventative/routine maintenance estimates only; does not include repair or replacement cost.
2. Labor cost includes wages and benefits for 2009 (Attachment D5).

4.4.3 Parasitic Losses (Costs)

4.4.3.1 Dual Flow

Parasitic power losses due to operation of the evaluated dual flow option are based on the following:

- Parasitic power losses are based on a 2009 market value of $98 MW-hr (Attachment D5).
- Estimated power requirements for operating the dual flow screens is based on the following conservative assumptions:
  - Screens would run continuously.
  - Screen motors would run on low speed for 75% of the time and high speed for large volumes of debris removal 25% of the time (Attachment D5).

Based on these assumptions, the additional parasitic losses associated with the operation of the evaluated dual flow fine mesh traveling screen option would be approximately 212 MW-hr per year. The corresponding annual cost associated with this power loss would be $20,800.

4.4.3.2 MultiDisc®

Parasitic power losses due to operation of the evaluated MultiDisc® option are based on the following:

- Parasitic power losses are based on a 2009 market value of $98 MW-hr (Attachment D5).
- Estimated power requirements for operating the MultiDisc® screens are based on the conservative assumption that the screens would run continuously.

Based on these assumptions, the additional parasitic losses associated with the operation of the evaluated MultiDisc® fine mesh traveling screen option would be approximately 1522 MW-hr per year. The corresponding annual cost associated with this power loss would be $149,200.

4.4.4 Lost Generating Capacity during Implementation

As discussed in Section 4.3.2, the actual tie-in from the new CWISs to the existing circulating water piping is estimated to take approximately 8 weeks (4 weeks of scheduled outage with an additional 4 weeks of forced construction outage) for each Unit. Based on 4 weeks of forced construction outage, the lost generating capacity associated with the implementation of the dual flow or MultiDisc® fine mesh traveling screen option would be approximately 315,840 MW-hr. The corresponding cost associated with this power loss would be $11,686,000 based on a 2009 replacement power cost of $37 MW-hr (Attachment D5). If the tie-in was unable to be scheduled during a scheduled outage, a forced construction outage would be required for the entire duration of the tie-in, resulting in increased costs due loss of energy generation.

4.4.5 Water Treatment Costs

As discussed in Section 4.1, the fine mesh traveling screens would be susceptible to fouling and would require high-pressure sprays for cleaning as well as periodic cleaning throughout the year. Although it is likely that the high-pressure sprays could sufficiently control fouling of the fine mesh traveling screens, a sodium hypochlorite system could also be required to limit biological growth and fouling based on the results of a three year site-specific study.

4.4.6 Estimated Useful Life of Major Equipment

The estimated useful life for each of the major components of the fine mesh traveling screen systems is included below:

- Dual Flow Fine Mesh Screen System - 25 to 30 years (Attachment D3).
- MultiDisc® Fine Mesh Screens - Limited installation experience.

4.5 Environmental Considerations

4.5.1 Waterway Impact

The Merrimack River is approximately 550 ft wide adjacent to Merrimack Station with a total riverfront length of 10,077 ft along the Merrimack Station property (Ref. 7.10) for a total adjacent river area of 5,542,400 ft^2. The existing CWISs for Units 1 and 2 extend up to 30 ft and 10 ft, respectively, from the shoreline of the Merrimack River, and cover a total river area of approximately 1200 ft^2. The new Unit 1 and Unit 2 CWISs for dual flow fine mesh screens would extend up to 55 ft and 45 ft, respectively, from the shoreline of the Merrimack River and cover a river area of approximately 6100 ft^2, while the new CWISs for MultiDisc® fine mesh screens would extend approximately 70 ft and 45 ft, respectively, from the shoreline of the Merrimack River and cover a river area of approximately 9200 ft^2. Addition of the new CWISs for dual flow fine mesh screens would diminish the river area in the vicinity of the Station by approximately 0.11% and new CWISs for MultiDisc® fine mesh screens would diminish the river area by approximately 0.17%.

In order to implement the evaluated fine mesh traveling screen option, the applicable regulatory agencies would have to be contacted regarding the permit restrictions associated with the construction of the new CWISs and any impacts resulting from the implementation of fine mesh traveling screens.

4.5.2 Aesthetic Impact

The larger CWISs required for the dual flow screen and MultiDisc® screen options would be more visible from the both the river and the land across the river compared to the existing CWIS.

The height for the new CWISs for both the dual flow and MultiDisc® options is estimated to be 27 ft. The height of both existing CWISs is 12 ft. Therefore, the new CWISs structures would be an estimated 15 ft taller than the existing structures.

The widths of the new dual flow screen structures for Unit 1 and Unit 2 are estimated to be 64 ft and 130 ft, respectively. The widths of the new MultiDisc® screen structures for Unit 1 and Unit 2 are estimated to be 92 ft and 223 ft, respectively. The widths of the existing Unit 1 and Unit 2 structures are approximately 30 ft and 35 ft, respectively. For the dual flow option this equates to an increase in width of 53% for Unit 1 and 73% for Unit 2. For the MultiDisc® option this equates to an increase in width of 67% for Unit 1 and 84% for Unit 2.

In order to implement the evaluated fine mesh traveling screen option, the applicable regulatory agencies would have to be contacted regarding the permit restrictions associated with the construction of the new CWISs and any impacts resulting from the implementation of fine mesh traveling screens.

4.5.3 Wildlife Habitat and Greenspace Impact

Both the dual flow and MultiDisc® fine mesh screen systems would require larger CWISs. Construction of the new CWISs would require the use of existing greenspace as well as some additional clearing and grubbing of existing vegetation along the river bank. This reduction in greenspace would have an unknown effect on any wildlife in the immediate vicinity of the present intake. A study to quantify this potential impact would be recommended prior to selecting the fine screen options.

In addition, in order to implement the evaluated fine mesh traveling screen option, the applicable regulatory agencies would have to be contacted regarding the permit restrictions associated with the construction of the new CWISs and any impacts resulting from the implementation of fine mesh traveling screens.

4.6 Impingement Mortality/Entrainment Reduction Assessment

The concept of using fine mesh screens for exclusion of eggs, larvae, and juvenile fish relies on gentle impingement on the screen's surface or retention within screening baskets, low pressure washing of the screen panels or baskets, transfer of the organisms to a sluiceway, and then sluicing the organisms back to the source water body. Success of an installation using fine mesh traveling screens is contingent on the application of satisfactory handling and recovery facilities to allow safe return of impinged organisms to the aquatic environment (Ref. 7.3). The design for the traveling screen options (dual flow and MultiDisc®) are for screens with a mesh size of 1.5 mm (i.e., square openings 1.5 mm by 1.5 mm) to be used continuously year round with a through- mesh velocity of ≤ 0.5 fps and a state-of-the-art fish return system with the following features:

- Fish buckets to capture and return organisms to river.
- Low pressure fish wash ≤ 15 psi.
- Smooth, curved, and gently sloped (1 ft drop per 4 LF) fish sluice.
- Discharge of fish sluice/trough ½ ft below low water level.
- Trough water velocity maintained at 3 to 5 fps.
- Minimum water depth in trough maintained at 4 to 6 in.

An evaluation of the potential for year-round operation of fine-mesh screens to reduce impingement mortality and entrainment at Merrimack Station was conducted by Normandeau (Ref. 7.15) and summarized below.

Mortality of fish that would have been impinged on standard-mesh screens (3/8-inch square openings) could be assumed to be reduced by 80-95% because of the low through-screen velocity. That assumption is consistent with the expectation that the swimming capabilities of juvenile and adult fish would enable them to avoid being impinged if the intake current is less than 0.5 fps. It is unknown, however, whether the same assumption is reasonable for eggs and larvae that would be entrained through standard-mesh screens but excluded by 1.5-mm-mesh screens, because of the limited swimming capability of eggs and larvae that are passively transported by water currents. Therefore, the ability of fine mesh screens to reduce impingement mortality at Merrimack Station is unknown and would require a site specific biological study at the Merrimack site.

However, Normandeau has been able to model a spectrum from the best-case to worst-case scenarios for the Merrimack site (Ref. 7.15) as summarized in Table 4-8.

Table 4-8: Potential for Year Round Operation of Fine Mesh Screens to Reduce Impingement Morality and Entrainment at Merrimack Station

Scenario	Impingement Mortality	Entrainment	Adult Equivalent Losses
Current Operation	18%	17%	17%
Assumption 1: 100% larval avoidance	100%	>99%	>99%
Assumption 2: 100% larval impingement with 58.7% survival	-10,000%	49%	43%
Assumption 3: 100% larval impingement with 100% mortality	-24,000%	49%	21%

As described by Normandeau (Ref. 7.15), the substantial increases in impingement mortality for Assumption 2 and Assumption 3 are due to the separate "percent reduction" standards for impingement mortality and entrainment and the fact that the annual number entrained is three orders of magnitude higher than the annual number impinged. Therefore, according to Normandeau, the true benefits of replacing conventional traveling screens with fine mesh traveling screens should be determined exclusively on the reductions in adult equivalents from the sum of those fish entrained and impinged with each technology. In addition, these results and the corresponding assumptions would need to be confirmed or refuted by further study.

5 Comparison of Alternative Technologies

The comparative matrix shown in Table 5-1 identifies the conceptual technology options that were further evaluated at EPA's request as potential alternative CWIS technologies for Merrimack Station.. The matrix provides the projected total costs and biological effectiveness (i.e., potential IM&E reductions achievable) of each technology option and ranks the options. As noted above, these projected costs and IM&E reduction estimates were developed on a conceptual basis, and therefore are contingent on the completion of the recommended three year site-specific study, which would obtain the information necessary to evaluate the magnitude of the expected fouling and establish the optimum slot size and operational period of the conceptual technology option.

Table 5-1: Comparative Matrix of Alternative Technology Options 1, 2, and 3 for Merrimack Station

Alternative Technology	Cost[1]		Biological Effectiveness (% Reduction)		Biological-Cost Effectiveness Ranking	Comments
	Initial	Annual	Impingement	Entrainment		
Option 1 - Wedgewire Screens with Upgraded Fish Return Systems	$ 8,508,000 - $ 8,816,000	$ 86,000	84	73 to 79 (Note 2)	High (17)	Wedgewire Screens would operate from April to July. Upgraded Fish Return system would operate from August to November. The existing screening systems would operate throughout the remaining months. Some construction activities would require an outage. A three year site specific study would be required prior to final design and installation.
Option 2 – Seasonal Deployment of Aquatic Filter Barrier and Upgraded Fish Return Systems	$ 9,955,000	$ 475,800	78	82	Medium (14)	Would be deployed from April to July. Upgraded Fish Return system would operate from August to November. The existing screening systems would operate throughout the remaining months. Rental of the AFB equipment is also available. A three year site specific study would be recommended prior to final design and installation.
Option 3a - Dual Flow Fine Mesh Traveling Screens and Upgraded Fish Handling and Return Systems	$ 54,608,000	$ 311,700	Note 3	49 to >99	Medium (11)	Would operate year-round. Some construction activities would require an outage. A three year site specific study would be recommended prior to final design and installation.
Option 3b - MultiDisc® Fine Mesh Traveling Screens and Upgraded Fish Handling and Return Systems	$ 71,383,000	$ 596,400	Note 3	49 to >99	Low (8)	Would operate year round. Some construction activities would require an outage. A three year site specific study would be recommended prior to final design and installation.

Notes:
1. Cost is for 1st Quarter 2009 in $U.S. Initial cost includes capital costs and lost generating capacity due to construction outages (Option 3 only). Annual cost includes O&M and parasitic losses.
2. Actual wedgewire screen performance would be determined through the recommended three year site-specific study, which would obtain the site-specific information necessary to evaluate the magnitude of the expected fouling and establish the optimum slot size and operational period of the screens.
3. A site-specific study would be needed to determine the potential impingement mortality reductions that could result from retrofitting fine-mesh traveling screens at Merrimack Station. According to Normandeau, while impingement mortality could be significantly reduced, the potential also exists for impingement mortality to significantly increase (Ref. 7.15).

The conclusions presented in the comparative matrix are summarized below:

Option 1 – Seasonal Deployment of Wedgewire Screens and Upgraded Fish Return Systems

The initial capital cost for wedgewire screens with upgraded fish return systems would range from approximately $8,508,000 to approximately $8,816,000, dependent on the slot size selected, with annual costs of approximately $86,000. Some construction activities associated with the installation of wedgewire screens would likely require an outage, although it is possible that these activities could be scheduled to coincide with a routine maintenance outage.

By operating wedgewire screens with a 1.5 mm slot size from April to July and the existing coarse mesh traveling screens with upgraded fish return systems from August through November, an up to 79% reduction in entrainment and an 84% reduction in impingement mortality could be attained. By operating wedgewire screens with a 9 mm slot size from April to July and the existing coarse mesh traveling screens with upgraded fish return systems from August through November, an up to 73% reduction in entrainment and an 84% reduction in impingement mortality could be attained. Reductions in adult equivalent losses for IM&E combined could range from 76% for the 3 mm through 9 mm slot size wedgewire screens to 81% for the 1.5 mm slot size wedgewire screens. However, because of the significant potential for screen fouling, prior to final design and construction a three year site specific study would be necessary to obtain information on the effect of site-specific parameters (i.e., river velocity, silting, debris, fouling, etc.) on the performance of the wedgewire screens with slot sizes ranging from 1.5 mm to 9 mm, in order to evaluate the magnitude of the expected fouling and establish the optimum slot size and operational period of the screens at the Station.

Option 2 – Seasonal Deployment of Aquatic Filter Barrier and Upgraded Fish Return Systems

The initial capital cost for an AFB system and upgraded fish return systems would be approximately $9,955,000, with annual costs of approximately $475,800.

If the conceptual AFB system discussed in this Report were installed and operated from April to July and the existing coarse mesh traveling screens were used with the conceptual upgraded fish return systems discussed in this report, impingement mortality and entrainment at Merrimack Station would be reduced, respectively, by approximately 78% and 82%. Prior to final design and construction, a three year site-specific study would be recommended to obtain information on the effect of site specific parameters (i.e., river velocity, silting, debris, fouling etc.) on the performance of the AFB system and verify the potential IM&E reductions achievable.

Option 3a – Dual Flow Fine Mesh Traveling Screens and Upgraded Fish Return Systems

The initial capital and lost generation cost for dual flow fine mesh traveling screens with a mesh size of 1.5 mm and upgraded fish return systems would be approximately $54,608,000, with annual costs of approximately $311,700. Some construction activities associated with the installation of dual flow fine mesh traveling screens would require an outage, although it is possible that some of these activities could be scheduled to coincide with a routine maintenance outage.

The ability of fine mesh screens to reduce impingement mortality at Merrimack Station is unknown and would require a site specific biological study at the Merrimack site. However, Normandeau has been able to model a spectrum from the best-case to worst-case scenarios for the Merrimack site. Normandeau has estimated that retrofitting the conceptual dual flow fine mesh traveling screens discussed in this Report at Merrimack Station could reduce entrainment at the Station by approximately 49% to greater than 99%*. According to Normandeau, while impingement mortality could be significantly reduced, the potential also exists for dual flow fine-mesh traveling screens to increase impingement mortality.

Option 3b – MultiDisc® Fine Mesh Traveling Screens and Upgraded Fish Return Systems

The initial capital and lost generation cost for MultiDisc® fine mesh traveling screens with a mesh size of 1.5 mm and upgraded fish return systems would be approximately $71,383,000, with annual costs of approximately $596,400. Some construction activities associated with the installation of MultiDisc® fine mesh traveling screens would require an outage, although it is possible that some of these activities could be scheduled to coincide with a routine maintenance outage.

The ability of fine mesh screens to reduce impingement mortality at Merrimack Station is unknown and would require a site specific biological study at the Merrimack site. However, Normandeau has been able to model a spectrum from the best-case to worst-case scenarios for the Merrimack site. Normandeau has estimated that retrofitting the conceptual MultiDisc® fine mesh traveling screens discussed in this Report at Merrimack Station could reduce entrainment at the Station by approximately 49% to greater than 99%*. According to Normandeau, while impingement mortality could be significantly reduced, the potential also exists for dual flow MultiDisc® traveling screens to increase impingement mortality.

* The only scenario that would satisfy CWA §316(b) with regard to impingement mortality and entrainment would be Assumption 1 scenario, in which larvae was assumed to completely avoid impingement.

6 Conclusions and Recommendations

Based on the engineering evaluation presented in this Report and the IM&E reduction analysis performed by Normandeau (Ref. 7.15) (as summarized in the comparative matrix and discussion provided in Section 5), Option 1 (Seasonal Deployment of Wedgewire Screens with Upgraded Fish Return Systems) constitutes BTA for Merrimack Station.

Option 1 includes the following components:

- Seasonal (April-July) use of wedgewire screens at both Units 1 and 2.
- Continuous use of the existing coarse mesh traveling screens with upgraded fish return systems at both Units 1 and 2 when the wedgewire screens are in use during August through November.

Option 1 would have the lowest capital (approximately $8,508,000 to approximately $8,816,000) and annual cost (approximately $86,000) compared to the other conceptual technology options evaluated as alternative CWIS technologies for Merrimack Station at EPA's request. In addition, Option 1 would satisfy CWA §316(b) with regard to IM&E by:

- Reducing impingement mortality by approximately 84% from baseline.
- Reducing entrainment from baseline by approximately 73% for 9 mm wedgewire screens to approximately 79% for 1.5 mm wedgewire screens.

A three year site specific study is necessary prior to the implementation of Option 1 at Merrimack Station in order to minimize both entrainment and fouling. Potential fouling of the wedgewire screens could negatively affect Station operations and, therefore, reliability of the Station, and the magnitude of this expected fouling needs to be fully evaluated on-site prior to screen selection and installation. Due to the significant potential for screen fouling in the Merrimack River at Merrimack Station, on-site physical testing of different slot sizes through a site-specific study would be required to evaluate the optimal slot size for the Station. Overall, the results of Normandeau's analysis show that the Phase II §316(b) Rule's performance standards of a 60-90% reduction in entrainment and an 80-95% reduction in impingement mortality could be attained at Merrimack Station by installing wedgewire screens with any of five slot sizes evaluated (1.5 mm through 9 mm) at both Unit 1 and Unit 2, operating them from April through July of each year, and installing and operating state-of-the-art fish return systems (in combination with the existing traveling screens) during August through November.

7 References

7.1 Public Service of New Hampshire (PSNH), Enercon Services, Inc, and Normandeau Associates. November 2007. *Response to the United States Environmental Protection Agency CWA § 308 Letter, PSNH Merrimack Station Units #1 and #2, Bow, New Hampshire.*

7.2 Normandeau Associates, Inc. October 2007. *Entrainment and Impingement Studies Performed at Merrimack Generating Station from June 2005 through June 2007.*

7.3 United States Environmental Protection Agency (USEPA). April 2002. *Technical Development Document for Proposed Section 316(b) Phase II Existing Facilities Rule (EPA 821-R-02-003)*, Washington, DC.

7.4 Dixon, Douglas. January 2005. *Cooling Water Intake Structures at Existing Power Plants,* EPRI Presentation on EPA Phase II Rule for Section 316(b) of CWA.

7.5 Dixon, Douglas. December 2004. *Laboratory Evaluation of Aquatic Filter Barrier (AFB) for Protecting Early Life Stages of Fish (1005534),* EPRI, Palo Alto, California.

7.6 Pankratz, Tom. 1995. *Screening Equipment Handbook for Industrial and Municipal Water and Wastewater Treatment*, 2^{nd} ed., Technomic Publishing Company, Inc., Lancaster, Pennsylvania.

7.7 Fletcher, Ian. May 1990. *A Review of Reported Fine Mesh Screen Applications for High Volume Water Intake Systems, and Recommendations for Further Investigations*, Reported to Consolidated Edison Company of New York.

7.8 Fletcher, Ian. July 1990. *Hydraulic and Mechanical Considerations and Addendum to A Review of Reported Fine Mesh Screen Applications for High Volume Water Intake Systems,* Reported to Consolidated Edison Company of New York.

7.9 RS Means Company, Inc. *RS Means Building Construction Cost Data 2008*, 66^{th} ed. 2008. Construction Publishers & Consultants, Kingston, Massachusetts.

7.10 Tax Map 41, Block 2, Lot 200. May 9, 2007. Existing Conditions Plan, Merrimack Station (File 16809.08), Bow, New Hampshire.

7.11 Padilla, Rodger, Maureen Rotondo, Chris Wilkinson and Karen Hochcraft. July 28, 2005. *A Pilot Study on Bio-fouling Resistance of 304 and 316 Stainless Steel and Copper Nickel Metal*, Division of Environmental Services (Fish Facilities Section), Department of Water Resources, State of California.

7.12 Daly, Steven, F. Frazil. March 1991. Ice Blockage of Intake Trash Racks. Cold Regions Technical Digest. No. 91-1. US Army Corps of Engineers.

7.13 Normandeau Associates, Inc. 1976. Merrimack River Monitoring Program. Bedford, NH. Submitted to PSNH.

7.14 USEPA. July 2004. National Pollutant Discharge Elimination System--Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, 69 Fed. Reg, 41575 (Jul. 9, 2004). Washington, DC.

7.15 Normandeau Associates, Inc. September 2009. Biological Performance of Intake Screen Alternatives to Reduce Annual Impingement Mortality and Entrainment at Merrimack Station. Bedford, NH.

Attachment A

Conceptualized Drawings

PSNH004-SK-001: Option 1 – 1.5 mm Wedgewire Screens Layout

PSNH004-SK-002: Option 1 – 9 mm Wedgewire Screens Layout

PSNH004-SK-003: Option 1 - Wedgwire Screens Connection to Screenhouse #1

PSNH004-SK-004: Option 1 - Wedgewire Screens Connection to Screenhouse #2

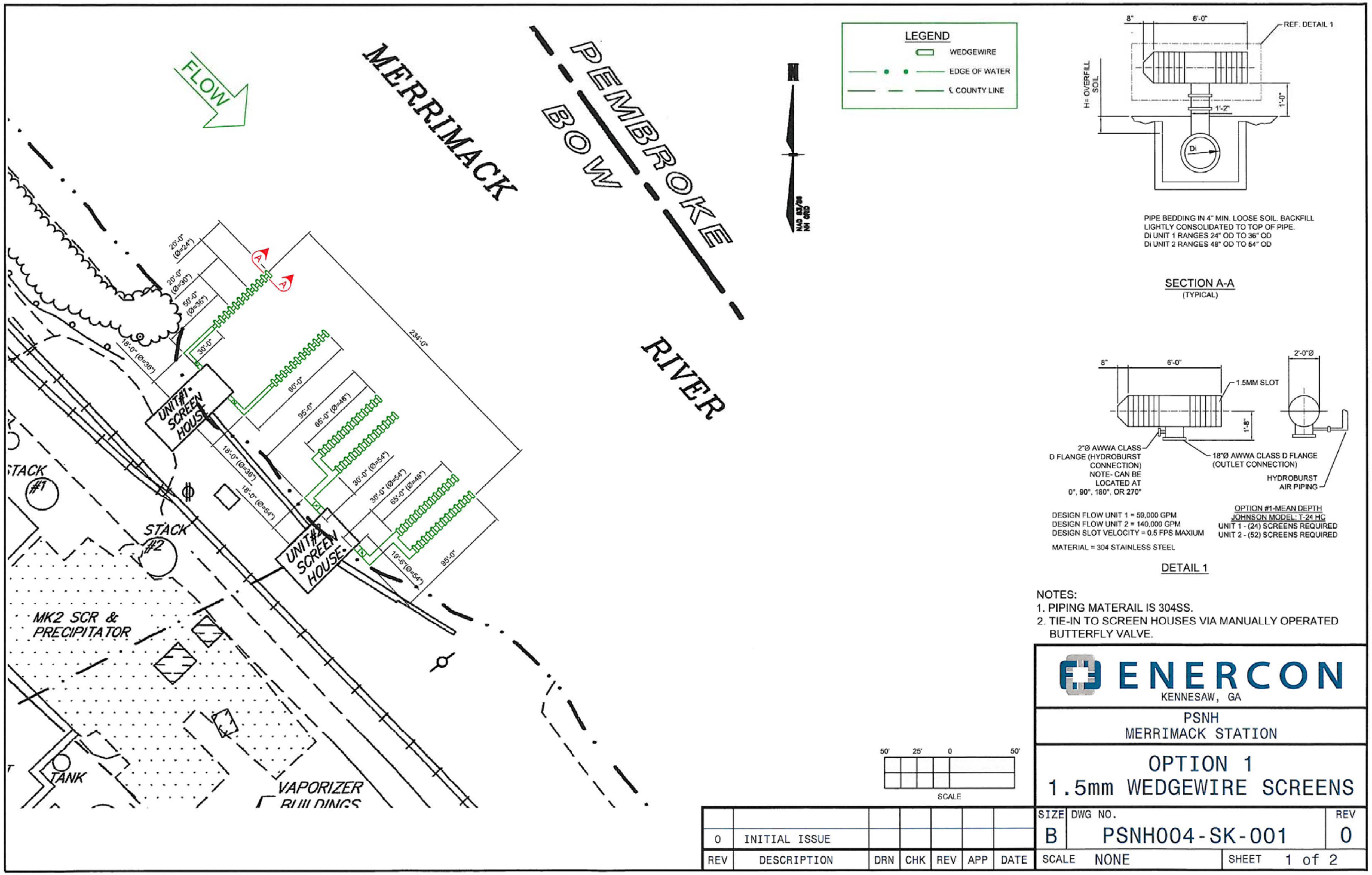
PSNH004-SK-005: Option 2 - Aquatic Filter Barrier Aerial View

PSNH004-SK-006: Option 3a - Dual Flow Fine Mesh Traveling Screens Layout

PSNH004-SK-007: Option 3b - MultiDisc® Fine Mesh Traveling Screens Layout

PSNH004-SK-008: Option 3a - Dual Flow Traveling Screens Unit 1 and Unit 2 Plan and Section

PSNH004-SK-009: Option 3b – MultiDisc® Traveling Screens Unit 1 and Unit 2 Plan and Section


FLOW
MERRIMACK
PEMBROKE
BOW
RIVER
LEGEND
WEDGEWIRE
EDGE OF WATER
℄ COUNTY LINE
UNIT #1 SCREEN HOUSE
UNIT #2 SCREEN HOUSE
STACK #1
STACK #2
MK2 SCR & PRECIPITATOR
TANK
VAPORIZER BUILDINGS
234'-0"
REF. DETAIL 1
H= OVERFILL SOIL
PIPE BEDDING IN 4" MIN. LOOSE SOIL BACKFILL LIGHTLY CONSOLIDATED TO TOP OF PIPE.
Di UNIT 1 RANGES 24" OD TO 36" OD
Di UNIT 2 RANGES 48" OD TO 54" OD
SECTION A-A
(TYPICAL)
1.5MM SLOT
2"Ø AWWA CLASS D FLANGE (HYDROBURST CONNECTION)
NOTE- CAN BE LOCATED AT 0°, 90°, 180°, OR 270°
18"Ø AWWA CLASS D FLANGE (OUTLET CONNECTION)
HYDROBURST AIR PIPING
DESIGN FLOW UNIT 1 = 59,000 GPM
DESIGN FLOW UNIT 2 = 140,000 GPM
DESIGN SLOT VELOCITY = 0.5 FPS MAXIUM
MATERIAL = 304 STAINLESS STEEL
OPTION #1-MEAN DEPTH
JOHNSON MODEL: T-24 HC
UNIT 1 - (24) SCREENS REQUIRED
UNIT 2 - (52) SCREENS REQUIRED
DETAIL 1
NOTES:
1. PIPING MATERAIL IS 304SS.
2. TIE-IN TO SCREEN HOUSES VIA MANUALLY OPERATED BUTTERFLY VALVE.
ENERCON
KENNESAW, GA
PSNH
MERRIMACK STATION
OPTION 1
1.5mm WEDGEWIRE SCREENS
SCALE
SIZE B
DWG NO. PSNH004-SK-001
REV 0
0 INITIAL ISSUE
REV DESCRIPTION DRN CHK REV APP DATE
SCALE NONE
SHEET 1 of 2

NOTES:
1. PIPING MATERAIL IS 304SS.

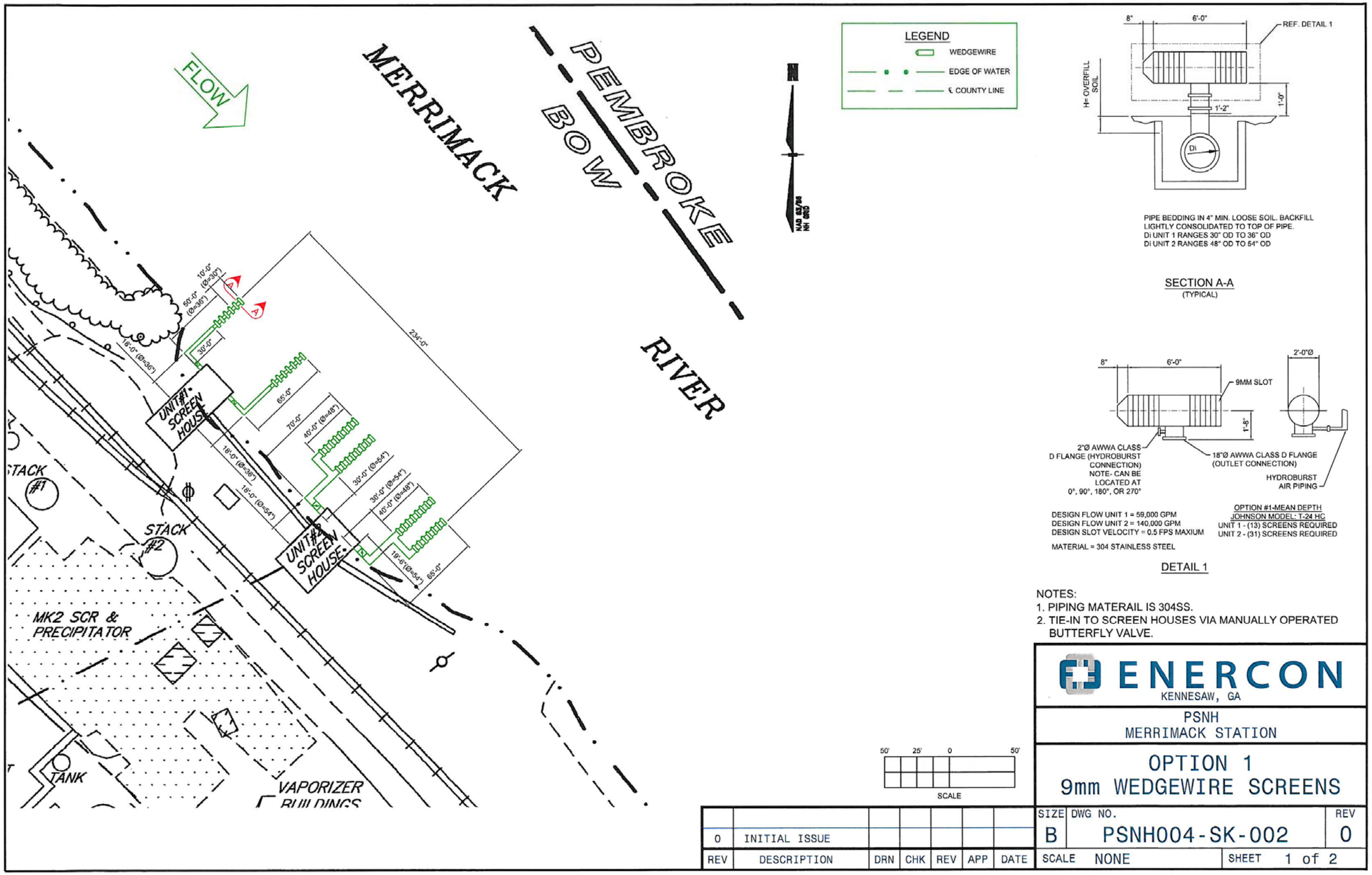
ENERCON
KENNESAW, GA

PSNH
MERRIMACK STATION

OPTION 1
1.5mm WEDGEWIRE SCREENS

REV	DESCRIPTION	DRN	CHK	REV	APP	DATE
0	INITIAL ISSUE					

SIZE	DWG NO.	REV
B	PSNH004-SK-001	0
SCALE NONE	SHEET 2 of 2	


FLOW
MERRIMACK
PEMBROKE
BOW
RIVER
LEGEND
WEDGEWIRE
EDGE OF WATER
℄ COUNTY LINE
NAD 83/86
NH GRID
10'-0" (Ø=30")
50'-0" (Ø=36")
18'-0" (Ø=36")
30'-0"
234'-0"
65'-0"
70'-0"
40'-0" (Ø=48")
30'-0" (Ø=54")
18'-0" (Ø=36")
18'-0" (Ø=54")
30'-0" (Ø=54")
40'-0" (Ø=48")
19'-6" (Ø=54")
65'-0"
UNIT#1 SCREEN HOUSE
UNIT#2 SCREEN HOUSE
STACK #1
STACK #2
MK2 SCR & PRECIPITATOR
TANK
VAPORIZER BUILDINGS
8"
6'-0"
REF. DETAIL 1
H= OVERFILL SOIL
1'-0"
1'-2"
Di
PIPE BEDDING IN 4" MIN. LOOSE SOIL. BACKFILL
LIGHTLY CONSOLIDATED TO TOP OF PIPE.
Di UNIT 1 RANGES 30" OD TO 36" OD
Di UNIT 2 RANGES 48" OD TO 54" OD
SECTION A-A
(TYPICAL)
8"
6'-0"
2'-0"Ø
9MM SLOT
1'-8"
2"Ø AWWA CLASS D FLANGE (HYDROBURST CONNECTION) NOTE- CAN BE LOCATED AT 0°, 90°, 180°, OR 270°
18"Ø AWWA CLASS D FLANGE (OUTLET CONNECTION)
HYDROBURST AIR PIPING
DESIGN FLOW UNIT 1 = 59,000 GPM
DESIGN FLOW UNIT 2 = 140,000 GPM
DESIGN SLOT VELOCITY = 0.5 FPS MAXIUM
MATERIAL = 304 STAINLESS STEEL
OPTION #1-MEAN DEPTH
JOHNSON MODEL: T-24 HC
UNIT 1 - (13) SCREENS REQUIRED
UNIT 2 - (31) SCREENS REQUIRED
DETAIL 1
NOTES:
1. PIPING MATERAIL IS 304SS.
2. TIE-IN TO SCREEN HOUSES VIA MANUALLY OPERATED BUTTERFLY VALVE.
50' 25' 0 50'
SCALE
ENERCON
KENNESAW, GA
PSNH
MERRIMACK STATION
OPTION 1
9mm WEDGEWIRE SCREENS
0 INITIAL ISSUE
REV DESCRIPTION DRN CHK REV APP DATE
SIZE B
DWG NO. PSNH004-SK-002
REV 0
SCALE NONE
SHEET 1 of 2

NOTES:
1. PIPING MATERAIL IS 304SS.

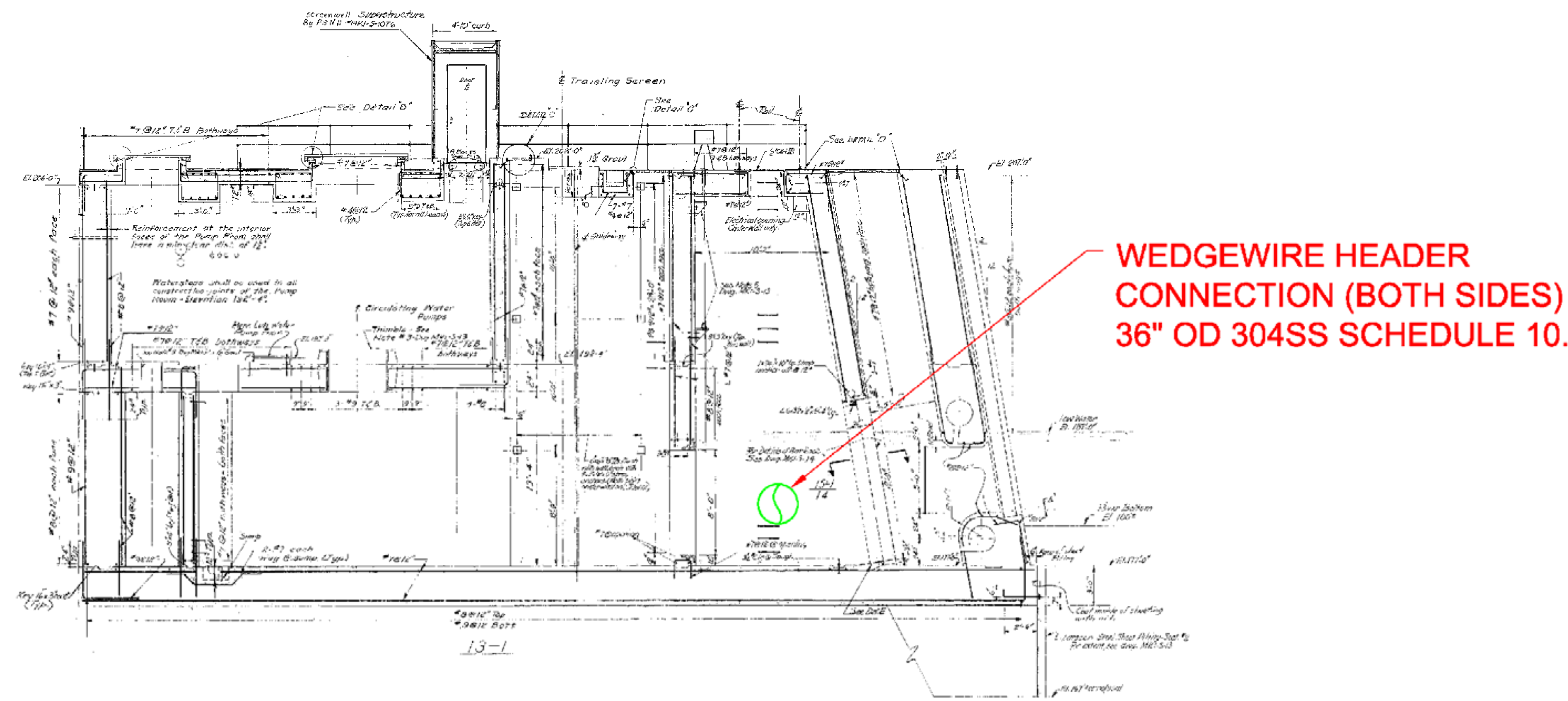
ENERCON
KENNESAW, GA

PSNH
MERRIMACK STATION

OPTION 1
9mm WEDGEWIRE SCREENS

SIZE	DWG NO.	REV
B	PSNH004-SK-002	0
SCALE NONE	SHEET 2 of 2	

REV	DESCRIPTION	DRN	CHK	REV	APP	DATE
0	INITIAL ISSUE					



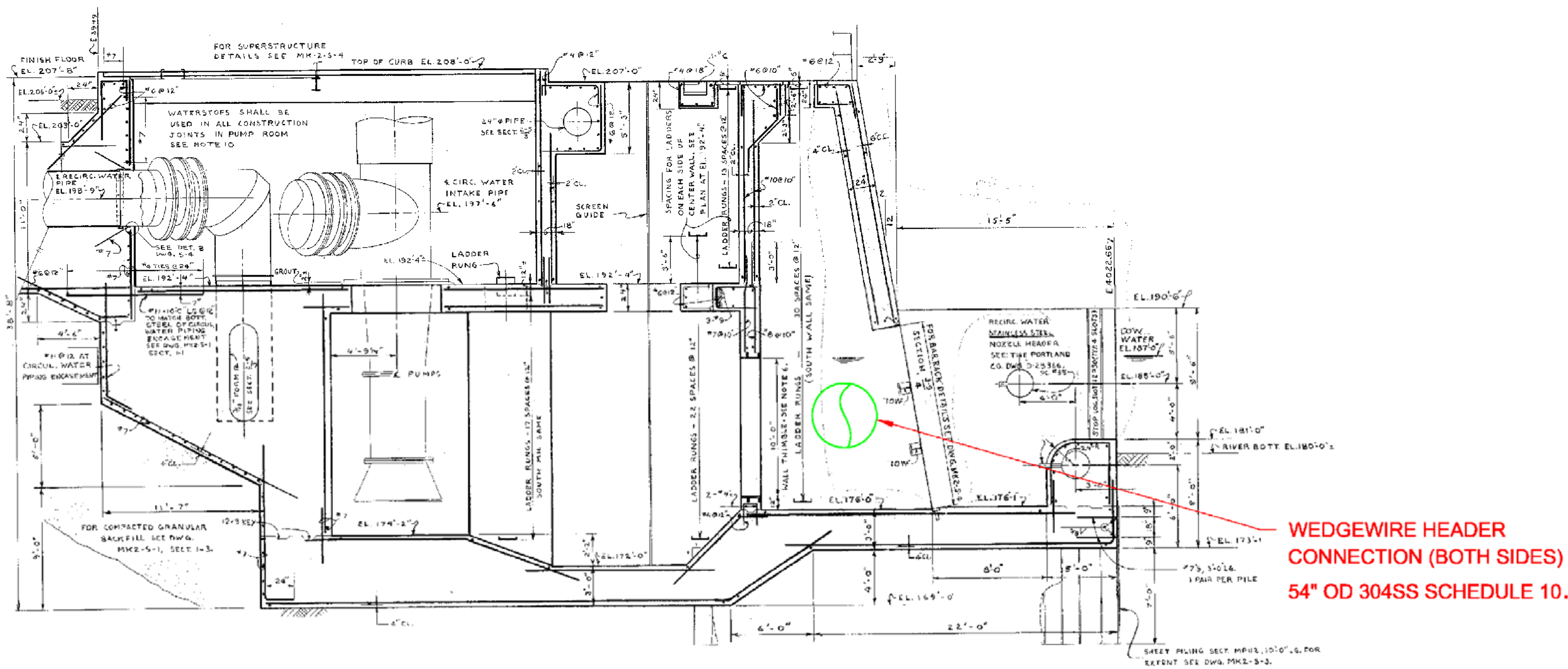
ENERCON
KENNESAW, GA

PSNH
MERRIMACK STATION

WEDGEWIRE CONNECTION
TO SCREEN HOUSE #1

REV	DESCRIPTION	DRN	CHK	REV	APP	DATE
0	INITIAL ISSUE					

SIZE	DWG NO.	REV
B	PSNH004-SK-003	0
SCALE NONE	SHEET 1 of 1	



ENERCON
KENNESAW, GA

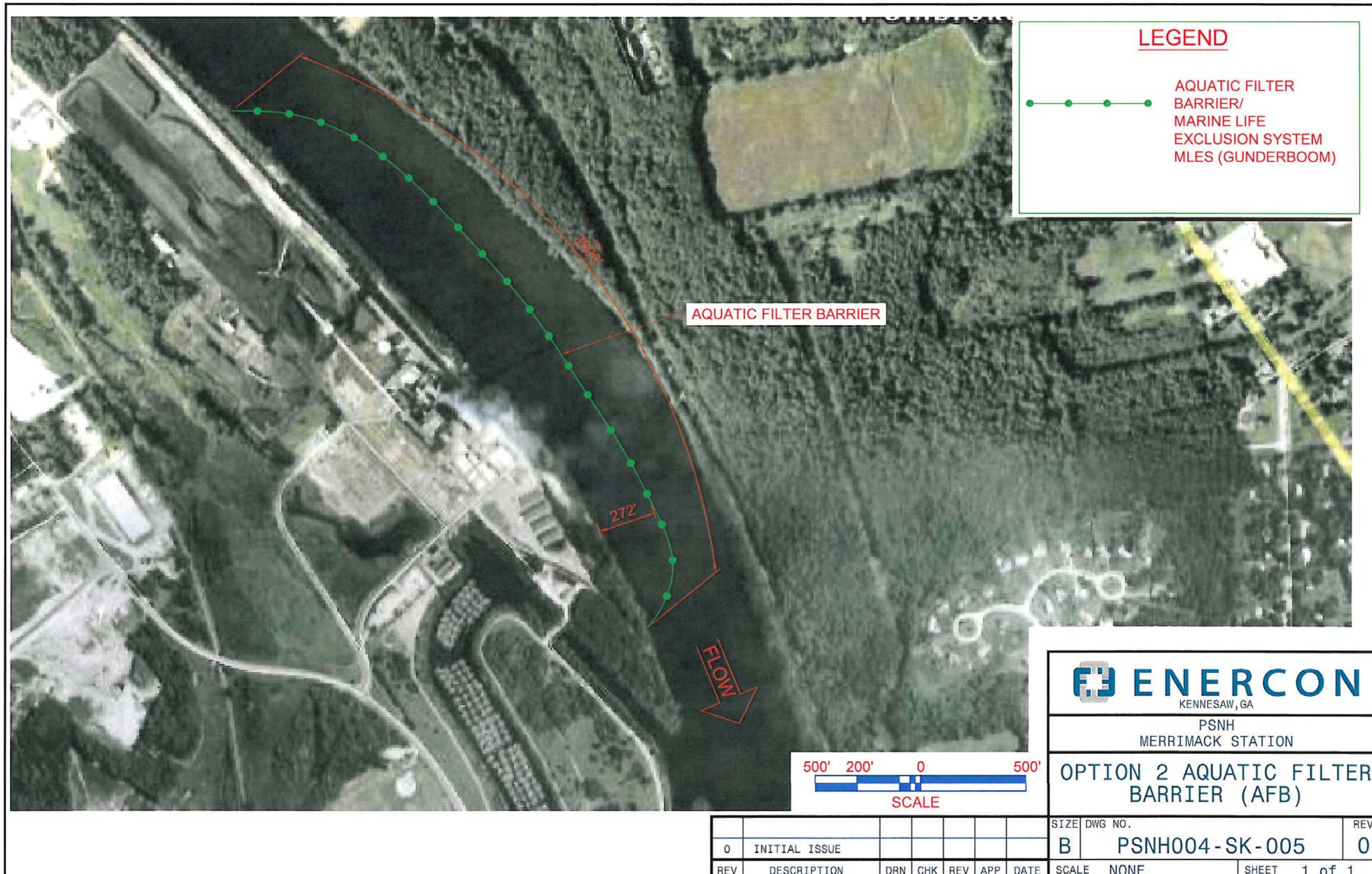
PNSH
MERRIMACK STATION

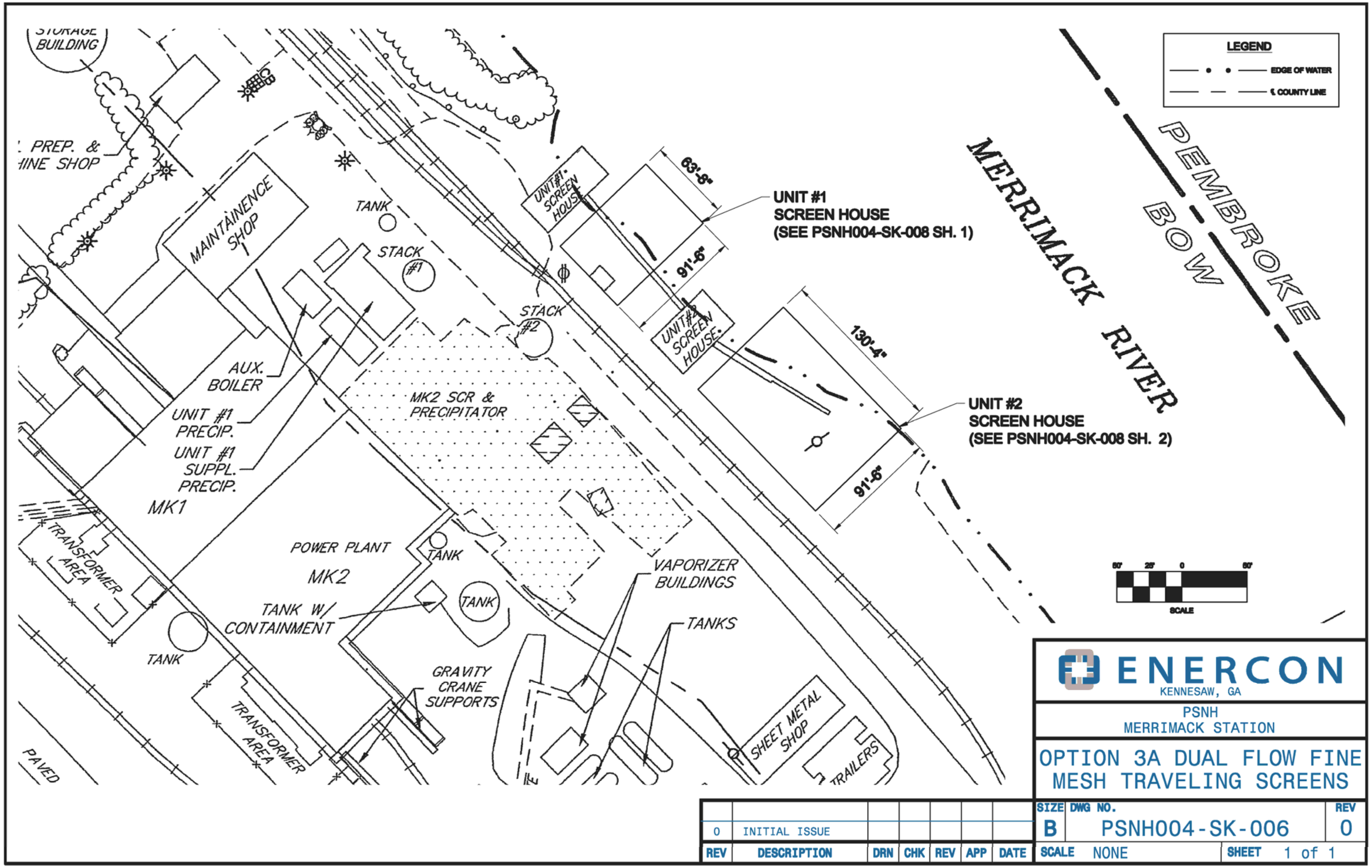
WEDGEWIRE CONNECTION
TO SCREEN HOUSE #2

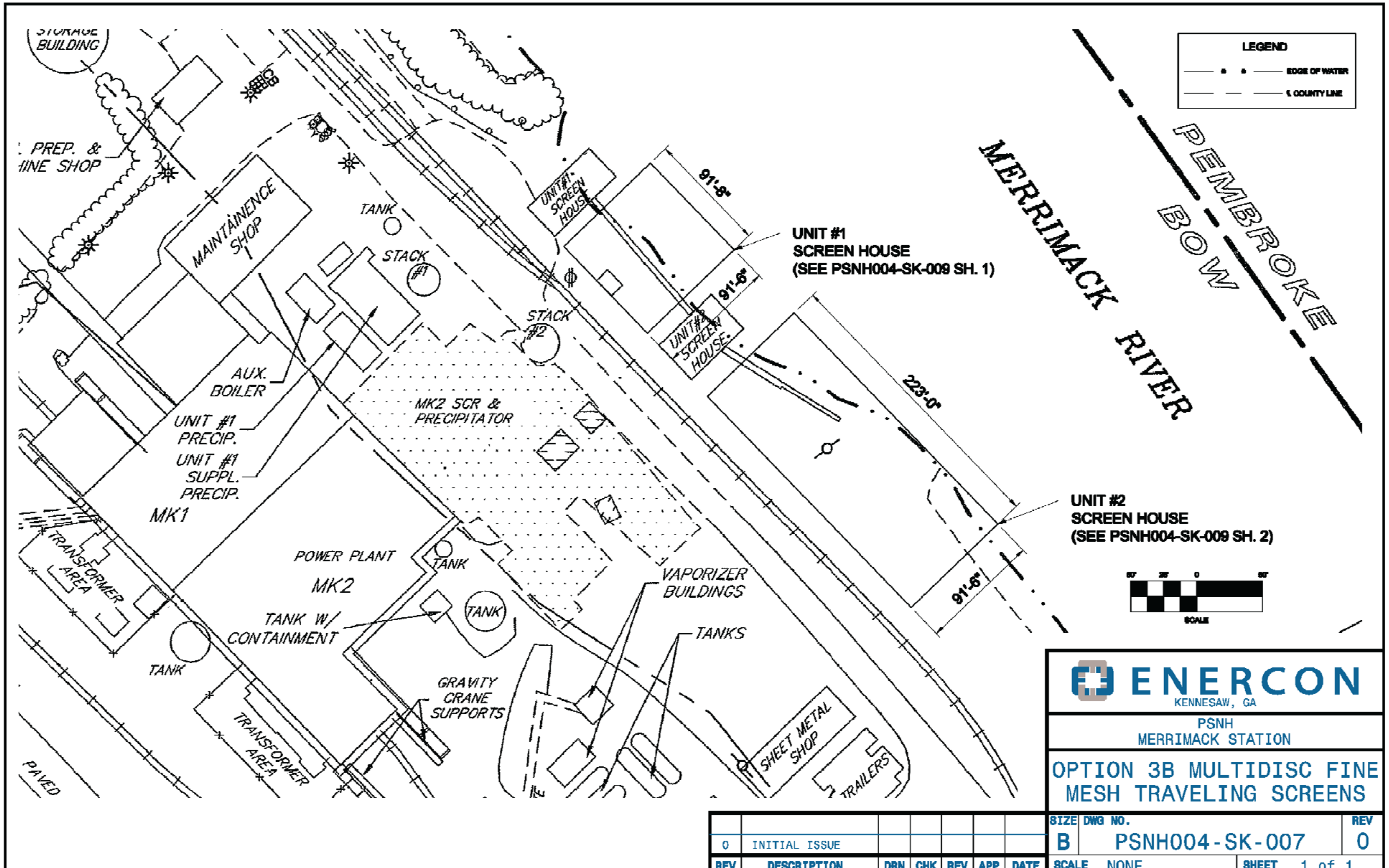
REV	DESCRIPTION	DRN	CHK	REV	APP	DATE
0	INITIAL ISSUE					

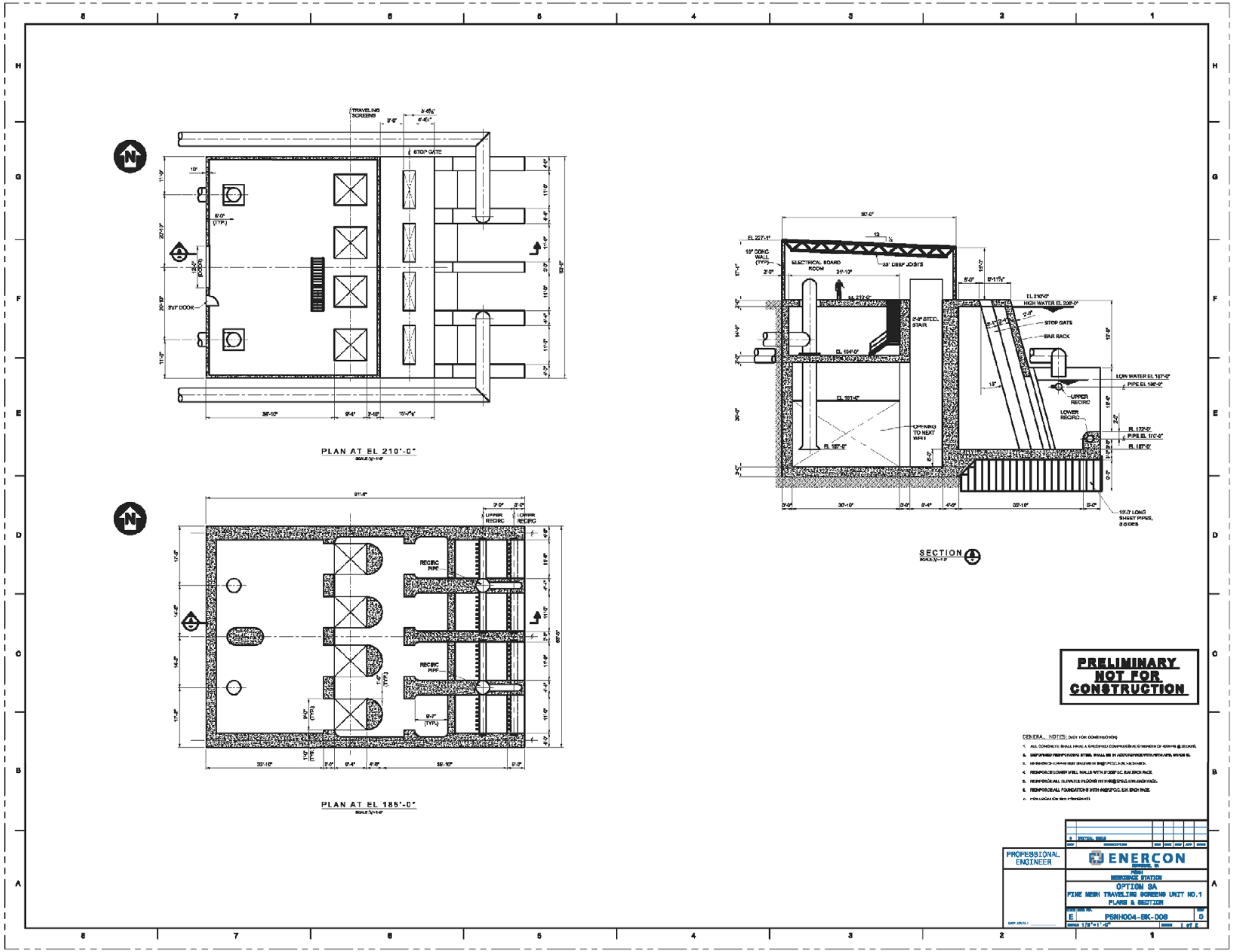
SIZE	DWG NO.	REV
B	PSNH004-SK-004	0

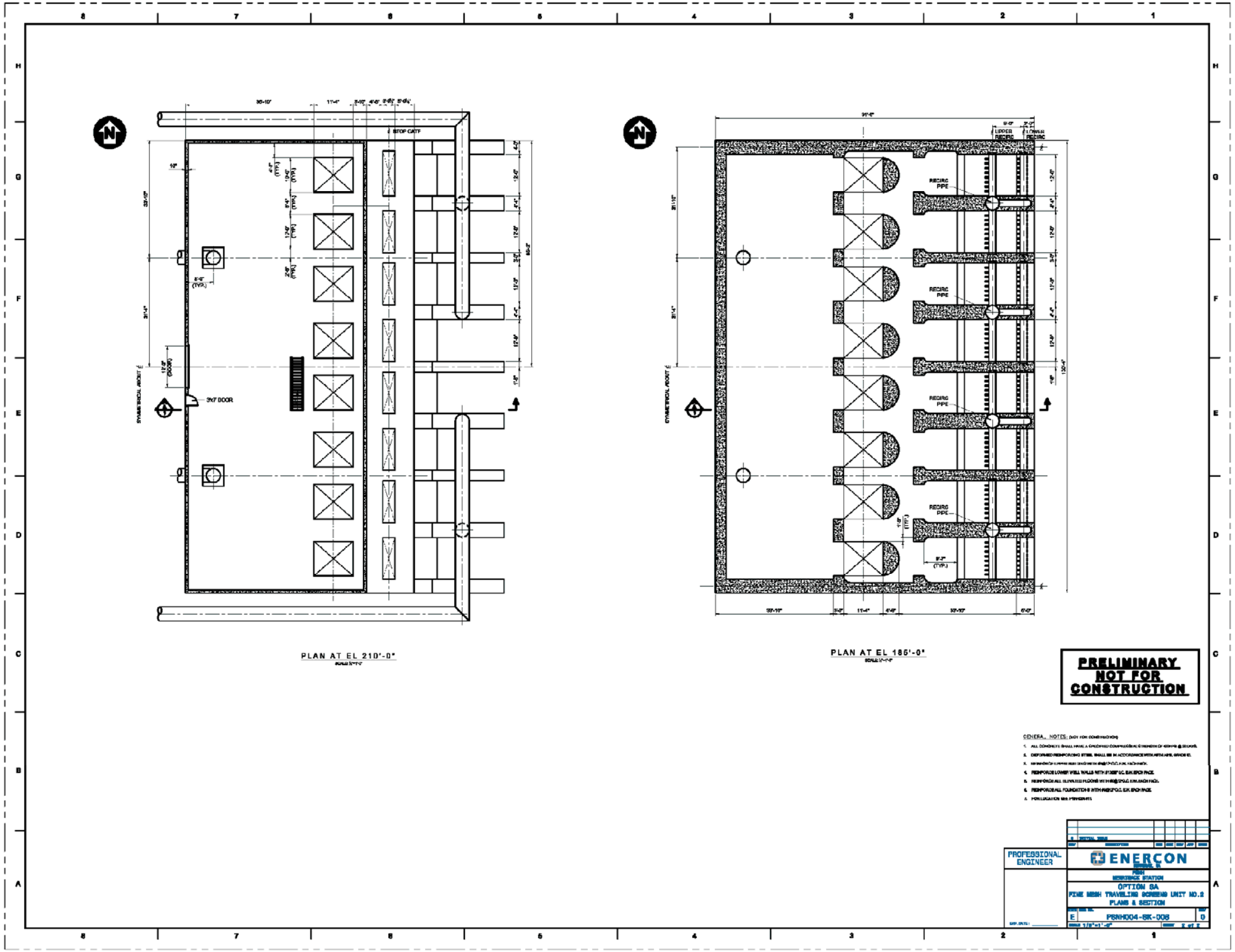
SCALE NONE SHEET 1 of 1

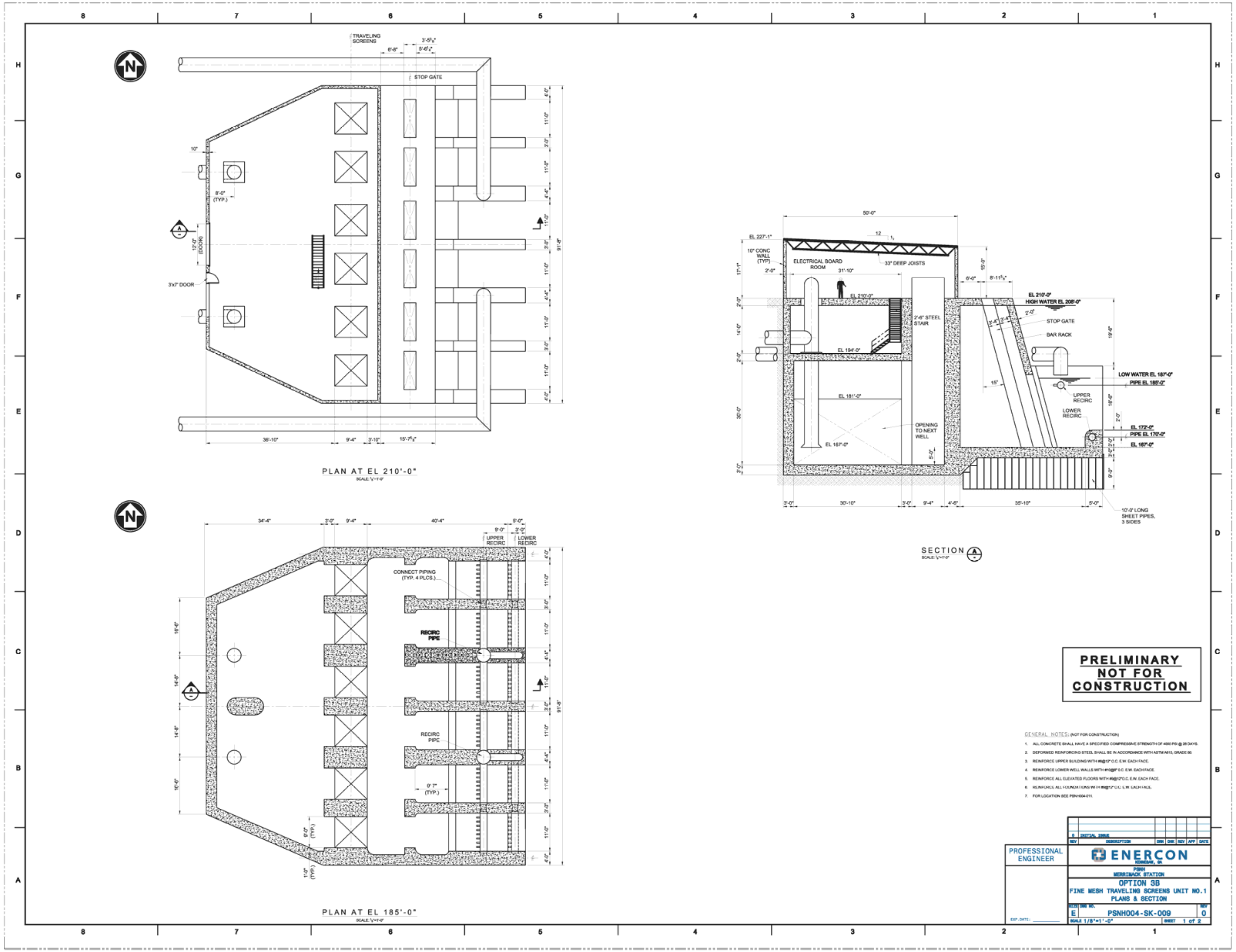

LEGEND
AQUATIC FILTER BARRIER/ MARINE LIFE EXCLUSION SYSTEM MLES (GUNDERBOOM)
AQUATIC FILTER BARRIER
272'
FLOW
500' 200' 0 500'
SCALE
ENERCON
KENNESAW, GA
PSNH
MERRIMACK STATION
OPTION 2 AQUATIC FILTER BARRIER (AFB)
SIZE B
DWG NO. PSNH004-SK-005
REV 0
SCALE NONE
SHEET 1 of 1
0 INITIAL ISSUE
REV DESCRIPTION DRN CHK REV APP DATE

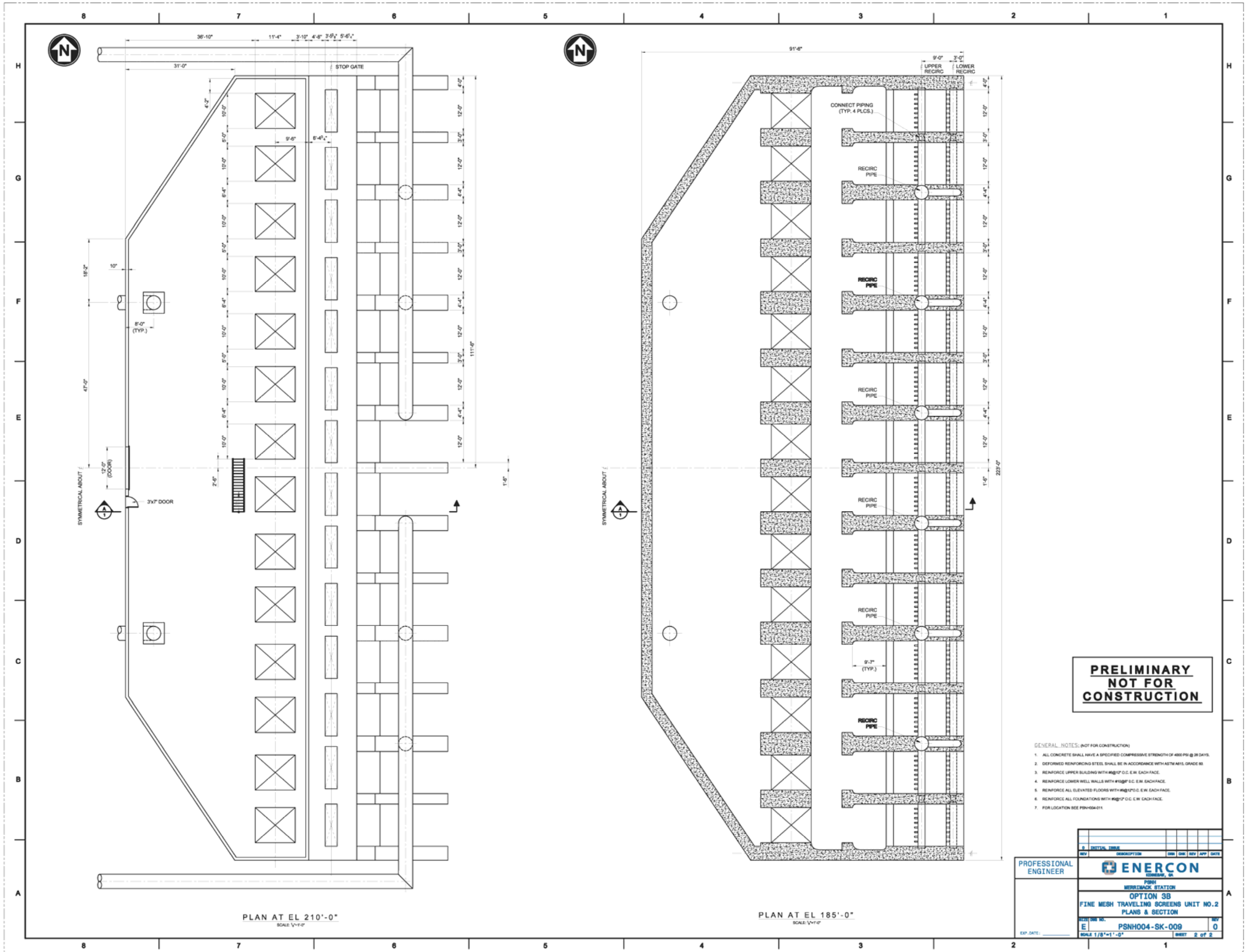

LEGEND
EDGE OF WATER
℄ COUNTY LINE
STORAGE BUILDING
PREP. & HINE SHOP
MAINTAINENCE SHOP
TANK
STACK #1
STACK #2
UNIT #1 SCREEN HOUSE
63'-8"
91'-6"
UNIT #1
SCREEN HOUSE
(SEE PSNH004-SK-008 SH. 1)
UNIT #2 SCREEN HOUSE
130'-4"
91'-6"
UNIT #2
SCREEN HOUSE
(SEE PSNH004-SK-008 SH. 2)
MERRIMACK RIVER
PEMBROKE
BOW
AUX. BOILER
UNIT #1 PRECIP.
UNIT #1 SUPPL. PRECIP.
MK2 SCR & PRECIPITATOR
MK1
TRANSFORMER AREA
POWER PLANT
MK2
TANK
TANK W/ CONTAINMENT
VAPORIZER BUILDINGS
TANKS
GRAVITY CRANE SUPPORTS
SHEET METAL SHOP
TRAILERS
PAVED
SCALE
ENERCON
KENNESAW, GA
PSNH
MERRIMACK STATION
OPTION 3A DUAL FLOW FINE MESH TRAVELING SCREENS
SIZE B
DWG NO. PSNH004-SK-006
REV 0
SCALE NONE
SHEET 1 of 1
0 INITIAL ISSUE
REV DESCRIPTION DRN CHK REV APP DATE


STORAGE BUILDING
PREP. & INE SHOP
MAINTAINENCE SHOP
TANK
STACK #1
STACK #2
AUX. BOILER
UNIT #1 PRECIP.
UNIT #1 SUPPL. PRECIP.
MK1
MK2 SCR & PRECIPITATOR
POWER PLANT
MK2
TANK
TANK W/ CONTAINMENT
TANK
TRANSFORMER AREA
TRANSFORMER AREA
PAVED
GRAVITY CRANE SUPPORTS
VAPORIZER BUILDINGS
TANKS
SHEET METAL SHOP
TRAILERS
UNIT#1 SCREEN HOUSE
UNIT#2 SCREEN HOUSE
91'-6"
91'-6"
223'-0"
91'-6"
UNIT #1
SCREEN HOUSE
(SEE PSNH004-SK-009 SH. 1)
UNIT #2
SCREEN HOUSE
(SEE PSNH004-SK-009 SH. 2)
MERRIMACK RIVER
PEMBROKE
BOW
LEGEND
EDGE OF WATER
COUNTY LINE
SCALE
ENERCON
KENNESAW, GA
PSNH
MERRIMACK STATION
OPTION 3B MULTIDISC FINE MESH TRAVELING SCREENS
SIZE B
DWG NO. PSNH004-SK-007
REV 0
SCALE NONE
SHEET 1 of 1
0 INITIAL ISSUE
REV DESCRIPTION DRN CHK REV APP DATE


PLAN AT EL 210'-0"
PLAN AT EL 185'-0"
SECTION
PRELIMINARY NOT FOR CONSTRUCTION
PROFESSIONAL ENGINEER
ENERCON
OPTION 5A
FINE MESH TRAVELING SCREENS UNIT NO.1
PLANS & SECTION
E
PSNH004-SK-006
0
1/8"=1'-0"
1 of 2


PLAN AT EL 210'-0"
3'x7' DOOR
STOP GATE
PLAN AT EL 185'-0"
RECIRC PIPE
UPPER RECIRC
LOWER RECIRC
PRELIMINARY NOT FOR CONSTRUCTION
GENERAL NOTES:
PROFESSIONAL ENGINEER
ENERCON
PSNH
MERRIMACK STATION
OPTION 8A
FINE MESH TRAVELING SCREENS UNIT NO.2
PLANS & SECTION
E
PSNH004-SK-008
0


PLAN AT EL 210'-0"
PLAN AT EL 185'-0"
SECTION A
PRELIMINARY NOT FOR CONSTRUCTION
TRAVELING SCREENS
STOP GATE
ELECTRICAL BOARD ROOM
33" DEEP JOISTS
2'-6" STEEL STAIR
HIGH WATER EL 208'-0"
BAR RACK
LOW WATER EL 187'-0"
UPPER RECIRC
LOWER RECIRC
OPENING TO NEXT WELL
10'-0" LONG SHEET PIPES, 3 SIDES
CONNECT PIPING (TYP. 4 PLCS.)
RECIRC PIPE
GENERAL NOTES:
PROFESSIONAL ENGINEER
ENERCON
PSNH MERRIMACK STATION
OPTION 3B
FINE MESH TRAVELING SCREENS UNIT NO.1 PLANS & SECTION
PSNH004-SK-009


STOP GATE
3'x7' DOOR
SYMMETRICAL ABOUT
PLAN AT EL 210'-0"
CONNECT PIPING (TYP. 4 PLCS.)
RECIRC PIPE
UPPER RECIRC
LOWER RECIRC
PLAN AT EL 185'-0"
PRELIMINARY NOT FOR CONSTRUCTION
GENERAL NOTES: (NOT FOR CONSTRUCTION)
1. ALL CONCRETE SHALL HAVE A SPECIFIED COMPRESSIVE STRENGTH OF 4000 PSI @ 28 DAYS.
2. DEFORMED REINFORCING STEEL SHALL BE IN ACCORDANCE WITH ASTM A615, GRADE 60.
3. REINFORCE UPPER BUILDING WITH #6@12" O.C. E.W. EACH FACE.
4. REINFORCE LOWER WELL WALLS WITH #10@8" O.C. E.W. EACH FACE.
5. REINFORCE ALL ELEVATED FLOORS WITH #6@12" O.C. E.W. EACH FACE.
6. REINFORCE ALL FOUNDATIONS WITH #9@12" O.C. E.W. EACH FACE.
7. FOR LOCATION SEE PSNH004-011.
0 INITIAL ISSUE
REV DESCRIPTION DRN CHK REV APP DATE
PROFESSIONAL ENGINEER
ENERCON KENNESAW, GA
PSNH MERRIMACK STATION
OPTION 3B
FINE MESH TRAVELING SCREENS UNIT NO.2
PLANS & SECTION
SIZE E DWG NO. PSNH004-SK-009 REV 0
SCALE 1/8"=1'-0" SHEET 2 of 2
EXP. DATE:

Attachment B

Schedules

B1: Option 1 - Schedule for Wedgewire Screens

B2: Option 2 - Schedule for Aquatic Filter Barrier

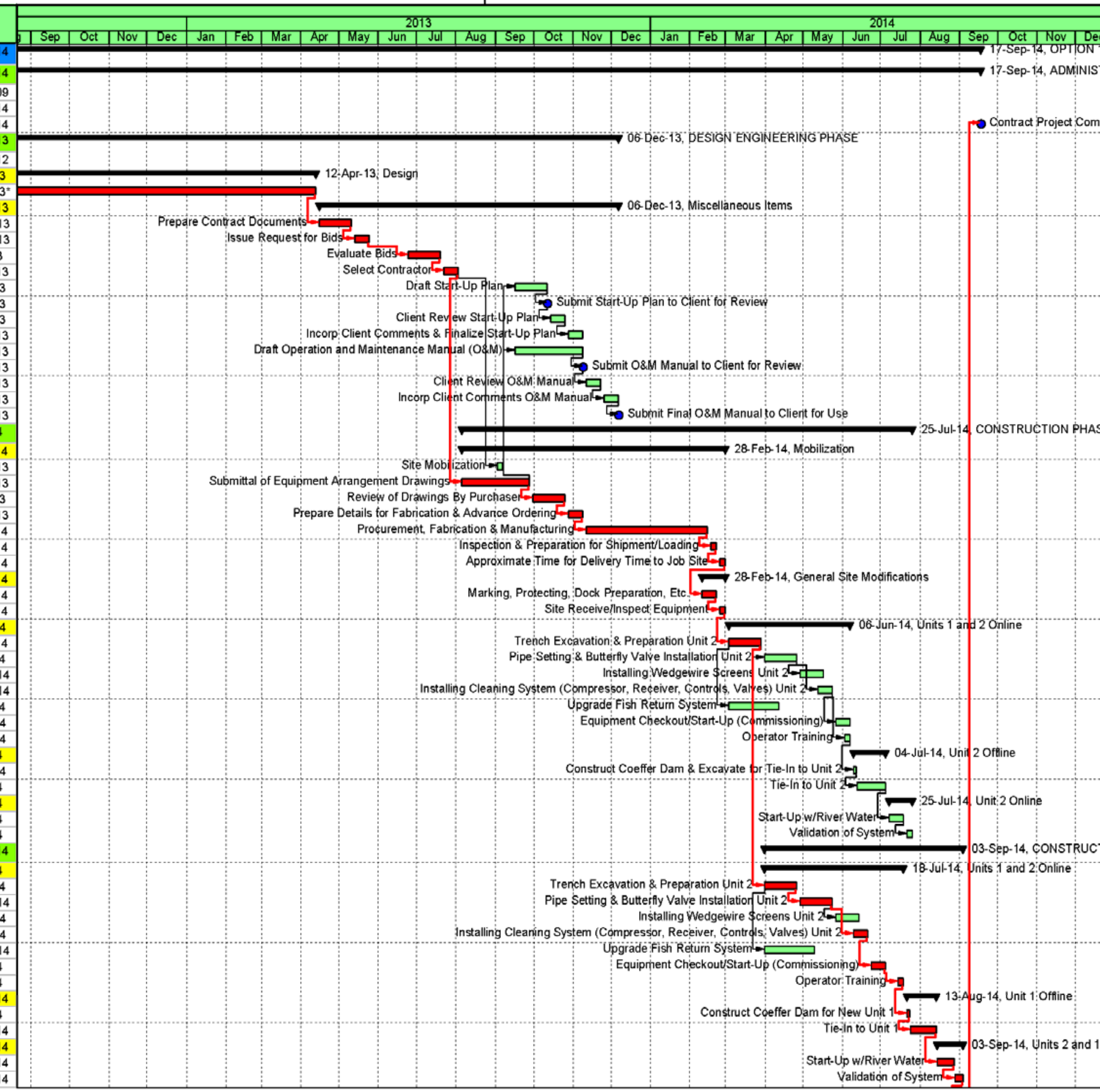
B3: Option 3a - Schedule for Dual Flow Fine Mesh Traveling Screens

B4: Option 3b - Schedule for MulitDisc® Fine Mesh Traveling Screens

Attachment B1: Option 1 - Schedule for Wedgewire Screens

OPTION 1 - Wedgewires - S Beaver | Classic WBS Layout | 02-Sep-09 08:41

Activity ID	Activity Name	Physical % Complete	Remaining Duration	Start	Finish
OPTION 1 - Wedgewires - S Beaver			1334	03-Aug-09	17-Sep-14
ADMINISTRATION			1334	03-Aug-09	17-Sep-14
CA	Contract Award	0%	0		03-Aug-09
DISC	Mechanical	0%	1334	03-Aug-09	17-Sep-14
EOP	Contract Project Completion	0%	0		17-Sep-14
DESIGN ENGINEERING PHASE			1131	03-Aug-09	06-Dec-13
A1540	Site Engineering Data Acquisition Study	0%	781	03-Aug-09	03-Aug-12
Design			180	06-Aug-12	12-Apr-13
A1000	Prepare Design	0%	180	06-Aug-12	12-Apr-13*
Miscellaneous Items			170	15-Apr-13	06-Dec-13
A1170	Prepare Contract Documents	0%	20	15-Apr-13	10-May-13
A1180	Issue Request for Bids	0%	10	13-May-13	24-May-13
A1190	Evaluate Bids	0%	20	24-Jun-13	19-Jul-13
A1200	Select Contractor	0%	10	22-Jul-13	02-Aug-13
A1210	Draft Start-Up Plan	0%	20	16-Sep-13	11-Oct-13
A1220	Submit Start-Up Plan to Client for Review	0%	0		11-Oct-13
A1230	Client Review Start-Up Plan	0%	10	14-Oct-13	25-Oct-13
A1235	Incorp Client Comments & Finalize Start-Up Plan	0%	10	28-Oct-13	08-Nov-13
A1240	Draft Operation and Maintenance Manual (O&M)	0%	40	16-Sep-13	08-Nov-13
A1250	Submit O&M Manual to Client for Review	0%	0		08-Nov-13
A1260	Client Review O&M Manual	0%	10	11-Nov-13	22-Nov-13
A1270	Incorp Client Comments O&M Manual	0%	10	25-Nov-13	06-Dec-13
A1280	Submit Final O&M Manual to Client for Use	0%	0		06-Dec-13
CONSTRUCTION PHASE - UNIT 2			255	05-Aug-13	25-Jul-14
Mobilization			150	05-Aug-13	28-Feb-14
A1290	Site Mobilization	0%	5	02-Sep-13	06-Sep-13
A1300	Submittal of Equipment Arrangement Drawings	0%	40	05-Aug-13	27-Sep-13
A1310	Review of Drawings By Purchaser	0%	20	30-Sep-13	25-Oct-13
A1320	Prepare Details for Fabrication & Advance Ordering	0%	10	28-Oct-13	08-Nov-13
A1330	Procurement, Fabrication & Manufacturing	0%	70	11-Nov-13	14-Feb-14
A1340	Inspection & Preparation for Shipment/Loading	0%	5	17-Feb-14	21-Feb-14
A1350	Approximate Time for Delivery Time to Job Site	0%	5	24-Feb-14	28-Feb-14
General Site Modifications			15	10-Feb-14	28-Feb-14
A1365	Marking, Protecting, Dock Preparation, Etc.	0%	10	10-Feb-14	21-Feb-14
A1366	Site Receive/Inspect Equipment	0%	5	24-Feb-14	28-Feb-14
Units 1 and 2 Online			70	03-Mar-14	06-Jun-14
A1370	Trench Excavation & Preparation Unit 2	0%	20	03-Mar-14	28-Mar-14
A1380	Pipe Setting & Butterfly Valve Installation Unit 2	0%	20	31-Mar-14	25-Apr-14
A1390	Installing Wedgewire Screens Unit 2	0%	15	28-Apr-14	16-May-14
A1400	Installing Cleaning System (Compressor, Receiver, Controls, Valves) Unit 2	0%	10	12-May-14	23-May-14
A1401	Upgrade Fish Return System	0%	30	03-Mar-14	11-Apr-14
A1410	Equipment Checkout/Start-Up (Commissioning)	0%	10	26-May-14	06-Jun-14
A1415	Operator Training	0%	5	02-Jun-14	06-Jun-14
Unit 2 Offline			20	09-Jun-14	04-Jul-14
A1420	Construct Coeffer Dam & Excavate for Tie-In to Unit 2	0%	3	09-Jun-14	11-Jun-14
A1421	Tie-In to Unit 2	0%	17	12-Jun-14	04-Jul-14
Unit 2 Online			15	07-Jul-14	25-Jul-14
A1430	Start-Up w/River Water	0%	10	07-Jul-14	18-Jul-14
A1440	Validation of System	0%	5	21-Jul-14	25-Jul-14
CONSTRUCTION PHASE - UNIT 1			113	31-Mar-14	03-Sep-14
Units 1 and 2 Online			80	31-Mar-14	18-Jul-14
A1450	Trench Excavation & Preparation Unit 2	0%	20	31-Mar-14	25-Apr-14
A1460	Pipe Setting & Butterfly Valve Installation Unit 2	0%	20	28-Apr-14	23-May-14
A1470	Installing Wedgewire Screens Unit 2	0%	15	26-May-14	13-Jun-14
A1480	Installing Cleaning System (Compressor, Receiver, Controls, Valves) Unit 2	0%	10	09-Jun-14	20-Jun-14
A1485	Upgrade Fish Return System	0%	30	31-Mar-14	09-May-14
A1490	Equipment Checkout/Start-Up (Commissioning)	0%	10	23-Jun-14	04-Jul-14
A1495	Operator Training	0%	5	14-Jul-14	18-Jul-14
Unit 1 Offline			18	21-Jul-14	13-Aug-14
A1500	Construct Coeffer Dam for New Unit 1	0%	3	21-Jul-14	23-Jul-14
A1501	Tie-In to Unit 1	0%	15	24-Jul-14	13-Aug-14
Units 2 and 1 Online			15	14-Aug-14	03-Sep-14
A1510	Start-Up w/River Water	0%	10	14-Aug-14	27-Aug-14
A1520	Validation of System	0%	5	28-Aug-14	03-Sep-14



Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

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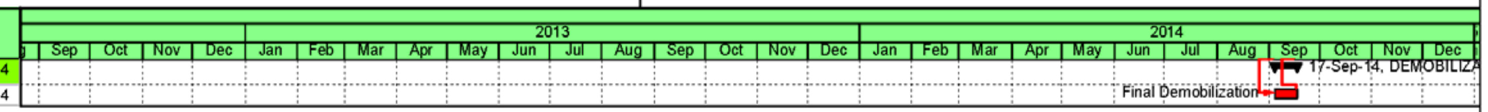
TASK filters: In Progress, Not Started.

Attachment B1: Option 1 - Schedule for Wedgewire Screens

OPTION 1 - Wedgewires - S Beaver | Classic WBS Layout | 02-Sep-09 08:41

Activity ID	Activity Name	Physical % Complete	Remaining Duration	Start	Finish
DEMOBILIZATION PLANS			10	04-Sep-14	17-Sep-14
A1580	Final Demobilization	0%	10	04-Sep-14	17-Sep-14



Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

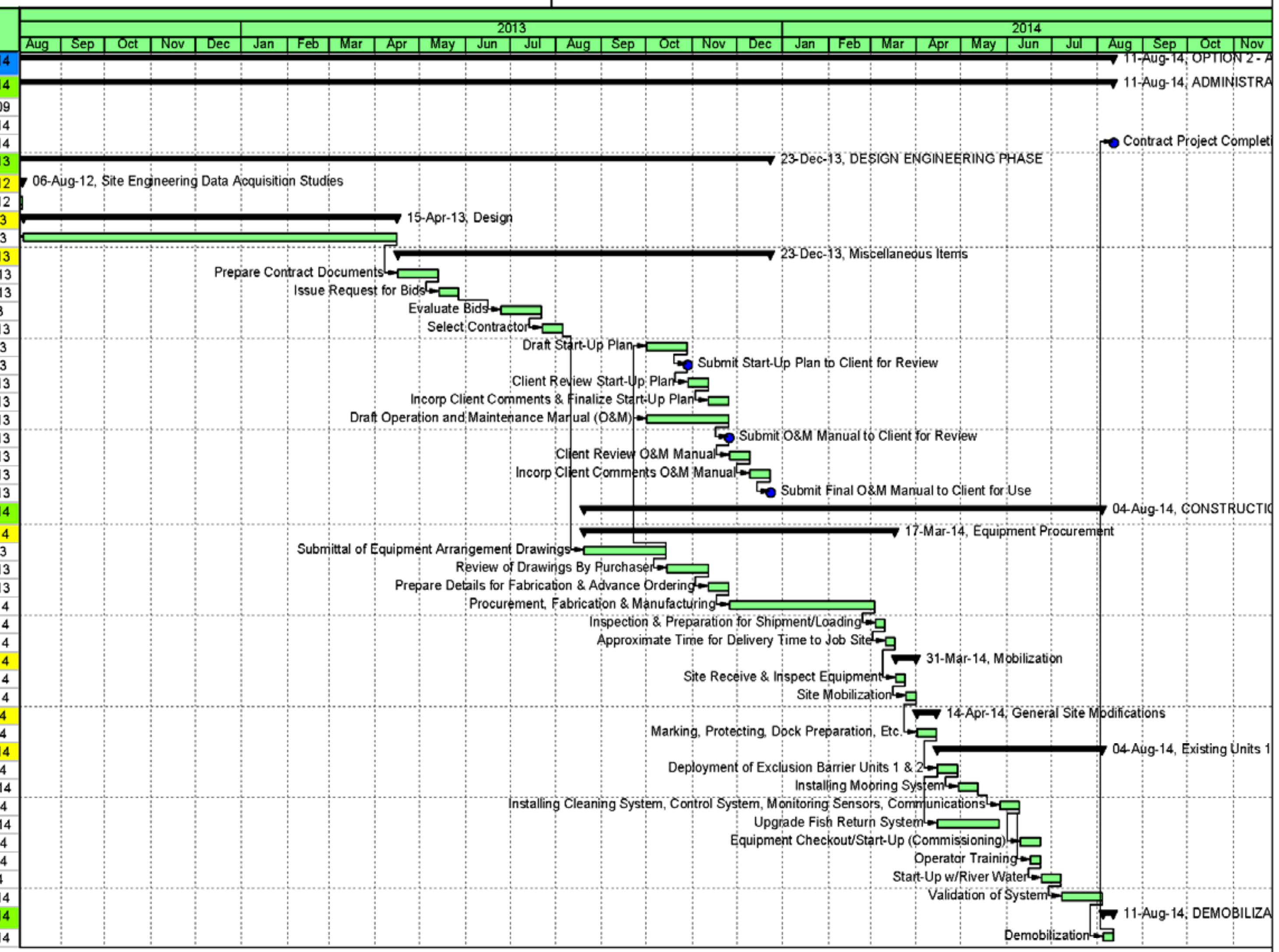
Page 2 of 2

TASK filters: In Progress, Not Started.

Attachment B2: Option 2 - Schedule for Aquatic Filter Barrier

OPTION 2 - Aquatic Filter Barrier - S Beaver | Classic WBS Layout | 02-Sep-09 08:41

Activity ID	Activity Name	Physical % Complete	Remaining Duration	Start	Finish
OPTION 2 - Aquatic Filter Barrier - S Beaver			1307	03-Aug-09	11-Aug-14
ADMINISTRATION			1307	03-Aug-09	11-Aug-14
CA	Contract Award	0%	0		03-Aug-09
DISC	Mechanical	0%	1307	03-Aug-09	11-Aug-14
EOP	Contract Project Completion	0%	0		11-Aug-14
DESIGN ENGINEERING PHASE			1142	03-Aug-09	23-Dec-13
Site Engineering Data Acquisition Studies			782	03-Aug-09	06-Aug-12
A1290	Site Engineering Data Acquisition Studies	0%	782	03-Aug-09	06-Aug-12
Design			180	07-Aug-12	15-Apr-13
A1000	Prepare Design	0%	180	07-Aug-12	15-Apr-13
Miscellaneous Items			180	16-Apr-13	23-Dec-13
A1170	Prepare Contract Documents	0%	20	16-Apr-13	13-May-13
A1180	Issue Request for Bids	0%	10	14-May-13	27-May-13
A1190	Evaluate Bids	0%	20	25-Jun-13	22-Jul-13
A1200	Select Contractor	0%	10	23-Jul-13	05-Aug-13
A1210	Draft Start-Up Plan	0%	20	01-Oct-13	28-Oct-13
A1220	Submit Start-Up Plan to Client for Review	0%	0		28-Oct-13
A1230	Client Review Start-Up Plan	0%	10	29-Oct-13	11-Nov-13
A1235	Incorp Client Comments & Finalize Start-Up Plan	0%	10	12-Nov-13	25-Nov-13
A1240	Draft Operation and Maintenance Manual (O&M)	0%	40	01-Oct-13	25-Nov-13
A1250	Submit O&M Manual to Client for Review	0%	0		25-Nov-13
A1260	Client Review O&M Manual	0%	10	26-Nov-13	09-Dec-13
A1270	Incorp Client Comments O&M Manual	0%	10	10-Dec-13	23-Dec-13
A1280	Submit Final O&M Manual to Client for Use	0%	0		23-Dec-13
CONSTRUCTION PHASE - UNITS 1 & 2			250	20-Aug-13	04-Aug-14
Equipment Procurement			150	20-Aug-13	17-Mar-14
A1310	Submittal of Equipment Arrangement Drawings	0%	40	20-Aug-13	14-Oct-13
A1320	Review of Drawings By Purchaser	0%	20	15-Oct-13	11-Nov-13
A1330	Prepare Details for Fabrication & Advance Ordering	0%	10	12-Nov-13	25-Nov-13
A1340	Procurement, Fabrication & Manufacturing	0%	70	26-Nov-13	03-Mar-14
A1350	Inspection & Preparation for Shipment/Loading	0%	5	04-Mar-14	10-Mar-14
A1360	Approximate Time for Delivery Time to Job Site	0%	5	11-Mar-14	17-Mar-14
Mobilization			10	18-Mar-14	31-Mar-14
A1295	Site Receive & Inspect Equipment	0%	5	18-Mar-14	24-Mar-14
A1300	Site Mobilization	0%	5	25-Mar-14	31-Mar-14
General Site Modifications			10	01-Apr-14	14-Apr-14
A1370	Marking, Protecting, Dock Preparation, Etc.	0%	10	01-Apr-14	14-Apr-14
Existing Units 1 & 2 Online			80	15-Apr-14	04-Aug-14
A1380	Deployment of Exclusion Barrier Units 1 & 2	0%	10	15-Apr-14	28-Apr-14
A1390	Installing Mooring System	0%	10	29-Apr-14	12-May-14
A1400	Installing Cleaning System, Control System, Monitoring Sensors, Commun...	0%	10	27-May-14	09-Jun-14
A1401	Upgrade Fish Return System	0%	30	15-Apr-14	26-May-14
A1410	Equipment Checkout/Start-Up (Commissioning)	0%	10	10-Jun-14	23-Jun-14
A1420	Operator Training	0%	5	17-Jun-14	23-Jun-14
A1430	Start-Up w/River Water	0%	10	24-Jun-14	07-Jul-14
A1440	Validation of System	0%	20	08-Jul-14	04-Aug-14
DEMOBILIZATION			5	05-Aug-14	11-Aug-14
A1450	Demobilization	0%	5	05-Aug-14	11-Aug-14



Actual Work | Remaining Work | Critical Remaining Work | Milestone | Summary

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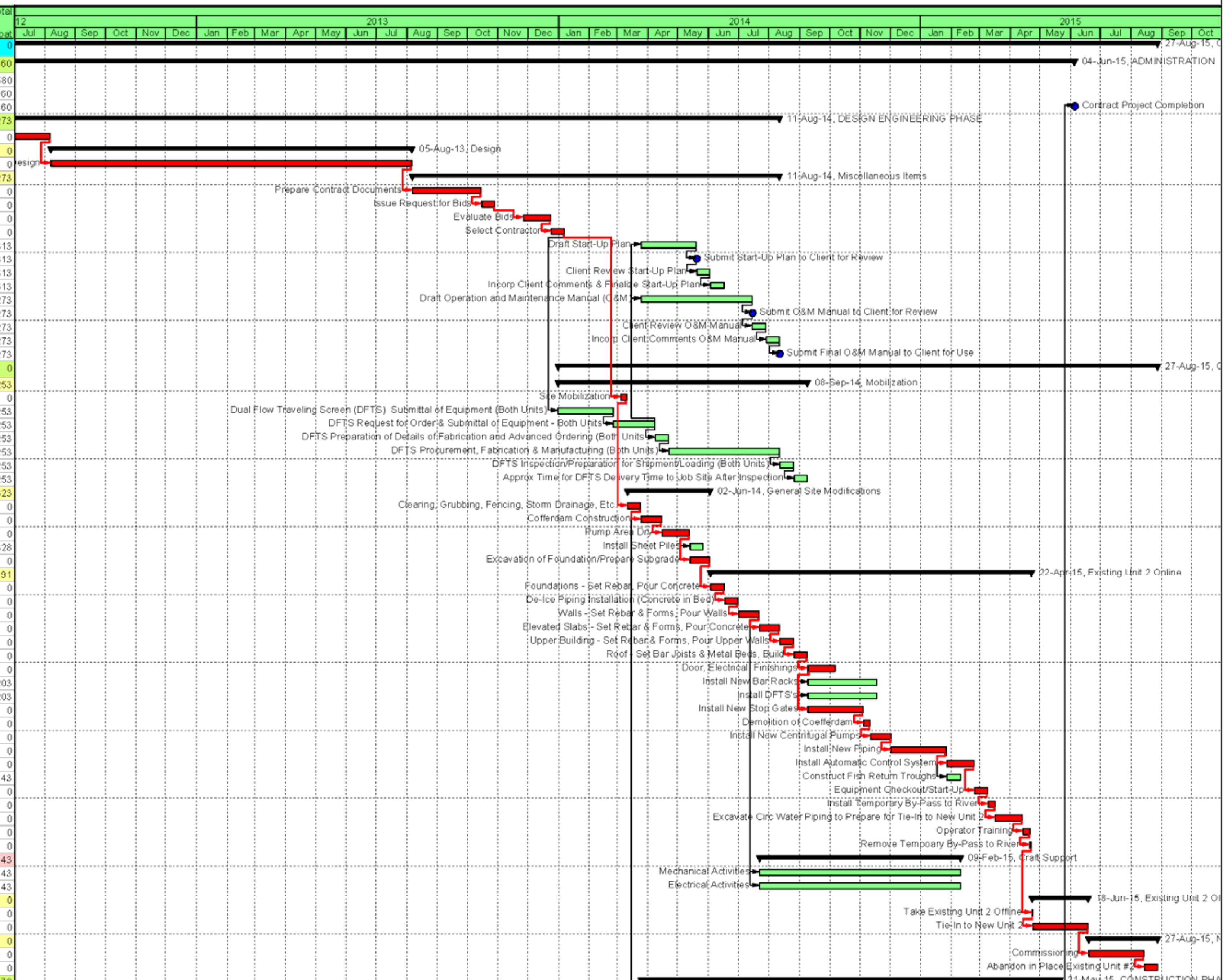
TASK filters: In Progress, Not Started.

ENERCON

Attachment B3: Option 3a - Schedule for Dual Flow Fine Mesh Traveling Screens

Activity ID	Activity Name	Physical % Complete	Remaining Duration	Start	Finish	Total Float
OPTION 3A - Dual Flow Fine Mesh Traveling Screens - S ...			1580	03-Aug-09	27-Aug-15	0
ADMINISTRATION			1520	03-Aug-09	04-Jun-15	60
CA	Contract Award	0%	0		03-Aug-09	1580
DISC	Mechanical	0%	1520	03-Aug-09	04-Jun-15	60
EOP	Contract Project Completion	0%	0		04-Jun-15	60
DESIGN ENGINEERING PHASE			1307	03-Aug-09	11-Aug-14	273
A1850	Site Engineering/Data Acquisition Study	0%	782	03-Aug-09	06-Aug-12	0
Design			260	07-Aug-12	05-Aug-13	0
A1000	Prepare Design	0%	260	07-Aug-12	05-Aug-13	0
Miscellaneous Items			265	06-Aug-13	11-Aug-14	273
A1170	Prepare Contract Documents	0%	50	06-Aug-13	14-Oct-13	0
A1180	Issue Request for Bids	0%	10	15-Oct-13	28-Oct-13	0
A1190	Evaluate Bids	0%	20	26-Nov-13	23-Dec-13	0
A1200	Select Contractor	0%	10	24-Dec-13	06-Jan-14	0
A1210	Draft Start-Up Plan	0%	40	25-Mar-14	19-May-14	313
A1220	Submit Start-Up Plan to Client for Review	0%	0		19-May-14	313
A1230	Client Review Start-Up Plan	0%	10	20-May-14	02-Jun-14	313
A1235	Incorp Client Comments & Finalize Start-Up Plan	0%	10	03-Jun-14	16-Jun-14	313
A1240	Draft Operation and Maintenance Manual (O&M)	0%	80	25-Mar-14	14-Jul-14	273
A1250	Submit O&M Manual to Client for Review	0%	0		14-Jul-14	273
A1260	Client Review O&M Manual	0%	10	15-Jul-14	28-Jul-14	273
A1270	Incorp Client Comments O&M Manual	0%	10	29-Jul-14	11-Aug-14	273
A1280	Submit Final O&M Manual to Client for Use	0%	0		11-Aug-14	273
CONSTRUCTION PHASE - NEW UNIT 2			433	31-Dec-13	27-Aug-15	0
Mobilization			180	31-Dec-13	08-Sep-14	253
A1290	Site Mobilization	0%	5	04-Mar-14	10-Mar-14	0
A1300	Dual Flow Traveling Screen (DFTS) Submittal of Equipment (	0%	40	31-Dec-13	24-Feb-14	253
A1310	DFTS Request for Order & Submittal of Equipment - Both Units	0%	30	25-Feb-14	07-Apr-14	253
A1320	DFTS Preparation of Details of Fabrication and Advanced Ord...	0%	10	08-Apr-14	21-Apr-14	253
A1330	DFTS Procurement, Fabrication & Manufacturing (Both Units)	0%	80	22-Apr-14	11-Aug-14	253
A1340	DFTS Inspection/Preparation for Shipment/Loading (Both Units)	0%	10	12-Aug-14	25-Aug-14	253
A1350	Approx Time for DFTS Delivery Time to Job Site After Inspection	0%	10	26-Aug-14	08-Sep-14	253
General Site Modifications			60	11-Mar-14	02-Jun-14	323
A1360	Clearing, Grubbing, Fencing, Storm Drainage, Etc.	0%	10	11-Mar-14	24-Mar-14	0
A1370	Cofferdam Construction	0%	15	25-Mar-14	14-Apr-14	0
A1380	Pump Area Dry	0%	20	15-Apr-14	12-May-14	0
A1390	Install Sheet Piles	0%	10	13-May-14	26-May-14	328
A1410	Excavation of Foundation/Prepare Subgrade	0%	15	13-May-14	02-Jun-14	0
Existing Unit 2 Online			232	03-Jun-14	22-Apr-15	91
A1420	Foundations - Set Rebar, Pour Concrete	0%	10	03-Jun-14	16-Jun-14	0
A1425	De-Ice Piping Installation (Concrete in Bed)	0%	10	17-Jun-14	30-Jun-14	0
A1430	Walls - Set Rebar & Forms, Pour Walls	0%	15	01-Jul-14	21-Jul-14	0
A1440	Elevated Slabs - Set Rebar & Forms, Pour Concrete	0%	15	22-Jul-14	11-Aug-14	0
A1450	Upper Building - Set Rebar & Forms, Pour Upper Walls	0%	10	12-Aug-14	25-Aug-14	0
A1460	Roof - Set Bar Joists & Metal Beds, Build	0%	10	26-Aug-14	08-Sep-14	0
A1470	Door, Electrical, Finishings	0%	20	09-Sep-14	06-Oct-14	0
A1480	Install New Bar Racks	0%	50	09-Sep-14	17-Nov-14	203
A1490	Install DFTS's	0%	50	09-Sep-14	17-Nov-14	203
A1500	Install New Stop Gates	0%	40	09-Sep-14	03-Nov-14	0
A1505	Demolition of Coefferdam	0%	5	04-Nov-14	10-Nov-14	0
A1510	Install New Centrifugal Pumps	0%	15	11-Nov-14	01-Dec-14	0
A1520	Install New Piping	0%	40	02-Dec-14	26-Jan-15	0
A1530	Install Automatic Control System	0%	20	27-Jan-15	23-Feb-15	0
A1540	Construct Fish Return Troughs	0%	10	27-Jan-15	09-Feb-15	143
A1550	Equipment Checkout/Start-Up	0%	10	24-Feb-15	09-Mar-15	0
A1551	Install Temporary By-Pass to River	0%	5	10-Mar-15	16-Mar-15	0
A1555	Excavate Circ Water Piping to Prepare for Tie-In to New Unit 2	0%	20	17-Mar-15	13-Apr-15	0
A1560	Operator Training	0%	5	14-Apr-15	20-Apr-15	0
A1561	Remove Tempoary By-Pass to River	0%	2	21-Apr-15	22-Apr-15	0
Craft Support			145	22-Jul-14	09-Feb-15	143
A1860	Mechanical Activities	0%	145	22-Jul-14	09-Feb-15	143
A1870	Electrical Activities	0%	145	22-Jul-14	09-Feb-15	143
Existing Unit 2 Offline			41	23-Apr-15	18-Jun-15	0
A1562	Take Existing Unit 2 Offline	0%	1	23-Apr-15	23-Apr-15	0
A1563	Tie-In to New Unit 2	0%	40	24-Apr-15	18-Jun-15	0
New Unit 2 Online			50	19-Jun-15	27-Aug-15	0
A1570	Commissioning	0%	40	19-Jun-15	13-Aug-15	0
A1590	Abandon in Place Existing Unit #2	0%	10	14-Aug-15	27-Aug-15	0
CONSTRUCTION PHASE - NEW UNIT 1			303	25-Mar-14	21-May-15	70



Actual Work | Critical Remaining Work | Summary
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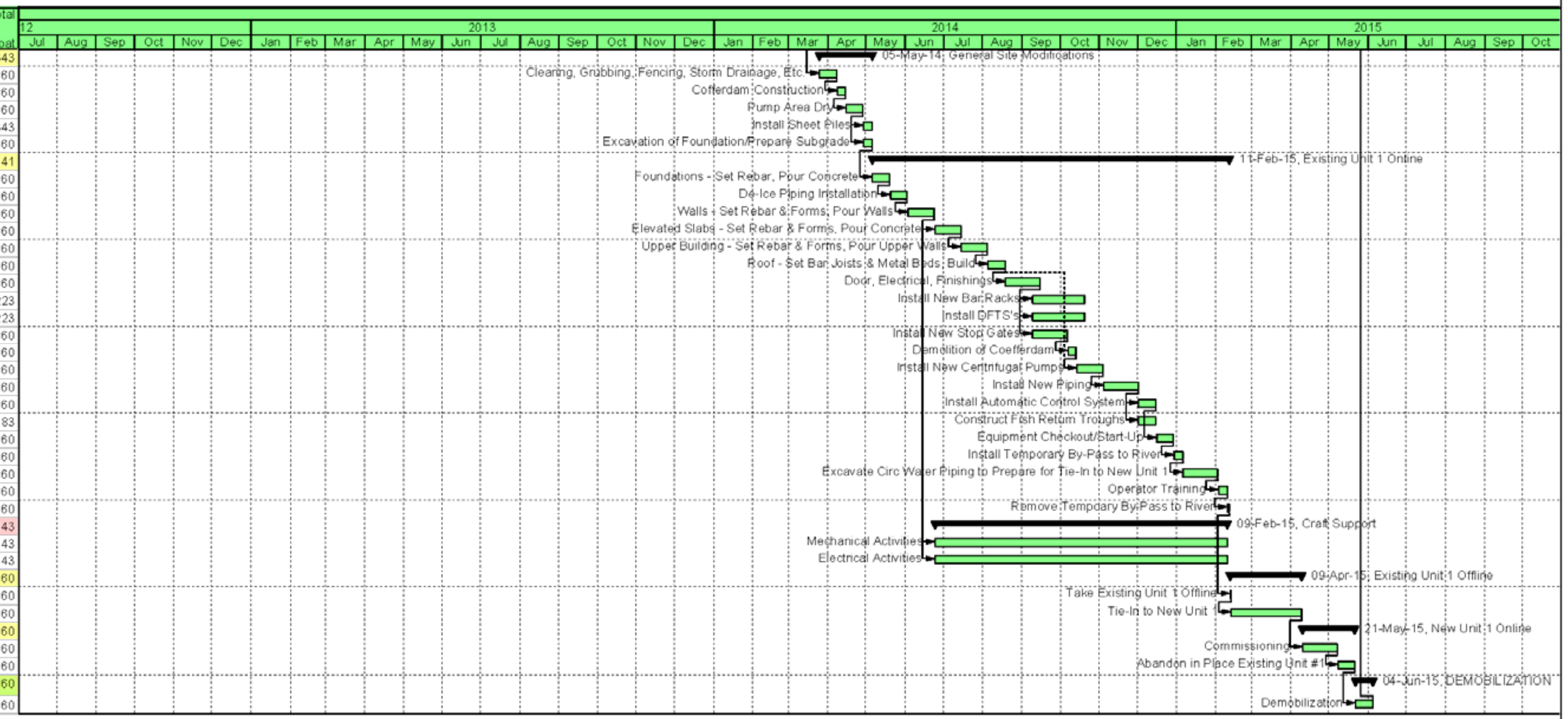
Attachment B3: Option 3a - Schedule for Dual Flow Fine Mesh Traveling Screens

Activity ID	Activity Name	Physical % Complete	Remaining Duration	Start	Finish	Total Float
General Site Modifications			30	25-Mar-14	05-May-14	343
A1600	Clearing, Grubbing, Fencing, Storm Drainage, Etc	0%	10	25-Mar-14	07-Apr-14	60
A1610	Cofferdam Construction	0%	5	08-Apr-14	14-Apr-14	60
A1620	Pump Area Dry	0%	10	15-Apr-14	28-Apr-14	60
A1630	Install Sheet Piles	0%	5	29-Apr-14	05-May-14	343
A1650	Excavation of Foundation/Prepare Subgrade	0%	5	29-Apr-14	05-May-14	60
Existing Unit 1 Online			202	06-May-14	11-Feb-15	141
A1660	Foundations - Set Rebar, Pour Concrete	0%	10	06-May-14	19-May-14	60
A1665	De-Ice Piping Installation	0%	10	20-May-14	02-Jun-14	60
A1670	Walls - Set Rebar & Forms, Pour Walls	0%	15	03-Jun-14	23-Jun-14	60
A1680	Elevated Slabs - Set Rebar & Forms, Pour Concrete	0%	15	24-Jun-14	14-Jul-14	60
A1690	Upper Building - Set Rebar & Forms, Pour Upper Walls	0%	15	15-Jul-14	04-Aug-14	60
A1700	Roof - Set Bar Joists & Metal Beds, Build	0%	10	05-Aug-14	18-Aug-14	60
A1710	Door, Electrical, Finishings	0%	20	19-Aug-14	15-Sep-14	60
A1720	Install New Bar Racks	0%	30	09-Sep-14	20-Oct-14	223
A1730	Install DFTS's	0%	30	09-Sep-14	20-Oct-14	223
A1740	Install New Stop Gates	0%	20	09-Sep-14	06-Oct-14	60
A1745	Demolition of Coefferdam	0%	5	07-Oct-14	13-Oct-14	60
A1750	Install New Centrifugal Pumps	0%	15	14-Oct-14	03-Nov-14	60
A1760	Install New Piping	0%	20	04-Nov-14	01-Dec-14	60
A1770	Install Automatic Control System	0%	10	02-Dec-14	15-Dec-14	60
A1780	Construct Fish Return Troughs	0%	10	02-Dec-14	15-Dec-14	183
A1790	Equipment Checkout/Start-Up	0%	10	16-Dec-14	29-Dec-14	60
A1791	Install Temporary By-Pass to River	0%	5	30-Dec-14	05-Jan-15	60
A1795	Excavate Circ Water Piping to Prepare for Tie-In to New Unit 1	0%	20	06-Jan-15	02-Feb-15	60
A1800	Operator Training	0%	5	03-Feb-15	09-Feb-15	60
A1805	Remove Tempoary By-Pass to River	0%	2	10-Feb-15	11-Feb-15	60
Craft Support			165	24-Jun-14	09-Feb-15	143
A1880	Mechanical Activities	0%	165	24-Jun-14	09-Feb-15	143
A1890	Electrical Activities	0%	165	24-Jun-14	09-Feb-15	143
Existing Unit 1 Offline			41	12-Feb-15	09-Apr-15	60
A1801	Take Existing Unit 1 Offline	0%	1	12-Feb-15	12-Feb-15	60
A1802	Tie-In to New Unit 1	0%	40	13-Feb-15	09-Apr-15	60
New Unit 1 Online			30	10-Apr-15	21-May-15	60
A1810	Commissioning	0%	20	10-Apr-15	07-May-15	60
A1830	Abandon in Place Existing Unit #1	0%	10	08-May-15	21-May-15	60
DEMOBILIZATION			10	22-May-15	04-Jun-15	60
A1840	Demobilization	0%	10	22-May-15	04-Jun-15	60



Actual Work | Critical Remaining Work | Summary
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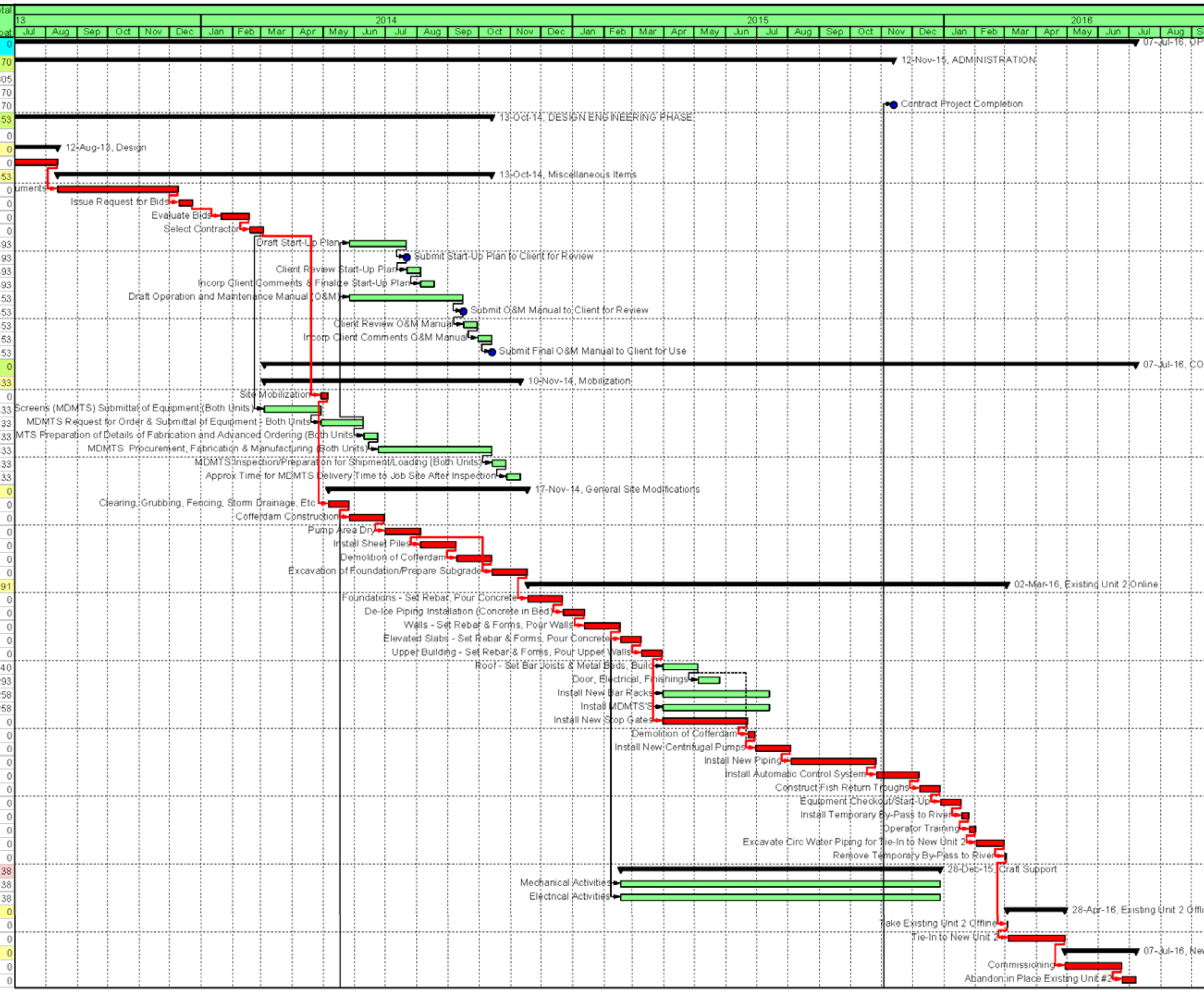
Attachment B4: Option 3b - Schedule for MultiDisc® Fine Mesh Traveling Screens

Activity ID	Activity Name	hysical % mplete	maining Duration	Start	Finish	Total Float
OPTION 3B - MultiDisc Mesh Traveling Screens - S Beaver			1805	03-Aug-09	07-Jul-16	0
ADMINISTRATION			1635	03-Aug-09	12-Nov-15	170
CA	Contract Award	0%	0		03-Aug-09	1805
DISC	Mechanical	0%	1635	03-Aug-09	12-Nov-15	170
EOP	Contract Project Completion	0%	0		12-Nov-15	170
DESIGN ENGINEERING PHASE			1352	03-Aug-09	13-Oct-14	453
A1850	Site Engineering/Data Acquisition Study	0%	787	03-Aug-09	13-Aug-12	0
Design			260	14-Aug-12	12-Aug-13	0
A1000	Prepare Design	0%	260	14-Aug-12	12-Aug-13	0
Miscellaneous Items			305	13-Aug-13	13-Oct-14	453
A1170	Prepare Contract Documents	0%	85	13-Aug-13	09-Dec-13	0
A1180	Issue Request for Bids	0%	10	10-Dec-13	23-Dec-13	0
A1190	Evaluate Bids	0%	20	21-Jan-14	17-Feb-14	0
A1200	Select Contractor	0%	10	18-Feb-14	03-Mar-14	0
A1210	Draft Start-Up Plan	0%	40	27-May-14	21-Jul-14	493
A1220	Submit Start-Up Plan to Client for Review	0%	0		21-Jul-14	493
A1230	Client Review Start-Up Plan	0%	10	22-Jul-14	04-Aug-14	493
A1235	Incorp Client Comments & Finalize Start-Up Plan	0%	10	05-Aug-14	18-Aug-14	493
A1240	Draft Operation and Maintenance Manual (O&M)	0%	80	27-May-14	15-Sep-14	453
A1250	Submit O&M Manual to Client for Review	0%	0		15-Sep-14	453
A1260	Client Review O&M Manual	0%	10	16-Sep-14	29-Sep-14	453
A1270	Incorp Client Comments O&M Manual	0%	10	30-Sep-14	13-Oct-14	453
A1280	Submit Final O&M Manual to Client for Use	0%	0		13-Oct-14	453
CONSTRUCTION PHASE - NEW UNIT 2			613	04-Mar-14	07-Jul-16	0
Mobilization			180	04-Mar-14	10-Nov-14	433
A1290	Site Mobilization	0%	5	29-Apr-14	05-May-14	0
A1300	MultiDisc Mesh Traveling Screens (MDMTS) Submittal of Equi...	0%	40	04-Mar-14	28-Apr-14	433
A1310	MDMTS Request for Order & Submittal of Equipment - Both U...	0%	30	29-Apr-14	09-Jun-14	433
A1320	MDMTS Preparation of Details of Fabrication and Advanced O...	0%	10	10-Jun-14	23-Jun-14	433
A1330	MDMTS Procurement, Fabrication & Manufacturing (Both Units)	0%	80	24-Jun-14	13-Oct-14	433
A1340	MDMTS Inspection/Preparation for Shipment/Loading (Both U...	0%	10	14-Oct-14	27-Oct-14	433
A1350	Approx Time for MDMTS Delivery Time to Job Site After Inspe...	0%	10	28-Oct-14	10-Nov-14	433
General Site Modifications			140	06-May-14	17-Nov-14	0
A1360	Clearing, Grubbing, Fencing, Storm Drainage, Etc.	0%	15	06-May-14	26-May-14	0
A1370	Cofferdam Construction	0%	25	27-May-14	30-Jun-14	0
A1380	Pump Area Dry	0%	25	01-Jul-14	04-Aug-14	0
A1390	Install Sheet Piles	0%	25	05-Aug-14	08-Sep-14	0
A1391	Demolition of Cofferdam	0%	25	09-Sep-14	13-Oct-14	0
A1410	Excavation of Foundation/Prepare Subgrade	0%	25	14-Oct-14	17-Nov-14	0
Existing Unit 2 Online			337	18-Nov-14	02-Mar-16	91
A1420	Foundations - Set Rebar, Pour Concrete	0%	25	18-Nov-14	22-Dec-14	0
A1425	De-Ice Piping Installation (Concrete in Bed)	0%	15	23-Dec-14	12-Jan-15	0
A1430	Walls - Set Rebar & Forms, Pour Walls	0%	25	13-Jan-15	16-Feb-15	0
A1440	Elevated Slabs - Set Rebar & Forms, Pour Concrete	0%	15	17-Feb-15	09-Mar-15	0
A1450	Upper Building - Set Rebar & Forms, Pour Upper Walls	0%	15	10-Mar-15	30-Mar-15	0
A1460	Roof - Set Bar Joists & Metal Beds, Build	0%	25	31-Mar-15	04-May-15	40
A1470	Door, Electrical, Finishings	0%	15	05-May-15	25-May-15	293
A1480	Install New Bar Racks	0%	75	31-Mar-15	13-Jul-15	258
A1490	Install MDMTS'S	0%	75	31-Mar-15	13-Jul-15	258
A1500	Install New Stop Gates	0%	60	31-Mar-15	22-Jun-15	0
A1505	Demolition of Cofferdam	0%	5	23-Jun-15	29-Jun-15	0
A1510	Install New Centrifugal Pumps	0%	25	30-Jun-15	03-Aug-15	0
A1520	Install New Piping	0%	60	04-Aug-15	26-Oct-15	0
A1530	Install Automatic Control System	0%	30	27-Oct-15	07-Dec-15	0
A1540	Construct Fish Return Troughs	0%	15	08-Dec-15	28-Dec-15	0
A1550	Equipment Checkout/Start-Up	0%	15	29-Dec-15	18-Jan-16	0
A1555	Install Temporary By-Pass to River	0%	5	19-Jan-16	25-Jan-16	0
A1560	Operator Training	0%	5	26-Jan-16	01-Feb-16	0
A1561	Excavate Circ Water Piping for Tie-In to New Unit 2	0%	20	02-Feb-16	29-Feb-16	0
A1571	Remove Temporary By-Pass to River	0%	2	01-Mar-16	02-Mar-16	0
Craft Support			225	17-Feb-15	28-Dec-15	138
A1870	Mechanical Activities	0%	225	17-Feb-15	28-Dec-15	138
A1880	Electrical Activities	0%	225	17-Feb-15	28-Dec-15	138
Existing Unit 2 Offline			41	03-Mar-16	28-Apr-16	0
A1562	Take Existing Unit 2 Offline	0%	1	03-Mar-16	03-Mar-16	0
A1563	Tie-In to New Unit 2	0%	40	04-Mar-16	28-Apr-16	0
New Unit 2 Online			50	29-Apr-16	07-Jul-16	0
A1570	Commissioning	0%	40	29-Apr-16	23-Jun-16	0
A1590	Abandon in Place Existing Unit #2	0%	10	24-Jun-16	07-Jul-16	0



Actual Work — Critical Remaining Work — Summary
Remaining Work — Milestone

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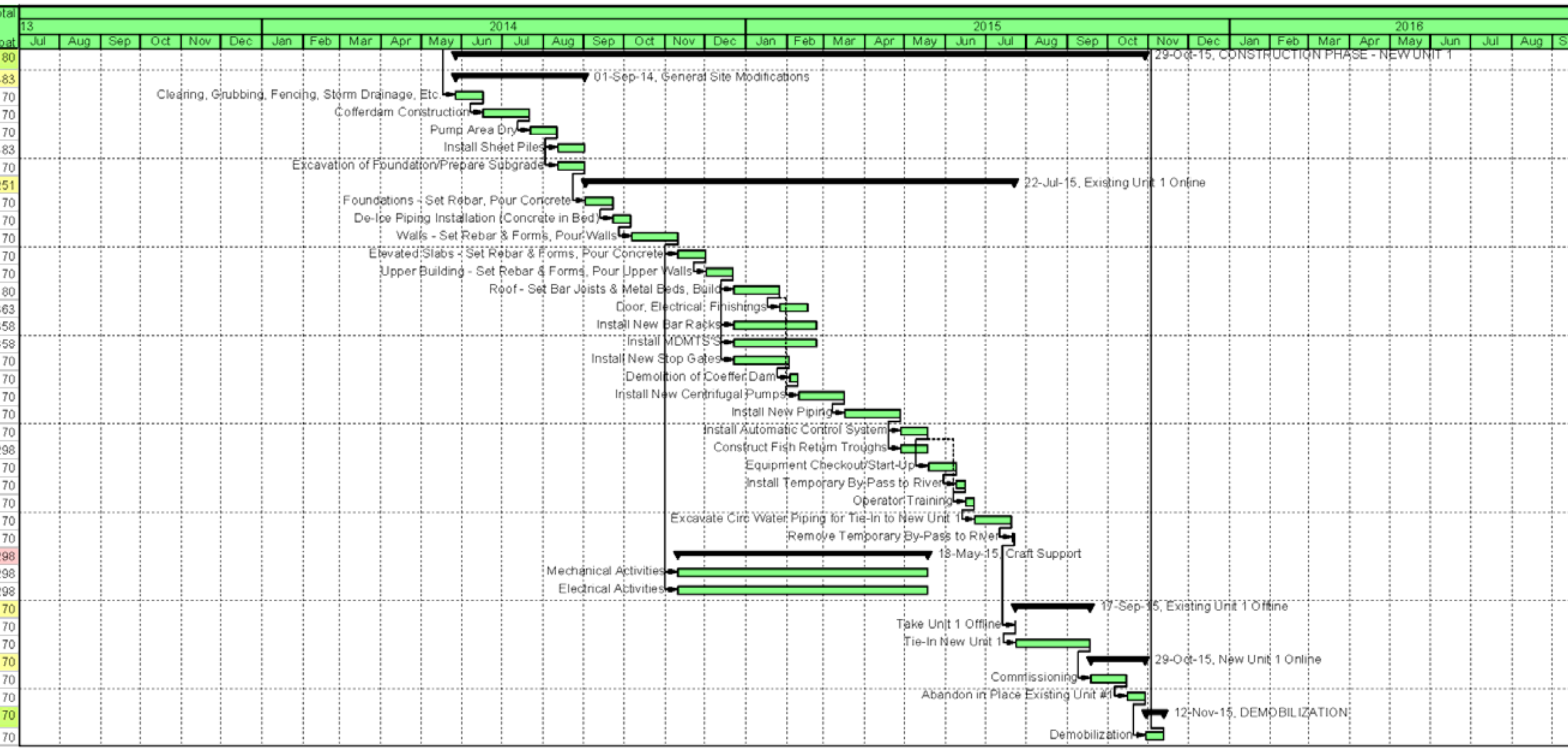
Attachment B4: Option 3b - Schedule for MultiDisc® Fine Mesh Traveling Screens

Activity ID	Activity Name	Physical % Complete	Remaining Duration	Start	Finish	Total Float
CONSTRUCTION PHASE - NEW UNIT 1			373	27-May-14	29-Oct-15	180
General Site Modifications			70	27-May-14	01-Sep-14	483
A1600	Clearing, Grubbing, Fencing, Storm Drainage, Etc.	0%	15	27-May-14	16-Jun-14	170
A1610	Cofferdam Construction	0%	25	17-Jun-14	21-Jul-14	170
A1620	Pump Area Dry	0%	15	22-Jul-14	11-Aug-14	170
A1630	Install Sheet Piles	0%	15	12-Aug-14	01-Sep-14	483
A1650	Excavation of Foundation/Prepare Subgrade	0%	15	12-Aug-14	01-Sep-14	170
Existing Unit 1 Online			232	02-Sep-14	22-Jul-15	251
A1660	Foundations - Set Rebar, Pour Concrete	0%	15	02-Sep-14	22-Sep-14	170
A1665	De-Ice Piping Installation (Concrete in Bed)	0%	10	23-Sep-14	06-Oct-14	170
A1670	Walls - Set Rebar & Forms, Pour Walls	0%	25	07-Oct-14	10-Nov-14	170
A1680	Elevated Slabs - Set Rebar & Forms, Pour Concrete	0%	15	11-Nov-14	01-Dec-14	170
A1690	Upper Building - Set Rebar & Forms, Pour Upper Walls	0%	15	02-Dec-14	22-Dec-14	170
A1700	Roof - Set Bar Joists & Metal Beds, Build	0%	25	23-Dec-14	26-Jan-15	180
A1710	Door, Electrical, Finishings	0%	15	27-Jan-15	16-Feb-15	363
A1720	Install New Bar Racks	0%	45	23-Dec-14	23-Feb-15	358
A1730	Install MDMTS'S	0%	45	23-Dec-14	23-Feb-15	358
A1740	Install New Stop Gates	0%	30	23-Dec-14	02-Feb-15	170
A1745	Demolition of Coeffer Dam	0%	5	03-Feb-15	09-Feb-15	170
A1750	Install New Centrifugal Pumps	0%	25	10-Feb-15	16-Mar-15	170
A1760	Install New Piping	0%	30	17-Mar-15	27-Apr-15	170
A1770	Install Automatic Control System	0%	15	28-Apr-15	18-May-15	170
A1780	Construct Fish Return Troughs	0%	15	28-Apr-15	18-May-15	298
A1790	Equipment Checkout/Start-Up	0%	15	19-May-15	08-Jun-15	170
A1795	Install Temporary By-Pass to River	0%	5	09-Jun-15	15-Jun-15	170
A1800	Operator Training	0%	5	16-Jun-15	22-Jun-15	170
A1801	Excavate Circ Water Piping for Tie-In to New Unit 1	0%	20	23-Jun-15	20-Jul-15	170
A1802	Remove Temporary By-Pass to River	0%	2	21-Jul-15	22-Jul-15	170
Craft Support			135	11-Nov-14	18-May-15	298
A1890	Mechanical Activities	0%	135	11-Nov-14	18-May-15	298
A1900	Electrical Activities	0%	135	11-Nov-14	18-May-15	298
Existing Unit 1 Offline			41	23-Jul-15	17-Sep-15	170
A1803	Take Unit 1 Offline	0%	1	23-Jul-15	23-Jul-15	170
A1804	Tie-In New Unit 1	0%	40	24-Jul-15	17-Sep-15	170
New Unit 1 Online			30	18-Sep-15	29-Oct-15	170
A1810	Commissioning	0%	20	18-Sep-15	15-Oct-15	170
A1830	Abandon in Place Existing Unit #1	0%	10	16-Oct-15	29-Oct-15	170
DEMOBILIZATION			10	30-Oct-15	12-Nov-15	170
A1860	Demobilization	0%	10	30-Oct-15	12-Nov-15	170



Actual Work | Critical Remaining Work | Summary | Remaining Work | Milestone

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CBI - Attachment C Removed

Attachment C

Cost Estimates

[redacted]

CBI - Attachment D Removed

Attachment D

Major Components, Vendor Data and References

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Attachment E
Site Specific Study Details

Merrimack Station

Alternative Technology Report

Proposed Three-Year Biological Evaluation Studies

Study Designs, Bidding Assumptions, and Budget Estimates

23 September 2009

Ref. No. 21351.001 Task 8

General Design and Assumptions

1. The primary objective is to compare the monthly and annual percent reduction in entrainment abundance and impingement mortality for one or more proposed alternate (new) technology(s) installed and tested at Merrimack Station to the existing technology and operational practices.
2. Percent reductions will be calculated based on both actual abundance and adult equivalent abundance.
3. Studies performed in each year will select one technology, apply it to one unit or to one intake forebay at a given unit (as appropriate), and leave the other unit or forebay with the existing technology installed and operated to allow comparison between the alternate technology tested and the existing technology. Therefore, the sampling design assumes the existing units or screens are replicates of each other.
4. Three consecutive years of biological evaluation for each technology, beginning in April 2011.
5. One technology is tested in each three year block (i.e., tests are sequential, not parallel, or based on multiple simultaneous comparisons of technologies installed at each unit).
6. Concurrent entrainment and impingement studies in all three years.
7. The primary sampling design for entrainment abundance, not survival, will be based on one sampling date in each of 17 consecutive weeks from 1 April through 31 July of each year, and each date includes a daytime and a nighttime sample for each technology and control evaluated (17 dates x 2 samples per date = 34 samples per year x 3 years = 102 total entrainment samples collected and analyzed for each test or control technology).
8. The alternative sampling design for entrainment abundance, not survival, will be based on one sampling date in each of 17 consecutive weeks from 1 April through 31 July of each year, and one date for every other week (an additional 7 dates) from 1 August through 30 November of each year, and each date includes a

daytime and a nighttime sample for each technology and control evaluated (24 dates x 2 samples per date = 48 samples per year x 3 years = 144 total entrainment samples collected and analyzed for each test or control technology). Entrainment sampling is not scheduled during November even though alternative intake technology testing is scheduled for impingement reductions then, because the 2006-2007 entrainment sampling at Merrimack Station indicated that no entrainment is likely to occur in November.

9. Impingement abundance and survival are determined from 1 January through 31 December of each year, with weekly sampling from 1 April through 31 December, and twice monthly sampling from 1 January through 31 March. Each sample consists of the fish and debris found in a 24 hour impingement collection, for a total of 45 sampling dates per year. Six-day or 13-day impingement samples are not collected or analyzed. Impingement collection efficiency tests are performed monthly, and the results are used to adjust raw impingement counts. Impingement survival will be performed weekly (fine mesh traveling screens only) or monthly if appropriate for the technology. (45 dates per year x 3 years = 135 impingement samples collected and analyzed for each test or control technology).
10. Field, laboratory, and analytical methods will be as described in the Normandeau report “Entrainment and Impingement Studies Performed at Merrimack Generating Station from June 2005 through June 2007” (October 2007), and in the associated QA/QC Plans.
11. An annual report will be provided 16 months after the start of each year of sampling. Each report after the first will combine the results of the previous reports.

<u>Narrow Slot Wedgewire Screens Deployed from April through July or April through November</u>

1. General study design and assumptions 1 through 11 above apply.
2. One full scale set of narrow slot wedgewire screens (24 in. diameter, 80 in. long) will be installed at one intake forebay at the same Merrimack Station unit (unit 1 or unit 2) allowing comparison to be made with the other forebay with the existing screening technology and operational practices at the same unit.
3. Each narrow slot wedgewire screen tested will have the same design, through-slot intake velocity of 0.5 feet per second or less, and the same design sweeping velocity of 0.5 feet per second or greater.
4. Studies performed in each year will determine the species composition, life stages, abundance, total length, and greatest body depth of ichthyoplankton entrained in the intake flow passing through one full scale narrow slot wedge wire screen of each mesh size, installed, oriented, and operated at the same location in the Merrimack River where a complete array would be installed, compared in a

simultaneous pair-wise manner to an unscreened cylinder of the same dimensions, design intake velocity, and sweeping velocity.

5. The following narrow slot wedgewire screen pairs are proposed for comparison:

Test Slot Width (open area)	Control Slot Width
1.5 mm	none
2.0 mm	none
3.0 mm	none
6.0 mm	none
9.0 mm	none

6. Narrow slot wedgewire screens of 1.0 mm slot width are excluded from testing due to engineering performance reasons.
7. One 3 inch or 4 inch entrainment sampling line will be installed to allow samples to be taken simultaneously from the water drawn through each test or control narrow slot wedgewire screen. Each sampling line will deliver sampling flow from the test or control screen in the river to a manifold on shore. Electric or gas pumps on shore will supply the suction for sampling. Our estimate does not include costs for purchasing or installing these sampling lines or pumps.
8. Water flow from each sampling line will deliver a nominal discharge of 250 gallons per minute (100 m^3 in ~106 minutes).
9. All samples will be collected in barrel type samplers using 300 micron netting.
10. Separate whole water samples will be collected during sampling and analyzed for wet weight, dry weight, ash free dry weight, and sediment grain size analysis.
11. Sweeping velocity will be continuously recorded during the test period from 1 April through 31 July (or 1 April through 30 November) using a point sampling flowmeter installed at the filtration surface of each wedgewire screen and aligned to measure directional currents along the long axis of each screen.
12. In addition to the wedgewire test and control sample pairs, entrainment samples will also be collected at the same unit during daytime and nighttime periods on each scheduled sampling date from the existing intake that is not equipped with the test wedgewire system.
13. One 3 inch or 4 inch entrainment sampling tap and ball valve will be installed in the screen house on the supply side of the intake pump before the supply lines converge to allow separate entrainment samples to be taken from the forebay at the same unit that is not equipped with the test wedgewire system. This tap should supply water flow at a nominal discharge of 250 gallons per minute (100 m^3 in ~106 minutes). Our estimate does not include costs for installing this tap.
14. No source water body sampling is proposed.

15. Impingement survival or collection efficiency will not be determined for the wedgewire screen system, just the conventional screens, during the period of wedgewire screen deployment tests.
16. The existing traveling screens at the test forebay will not be sampled during the 1 April through 31 July (or 1 April through 30 November) period of wedgewire screen deployment tests. The existing traveling screens at the wedgewire system forebay will be sampled for impingement, impingement survival, and collection efficiency during August through March (or December through March).
17. Impingement and impingement mortality are both assumed to be 0% for the wedgewire screens tested.
18. The primary sampling design for narrow slot wedgewire screen testing at one unit of Merrimack Station from 1 April through 31 July involves the collection and analysis of 374 ichthyoplankton samples per year ((34 day or night sampling events per year x 2 conditions (test and control) x 5 wedgewire mesh sizes) + 34 control samples taken from the conventional intake).
19. The estimated stand-alone study price for narrow slot wedgewire screen testing at one unit of Merrimack Station from 1 April through 31 July is:

    2011 = $ 550,000

    2012 = $ 510,000

    2013 = $ 530,000

    Total = $1,590,000

20. The alternate sampling design for narrow slot wedgewire screen testing at one unit of Merrimack Station from 1 April through 30 November involves the collection and analysis of 528 ichthyoplankton samples per year ((48 day or night sampling events per year x 2 conditions (test and control) x 5 wedgewire mesh sizes) + 48 control samples taken from the conventional intake). Entrainment sampling is not scheduled during November even though the narrow slot wedgewire screens will be deployed and tested for impingement reductions then.
21. The estimated stand-alone study price for narrow slot wedgewire screen testing at one unit of Merrimack Station from 1 April through 30 November is:

    2011 = $ 580,000

    2012 = $ 550,000

    2013 = $ 575,000

    Total = $1,705,000

Aquatic Filter Barrier Deployed from April through July or April through November

1. General study design and assumptions 1 through 11 above apply.
2. The aquatic filter barrier (AFB) will be installed to protect one entire intake (either unit 1 or unit 2) and the other unit (either unit 2 or unit 1) will have the existing screening technology and operational practices and serve as a control.
3. Two new 3 inch or 4 inch entrainment sampling taps and ball valves will be installed in each screen house on the supply side of the intake pumps before the supply lines converge to allow separate entrainment samples to be taken from the test and control unit's forebay. Each tap should each supply water flow at a nominal discharge of 250 gallons per minute (100 m^3 in ~106 minutes). Our estimate does not include costs for installing these taps.
4. Impingement survival and collection efficiency will be determined for the fish collected from the existing traveling screens operated at both the test unit and control unit screen houses.
5. The price estimate does not include labor or materials to install, remove, or maintain the AFB.
6. The price estimate does not include any source water sampling inside or outside of the AFB during its deployment.
7. The primary sampling design for AFB testing at one unit of Merrimack Station from 1 April through 31 July involves the collection and analysis of 68 ichthyoplankton samples per year (34 day or night sampling events per year + 34 control samples taken from the conventional intake).
8. The estimated stand-alone study price for AFB testing at one unit of Merrimack Station from 1 April through 31 July is:

   2011 = $ 350,000

   2012 = $ 360,000

   2013 = $ 375,000

   Total = $1,085,000
9. The alternate sampling design for AFB testing at one unit of Merrimack Station from 1 April through 30 November involves the collection and analysis of 96 ichthyoplankton samples per year (48 day or night sampling events per year + 48 control samples taken from the conventional intake). Entrainment sampling is not scheduled during November even though the AFB will be deployed and tested for impingement reductions then.

10. The estimated stand-alone study price for AFB testing at one unit of Merrimack Station from 1 April through 30 November is:

    2011 = $ 375,000

    2012 = $ 380,000

    2013 = $ 395,000

    Total = $1,150,000

Fine Mesh Traveling Screens and Fish Return System Deployed Year Round

1. General study design and assumptions 1 through 11 above apply.
2. One fine mesh traveling screen of 1.5 mm mesh size (open dimensions) will be installed at one intake forebay of either unit 1 or unit 2, allowing comparison to be made with the other forebay with the existing screening technology and operational practices at the same unit of Merrimack Station.
3. Two new 3 inch or 4 inch entrainment sampling taps and ball valves will be installed in the screen house where the test occurs on the supply side of the intake pumps before the supply lines converge to allow separate entrainment samples to be taken from the test and control unit's forebays. Each tap should each supply water flow at a nominal discharge of 250 gallons per minute (100 m^3 in ~106 minutes). Our estimate does not include costs for installing these taps.
4. All mesh panels of the fine mesh traveling screen installed at the test forebay will have the same mesh.
5. Impingement survival and collection efficiency will be determined with each weekly impingement sample from 1 April through 31 July, and will be determined on one randomly selected sampling date per month in all remaining months, for both the existing traveling screen and the fine mesh test screen operated at the selected unit screen house.
6. All impingement survival sampling will occur at the discharge end of the installed fish return system.
7. The installed fish return system will allow sampling access from land at the discharge end without the need for boat access, and will allow separation of the impingement collections from both the test and existing screens.
8. No source water body sampling is proposed.
9. In addition to the impingement abundance and survival samples, the entrainment sampling design for fine mesh traveling screen testing at one unit of Merrimack Station from 1 April through 31 July involves the collection and analysis of 68

ichthyoplankton samples per year (34 day or night sampling events per year from the test screen + 34 control samples taken from the conventional screen).

10. Estimated stand-alone study price for year-round testing of fine mesh traveling screens at one unit of Merrimack Station is:

    2011 = $ 400,000

    2012 = $ 390,000

    2013 = $ 410,000

    Total = $1,200,000

Attachment F

Biological-Cost Effectiveness Analysis

In order to further evaluate the various options, a biological-cost effectiveness analysis was performed. The following objectives were identified for determining the BTA for minimizing impingement mortality and entrainment at the Merrimack Station CWISs:

- Minimize impingement mortality
- Minimize entrainment
- Minimize capital cost
- Minimize operation and maintenance cost

Each option was scored on a scale of 1 to 5. For the biological objectives, a score of 5 would represent a 100% reduction from baseline while a score of 1 would represent a 0% reduction from baseline. For the cost objectives, a score of 5 would represent a minimal cost while a score of 1 would represent a high cost. The option with the highest score would be potentially determined as the BTA for minimizing adverse environmental impacts from Merrimack Station's cooling water intake structures. Biological-cost effectiveness was further broken down into the following:

- High (> 15): High potential of matching BTA for Merrimack Station
- Medium (10 to 15): Average potential of matching BTA for Merrimack Station.
- Low (< 10): Low potential of matching BTA for Merrimack Station.

The results of this analysis are tabulated below.

Technology	Cost/Ranking		Biological Effectiveness (% Reduction)/Ranking		Biological-Cost Effectiveness Ranking
	Initial	Annual	Impingement	Entrainment	
Option 1 – Seasonal Deployment of Wedgewire Screens and Upgraded Fish Return Systems	$ 8,508,000 to $ 8,816,000	$86,000	84	73-79	High
	5	5	4	3 (Note 4)	17
Option 2 – Seasonal Deployment of an Aquatic Filter Barrier and Upgraded Fish Return Systems	$9,955,000	$475,800	78	82	Medium
	4	3	3	4	14
Option 3a - Dual Flow Fine Mesh (1.5 mm) Traveling Screens with Upgraded Fish Handling and Return Systems	$54,608,000	$311,700	Note 1	49 to >99 (Note 3)	Medium
	3	4	1 (Note 2)	3 (Note 4)	11
Option 3b - MultiDisc® Fine Mesh (1.5 mm) Traveling Screens with Upgraded Fish Handling and Return Systems	$71,383,000	$596,400	Note 1	49 to >99 (Note 3)	Low
	2	2	1 (Note 2)	3 (Note 4)	8

Notes:

1. Only a site specific study on the fine-mesh traveling screens would be able to determine the impingement mortality for Merrimack Station. Normandeau provided theoretical results (Ref. 7.15) estimating that impingement mortality could be significantly reduced; however, the potential exists to increase impingement mortality.
2. A value of 1 was assigned due to the potential for increased impingement mortality.
3. Based on the lack of data on the benefits of fine mesh traveling screens and the scenarios and assumptions required for the evaluation of these options at Merrimack Station, a range of entrainment benefits was assigned by Normandeau (Ref. 7.15).
4. A value of 3 was assigned to account for the range in entrainment reduction..

As shown in the table above, the technology with the highest biological-cost effectiveness ranking was narrow slot wedgewire screens with upgraded fish return systems. However, prior to final determination of BTA for Merrimack Station, a three year site specific study would be recommended to determine the optimum slot size and verify the biological benefits of this technology. Although it is possible that, based on the results of the site specific study, the optimal slot size could change and, therefore, the associated costs and/or biological benefits could change, it is unlikely that the relative ranking of any of the technologies evaluated would be affected.