AlexRenew
1800 Limerick Street
Alexandria, VA 22314
alexrenew.com

AlexRenew

Request for Proposals for:

Professional Engineering Services to Support Preliminary and Primary Systems Upgrade Program

RFP 24-020

November 6, 2023

Proposals shall only be submitted electronically via e-mail to Igor Scherbakov, Procurement Manager, at Igor.Scherbakov@AlexRenew.com on or before 2:00 PM ET, December 19, 2023. Paper copies will not be accepted. AlexRenew will conduct an Information Session and Site Tour for this solicitation on November 15, 2023, from 10:00 AM to 12:00 PM ET at AlexRenew's Environmental Center, Conference Room 600.

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LIST OF ATTACHMENTS

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1 INTRODUCTION

The City of Alexandria, Virginia Sanitation Authority d/b/a AlexRenew submits this Request for Proposals (RFP) to solicit Proposals from those entities (Respondents) interested in providing Professional Engineering in support of AlexRenew's Preliminary and Primary Systems Upgrades (Project) Program and other WRRF liquid processes as deemed necessary for the AlexRenew Water Resource Recovery Facility (WRRF). It is anticipated that the successful Respondent will enter into a professional services contract (Contract) with AlexRenew. This solicitation is being conducted as a competitive negotiation for professional services, in accordance with Virginia Code § 2.2-4302.2. AlexRenew may decide to include Resident Engineering and Inspection (RE&I) services in the Contract by amendment.

Respondent's Proposal must meet all requirements established by this RFP. Requirements of this RFP generally will use the words "shall", "will", or "must" (or equivalent terms) to identify a required item that must be submitted with a Respondent's Proposal. Failure to meet any RFP requirement may render a Respondent's Proposal non-responsive. The extent to which a Respondent meets or exceeds evaluation factors will be rated by AlexRenew and be reflective of AlexRenew's scoring (in its sole discretion) of a Respondent's Proposal.

1.1 Definitions

General and specific terms of reference used in this RFP include, but are not limited to:

A. **Business Day**: Any day on which the Owner is open for business.

B. **Construction-Manager-At-Risk (CMAR)**: The construction firm overseeing and performing work for the Project.

C. **Contract:** The contract resulting from this solicitation.

D. **Engineer:** The successful Respondent selected to perform the services associated with this solicitation.

E. **Key Personnel:** For the purposes of this RFP, those individuals identified by a Respondent under Section 3.5.

F. **Guaranteed Maximum Price (GMP):** The amount accepted by the Owner and CMAR as the maximum cost for construction for specified work packages under the CMAR's contract.

G. **Owner:** AlexRenew.

H. **Preliminary Engineering Report:** AlexRenew WRRF Preliminary/Primary System Upgrades Final Preliminary Engineering Report dated September 28, 2023, incorporated into the RFP as Attachment A.

I. **Procurement:** The Owner's process for selecting the Engineer to provide services.

J. **Proposal:** The document submitted by a Respondent in response to this RFP, including any completed forms, attachments, and exhibits.

K. **Respondent:** The entity that submits a Proposal in response to this RFP.

L. **Request for Proposals (RFP)**: This Procurement document.

M. **Preliminary and Primary Systems Upgrade Program (Project):** The various upgrades to AlexRenew's preliminary and primary treatment processes at the WRRF as described in Section 2.3.

N. **Water Resource Recovery Facility (WRRF):** AlexRenew's wastewater treatment plant.

2 BACKGROUND INFORMATION

2.1 Overview of AlexRenew

Established in 1952 by the Alexandria City Council, AlexRenew's mission is to clean wastewater and protect public health and the environment. AlexRenew is governed by an Alexandria City Council-appointed five-member citizen Board of Directors and is a political subdivision of the Commonwealth of Virginia created under the Virginia Water and Waste Authorities Act. AlexRenew is an independent, special-purpose government unit with administrative and fiscal independence from the City of Alexandria. AlexRenew serves more than 300,000 people in the City of Alexandria and parts of Fairfax County, Virginia. It currently maintains capital assets valued at approximately $1.1 billion and treats approximately 38 MGD (up to 116 MGD during wet weather) of wastewater at its WRRF, located in Alexandria, Virginia.

2.2 Overview of AlexRenew's Liquid Treatment Process

AlexRenew's WRRF liquid treatment process consists of the following main processes: coarse screening, raw sewage pumping, fine screening, grit removal, grit and screenings loading, primary settling, biological nutrient removal, secondary settling, tertiary treatment, and UV disinfection. The liquid process facility layout at the WRRF highlighting the preliminary and primary systems is presented in Figure 2.1.

Figure 2.2 provides a process flow schematic of the liquid treatment processes at AlexRenew. Raw wastewater first goes through a series of screens and grit separators to remove large solids. Flows are then transported into the primary settling tanks for removal of suspended solids, fats, oils and grease. Screenings and grit are removed from the facility for disposal at the Covanta Waste Energy Facility located in Fairfax, Virginia. After primary settling, the water is pumped to biological reactor basins for nutrient removal and then onto secondary settling tanks. The next step of tertiary treatment includes settling tanks, filters, and UV disinfection, before going through post-aeration and discharging to Hunting Creek.

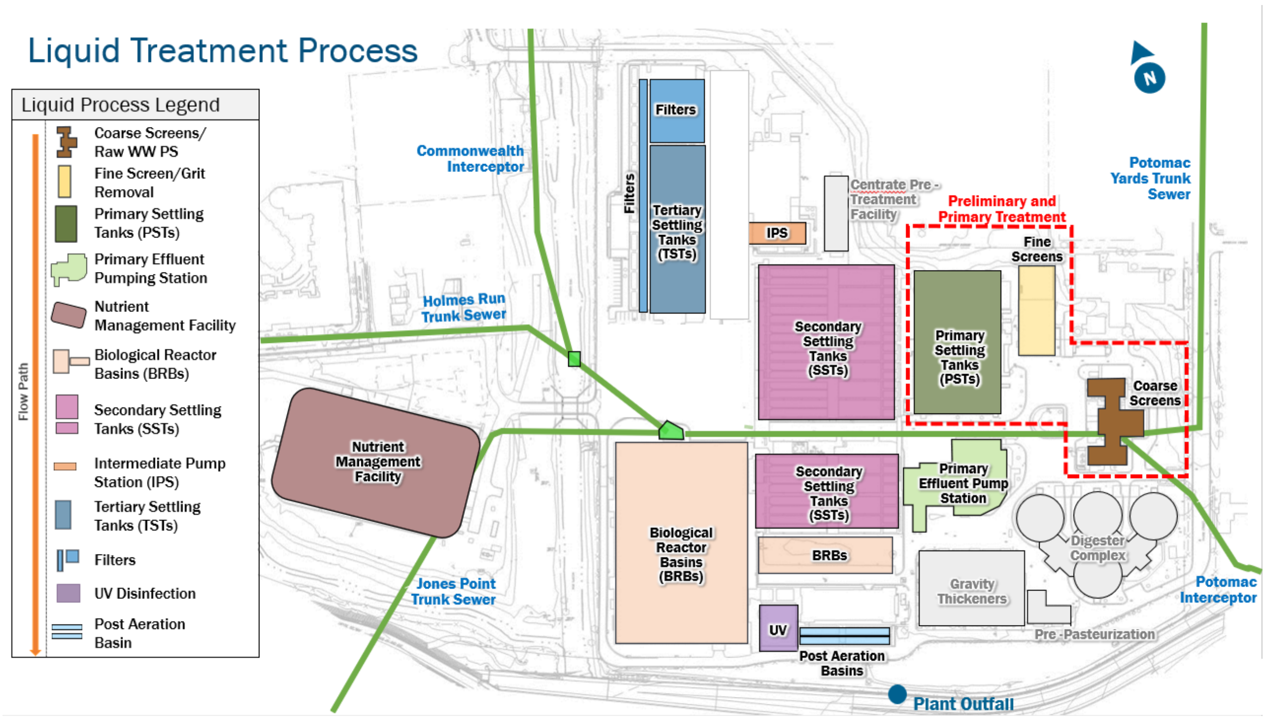

Figure 2.1. AlexRenew's Liquid Treatment Process

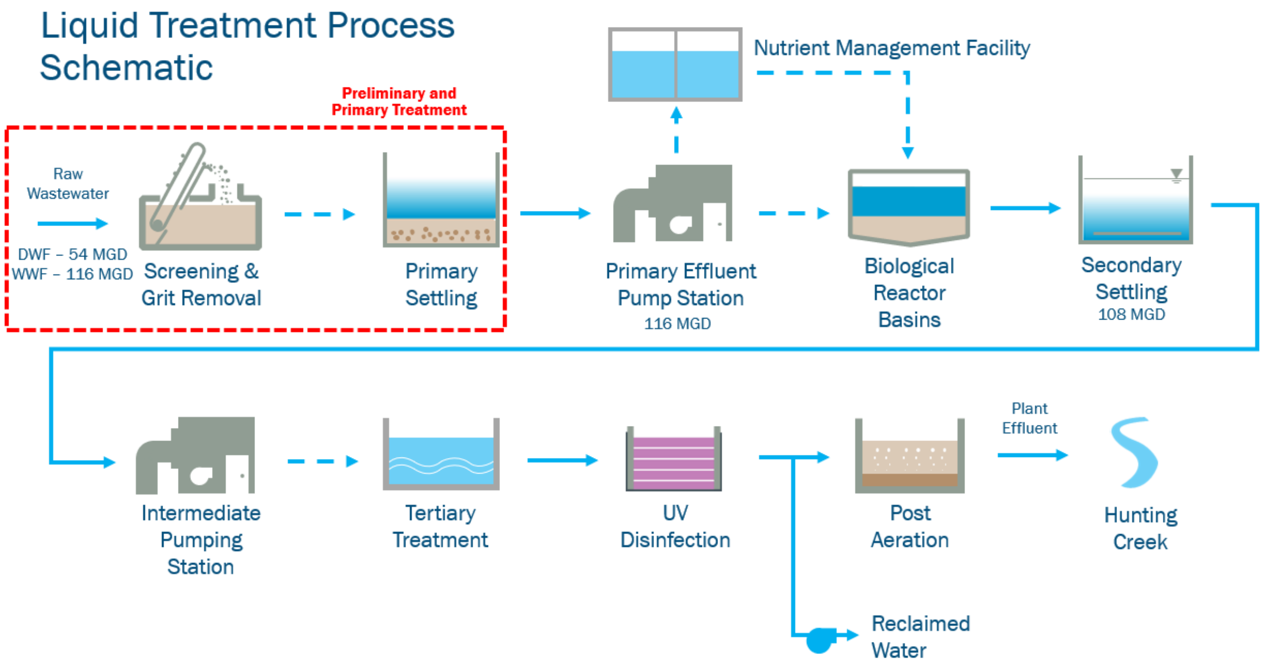

Figure 2.2. AlexRenew's Liquid Treatment Process Flow Schematic

2.3 Preliminary and Primary Systems Upgrade Program (Project)

In August 2020, AlexRenew began assessing the condition and performance of the WRRF's preliminary and primary treatment processes. Several operational, performance, and reliability deficiencies were identified in the coarse screening, influent pumping, fine screening, grit removal, grit and screenings loading, primary settling, and primary scum removal processes. Additionally, many of these components are nearing the end of their useful lives. Upgrading equipment and remediating deficiencies as soon as possible will mitigate the risks of current equipment failure and systems downtime due to the complexity and age of the equipment. Refer to Attachment A for a copy of the AlexRenew WRRF Preliminary/Primary System Upgrades Final Preliminary Engineering Report (PER) dated September 28, 2023.

AlexRenew determined that a collaborative delivery method would be the most practicable means to perform these upgrades due to the necessity, timing, and complexity of the tasks, working in and around active systems, and ensuring the safety of operations and maintenance teams. Table 2.1 provides a summary of currently anticipated upgrades identified in the PER to be performed as part of the Project.

Table 2.1 Description of Work as Identified in the PER

Component	Description
Primary Weir Observation House (PWOH)	Refurbish the existing building including metal roof panels, structural steel supports and other steel components, building lighting, electrical equipment and conduits, and odorous air piping
Primary Settling Tanks (PST)	Replace influent baffles, slide gates, scum skimmers, and handrails, and relocate an existing walkway
Primary Settling Tanks Effluent Channel	Concrete and metal support repair or replacement for the primary settling tanks' effluent channel and control structures
Coarse Screening	• Add a new coarse screening influent channel including channel isolation gates which requires an expansion of the existing building • Replace two (2) existing screens to include new washer/compactor units and discharge chutes for each screen • Miscellaneous improvements to the coarse screening system
Raw Sewage Pumping Station (RSPS)	Replace six (6) existing raw sewage pumps with new dry-pit submersible pumps and new concrete pedestals • Upgrade the VFDs, valves, and instrumentation control • Wet well and pump room enhancements
RSPS Suction and Discharge Structures	Interior surface coating of wet wells, suction conduits, and concrete portion of discharge conduits. Determining inspection and rehabilitation services
Fine Screening	• Replace four (4) existing screens replacement and provision of four (4) new screens with washer/compactors and instrumentation and controls • Replace two (2) existing fine screens transfer conveyors • Install two (2) new fine screenings transfer conveyors • Concrete coating on the screen channels removal and replacement
Conveyors and Loading	• Provide two (2) roll-off containers on an automated rail system with new discharge ports for fine screening and grit loading • Install four (4) new shaftless fine screenings screw conveyors • Install two (2) new shafted grit screw conveyors
Primary Scum	• Upgrades to the primary scum system, sludge pumping system including piping and valve replacements
Grit Removal	• Replace two (2) existing vortex grit separators and associated pumps with two (2) new vortex grit separators with the V-Force baffle and pumps • Replace two (2) existing vortex grit separators and associated pumps with three (3) new stacked tray grit removal units and pumps • Replace associated grit piping with abrasion resistant materials • Replace four (4) existing grit classifiers with four (4) new grit washers and provide new equipment platform • Construct new dewatering equipment access stairs and platform

2.4 Project Capital Cost and Schedule

The capital cost of the Project is currently estimated at $80 million. Figure 2.3 illustrates the anticipated overall Project schedule.

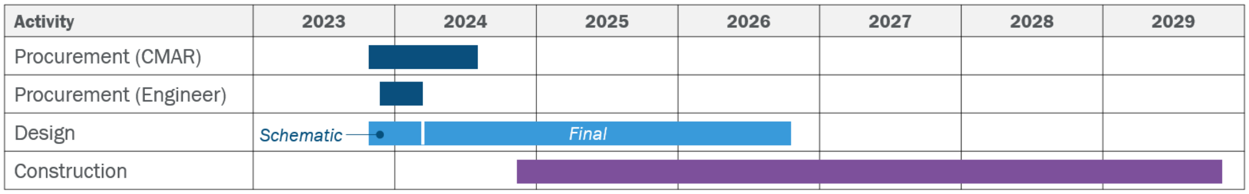

Figure 2.3 Anticipated Project Schedule

The estimates of the value and schedule are approximations and provided to assist interested participants in determining whether to submit a proposal.

2.5 Engineer's Scope of Work

Engineer will work with Owner and CMAR to advance the design of the Project. Specialties may include general civil engineering; mechanical, electrical, and plumbing (MEP) engineering; architectural services; wastewater engineering; land surveying; hydraulics engineering; hydrology; environmental studies; public utility management; cost estimation; project- and portfolio-management services; operations and maintenance support; process troubleshooting; SCADA programming services; permitting services; and other services as needed to fulfill Owner's needs.

All services shall be performed in compliance with industry standards of practice and all federal, state, and local laws, ordinances and regulations including EPA, Virginia Department of Environmental Quality (VDEQ), Virginia State Health Department, VOSHA (Virginia Occupational Safety and Health Agency) and OSHA rules and regulations.

The Scope of Work is divided into two phases – Phase I: Preconstruction Services and Phase II: Construction as described below.

2.5.1 Phase I: Preconstruction Services

During Phase I, Engineer will advance the schematic design, cost estimate, and schedule of the identified upgrades to the final design deliverables. A CMAR will be engaged during the design process to provide input on construction, phasing, and maintenance of plant operations (MOPO) into the planning and design of the upgrades. Anticipated scope for Phase I includes but is not limited to:

A. **Design.** Advance the Project from schematic to final design potentially within multiple GMPs. Develop early work packages, drawings, (in latest versions of AutoCAD Civil 3D), 3D models and clash detection studies (in latest version of Revit and Navisworks), and specifications.

B. **Site Specific Investigations.** Plan and perform field investigations as needed to advance the design, develop preliminary MOPO plans, and/or assess the condition of existing facilities. May include geotechnical, utility locates, cultural resource surveys, verification of as-built conditions as required to advance the design.

C. **Project Meetings and Workshops.** Participate in regular meetings or workshops with CMAR, Owner, and/or others as needed for onboarding, design/constructability reviews, scheduling, package development, or other coordination items.

D. **Schedule.** Develop a baseline design schedule with input from CMAR that is regularly updated throughout Preconstruction Services. Review CMAR's construction schedule and incorporate it into a Master Project Schedule. Work collaboratively with CMAR to mitigate any perceived schedule challenges.

E. **Cost Model.** Participate in a collaborative process with respect to the determination of probable cost of the Project, review CMAR's cost estimate, validate costs, and participate in joint open book price development. Support Owner to reach agreement with CMAR on the Phase II Construction Price Proposal and Amendment.

F. **Milestone Design Reviews and Workshops.** Participate in meetings or workshops related to key milestone design reviews to provide input.

G. **Permitting Services.** Develop documentation and applications, responses to requests for information, and meeting attendance to obtain project permits and any other regulatory requirements.

H. **Value Engineering, Constructability, and Packaging Reviews.** Participate with CMAR in regular informal value engineering, constructability, and packaging reviews of the design package deliverables to identify, evaluate, and propose cost-effective alternatives and changes to improve Project constructability, and provide input on packaging.

I. **Equipment Pre-Purchase.** Identify long-lead equipment procurement items, if any, and coordinate with Owner and CMAR on how to prevent or minimize impacts to the Project, including pre-purchase.

J. **Plant Operations Interface.** Coordinate with plant staff and tCMAR on developing a preliminary list of plant impacts and incorporate potential mitigations and sequencing in the design documents. Provide educational training to staff. This may include support and development of a risk mitigation plan.

K. **Commissioning Plans.** Take the lead and work with CMAR and Owner to establish a draft commissioning plan to capture any additions to the Project engineering and design that would facilitate commissioning and acceptance.

L. **Risk Identification:** Identify and manage risks and participate in Project Risk Management meetings.

M. **Other Services.** Provide other types of professional and non-professional services of a nature consistent with the intent of this RFP as so directed by AlexRenew.

2.5.2 Phase II: Construction Services

During Phase II, Engineer will provide Engineering Services During Construction (ESDC) on the scope developed during Phase I. This will include, but is not limited to, project management services, master schedule management, permitting and compliance activities, change management support, record drawing development, startup and commissioning support, and technical support on all aspects of the Project. During this Phase, Owner may decide to add RE&I services under this Contract by amendment.

2.6 Anticipated Contract Terms and Conditions

AlexRenew anticipates using a contract based on the most current Engineer Joint Contract Documents Committee (EJCDC) CMAR 500, revised as determined by AlexRenew.

2.7 Procurement Schedule

AlexRenew anticipates conducting the Procurement in accordance with the list of milestones outlined in Table 2.2. These milestones are subject to revision, and AlexRenew, at its sole discretion, reserves the right to modify the milestones as it finds necessary.

AlexRenew will conduct an Information Session and Site Tour for this RFP at AlexRenew's Environmental Center, Conference Room 600 (Ed Semonian Board Room). Respondents are limited to five (5) participants per team at the Information Session and Site Tour.

BRING YOUR OWN PERSONAL PROTECTIVE EQUIPMENT INCLUDING A HARD HAT, SAFETY VEST, AND CLOSED SHOES FOR THE SITE TOUR.

Table 2.2. Project Procurement Schedule

Date	Activity
November 6, 2023	Issue RFP
November 15, 2023	Pre-proposal Meeting and Site Tour 10:00 AM to 12:00 PM Local Time
December 5, 2023	Last Date to Submit Questions Regarding RFP; 2:00 PM Local Time
December 12, 2023	Last Day for AlexRenew to Issue Addenda
December 19, 2023	Proposals Due; 2:00 PM Local Time
January 2024	Discussions and Negotiations with Selected Respondents
February 2024	Contract Approval by AlexRenew Board of Directors
March 2024	Anticipated Notice to Proceed for Contract

2.8 AlexRenew Point of Contact

AlexRenew's sole point of contact (POC) for matters related to Procurement shall be Igor Scherbakov. AlexRenew's POC is the only individual authorized to discuss this Procurement with any interested parties, including Respondents. All communications outside of the Information Meeting and Site Tour and with AlexRenew's POC about the Project or this Procurement shall be in writing, as required by applicable provisions of this RFP.

Igor Scherbakov
AlexRenew
Procurement Manager
igor.sherbakov@alexrenew.com

Prior to the award of the Contract resulting from this solicitation, Respondents are prohibited from contacting AlexRenew staff other than the AlexRenew POC identified above. Respondents are also prohibited from contacting any member of the AlexRenew Board of Directors and any other staff or entities contributing to the development of the Project. Any such contact may result in disqualification from participating in this procurement.

AlexRenew disclaims the accuracy of information derived from any source other than AlexRenew's POC, and the use of any such information is at the sole risk of the Respondent.

3 PROPOSAL CONTENTS

Respondents are advised that the Proposal shall include specific information that will demonstrate the qualifications and experience required by this RFP. The Proposal shall consist of all information required under this Section 3, in the order and format specified in Section 5.

Respondents are advised that AlexRenew reserves the right to conduct an independent investigation of any information, including prior experience and performance, identified in the Proposal by contacting project references, accessing public information, contacting independent parties, or any other means. AlexRenew further reserves the right to request additional information from a Respondent during the evaluation of that Respondent's Proposal. If the Respondent has concerns about information included in its Proposal that may be deemed confidential, the Respondent shall adhere to the requirements set forth by Section 8.6.

3.1 Cover Page

Include a cover page that contains the following title "Proposal for Contract 24-020: Professional Engineering Services to Support Preliminary and Primary Upgrade Program (CMAR)." The cover shall also include the name of the Respondent. The cover need not identify any other entities other than the Respondent, but may contain other items (photos, logos, etc.) at the discretion of the Respondent.

3.2 Table of Contents

Include a Table of Contents outlining the contents of the Proposal that allows for at least three (3) levels of content to address the level of detail provided in the document.

3.3 Submittal Letter

Each Respondent shall provide a Submittal Letter on the Respondent's letterhead that formally conveys the Proposal to AlexRenew. The letter must be signed by the Respondent's authorized representative who is empowered to sign such material and to commit the Respondent to the representations and obligations contained in the Proposal. If the Respondent is a corporation, an authorized officer shall sign his/her name and indicate his/her title beneath the full corporate name.

3.4 Team Organization and Commitment

The Respondent shall provide sufficient information to enable AlexRenew to understand and evaluate the Respondent's team organization and commitment. The Respondent shall provide:

A. A detailed narrative of the Respondent's ability and capacity to provide the services described in Section 2.5 during the established timeframe and how the Respondent's organization functions to achieve that goal. Focus should be on how the team is structured to best support Owner and CMAR during Phases I and II.

    1. A one-page chart/graphic illustrating the Respondent's organizational structure and details of the "chain of command" responsibilities. If the Respondent intends to use a specific subconsultant, then it may identify such entity by name in the organization

chart; however, the requirements of Section 8.3 (Obligation to Keep the Team Intact) shall apply for such identified entities.

3.5 Key Personnel

Provide Key Personnel as follows, with demonstrated experience in their proposed roles:

A. Professional Engineering Services (PES) Project Manager. A Virginia-licensed professional engineer who will provide project management services and be the day-to-day point of contact for AlexRenew on all matters associated with this professional services engagement. This individual shall be an experienced wastewater treatment professional. This individual shall be responsible for the overall coordination and integration of all work under the Project and for ensuring a coordinated and consistent approach to the execution of all work, including adherence to safety, quality, budget, schedule, and project delivery standards in alignment with AlexRenew requirements and expectations.

B. Lead Wastewater Engineer/Subject Matter Expert (SME). A licensed and qualified individual who will provide knowledge and expertise related to the wastewater headworks process design elements of the work.

C. Lead Structural Engineer/Subject Matter Expert (SME). A licensed and qualified individual who will provide knowledge and expertise in response to the anticipated structural elements of the work.

D. Permitting Lead. A competent and experienced individual who will provide knowledge and expertise in response to the anticipated permitting elements of the work.

E. Maintenance of Plant Operations (MOPO) Specialist. A competent and experienced individual who will provide knowledge and expertise related to maintenance of plant operations during the work.

Provide information that demonstrates the experience of the proposed Key Personnel, including:

A. A narrative that describes the individual's academic and professional qualifications and experience as it relates to the Project and to the individual's specified role;

B. Full resumes (up to 3 pages in length) in Appendix A highlighting experience in the proposed role and clearly stating their role on this Project; and

C. Availability including the scheduled final completion date and contact information of the project owner for all current projects.

Provide information that summarizes the experience of the proposed Key Personnel, as well as Key Personnel reference projects and references as described in A-F below. Information should be provided in the table format shown in Table 3.1.

A. Role

B. Name

C. Total years of experience

D. Years with current entity

E. Reference Projects. Two (2) reference projects with emphasis on project(s) completed while employed with the current entity.

F. References. Two (2) project references; one reference tied to each reference project.

Table 3.1. Summary of Key Personnel Experience

Key Personnel Role	Name	Years of Experience	Years with Entity	Reference Project(s)	Reference(s)
PES Project Manager	Firm/Staff name	Total years of experience	# years with entity	• Project Name • Proj. Owner • Proj. Location • Role on project • One (1) sentence description of work performed.	• Name • Title • Address • Phone • Email
				• Project Name • Proj. Owner • Proj. Location • Role on project • One (1) sentence description of work performed.	• Name • Title • Address • Phone • Email
Lead Wastewater Engineer/SME	" "	" "	" "	" "	" "
Lead Structural Engineer/SME	" "	" "	" "	" "	" "
Permitting Lead	" "	" "	" "	" "	" "
Maintenance of Plant Operations (MOPO) Specialist	" "	" "	" "	" "	" "

3.6 Related Project Experience

Provide sufficient information to enable AlexRenew to understand and evaluate the experience of the Respondent on projects of similar scope and complexity. AlexRenew intends to evaluate Respondents based upon engineering and design services associated with:

A. Key Personnel engagement on projects.
B. Wastewater Headworks Design Experience.
C. Work at active wastewater treatment plant and maintenance of plant operations (MOPO) and flow during construction.

D. Experience with providing design and engineering services on construction projects using collaborative delivery methods.

E. Experience with City of Alexandria permitting.

F. Project team history of working together and engagement of Key Personnel on reference projects outlined in Table 3.2.

G. The Owner has not yet determined which entity will provide RE&I services for the Project. However, if Respondent has internal capabilities to self-perform (i.e., perform without using a subconsultant) RE&I services for projects of similar scope to the Project include a description of those capabilities in this section.

Provide three (3) reference projects that the Respondent considers most relevant for demonstrating the team's qualifications reflecting the items identified in Sections 2.5 and 3.6. The three (3) reference projects must have been performed within the ten (10) years prior to the issuance date for this RFP and be of similar size and scope to the Project, by any method of project delivery.

Complete Table 3.2 and include Items A-G below, in the table or similar structure to encompass the required content. The table may be broken out for each project (for example, one project per page).

A. The name, location, description, and total construction value of the project. The delivery method (design-build, construction manager at-risk, design-bid-build, etc.) under which the project was designed and constructed.

B. The name of the client/owner and contact information including the name, address, phone number, and email for a person representing the client/owner who was in responsible charge of the project and knowledgeable of the Respondent's role and work.

C. The date the project started and the actual project completion date.

D. The Respondent's role and scope performed on the project.

E. Roles and responsibilities of Key Personnel.

F. Summarize the relevant technical scope elements (see Section 2.5) similar to the Project.

G. Identify significant challenges encountered and solutions provided during the project.

Table 3.2. Project Experience Summary

		Project 1	Project 2	Project 3
Project Information	Project Name			
	Project Location			
	Project Description			
	Total Construction Value			
	Delivery Method			
Client/Owner Information	Name			
	Address			
	Phone			
	Email			
Schedule	Notice to Proceed Date			
	Actual Completion Date			
Respondent's Role	Role/Scope			
	Key Personnel and Role(s)			
	Relevant Technical Scope Elements			
	Significant Challenges and Solutions			

3.7 Supporting CMAR Process Management

Provide a narrative that explains Respondent's experience, practical understanding, and suggestions on how Respondent can best support Owner during the preconstruction period to accomplish the goal of early CMAR involvement. The narrative should address, among other things: (a) development of cost models and performance of value engineering and constructability reviews; and (b) key milestones during design development where CMAR will be actively involved with Respondent. Also provide any lessons-learned about how the preconstruction period can be optimized learned from past collaborative delivery projects where Respondent has been involved.

3.8 Other Forms and Required Documents

3.8.1 RFP 24-020 Cover Sheet

Complete the RFP-24-020 Cover Sheet included as Attachment C and include it as the first page of the Proposal.

3.8.2 RFP 24-020 Checklist

Respondents shall complete the RFP-24-020 Checklist provided as Attachment D and include it in the Proposal. The purpose of the RFP Checklist is to aid the Respondent in ensuring all submittal requirements have been included and to provide a page reference indicating the location of each submittal requirement in the Respondent's Proposal. The RFP Checklist is provided to assist the Respondent in preparing its Proposal as a guide only – it does not absolve the Respondent from meeting all requirements of the RFP.

3.8.3 SCC Registration

Any Respondent organized as a stock or non-stock corporation, limited liability company, business trust, or limited partnership or registered as a limited liability partnership shall be authorized to transact business in the Commonwealth of Virginia as a domestic or foreign business entity if so required by Title 13.1 or Title 50 of the Code of Virginia, or as otherwise required by law. The proper and full legal name of the firm or entity and the identification number issued to the Respondent by the Virginia State Corporation Commission must be written in the space provided on the State Corporation Commission (SCC) Form provided as Attachment E. Any Respondent that is not required to be authorized to transact business in the Commonwealth shall include in its proposal a statement describing why the Respondent is not required to be authorized.

Execute and return the SCC Registration Form for each Respondent business entity. Provide the name, registration number, type of corporation and status.

4 EVALUATION OF PROPOSALS

AlexRenew will review the Proposals for responsiveness to the requirements of this RFP and evaluate all responsive Proposals according to factors and weightings outlined in Table 4.1.

Table 4.1. Evaluation Factors and Weighting

Evaluation Factor	Weighting (percentage)
Team Organization and Commitment	10
Key Personnel	40
Related Project Experience	40
Supporting CMAR Process Management	10

Each evaluation factor has an assigned maximum weight as indicated above. The Submittal Letter and all additional requirements and submittals from Section 3.8 are considered pass/fail submissions.

AlexRenew may identify two (2) or more proposals deemed fully qualified, responsible, and suitable. These Respondents may be invited to individual discussions to demonstrate their ability to provide the services required under this Contract. Respondents selected for individual discussions will be encouraged to elaborate on their approach, Key Personnel, experience, and qualifications. Details will be provided when individual discussions are scheduled.

At the conclusion of the individual discussions, AlexRenew will enter into negotiations with the highest ranked Respondent. The parties may negotiate changes in the proposal if deemed in the best interest of AlexRenew. Negotiations may include, but are not limited to:

A. Contract Terms (example Professional Services Agreement to be provided as an addendum).
B. Contract start dates and durations.
C. Contract scope of work and deliverables.
D. Staffing levels and hours.
E. Proposed personnel.
F. Contract pricing.
G. Contract start date.

If a contract can be negotiated at a price considered fair and reasonable and pursuant to contractual terms and conditions acceptable to AlexRenew, the award shall be made to that Respondent. Otherwise, negotiations with the Respondent ranked first shall be formally terminated and negotiations conducted with the Respondent ranked second, and so on through those Respondents deemed fully qualified, responsible, and suitable until such a contract can be negotiated at a fair and reasonable price.

Should AlexRenew determine, at its sole discretion, that only one Respondent is fully qualified, or that one Respondent is clearly more highly qualified and suitable than the others under consideration following receipt and evaluations of proposals, AlexRenew may enter into negotiations with that Respondent without creating a Shortlist or having further individual discussions.

When AlexRenew has decided to award the Contract and successfully completed negotiation of the Contract with such Respondent, the result of such decision will be posted on the AlexRenew website.

5 PROPOSAL SUBMITTAL REQUIREMENTS

5.1 Format

This Section describes the submittal and format requirements that all Respondents must satisfy in submitting a Proposal. Failure of any Respondent to submit its Proposal in accordance with this RFP may result in rejection.

Proposals shall be organized as outlined in Table 5.1.

Table 5.1. Proposal Outline

Proposal Section	Contents	Page Limit
--	Cover Page	N/A
--	RFP-24-020 Cover Sheet	N/A
--	Table of Contents	N/A
1	Submittal Letter	1
2	Team Organization and Commitment	2
3	Key Personnel	3
4	Related Project Experience	4
5	Supporting CMAR Process Management	2
Appendix A	Resumes	3 pages per resume
Appendix B	RFP 24-020 Checklist	N/A
Appendix C	SCC Registration Form	N/A

Pages shall be 8.5-inch by 11-inch with minimum of 0.5-inch margins. Use of 11-inch by 17-inch pages is ***prohibited.*** Minimum font size shall be 11 point. Figures and tables may use a minimum font size of 9 point. All content shall be in English.

5.2 Submission

Proposals must be delivered electronically **via e-mail ONLY** to the following contact, marked with the Respondent's name no later than the time and date deadline specified in this RFP:

Igor Scherbakov
Procurement Manager
igor.scherbakov@alexrenew.com

E-Mail Subject for Proposal Submission: RFP 24-020 [RESPONDENT'S NAME]

Proposals received after the submission date and time prescribed herein will not be considered and will be returned to the Respondent. If confirmation of Proposal receipt is needed, please use the "Request Delivery Receipt" or similar email option when submitting the Proposal. Paper copies of Proposals will not be accepted.

6 QUESTIONS AND ADDENDA

6.1 Questions and Clarifications

All questions and requests for clarification regarding this Procurement shall be submitted to AlexRenew's POC via e-mail only. No requests for additional information, clarification, or any other communication should be directed to any other individual.

NO ORAL REQUESTS FOR INFORMATION WILL RECEIVE A RESPONSE.

All e-mail communications to AlexRenew from Respondents shall specifically reference the correspondence as being associated with "Preliminary and Primary Systems Upgrade Program RFP-24-020."

All questions or requests for clarification must be submitted by the due date and time set forth in Section 2.8. Questions or clarifications requested after such date and time will not be answered, unless AlexRenew elects, in its sole discretion, to do so.

6.2 Addenda

Changes to the Procurement, in the form of addenda, may be issued between the release and submission dates. Receipt and incorporation of all addenda into the Proposal must be acknowledged in the RFP-24-020 Checklist. Notice of addenda will be posted on eVA at http://www.eva.virginia.gov and the AlexRenew website http://alexrenew.com. All potential Respondents are encouraged to monitor these web pages for the most current addenda.

7 RIGHTS AND RESERVATIONS OF ALEXRENEW

In connection with this Procurement, AlexRenew reserves to itself all rights (which rights shall be exercisable by AlexRenew at its sole discretion) available to it under applicable law, including without limitation, the following, with or without cause and with or without notice:

A. The right to cancel, withdraw, postpone, or extend this RFP in whole or in part at any time prior to the execution by AlexRenew of a contract, without incurring any obligations or liabilities.

B. The right to issue a new RFP.

C. The right to reject any and all submittals, responses, and Proposals received at any time.

D. The right to modify any or all dates set or projected in this RFP.

E. The right to terminate evaluations of responses received at any time.

F. The right to suspend and terminate the Procurement process for this Contract, at any time.

G. The right to revise and modify, at any time prior to the Proposal submittal date, factors it will consider in evaluating responses to this RFP and to otherwise revise its evaluation methodology. Should any modifications occur, Respondents will be notified.

H. The right to waive or permit corrections to data submitted with any response to this RFP until such time as AlexRenew declares in writing that a particular stage or phase of its review of the responses to this RFP has been completed and closed.

I. The right to issue addenda, supplements, and modifications to this RFP, including but not limited to modifications of evaluation factors or methodology and weighting of evaluation factors.

J. The right to permit submittal of addenda and supplements to data previously provided with any response to this RFP until such time AlexRenew declares in writing that a particular stage or phase of its review of the responses to this RFP has been completed and closed.

K. The right to hold meetings and conduct discussions and correspondence with one or more of the Respondents responding to this RFP to seek an improved understanding and evaluation of the responses to this RFP.

L. The right to seek or obtain data from any source that has the potential to improve the understanding and evaluation of the responses to the RFP, including the right to seek clarifications from Respondents.

M. The right to permit Respondents to add or delete entities and/or Key Personnel until such time as AlexRenew declares in writing that a particular stage or phase of its review has been completed and closed.

N. The right to add or delete Respondent responsibilities from the information contained in this RFP.

O. The right to appoint and change appointees of any members of AlexRenew's evaluation team.

P. The right to use assistance of technical and legal experts and consultants in the evaluation process.

Q. The right to waive deficiencies, informalities and irregularities in a Proposal, accept and review a non-conforming Proposal, or seek clarifications or supplements to a Proposal.

R. The right to disqualify any Respondent that changes its submittal without AlexRenew approval.

S. The right to respond to all, some, or none of the inquiries, questions and/or requests for clarification received relative to the RFP.

8 MISCELLANEOUS

8.1 Remedies

Respondents may refer to Sections 2.2-4357 through 2.2-4366 of the Code of Virginia to determine their remedies concerning this competitive process.

8.2 No Obligations for Proposal Costs

AlexRenew assumes no obligations, responsibilities, nor liabilities, fiscal or otherwise, to reimburse all or part of the costs incurred or alleged to have been incurred by parties considering a response to and/or responding to this Procurement. All such costs shall be borne solely by each Respondent.

8.3 Obligation to Keep the Team Intact

The team proposed by Respondent, including but not limited to the Respondent's organizational structure and other individuals identified pursuant to Sections 3.4 and 3.5, shall remain intact for the duration of the Procurement and, if the Respondent is awarded the Contract, the duration of the Contract. The Respondent shall not change or substitute any Key Personnel except due to voluntary or involuntary termination of employment, retirement, death, disability, incapacity, or as otherwise approved by AlexRenew. Any proposed change of Key Personnel must be submitted in writing to AlexRenew's POC, who, in his/her sole discretion, will determine whether to authorize a change. Unauthorized changes to the Respondent's organizational structure and/or Key Personnel at any time during Procurement may result in the elimination of the Respondent from further consideration. Job duties and responsibilities of Key Personnel shall not be delegated to others for the duration of the Contract.

8.4 Conflict of Interest

Each Respondent shall require its proposed team members to identify potential conflicts of interest or a real or perceived competitive advantage relative to this Procurement. Respondents are notified that prior or existing contractual obligations between a company and a federal or state agency relative to the Project may present a conflict of interest or a competitive advantage. If a potential conflict of interest or competitive advantage is identified, the Respondent shall provide the pertinent information in a separate letter addressed to AlexRenew's POC along with its Proposal.

AlexRenew, in its sole discretion, will make a determination relative to potential organizational conflicts of interest or a real or perceived competitive advantage, and its ability to mitigate such a conflict. An organization determined to have a conflict of interest or competitive advantage relative to this Procurement that cannot be mitigated, shall not be allowed to participate in this Procurement. Failure to abide by AlexRenew's determination in this matter may result in a Proposal being declared non-responsive.

8.5 Ethics in Public Contracting Act

AlexRenew may, in its sole discretion, disqualify the Respondent from further consideration for the award of the Contract if it is found after due notice and examination by AlexRenew that there is a violation of the Ethics in Public Contracting Act, § 2.2-4367 et seq. of the Virginia Code, or any similar statute involving the Respondent in the procurement of the Contract.

8.6 Virginia Freedom of Information Act

All Proposals submitted to AlexRenew become the property of AlexRenew and are subject to the disclosure requirements of § 2.2-4342 of the Virginia Public Procurement Act and the Virginia Freedom of Information Act (FOIA) (§ 2.2—3700 et seq. of the Code of Virginia). Respondents are advised to familiarize themselves with the provisions of each Act referenced herein to ensure that documents identified as confidential will not be subject to disclosure under FOIA. In no event shall AlexRenew be liable to a Respondent for the disclosure of all or a portion of a Proposal submitted pursuant to this request not properly identified as confidential.

If a Respondent has special concerns about information which it desires to make available to AlexRenew but which it believes constitutes a trade secret, proprietary information, or other confidential information exempted from disclosure, such Respondent should specifically and conspicuously designate that information as such in its Proposal and state in writing why protection of that information is needed. The Respondent should make a written request to AlexRenew's POC. The written request shall:

A. Invoke such exemption upon the submission of the materials for which protection is sought;
B. Identify the specific data or other materials for which the protection is sought;
C. State the reasons why the protection is necessary; and
D. Failure to take such precautions prior to submission of a Proposal may subject confidential information to disclosure under the Virginia FOIA.

RESPONDENTS SHALL NOT DESIGNATE AS TRADE SECRETS OR PROPRIETARY INFORMATION (A) THE RESPONDENT'S ENTIRE PROPOSAL OR (B) ANY PORTION OF THE PROPOSAL THAT DOES NOT CONTAIN TRADE SECRETS OR PROPRIETARY INFORMATION.

Nothing contained in this provision shall modify or amend requirements and obligations imposed on AlexRenew by applicable law, and the applicable law(s) shall control in the event of a conflict between the procedures described above and any applicable law(s).

In the event AlexRenew receives a request for public disclosure of all or any portion of a Proposal identified as confidential, AlexRenew will attempt to notify the Respondent of the request, providing an opportunity for such Respondent to assert, in writing, claimed exemptions under the FOIA or other Virginia law. AlexRenew will come to its own determination whether or not the requested materials are exempt from disclosure. In the event AlexRenew elects to disclose the requested materials, it will provide the Respondent with advance notice of its intent.

8.7 Compliance with the Law in Virginia

Failure to comply with the law regarding those legal requirements in Virginia (whether federal or state) about a Respondent's ability to lawfully offer and perform any services proposed or related to the Project may result in AlexRenew determining that the Respondent is non-responsible, and/or that the Respondent should be disqualified from participation in the Procurement.

8.8 Debarment and Other Adverse Contract Actions

If any Respondent entity or individual serving as an officer, director, owner, project manager, procurement manager or chief financial officer of the Respondent entity has experienced one or more of the following incidences over the past five (5) years, the Respondent shall provide a narrative (3 pages or less) to describe and/or explain the circumstances associated with such incidence:

A. Any contract has been terminated due to its default.

B. Any criminal conviction, and any violation of any federal, state, or local statute or regulation, or of any court order addressing or governing antitrust, public contracting, employment discrimination, false claims, or prevailing wages.

C. Any debarment, or any consideration for debarment, on public contracts by any federal, state, or local government, or by any agency of such government.

8.9 Non-Discrimination

AlexRenew does not discriminate against faith-based organizations in accordance with the Code of Virginia, § 2.2-4343.1 or against a Respondent because of race, religion, color, sex, national origin, age, disability, or any other basis prohibited by state law relating to discrimination in employment in the performance of its procurement activity.

Attachment A
AlexRenew WRRF Preliminary/Primary System Upgrades Final Preliminary Engineering Report (September 28, 2023)

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AlexRenew WRRF Preliminary/Primary System Upgrades

Final Preliminary Engineering Report

Alexandria Renew Enterprises

September 28, 2023

→ **The Power of Commitment**

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<tr><td>S4</td><td>A</td><td>L. Musselman, J. Cannon</td><td>T. Young</td><td>*Record on file</td><td>V. Maillard</td><td>*Record on file</td><td>7/28/23</td></tr>
<tr><td>S4</td><td>B</td><td>L. Musselman, J. Cannon</td><td>T. Young</td><td>*Record on file</td><td>V. Maillard</td><td>*Record on file</td><td>9/28/23</td></tr>
</table>

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The Power of Commitment

Executive Summary

The Alexandria Renew Enterprises Water Resource Recovery Facility (WRRF) is rated for 54 million gallons per day (MGD) wastewater treatment plant that current treats an average flow of 34.9 MGD. The facility was recently re-rated to accept a peak influent flow of 116 MGD under the RiverRenew project. Three structures within AlexRenew's WRRF house the Preliminary and Primary Treatment System (System) main processes. Many of the System components have reached their useful life or are experiencing periodic operation and maintenance issues. Furthermore, the completion of the RiverRenew Tunnel System (expected start operation July 2025) will increase the combined sewer flows to the plant and affect System performance. AlexRenew intends to upgrade the System to account for this change in WRRF mission (which will now also include wet weather flow management and treatment), improve performance, operability, maintainability, and redundancy. The following major components and their associated ancillary equipment were included in the scope of services for this project:

– Coarse Screening: Rags and other large debris present in raw influent wastewater are currently removed by two mechanically cleaned coarse screens with a combined capacity of 120 mgd. The capacity of the system is adequate to treat the expansion design peak flow of 116 mgd, but the current system does not provide redundancy if a coarse screen is out of service. In addition, there are maintenance access challenges with the existing screens. More robust screening is desired to accommodate peak flow events.
– Raw Sewage Pump Station and Discharge Conduits: Constructed in 1954, the Raw Sewage Pump Station's six pumps have undergone extensive maintenance, and some have been re-built. Their performance is inconsistent, and the existing drives are no longer supported by the manufacturer. The pumps appear to have reached their useful life and require major rehabilitation or replacement. Since construction in 1954, the wet wells, suction conduits, and discharge conduits had undergone limited inspection and their condition was unknown. The conduits require investigation and potential rehabilitation to improve flow through the system.
– Fine Screening: The existing fine screens are reaching the end of their effective life and are prone to significant material carryover. Debris, rags, and trash are passing through the system and collecting in the downstream equipment. Replacement with a more efficient fine screening system is needed. Other improvements to increase automation and reduce clogging of the washed and compacted fine screenings are also desired.
– Grit Removal: Poor grit removal efficiency in the grit removal system has resulted in excessive grit carryover to the primary settling tanks. Grit in the primary sludge results in excessive equipment wear and consumes capacity in the solids handling system. The grit removal equipment is also in poor condition and the truck loading operation is inefficient. RiverRenew will bring increased grit loadings to the plant following storm events during the tunnel dewatering and improved operation of the grit removal system is essential.
– Primary Settling Tanks: The eight primary settling tanks are in good condition and have adequate capacity. However, rusting and corrosion are present in the Primary Weir Observation House due to the humid environment. In addition, the primary settling tank scum removal and concentration system is not performing well. RiverRenew will increase solids loading to the settling tanks following peak flow events and the impact of this requires further evaluation.

The purpose of this report is to present the recommended upgrade alternatives for each unit process described herein and provide the basis of design to upgrade the preliminary and primary wastewater treatment systems at AlexRenew's WRRF located at 1800 Limerick Street, Alexandria, VA 22314. GHD prepared Process Evaluation Technical Memoranda (TM) in the earlier phases of the project for the following unit processes at AlexRenew:

– Coarse Screening
– Raw Sewage Pump Station
– Conduits
– Fine Screening
– Grit Removal

– Fine Screening and Grit Loading
– Primary Settling Tanks

This report highlights the existing conditions, identified deficiencies, critical success factors, and design criteria to develop various alternatives for the Preliminary/Primary System Upgrades (PPSU) project. Additionally, an alternative evaluation to compare the non-cost factors, capital costs, and lifecycle costs was developed for each unit process alternative. The recommended approach was developed following a holistic consideration of both the cost and non-cost evaluation criteria. The results of the unit process evaluation are summarized in Table 1-1 which provide an overview of the recommended upgrade for each unit process. Note that this table does not include Primary Settling Tank equipment replacement, which was advanced to an immediate project due to equipment failures and was removed from the PPSU project.

Table 1-1 Summary of Recommend PPSU Projects

Unit Process	Recommended Alternative	Recommended Capital Project Description	No.
Coarse Screening	Alternative 4	Construction of a third coarse screen channel	CS-1
Coarse Screening	Alternative 4	Replacement of existing coarse screens and building improvements	CS-2
RSPS	Alternative 3	RSPS pump replacement	R-1
RSPS	Alternative 3	Wet well and pump room enhancements	R-2
Conduits	Alternative 2	Coat wet wells, suction conduits, and concrete portion of discharge conduits	C-1
Conduits	Alternative 2	Remaining conduit inspection/rehabilitation	C-2
Fine Screening	Alternative 4	Fine screening upgrades	FS-1
Grit Removal	Alternative 3	Replacement of existing grit separators and pumps	G-1
Grit Removal	Alternative 3	Installation of new grit separators and pumps	G-2
Grit Removal	Alternative 3	Installation of new grit washers	G-3
Loading	Alternative 2	Roll off container rail system for each Truck Bay	L-1
Loading	Alternative 2	Conveyor replacement	L-2
Primary Settling	Alternative 1	Refurbishment of PWOH and improve scum skimmer access	P-1
Primary Scum	Alternative 2	Primary scum, sludge pumping upgrades, and PST pipe gallery work	P-2
Primary Settling	Alternative 1	PST baffles, gates, scum skimmer, and handrail replacement	P-3
Primary Settling	N/A	Repair or replace degraded concrete and metal supports for the primary settling tanks effluent channel [1]	P-4

Note:
1. Recommended upgrades based on the Condition Assessment and Proposed Repair Plan Technical Memorandum from October 2022.

After discussion at the PPSU Construction Manager at Risk (CMAR) Discussion Workshop, GHD and AlexRenew agreed that to split the PPSU project into three phases for CMAR delivery. The projects were bundled into three phases based on a qualitative assessment of anticipated construction sequencing constraints and the need to maintain plant operations during construction.

Due to the limited design work, permitting, and temporary facilities (bypass pumping) required, AlexRenew's desire to complete the work by 2025, and location of the capital projects, it is recommended that the project surrounding the primary settling tanks be bundled together and completed in Phase 1, the Building A unit process upgrades in Phase 2, and the remaining Building K process upgrades in Phase 3 as outlined in Table 1-2. These projects were bundled together into a three-phase CMAR program delivery which allows for the entire project to benefit from the CMAR involvement, provides smaller, staggered review packages with improved cost control, and reduces the schedule by one year from the baseline two-phase DBB delivery.

Additional sequence of construction and maintenance of plant operations considerations for the Phase 2 work were considered. Bypass pumping is required for construction of the third coarse screen channel as well as for the RSPS and conduit work. Due to the need of bypass pumping for these upgrades as well as the location to one another, it is recommended that the projects are sequenced together in Phase 2 to reduce the duration of bypass pumping at Building A.

Similarly for Phase 3, bypass pumping is required for replacement of the existing grit separators and associated grit pumping as well as construction of the three new grit separator units and associated pumping at Building K. Due to the need of bypass pumping for these upgrades as well as the location to one another, it is recommended that the projects are sequenced together in Phase 3 to reduce the duration of bypass pumping at Building K.

Table 1-2 Phase 1, Phase 2, and Phase 3 Recommended Capital Projects

Unit Process	Recommended Alternative	Recommended Capital Project Description	Project Phase	No.
Primary Settling	Alternative 1	Refurbishment of PWOH and improve scum skimmer access	1	P-1
Primary Settling	Alternative 1	PST baffles, gates, scum skimmer, and handrail replacement	1	P-3
Primary Settling	N/A	Repair or replace degraded concrete and metal supports for the primary settling tanks effluent channel [1]	1	P-4
Coarse Screening	Alternative 4	Construction of a third coarse screen channel	2	CS-1
Coarse Screening	Alternative 4	Replacement of existing coarse screens and building improvements	2	CS-2
Fine Screening	Alternative 4	Fine screening upgrades	3	FS-1
RSPS	Alternative 3	RSPS pump replacement	2	R-1
Loading	Alternative 2	Roll off container rail system for each Truck Bay	3	L-1
Loading	Alternative 2	Conveyor replacement	3	L-2
RSPS	Alternative 3	Wet well and pump room enhancements	2	R-2
Primary Scum	Alternative 2	Primary scum, sludge pumping upgrades, and PST pipe gallery work	2	P-2
Grit Removal	Alternative 3	Replacement of existing grit separators and pumps	3	G-1
Grit Removal	Alternative 3	Installation of new grit separators and pumps	3	G-2
Conduits	Alternative 2	Coat wet wells, suction conduits, and concrete portion of discharge conduits	2	C-1
Conduits	Alternative 2	Remaining conduit inspection/rehabilitation	2	C-2
Grit Removal	Alternative 3	Installation of new grit washers	3	G-3

Note:
1. Recommended upgrades based on the Condition Assessment and Proposed Repair Plan Technical Memorandum from October 2022.

The implementation schedule of the recommended PPSU project is included in Appendix J and summarized in Table 1-3. The schedule assumes Phase 2 construction cannot begin until Phase 1 95% design is complete to allow for sufficient time for input from the City of Alexandria on the potential permits required for Phase 2 and Phase 3. Additionally, the schedule assumes that construction in Building A and Building K can occur concurrently during Phase 2 and Phase 3 to limit the duration of onsite construction.

Table 1-3 Project Phase Schedule Summary

	Design	Construction	Total
Phase 1 – PST	16 months	18 months	6 years, 1 month
Phase 2 – Building A	16.5 months	34 months (6 months concurrent with Phase 1)	
Phase 3 – Building K	16.5 months	36 months (28 months concurrent with Phase 2)	

The probable construction cost is an important evaluation factor in selecting the recommended alternative for each unit process. Probable construction costs for each alternative were estimated at -20% to +30% accuracy, based on AACE Class 3 cost estimating. Some assumptions based on normal engineering practice are summarized in Section 4.2.1. Additionally, a life-cycle cost analysis is a useful tool to determine the most cost-effective alternative based upon the initial construction cost estimate and long-term (typically 20 years) operation and maintenance cost (net present value, or NPV). Some assumptions based on normal engineering practice are summarized in Section 4.2.2. The individual unit process estimated construction costs and life cycle costs were combined to determine the overall project costs for Phase 1, Phase 2, and Phase 3. The total project phase construction costs are shown in Table 1-4.

Table 1-4 Phase 1, Phase 2, and Phase 3 Estimate of Probable Construction Costs

	Phase 1	Phase 2	Phase 3
2021 Project Cost (-20% to +30% accuracy)	$11,826,000	$27,892,000	$40,427,000
Mid-Point to Construction Project Cost (-20% to +30% accuracy)	$13,044,000	$32,308,000	$46,828,000

Table 1-5 combines the 2021 construction cost estimate and the 20-year net present value for the associated projects included in the respective Phase 1 and Phase 2.

Table 1-5 Phase 1, Phase 2, and Phase 3 Life Cycle Cost

	Phase 1	Phase 2	Phase 3
2021 Construction Cost Estimate (w/o Contingency)	$10,183,000	$22,970,000	$33,293,000
20-Yr O&M NPV	$1,774,000	$22,445,000	$54,875,000
Total (-20% to +30% accuracy)	**$11,957,000**	**$45,415,000**	**$88,168,000**

The proposed Phase 1 project will cost approximately $13.04M to the midpoint of construction in 2025, Phase 2 will cost approximately $32.31M to the midpoint of construction in 2027, and Phase 3 will cost approximately $46.83M to the midpoint of construction in 2027.

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Appendices

1. Introduction

This report is prepared as part of Task Order WA_20-001-C-01, or Preliminary/Primary System Upgrades (PPSU), to present the recommended upgrade alternatives for each unit process described herein and provide the basis of design to upgrade the preliminary and primary wastewater treatment systems at AlexRenew's WRRF located at 1800 Limerick Street, Alexandria, VA 22314.

1.1 Background

Three structures within AlexRenew's WRRF house the Preliminary and Primary Treatment System (System) main processes. Many of the System components have reached their useful life or are experiencing periodic operation and maintenance issues. Furthermore, the completion of the RiverRenew project (expected start operation July 2025) will increase the combined sewer flows to the plant and affect System performance. AlexRenew intends to upgrade the System to account for this change in WRRF mission (which will now also include wet weather flow management and treatment), improve performance, operability, maintainability, and redundancy. The following major components and their associated ancillary equipment were included in the scope of services for this project:

- Coarse Screening: Rags and other large debris present in raw influent wastewater are currently removed by two mechanically cleaned coarse screens with a combined capacity of 120 mgd. The capacity of the system is adequate to treat the expansion design peak flow of 116 mgd, but the current system does not provide redundancy if a coarse screen is out of service. In addition, there are maintenance access challenges with the existing screens. More robust screening is desired to accommodate peak flow events.
- Raw Sewage Pump Station and Discharge Conduits: Constructed in 1954, the Raw Sewage Pump Station's six pumps have undergone extensive maintenance, and some have been re-built. Their performance is inconsistent, and the existing drives are no longer supported by the manufacturer. The pumps appear to have reached their useful life and require major rehabilitation or replacement. Since construction in 1954, the wet wells, suction conduits, and discharge conduits had undergone limited inspection and their condition was unknown. The conduits require investigation and potential rehabilitation to improve flow through the system.
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- Primary Settling Tanks: The eight primary settling tanks are in good condition and have adequate capacity. However, rusting and corrosion are present in the Primary Weir Observation House due to the humid environment. In addition, the primary settling tank scum removal and concentration system is not performing well. RiverRenew will increase solids loading to the settling tanks following peak flow events and the impact of this requires further evaluation.

Note that Primary Settling Tank equipment replacement was advanced to an immediate project due to equipment failures and was removed from the PPSU project.

GHD prepared Process Evaluation Technical Memorandum in the earlier phases of the project for the following unit processes at AlexRenew:

- Coarse Screening
- Raw Sewage Pump Station

– Conduits
– Fine Screening
– Grit Removal
– Fine Screening and Grit Loading
– Primary Settling Tanks

The TMs highlight the existing conditions, identified deficiencies, critical success factors, and design criteria to develop various alternatives for upgrade of the unit process. Additionally, an alternative evaluation to compare the non-cost factors, capital costs, and lifecycle costs was developed for each unit process alternative. The recommended approach was developed following a holistic consideration of both the cost and non-cost evaluation criteria. The sections that follow provide a brief summary of the existing conditions, deficiencies, critical success factors and recommendations for each process area within the PPSU project.

The individual unit process recommendations were then combined to create an overall PPSU delivery program to implement the upgrades which is further detailed in Section 13.

1.2 Purpose of This Report

The purpose of this report is to summarize the recommended upgrades for each unit process to meet all current and future needs based on an economic and technical evaluation. This report presents the recommendations resulting from the TM evaluation and provides a recommended sequence, schedule, and cost for the PPSU project.

1.3 Scope

The scope of this report includes the following:

– Evaluation of existing unit process assets.
  - Coarse Screening
  - Raw Sewage Pump Station
  - Conduits
  - Fine Screening
  - Grit Removal
  - Fine Screening and Grit Loading
  - Primary Settling Tanks
– Determination of access, operation, maintenance, and technical feasibility for all unit process upgrade alternatives.
– Evaluation of non-cost factors for unit process upgrades alternatives.
– Evaluation of opinion of probable construction cost (OPCC) for unit process upgrades alternatives.
– Detailed layouts, cross sections, schematic design, and conceptual design criteria for recommended unit process upgrades.
– Evaluation of law, regulation, ordinances, and permitting requirements for the overall project delivery.
– Evaluation of any potential risk in design, construction, scheduling, budget, or operation.

2. Existing Facility Condition Assessment

GHD conducted a condition assessment on the existing preliminary and primary treatment unit processes which consisted of reviewing the background information provided by AlexRenew, attending site visits with AlexRenew staff, as well as conducting Process Background Workshops with the AlexRenew Core Team during the early stages of the project.

2.1 Coarse Screening

Building A was expanded in 2005 as part of the "Advanced Wastewater Treatment Facility Upgrade" project to add a new Coarse Screen Room to house mechanical bar screens. It includes two mechanical bar screens with multiple dumpsters for screening storage and removal. The mechanical bar screens replaced the original manual bar rake system which was installed in the 1950s. Each screen is equipped with two slide gates to isolate each coarse screen for maintenance. The existing plan for Building A is presented in Figure 2-1 and highlights the Coarse Screen Area location.

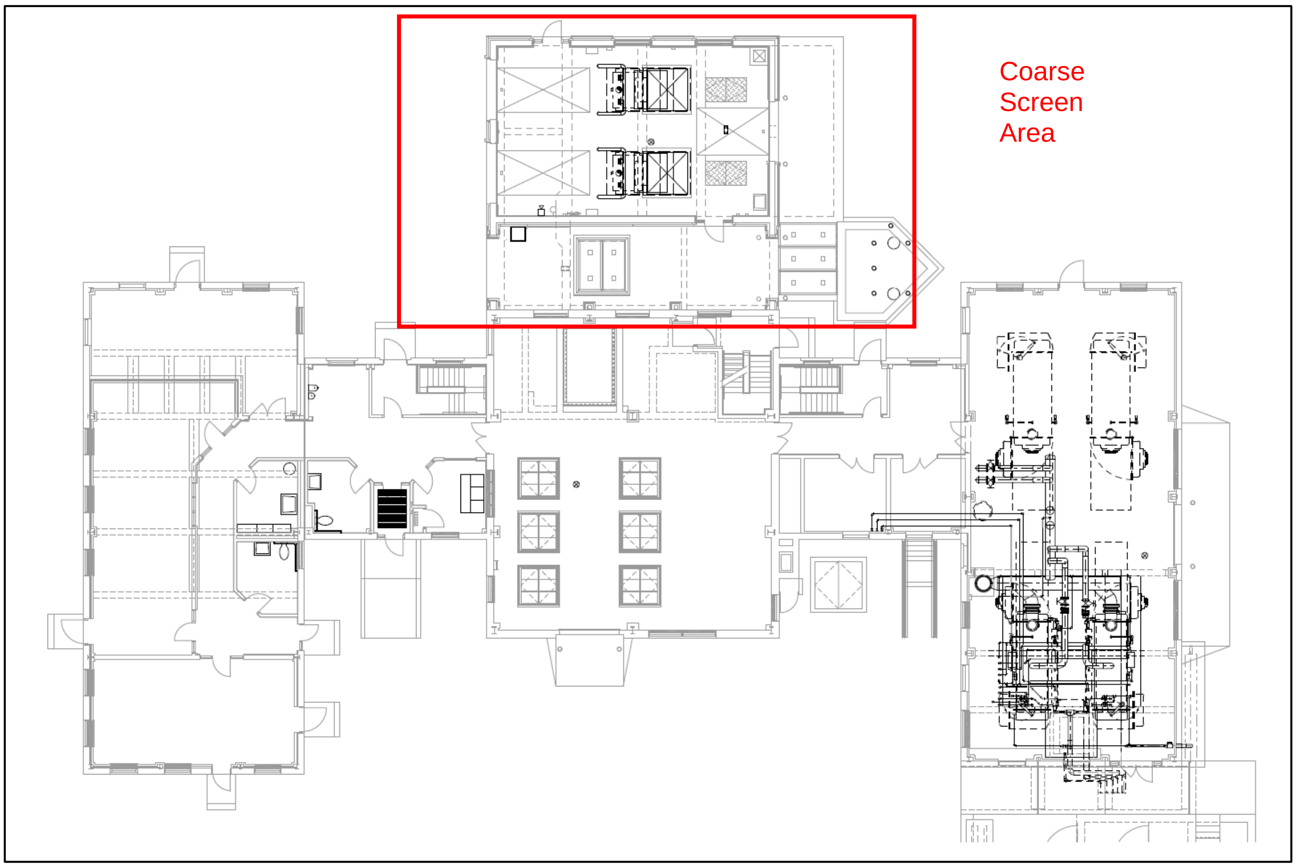


Figure 2-1 Existing Building A Plan with Coarse Screen Area Highlighted

The AlexRenew WRRF accepts wastewater from a combined sewer system that includes various debris. The existing coarse screens provide the first line of defense to the treatment facility equipment particularly the Raw Sewage Pump Station (RSPS). Raw wastewater from the Commonwealth Interceptor and the Potomac Interceptor combines at the existing Flow Control Structure No. 1, adjacent to the Coarse Screen Room. A channel extends along the south wall of the Coarse Screen Room from the Flow Control Structure to the two screens. Raw wastewater from the Potomac Yards Trunk Sewer enters directly into this screen influent channel. The combined flow splits between the two coarse screen channels. Any solids larger than 2-5/8" would be caught by the coarse screens and removed from the influent.

The site plan of the existing Coarse Screen Area is presented in Figure 2-2 and shows the incoming sewers and other major buried utilities.

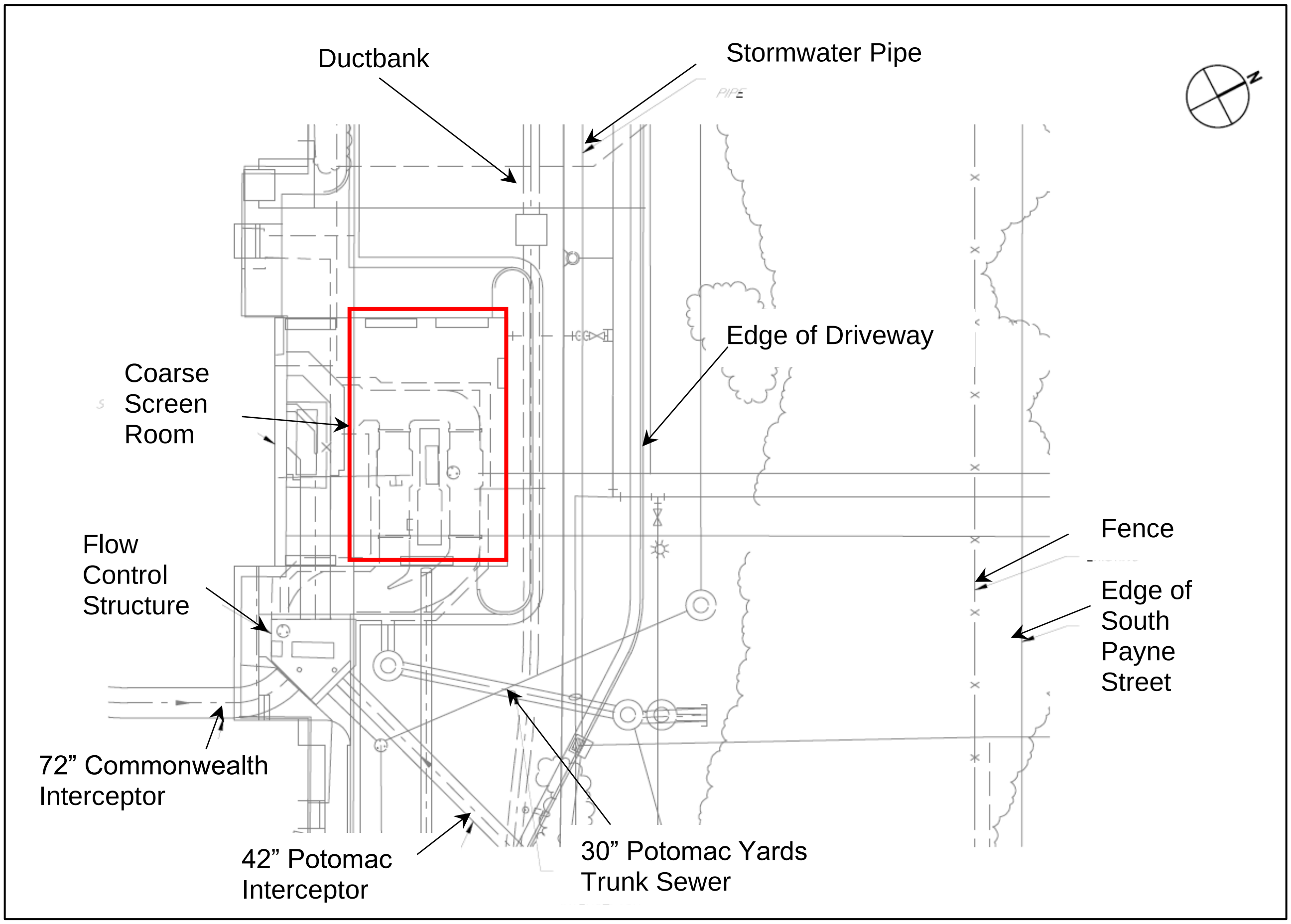


Figure 2-2 Existing Coarse Screen Area Site Plan

Design information for the existing coarse screening system is summarized in Table 2-1.

Table 2-1 Existing Coarse Screening System

Parameters	Design Information
Quantity	2
Supplier and model	US Filter/Envirex GB-23 COG Rake Bar Screens
Screen hydraulic capacity [1 3]	60 MGD each
Screen channel width	6.0 ft
Screen channel depth [2]	12.75 ft
Screen side frame length	41.55 ft
Depth from screen bottom to first floor	28.5 ft
Material of construction	Type 316 stainless steel
Bar opening size	2-5/8 inch
Maximum head loss [1 3]	3.0 inches
Drive motor (explosion-proof)	3.0 Hp (460 VAC/3-phase/60-hertz)

Parameters	Design Information
Angle of installation	80 degrees
Electrical equipment rating	National Electric Code (NEC) Class I, Group D, Division 2 [4]
Operation Control	Timer / High Water Level Float Switch

Notes:
1. At a screen upstream WL of Elevation -3.00 ft based on 108 MGD design flow plus recycles.
2. From bottom to top of screen channel.
3. Reference: Record Drawing G-27 of "Advanced Wastewater Treatment Facility Upgrade, Package D".
4. Coarse Screen Room and Basement (above channel covers) are derated from Class I, Division 1 by continuous ventilation at 12 air changes per hour.

The existing hydraulic profile across the coarse screens at the peak design flow of 116 MGD plus internal plant recycles (119 MGD total flow) is shown in Figure 2-3. Note that Record Drawing A-S-120C indicates screen channel floor is flat at Elevation -10.75. The hydraulic profile indicates a water depth downstream of the coarse screens of 6.08 ft at peak design flow. The downstream water depth is controlled by the operation of the raw sewage pumps.

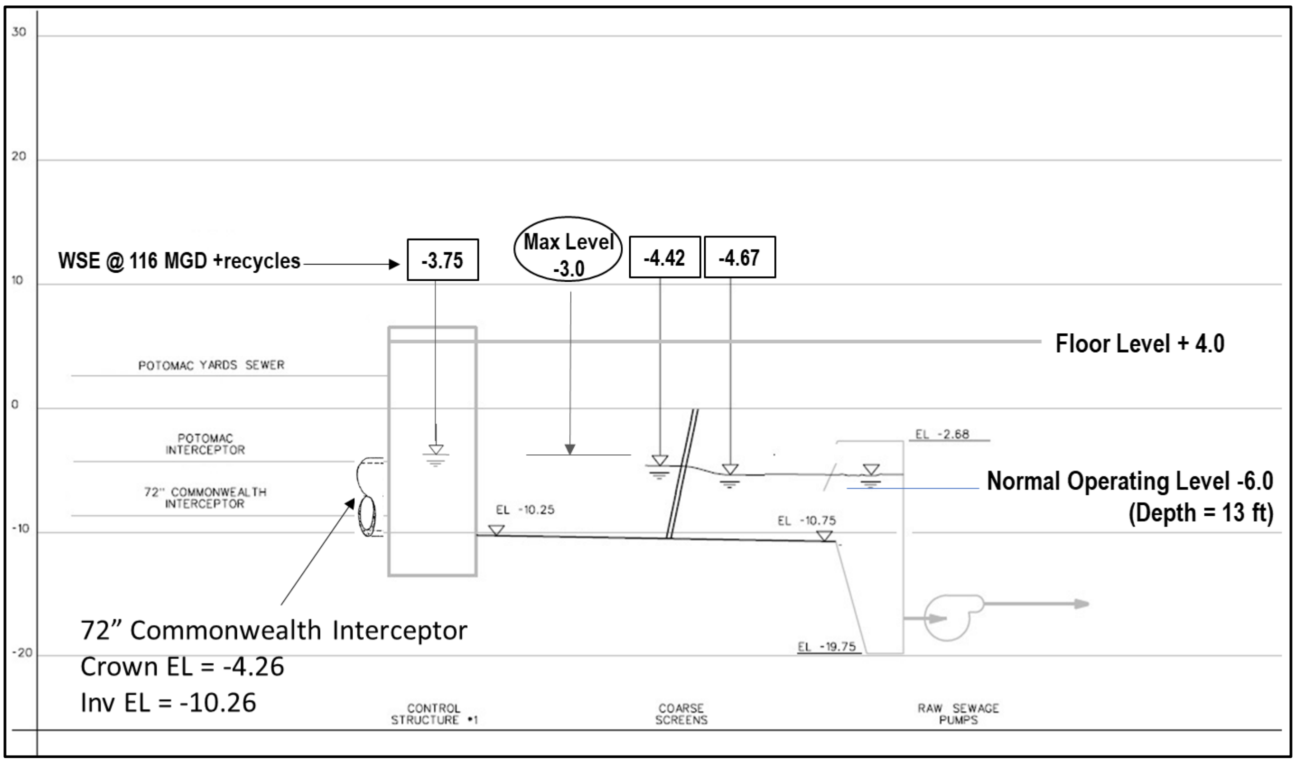


Figure 2-3 Existing Hydraulic Profile Across Fine Screens (courtesy Jacobs, 2021)

The calculated approach velocity at the anticipated normal operational conditions, design average flow of 54 MGD and a maximum water depth of 7.25 ft, is 1.9 ft/s which meets the required velocity of 1.25 to 3.0 ft/s in the SCAT Regulations, Paragraph 12 VAC 5-581-560. D. Grit settling has not been identified by the operation staff as an operational issue.

A site visit of the coarse screening system was conducted on 10/14/2020. The site visit photos of the existing coarse screening system are shown in Figure 2-4, Figure 2-5, and Figure 2-6.

Figure 2-4 Existing Coarse Screen Room (Exterior View Looking South)

Figure 2-5 Existing First Floor Coarse Screen Room

Figure 2-6 Existing Coarse Screening Area Basement

Normally the plant runs one coarse screen at a time. The second coarse screen is placed into service at high flows (when the capacity of the first screen anticipated to be exceeded) by opening the sluice gates and turning the unit on.

The existing coarse screens have been in service for more than 15 years. The screening removal data from January 2015 to August 2020 were reviewed and analyzed and the results are presented in Figure 2-7, including daily flows and calculated daily coarse screening quantities per million gallons of flow. The associated 30-day moving average values are also shown.

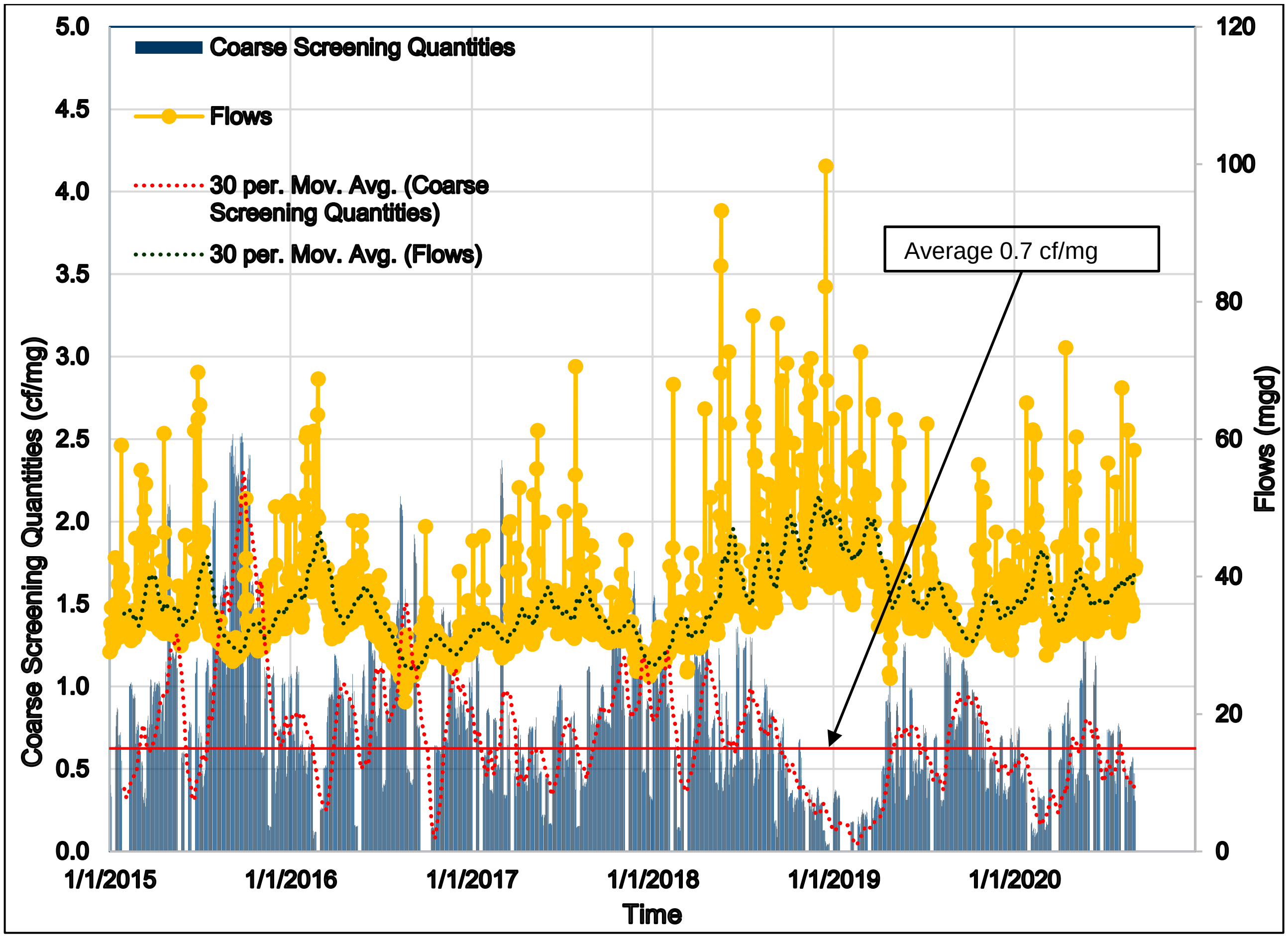


Figure 2-7 Historical Coarse Screening Removal

The data indicates that the average coarse screening removal rate ranges from 0.2 to 2.5 cf/MG, with an average of 0.7 cubic foot per million gallons (cf/MG). This is comparable to the average coarse screening removal rate for a 50 mm (2") screen of 0.8 CF/MG shown published in industry standard reference documents as shown in Table 2-2.

Table 2-2 Typical Screen Removal Rates [1]

Screen Opening Size	Volume of Screening Removed (CF/MG) – Range	Volume of Screenings Removed (CF/MG) – Average
6 mm (1/4")	7-13.5	9.5
12.5 mm (1/2")	5-10	7.0
25 mm (1")	2-5	3.0
37.5 mm (1.5")	1-2	1.5
50 mm (2")	0.5 – 1.5	0.8

Note:
1. From Metcalf & Eddy Wastewater Engineering, 5th Edition, Table 5-2.

Uncompacted coarse screenings are discharged into 4 CY dumpsters. Drains in the bottom of the dumpster allow residual water to drain into the trench drains on the floor. The dumpsters are rotated daily by plant operations staff using a forklift to place a new dumpster behind the screen, although the dumpsters are often not full when rotated. Six dumpster bins can fit within the building (three behind each screen). Screenings in the dumpsters are collected three days per week (normally Tuesdays, Thursdays, and Saturdays) by a contractor (American) and hauled to landfill disposal. The same contractor is responsible for hauling a similar sized 4 CY dumpster which handles screenings from the pre-pasteurization screen press. The dumpsters are owned by the contractor.

Based on an engineering and operations review of the existing coarse screening system, comments received from the operation staff on December 2, 2020, and during the Process Background Workshop with the AlexRenew Core Team on December 3, 2020, the following deficiencies were identified with the existing system:

1. Unsatisfactory performance, passing large amounts of solids such as leaves and rags downstream

According to Water Environment Federation (WEF) MOP8, coarse screens typically have screen openings which are larger than 0.25 inch and up to 1.5 inch in size. The current 2-5/8” screen opening size is larger than this range, and results in a relatively low screenings capture rate of 0.7 cf/MG. The large screen opening size allows a significant quantity of material to pass through the screens and onto downstream unit processes. In addition, climber screens have only a single rake arm and it can take over a minute for the rake to make a single pass across the screen face, causing solids to accumulate on the screen face rapidly during a high flow event. The velocity across the obstructed screen face increases, as a result and can drive debris through the screen openings before the rake arm can return to clean the screen face.

Although the screens have served to protect the influent pumps from significant clogging problems, the relatively poor screening removal has resulted in most of the leaves, rags, and other debris in the influent passing down to the fine screens. As a result, the fine screens frequently become overwhelmed with high solids loadings during high flow events. More effective removal of debris by the coarse screens would reduce the loading on the fine screens and help to prevent them from being overloaded so easily during high flow events.

2. No redundant unit exists, and risk of failure is high

Both existing screens must be in operation to pass peak weather flows higher than 60 million gallon per day (MGD). Therefore, the existing coarse screens do not meet Virginia Department of Health SCAT Regulations. Paragraph 12 VAC 5-581-560.C.2 of the SCAT Regulations requires “Where two or more mechanically cleaned screens are used, the design shall provide for taking any unit out of service without sacrificing the capability to handle the peak design flow”.

Should one of the screens become clogged, fail, or need be taken out of service for maintenance, there is no installed redundant screening unit, and no means of bypassing flow around the screens. Therefore, if one of the screens clogs or fails to operate properly for any reason, the screen will quickly blind with solids and cause upstream flow to back up into the collection system. This can cause an overflow to occur.

3. Equipment is at the end of its expected useful life

As indicated above, the existing coarse screens were installed in 2005 and are nearing the end of their expected useful 20-year life. At least one coarse screen is in constant use 24 hours per day 365 days per year and experience heavy wear from rags and grit in the influent wastewater. As the screens age, the risk of screen failure increases.

4. Equipment is no longer supported by original equipment manufacturer

The manufacturer of the existing screens, US Filter, sold the screen line and no longer supports these units. The company who purchased the screen line, Evoqua, does not support these units either. Without manufacturer support, spare parts and service assistance for the units are not readily available. In addition, renovation or upgrade of the existing screens by the original equipment manufacturer is not possible.

5. Motor and rake arm are hard to safely access for maintenance

The motor is attached to the rake arm, which moves vertically across the entire face of the screen. The normal “rest” location for the rake arm is approximately 13 feet above the first floor, making the motor difficult to access in this location. If the rake arm becomes jammed somewhere along its running path, the plant staff has to access the rake arm to dislodge it wherever it gets stuck, which could be at any point on the screen face and could be challenging to access.

6. Screenings handling requires daily manual effort

The removed coarse screenings drop to an open top 4 CY dumpster. The operation staff must rake them down multiple times per shift to distribute the screenings in the dumpster. The dumpsters are switched on a daily basis by plant operational staff using a forklift. Due to limited storage space in the building, the operators have to stack all of the screenings dumpsters in a row behind the screens, so in order to remove one and replace it with a new dumpster, all three dumpsters behind the screen must be pulled out of the building in order to switch the dumpster behind the screen. During storm events, it may be necessary to switch the dumpsters more often. While the existing process is workable for the staff, should finer coarse screens be considered which have greater screenings capture, screening materials handling effort and frequency should be considered in the evaluation.

7. Screenings drainage

Drainage from the dumpster collects on a floor drain and drops straight down to the lower level on top of the effluent gates, causing corrosion and leaving standing water on the floor. Better routing of floor drainage directly to the screen channels is desired.

8. Building maintenance access

Plant staff uses a forklift to access the upper part of the screens, but the floor hatches in front of the screens are not rated for this load so steel plates have to be installed over them to allow equipment access. Also, the doors on the south side of the building are not aligned with the screens so access to the units for maintenance is restricted.

9. RiverRenew project may require more robust screening to accommodate peak flow events

The RiverRenew project will capture current combined sewer overflows and route these flows to the treatment plant. The additional captured flow includes stormwater flow into the combined sewer portion of the collection system and is more likely to include high loadings of large solids such as leaves, roadway debris and grit, than other separated sewer portions of the collection system. Although flows captured and returned to the plant via the RiverRenew Tunnel Dewatering Pump Station will not contain solids larger than 3” diameter, this flow could contain significant amounts of debris impacting the coarse screen loading rates. The capture and return of this flow will also result in more sustained peak flows than are currently experienced at the plant.

Three major critical success factors were identified to address the above deficiencies:

– Upgrade coarse screening equipment
– Provide coarse screening redundancy
– Improve coarse screening materials handling

2.2 Raw Sewage Pump Station

AlexRenew WRRF receives both separate and combined sewage from five primary interceptors that converge upstream of Building A. Raw sewage that enters the basement of Building A is split equally between two channels that contain coarse screens for the purpose of removing large debris. The screened effluent momentarily rejoins to a common channel before diverging to two wet wells in the basement of Building A, which signifies the beginning of the RSPS process. Raw sewage is pumped from a low elevation in the wet wells to a high elevation in Building K to utilize gravity flow through the remaining preliminary and primary processes. The RSPS consists of two identical trains known as the North Side and South Side that remain hydraulically independent beginning from the flow split at the wet wells until they combine in the common fine screen channel in Building K. The following description highlights the existing arrangement for one side of the RSPS but is equally applicable to describe the other side since they share identical processes. A schematical representation of the existing RSPS arrangement is presented in Figure 2-8. Figures 1 and 2 in Appendix B show plan and section views of the RSPS in Building A.

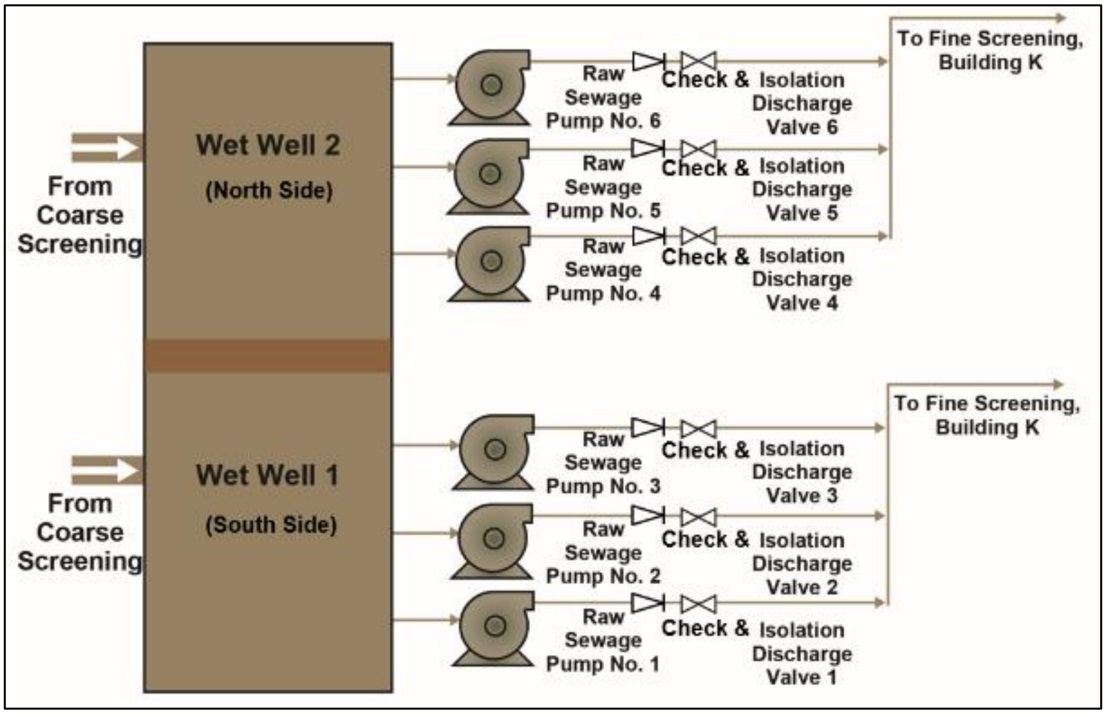


Figure 2-8 Schematic of RSPS

Following stop log grooves in the influent channel, the floor declines steeply and widens to provide storage for the wet well. A submerged, rectangular suction conduit separated from the wet well by a motorized sluice gate is routed beneath the pump room. The suction conduit branches outwards to the volutes of the three dry pit non-clog end-suction centrifugal pumps. The pumps draw sewage from the suction conduit beneath the pump room and discharge to short, horizontal runs of cast iron pipe installed with a check valve and knife gate valve before exiting into a common rectangular concrete discharge conduit. Raw sewage in the discharge conduit is conveyed below grade to Building K for fine screening and further preliminary and primary treatment. Between Building A and Building K the original rectangular concrete discharge conduit transitions to a newer circular cast iron pipe that was installed during the construction of Building K around 1998 as part of the “Advanced Wastewater Treatment Facility Upgrade” project to replace the earlier fine screening system designed in 1972.

The RSPS was constructed in 1954 as part of the “AVA Sewage Treatment Plant Divisions I – V” project, which included the design of Building A and the original Screens and Grit Building among others. Since initial construction no major structural upgrades to the wetted portion of the RSPS has occurred, such that the wet wells, suction conduits, pumping arrangement, and discharge conduits within Building A are taken to be in a condition reflective of continuous use since 1954. The mechanical equipment, instrumentation, and miscellaneous structural elements associated with the RSPS have been upgraded on occasions since initial construction, however significant upgrades occurred in 1972 as part of the “Additional Sewage Disposal Works Preliminary Treatment Units Upgrade” project and in 2005 as part of the “Advanced Wastewater Treatment Facility Upgrade”. Table 2-3 presents a summary of the key upgrades to the RSPS that have occurred since initial construction.

Table 2-3 RSPS Upgrades

Year	Description of Upgrade
1954	– Initial construction

Year	Description of Upgrade
1972	– Two new raw sewage pumps and two modified existing pumps – Motor platform extension – Discharge conduit rerouted to New Screen and Grit Building
1998	– New circular raw sewage discharge conduits connecting existing discharge conduits to Building K
2005	– Bar racks removed from wet wells – Gate Access Room modified (above wet wells). Includes new sluice gate actuators and wet well level bubblers – New motors for raw sewage pumps 1, 4, 5, and 6 – New Pump Room sump pumps and associated discharge piping – New raw sewage pump discharge pressure switches and pump seal water connections – New ladder into RSPS sump pit
2014	– Installed check valves and knife gate valves on RSPs discharges
2018-2019	– New VFDs

Since initial construction, AlexRenew has experienced a continual increase in influent flows that necessitated more capacity from the RSPS. As pumps neared the end of their useful life, they were replaced with larger pumps to convey higher flows. Additionally, a pre-engineered area reserved for a future pump on the North Side was utilized when Pump 6 was first installed in 1972. Pumps were generally not replaced together and therefore varying drive technologies, design points, and manufacturers/models have operated simultaneously. The initial design had three gas powered, extended shaft, right angle gear drives and two constant speed driven induction motors. Over time, all pumps were modified or replaced with close coupled induction motors that were driven by constant speed drives and eventually, variable frequency drives. Several of the existing pumps have been rehabilitated without consulting the manufacturer. Within the past ten years, several pumps have been rebuilt. A detailed history of the raw sewage pumps is presented in Table 2-4, and a summary of the current raw sewage pumps is presented in Table 2-5. The information provided in Table 2-4 and Table 2-5 is based on record drawings, AlexRenew background information, and data provided from the pump manufacturer. Data is inconsistent between sources, particularly regarding the year of installation. Best judgement was used to fill gaps and correct inconsistent data.

Table 2-4 Raw Sewage Pump History

Pump Attribute	RSP #1	RSP #2	RSP #3	RSP #4	RSP #5	RSP #6
Initial Construction (1954)						
Manufacturer	Worthington Corporation	Worthington Corporation	Worthington Corporation	Worthington Corporation	Worthington Corporation	NA
Model	20 MCZ-1	24 MCZ-1	24 MCZ-1	24 MCF-1	24 MCF-1	NA
Design Point: Flow Head	 14 MGD 33 ft	 21 MGD 35 ft	 21 MGD 35 ft	 21 MGD 35 ft	 21 MGD 35 ft	 NA NA
Motor	Gas Engine	Gas Engine	Gas Engine	Induction Motor	Induction Motor	NA
Engine or Motor Horsepower	122	187	187	150	150	NA
Additional Sewage Disposal Works Preliminary Treatment Units Upgrade (1972)						
Manufacturer	Worthington Corporation	Initial Const	Initial Const	Initial Const	Initial Const	Worthington Corporation

Pump Attribute	RSP #1	RSP #2	RSP #3	RSP #4	RSP #5	RSP #6
Model	24 MNF	Initial Const	Initial Const	Initial Const	Initial Const	24 MNF
Design Point: Flow Head	 30 MGD 42 ft	 18 MGD 42 ft	 18 MGD 42 ft	(Modified) [1] 30 MGD 42 ft	(Modified) [1] 30 MGD 42 ft	 30 MGD 42 ft
Motor	Induction Motor	Initial Const	Initial Const	Induction Motor	Induction Motor	Induction Motor
Engine or Motor Horsepower	300	Initial Const	Initial Const	300	300	300
Alexandria Sanitation Authority – Contract #6 – Raw Sewage Pump Station (Circa 2001 - 2005)						
Manufacturer	'72 upgrade	Worthington Corporation	Flowserve	Flowserve	Unknown [3]	'72 upgrade
Model	'72 upgrade	24 MCF	24MN28A [2]	24MN28A	Unknown [3]	'72 upgrade
Design Point: Flow Head	'72 upgrade	 30 MGD 42 ft	 30 MGD 42 ft	 30 MGD 42 ft	'72 upgrade	'72 upgrade
Motor	'72 upgrade	Induction Motor	Induction Motor	Induction Motor	'72 upgrade	'72 upgrade
Engine or Motor Horsepower	'72 upgrade	300	300	300	'72 upgrade	'72 upgrade

Notes:

1. Impeller increased from 23" to 26 ½" diameter. Also, larger motor installed.
2. Conflicting information between record drawings, AlexRenew background information, and pump manufacturer. Possibly still had initial 24 MCZ pump model.
3. Conflicting information between record drawings, AlexRenew background information, and pump manufacturer. RSP #5 may have been replaced-in-kind between initial construction and 2001.

Table 2-5 Current Raw Sewage Pump Data

Pump Attribute	RSP #1	RSP #2	RSP #3	RSP #4	RSP #5	RSP #6
Manufacturer	Flowserve (acquisition)	Flowserve (acquisition)	Flowserve	Flowserve	Flowserve (acquisition)	Flowserve (acquisition)
Model	24 MNF	24 MCF	24MN28A	24MN28A	24 MCF	24 MNF
Installation Year	1975 [1]	1992 [1]	2000 [1]	1986 [1]	Unknown [1]	1975
Design Point: Flow Head	 30 MGD 42 ft	 30 MGD 42 ft	 30 MGD 42 ft	 30 MGD 42 ft	 30 MGD 35 ft	 30 MGD 42 ft
Inlet Size Outlet Size	26" 24"	26" 24"	26" 24"	26" 24"	26" 24"	26" 24"
Motor Manufacturer	US Motor	US Motor	US Motor	US Motor	US Motor	US Motor
Motor Horsepower	300	300	300	300	300	300
Motor Install Year	2005	2005	2005	2005	2005	2005
Drive	VFD	VFD	VFD	VFD	VFD	VFD
Drive Install Year	2017-2018	2017-2018	2017-2018	2017-2018	2017-2018	2017-2018

Pump Attribute	RSP #1	RSP #2	RSP #3	RSP #4	RSP #5	RSP #6
Pump Rebuild	2017	NA	2018	New rotating assembly 2001	2015	2014

Note:
1. Conflicting information between record drawings, AlexRenew background information, and pump manufacturer.

As stated, the capacity of the RSPS has continually increased since initial construction to manage the increasing influent flow. Evidently, the design criteria for the RSPS has changed to accommodate the increased flow and facility expansions. The RSPS is currently designed to meet the criteria presented in Table 2-6. Actual flow data from 2008-2018 is presented concurrently, courtesy of Jacobs 2019, “AlexRenew Process Manual Module 22: Plant Hydraulics” PowerPoint presentation dated October 2019.

Table 2-6 Existing Raw Sewage Pump Station Design Criteria

Condition	Design Flow (MGD)	2008-2018 Data
Average Daily Flow	54	34.9
Max Month Flow	70	45
Max Week	80	60
Max Day	90	92
Peak Instantaneous	108	120

As a consequence of receiving combined sewage, AlexRenew experiences significant spikes in influent flow attributed to storm events. Figure 2-9 illustrates how instantaneous flows have spiked during wet weather events from September 2019 to March 2021. Figure 2-10 illustrates how a single wet weather event affected influent flow. Rainfall data was collected from NOAA Local Climatological Data for Ronald Reagan National Airport for a wet weather event from February 26 to March 1, 2021.

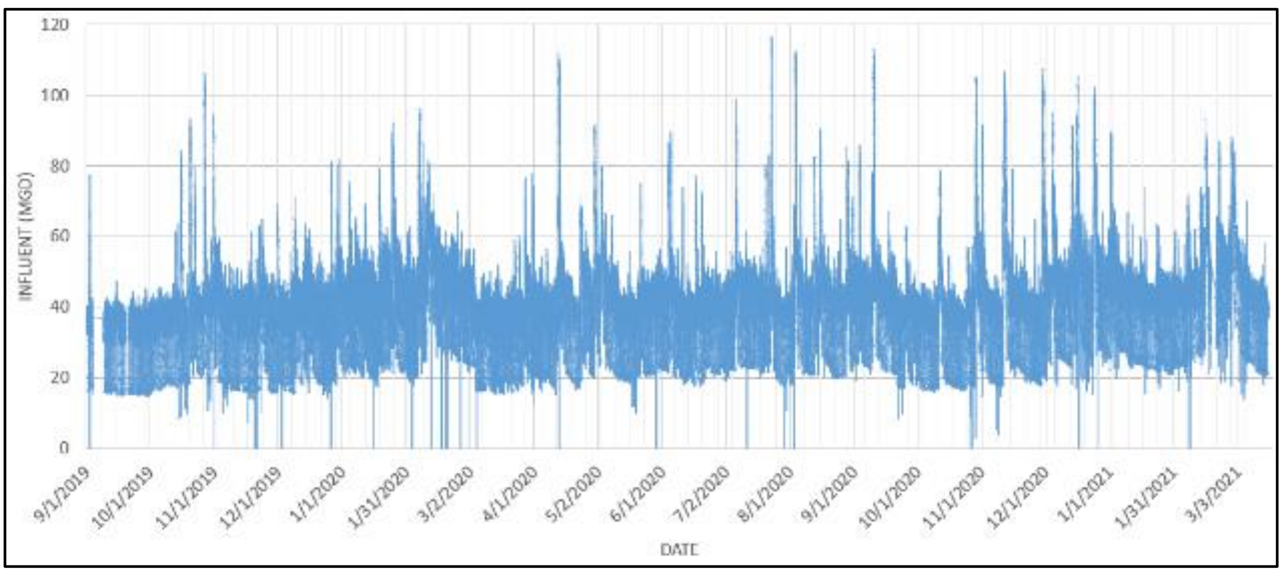


Figure 2-9 Instantaneous Influent Flow from September 2019 to March 2021

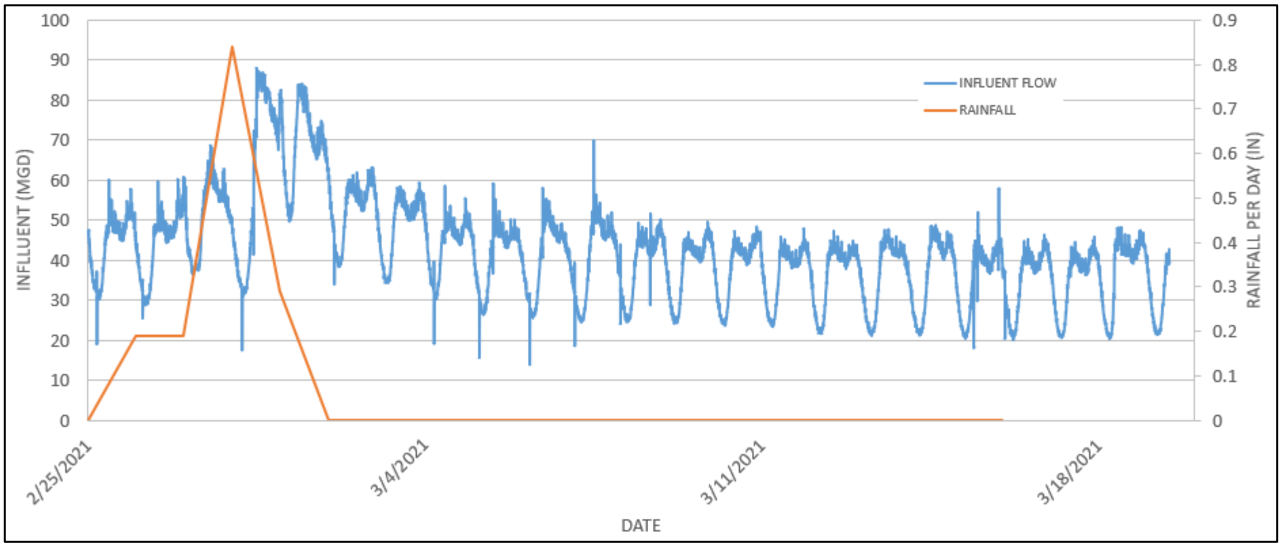


Figure 2-10 Wet Weather Event February 26 through March 1, 2021

Beyond the pumping infrastructure, numerous auxiliary components are included in the RSPS to provide adequate isolation, pump protection, and facilitate maintenance. The existing system auxiliary mechanical equipment is presented in Table 2-7. Other existing auxiliary systems include valving and drainage to sump pits, sump pumps with discharge piping routed to wet wells, and seal water for raw sewage pumps supplied with plant water (W3).

Table 2-7 Auxiliary Mechanical Equipment

Parameter	Design Criteria
Wet Well Sluice Gate	
Quantity	2
Manufacturer and Model	Rodney Hunt
Size	5 ft width x 5 ft height
Actuator Motor	5 hp
Discharge Check Valve	
Quantity	6
Size	30-inch diameter
Manufacturer	Pentair/Tyco
Style	Spring weighted, single wafer
Discharge Isolation Valves	
Quantity	6
Size	30-inch diameter
Manufacturer	Lined Valve Company
Style	Knife gate valve, chain wheeled operator

The RSPS is normally monitored and controlled on the plant SCADA system through PLC-13 located in CP 13, in Building A. The PLC receives and analyzes local instrument readings and control switch signals to select and modulate the speed of the raw sewage pumps via VFDs. The raw sewage pumps operate to maintain a setpoint level in the wet wells. Each wet well is monitored independently by a bubbler system and newer ultrasonic level sensor

(LIT11-121(2)). AlexRenew stated the bubbler system is only used as back-up to the ultrasonic level sensor since a 5-foot difference is recorded between the two instruments. Moreover, the ultrasonic level senor in the adjacent wet well can be used as backup if one malfunctions since both wet wells maintain similar levels. During the RSPS testing protocol meeting with AlexRenew it was stated that no ultrasonic level sensors are installed. Prior to final design, the current level sensor operation needs to be confirmed. The following wet well levels are setpoints for the existing system:

– Normal Operating Level: 13 ft (WSE -6.0)
– High Level: 15.25 ft (WSE -3.75)
– High – High Level: 15.5 (WSE -3.5)
– Low Level: 8 ft (WSE -11)
– Low – Low Level: 5.75 ft (WSE -13.25)

When the wet well level increases, the controller ramps one pump to maximum speed before turning on a second pump. The pump with the least cumulative run time is selected by the controller. The second pump must ramp up to a sufficient speed to open the spring weighted check valve on the pump discharge before flow can enter the system. According to the control narrative dated April 2006, the previous system opened a motorized butterfly valve on the pump discharge when the pump reached a transfer speed of 78%. It is hypothesized that a similar speed is required to open the check valve, as supported by discussions with AlexRenew staff during the Hydraulics and RSPS Process Background Workshop. Once a new pump is activated and reaches transfer VFD speed, the online pumps will adjust to a similar speed to equally split the flow. All pumps will modulate at the same speed once in service.

Conversely, when the wet well level decreases, all running pumps are turned down equally until a setpoint speed is reached, at which point the controller selects the pump with the greatest cumulative runtime to be shutdown. The remaining pump(s) in service is ramped up to maintain wet well level. According to the control narrative dated April 2006, the previous system shutdown a pump when the in-service pumps reached a transfer speed of between 55 and 72%, depending on the total number of pumps in service. Given that the current check valve arrangement cannot modulate the pressure at which the valve opens and closes, it is understood that the check valve will close at the same pump speed at which it opened. This speed is approximately 80% as stated by AlexRenew staff during the Hydraulics and RSPS Process Background Workshop. The inability of the check valve to modulate the pump speed at which the valve closes may explain why AlexRenew has experienced premature fault from check valve closure when they were previously able to run pumps at speeds as low as 55%.

Additional instruments monitored by the PLC for RSPS control includes the following:

– Wet Well Sluice Gate position (open/closed), G11-130(2)
– Raw Sewage Pumps:
– Drive Fault
– Loss of Power
– Check Valve position (open/closed)
– Isolation Valve position (open/closed)
– Motor Overtemperature
– Emergency Stop
– High Discharge Pressure
– Pump Response Fail
– Restart Inhibit (cannot restart for four minutes after pump is stopped)
– Air Receiver Pressure (for Bubbler System)

A site visit for the conduits and RSPS system was conducted on October 14, 2020, with subsequent photos taken during the conduits inspection on March 23, 2021, and RSPS testing on June 29, 2021. The selected photos of the existing RSPS system are shown in Figure 2-11, Figure 2-12, and Figure 2-13. Additional photos focusing on the conduits are shown in Section 2.3.

Figure 2-11 Floor Hatches Above Raw Sewage Pumps

Figure 2-12 Pump Room

Figure 2-13 Typical Raw Sewage Pump Discharge

Based on an engineering and operations review of the existing RSPS, the written answers to questions received from the operations staff on November 17, 2020, and the discussions during the Process Background Workshop with the AlexRenew Core Team on November 12, 2020, the following deficiencies were identified with the existing system:

1. Underperforming raw sewage pumps

The raw sewage pump station is underperforming as substantiated by real-time wet weather events and hydraulic modelling. Previous evaluations of the preliminary treatment attribute the underperformance to aging raw sewage pump assemblies coupled with aging suction and discharge conduits. A more detailed description and analysis of the wet wells, suction conduits, and discharge conduits is provided in the Conduits TM.

In 2019, Jacobs presented the firm capacity of the RSPS at 125 MGD with five pumps in service from their "AlexRenew Process Manual Module 22" presentation. Hydraulic modelling by CH2M in 2017 indicated that the pump station has a firm capacity of 148 MGD with five pumps in service from their "Preliminary and Primary Treatment Condition Assessment Technical Memorandum". A case study high flow event is presented in Figure 2-14, which occurred February 24th and 25th, 2016.

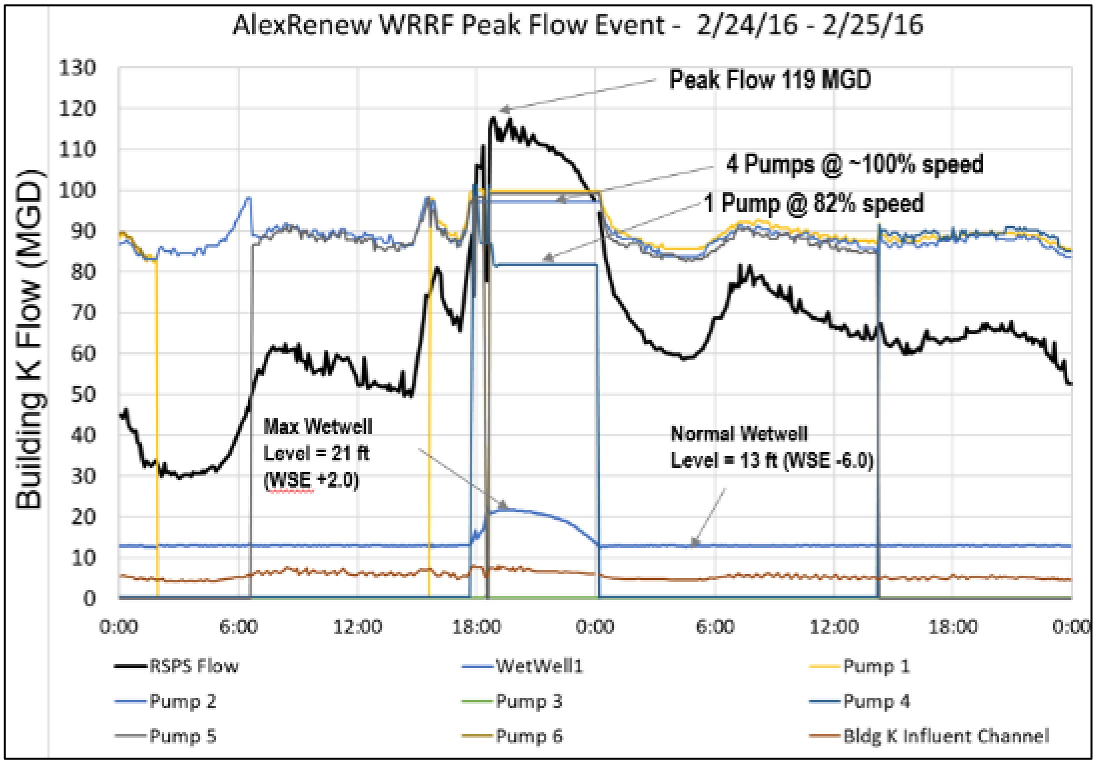


Figure 2-14 High Flow Event Case Study February 24th and 25th 2016

Unlike the firm capacities previous stated, the case study demonstrates the flow rate when the wet well is at maximum level, four pumps at maximum speed and one pump at 82% speed. While not a direct comparison, the case study illustrates that the RSPS is underperforming compared to the firm capacity models. CH2M recreated the conditions that the RSPS experienced during the case study using their hydraulic model and determined the RSPS should have been able to produce 154 MGD compared to the average of 110 MGD that was observed.

2. Raw sewage pump maintenance issues

AlexRenew expressed additional concerns with the raw sewage pumps, which includes the following:

Excessive vibrations.

Mechanical seals wearing out/leaking. (Monthly PM for pumps includes, but not limited to, greasing bearings, cleaning seal water strainers, coupling inspection and grid greasing, and inspecting for corrosion and leakage).

Discharge pressure sensing line blockages. Non-functioning discharge pressure gauges and transmitters.

Emergency stop buttons for the raw sewage pumps are positioned such that they easily pressed by accident, which causes unintentional shutdown of pumps.

3. Air binding of raw sewage pumps

AlexRenew has expressed concerns that the raw sewage pumps often become air bound. Operators must blowoff bound air through the discharge pressure sensing line. This task is complicated by blockages in the pressure sensing line.

4. Check valves cause pumps to fault

It is observed that the check valves on the discharge of the raw sewage pumps shut when the pump speed is lowered to approximately 80%. The check valve position switches cause the pumps to fault. As discussed previously, the older butterfly valve arrangement allowed PLCs and operators to control the pump speed at which the valve would open and close.

5. Difficult isolation valve actuation

The chainwheel operators used to actuate the knife gate valves on the discharge of the raw sewage pumps requires approximately 30 minutes to fully open or close. Accessing the chain is difficult and operators normally climb on the discharge conduit or 30" discharge pipe for ease in actuation. This creates an unsafe condition for operators.

6. Wet wells cannot be isolated

The current RSPS layout has grooves in the influent channel walls for stop logs upstream of the wet wells and sluice gates upstream of the suction conduit. However, the stop logs have proven to be an ineffective means to isolate the wet wells, and per GHD's understanding, have not been used successfully since initial construction. A custom solid metal plate was made to place in the stop log grooves, but it has not been used successfully either. The sluice gates separating the wet wells from the suction conduits were installed during initial construction in the 1950's, and only the shafts and actuators were replaced in the "Advanced Wastewater Treatment Facility Upgrade" project in 2005. Operation of the sluice gates for suction conduit isolation has proven to be difficult and unreliable.

7. Ineffective means to drain discharge conduits

Before the check valves were installed in 2014, the standard procedure to drain the discharge conduits was to open a butterfly valve on a pump's discharge, which allowed wastewater to flow back through the pump into the wet well. A similar procedure is currently practiced to drain the discharge conduits, but requires operators to manually force open the valve using a bottle jack or chain falling method. These methods pose a safety concern to operators and have the potential to damage the check valve.

8. Sump pump and drainage system failing

The Pump Room sump pit is difficult to access. Removing sump pumps requires the bridge crane because a tripod or other removal equipment cannot fit due to inadequate space and lack of a flat surface. The original pumps have been continually replaced. The current stainless steel sump pumps in the pump room are temporary and do not last long. The pumps malfunction and fault. Moreover, water intrusion into the sump pit is normal.

Drainage in the pump room is problematic. The existing cast iron drainpipes are prone to clogging. During the Process Background Workshop with the AlexRenew Core Team on November 12, 2020, it was discussed that seven of the eight drains were currently clogged. The clogged drains coupled with malfunctioning sump pumps contribute to flooding in the pump room.

The following major critical success factors were identified to address these the deficiencies:

- Upgrade the raw sewage pumps to increase capacity and lower maintenance burden.
- Upgrade auxiliary equipment associated with the RSPS to improve operations and maintenance, improve safety, permit adequate isolation, and improved system monitoring.

2.3 Raw Sewage Conduits

The AlexRenew WRRF receives both separate and combined sewage from five primary interceptors that converge upstream of Building A. Raw sewage that enters the basement of Building A is split equally between two channels that contain coarse screens for the purpose of removing large debris. The screened effluent momentarily re-joins to a common channel before diverging into two wet wells located in the basement of Building A, which signifies the beginning of the RSPS process. Raw sewage is pumped from a low elevation in the wet wells to a high elevation in Building K to utilize gravity flow through the remaining preliminary and primary treatment processes. The RSPS consists of two identical trains known as the North Side and South Side that function independently beginning from the flow split at the wet wells until they combine in the common fine screen channel in Building K. The following description highlights the existing arrangement for one side of the RSPS but is equally applicable to describe the other side since they share identical processes. The existing RSPS arrangement is presented in Figure 2-15. Figures 1 and 2 in Appendix C show plan and section views of the RSPS wet wells, suction conduits, and discharge conduits.

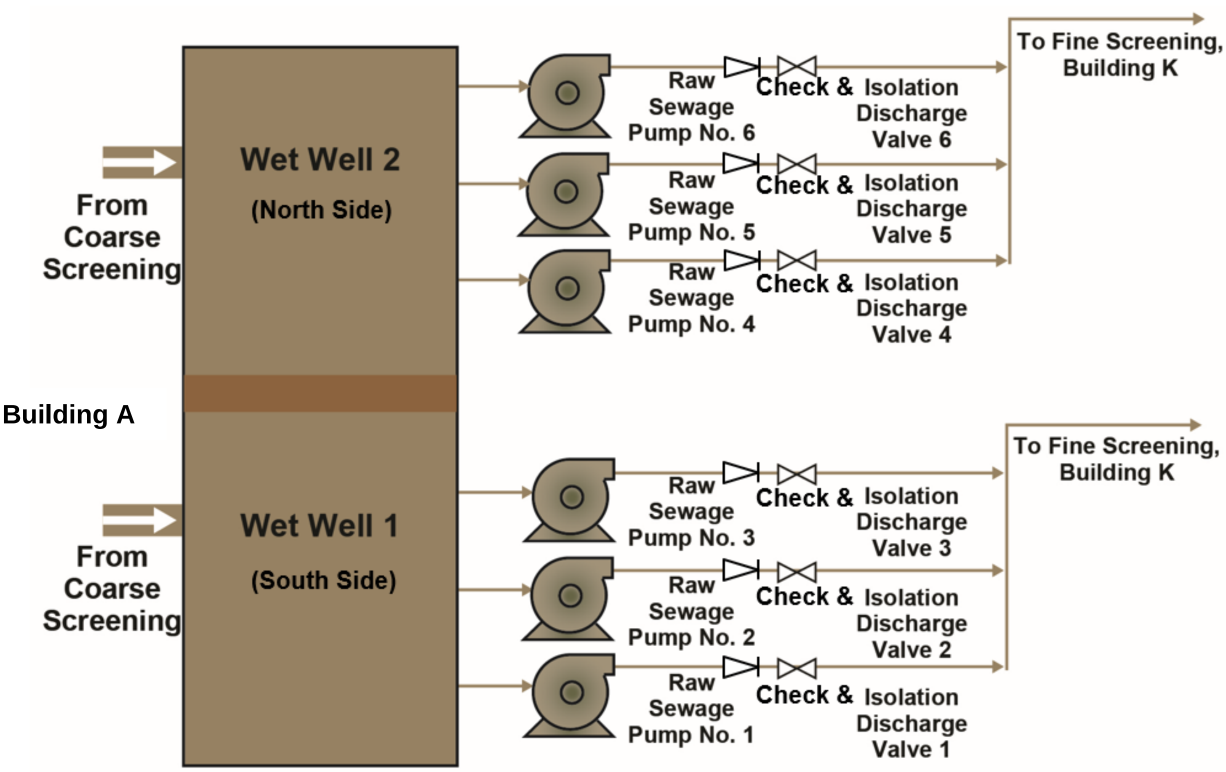


Figure 2-15 Existing RSPS Process Diagram

Following the stop log grooves in the influent channel, the floor declines steeply and widens to provide storage volume for the wet well. A submerged, rectangular suction conduit is separated from the wet well by a motorized sluice gate that is routed beneath the pump room. The suction conduit branches outwards to the volutes of three dry pit, non-clog end-suction pumps. These pumps draw sewage from the suction conduit located beneath the pump room, and discharge to short, horizontal runs of 30-inch diameter pipe installed with a check valve and knife gate valve before exiting into a common, rectangular-shaped concrete discharge conduit. Raw sewage received in the discharge conduit is conveyed below grade to Building K for fine screening and further preliminary and primary treatment. Between Building A and Building K the original rectangular concrete discharge conduit transitions to a newer, circular raw sewage pipe that was installed during the construction of Building K around year 1998 as part of the "Advanced Wastewater Treatment Facility Upgrade" project to replace the fine screening system designed in year 1972.

The RSPS was constructed in 1954 as part of the "AVA Sewage Treatment Plant Divisions I – V" project, which included the design of Building A and the original Screens and Grit Building, among others. Since original construction, no major structural upgrades were made to the wetted portion of the RSPS, such that the wet wells, suction conduits, pumping arrangement, and discharge conduits within Building A are presumed to be in a condition reflective of continuous use since 1954. The mechanical equipment, instrumentation, and miscellaneous structural elements associated with the RSPS have been upgraded on occasions since initial construction and are discussed in more detail in the RSPS TM. Significant changes to the discharge conduit's routing have occurred twice since initial construction. First in year 1972 as part of the "Additional Sewage Disposal Works Preliminary Treatment Units Upgrade" project, which transferred flow to the new Screen and Grit Building and lastly in year 1998 to Building K, as previously indicated. Additional modifications to the wet wells occurred in year 2005 as part of the "Advanced Wastewater Treatment Facility Upgrade". However, this upgrade mostly involved the non-wetted portion of the wet wells, except for the removal of the original bar screen racks that were used for coarse screening prior to installation of the current coarse screens.

The influent channels leading to the wet wells are reinforced concrete construction, 6 feet wide by 8 feet high, with a typical water level of 4.75 feet above channel floor. The channel floor slopes steeply into the wet well such that the sidewall height increases to 17 feet at the suction conduit entrance. Typical wet well level is maintained at a depth of

13 feet (WSE -6.0) but can operate between a high level alarm of 15.25 feet (WSE -3.75) and low level alarm of 8 feet (WSE -11.0). High-high and low-low switches are reached at 15.5 feet (WSE -3.5) and 5.75 feet (WSE -13.75) respectively. Each suction conduit has a square opening into a wet well with a side length of 5 feet. With a crown elevation of -13.5, the suction conduits are always submerged. As the suction conduits extend to the individual pump volutes, the common suction conduit becomes smaller; first to 4 feet wide by 4 feet high, and then to 4 feet wide by 2 feet high. Individual pump suction conduits branch at a 45-degree angle from the common suction conduit with a cross section of 4 feet wide x 2 feet high. Tapered openings in the Pump Room floor slab join the suction conduits to the pump volutes, which decrease from 36 inches to 26 inches in diameter. The pumps discharge into a cast iron pipe that increases from 24 inches to 30 inches in diameter. After passing through a spring weighted, single-wafer check valve and knife gate valve, flow is pumped into a 30 inch wide by 54 inch tall, reinforced concrete discharge conduit. The original discharge conduits constructed in the 1950's are intercepted by newer raw sewage pipes from the 1998 "Advanced Wastewater Treatment Facility Upgrade" for Building K. Much of the raw sewage pipe is 60 inch diameter. However, the North Side connection has a short run of 48 inch pipe before transitioning to 60 inch diameter. These raw sewage pipes are routed beneath Building K and discharge into a 6 foot by 7 foot concrete riser that joins with the common fine screen channel, that has a top-of-riser elevation of 24.5 feet. However, the common fine screen channel typically operates between a water level of 1 foot (WSE 25.5) and 7.9 feet (WSE 32.4).

Since initial construction, AlexRenew has experienced a continual increase in influent flows that necessitated more capacity from the RSPS. As these pumps neared the end of their useful life, they were replaced with larger pumps to convey the higher flows. Additionally, a pre-engineered area reserved for a future pump on the North Side was utilized when Pump 6 was first installed in 1972. It is evident that while the original wet wells, suction conduits, and discharge conduits were designed for higher future flows, the current peak influent flows are reaching the maximum recommended capacity of the discharge conduits based on velocity. Table 2-8 shows the original design point of the raw sewage pumps compared to their design point today.

Table 2-8 Design Point of Raw Sewage Pumps at Initial Construction and Current Peak Flows

Pump No.	1954	2021
RSP #1	14 MGD @ 33 ft TDH	30 MGD @ 42 ft TDH
RSP #2	21 MGD @ 35 ft TDH	30 MGD @ 42 ft TDH
RSP #3	21 MGD @ 35 ft TDH	30 MGD @ 42 ft TDH
RSP #4	21 MGD @ 35 ft TDH	30 MGD @ 42 ft TDH
RSP #5	21 MGD @ 35 ft TDH	30 MGD @ 42 ft TDH
RSP #6	-	30 MGD @ 42 ft TDH

The RSPS is currently designed to meet the criteria presented in Table 2-9. Actual flow data from 2008-2018 is presented concurrently, courtesy of Jacobs, "AlexRenew Process Manual Module 22: Plant Hydraulics" PowerPoint presentation dated October 2019.

Table 2-9 Current Design Criteria Compared with Actual Data

Condition	Design Flow (MGD)	2008-2018 Data
Average Daily Flow	54	34.9
Max Month Flow	70	45
Max Week	80	60
Max Day	90	92
Peak Instantaneous	108	120

As a consequence of receiving combined sewage, AlexRenew experiences significant spikes in influent flow attributed to rainfall events. Figure 2-16 illustrates how instantaneous flows spiked during wet weather events from September 2019 to March 2021. Figure 2-17 illustrates how a single wet weather event affected influent flow. Rainfall data was collected from NOAA Local Climatological Data for Ronald Reagan National Airport for a wet weather event from February 26 to March 1, 2021.

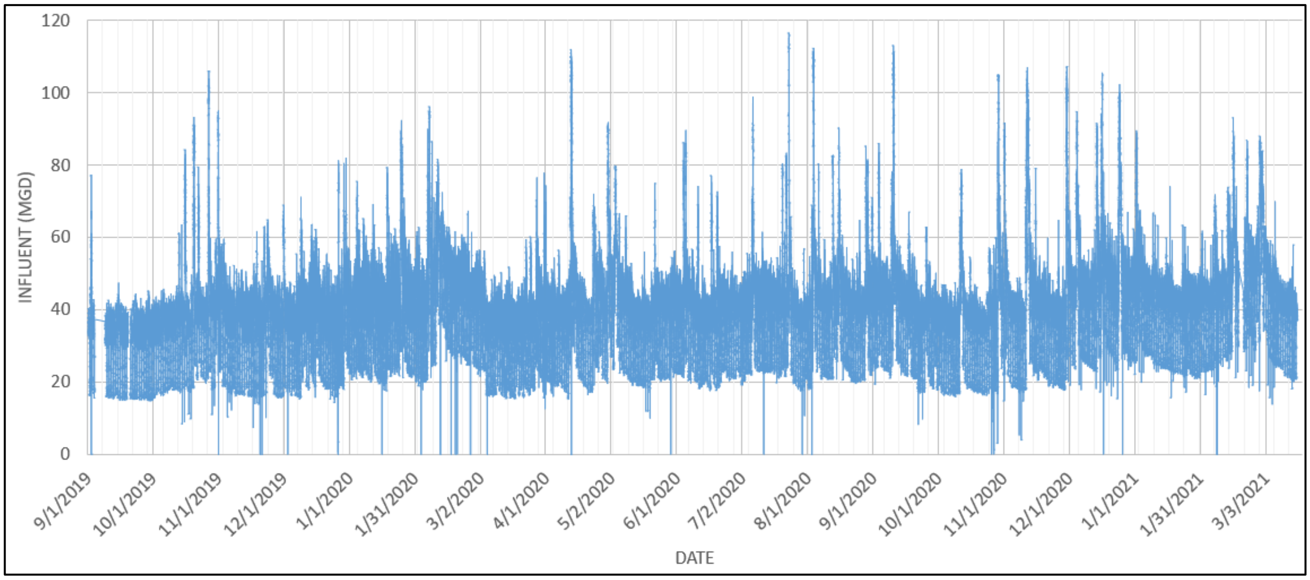


Figure 2-16 ***Instantaneous Influent Flow from September 2019 to March 2021***

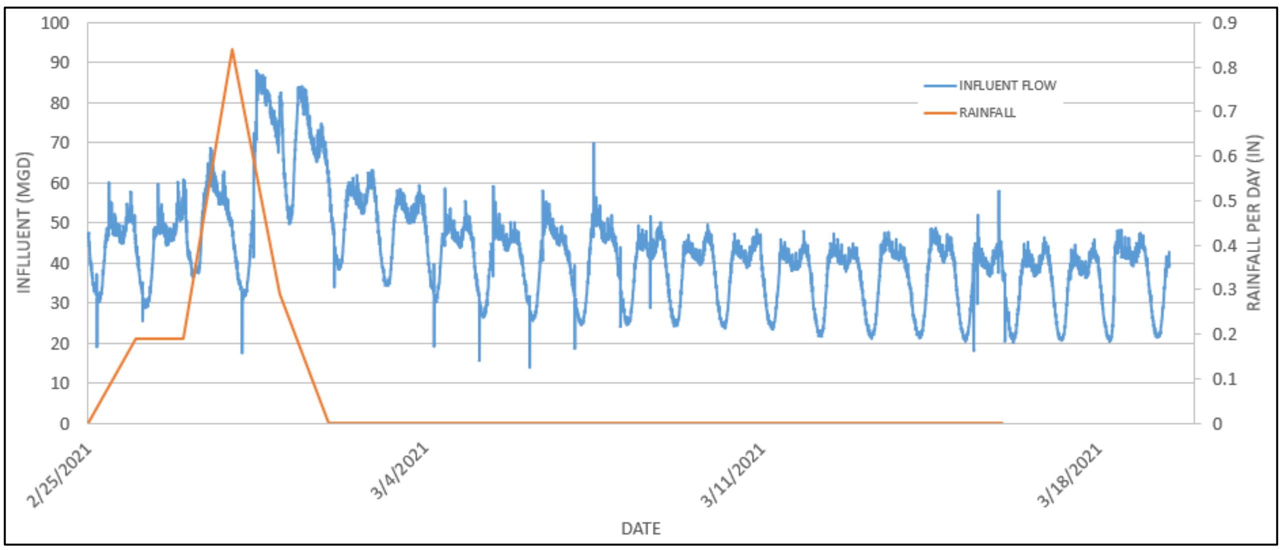


Figure 2-17 ***Wet Weather Event February 26 through March 1, 2021***

A site visit of the conduit system and RSPS system was conducted on October 14, 2020. Photos were taken during the conduits inspection on March 23, 2021, and RSPS testing on June 29, 2021. The selected photos of the existing conduits system are shown in Figure 2-18 and Figure 2-19. Additional photos focusing on the mechanical equipment in Building A are shown in the RSPS TM.

Figure 2-18 Exiting Building A and K (Exterior View Looking Northeast – Panned)

Figure 2-19 Building A Pump Room - South Side discharge conduit (left) and Discharge Piping Arrangement (right)

Based on an engineering and operations review of the existing RSPS, the written answers to questions received from the operations staff on November 17, 2020, and the discussions during the Process Background Workshop with the AlexRenew Core Team on November 12, 2020, the following deficiencies were identified with the existing system:

1. Deteriorated wet wells, suction conduits, and discharge conduits

The RSPS is underperforming as substantiated by real-time wet weather events and hydraulic modelling. Previous evaluations of the preliminary treatment attribute the underperformance to aging raw sewage pump assemblies coupled with aging suction and discharge conduits. AlexRenew has identified the concrete discharge conduits leading from the RSPS as a possible limitation on the performance of the raw sewage pumps. Since construction in 1954, the wet wells, suction conduits, and discharge conduits had not been inspected and their condition was unknown. A more detailed description and analysis of the raw sewage pumps will be provided in the RSPS TM.

2. Difficult to isolate and drain wet wells and conduits

The current RSPS layout has grooves in the influent channel walls for stop logs upstream of the wet wells and sluice gates upstream of the suction conduit. The stop logs have proven to be an ineffective means to isolate the wet wells and have not been used successfully since original construction. A custom solid metal plate was made to be placed in the stop log grooves but has reportedly not been effective. The sluice gates separating the wet wells from the suction conduits were installed during initial construction in the 1950's, and only the shafts and actuators were replaced in the "Advanced Wastewater Treatment Facility Upgrade" project in 2005. Operation of the sluice gates for suction conduit isolation has proven to be difficult and unreliable.

Before the check valves were installed in 2014, the standard procedure to drain the discharge conduits was to open a butterfly valve located on the pump's discharge, which allowed wastewater to flow back through the pump and into the wet well. A similar procedure is currently practiced to drain the discharge conduits, but requires operators to manually force open the valve using a hydraulic bottle jack or chain fall method. These methods pose safety concerns to operators and have the potential to damage the check valve.

Deficiencies with isolation and drainage are evaluated in detail in the RSPS TM.

3. Limited bypass flexibility

While current operations allow each side of the RSPS to be placed out-of-service for maintenance, the theoretical capacity of the pump station is reduced from 120 MGD to 60 MGD. As illustrated in Figure 2-16 above, exceeding the reduced capacity has a higher probability. The time it takes to bring an out-of-service side of the RSPS back online exceeds the time it takes stormwater to reach the facility. Once rainfall begins in the service area, stormwater will arrive at the facility before the out-of-service side of the RSPS can be placed back into service. Therefore, planned shutdowns for the RSPS must be executed during dry weather and must have short durations.

According to discussions with AlexRenew's core team on November 12, 2020, the RSPS has never been bypassed.

The following major critical success factors were identified to address these deficiencies:

– Rehabilitate the wet wells, suctions conduits, and discharge conduits to lower system friction losses and extend the life of the existing structures.
– Develop an effective means to bypass one side of the RSPS.

2.4 Fine Screening

The AlexRenew WRRF accepts wastewater from both separate and combined sewer systems. Raw wastewater flows through the existing coarse screens to remove large solids into the existing wetwell of the Raw Sewage Pump Station (RSPS). It is then pumped to the existing fine screens to remove solids larger than ¼ inch. The screened wastewater then passes through a grit removal system to the downstream primary and secondary treatment processes.

The existing fine screening system is housed in Building K which was construction around 1998 as part of the "Advanced Wastewater Treatment Facility Upgrade" project to replace the original fine screening system. It includes four continuous self-cleaning moving media fine screens. Each screen is directly coupled with an associated washer/compactor. The cleaned and compacted fine screenings are then conveyed by two screening conveyors and combined with the dewatered grit to discharge to one of two open bed trailers in the Truck Bay. Each fine screen is equipped with two motorized isolation slide gates that can isolate each screen channel for maintenance.

The existing plan for Building K is presented in Figure 2-20 and highlights the Fine Screen Area location. Figures 1 and 2 in Appendix D show the details of the existing Fine Screen Area.

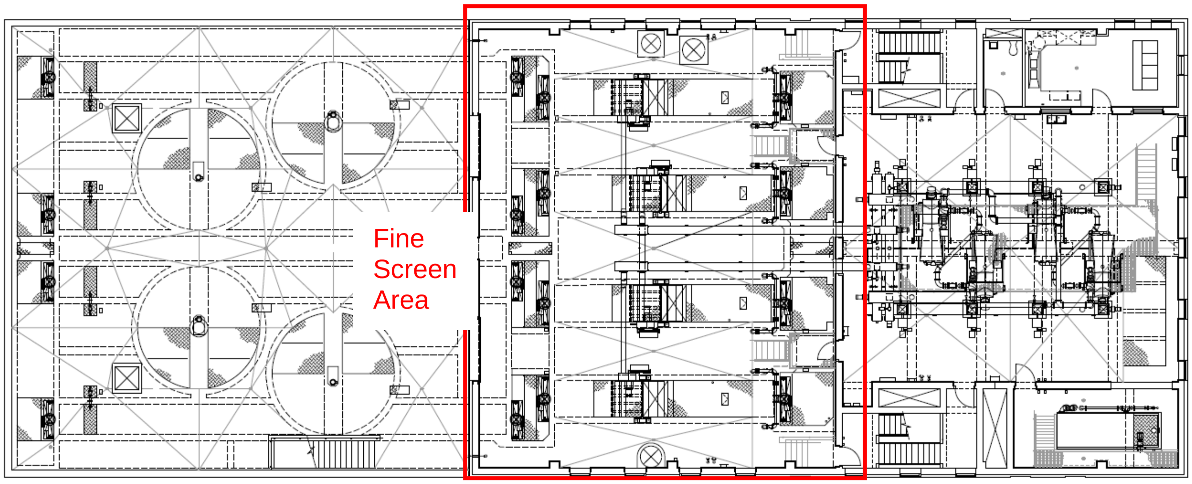


Figure 2-20 Existing Building K Plan with Fine Screen Area Highlighted

The isometric view of the existing fine screening system layout is presented in Figure 2-21.

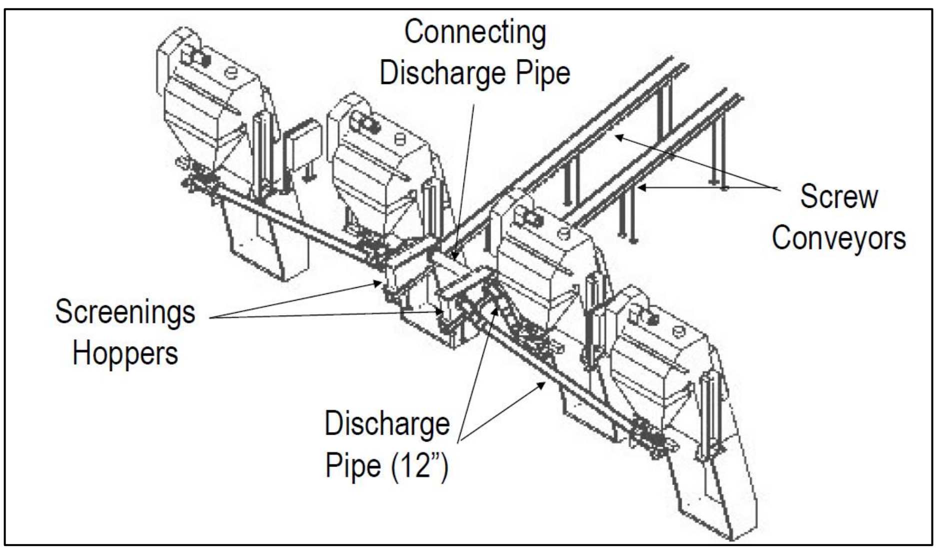


Figure 2-21 Existing Fine Screens Layout Isometric View (Courtesy Jacobs 2019)

The existing fine screens are continuous self-cleaning moving media fine screens supplied by Parkson Corporation that remove screenings as described below.

– Solids larger than the nominal screen opening are captured on the filter elements and then conveyed upward on the filter belt to be discharged at the rear of the unit.
– This type of screen can build up an undisturbed mat of solids on the screen surface which can remove solids smaller than the nominal screen opening size.
– At the top of the unit, as the tip of one row of elements passes between the shanks of the elements on the lower row, captured screenings are pushed off the elements into a hopper below. A rotating brush and spray water bar are also used to help remove screenings that may remain on the filter belt.
– Captured screening and washwater fall down a hopper and into a washer/compactor located immediately below each screen discharge. The washer/compactor washes and dewaters the screenings; washwater is returned to the downstream screening channel.

The design information of the existing fine screening system is summarized in Table 2-10.

Table 2-10 Existing Fine Screening System

Parameters	Design Information
Screens (M12-1501, 1502, 1503, 1504)	
Quantity	4
Supplier and model	Parkson Aqua Guard Filter Screens AG-S-A
Screen hydraulic capacity	40 MGD each
Screen channel width	6.0 ft
Screen channel depth	9.5 ft
Screen channel length	38.0 ft
Material of construction	Type 304 stainless steel
Bar opening size	¼ inch or 6 mm
Maximum head loss [1]	13.8 inches
Drive motor (explosion-proof)	2.0 Hp (460 VAC/3-phase/60-hertz)
Angle of installation	75 degrees
Operation Control	Timer / High Water Level Float Switch
Washer/Compactors (M12-1601/1681, 1602/1802, 1603/1803, 1604/1804)	
Quantity	4
Supplier and model	Parkson Rotopress RP200 / SpiralKlean SK100
Drive motor (explosion-proof)	2.0 Hp (460 VAC/3-phase/60-hertz)
Capacity	1.3 cubic yard per hr
Screening Conveyors (M12-3101, 3102)	
Quantity	2
Supplier and model	Pro-Equipment Pro-Veyor SDK 356x12000
Drive motor (explosion-proof)	7.5 Hp (460 VAC/3-phase/60-hertz)
Type	Shaftless
Spiral OD	12 inch
Capacity	100 cubic feet per hr

Note:
1. Reference: Drawing G-22 of "Advanced Wastewater Treatment Facility Upgrade, Package A" and O&M manuals.

The existing hydraulic profile across the fine screens at the peak design flow of 116 MGD (after the RiverRenew project) plus internal plant recycles (120 MGD total flow) is shown in Figure 2-22.

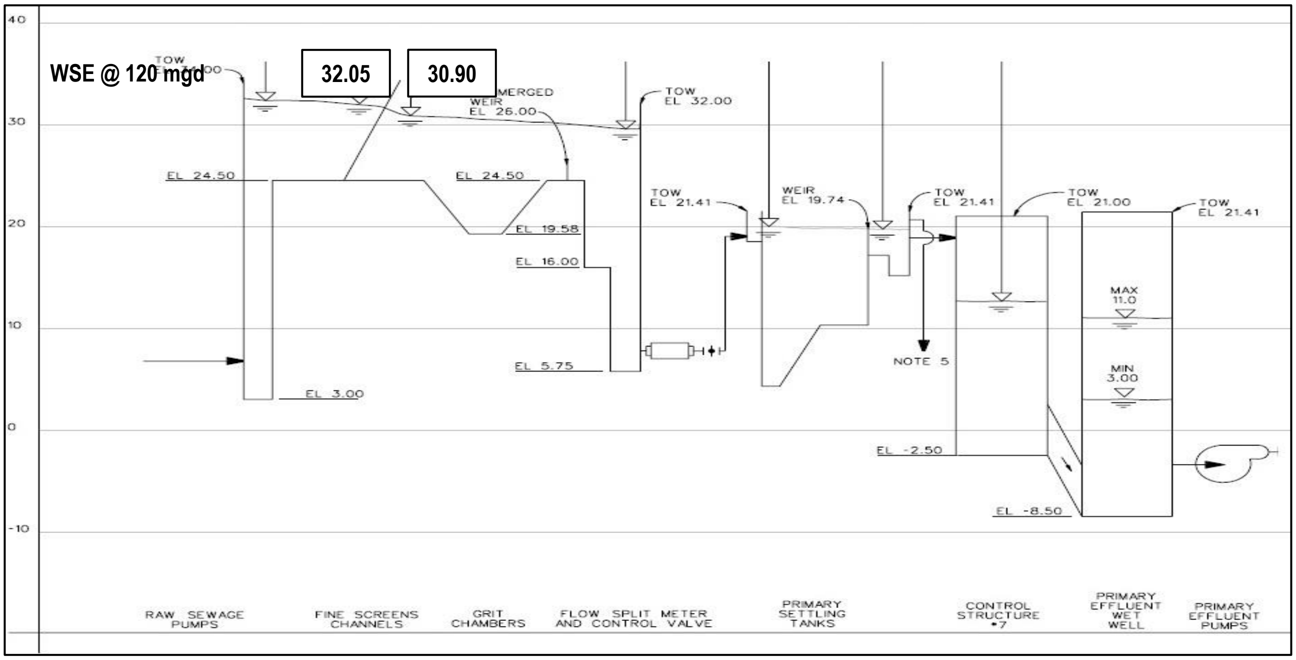


Figure 2-22 Existing Hydraulic Profile Across Fine Screens (Courtesy Jacobs 2019)

Note:

1. Reference: AlexRenew Process Manual Module 22: Plant Hydraulics.

A site visit of the fine screening system was conducted on 10/14/2020. The selected photos of the existing fine screening system are shown in Figure 2-23, Figure 2-24, Figure 2-25, and Figure 2-26.

Figure 2-23 Existing Building K (Exterior View Looking North)

Figure 2-24 Existing Fine Screens with Washer/Compactors

Figure 2-25 Existing Fine Screening Transfer Conveyors

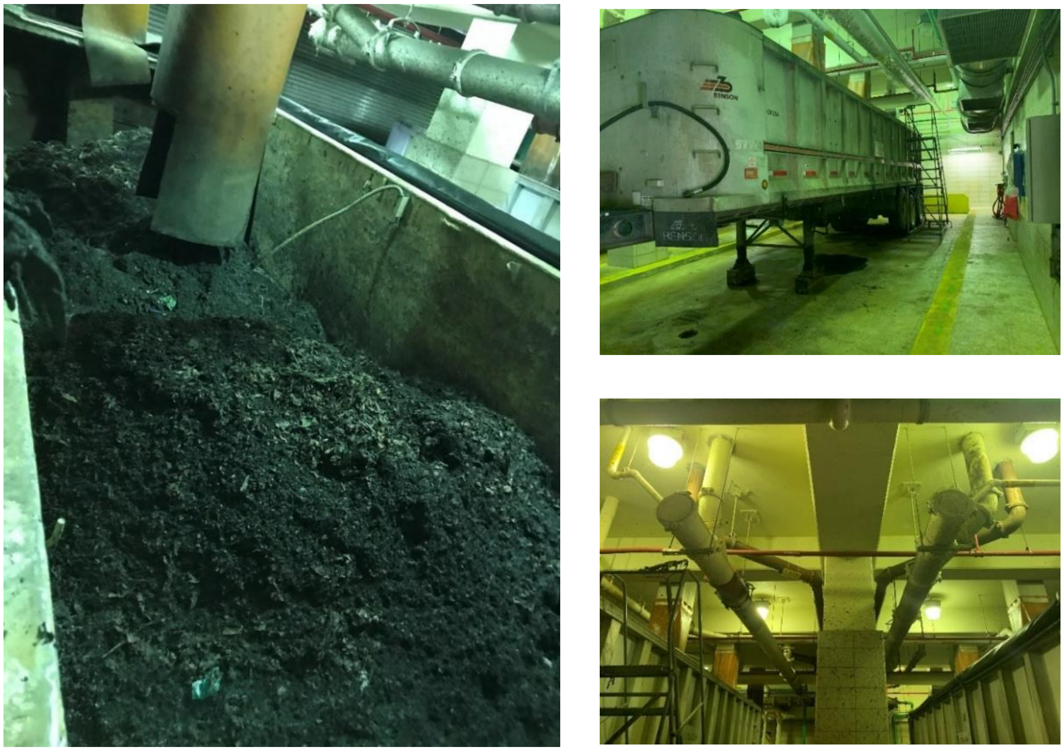


Figure 2-26 Existing Fine Screening/Grit Truck Bay Area

The existing fine screens have been in continuous service for more than 20 years and their performance has gradually deteriorated which allows solids to pass through creating downstream operational issues. AlexRenew provided data which measures the combined tonnage of hauled grit, fine screenings, and thickened grease hauled by the contractor. Due to combined material data, an accurate measurement of the fine screenings removed from the system cannot be determined. However, the plant has observed a significant amount of screenable material passing through the screens and into the primary settling tanks. These materials cause clogging of the primary sludge pumps, buildup of floatable solids in the scum removal system, and buildup of rags in the gravity thickeners as shown in Figure 2-27.

Figure 2-27 Materials Passing Downstream of the Screens

In addition, the associated washer/compactors cannot process the fine screenings, especially leaves, fast enough during peak flow conditions, which creates significant operational problems of the whole preliminary and primary treatment process. Some recent photos showing the washer/compactors have been overwhelmed with materials are presented in Figure 2-28.

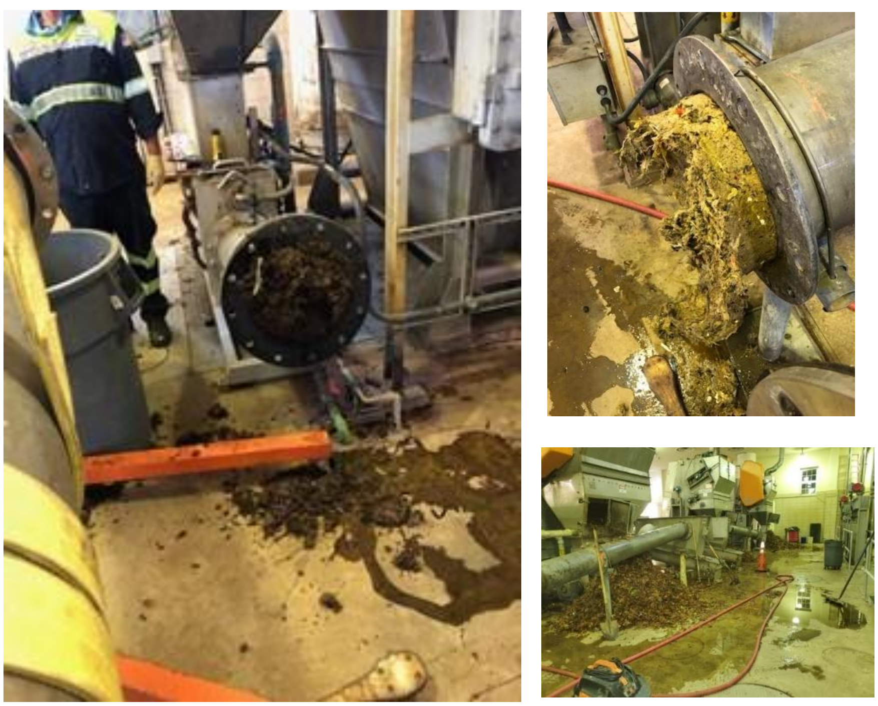


Figure 2-28 Clogging of Fine Screening System Due to Leaves During Peak Flow Conditions

Based on an engineering and operations review of the existing fine screening system, the written answers to questions received from the operations staff on December 2, 2020, and the discussions during the Process Background Workshop with the AlexRenew Core Team on December 3, 2020, the following deficiencies were identified with the existing system:

1. Excessive material pass-through and carryover clogging downstream equipment

Although the spacing of the filter slots have ¼" wide openings, the rectangular opening between filter elements is much longer in the vertical direction, allowing solids larger than ¼" to pass through the screen if they turn parallel to the slot opening as shown in Figure 2-29. In addition, the plastic "teeth" which form the filter elements can be damaged by larger objects in the wastewater flow and break off, resulting in large gaps in the filter element that solids can pass through. Finally, the brush and spray mechanism at the top of the screen which remove solids from each screen is not very efficient at removing materials from the filter elements. These materials can travel down the back side of the filter belt and then be dislodged by the influent flow velocity across the screens and carried downstream.

It is anticipated that upgrade of the fine screening system would improve the screening capture performance.

Figure 2-29 Existing Style of Plastic Filter Opening Slots

2. Clogging of washer/compactors with high solids loads (especially leaves)

The existing screening washer/compactors appear to be significantly undersized to handle the high solids loading received at the facility during peak flow events. Climate change is predicted to yield more frequent and intense precipitation events, and with the increased influent flow, AlexRenew can expect a proportional increase in leaves and debris entering our treatment system during these events. The operation of the washer/compactors is the biggest challenge of the preliminary and primary system to the operation staff as they frequently become overloaded by leaves and other debris during high flow events which causes the units to fail. When a storm event is anticipated, a staff member needs to stand by to monitor the system operation and to disconnect the washer/compactors and manually clean the screens if the washer/compactors become overloaded. The need to continuously staff this system during storm events causes a significant operations burden for AlexRenew, as well as a maintenance burden after the event to repair and reconnect the compactors.

Upgrade of the coarse screens to improve coarse screening capture should help reduce the solids loading to the fine screens, but without a corresponding upgrade of the existing washer/compactors, the potential for clogging and equipment failure under high solids loading rates remains.

Compacted screenings have also caused damage to the transfer conveyors at the location of the drop to the combined grit/screening conveyors as the compacted screenings may be too hard to drop down.

3. Channel coating system is failing

It is observed that the existing coating system of the fine screen channels has peeled off in some places. The operation staff indicated that the coating below the water level is in worse condition than the coating above the water level due to friction by solids.

4. Equipment is at the end of its useful life

As indicated above, the existing fine screens and washer/compactors were installed in 1998 and are nearing the end of their useful life. As the screens age, the risk of screen failure increases.

The operations staff have indicated that grit is present in the fine screen channels but do not consider grit settling to be a significant issue. Other mechanical and electrical equipment in the building has been indicated to be in acceptable operating condition.

The following two major critical success factors were identified to address these identified deficiencies:

- Upgrade fine screening equipment to increase screening capture rates
- Improve screenings handling system to provide more capacity and reduce equipment failures

2.5 Grit Removal

The AlexRenew WRRF accepts wastewater from both separate and combined sewer systems. Raw wastewater flows through the existing coarse screens to remove large solids and into the existing wetwell of the Raw Sewage Pump Station (RSPS). It is then pumped to the existing fine screens to remove solids larger than ¼ inch. The screened wastewater then passes through a grit removal system and onto the downstream primary and secondary treatment processes.

The existing grit removal system is in Building K, Preliminary Treatment Building, which was constructed around 1998 as part of the “Advanced Wastewater Treatment Facility Upgrade” project. Screened wastewater enters the system from the fine screens and flows through the vortex grit separators. Each grit separator allows grit in the wastewater to settle to a submerged hopper. The degritted wastewater flows out of the vortex grit separators and into an effluent channel which distributes flow to the primary clarifiers. Settled grit in the separator hoppers is pumped up to the grit dewatering system. At the grit dewatering system, pumped grit slurry is discharged into the grit hydrocyclones which concentrate the grit before discharging into the grit classifiers. The grit classifiers settle the concentrated grit slurry and slowly withdraw the settled grit from the fluid, allowing it to air dry before discharging into the grit conveyors. Overflow from the hydrocyclones and classifiers is returned to plant influent via the plant drain and discharged to the common fine screen influent channel. The grit conveyors discharge the grit to the transfer conveyors then to the truck loading conveyors, which is discussed in greater detail in Section 2.6.

The existing plan for Building K is presented in Figure 2-30 and highlights the Grit Separator Area location and Grit Dewatering Area location and Figure 2-31 highlights the Grit Pump Area. A process flow diagram of the existing grit removal system is shown in Figure 2-32. Figures 1, 2, and 3 in Appendix E show the details of the existing Grit Separator, Pump, and Dewatering areas as well as a process flow diagram of the existing system.

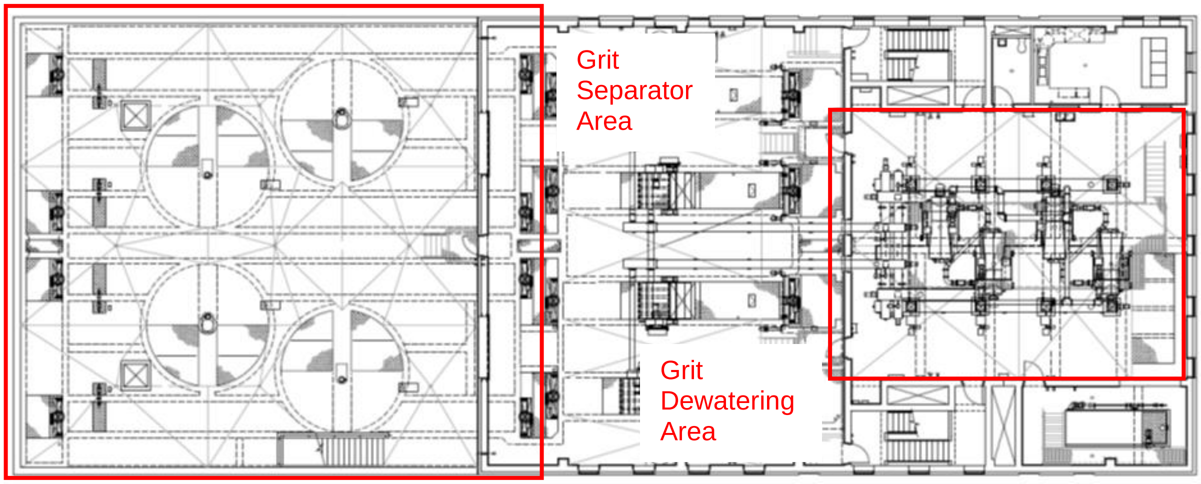


Figure 2-30 *Existing Building K Plan with Grit Separator and Dewatering Areas Highlighted*

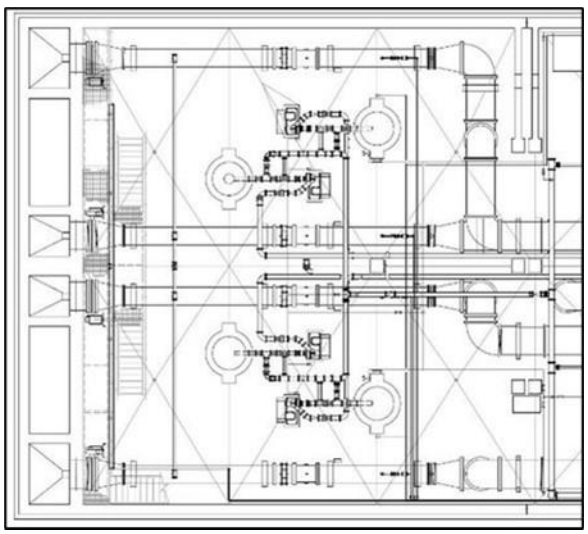


Figure 2-31 *Grit Pump Room*

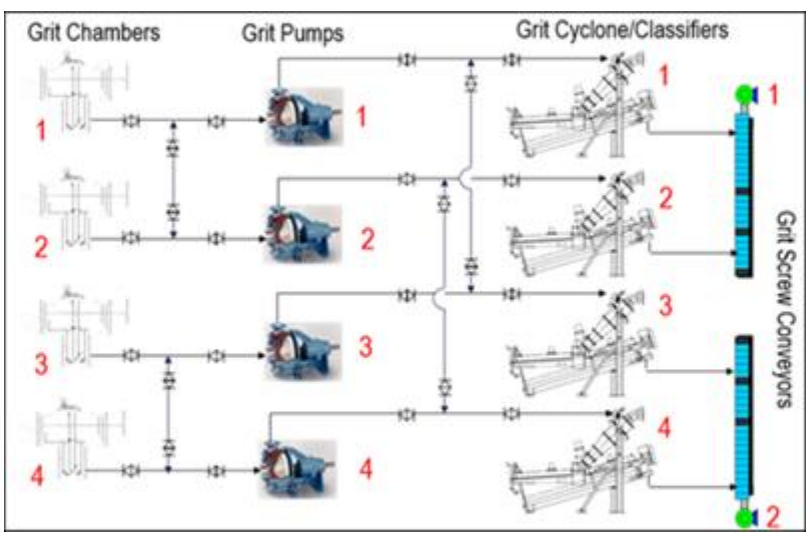


Figure 2-32 *Grit Removal System Process Overview (Source: AlexRenew Process Manual Module 4 – Preliminary and Primary Treatment*

Detailed design information of the existing grit removal system is summarized in Table 2-11.

Table 2-11 Existing Grit Removal System Design Information

Parameters	Design Information
Grit Separators (M13-1501, 1502, 1503, 1504)	
Quantity	4
Type	Mechanically Induced Vortex
Supplier and model	Smith & Loveless Model 50.0 PISTA
Grit separator hydraulic capacity	40 MGD each
Grit separator channel width	5.0 feet
Grit separator diameter	20.0 feet
Grit separator volume	2931 cf
Grit hopper diameter	5.5 feet
Materials of construction	Tank walls: Concrete Mixer column: Concrete Mixer: Steel
Drive motor (explosion-proof)	2.0 Hp (460 VAC/3-phase/60-hertz; explosion proof)
Grit Pumps (P13-2101, 2102, 2103, 2104)	
Quantity	4
Supplier and model	Wemco 4x4 Model C
Capacity	500 gpm @ 55 TDH
Type	Centrifugal, Recessed Impeller
Drive motor	25 Hp (460 VAC/3-phase/60-hertz; explosion proof)
Grit Hydrocyclones (M13-2501, 2502, 2503, 2504)	
Quantity	4
Supplier and model	Wemco 1500C Wemclone
Grit hydrocyclone hydraulic capacity	500 gpm @ 7 psi
Material of construction	Hydrocyclone: Aluminum
Grit Classifiers (M13-2601, 2602, 2603, 2604)	
Quantity	4
Supplier and model	Wemco 18” Hydrogritter
Grit classifier capacity	36 cf/hr
Screw type	Helical
Screw diameter	18 inches
Conveyor speed	8 rpm
Material of construction	Tank: Steel Spiral: Stainless steel
Drive motor	1 Hp (460 VAC/3 phase/60 Hertz; explosion proof)

The existing grit removal system has been in service for more than 20 years and the performance has gradually deteriorated resulting in material carryover to downstream unit processes. AlexRenew provided data which measures the combined tonnage of hauled grit, fine screenings, and thickened grease hauled by the contractor. Due to the combined material data, an accurate measurement of the grit removed from the system cannot be determined.

Flow enters the PISTA vortex grit separators tangentially through the floor-level opening via five-foot-wide declined channel to control the velocity. Figure 2-33 shows the north side of Building K and the grit deck where the separator units are located. Figure 2-34 shows the fine screen effluent and grit separator isolation gates. Degritted wastewater flows through the 360-degree-in-line separator over the five-foot-wide effluent channel to the common grit effluent channel. The settled grit is stored in the hopper where it is suspended by the propeller shaft mixer blades and is fluidized to prevent the grit from hardening prior to being pumped to the dewatering equipment. Ferric chloride can be added downstream of each grit separator to the effluent channel, although this chemical feed point is not in current use. Each grit separator can be placed in and out of service using the sluice gates upstream and downstream of each unit. During average flow conditions two grit separators are in service to handle up to 80 MGD. Typically, Grit Separator 1 and either Grit Separators 3 or 4 are the units in service to balance flow on each side of Building K. At peak flow conditions three grit separators are online to handle up to 120 MGD. Grit Separator 2 is currently placed out of service due to mechanical issues. When a grit separator is placed into service, the SCADA system automatically opens the influent and effluent sluice gates, turns on the PISTA mixer motor, opens the ferric chloride feed valve (if in use), initiates the grit pump timer cycle, and turns on the corresponding grit conveyor.

Figure 2-33 Building K Grit Deck

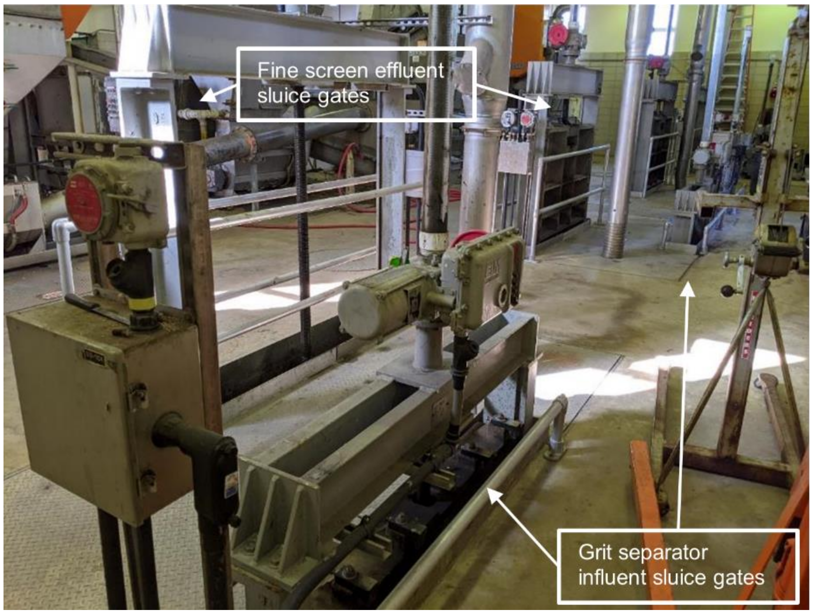


Figure 2-34 Fine Screens and Grit Separator Isolation Sluice Gates

Degritted wastewater flows from the common grit effluent channel via four 30-inch to 48-inch pipes in the basement of Building K to the primary settling tanks. Settled grit slurry in the storage hopper is pumped via four grit pumps in the basement of Building K to the grit hydrocyclones located on the second floor of Building K in the Cyclone Classifier Room. The suction side of a pump pair (grit pumps 1 and 2 and grit pumps 3 and 4) are interconnected to allow for one grit pump to service two grit separators, providing redundancy. The pump pair discharge is also interconnected to allow for one grit pump to send grit slurry to one of two grit hydrocyclones. However, typical operating conditions consist of one grit pump servicing its dedicated hydrocyclone. There are W3 (plant effluent water) flushing line connections on the suction side of each pump and two points along the interconnection line between the pump pairs shown in Figure 2-36 and Figure 2-35. The W3 water is used to flush the grit slurry lines to clean for disassembly or troubleshooting and requires manual valve operation and longer pump cycle times. The grit pumps run on an adjustable timed cycle, typically set at 20 minutes on, 60 minutes off. When the grit pump timer cycle is initiated, the contents in the storage hopper are pumped to the hydrocyclone for volume reduction upstream of the grit classifiers.

Figure 2-35 Grit Pumps 3 and 4 Interconnection and W3 Flushing Lines

Figure 2-36 Grit Pump 4

The four grit hydrocyclones, are located in the Cyclone Classifier Room on the second floor of Building K. Figure 2-37 shows the existing grit hydrocyclone and classifier units and Figure 2-38 shows the interconnection line between two grit hydrocyclone units in the Cyclone Classifier Room. Centrifugal forces in the hydrocyclone forces the heavy grit to the outer wall of the unit and from there gravity moves it to the bottom of the hydrocyclone, also known as the apex or spigot, and to the classifier while the lighter organic grit and wastewater overflow the top of the hydrocyclone, also known as the vortex fider, to the process drain to be recycled to the fine screens influent channel. The hydrocyclones have no moving parts and accept the entire flow from the grit pumps.

The grit classifier concentrates the grit by sedimentation. Each classifier has an inclined 18-inch helical screw at the bottom which conveys the settled grit from the bottom of the tank. Some water is drained from the grit as it is slowly conveyed to the top of the inclined screw from where it is discharged onto the grit screw conveyors. The lighter material that does not settle in the classifier is discharged over the internal weir to be recycled at the fine screens influent channel via the process drain. The grit classifier is placed into service when the associated grit separator and grit pump are placed into service. Figure 2-39 and Figure 2-40 show the grit hydrocyclone and classifier units at AlexRenew.

Figure 2-37 Cyclone Classifier Room

Figure 2-38 Grit Hydrocyclone Unit

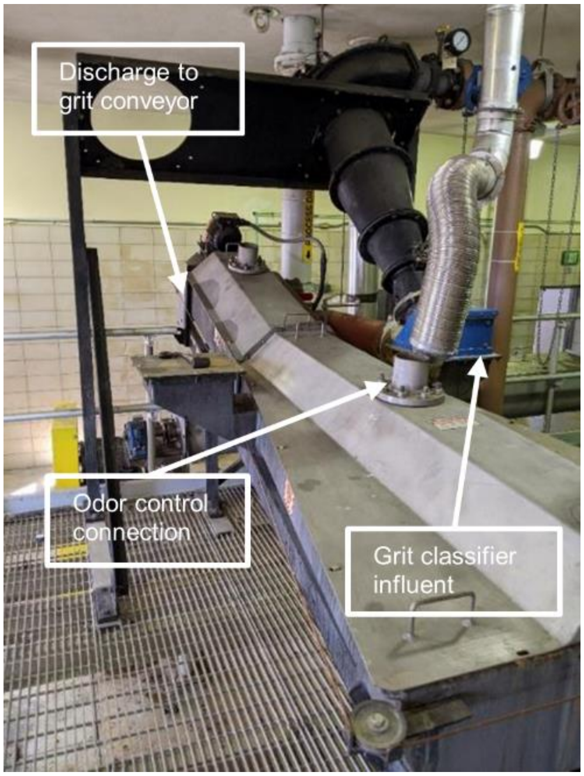


Figure 2-39 Grit Hydrocyclone and Classifier

Figure 2-40 Grit Classifier and Process Drain

GHD developed a steady state hydraulic model in a spreadsheet to assess the flow conditions in the existing grit removal facilities. The key findings of the assessment are summarized in Table 2-12.

Table 2-12 Flow Conditions of Existing Grit System

Plant Influent Flow Rate (MGD)	No. Grit Units in Operation	Flow per Grit Unit (MGD)	Water Surface Elevation in common channel downstream of grit units (ft)	Grit Unit Head Loss (ft)	Water Surface Elevation in common channel upstream of grit units (ft)	Grit Influent Channel Velocity (ft/s)
120	4	30	25.38	1.80	29.82	2.10
120	3	40	25.38	2.18	30.62	2.80
54	3	18	21.16	1.33	28.76	1.26
54	2	27	21.16	1.67	29.54	1.89
20	1	20	20.02	1.47 [1]	28.94	1.40

Note:
1. Grit unit head loss estimates were provided by the manufacturer. Value Interpolated from Manufacturer Data.

During average and low flow conditions, the influent flow velocities are below 2 feet per second (ft/s) and therefore there is a risk of grit deposition in the influent channel. During peak flow conditions, with all units in service, the influent flow velocities are still relatively low at 2.10 ft/s and therefore the ability to scour previously deposited grit is limited. Nonetheless, settled grit will eventually make its way into the grit basin.

Although the units are identical in size, there is a risk of unequal flow distribution due to the low overall head loss and preferential flow paths between the four existing units. A detailed hydraulic analysis to determine the actual flow distribution between the four units is beyond the scope of this TM. The steady state hydraulic model assumes even flow distribution between all in service grit units.

Based on an engineering and operations review of the existing grit removal system, written answers to questions received from the operation staff on November 5, 2020, and the discussions during the Process Background Workshop with the AlexRenew Core Team on November 6, 2020, the following deficiencies were identified with the existing system:

1. Unsatisfactory grit removal efficiency resulting in grit carryover to downstream unit processes

Grit carryover to the primary settling tanks has been observed by AlexRenew personnel and as concluded by the grit sampling, there is carryover of grit particles to the primary clarifiers downstream due to the poor removal performance. 81% of all grit 106 micron and greater was captured by the grit separators during test conditions, falling below the manufacturer's claimed removal rates. An estimated 30 lb/MG or 591,300 pounds per year of grit is escaping the grit separators units per year under average conditions and is carried over downstream to the primary clarifiers. Based on sampling data collected, most grit carried over to the primary settling tanks was removed in those tanks, with less than 3 grams escaping in the collected samples. Over time, the grit carryover will lead to excessive equipment wear for primary clarifier mechanisms, sludge pumps, and downstream solids handling equipment. The grit will also consume useable capacity in solids handling system tanks such as the anaerobic digesters from which it will need to be periodically removed.

2. Equipment is at the end of its expected useful life and requires replacement

Existing equipment is at the end of its useful life after years of operation handling an abrasive material in a corrosive environment. The mixer in grit separator 2 has rusted and fallen apart, requiring the unit be removed from normal service. The grit hydrocyclones have been retrofitted in the past due to built-up of calcified grit. The classifier conveyors have experienced numerous mechanical breakdowns also been serviced many times due to extreme wear.

3. Excessive wear on grit piping

Grit discharge piping and valves have experienced excessive wear due from the abrasive grit slurry and several sections have had to be replaced. There is also wear along the 90-degress elbows upstream of the hydrocyclones, on the suction side of the grit pumps, and along the grit classifier overflow piping.

4. Clogged floor drains

The floor drains have been reported to be clogged with grit. Further investigation into pipe sagging and additional inspections to troubleshoot the clogging should be considered. Installation of sediment bucks in place of the existing floor drains is recommended. It is a wide type of drain used to catch sediment and prevent material from getting in the drain pipes. The bucket would need to be periodically cleaned out to remove the captured material. Additionally, it would require demolishing the circular drain and reconnecting the new sediment bucket to the old piping.

The following major critical success factors were identified to address these identified deficiencies:

– Improve grit removal efficiency to reduce grit carryover
– Replace aged equipment
– Provide more system resiliency

2.6 Fine Screenings and Grit Loading

The existing fine screenings and grit loading system is located in the Preliminary Treatment Building (Building K), which was constructed around 1998 as part of the "Advanced Wastewater Treatment Facility Upgrade" project. The washed and compacted fine screenings discharge onto the two fine screenings conveyors which transport material from the washer/compactors to the combined material transfer conveyors. Washed and dewatered grit discharges from the cyclone/classifier units onto the two grit conveyors to be transported to the combined material transfer conveyors. The two combined material transfer conveyors accept fine screenings and grit to transport to either one of the combined material truck loading conveyors via forward and reverse operation. The truck loading conveyors have four discharge ports to dispose of the material below to the trailers located in the Truck Bay. There are two trailers, one located in each Truck Bay that collect fine screenings and grit. The material is then removed from the facility via Synagro for hauling and disposal to Covanta Waste Energy Facility located in Fairfax, Virginia.

The existing plan for Building K is presented in Figure 2-41 and Figure 2-42, which highlight the Grit Dewatering Area location and Truck Bay Area location, respectively. Figure 2-43 shows a schematic overview of the operation of the conveyor system.

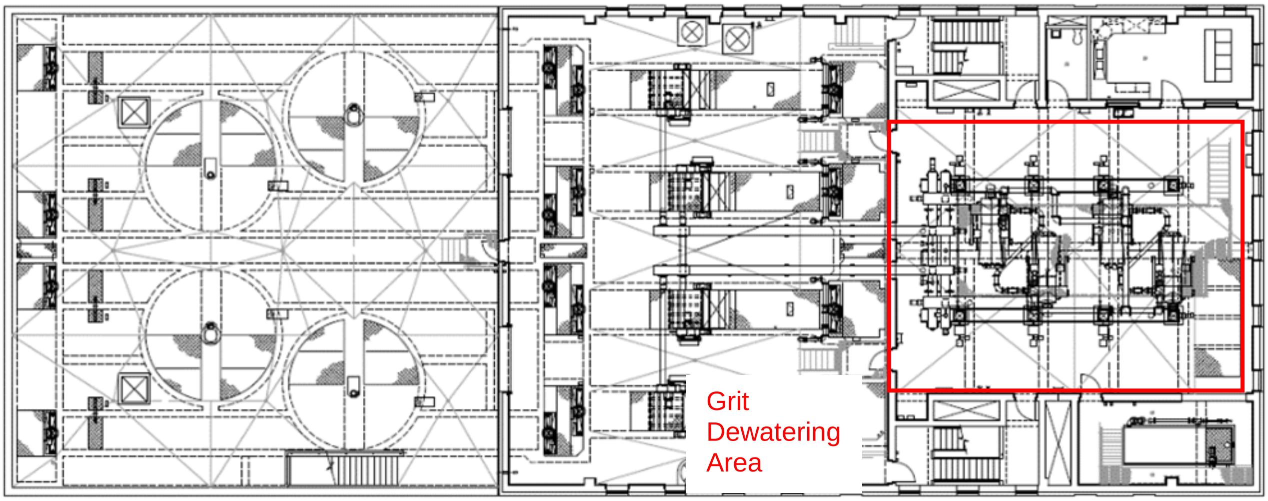


Figure 2-41 Existing Building K Plan with Grit Dewatering Area Highlighted

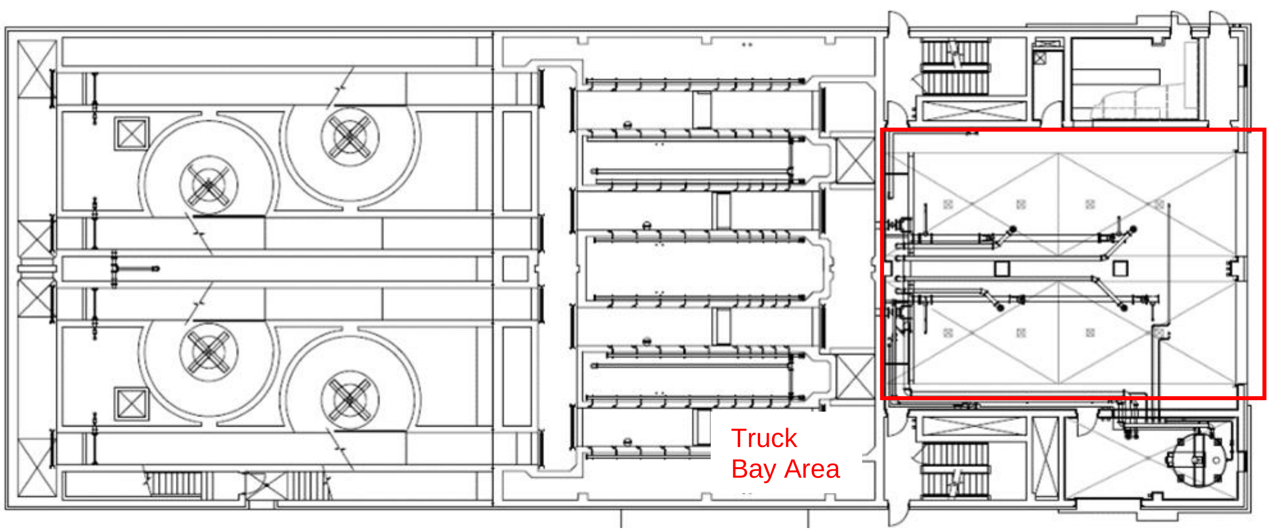


Figure 2-42 Existing Building K Plan with Truck Bay Area Highlighted

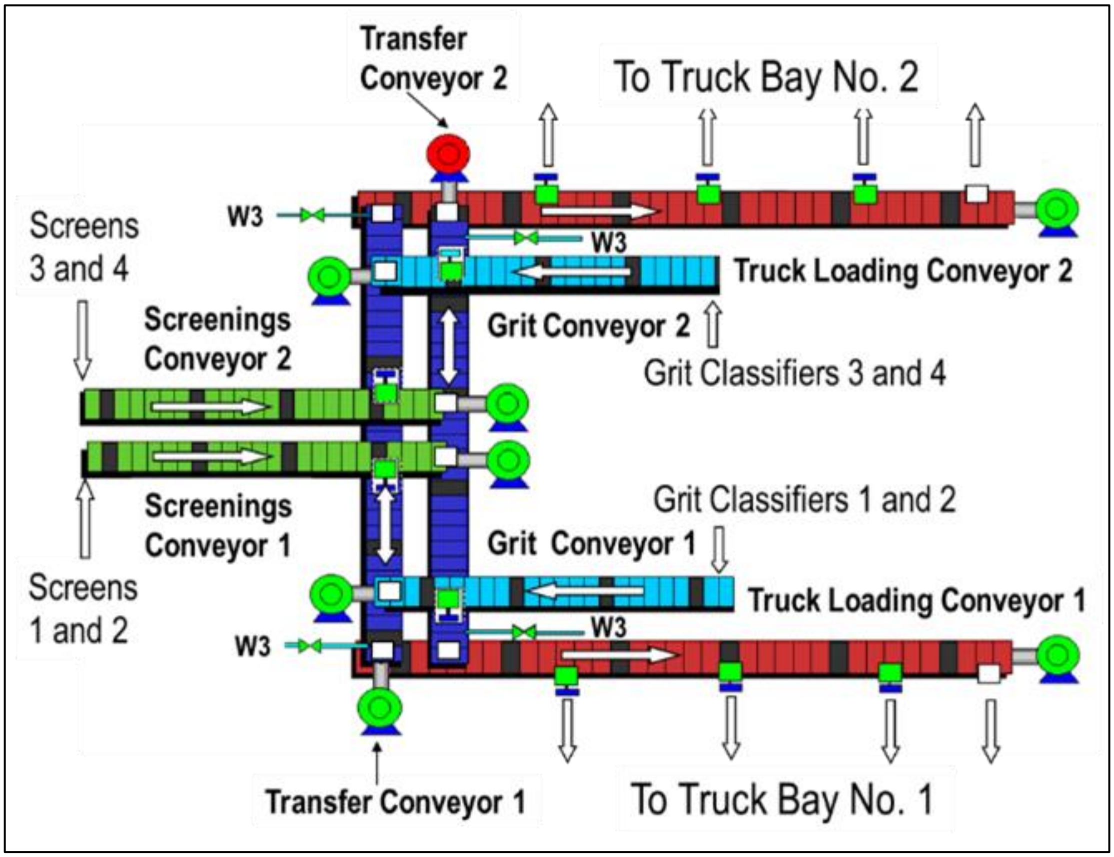


Figure 2-43 Conveyor Operation at AlexRenew (Courtesy AlexRenew Process Manual Module 4 – Preliminary and Primary Treatment)

The existing fine screenings conveyors are shaftless screw conveyors. The shaftless design is supported by a replaceable liner that conforms to the radius of the trough. Typically, shaftless conveyors are used for moving bulk solids that tend to be fibrous or sticky – such as dewatered screenings or biosolids. The liner is a wear item, but if the material is not abrasive, it can have a long service life.

The original design for the grit, transfer, and truck loading conveyers were shafted screw conveyors. Over time, the transfer and truck loading shafted conveyors were replaced with shaftless conveyors to reduce clogging of the screws with rags. Currently AlexRenew has shaftless screw conveyors for their fine screenings, transfer, and truck loading conveyors and shafted screw conveyors for their grit conveyors. The shafted design has a center pipe to support the screw as it conveys the material without allowing the screw to contact the trough or liner. This type of screw is more commonly used with abrasive materials like grit which would quickly wear through the tough liner on a shaftless screw. However, rags and fibrous materials can easily get hung up on the bearings of a shafted screw conveyor, which can be problematic when handling a combined material of screening and grit.

Detailed design information of the existing grit loading system is summarized in Table 2-13.

Table 2-13 Existing Fine Screenings and Grit Loading System Design Information

Parameters	Design Information
Fine Screenings Conveyors (M13-2901, 2902)	
Quantity	2
Supplier and model	US Filter
Drive motor (explosion-proof)	5 Hp (460 VAC/3-phase/60-hertz)
Type	Shaftless

Parameters	Design Information
Screw diameter	12 in
Conveyor speed	25 rpm
Peak loading	5,000 lbs/hr
Length	47 ft
Angle of inclination	12 deg
Grit Conveyors (M13-2901, 2902)	
Quantity	2
Supplier and model	US Filter
Drive motor (explosion-proof)	5 Hp (460 VAC/3-phase/60-hertz)
Type	Shafted
Screw diameter	14 in
Conveyor speed	20 rpm
Peak loading	20,000 lbs/hr
Length	30 ft and 39 ft
Angle of inclination	1 deg
Transfer Conveyors (M12-3201, M12-3202)	
Quantity	2
Supplier and model	US Filter
Drive motor (explosion-proof)	7.5 Hp (460 VAC/3-phase/60-hertz)
Type	Shaftless
Screw diameter	14 in
Conveyor speed	25 rpm
Peak loading	25,000 lbs/hr
Length	24 ft
Angle of inclination	0 deg
Truck Loading Conveyors (M13-3001, 3002)	
Quantity	2
Supplier and model	US Filter/ASDOR
Drive motor (explosion-proof)	7.5 Hp (460 VAC/3-phase/60-hertz)
Type	Shaftless
Screw diameter	14 in
Conveyor speed	30 rpm
Peak loading	25,000 lbs/hr
Length	40 ft
Angle of inclination	1 deg

2.6.1 Overview of Fine Screenings and Grit Conveyance

The fine screenings are washed and compacted via four washer/compactor units located in the Screening Room of Building K. Two washer/compactor units discharge the compacted material to each of two screening conveyors and the filtrate drains back to the fine screen channel. The two inclined fine screenings conveyors transport material from the Screening Room to the Cyclone Classifier Room in Building K. In the Cyclone Classifier Room, the fine screenings conveyors discharge onto the center of the two transfer conveyors. The fine screenings conveyors have two discharge points, the first being an automatic slide gate and the second is always opened to prevent accumulation and provide redundant discharge locations to either transfer conveyor. The screening conveyors automatically turn on when the associated fine screen is placed into service; an alarm and visual are initiated ten seconds prior to the start of the conveyors. Figure 2-44 shows the fine screens and the fine screenings conveyors from the Screenings Room to the Cyclone Classifier Room.

Figure 2-44 Fine Screens Screening Conveyors from the Screening Room to the Cyclone Classifier Room

The grit conveyors located in the Cyclone Classifier Room receive grit directly from the classifier units. Two classifier units discharge dewatered grit to the associate grit conveyors. The two grit conveyors transfer material from the classifiers to the transfer conveyors in the Cyclone Classifier Room. Grit is discharged onto the ends transfer conveyors. There are two discharge points on the grit conveyors, like the fine screenings conveyors, the first is a motorized slide gate and the second is always open to prevent grit accumulation and provide redundant grit disposal locations. The grit conveyors automatically turn on when the associated grit classifier is placed into service; an alarm and visual are initiated ten seconds prior to the start of the conveyors.

Figure 2-45 shows the grit classifier discharge to the grit conveyors as well as the truck loading conveyor and motorized slides gates below it.

Figure 2-45 Grit and Truck Loading Conveyors

The transfer conveyors are oriented perpendicular to the screening and grit conveyors in the Cyclone Classifier Room and transfer fine screenings and grit to the truck loading conveyors. The fine screenings and grit conveyors can discharge separately into a corresponding transfer conveyor, or the material can be combined for disposal on either transfer conveyor. Each transfer conveyor is equipped with W3 spray nozzles on both ends of the conveyor to prevent material from drying and hardening. Standard operation at AlexRenew consists of combining the fine screenings and grit for hauling and disposal. Additionally, the transfer conveyors can load material to either truck loading conveyor due to its forward and reverse operation. The transfer conveyors have two operation modes: separate and combined. In separate mode, the fine screenings and grit discharge into separate transfer conveyors, truck loading conveyors, and trailers. In together mode, the fine screenings and grit discharge into the same transfer conveyor, truck loading conveyor, and trailer. The selected Truck Bay for disposal will dictate which trailer will be loaded first. In both modes, the W3 valve will automatically open once a conveyor is placed into service. Figure 2-46 shows the grit, transfer, and truck loading conveyor discharge locations.

The truck loading conveyors are the final transfer of material for disposal to the trailers in the Truck Bay below.

The truck loading conveyors accept fine screenings and grit from the transfer conveyors and discharge material via four discharge chutes to the trailer in the Truck Bay below to provide even distribution of material. The first three discharge points are equipped with motorized slide gates and the fourth discharge location at the end of the conveyor is always open to prevent accumulation. The gates automatically open and close one at a time for a pre-set period. There is always a trailer in each Truck Bay to collect material in case a truck loading conveyor faults or is out of service.

The existing screening and grit loading system has reached its end of useful life. The conveyors and container loading systems are maintenance intensive and require constant attention to keep up with incoming material load. A more reliable and efficient fine screenings and grit loading system is required.

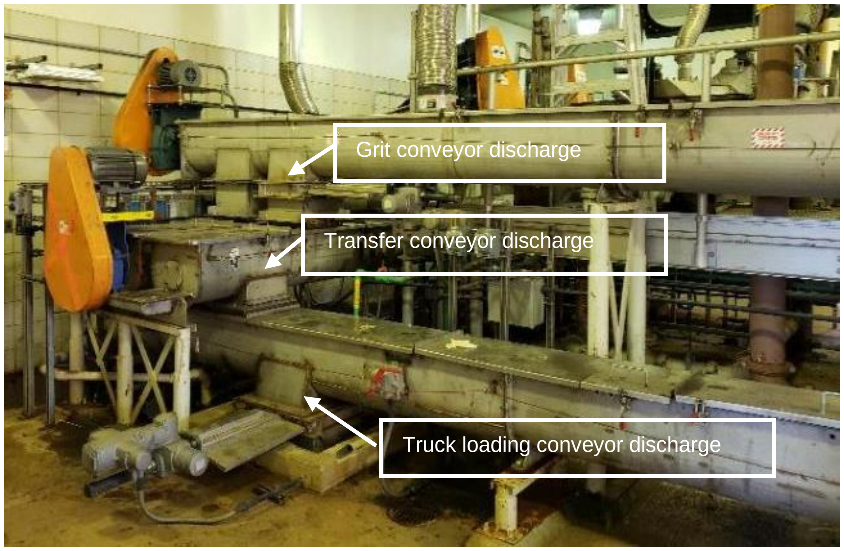


Figure 2-46 Conveyor Discharge Overview

2.6.2 Overview of Fine Screenings and Grit Hauling Operations

Standard operations at AlexRenew consist of disposing the fine screenings and grit together into the open bed trailers located in the Truck Bay. The conveyor configuration allows for AlexRenew to separately dispose of the material, however GHD was advised that the normal mode of operation is to combine the material for offsite disposal. There are four discharge chutes to the trailers below. Currently, there are two trailers on site in the Truck Bay of Building K to collect fine screenings and grit. One trailer is approximately 38 feet long and the other is about 32 feet long. The longer trailer can collect material from all four discharge points whereas the 32 feet long trailer can only collect material from three. Figure 2-48 shows the open bed trailer accepting material from three of the four discharge points.

Synagro, the hauling contractor, comes to the site about two times a week to move the trailer forward or backwards based on accumulation. AlexRenew indicated that when the pile is high enough, they will close one gate from the truck loading conveyor and open the next gate to load the trailer. However, the piles still need to be manually raked by operations staff to move material to the sides to optimize trailer filling. Figure 2-47 shows the fine screenings and grit piles formed in the trailer.

Figure 2-48 Open Bed Trailer Utilizing Three Discharge Points

Figure 2-47 Screenings and Grit Piles

Synagro indicated that when they are leaving the site to disposal of the fine screenings and grit material, they stop at the scale and weight the trailer. Upon return to the site, Synagro weighs the empty truck tare prior to placing the trailer back in the Truck Bay. The trailers can hold approximately 46,000 pounds of material, however AlexRenew stated that they typically haul loads of 24,000-32,000 pounds.

The fine screenings and grit loading data from January 2015 to August 2020 was reviewed and analyzed and the results are presented in Figure 2-49. On average, AlexRenew collects about 83,000 pounds of fine screenings and grit per month from January 2015 to September 2020. This would result in about two hauls per month and less than one haul a week when filling the trailers to their maximum or near maximum weight capacity. A peak fine screenings and grit load of 158,860 pounds occurred in May 2019 which would result in four hauls for the month at the trailer's maximum weight capacity. Based on the hauling data, the trailer was actually hauled five times in May 2019.

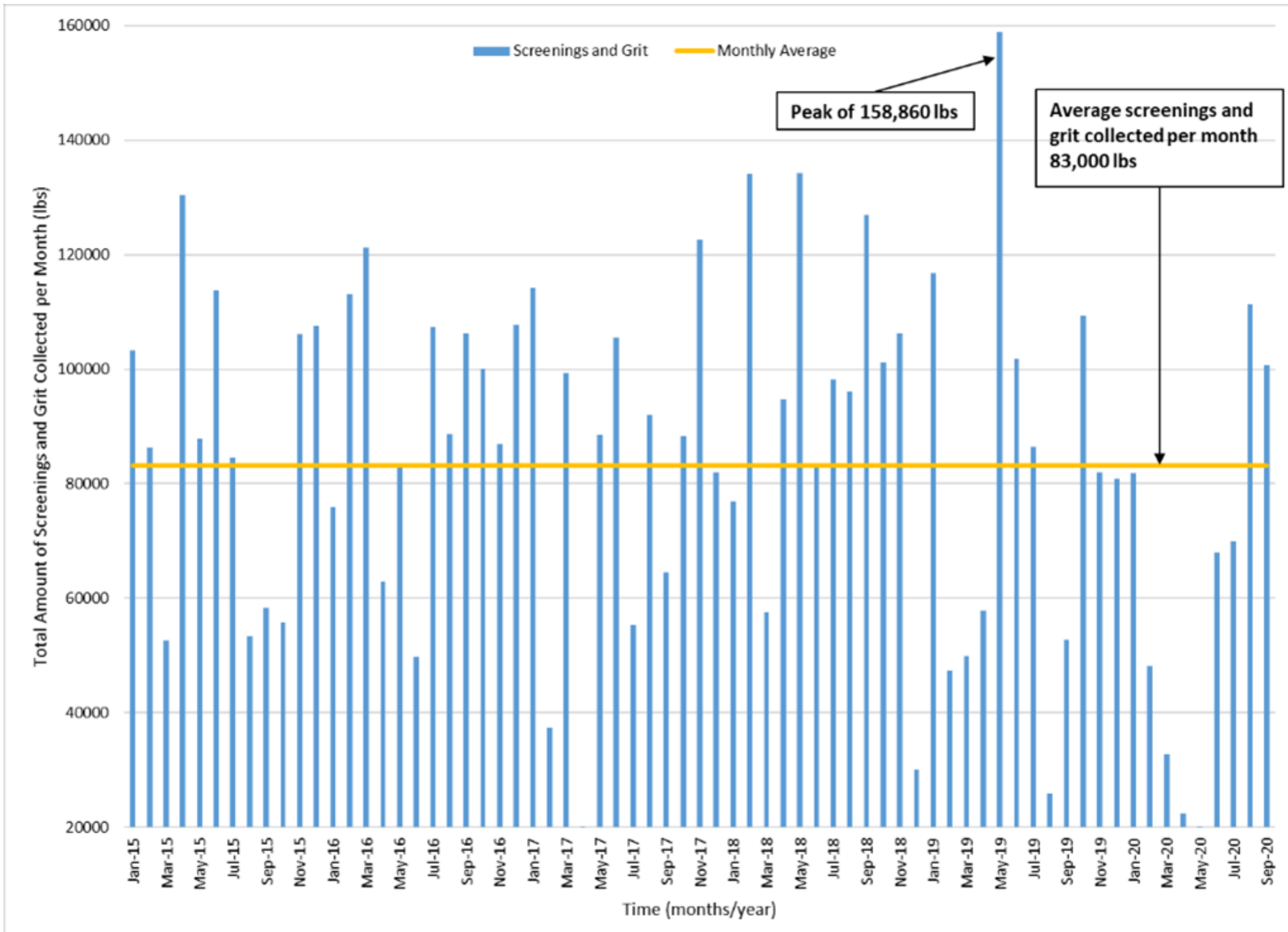


Figure 2-49 Historical Fine Screenings and Grit Collected per Month

Based on an engineering and operations review of the existing fine screenings and grit loading system, the written answers to questions received from the operation staff on November 5, 2020, and the discussions during the Process Background Workshop with the AlexRenew Core Team on November 6, 2020, the following deficiencies were identified with the existing system:

1. Unsatisfactory and unreliable conveyor operation

While the plant operators reported no issues with the shaftless screw conveyors used for fine screenings only, and manageable issues with shafted screw conveyors used for grit only, the operators reported repeated problems and extensive maintenance was required for the shafted screw conveyors which handle combined screening and grit together. Rags are often found wrapped around the shaft and bearings of the combined fine screenings and grit conveyors. The interior sides of the trough are prone to two to three inches of caked grit and other solids. To remove the clogged rags and grit, AlexRenew stops the conveyors, manually open the conveyor at the hatch, and remove the screw. To dislodge the material, the conveyor is manually placed in reverse and then set back forward.

2. Difficulties in conveyor access

The conveyors in the Cyclone Classifier Room are difficult to access to maintain or remove clogged material. The grit and the truck loading conveyors are stacked on top of each other, while the transfer conveyors run underneath the classifier platform so the center section of them is not accessible.

3. Frequent operator attention for manual leveling of material in trailers

The fine screenings and grit are disposed in open bed trailers. The uneven distribution of material requires operators to manually rake material around to even the load. There is a safety hazard while moving the material, operators must stand on a portable stair to see and access the trailer to level the material.

4. Floor drains in the Truck Bay area are prone to clogging

The truck beds need to be drained of water and grit tends to also be drained in the process. The grit accumulates and clogs the drains.

The following major critical success factors were identified to address these identified deficiencies:

- Improve fine screenings and grit conveyance operations
- Optimize hauling operations
- Minimize equipment wear
- Maintain operator health and safety

2.7 Primary Settling

The AlexRenew WRRF includes eight primary settling tanks (Figure 2-50) that provide treatment for raw sewage that has received preliminary treatment for removal of screenings and grit. In addition, the primary settling tanks also provide treatment for some in-plant recycle flows including backwash water from the tertiary filter system and water removed from fine screenings, grit, and combined primary and secondary scum.

The primary objective of treatment in the primary settling tanks is to remove settleable solids and associated organic matter to reduce the concentrations of total suspended solids (TSS), 5-day biochemical oxygen demand (BOD_5) and organic nitrogen in the wastewater. These reductions in concentration are necessary to avoid overloading downstream advanced biological wastewater treatment systems.

Fats, oils, and grease (referred to as FOG) and other light floatable solids are skimmed from the surface of the primary settling tanks. The material skimmed from the surface of the settling tanks is referred to as primary scum and is collected and conveyed to a scum pumping station wet well where it mixes with scum removed from the surface of the secondary clarifiers. The combined scum is pumped to scum concentrating equipment located in Building K. Concentrated scum is discharged to containers for co-disposal with dewatered fine screenings and grit.

Figure 2-50 Primary Settling Tanks and Primary Weir Observation House

A simplified process flow schematic of the primary settling tanks and primary scum handling system is presented in Figure 2-51. Effluent from the Grit Removal System in Building K is conveyed by gravity flow to the primary settling tanks through four 48-inch diameter primary influent pipes (Figure 2-52). A 30-inch diameter magnetic flow meter is installed in each primary influent feed line and the flow is balanced to each primary influent pipe using 30-inch diameter butterfly valves located downstream of the flow meters. Under normal flow conditions, six primary settling tanks are typically in service. The other two tanks are drained, cleaned, and remain ready to be put into service when peak wet weather flow conditions require.

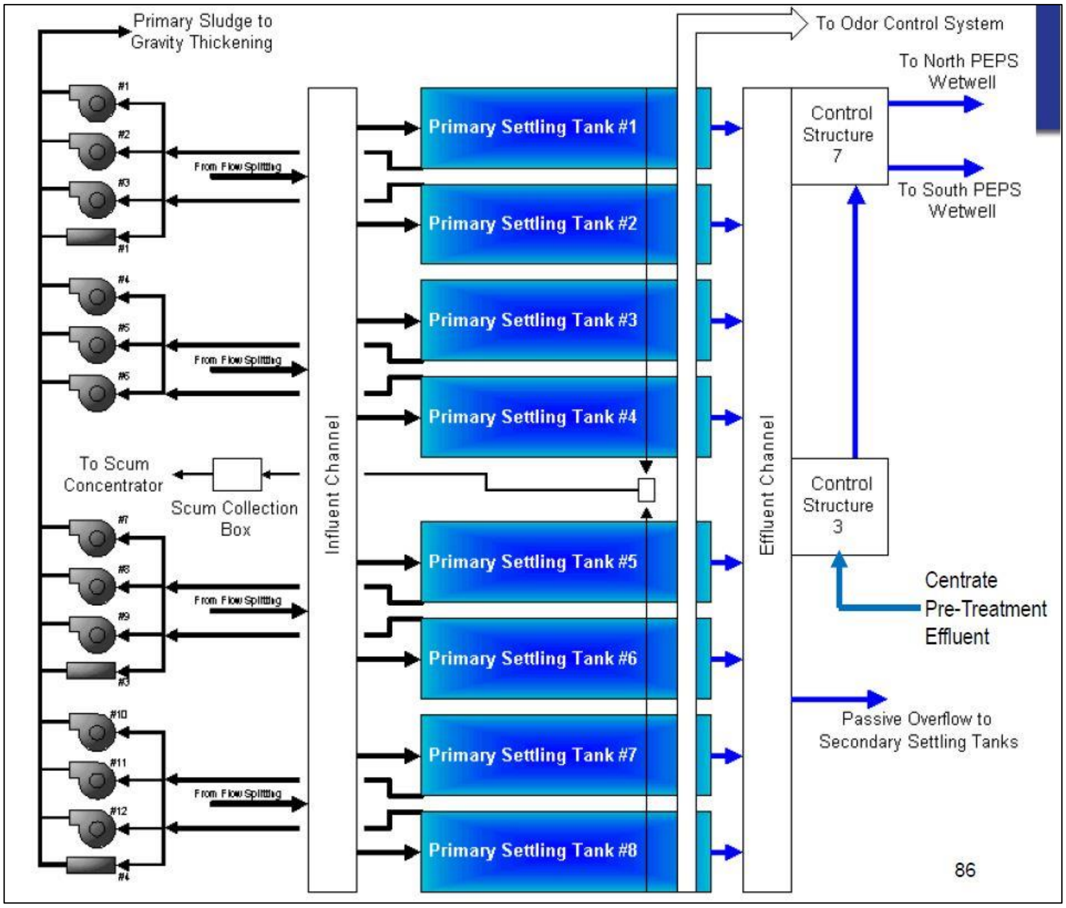


Figure 2-51 *Primary Settling Tanks Process Flow Schematic (Source: AlexRenew Process Manual Module 4 – Preliminary and Primary Treatment)*

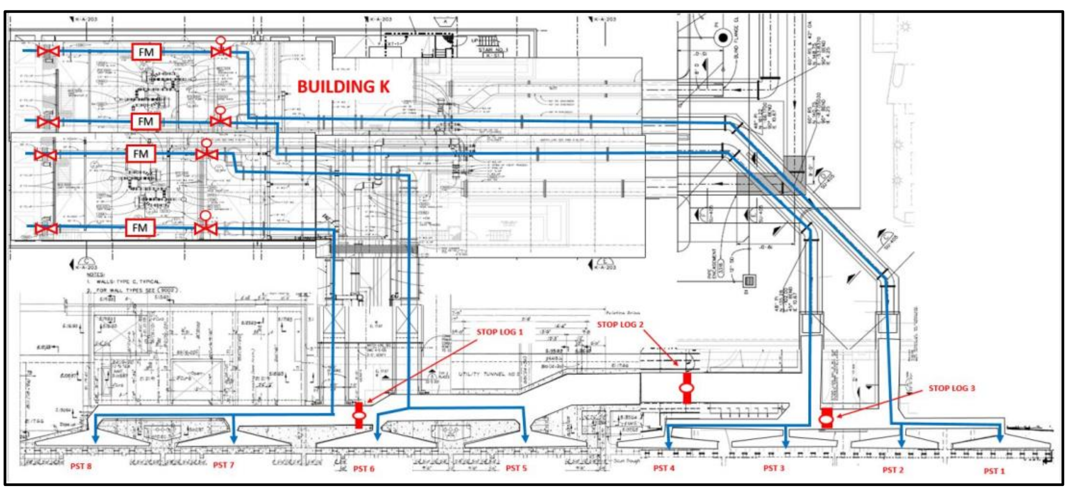


Figure 2-52 *Primary Settling Tank Influent Flow Distribution*

The 48-inch diameter primary influent pipes terminate at boxes that connect to primary influent flow channels that distribute the wastewater flow to the primary settling tanks in service. The primary influent channels were designed with stop logs at three locations. The design intent for the stop log locations was to allow the wastewater flow conveyed by each 48-inch diameter primary influent pipe to be isolated for distribution to one pair of primary settling tanks. However, the AlexRenew WRRF staff currently operates the primary settling tanks without the stop logs installed. Under certain conditions, the AlexRenew staff believe the wastewater flow distributes unequally to the primary settling tanks in service.

Each primary settling tank is equipped with two longitudinal chain-and-flight sludge collectors and one chain-and-flight cross collector driven by a single combination drive unit. The sludge collectors scrape settled solids from the bottom of the tank to a sludge hopper located at the influent end of each primary settling tank. On return to the effluent end of the tank, the longitudinal collectors skim the surface of the tanks moving light floating solids to a scum baffle and rotating scum collector equipped with an electric actuator (Figure 2-53).

Figure 2-53 Primary Settling Tank Scum Skimmer Electric Actuators

Three centrifugal recessed impeller pumps (Figure 2-54) are installed for removing settled solids from the sludge hoppers for each pair of two primary settling tanks. Two pumps normally operate, one dedicated to each settling tank. The third pump is an installed spare that remains ready to be put into service when needed. Normally, the primary sludge pumps run continuously pumping primary sludge to gravity sludge thickeners at a rated capacity of 350 gallons per minute (gpm) for a total primary sludge flow of approximately 3 MGD with six (6) primary settling tanks in service.

The primary settling tank system includes provisions for adding ferric chloride for chemically enhanced primary treatment (CEPT). CEPT is of benefit in certain circumstances for phosphorus removal and/or reduction of solids and organic loads to downstream biological wastewater treatment systems. AlexRenew reports that CEPT is not currently used and is not anticipated to be used in the foreseeable future.

Figure 2-54 ***Primary Sludge Pumps***

A simplified process flow schematic illustrating the primary scum conveyance and handling system is presented in Figure 2-55. Primary scum is conveyed by gravity flow to a Scum Pump Station wet well (Figure 2-55) where it mixes with secondary scum from the secondary clarifiers. One scum grinder and two submersible recirculating chopper pumps are installed in the wet well. Manual valves on the scum pump discharge can be opened for recirculation and mixing of the wet well contents. The scum pumps are used to transfer the combined (primary and secondary) scum to a scum concentration system located in Building K.

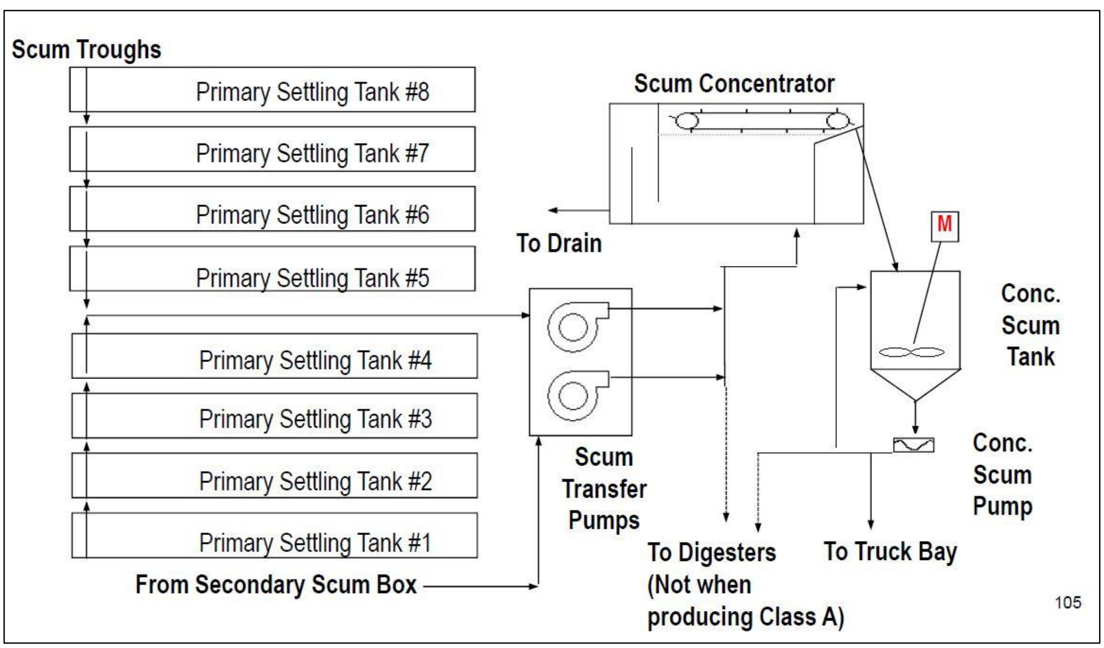


Figure 2-55 ***Scum Conveyance and Handling System Process Flow Schematic (Source: AlexRenew Process Manual Module 4 – Preliminary and Primary Treatment)***

The scum handling system consists of three major components, a scum concentrator (Figure 2-57), a concentrated scum tank (Figure 2-56) and a concentrated scum transfer pump (Figure 2-58). FOG and light solids float to the surface in the scum concentrator where they collect and concentrate as they are skimmed off by a chain-and-flight collector mechanism to the concentrated scum tank. Water removed from the scum flows over a weir and is drained to the plant influent for treatment.

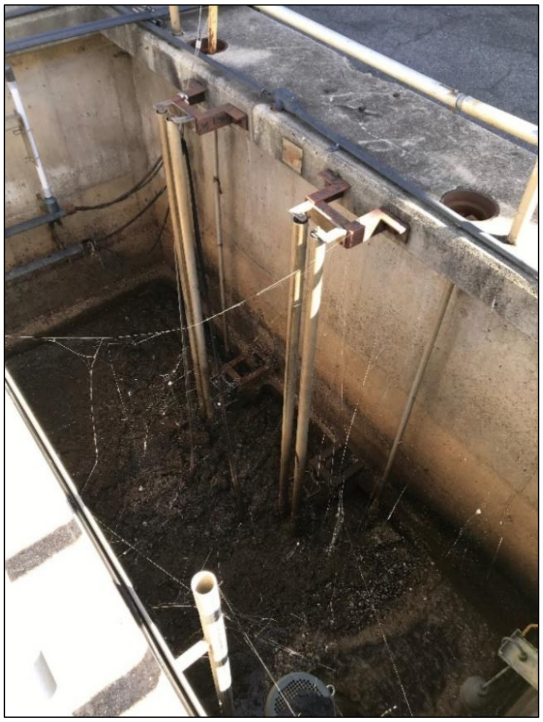


Figure 2-56 Scum Pumping Station

Figure 2-57 Scum Concentrator

Figure 2-58 Concentrated Scum Tank and Pump

The concentrated scum tank is heated and equipped with a mechanical mixer. A progressive cavity pump is used to transfer the concentrated scum to the truck bays in Building K for truck loading and subsequent removal and offsite disposal along with screenings and grit. The system also includes piping and valves to allow the concentrated scum to be pumped to the anaerobic digesters. AlexRenew staff report that pumping to the digesters is not used, however, due to concerns for contaminating the digested sludge and preventing disposal as Class A biosolids.

The existing primary settling tanks operate within industry standard loading rates, achieve generally relatively equal flow distribution between the units with the stop logs in place, and achieve target removal performance under simulated design conditions. Therefore, no major deficiencies were identified with respect to the primary settling tank capacity or performance. It was noted that a minor improvement of flow distribution could be achieved by installing a flow control device at the influent to PST-8 to provide a more even flow distribution between PST-7 and PST-8.

Based on the results of the primary settling tank stress test and review of operating records for the period of January 1, 2015, through August 31, 2020, primary sludge pumping capacity appears to be adequate. The primary settling tanks achieve target removals, even under peak hydraulic loading conditions that approach the projected peak flow expected from implementation of the RiverRenew project. AlexRenew staff report occasional problems resulting from clogging of the pumps during high solids loading events. It is expected that the frequency and magnitude of high solids loading conditions that contribute to clogging of the primary sludge pumps will be significantly reduced with improvements to influent coarse screening, fine screening, and grit removal. However, AlexRenew may want to consider installing in-line sludge grinders in the pump suction piping as an additional means to reduce pump clogging.

Following is a listing of deficiencies identified for the existing primary settling and scum handling systems:

– Primary Weir Observation House
  1. Deterioration of paint and the wet, humid atmosphere in the building has caused significant corrosion to metal building components (structural steel supports, metal roofing, etc.), odorous air piping, and electrical equipment, lighting, fire alarm components, conduits, and wiring.

2. The odorous air fan is located above the tanks and is not easily accessible for maintenance.
3. Plant water supply to the building (1” diameter) is insufficient to provide required flow and pressure for weir washdown.
4. The scum skimmer pipe is located under the across tank walkway located immediately outside the PWOH building (upstream side of PWOH). The location of the pipe makes it difficult for the operators to effectively wash down solids and scum that tend to harden and accumulate in the pipe over time.

– Scum Handling
1. The scum concentrator and heated scum day tank are operation and maintenance intensive and often out of service. Discharge piping is frequently clogged by congealed fats, oil, and grease preventing transfer of concentrated scum from the day tank to the truck loading area.

– Primary Sludge Pumping
1. The operators report periodic problems with pumps clogging primarily during high solids load events. The frequency and magnitude of pump clogging problems is reasonably expected to decrease with implementation of improvements for more effective influent wastewater screening and grit removal.

– Miscellaneous
1. Rags and other large stringy solids tend to collect on baffles located at the influent end of each primary settling tank downstream of the tank inlet ports. This deficiency will be significantly reduced or eliminated with improvements to the WRRF influent coarse and fine screening facilities.
2. Floating solids tend to collect at the influent end of Primary Settling Tank No. 8 in the area above the sludge cross collector. When the settling tank is taken out of service, AlexRenew staff need to be careful to avoid overloading and potentially breaking the flights on the sludge cross collector mechanism. It is unclear why this occurs only for Primary Settling Tank No. 8 as the tank appears to be constructed like all other tanks. GHD was unable to physically observe this condition as the tank was not in service during GHD’s site visit on November 4, 2021. Further investigation is recommended when the tank is back in service and the condition can be observed.
3. The AlexRenew WRRF staff report that when some primary settling tanks are removed from service and drained, some seepage is observed through the concrete tank walls of adjacent tanks. GHD recommends that a detailed structural evaluation of the tank walls be performed either during design of the PPSU improvements or during the maintenance contract to replace the primary settling tank sludge collector mechanisms and drives.
4. Wooden baffles located downstream of the scum collector mechanisms are missing or damaged in several of the primary settling tanks. This allows buildup of scum and solids on the primary settling tank effluent weir troughs to the point where flow is restricted or completely blocked from V-notches in the weir trough closest to the scum skimmer mechanism. GHD recommends that AlexRenew consider replacing or repairing the baffles under the maintenance contract at the time when each primary settling tank is drained to replace the sludge collector mechanism and drives.
5. A structural evaluation performed by HDR, Inc. identified significant degradation of concrete and metal supports for grating over the effluent channel. The effluent channel has operated for several years with a tarp over the grating to control odors and the concrete degradation is attributed to accumulation of hydrogen sulfide in the headspace under the tarp. AlexRenew has expressed interest in connecting the effluent channel to the odor control system serving the PWOH. If the effluent channel were to be ventilated at a rate of 12 air changes per hour, like the design ventilation rate for the PWOH, then the amount to roughly an additional 1100 cfm of air to be treated by the plant odor control system. This would be an increase of less than approximately 5% of the design air flow (25,400 cfm) from the PWOH to the plant odor control system. GHD recommends that the potential impact on the on the plant odor control system be evaluated during design of the PPSU improvements.
6. Scum troughs do not function well due to age and mechanical failure and require replacement. In addition, the existing system does not effectively move scum into the trough and through the trough and channels to the scum wet well. An automated timed spray header is desired in front of each scum trough to push scum

toward trough prior to actuation, along with an automated scum trough flushing system for cleaning trough and channel after each use. Another requirement is the addition of plant water hose bibs adjacent to each pair of scum skimming mechanisms for manual washdown when required.

7. The grinder, two recirculating chopper pumps, controls, mixing valves and piping, telescoping valve, and drain valve in the scum wet well have reached the end of their useful life and need replacement.
8. Some portions of the handrail around the primary settling tanks do not appear to meet current code requirements and do not align with the newer handrail sections.
9. Some of the older sludge and drain valves in the primary settling tank pipe gallery (those which are original and have not been replaced over recent years) do not function well or at all and should be replaced.
10. The abandoned (plunger style) sludge pumps in the PST equipment gallery restrict access to other in-use equipment and should be demolished.
11. Influent stop plates at the primary settling tanks do not seat well and should be replaced with gates which are easier to use for isolating tanks.
12. Lighting and HVAC in the primary sludge tank equipment gallery should be reviewed for NFPA 820 compliance prior to upgrade (outside of the scope of the current task order).

The list above does not include condition deficiencies associated with the existing Primary Settling Tank sludge and scum removal equipment, because replacement of this equipment was advanced to an immediate project due to equipment failures and was removed from the PPSU project.

The above deficiencies were identified based on the following:

– Review of construction drawings and other background information provided by AlexRenew for the primary settling and scum handling systems
– Comments received from the AlexRenew operation staff during a site visit by GHD on October 14, 2020
– Comments received from the AlexRenew Core Team during the Process Background Workshop on October 20, 2020
– Email communication received from AlexRenew on October 27, 2021 regarding a failure of the sludge collector mechanism in Primary Settling Tank No. 6 and subsequent recommendations for repairs developed by Geiger Associates
– Comments received from the AlexRenew Core Team during the Technical Memorandum Workshop on November 1, 2021
– Comments received from AlexRenew maintenance staff during a site visit by GHD on November 4, 2021
– Discussion of primary settling tank repairs during a meeting on November 11, 2021, with representatives of AlexRenew and Geiger Pump & Equipment Co.
– Email communication received from AlexRenew on November 29, 2021 regarding results of a structural evaluation performed for AlexRenew by HDR, Inc. for the primary effluent flow channel.

3. Flows and Loads

The purpose of the flows and loads section is to document the development of the updated plant design flows and loads for the PPSU project.

3.1 Current and Design Flows

The AlexRenew WRRF is currently designed to meet the criteria presented in Table 3-1. With the completion of the RiverRenew project, the WRRF peak hydraulic influent flow will be increasing from 108 MGD to 116 MGD.

Table 3-1 AlexRenew WRRF Influent Design Criteria

Condition	Design Flow (MGD)	2008-2018 Data [1]
Average Daily Flow	54	34.9
Max Month Flow	70	45
Max Week	80	60
Max Day	90	92
Peak Instantaneous	108 (current) 116 (following RiverRenew)	120

Notes:
1. AlexRenew WRRF actual flow data courtesy of Jacobs 2019, "AlexRenew Process Manual Module 22: Plant Hydraulics" PowerPoint presentation dated October 2019.
2. Design influent flows do not include internal plant recycle flows.

A major upgrade to AlexRenew's collection system, called the RiverRenew project, is set to be completed by June 2025. The RiverRenew project includes increasing the raw influent peak hydraulic flow from the current permit limit of 108 MGD to 116 MGD and constructing tunnels to collect and transport wet weather flows that exceed the capacity of the system. The incoming wet weather flows will be treated through preliminary and primary treatment and therefore the PPSU upgrades will be designed to meet the future flow as outlined in Table 3-2.

Table 3-2 Unit Process Hydraulic Capacity at AlexRenew

Unit Process	Current Hydraulic Capacity (MGD)	Future Capacity for Raw Influent of 116 MGD
Raw Sewage Flow	108	116
Coarse Screening	120	119
Raw Sewage Pump Station	125	119
Fine Screening	120	125 [2]
Grit Removal	120	125 [2]
Primary Settling	125 [3]	125

Notes:
1. Hydraulic capacities courtesy of Jacobs 2019, "AlexRenew Process Manual Module 22: Plant Hydraulics" PowerPoint presentation dated October 2019.
2. The existing fine screening and grit removal systems have sufficient capacity if the filter backwash is not diverted to Building K. The 108 to 116 MGD upgrade project is installing additional piping and valves to allow filter backwash to be directed to the primary settling tanks under high flow conditions.
3. Eight tanks required to meet SCAT guideline of peak loading of 2,500 gpd/sf.

3.2 Current and Design Loads

The raw influent to the AlexRenew WRRF consists of wastewater collected from a combined sewer system that includes various debris. Raw wastewater is collected from the Commonwealth Interceptor and the Potomac Interceptor which combines at the existing Flow Control Structure No. 1, adjacent to the Coarse Screen Room as well as from the Potomac Yards Trunk Sewer which enters directly into the coarse screen influent channel as shown in Figure 3-1. The current and design loads are further discussed in the individual unit process sections herein.

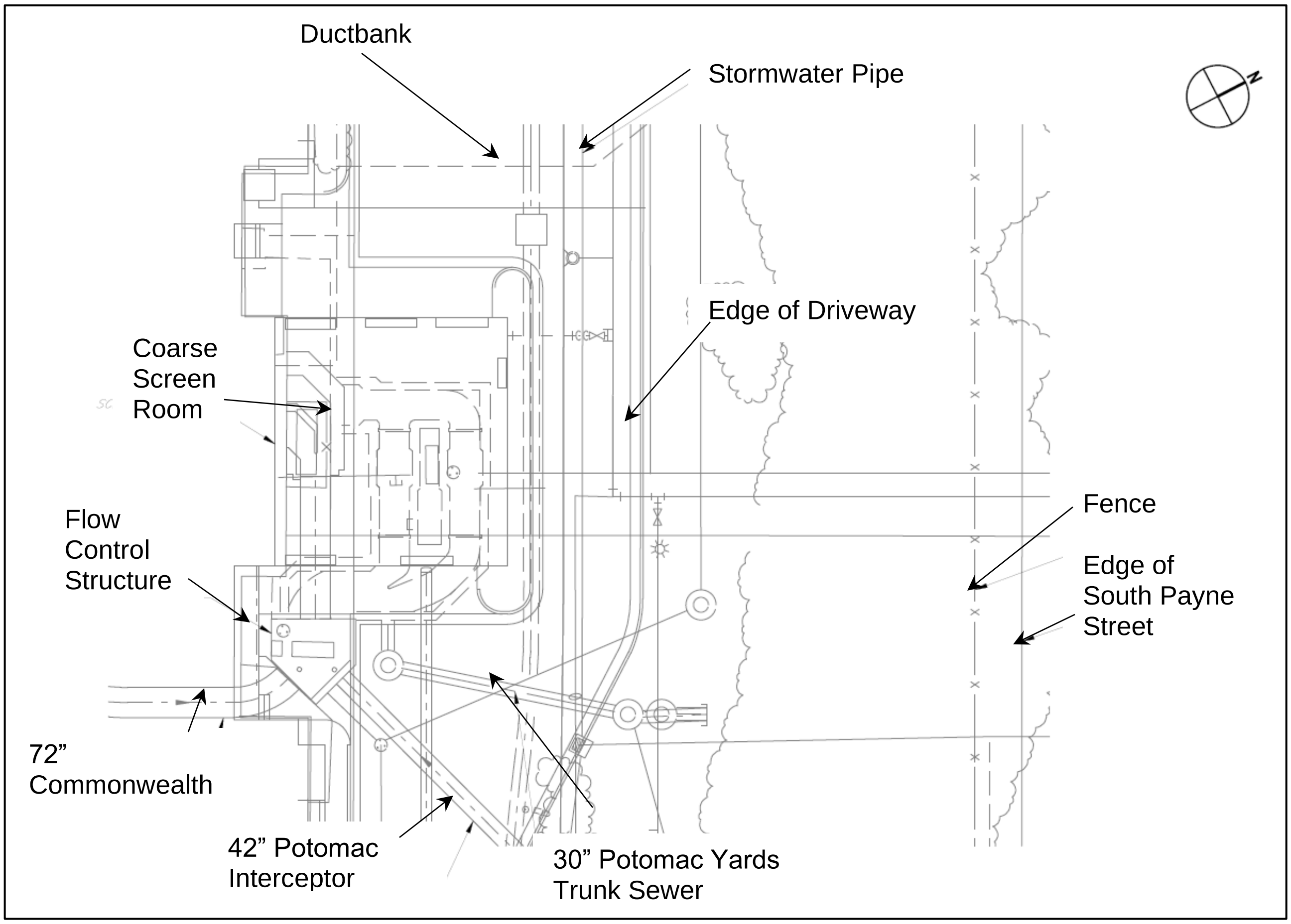


Figure 3-1 Site Plan of Incoming Sewer to Building A

4. Approach

4.1 Alternative Analysis Criteria

For each alternative, the following 11 evaluation factors were considered:

- Concept Arrangement
- Operational Efficiency and Reliability
- Process Resiliency
- Sustainability
- Maintenance Requirements
- Safety
- Constructability
- Maintenance of Plant Operations
- Impact on Other Processes
- Public Impact
- Adaptability to Meet Future Requirements

GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost factors for each alternative. In this model, each alternative was assigned a rating for each evaluation factor corresponding to the three colors of a traffic light:

– If an alternative has a "favorable" rating relative to the other alternatives for an evaluation factor, it is assigned a "green" light.
– If an alternative has a "moderate" or "neutral" rating relative to the other alternatives for an evaluation factor, it is assigned a "yellow" light.
– If an alternative has an "unfavorable" rating relative to the other alternatives for an evaluation factor, it is assigned a "red" light.

More than one alternative can be assigned the same color rating if they are deemed essentially equal for a particular evaluation factor.

Following the evaluation of non-cost factors through the "Traffic Light" Decision Model, capital and lifecycle cost estimates were developed for each alternative.

The approach was developed following a holistic consideration of both the cost and non-cost evaluation criteria. This approach takes into consideration the five Strategic Outcomes included in AlexRenew's Decision Model. These Strategic Outcomes include:

– Operational Excellence
– Adaptive Culture
– Watershed Stewardship
– Public Trust
– Financial Resilience

4.2 Cost Estimating Assumptions

4.2.1 Opinion of Probable Construction Costs

In addition to those non-cost evaluation factors described above, the probable construction cost is an important evaluation factor in selecting the recommended alternative for each unit process. Some assumptions based on normal engineering practice are summarized below:

– Probable construction costs for each alternative were estimated at -20% to +30% accuracy, based on AACE Class 3 cost estimating.
– Contractor general conditions were assumed to be 12% of the total construction cost.
– Mobilization and demobilization were assumed to be 3.5% of the total construction cost.
– General contractor overhead and profit of 20% was included within the unit cost for each construction cost.
– Equipment installation cost was estimated to be 30% of the equipment cost.
– Soft costs were assumed to be 40% of the total construction cost which include project management, engineering, construction management, and project administration costs.
– All construction costs are presented in 2021 US dollars. Revised estimates will need to be prepared during the design phases and those estimates will need to be escalated to each phases' midpoint of construction.

4.2.2 Life-Cycle Costs

Life-cycle cost analysis is a useful tool to determine the most cost-effective alternative based upon the initial construction cost estimate and long-term (typically 20 years) operation and maintenance cost (net present value, or NPV).

Some assumptions are made to calculate the 20-year NPV operation and maintenance cost for each alternative, as detailed in each NPV calculation included in Appendix I. Some assumptions based on normal engineering practice are summarized below:

- NPV is based on 20 years from 2021.
- Average labor rate for estimating was assumed to be $47.19 per hour.
- General maintenance markup was assumed to be 2% of the total estimated cost of the equipment.
- Electric cost was assumed to be $0.08 per kW/hr.
- Cost to haul and dispose coarse screenings was assumed to be $64 per ton.
- Cost to haul fine screenings and grit offsite was assumed to be $595 per truck and $49 per ton of material at Covanta.
- As discussed with AlexRenew, inflation rate was assumed to be 2.49% and nominal discount rate was assumed to be 3%.

5. Coarse Screening Evaluation

Upgrade of the existing coarse screens is recommended to address identified issues with equipment age, maintenance challenges, and unsatisfactory performance. Upgrade of the existing coarse screens by the original equipment manufacturer is not possible because this equipment line has been sold and no longer supported. Therefore, the following coarse screening alternatives were considered for upgrade of the existing coarse screening system.

- Coarse Screening Alternative 1: Provide Two 1” to 2-1/4” Variable-Opening Flex-Rake Mechanical Screens with a Bypass Conduit Discharging Directly to Two 4 CY Dumpsters
- Coarse Screening Alternative 2: Provide Two 1” to 2-1/4” Variable-Opening Flex-Rake Mechanical Screens with Two Washer/Compactors and a Bypass Conduit Discharging to Two Loadout Conveyors to Fill Two Self-Leveling Roll-Off Containers
- Coarse Screening Alternative 3: Provide Three 1” Flex-Rake Mechanical Screens Discharging Directly to Three 4 CY Dumpsters
- Coarse Screening Alternative 4: Provide Three 3/4” Flex-Rake Mechanical Screens with Three Washer/Compactors Discharging Directly to Three 4 CY Dumpsters
- Coarse Screening Alternative 5: Provide Three 3/4” Flex-Rake Mechanical Screens with Three Washer/Compactors Discharging to Three Loadout Conveyors to Fill Three Self-Leveling Roll-Off Containers

All coarse screening alternatives will include the following:

- Upgrade of the instrumentation and controls package provided by the screen manufacturer. The I&C package would include upstream and downstream ultrasonic level sensors for each screen and a differential level-based control system for the new mechanical coarse screens.
- Installation of new screen influent and effluent slide gates.
- Replacement of the existing channel dewatering pump and associated valves.
- Installation of the new roll-up doors on the south side of the Coarse Screen Room to be located in front of the screens.
- Replace the access hatches in the Coarse Screen Room to be rated for forklift loads.
- Replace the influent channel float and improve access.
- Install new channel floor hatches in the basement of the Coarse Screen Room.
- Connect the Coarse Screen Room floor drains to the process drain.

– Relocation of the high level float in the influent channel to be more accessible.

5.1 Basis of Design

The Level of Service Goals presented in Table 5-1 were selected as the Basis of Design Criteria for the coarse screens upgrade. These Level of Service Goals were developed in conjunction with AlexRenew Staff at the Coarse Screening Process Background Workshop.

Table 5-1 Level of Service Goals for Coarse Screening Basis of Design Criteria

Parameters	Basis of Design
Minimum flow	20 MGD
Design average daily flow	54 MGD
Design peak hourly flow	120 MGD
Coarse screen capacity, per screen	60 MGD
Screen unit redundancy	Pass peak hour flow with one unit out of service
Screen opening size [1]	¾ to 1 inch
Average anticipated screenings [2]	2.06 CF / mg
Average anticipated screenings	4.64 CF / hr
Peak hour anticipated screenings [3]	10.3 CF / mg
Peak hour anticipated screenings	51.5 CF / hr
Screening quality	Consider options which provide washing and compaction for all screenings
Volume reduction goal	70%
Weight reduction goal	65%
Control automation	Differential level control / high level backup control
Materials of construction	Type 316 SS or equally corrosion resistant material
Area electrical classification	Class I, Group D, Division 2 [4]
Odor control	Cover all equipment and channels; connect to existing odor control system
Maintenance Improvement	Ease of maintenance access to critical components

Notes:

1. For alternatives with only two coarse screes, a variable opening screen is recommended to provide added flexibility to accommodate peak flows.
2. Based on onsite screen testing for a 19 mm (3/4”) coarse screen conducted December 13 and 14, 2021 by Hydro-Dyne Engineering.
3. Assumed a peaking factor of 5.0.
4. Coarse Screen Room and Basement (above channel covers) would be derated from Class I, Division 1 by continuous ventilation at 12 air changes per hour.

The Virginia Department of Health SCAT Regulations, Paragraph 12 VAC 5-581-560.C states “One of the critical parameters in selecting the new coarse screen is the screen opening size. Clear openings between the bars of coarse screens should be from one to 1-3/4 inches. Other size openings will be considered on a case-by-case basis.”

The existing coarse screen opening size of 2-5/8 inches is outside of the normal range of the coarse screen design stated in WEF MOP 8, as well as above the maximum opening size noted in the Virginia SCAT regulations. This is likely one of the main reasons for unsatisfactory screen performance. It is recommended that the new coarse screen have smaller screen openings to remove more screenings and relieve some of the heavy screenings load currently experienced by the fine screens. However, overly fine screening could capture too much material, causing excess headloss in the channels and resulting in significant increase in the amount of coarse screenings materials to handle.

A review of several similar size headworks screening facilities in successful operation with combined sewer systems was evaluated and the design information summarized in Table 5-2.

Table 5-2 Coarse Screens at WWTPs Treating Combined Sewer Flows

Facility	Location	Screen Supplier	Screen Type	Peak Flow	Screen Opening
Malabar WWTP	Sydney, AU	Kuhn	Multi-Rake	343 MGD	½ inch
Springfield WWTP	Springfield, OH	Huber	Multi-Rake	50 MGD	½ inch
91st Ave WWTP	Phoenix, AZ	Duperon	Flex Rake	68 MGD each	½ inch
Metropolitan WWTP	Colombia, SC	Hydro-Dyne	Multi-Rake	61 MGD	0.6 inch
Upper Blackstone WPCAD	Worchester, MA	Fairfield	Caternary Bar Screen	160 MGD	5/8 inch
Santa Clara WPCP	San Jose, CA	Duperon	Flex Rake	80 MGD each	5/8 inch
Oneida County WPCP	Utica, NY	Duperon	Flex Rake	76 MGD	¾ inch
Quincy WWTP	Quincy, IL	Huber	Multi-Rake	80 MGD	¾ inch
Belleville WRF	Belleview, IL	Huber	Multi-Rake	100 MGD	¾ inch
Rocky River WWTP	Rocky River, OH	Huber	Multi-Rake	170 MGD	¾ inch
Back River WWTP	Baltimore, MD	Duperon	Flex Rake	469 MGD	1.0 inch
Gold Bar WWTP	Edmonton, Canada	Duperon	Flex Rake	105 MGD each	1.5 inch

After review of the on-site screen testing data and consultation with equipment manufacturers, GHD recommends the following:

For coarse screening alternatives with three screens (providing added redundancy and lower loading rates per screen) and washer/compactors (reducing the volume of screenings for removal) a ¾-inch screen is recommended.

For coarse screening alternatives without washer/compactors, a 1" screen is recommended (to avoid filling the dumpsters too quickly).

For coarse screening alternatives with only two coarse screens, a variable opening screen is recommended to provide added flexibility to accommodate peak flows when a unit is out of service before the bypass conduit would need to be opened. Variable opening screens can mechanically enlarge the screen opening size (in the case of a 1-inch screen, to 2-1/4 inches) to accommodate greater flows with less headloss during peak flow periods. This type of screen is new to the market.

Hydraulic parameters for the recommended screening sizes are summarized in Table 5-3. Ideal screen performance is achieved with a slot velocity of 2 to 4 ft/s but satisfactory performance may be obtained up to 5 ft/s.

Table 5-3 Hydraulic Parameters for Recommended Screening Sizes

Screen Opening Size	Maximum Recommended Flow per Screen (MGD)	Slot Velocity with 6 ft. Downstream WL (ft/s)	Headloss with 6 ft Downstream WL and 30% Blinding (in)
¾"	60	5.00	3.70
1"	60	4.74	4.41
2-1/4"	72	5.00	4.32

Upgrade of the coarse screening process was developed through a coarse screening alternative evaluation to achieve the following three major critical success factors listed below:

– Upgrade coarse screening equipment
– Provide coarse screening redundancy
– Improve coarse screening materials handling

5.2 Coarse Screening Alternative 1: Provide Two 1” to 2-1/4” Variable-Opening Flex-Rake Mechanical Screens with a Bypass Conduit Discharging Directly to Two 4 CY Dumpsters

This coarse screening alternative was developed to provide improvement to the existing coarse screening process at the lowest capital cost. It does not provide coarse screening for the full range of flow when one screen is out of service and peak flows occur but does reduce collection system backups and potential for overflow due to coarse screen failure. This coarse screening alternative has several negative aspects but was kept in consideration in case permitting constraints will not allow expansion of the Coarse Screen Room. The bypass conduit is expected to only be utilized for peak flow events when one screen is out of service. Screenings discharge directly to the dumpster in the Coarse Screen Room.

5.2.1 Description

This coarse screening alternative provides the ability to bypass the variable-opening mechanical coarse screens during a high flow event if necessary due to mechanical screen failure but does not provide screening of the bypassed flow.

5.2.2 Concept Arrangement

The concept arrangement is shown in Figures 10 and 11 of the Appendix A.

5.2.3 Operational Efficiency and Reliability

The variable-opening mechanical screen will require much less operational effort than a manually cleaned screen, while at the same time providing better screening removal due to the smaller screen size at average (1”) and peak flows (2-1/4”). Additionally, this coarse screening alternative prevents overflow upon mechanical coarse screen failure but does not screen bypassed flow, which could result in clogging or failure of downstream equipment.

Wet screenings would discharge directly to the dumpsters requiring operators to rake and move the dumpster daily which is similar to present loading operations.

5.2.4 Process Resiliency

This coarse screening alternative provides the ability to bypass the variable-opening mechanical coarse screens during a high flow event if necessary due to mechanical screen failure but does not provide screening of the bypassed flow. Each screen would have a dedicated dumpster for screenings disposal.

5.2.5 Sustainability

This coarse screening alternative is the least sustainable due to the lack of washing and compaction of screenings as well as disposal into open dumpsters creating an odorous environment in the Coarse Screen Room.

5.2.6 Maintenance Requirements

Sending unscreened flow to downstream equipment during a high flow event could result in additional maintenance to unclog or restore downstream equipment.

5.2.7 Safety

Manual raking of the unwashed and uncompacted screenings in the dumpster is still required for this alternative. No additional negative safety aspects are anticipated.

5.2.8 Constructability

The existing screening system can be disassembled for removal through the building doors one at a time. The new variable-opening screens would be installed the same way, without building modifications such as roof removal. A gantry crane or other lift equipment would be required to facilitate installation. Confined space entry safety guidance should be followed when installing the new coarse screens.

In order to construct bypass conduit, bypassing the existing Flow Structure No. 1 would be necessary. That entails bypass pumping from the upstream manhole on both the Commonwealth Interceptor and the Potomac Interceptor to the existing coarse screens, downstream of the closed influent slide gates. Bypass pumping of the last segment of the Potomac Yards Trunk Sewer will also be required to modify the last segment of pipe to connect to the new coarse screen influent channel.

It will also require isolation of the effluent channel from Coarse Screen No. 2 to connect back to the existing effluent channel. Bypass pumping would be required to install a temporary bulkhead in the effluent channel for this connection.

During construction of the new bypass conduit, the driveway around the back side of the Coarse Screen Room would need to be closed off for the excavation and construction of the bypass channel. The screening dumpsters could still be accessed by driving around Building A from the other direction along the west side of Building A. Sheeting and dewatering would be necessary for the excavation and construction of the new bypass conduit.

Additionally, access for the Alexandria Fire Department along the east side of Building A needs to be maintained during construction. If the fire department cannot access the facility via the west side of Building A, the driveway would need to be temporarily widened prior to construction of the bypass conduit to provide access to the fire training facility adjacent to Building K from South Payne Street.

5.2.9 Maintenance of Plant Operations

Bypass pumping all flow around the coarse screens would be required to install (and later remove) the bulkheads in the influent and effluent conduits. Construction can be sequenced to maintain one mechanical coarse screen in service at all times during construction. Partial bypass of flow would be required for high flow events.

5.2.10 Impact on Other Unit Processes

The smaller opening size of the new mechanical screens would remove more solids from the wastewater stream due to its smaller opening size. This would provide improved protection for downstream equipment and reduce the screenings load on the fine screens and reducing the risk of the fine screens becoming overloaded and failing. Additionally, at peak flows, the proposed 2-1/4” opening is smaller than the existing coarse screens and will provide protection for downstream equipment. The new mechanical screens would operate on a differential level-based control system as described in Section 5.

The bypass conduit would provide operational flexibility to the coarse screening system to facilitate screen maintenance. However, the bypassed flow will carry debris downstream that may damage or failure of downstream equipment, particularly the raw sewage pumps and grit pumps. It will also increase the screenings loading to the fine screens.

5.2.11 Public Impact

None of the coarse screening alternatives would have a significant public impact.

5.2.12 Adaptability to Future Requirements

Should SCAT regulations be changed in the future to require coarse screening of all influent flow, this coarse screening alternative would not be compatible with that requirement and would need to be augmented by an additional stand-by mechanical screen.

This coarse screening alternative does not provide washing and compaction of coarse screenings. Although washing and compaction of coarse screenings is not required by current regulation or by the contractor which disposes of the coarse screenings, washing and compaction of all screenings is required in other locations, including all of the wastewater treatment facilities in the UK. Should such requirements be imposed in the US, this coarse screening alternative would not provide that capability for AlexRenew, however, it can be implemented in the future simply by adding washer compactors within the existing building footprint.

5.3 Coarse Screening Alternative 2: Provide Two 1” to 2-1/4” Variable-Opening Flex-Rake Mechanical Screens with Two Washer/Compactors and a Bypass Conduit Discharging to Two Loadout Conveyors to Fill Two Self-Leveling Roll-Off Containers

Similar to Coarse Screening Alternative 1, this coarse screening alternative was developed to provide improvement to the existing coarse screening process at the lowest capital cost. It does not provide coarse screening for the full range of flow when one screen is out of service and peak flows occur but does reduce collection system backups and potential for overflow due to coarse screen failure. This coarse screening alternative has several negative aspects but was kept in consideration in case permitting constraints will not allow expansion of the Coarse Screen Room. The bypass conduit is expected to only be utilized for peak flow events when one screen is out of service. This coarse screening alternative also provides improved material handling.

5.3.1 Description

Similar to Coarse Screening Alternative 1, this coarse screening alternative provides the ability to bypass the variable-opening mechanical coarse screens during a high flow event if necessary due to mechanical screen failure but does not provide screening of the bypassed flow. This coarse screening alternative also provides each screen with its own washer/compactor, loading conveyor, and self-leveling roll-off container.

5.3.2 Concept Arrangement

The concept arrangement is shown in Figures 12 and 13 of Appendix A.

5.3.3 Operational Efficiency and Reliability

The variable-opening mechanical screen will require much less operational effort than a manually cleaned screen, while at the same time providing better screening removal due to the smaller screen size at average (1”) and peak flows (2-1/4”). Additionally, this coarse screening alternative prevents overflow upon mechanical coarse screen failure but does not screen bypassed flow, which could result in clogging or failure of downstream equipment.

The washed and compacted screenings are fed to the load out conveyor to be transported to the internal screw of the dedicated roll-off container to provide optimal container filling without the need for operators to manually level the piles. The internal leveling screw would be shaftless for screenings material disposal. The use of self-leveling containers would also eliminate the need for operators to move the container as it would be hauled for material disposal by a contractor.

5.3.4 Process Resiliency

Similar to Coarse Screening Alternative 1, this coarse screening alternative provides the ability to bypass the variable-opening mechanical coarse screens during a high flow event if necessary due to mechanical screen failure but does not provide true process redundancy because the bypassed flow is not screens. Each screen would have a dedicated washer/compactor, loadout conveyor, and self-leveling roll-off container for screenings disposal. Additionally, the self-leveling roll-off containers provide more storage volume than the existing dumpsters.

5.3.5 Sustainability

The primary sustainability benefit of this screen is the reducing the volume of screening material for disposal by washing and compacting the screenings to remove organics and excess water. Additionally, the screenings are loaded into an enclosed roll-off container with an internal leveling screw used to even the material piles.

5.3.6 Maintenance Requirements

Maintenance requirements for the proposed screens would be simplified because the main maintenance components can be accessed from floor level. However, additional routine maintenance would be required for the conveyors and self-leveling roll-off containers. Additional operator attention is required for the washer/compactor units. Manual intervention is required to unclog the units with large debris removed by the screens. Sending unscreened flow through the bypass conduit during high flow events requires maintenance to unclog or restore downstream equipment.

5.3.7 Safety

The washer/compactors and load-out conveyors can be easily accessed for maintenance from the floor. The self-leveling roll-off containers are a significant improvement to the existing dumpster loading operation as it is an enclosed system and ultimately eliminates the need to manually move the containers around. No additional negative safety aspects are anticipated.

5.3.8 Constructability

Construction aspects for the new screens are similar to Coarse Screening Alternative 1. Installation of the washer/compactor, loadout conveyor and self-leveling roll-off containers would occur at the same time as the screens. Installation of wheel plates and guide rails for the self-leveling roll-off containers are required.

5.3.9 Maintenance of Plant Operations

MOPO for this alternative would be similar to Coarse Screening Alternative 1.

5.3.10 Impact on Other Unit Processes

This coarse screening alternative would have all the same benefits as Coarse Screening Alternative 1. The process control modifications for this alternative are the same as for Coarse Screening Alternative 1.

5.3.11 Public Impact

None of the coarse screening alternatives would have a significant public impact.

5.3.12 Adaptability to Future Requirements

Better coarse screening capture efficiency will reduce the loading on the downstream fine screens. Should AlexRenew need to implement enhanced treatment processes in the future which require finer screens, having better coarse screening capture will improve the performance of those systems.

This coarse screening alternative also provides washing and compaction of coarse screenings. Although washing and compaction of coarse screenings is not required by current regulation or by the contractor which disposes of the coarse screenings, washing and compaction of all screenings is required in other locations, including all the wastewater treatment facilities in the UK. Should such requirements be imposed in the US, this coarse screening alternative would already provide that capability for AlexRenew.

5.4 Coarse Screening Alternative 3: Provide Three 1" Flex-Rake Mechanical Screens Discharging Directly to Three 4 CY Dumpsters

This coarse screening alternative was developed as the lowest capital cost coarse screening alternative to provide true coarse screening process redundancy (i.e., allowing sustained operation and coarse screening of maximum flow with one mechanical coarse screen out of service) by providing a third channel.

5.4.1 Description

This coarse screening alternative provides three parallel mechanical coarse screens, each with its own dumpster for screenings disposal.

5.4.2 Concept Arrangement

The concept arrangement is shown in Figures 14 and 15 of Appendix A.

5.4.3 Operational Efficiency and Reliability

Operation of the mechanical screen in the third channel would be similar to the other two coarse screens and no additional operation complexity is anticipated. The screens can be monitored and controlled by the plant SCADA system. Having a third mechanical screen will provide plant operations staff true operational flexibility.

5.4.4 Process Resiliency

This coarse screening alternative provides 1" automated mechanical coarse screening for all flows, even when a unit is out of service. Each screen has a dedicated dumpster for screenings disposal.

5.4.5 Sustainability

Similar to Coarse Screening Alternative 1 in regard to sustainability, the lack of washing and compaction of screenings will result in more disposal volume and more trips to landfill than if the screenings were washed and compacted.

5.4.6 Maintenance Requirements

Maintenance requirements for the proposed screens would be similar to the maintenance requirements for the existing screens, however, maintenance access would be simplified because the main maintenance components can be accessed from floor level.

5.4.7 Safety

Similar to Coarse Screening Alternative 1, manual raking of the unwashed and uncompacted screenings in the dumpster is still required for this coarse screening alternative. No additional negative safety aspects are anticipated.

5.4.8 Constructability

Construction of the third screen channel requires bypassing the existing Flow Structure No. 1 from the upstream manhole on both the Commonwealth Interceptor and the Potomac Interceptor to the existing coarse screens, downstream of the closed influent and effluent slide gates. Bypass pumping of the last segment of the Potomac Yards Trunk Sewer will also be required to modify the last segment of pipe to connect to the new coarse screen influent channel.

The below grade construction requires relocation of the existing ductbank running along the east side of the Coarse Screen Room which feeds power to Building A.

For the above grade expansion of the existing Coarse Screen Room, the existing east wall would be demolished, and a new beam and column installed to support the roof in this area prior to demolition.

Additionally, access for the City of Alexandria Fire Department along the east side of the Building A needs to be maintained during construction. If the fire department cannot access the facility via the west side of Building A, the driveway along the east side of Building A would need to be widened prior to construction of the third channel to provide access to the fire training facility, adjacent to Building K, from South Payne Street. American Disposal could access the dumpsters for disposal via the driveway along the west side of Building A, as opposed to the driveway along the east side. The expansion of the building would necessitate relocation of the driveway around the expanded Coarse Screen Room, resulting in a 12 foot reduction of the conservation area grass buffer to the property line at South Payne Street. Stormwater collection and treatment modifications may be required in this area due to the building expansion and driveway relocation. This coarse screening alternative will also require more extensive planning approvals and permits from the City of Alexandria than the other alternatives.

5.4.9 Maintenance of Plant Operations

Construction of this coarse screening alternative would require temporary power to Building A for the ductbank relocation and bypass pumping to isolate the influent and effluent channel for construction and to relocate the Potomac Yards Trunk Sewer.

Construction can be sequenced to maintain two mechanical coarse screens in service at all times during construction.

5.4.10 Impact on Other Unit Processes

Having a third mechanical screen will allow true flexibility for the operations and maintenance staff to take any coarse screen off-line for maintenance and still provide screening of all influent flow. This will provide the best protection from clogging and debris for downstream treatment equipment.

The process control modifications for this alternative are the same as for Coarse Screening Alternative 1.

5.4.11 Public Impact

None of the coarse screening alternatives would have a significant public impact.

5.4.12 Adaptability to Future Requirements

This coarse screening alternative does not provide washing and compaction of coarse screenings. Although washing and compaction of coarse screenings is not required by current regulation or by the contractor which disposes of the coarse screenings, washing and compaction of all screenings is required in other locations, including all of the wastewater treatment facilities in the UK. Should such requirements be imposed in the US, this coarse screening alternative would not provide that capability for AlexRenew, however, it can be implemented in the future simply by adding washer compactors within the existing building footprint.

5.5 Coarse Screening Alternative 4: Provide Three ¾" Flex-Rake Mechanical Screens with Three Washer/Compactors Discharging Directly to Three 4 CY Dumpsters

This coarse screening alternative is similar to Coarse Screening Alternative 3, however the screenings are washed and compacted prior to disposal to the dumpster to provide improved loading operations in addition to true coarse screening process redundancy.

5.5.1 Description

This coarse screening alternative provides three parallel mechanical coarse screens, each with its own washer/compactor discharging directly to 4 CY dumpsters.

5.5.2 Concept Arrangement

The concept arrangement is shown in Figures 16 and 17 of Appendix A.

5.5.3 Operational Efficiency and Reliability

Operation of the mechanical screen in the third channel would be similar to the other two coarse screens and no additional operation complexity is anticipated. The screens can be monitored and controlled by the plant SCADA system. Having a third mechanical screen will require much less operational effort than a manually cleaned screen, while at the same time providing better screening removal due to the smaller screen size and allowing plant operations staff true flexibility in choosing which mechanical screen(s) to operate.

Similar to Coarse Screening Alternative 2, additional operator attention is required for the washer/compactor units. Manual intervention is required to unclog the units with large debris removed by the screens.

The operation of this coarse screening alternative would be more complex than the current operation since more equipment is included in the process that requires operator attention. However, routine checks of the equipment and remaining dumpster volume and manual raking of the screenings would be the same as the current operation. The screenings volume would be significantly compacted, making the dumpster switch and screening disposal less frequent.

5.5.4 Process Resiliency

This coarse screening alternative provides ¾" automated mechanical coarse screening for all flows, even when a unit is out of service. Each screen has a dedicated washer/compactor and dumpster for screenings disposal.

5.5.5 Sustainability

The primary sustainability benefit of this screen is the reducing the volume of screening material for disposal by washing and compacting the screenings to remove organics and excess water. Additionally, the screenings are washed and uncompacted, requiring less frequent hauling compared to unwashed and uncompacted screenings.

5.5.6 Maintenance Requirements

Maintenance requirements for the proposed screens would be simplified because the main maintenance components can be accessed from floor level. However, additional operator attention is required for the washer/compactor units. Manual intervention is required to unclog the units with large debris removed by the screens.

5.5.7 Safety

Similar to Coarse Screening Alternative 1, manual raking of screenings in the dumpster would still be required, however, the material would be washed and compacted, containing less organic content and water.

5.5.8 Constructability

Construction aspects for the new screens are similar to Coarse Screening Alternative 3. Installation of the washer/compactor units would occur at the same time as the screens. Construction duration is expected to be the shorter than Coarse Screening Alternative 3.

5.5.9 Maintenance of Plant Operations

MOPO aspects for this alternative are the same as Coarse Screening Alternative 3.

5.5.10 Impact on Other Unit Processes

This coarse screening alternative would have all the same benefits as Coarse Screening Alternative 3.

5.5.11 Public Impact

None of the coarse screening alternatives would have a significant public impact.

5.5.12 Adaptability to Future Requirements

It is anticipated that this coarse screening alternative approach is compatible with any anticipated future regulatory or worker safety requirements.

5.6 Coarse Screening Alternative 5: Provide Three ¾” Flex-Rake Mechanical Screens with Three Washer/Compactors Discharging to Three Loadout Conveyors to Fill Three Self-Leveling Roll-Off Containers

This coarse screening alternative is similar to Coarse Screening Alternative 2 but provides a third channel for true coarse screening redundancy and improved operational efficiency and flexibility.

5.6.1 Description

This coarse screening alternative provides three parallel mechanical coarse screens, each with its own washer/compactor, load-out conveyor, and self-leveling roll-off container.

5.6.2 Concept Arrangement

The concept arrangement is shown in Figures 18 and 19 of Appendix A.

5.6.3 Operational Efficiency and Reliability

Operation of the mechanical screen in the third channel would be similar to the other two coarse screens and no additional operation complexity is anticipated. The screens can be monitored and controlled by the plant SCADA system. Having a third mechanical screen will require much less operational effort than a manually cleaned screen, while at the same time providing better screening removal due to the smaller screen size and allowing plant operations staff true flexibility in choosing which mechanical screen(s) to operate.

The washed and compacted screenings are fed to the load out conveyor to be transported to the internal screw of the dedicated roll-off container to provide optimal container filling without the need for operators to manually level the piles. The internal leveling screw would be shaftless for screenings material disposal. The use of self-leveling containers would also eliminate the need for operators to move the container as it would be hauled for material disposal by a contractor.

5.6.4 Process Resiliency

This coarse screening alternative provides ¾" automated mechanical coarse screening for all flows, even when a unit is out of service. There is a dedicated washer/compactor, loadout conveyor, and self-leveling roll-off container for each screen.

5.6.5 Sustainability

The primary sustainability benefit of this screen is the reducing the volume of screening material for disposal by washing and compacting the screenings to remove organics and excess water. Additionally, the screenings are loaded into an enclosed roll-off container with an internal leveling screw used to even the material piles. The self-leveling roll-off containers would require fewer hauls per year compared to the dumpsters.

5.6.6 Maintenance Requirements

Maintenance requirements for the proposed screens would be simplified because the main maintenance components can be accessed from floor level. However, additional routine maintenance would be required for the conveyors and self-leveling roll-off containers. Additional operator attention is required for the washer/compactor units. Manual intervention is required to unclog the units with large debris removed by the screens.

5.6.7 Safety

The washer/compactors and load-out conveyors can be easily accessed for maintenance from the floor. The self-leveling roll-off containers are a significant improvement to the existing dumpster loading operation as it is an enclosed system and ultimately eliminates the need to manually move the containers around.

5.6.8 Constructability

Construction aspects for the new screens are similar to Coarse Screening Alternative 3. Installation of the washer/compactor, loadout conveyor and self-leveling roll-off containers would occur at the same time as the screens.

Installation of wheel plates and guide rails for the self-leveling roll-off containers are required. Construction duration is expected to be the longest of all the alternatives.

5.6.9 Maintenance of Plant Operations

MOPO aspects for this Coarse Screening Alternative are the same as Coarse Screening Alternative 3.

5.6.10 Impact on Other Unit Processes

This coarse screening alternative would have all the same benefits as Coarse Screening Alternative 4.

5.6.11 Public Impact

None of the coarse screening alternatives would have a significant public impact.

5.6.12 Adaptability to Future Requirements

The adaptability to future requirements would be the same as Coarse Screening Alternative 4.

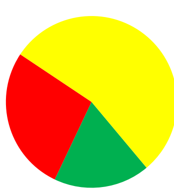
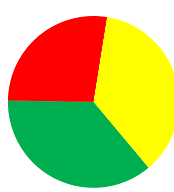
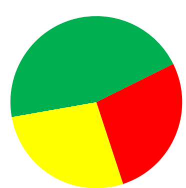
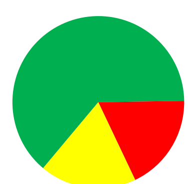
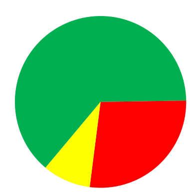
5.7 Evaluation of Coarse Screening Alternatives

As discussed in Section 4.1, GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost evaluation factors of the five coarse screening alternatives as shown in Table 5-4.

Table 5-4 Summary of Coarse Screening Alternatives

Criteria	Alternative 1 Two Variable-Opening Flex-Rake Screens + Bypass Conduit with Direct Discharge to Dumpsters	Alternative 2 Two Variable-Opening Flex-Rake Screens + Bypass Conduit + Washer/ Compactor Discharging to Conveyors to Fill Self-Leveling Roll-Off Containers	Alternative 3 Three Flex-Rake Screens with Direct Discharge to Dumpsters	Alternative 4 Three Flex-Rake Screens + Washer/ Compactor with Direct Discharge to Dumpsters	Alternative 5 Three Flex-Rake Screens + Washer/ Compactor Discharging to Conveyors to Fill Self-Leveling Roll-Off Containers
Layout					
	Least significant site modifications required.	Minor building modifications. Additional load out conveyors and self-leveling roll-off containers require a larger footprint.	Building extension requires driveway relocation and decreases buffer to property line.	Building extension requires driveway relocation and decreases buffer to property line.	Building extension requires driveway relocation and decreases buffer to property line.
Operational Efficiency and Reliability					
	No screening during bypass operation. Manual raking required to level screenings in dumpster.	No screening during bypass operation. Even loading via conveyor to self-	Provides complete coarse screening to 1" through all three channels. Manual raking required to level	Provides complete coarse screening to ¾" through all three channels. Manual raking required to level	Provides complete coarse screening to ¾" through all three channels. Even loading via conveyor to self-

Criteria	Alternative 1 Two Variable-Opening Flex-Rake Screens + Bypass Conduit with Direct Discharge to Dumpsters	Alternative 2 Two Variable-Opening Flex-Rake Screens + Bypass Conduit + Washer/ Compactor Discharging to Conveyors to Fill Self-Leveling Roll-Off Containers	Alternative 3 Three Flex-Rake Screens with Direct Discharge to Dumpsters	Alternative 4 Three Flex-Rake Screens + Washer/ Compactor with Direct Discharge to Dumpsters	Alternative 5 Three Flex-Rake Screens + Washer/ Compactor Discharging to Conveyors to Fill Self-Leveling Roll-Off Containers
		leveling roll-off container.	screenings in dumpster.	screenings in dumpster.	leveling roll-off container.
Process Resiliency	🔴	🔴	🟢	🟢	🟢
	Ability to capture all solids larger than 2-1/4” during all operating conditions but lets solids pass downstream when bypass channel used.	Ability to capture all solids larger than 2-1/4” during all operating conditions but lets solids pass downstream when bypass channel used.	Redundancy provided, capture all solids larger than 1” during all operating conditions.	Redundancy provided, capture all solids larger than ¾” during all operating conditions.	Redundancy provided, capture all solids larger than ¾” during all operating conditions.
Sustainability	🔴	🟢	🔴	🟢	🟢
	Unwashed and uncompacted screenings discharge to open dumpsters.	All screenings washed and compacted discharge to enclosed loading containers.	Unwashed and uncompacted screenings discharge to open dumpsters.	All screenings washed and compacted discharge to open dumpsters.	All screenings washed and compacted discharge to enclosed loading containers.
Maintenance Requirements	🟡	🔴	🟢	🟡	🔴
	Routine maintenance required; however, additional maintenance may be required downstream after bypass use	Routine maintenance required for conveyors and self-leveling roll-off containers. Additional maintenance may be required downstream after bypass use. Manual intervention required for clogged washer compactors.	Routine maintenance similar to existing system.	Routine maintenance required for washer/compactors . Manual intervention required for clogged washer compactors.	Routine maintenance required for washer/compactors , conveyors, and self-leveling roll-off containers. Manual intervention required for clogged washer compactors.
Safety	🟢	🟢	🟢	🟢	🟢
	No safety concerns.	No safety concerns.	No safety concerns.	No safety concerns.	No safety concerns.

Criteria	Alternative 1 **Two Variable-Opening Flex-Rake Screens + Bypass Conduit with Direct Discharge to Dumpsters**	Alternative 2 **Two Variable-Opening Flex-Rake Screens + Bypass Conduit + Washer/ Compactor Discharging to Conveyors to Fill Self-Leveling Roll-Off Containers**	Alternative 3 **Three Flex-Rake Screens with Direct Discharge to Dumpsters**	Alternative 4 **Three Flex-Rake Screens + Washer/ Compactor with Direct Discharge to Dumpsters**	Alternative 5 **Three Flex-Rake Screens + Washer/ Compactor Discharging to Conveyors to Fill Self-Leveling Roll-Off Containers**
Constructability	Least complex construction.	Least complex construction.	Most complex construction.	Most complex construction.	Most complex construction.
Maintenance of Plant Operations	Bypass pumping required.	Bypass pumping required.	Bypass pumping and temporary power required, but ability to maintain 2 screens in service.	Bypass pumping and temporary power required, but ability to maintain 2 screens in service.	Bypass pumping and temporary power required, but ability to maintain 2 screens in service.
Impact on Other Unit Processes	Pass all solids downstream during bypass operation.	Pass all solids downstream during bypass operation.	Capture all solids larger than 1”	Capture all solids larger than ¾”	Capture all solids larger than ¾”
Public Impact	No significant impact.	No significant impact.	Building expansion to maintain similar architecture and fire department access road.	Building expansion to maintain similar architecture and fire department access road.	Building expansion to maintain similar architecture and fire department access road.
Adaptability to Future Requirements	Compatible with SCAT regulations but does not provide washing/compaction of coarse screenings (could be added in future).	Should be compatible with any future requirements.	Compatible with SCAT regulations but does not provide washing/compaction of coarse screenings (could be added in future).	Should be compatible with any future requirements.	Should be compatible with any future requirements.
Summary					

Coarse Screening Alternatives 4 and 5 have the highest number of favorable attributes based on the criteria above, but Coarse Screening Alternative 5 has more negative attributes, mostly attributed to layout, maintenance requirements, and constructability.

5.8 Coarse Screening Alternative Cost Analysis

Each coarse screening alternative was provided a probable construction cost and life-cycle cost to be considered for selection of the recommended alternative. Section 4.2 outlines the assumptions made based on normal engineering practice. Table 5-5 summarizes the construction cost estimate and life cycle cost of each coarse screening alternative. Detailed OPCC estimates are included in Appendix H and detailed lifecycle cost calculations are included in Appendix I.

Table 5-5 Opinion of Probable Construction Cost and Life-Cycle Costs for the Coarse Screening Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Construction Cost (-20% to +30% accuracy)	$7,470,000	$9,399,000	$13,806,000	$14,873,000	$16,566,000
Soft Costs (40%) [1]	$2,298,000	$2,892,000	$4,248,000	$4,576,000	$5,097,000
2021 Project Cost (without contingency)	**$8,044,000**	**$10,122,000**	**$14,868,000**	**$16,017,000**	**$17,840,000**
20-Yr O&M NPV	$1,732,000	$1,817,000	$1,496,000	$1,390,000	$2,096,000
Total	**$9,776,000**	**$11,939,000**	**$16,364,000**	**$17,407,000**	**$19,936,000**

Note:
1. Soft costs include project management, engineering, construction management, and project administration costs.

The Life Cycle Costs of the alternatives are presented in Figure 5-1 for comparison.

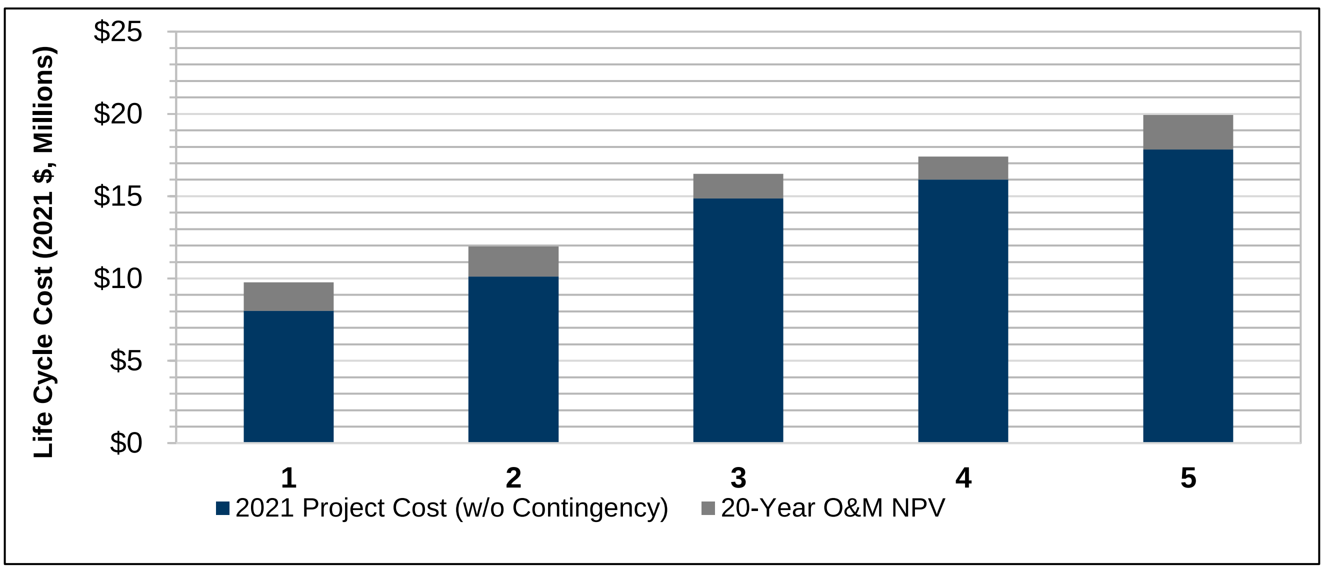


Figure 5-1 Life Cycle Cost Comparison

5.9 Recommended Coarse Screening Alternative

GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost factors for each coarse screening alternative. Based on our evaluation, Coarse Screening Alternative 4 was the highest ranked.

Following the evaluation of non-cost factors, capital and lifecycle cost estimates were developed for each coarse screening alternative. While Coarse Screening Alternative 1 had the lowest capital costs, this coarse screening alternative has several highly undesirable ratings which impact process resiliency, sustainability, and impact on other unit processes. For these reasons, this coarse screening alternative is not preferred unless expansion of the Coarse Screen Room is not possible due to permitting restrictions.

Coarse Screening Alternative 4 is the recommended coarse screening alternative in the event that expanding Building A is feasible. Coarse Screening Alterative 4 was selected following a holistic consideration of both the cost and non-cost evaluation criteria. This coarse screening alternative has an estimated AACE Class 3 project cost escalated to mid-point of construction (2025) of $17,666,000 (-20% to +30% range of accuracy).

Coarse Screening Alternative 4 includes:

– Replacement of the two existing 2-5/8” climber screens with ¾” flex-rake mechanical screens including hopper diverter chute
– Construction of a new screening influent channel and a new third screen channel
– Expansion of the existing Coarse Screen Room to cover the third screen channel
– Installation of a third ¾” flex-rake mechanical screen in the new screening channel
– Addition of washer/compactors for all three coarse screens
– Addition of short discharge chutes for all three coarse screen washer/compactors
– Continued use of 4 CY dumpsters for screenings disposal
– Replacement of coarse screen influent and effluent slide gates
– Replacement of screening channel dewatering pump and valves
– Replacement of existing floor hatches and modification of overhead doors to accommodate forklift loading for equipment maintenance
– Relocation of the high level float in the influent channel to be more accessible
– Modifications to existing Coarse Screen Room electrical, HVAC, and odor control systems to accommodate the expanded room size and new/replaced equipment
– Site and yard piping modifications to support the improvements

Coarse Screening Alternative 4 provides the following benefits to AlexRenew that align with the Strategic Outcomes of AlexRenew’s 2040 Vision Statement:

– Operational Excellence
  - Ensures robust environmental compliance by improving coarse screening removal efficiency, reducing the screenings load to the fine screens to improve the reliability of that system, and provides complete process redundancy to prevent overflows or sewer backups when a unit is out of service.
– Adaptive Culture
  - Increases the efficiency of the coarse screening process, improves process reliability for both coarse screening and downstream treatment processes, and reduces the current safety hazards associated with maintenance of the existing climber screens.
– Watershed Stewardship
  - Does not significantly increase energy use at the facility, while significantly decreasing greenhouse gas emissions and landfill capacity used for screenings removal by washing and compacting the screenings thereby reducing the off-site hauling frequency.
– Public Trust
  - Does not have any negative impacts on the surrounding community and decreases the potential of odors associated with the process.
– Financial Resilience
  - This coarse screening alternative has the lowest capital and lifecycle costs to meet all three critical success factors.

6. Raw Sewage Pump Station Evaluation

Potential upgrades for the RSPS pumps were divided into three alternatives:

- RSPS Alternative 1: Rehabilitate Existing Pumps
- RSPS Alternative 2: Install Replacement Dry-Pit Vertical Close-Coupled Pumps
- RSPS Alternative 3: Install Replacement Dry-Pit Submersible Pumps

A fourth RSPS alternative that installs replacement gas driven pumps was considered but ultimately found inadequate for detailed evaluation. A summary of the gas driven pump alternative is presented to justify why a detailed evaluation was not included.

As stated in Section 2.2, the original construction consisted of three gas engine pumps and two induction motor pumps that operated at design points well below the performance criteria for the current pumps. The gas engines were located in the Engine Room, which currently has overhead doors to access from the exterior and floor hatches to pull pumps and motors from the pump room two floors below. The gas engines had right angle gear drives and extended shafts to rotate the pump impellers. Design drawings from the 1954 "AVA Sewage Treatment Plant Divisions I – V" project show the layout of the gas engine pumps, which is presented below in Figure 6-1.

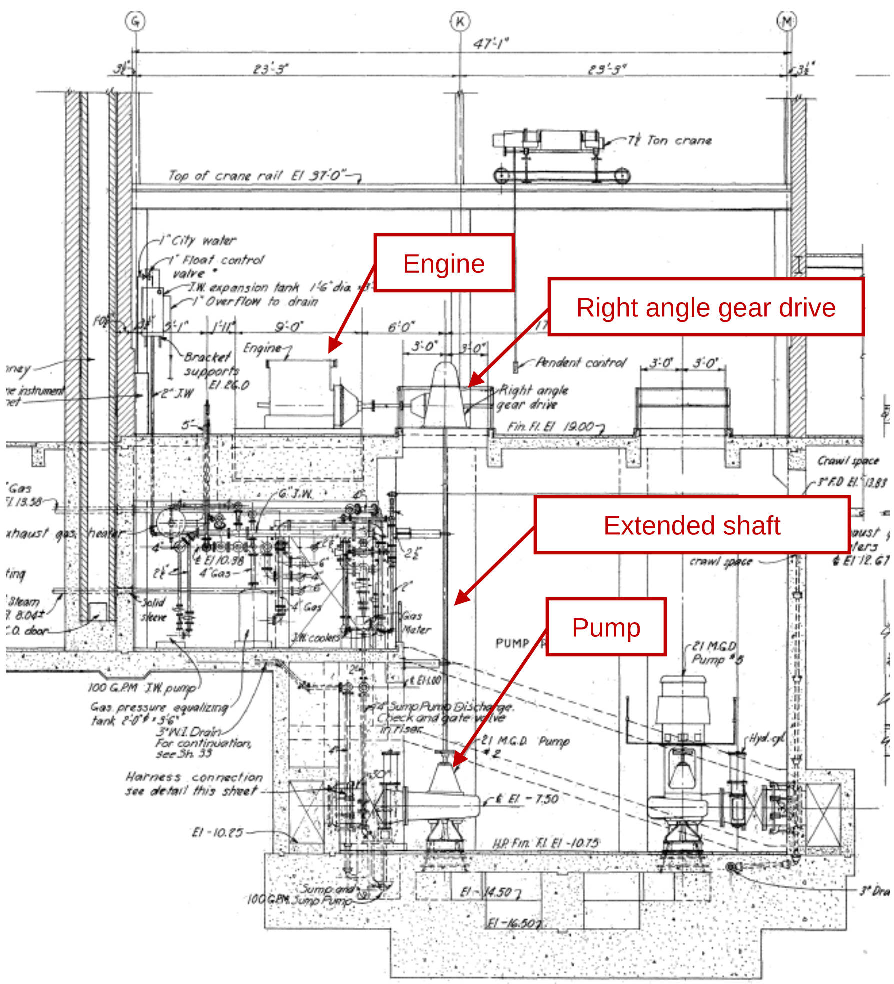


Figure 6-1 Gas engine layout from 1954 "AVA Sewage Treatment Plant Divisions I – V" project

The Engine Room was designed asymmetrically to only accommodate gas engines on the south side of the room. Therefore, space constraints limit gas powered engines to raw sewage pumps 1, 2, and 3. The pumps on the north side of the room must remain induction motors, which prevents uniformity between all pumps as idealized. The intent is for the new gas engine pumps to be fueled by digester gas captured onsite. The digester gas currently produced is being burned to atmosphere rather than being used for beneficial purposes. AlexRenew has expressed interest in using digester gas to save energy and for environmental sustainability. GHD agrees that an assessment to determine the most beneficial use of digester gas should be considered. However, the reuse of digester gas is better evaluated separately from the RSPS. It is understood from the RSPS and Conduits Technical Memorandum Workshop that the digester gas would need to be cleaned to pipeline grade before powering gas engine pumps. Moreover, it is unknown if the quantity of clean digester gas produced at AlexRenew is sufficient to power the raw sewage pumps. In GHD's experience, most utilities that capture digester gas power generators than produce electricity for the plant. This arrangement allows the greatest flexibility for energy use. A detailed assessment would presumably optimize the locations of digester gas cleaning equipment and generator. A concern voiced by AlexRenew during the forementioned workshop is the loud operation of the original gas engines. To mitigate this concern, a generator located in a typically unoccupied location would be ideal for plant staff. For these reasons GHD did not proceed with a detailed analysis of gas engine pumps as a proper alternative.

In addition to replacing the pumps, several other potential improvements to the RSPS were identified through meetings and communication with AlexRenew. The following upgrades were developed for the RSPS and are independent of the pump alternative evaluation. These upgrades are to provide general operational and maintenance improvements to the RSPS. Many of the additional system upgrades are independent of each other, such that numerous combinations of upgrades can be selected. This gives AlexRenew flexibility in choosing upgrade selections. However, some upgrades are dependent on each other, such that it prevents select upgrades from being chosen simultaneously.

– Upgrade 1: Upgrade knife gate valves with electric actuators
– Upgrade 2: Retrofit existing discharge check valves or install new pressure cushioned swinging disc check valves as necessary
– Upgrade 3: Replace existing check valves and knife gate valves with electric or pneumatically actuated butterfly or ball valves
– Upgrade 4: Replace wet well sluice gates with new slide gates (upstream of wet wells)
– Upgrade 5: Upgrade wet well stop plate groove to accept new stop logs
– Upgrade 6: New centralized sump pit with permeant explosion proof sump pumps; plug existing drains and install a new trough drain design
– Upgrade 7: Install new discharge conduit draining system
– Upgrade 8: Upgrade gates on drain lines to sump pit
– Upgrade 9: General controls and instrumentations – move E-stop, replace wet well level sensor instrumentation, raw sewage pump pressure sensors and transmitters, check valve position switch, etc.
– Upgrade 10: Advanced pump monitoring and controls instrumentation

All of the upgrades listed above are not considered to extend the time needed for temporary bypassing. It is expected that these upgrades are independent of bypass operation or can be installed during the time already allotted to install the new raw sewage pumps.

6.1 Basis of Design

The Level of Service Goals presented in Table 6-1 were selected as the Basis of Design Criteria for the RSPS upgrade. Design criteria for the RSPS upgrade considered concurrent plant upgrades, hydraulic modeling, field testing, and system curve analysis. A summary of considerations that developed the design criteria is provided herein.

Table 6-1 Level of Service Goals for RSPS Basis of Design Criteria

Parameter	Basis of Design
Design average daily flow	54 MGD
Design peak instantaneous flow	120 MGD
RSPS capacity, 4 pumps in service	120 MGD
Raw sewage pump design point, per pump	30 MGD 48 ft TDH
Design maximum flow per side [1]	60 MGD
Isolation and redundancy	The wet wells shall be capable of complete isolation from one another, such that influent flow can be passed while one side is out-of-service.
Drainage	Wet wells, suction conduits, and discharge conduits shall have reliable means for drainage.
Control automation	Wet well level control
Cavitation prevention	Reset low water alarm to prevent water entrapment or NPSHr violations.
Operation and maintenance and improvements	Isolation valves, pump room drains, and sump pumps shall operate effectively.

Note:

1. Virginia Sewage Collection and Treatment Regulations (SCAT); the design velocity in pump piping should not exceed (i) six feet per second in the suction piping, and (ii) in the discharge piping, eight feet per second.

As mentioned in Section 3.1, the completion of RiverRenew will increase the raw influent peak hydraulic flow from the current permit limit of 108 MGD to 116 MGD through preliminary and primary treatment.

Limitations in the current collection system prevents the treatment facility from receiving influent flow greater than approximately 120 MGD, which results in overflows in the system rather than an overflow at the headworks building.

The Virginia Sewage Collection and Treatment Regulations (SCAT) recommends force mains at wastewater facilities to operate at a velocity of no greater than 8 feet per second. This is to protect the conduits from scour, protect valves, minimize water hammer, and lower friction losses in the system. At a velocity of 8 feet per second, the 30-inch wide x 54-inch high discharge conduits constrain the system to a maximum capacity of 116 MGD if flow is equally split between both sides of the RSPS.

Acknowledging that the headworks building is only capable of receiving approximately 120 MGD, it is recommended to set the design criterion of the RSPS to pass a maximum instantaneous peak flow of 120 MGD with two pumps out of service, i.e., one out-of-service on each side of the RSPS. This meets the requirement set by SCAT and by VA DEQ, which require one pump to be out of service at max design flow. At 8.25 feet per second, the discharge conduit velocity would be slightly above the recommendations of SCAT. Given this condition does not occur often or last for extended periods of time, the high velocity is not a concern.

It is anticipated two of the three RSPS alternatives discussed in this section will require some duration of bypass pumping around the RSPS during construction. Bypass pumping would be required to transport influent flow from Building A to Building K when one half of the RSPS is out of service. It is anticipated that RSPS Alternatives 2 and 3 will require each half of the RSPS to be taken out of service in turn to facilitate the minor piping and structural modifications necessary to fit the replacement pumps into the existing footprint. It may also be required to make some piping changes for RSPS Alternative 1, so bypass pumping may be required for that RSPS alternative as well. During construction, the current design criteria for the RSPS must be maintained at 108 MGD. The online side of the RSPS can pass 60 MGD, while the remaining capacity, approximately 50 MGD, must be provided through bypass pumps. Godwin provided a bypass solution that requires five model CD400M pumps that can operate on either diesel or electricity. The 18-inch diameter pump suctions would be placed into Control Structure No. 1 located directly upstream of Building A, with the pumps arranged in the road/yard on the east side of the building. The pumps are to discharge into a common manifold that then splits between two parallel 30-inch diameter discharge lines that run from the east side of Building A to the east side of Building K. The discharge lines are to be routed onto the grit deck of Building K, into the fine screen room, then into the individual fine screen influent channels. A sixth bypass pump is required for redundancy. Figure 6 in Appendix B presents the layout described. Suction lift from the water level in Control Structure No. 1 to the eye of the bypass pumps is approximately 21-feet based on the lowest overflow elevation in the collection system. Godwin requests that additional surcharging be allowed during high flow events to facilitate more efficient operation of the bypass pumping system. By reducing the suction lift by several feet, the efficiency of the bypass pumps nearly doubles. It is expected that during typical diurnal flows, all influent flow will be passed through the online side of the RSPS and not the bypass pumps. Only during events where the influent flow rises above 60 MGD does the bypass pumps start passing flow. The bypass operation described hitherto draws wastewater from upstream of the coarse screens, which may create operational challenges from debris blockages. It also presents challenges with a high static lift and expansive laydown area. While acceptable for budgetary purposes, alternative bypass options that consider the following are to be evaluated in final design:

- Explore alternative location/routing (under concrete covers in the breezeway, not cutting across fire department training grounds, etc.).
- Explore pump power source options (diesel, electricity, etc.). Consider sustainable sources if feasible.
- GHD to include a sequencing constraint in the contract to not perform work requiring bypass pumping during the fall, unless the proposed pumps are able to handle large masses of leaves.

Only RSPS Alternatives 2 and 3 require bypassing, however, many of the miscellaneous upgrades will require bypassing or installation while half of the RSPS is out of service.

6.2 RSPS Alternative 1: Rehabilitate Existing Raw Sewage Pumps

The existing pumps have been rehabilitated multiple times over the course of their service. This RSPS alternative considers the impacts of implementing another rebuild on the existing pumps to extend their service again.

6.2.1 Description

Under this RSPS alternative, each of the six pumps would receive a full replacement of their drives and rotating assemblies, including motors, shafts, couplings, impellers, and VFDs. The pump volutes would not be replaced, and therefore no new or adjusted connections would need to be made to the existing piping. New pump controls could be implemented as well as a part of this upgrade.

6.2.2 Concept Arrangement

The layout for this RSPS alternative would be identical to the existing equipment layout in Building A.

6.2.3 Operational Efficiency and Reliability

The existing pumps are not capable of producing 30 MGD per pump with multiple pumps in service. Even with new impellers and drives, the rehabilitated pumps would not be able to produce 30 MGD running individually or together. Therefore, the design goal of meeting 60 MGD per wet well, or 120 MGD total, with one pump in each wet well out of service (four total pumps running at 120 MGD) would not be achievable. However, with three pumps running in each wet well the design flow of 120 MGD would be achievable.

6.2.4 Process Resiliency

As stated in Section 6.1.3, the rehabilitated pumps would not be able to pump 60 MGD per wet well with one unit out of service. All three pumps per wet well would need to run to produce 60 MGD. This leaves no redundant pump available.

With five of the six rehabilitated pumps operating, it is theoretically possible that the station as a whole would pump 120 MGD. This would require an uneven flow split between the wet wells, with one side pumping under 60 MGD with two pumps and the other side pumping over 60 MGD with three pumps. While this does not meet the intended design redundancy for the upgraded RSPS, it does provide some redundancy for the system.

6.2.5 Sustainability

The upgraded motors and drives would be similar to the existing system and would not be a change to the existing power usage of the station.

6.2.6 Maintenance Requirements

Rehabilitating the existing pumps would extend their life, but there is a limit to how long a rebuild will last compared to a new pump. It is likely that the service life of the rehabilitated pump would not match that of a new pump, and that additional repairs or rehabilitation would be required in the next 20 years.

6.2.7 Safety

Rehabilitating the existing pumps would not change any aspect of the RSPS with regards to safety.

6.2.8 Constructability

No modification to the existing station would be required to facilitate construction of the rehabilitated pumps. The pump volutes, which are connected to the suction and discharge piping, would not be replaced in this RSPS alternative, and would therefore not require any changes or special fittings to match the existing suction and discharge piping and structural penetrations.

6.2.9 Maintenance of Plant Operations

It may be possible to rehabilitate each of the existing pumps in sequence with each other such that only one pump is ever out of service at a time. This would greatly ease constructability of the station as the remaining five pumps could continue in service and meet the flow requirements of the station.

However, if a second pump failed or required maintenance while one pump was already out of service for replacement, the station would not be able to meet peak capacity. Considering the age and service history of the existing pumps, it is recommended that some bypass pumping be provided for this alternative in case more than one pump was required to be out of service at a time. Providing bypass pumping may also help shorten the duration of construction required to rehabilitate the existing pumps, as the bypass pumps could bypass one of the two wet wells temporarily while that wet well’s three pumps are taken out of service and rehabilitated simultaneously.

Refer to the introduction of this section for more information on the proposed bypass pumping arrangement.

6.2.10 Impact on Other Unit Processes

Any impacts to other unit processes as a result of operation of the RSPS would be the same between this RSPS alternative and the existing RSPS operation.

6.2.11 Public Impact

Any impacts to the public as a result of the RSPS would be the same between this RSPS alternative and the existing RSPS operation.

6.2.12 Adaptability to Future Requirements

This RSPS alternative would require five of the six pumps to operate to pump the design peak flow of 120 MGD. This provides the least flexibility of the evaluated RSPS alternatives to accommodate future flows.

6.3 RSPS Alternative 2: Install Replacement Dry-Pit Vertical Close-Coupled Pumps

This RSPS alternative involves replacing all six pumps with new pumps of the same make and model, sized for the intended design service.

6.3.1 Description

Under this RSPS alternative, all six pumps would be completely replaced with new pumps of the same style (dry-pit vertical close-coupled) as the existing pumps. The new pumps would be slightly larger to accommodate the intended design points and would require larger motors and drives as well. The basis of design for the pump selected for this RSPS alternative is the Flowserve Model 24MNF33A FR9H.

To facilitate construction of the new pump suction location into the existing concrete suction conduit, a portion of the existing slab pump room slab would need to be demolished. This slab demolition would need to extend beyond the limits of the suction conduit to provide a bearing surface for the replacement slab to rest upon. The pump suction piping would be formed up in the new slab, creating a watertight seal for the finished installation. Staging this construction would need to be done by wetwell, leaving half of the station online while the offline half was modified with the new slab and pumps.

6.3.2 Concept Arrangement

The layout for this RSPS alternative would be substantially similar to the existing layout, although minor alterations to the existing piping connections would be required to accommodate the connections to the Flowserve pump. The larger motors would also require an expansion to the elevated metal catwalk above the pumps to facilitate ease of access to the motor. A concept layout is shown in Figure 3 and Figure 4 included in Appendix B.

6.3.3 Operational Efficiency and Reliability

This RSPS alternative would improve the operational efficiency and reliability of the existing system by providing all new equipment with an expected service life of 20 years.

6.3.4 Process Resiliency

The new pumps would enhance the available system redundancy by providing a spare pump per wet well. Thus, at peak flows, each wet well could operate with only two of the three pumps, for a total of four out of six available pumps operating, to meet peak flows of 120 MGD.

6.3.5 Sustainability

The proposed pumps would require larger motors than the existing station, but fewer pumps would be required to run to meet design flows. It is anticipated that the net effect of this RSPS alternative will be similar to the existing system and would not be a change to the existing power usage of the station. The existing pumps removed as part of this RSPS alternative can be recycled to limit waste generation.

6.3.6 Maintenance Requirements

Maintenance requirements for this RSPS alternative would be similar to the existing pumps, although the need for frequent rebuilds would be eliminated as the new pumps should have a service life of at least 20 years.

6.3.7 Safety

Replacing existing pumps would not change any aspect of the RSPS with regards to safety.

6.3.8 Constructability

Minor modifications to the system layout would be required to facilitate construction of the new pumps, including piping modifications and repositioning the concrete opening into the rectangular suction conduits. This work would not require significant effort or difficulty but would be more involved than the construction for RSPS Alternative 1. The existing 7.5-ton capacity bridge crane and hoist can support the weight of the pump and motor.

6.3.9 Maintenance of Plant Operations

Unlike RSPS Alternative 1, it would not be possible to replace each pump in sequence with each other such that only one pump is ever out of service at a time. The need to modify the suction-side slab penetrations means that the replacements would need to be done by wet well, i.e., three pumps on one half of the wet well would be replaced at the same time, followed by three pumps on the other half of the wet well.

It will therefore be necessary that bypass pumping be provided for this alternative to handle peak flows when one wet well is out of service for pump replacement. Refer to the introduction in this section for more information on the proposed bypass pumping arrangement.

6.3.10 Impact on Other Unit Processes

Any impacts to other unit processes as a result of operation of the RSPS would be the same between this RSPS alternative and the existing RSPS operation.

6.3.11 Public Impact

Any impacts to the public as a result of the RSPS would be the same between this RSPS alternative and the existing RSPS operation.

6.3.12 Adaptability to Future Requirements

This RSPS alternative would provide the capability for the station to meet the 120 MGD design peak flow with two pumps out of service. A firm capacity of 150 MGD is therefore available if needed for future flows.

6.4 RSPS Alternative 3: Install Replacement Dry-Pit Submersible Pumps

This RSPS alternative considers replacing the existing pumps with a different style of pump.

6.4.1 Description

Under RSPS this alternative, all six pumps would be completely replaced with new pumps of a different style. Dry-pit submersible pumps are designed with a casing that fully encapsulates the pump, motor, and coupling, making the pump fully submersible. This casing prohibits effective air-cooling of the motor, so ordinary submersible pumps are cooled by the submersion of the pump in the pumped fluid. Dry-pit submersible pumps are ordinarily not submerged, and therefore require a cooling system that pumps glycol through the casing to keep the motor cool during operation. Advantages to this pump style include its ability to continue to operate while submerged, which could occur if the RSPS was ever flooded due to structural or piping leaks or failure. Another advantage is that the complete encapsulation of the pumping system provides a cleaner installation without seal water drips or leaks. Similar to RSPS Alternative 2, the new pumps would be slightly larger to accommodate the intended design points and would require larger motors and drives as well. The basis of design pump selected for this alternative is the Flygt CT 3602/866 or NT 351_905. The exact model is to be evaluated further during the design phase.

Similar to RSPS Alternative 2, slab replacement over the suction conduits would be required to facilitate the new pump suction piping.

6.4.2 Concept Arrangement

The layout for this RSPS alternative would be similar to the existing layout, although minor alterations to the existing piping connections would be required to accommodate the connections to the Flygt pump. Since the pumps are fully encapsulated, there would be no need for the elevated metal catwalk to access the motors on the pumps. This catwalk could therefore be removed. The glycol cooling system would be installed internally to the pump casing. Suction and discharge inspection ports are not integral to the pump but can be installed in the upstream and downstream piping. A concept layout is shown in Figure 6 and Figure 7 included in Appendix B.

6.4.3 Operational Efficiency and Reliability

This RSPS alternative would improve the operational efficiency and reliability of the existing system by providing all new equipment with an expected service life of 20 years.

6.4.4 Process Resiliency

The new pumps would enhance the available system redundancy similar to RSPS Alternative 2. However, the addition of the glycol cooling system creates an additional point of failure for the pumping system as a whole.

6.4.5 Sustainability

The proposed pumps would require larger motors than the existing station, but fewer pumps would be required to run to meet design flows. It is anticipated that the net effect of this RSPS alternative will be similar to the existing system and would not be a change to the existing power usage of the station.

6.4.6 Maintenance Requirements

Maintenance requirements for this RSPS alternative would be similar to the existing pumps, although the need for frequent rebuilds would be eliminated as the new pumps should have a service life of at least 20 years. The glycol cooling system would have some additional maintenance, namely the replacement of the cooling fluid approximately every 7-10 years.

6.4.7 Safety

Safety impacts would be similar to RSPS Alternative 2.

6.4.8 Constructability

Constructability for this alternative would be similar to RSPS Alternative 2. The existing 7.5-ton capacity bridge crane and hoist can support the weight of the pump and motor.

6.4.9 Maintenance of Plant Operations

Similar to RSPS Alternative 2, bypass pumping would be required for the installation of these pumps. Refer to the introduction of this section for more information on the proposed bypass pumping arrangement.

6.4.10 Impact on Other Unit Processes

Any impacts to other unit processes as a result of operation of the RSPS would be the same between this RSPS alternative and the existing RSPS operation.

6.4.11 Public Impact

Any impacts to the public as a result of the RSPS would be the same between this RSPS alternative and the existing RSPS operation.

6.4.12 Adaptability to Future Requirements

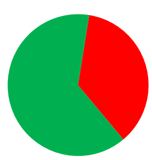
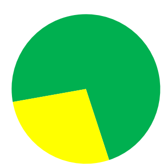
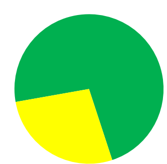
This RSPS alternative would provide the capability for the station to meet the 120 MGD design peak flow with two pumps out of service. A firm capacity of 150 MGD is therefore available if needed for future flows.

6.5 Evaluation of Raw Sewage Pump Station Alternatives

As discussed in Section 4.1, GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost evaluation factors of the five alternatives as shown in Table 6-2.

Table 6-2 GHD's "Traffic Light" Decision Model

Criteria	Alternative 1	Alternative 2	Alternative 3
	Rehabilitate Existing Pumps	**Replacement with Dry-Pit Close-Coupled Vertical Pumps**	**Replacement with Dry-Pit Submersible Pumps**
Layout			
	Identical to existing.	Substantially similar to existing.	Substantially similar to existing.
Operational Efficiency and Reliability			
	More pumps need to operate to meet design flows.	New pumps will meet design requirements.	New pumps will meet design requirements.
Process Resiliency			
	Pumps will not meet design redundancy.	Pumps provide firm capacity of 150 MGD.	Dry-pit submersible pumps can operate if the pump room is flooded.
Sustainability			
	Similar to existing.	Similar to existing.	Similar to existing.

Criteria	Alternative 1	Alternative 2	Alternative 3
	Rehabilitate Existing Pumps	**Replacement with Dry-Pit Close-Coupled Vertical Pumps**	**Replacement with Dry-Pit Submersible Pumps**
Maintenance Requirements			
	Rehabilitated pumps will likely need additional maintenance/rebuilds compared to new.	Improved over existing.	Improved over existing.
Safety			
	Similar to existing.	Similar to existing.	Similar to existing.
Constructability			
	Pumps would align with existing layout.	Some piping/structural changes required.	Some piping/structural changes required.
Maintenance of Plant Operations			
	Bypass pumping recommended.	Bypass pumping required.	Bypass pumping required.
Impact on Other Unit Processes			
	No impacts.	No impacts.	No impacts.
Public Impact			
	No impacts.	No impacts.	No impacts.
Adaptability to Future Requirements			
	No capacity for additional flow.	Firm capacity of 150 MGD.	Firm capacity of 150 MGD.
Summary			

RSPS Alternative 1 has the highest number of “red lights” of any alternative. RSPS Alternatives 2 and 3 have the same rating, with neither having any “red lights”.

6.6 Raw Sewage Pump Station Alternative Cost Analysis

Each RSPS alternative was provided a probable construction cost and life-cycle cost to be considered for selection of the recommended alternative. Section 4.2 outlines the assumptions made based on normal engineering practice. Table 6-3 summarizes the construction cost estimate and life cycle cost of each alternative. Detailed OPCC estimates are included in Appendix H and detailed lifecycle cost calculations are included in Appendix I.

Table 6-3 Opinion of Probable Construction Cost and Life-Cycle Costs for the Raw Sewage Pump Station Alternatives and Additional Improvements

	Alternative 1	Alternative 2	Alternative 3	Additional Improvements
Construction Cost (-20% to +30% accuracy)	$4,150,000	$5,100,000	$4,830,000	$3,090,000
Soft Costs (40%) [1]	$1,660,000	$2,040,000	$1,930,000	$1,240,000
2021 Project Cost (without contingency)	**$5,810,000**	**$7,140,000**	**$6,760,000**	**$4,330,000**
20-Yr O&M NPV	$7,480,000	$8,220,000	$7,910,000	N/A
Total	**$13,300,000**	**$15,400,000**	**$14,700,000**	**$4,330,000**

Note:

1. Soft costs include project management, engineering, construction management, and project administration costs.

The Life Cycle Costs of the alternatives are presented in Figure 6-2 for comparison.

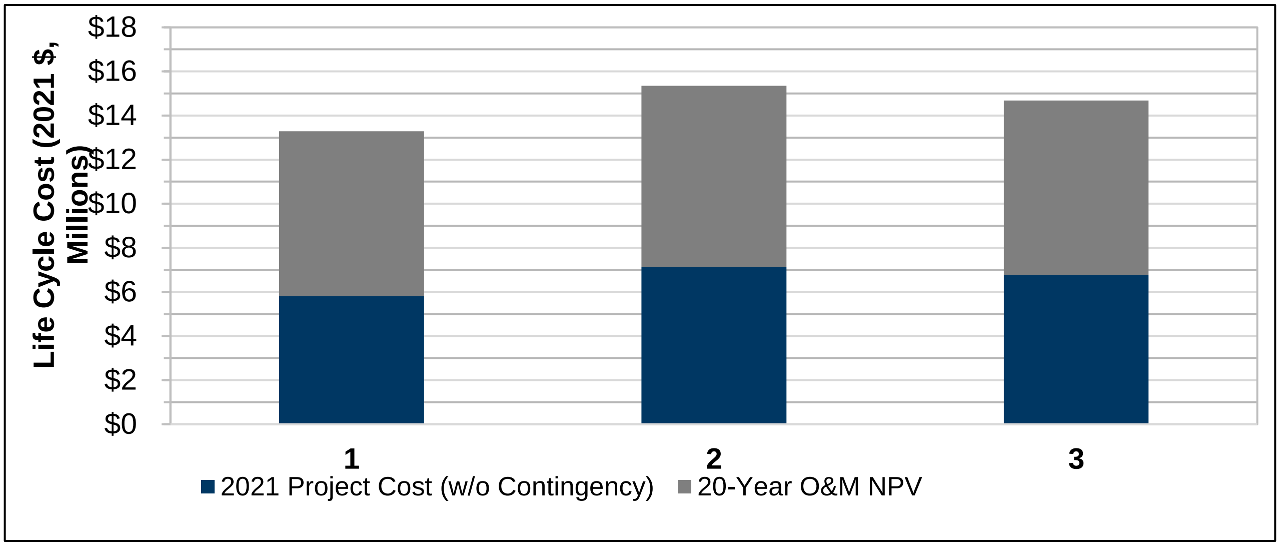


Figure 6-2 Raw Sewage Pump Station Life Cycle Cost Comparison

6.7 Recommended Raw Sewage Pump Station Alternative

The recommended approach was developed following a holistic consideration of both the cost and non-cost evaluation criteria.

As can be seen with the Traffic Light Decision Model in Table 6-2, RSPS Alternatives 2 and 3 are favored equally. While the capital and lifecycle cost comparison shown in Figure 6-2 indicates similar capital and lifecycle costs for both RSPS alternatives, RSPS Alternative 3 is clearly the more economical selection. When also acknowledging that AlexRenew staff expressed keen interest in RSPS Alternative 3 during the RSPS and Conduits Technical Memoranda Workshop on February 7, 2022, RSPS Alternative 3 is overwhelmingly considered to provide the best combination of performance, operations, and maintenance benefits to AlexRenew.

RSPS Alternative 3 includes:

- Replacing all existing raw sewage pumps with new dry-pit submersible pumps. The new pumps are to operate at the same capacity, but with higher head than the existing pumps.
- Replace all existing 300 Hp motors with new 350 Hp motors.
- Replace all existing VFDs with new VFDs.
- Construct new suction penetrations into the suction conduits.
- Construct new concrete pedestals for the raw sewage pumps.

Additional system upgrades recommended include:

- Upgrade 1, Option 1: Upgrade knife gate valves with Rotork electric actuators
- Upgrade 3, Option 2: Replace existing check valves with electronic or pneumatically actuated ball valves
- Upgrade 4: Replace wet well sluice gate with new slide gates (upstream of wet wells)
- Upgrade 5: Upgrade wet well stop plate groove to accept new stop logs
- Upgrade 6: New centralized sump pit with permeant explosion proof sump pumps; plug existing drains and install a new trough drain design
- Upgrade 8: Upgrade gates on drain lines to sump pit
- Upgrade 9: General controls and instrumentations – move E-stop, replace wet well level sensor instrumentation, raw sewage pump pressure sensors and transmitters, check valve position switch, etc.
- Upgrade 10 (partially): Advanced pump monitoring and controls instrumentation. Monitoring of vibration and air binding only

It is recommended that the RSPS system improvements be made before or concurrent with improvements to the Conduits system. The Conduits system improvements will also require bypass pumping and may be installed concurrently with the RSPS improvements to limit bypass operation costs. It is recommended that the suction penetration improvements are made before the Conduits improvements to allow a seamless coating to the suction conduits.

RSPS Alternative 3 and the recommended additional system upgrades provide the following benefits to AlexRenew that align with the Strategic Outcomes of AlexRenew’s 2040 Vision Statement:

- Operational Excellence
  - Provides industry leading pumping technology to meet required performance criteria. Upgraded auxiliary equipment and instrumentation provide accurate controls, more effective function of existing systems, and reliability.
- Adaptive Culture
  - Decreases maintenance and emergency repairs from failed equipment. Eliminates the need for operators to use the chainwheel knife gate valves, which aligns with AlexRenew safety culture.
- Watershed Stewardship
  - By meeting future performance criteria, the RSPS will be able to better handle high flow event, which decreases the potential of SSOs.
- Public Trust
  - Does not have any negative impacts on the surrounding community.
- Financial Resilience
  - The selected alternative has less capital and lifecycle costs compared to rehabilitating the existing pumps.

7. Raw Sewage Conduits Evaluation

The following conduits alternatives were developed for the upgrade of the conduits system:

- Raw Sewage Conduits Alternative 1: Spray on Geopolymer Liner
- Raw Sewage Conduits Alternative 2: Epoxy Coating
- Raw Sewage Conduits Alternative 3: Carbon Fiber Wrap

One consideration in selecting the conduits alternative was understanding the material that was used in the fine screen and grit channels that deteriorated rapidly. Specification 09900-3.9.I. for the construction of Building K states that the walls of all screen and grit channels in Building K were to be applied with one coat of elastomer polyurethane. Polyurethanes can create durable, chemically resistant protection for concrete structures. They are known for UV resistance, gloss retention, and color stability. However, they are sensitive to humidity and moisture during installation and curing. Polyurethanes are more temperamental than other coating types, i.e., require better preparation, have more stringent curing condition, and longer curing times. Comparatively, epoxy coatings are considered “surface tolerant”, meaning they have excellent adhesion to many substrates.

All conduits alternatives noted above will require an unknown amount of structural repair to the concrete surfaces prior to application of a protective coating. CCTV footage captured during the inspection of the South Side of the RSPS indicated moderate pitting with no evidence of extensive mass loss or spalling. However, to accurately predict costs associated with structural damage, three repair details labelled, Type 1, Type 2, and Type 3, were created to show how repairs can be made to correct varying degrees of structural damage.

“Type 1” damage is defined as areas with minor damage less than 3/4-inch depth without spalling. This includes the areas identified with moderate pitting in the CCTV footage and is conservatively assumed to include all concrete surfaces. Type 1 repairs can vary slightly depending on the alternative selected and the supplier’s recommendation, but predominantly include pressure cleaning, removing loose material, and patching with an approved mortar or epoxy.

“Type 2” damage is defined as spalled concrete less than 1 1/2-inch depth where reinforcing steel is not exposed. No locations with Type 2 damage were identified in the CCTV footage. Repairs for locations exhibiting this type of damage is similar Type one, with the exception that a different type of mortar and/or several lifts of a thinner mortar are required.

“Type 3” damage is defined as spalled concrete with exposed reinforcing steel. Of the three damage types, this type is the most severe. No locations with Type 3 damage were identified in the CCTV footage. This repair procedure differs from the previous two and requires the following steps:

– The area must be shored prior to start of repair work.
– The exterior of the spall must be saw-cut to a minimum of 1/4-inch.
– Concrete must be removed around the damaged rebar to expose damage.
– Damaged rebar must be removed and spliced with new rebar, supported with gunite clips, and repaired by patching with an approved mortar.

It is anticipated that all conduits alternatives considered require bypassing of the RSPS. Bypass pumping is required to transport influent flow from Building A to Building K when one half of the RSPS is out of service. The current design criteria for the RSPS is to be maintained at 108 MGD. The online side of the RSPS can pass 60 MGD, while the remaining capacity, approximately 50 MGD, must be provided through bypass pumps. Godwin provided a bypass solution that requires five model CD400M pumps that can operate on either diesel fuel or electricity. The 18-inch diameter pump suctions are be placed into Control Structure No. 1 located directly upstream of Building A, with the pumps arranged in the road/yard on the east side of the building. The pumps are to discharge into a common manifold that then splits between two parallel 30-inch diameter discharge lines that run from the east side of Building A to the east side of Building K. The discharge lines will be routed onto the grit deck of Building K, into the Fine Screen Room, then into the individual fine screen influent channels. A sixth bypass pump is required for redundancy. Figure 6 in Appendix C presents the layout described. Suction lift from the water level in Control Structure No. 1 to the eye of the bypass pumps is approximately 21-feet based on the lowest overflow elevation in the collection system. Godwin requests that surcharging be allowed during high flow events to facilitate more efficient operation of the bypass pumping system. By reducing the suction lift by several feet, the efficiency of the bypass pumps nearly doubles. It is expected that during typical diurnal flows, all influent flow will be passed through the online side of the RSPS and not the bypass pumps. Only during events where the influent flow rises above 60 MGD does the bypass pumps start passing flow. The bypass operation described hitherto draws wastewater from upstream of the coarse screens, which may create operational challenges from debris blockages. It also presents challenges with a high static lift and expansive laydown area. While acceptable for budgetary purposes, alternative bypass options that consider the following are to be evaluated in final design:

– Explore alternative location/routing (under concrete covers in the breezeway, not cutting across fire department training grounds, etc.)
– Explore pump power source options (diesel, electricity, etc.). Consider sustainable sources if feasible.

GHD will include a sequencing constraint in the contract to not perform work requiring bypass pumping during the fall, unless the proposed pumps are able to handle large masses of leaves.

While all coating alternatives require bypassing, the duration of bypass is dependent on the conduits alternative selected and is reflected in the cost estimates for each conduits alternative.

As previously mentioned, upgrades to the raw sewage pumps and miscellaneous mechanical equipment associated with the RSPS are described in Section 6.

7.1 Basis of Design

The level of service goals presented in Table 7-1 were selected as the basis of design criteria for the conduit system. Design criteria for the conduit system considered concurrent plant upgrades, hydraulic modeling, field testing, and system curve analysis. A summary of considerations that developed the design criterion is provided herein.

Table 7-1 Level of Service Goals for Conduits Basis of Design Criteria

Parameter	Basis of Design
Design average daily flow	54 MGD
Design peak instantaneous flow [1]	120 MGD
Design maximum flow per side [1]	60 MGD
Rehabilitation of concrete structures	Rebuilding concrete structures that exhibit spalling or max loss. Provide a protective coating against future degradation to concrete surfaces.
Max velocity with both sides operating	8.25 fps

Note:
1. Virginia Sewage Collection and Treatment Regulations (SCAT); the design velocity in pump piping should not exceed (i) six feet per second in the suction piping, and (ii) in the discharge piping, eight feet per second.

The design flow rates were analyzed in more detail in the RSPS TM. In summary, the RiverRenew project scheduled for completion in 2025 will require the RSPS to increase the current peak instantaneous flow from 108 MGD to 116 MGD. However, the collection system can deliver approximately 120 MGD during high flow events as demonstrated by the case study on February 24th and 25th of 2016, which is shown in the RSPS TM. Maximum velocities in the discharge conduits dictate how much flow can be conveyed safely without damaging the system or creating an unsafe condition. The design criteria were selected to allow the greatest influent flows to be conveyed from the headworks building to Building K. This requires a peak instantaneous flow capacity of 120 MGD with one pump out of service as required by Sewage Collection and Treatment Regulations (SCAT) and set by VA DEQ. To ensure redundancy on each side of the RSPS, the 120 MGD capacity to be conveyed with two pumps out of service (one pump out of service on each side).

7.2 Conduits Alternative 1: Spray on Geopolymer Liner

This conduits alternative includes the application of a fiber-reinforced geopolymer mortar to the concrete surfaces. The geopolymer readily adheres to the prepared surface and hardens to form a chemically resistant, concrete surface specifically designed to restore structural integrity, performance and design life of large diameter sewer mains, water mains, culverts, and manholes. Geopolymer would be applied to all concrete surfaces in the wet wells, suction conduits, and discharge conduits.

7.2.1 Description

Geopolymer is a cementitious material made from a mixture of active pozzolanic material, such as fly-ash, with an alkaline activator, such as lye. The result is a product that looks like Portland cement but with superior properties. Michels Corporation and SAK Construction were contacted for budgetary proposals to install a geopolymer coating to the RSPS structures. Typical performance characteristics of a geopolymer called Geokrete® by Quadex® is presented in Table 7-2.

Table 7-2 Geokrete® Performance Characteristics

Parameter	Performance Characteristic
Compressive Strength (ASTM C39 and C109)	28-days >8,000 psi
Flexural Strength (ASTM C78)	28-days > 800 psi
Bond Strength (ASTM C882)	28-days > 3,000 psi
Modulus of Elasticity (ASTM C469)	28-days = 5.49 x 10^6 psi
Chemical Resistance (ASTM C267)	0% mass loss in 8 weeks sulfuric acid @ pH 1.0 immersion
Chloride Ion Penetration Resistance (ASTM C1202)	28-Days <250 Coulombs
Split Tensile Strength (ASTM C496)	28-days >900 psi
Shrinkage (ASTM C1090)	28-days <0.02%
Freeze Thaw (ASTM C666)	No visible damage after 300 cycles
Abrasion Resistance (ASTM C1138)	6 cycles at 28 day – loss <1.0%

Figure 7-1 provides before and after photos of a circular pipe rehabilitated with Geokrete® products by Quadex®.

Figure 7-1 Geokrete® Before and After Photos

7.2.2 Concept Arrangement

The concept arrangement does not differ from the existing layout of the RSPS. All concrete surfaces within the wet wells, suction conduits, and discharge conduits would be coated with a thin layer of geopolymer to act as a protective layer. Locations with substantial mass loss are to be built back flush with the existing surface using flowable fill (Quad-Flow) and will receive a thicker coating for structural restoration. As stated in Section 7.1, the 60-inch raw sewage lines are in good condition and are not recommended to receive geopolymer application. The arrangement for Conduits Alternative 1 is shown in Figures 3, 4, and 5 included in Appendix C.

7.2.3 Operational Efficiency and Reliability

Applying geopolymer to the RSPS structures is expected to extend the life of the conduit system by providing a protective coating. In locations that experienced concrete mass loss or spalling, the geopolymer can be applied to a greater thickness for structural repair. Geopolymer has excellent resistance to H_2S corrosion and abrasion with a minimum 50-year service life.

7.2.4 Process Resiliency

This conduits alternative does not change the level of redundancy of the existing system. The smooth surface of the geopolymer lowers friction losses in the system, which would allow each side of the RSPS to pass more flow. However, the cross-sectional area of the conduits slightly decreases, which would increase the velocity through the conduits. The advantage of the smoother surface and disadvantage of the smaller cross-sectional area are both insignificant. As such, the redundancy, or ability to pass flow through one side of the RSPS, is not affected by this alternative.

7.2.5 Sustainability

This conduits alternative extends the life of the concrete structures, which may be a net reduction of materials when compared to future repairs that must address further deterioration of the unprotected structures. This conduits alternative has similar sustainability when compared to other conduits alternatives.

7.2.6 Maintenance Requirements

This conduits alternative lessens the maintenance burden of AlexRenew. If improvements are not made, it is recommended to schedule inspections of the system every five years to assess conditions and evaluate the need for repairs. With improvements, it is recommended to schedule inspections every ten years, especially since the product has a minimum design life of 50-years.

7.2.7 Maintenance Accessibility/Safety

This conduits alternative does not change the safety or accessibility of the RSPS structures. However, other mechanical upgrades discussed in the Section 6 will improve isolation and safety.

7.2.8 Constructability

Applying a geopolymer coating may include the following steps. The actual procedure is dependent on the selected manufacturer’s recommendations.

1. Prior to mobilization, one side of the RSPS must be taken out of service. For isolation, a temporary bulkhead shall be installed upstream of the wet well stop log groove. A temporary bulkhead shall also be installed in the common fine screen channel to separate fine screen channels one and two from channels three and four. Once isolated, the wet well, suction conduit, and discharge conduit can be drained using existing protocols.
2. All surfaces to be coated shall be cleaned and prepared to accept geopolymer. Cleaning and surface preparation may consist of the following. As previously noted, the actual cleaning and preparation is specific to each manufacturer.
    a. Excessive debris, sediment, or other foreign materials which may impact the effectiveness of the surface preparation process shall be removed prior to proceeding.
    b. Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be addressed per Manufacturers’ recommendations.

c. Surface preparation method, or combination of methods, that may be used include high-pressure water cleaning (minimum 3,500 psi), water jetting, abrasive blasting, grinding or scarifying. When grease or oil are present within the host infrastructure, steam, heated water (up to 200°F) or a detergent approved by Owner may be added to the water and used integrally with the high-pressure water cleaning and other methods as referenced in industry accepted standards.
d. Loose debris materials resulting from the cleaning of the structure shall be removed.
e. Loose or defective concrete, grout, etc. shall be removed to provide an even surface.
f. Exposed rebar shall be pressure washed to remove any extraneous materials, such as dirt, oil, grease, debris and loose rust scale.

3. After the surface has been cleaned and prepared, a pre-construction inspection shall be conducted to evaluate the existing condition and determine the amount of rehabilitation effort warranted. The square footage of areas requiring repairs in accordance with Type 1, 2, and 3 structural repairs shall be documented. The inspection shall be overseen by a manufacturer certified inspector and include the recording of CCTV footage/photos.
4. Active leaks and cracks are to be sealed using the manufacturer's approved materials and protocol.
5. Type 1, 2, and 3 structural repairs are to be completed during this step using the manufacturer's approved mortar or flowable fill.
6. After leaks, cracks, spalling, pitting, etc. have been repaired, patched, and given time to cure, a pre-lining inspection shall be conducted to evaluate the quality of preliminary repairs and to determine acceptability of the surface condition to receive geopolymer. The inspection shall be overseen by a manufacturer certified inspector and include the recording of CCTV footage/photos.
7. The geopolymer mortar is mixed with water at grade and pumped to the point of application. Once the mortar reaches the point of application it is hand sprayed to a design thickness of 1/2-inch for a protective layer or greater than 1-inch for structural restoration. Typically, geopolymer is applied to large conduits using a low-pressure spin cast device. The rectangular surfaces of the RSPS structures are not a good candidate for the spin cast device and require a hand spray application.
8. After the geopolymer has cured, a final inspection shall be made by the manufacturer certified inspector and include the recording of CCTV footage/photos. Any deficiencies in the finish lining shall be marked and repaired by the applicator.
9. Lastly, bulkheads are to be removed and the system is to be placed back in service.

Constructability is a challenge for geopolymer. Manufacturers are hesitant to recommend geopolymer because the application is difficult in the tight spaces. A contractor would have to enter the 30-inch wide by 54-inch tall discharge conduits and spray all surfaces to the design thickness. The cementitious behavior of geopolymer makes the material difficult to work with and control. It is recommended for potential installers to evaluate the feasibility of applying this product with a site visit during final design.

Total construction duration expected to take six weeks. Each discharge conduit and suction conduit/wet well requires one week for cleaning, preparation, and coating (four weeks total). An additional week is required to rebuild damaged concrete and to apply a preliminary mortar coating to all surfaces. Another week is required for isolation, inspections, and testing.

7.2.9 Maintenance of Plant Operations

All conduits alternatives require one side of the RSPS to be taken out of service for the rehabilitation material to be applied. During this time, the in-service side of the RSPS can convey influent flow up to 60 MGD. Temporary bypass pumps and piping will need to convey any additional influent flow to Building K. Bypass pumps are to be placed in Control Structure No. 1 immediately upstream of Building A. Temporary piping to be routed to the individual fine screen channels in Building K. Bypass pumping will be required for six weeks as described by the following schedule: one week is required for isolating, inspecting, and testing the structures; one week is required to repair cracks, rebuild damaged concrete, and to apply mortar; each side of the RSPS will require a minimum of two weeks to install the geopolymer coating. The bypass pumps shall be maintained by the contractor, but operation and reliability of the online side of the RSPS is to be maintained by AlexRenew. As shown in Figure 6 in Appendix C, the bypass pumping arrangement will block traffic routes on the east side of Building A. Access to the coarse screens is to be maintained on the north side of the building, but vehicles will not be able to access the coarse screens from the south side. The bypass piping is to run off the road around the north side of Building A and will block the driveway to the firefighting training building. Mitigation for the blocked drive may consist of a temporary structure over the bypass pipes to allow vehicle crossing or coordinating with the owners to inform them of the temporary blockage prior to construction. While the proposed route is not faultless, it is short compared to routes from other control structures and is less obstructive than being routed on the west side of Building A.

AlexRenew operators would need to be mindful of plant flows during bypass operations. The bypass influent flow will not be routed through the coarse screens and may increase solids capture and blinding of the fine screens.

7.2.10 Impact on Other Unit Processes

This conduits alternative does not impact upstream or downstream processes. As stated above, the smoother geopolymer surfaces and smaller cross-sectional areas of the structures are insignificant on the raw sewage pumps' performance.

7.2.11 Public Impact

This conduits alternative does not have any negative impacts on the surrounding community.

7.2.12 Adaptability to Future Requirements

This conduits alternative extends the life of the existing structures but does not increase the capacity of the RSPS to accept higher future flows. If more capacity is required in the future, it is recommended that the discharge conduits are upsized to maintain peak velocities within the recommended range for force mains.

7.3 Conduits Alternative 2: Epoxy Coating

This conduits alternative includes the application of a 100% solids, high-build epoxy coating formulated to provide long-term corrosion protection and structural enhancement for wastewater infrastructure subject to high levels of corrosion and/or abrasion in both municipal and industrial applications. Epoxy would be applied to all concrete surfaces in the wet wells, suction conduits, and discharge conduits.

7.3.1 Description

The epoxy coating would provide a smooth, hard, ceramic like surface on the concrete structures. This barrier protects the existing concrete from chemical attack and abrasion from fluid media. Structural repairs to address spalling, mass loss, exposed rebar, cracks, etc. would be performed with mortar and crack injection products prior to the epoxy coating. While deteriorated locations will receive isolated structural repairs, most of the surfaces would receive non-structural epoxy coating repairs. Michels Corporation, SAK Construction, and Sika were contacted for budgetary proposals to coat the RSPS structures with epoxy. Different style epoxy coatings were recommended by the contacted suppliers. Michels Corporation and SAK Construction proposed a high-build, non-VOCs polymer epoxy that is capable of building to 250 mils in a single layer or greater. While surface preparation is paramount, the epoxy coatings are advertised as being directly applied to the existing, damp concrete surface. GHD recommends a preliminary coating of epoxy or mortar to the entire surface to address pitting (Type 1 repair) and to provide a moderately dry surface for better adhesion of the final epoxy coating. The importance of having a dry surface was reinforced in conversation with SAK Construction, who stressed that the damp surface must have a low moisture content that is surface saturated dry. One way to guarantee an appropriate surface condition is to provide the preliminary coating. The typical performance characteristics of the epoxy recommended by SAK Construction, Quadex Structure Guard® is presented in Table 7-3.

Table 7-3 Quadex Structure Guard® Performance Characteristics

Parameter	Performance Characteristic
Compressive Strength (ASTM D695)	13,300 psi
Flexural Strength (ASTM D790)	15,700 psi
Adhesion to Concrete (ASTM D4541)	Substrate failure
Flexural Modulus (ASTM D790-86)	530,000 psi
Tensile Strength (ASTM D638)	8700 psi
Elongation	6.6%
Shore D Hardness (ASTM D2240)	87.5
Taber Abrasion Resistance (ASTM 4060)	<80 mg loss (1kg load @1000 cycles)

Figure 7-2 shows before and after photos of a flow split structure with Quadex Structure Guard®.

Figure 7-2 Quadex Structure Guard® Before and After Photos

Sika proposed a high-build, 100% VOCs epoxy resin coating that is to be applied in multiple layers 4-7 mils each. Surface preparation is paramount, and Sika stressed that epoxies need to be applied to a dry surface for bonding. Sika recommended a thin mortar/epoxy coating to fill pitting, bug holes, etc., which would be applied to the entire concrete surface with the primary objective of creating an acceptably dry surface that the epoxy will readily absorb into for superior bonding. The preliminary mortar/epoxy coating could be applied thicker in areas to create a smooth surface. The typical performance characteristics of the preliminary mortar/epoxy and final epoxy recommended by Sika is presented in Table 7-4 and Table 7-5.

Table 7-4 Preliminary Mortar/Epoxy – Sikagard® - 75 EpoCem® Performance Characteristics

Parameter	Performance Characteristic
Abrasion Resistance (ASTM D-4060)	28-days - 0.3
Compressive Strength (ASTM C-579B)	28-days - 7,000 psi
Flexural Strength (ASTM C293)	28-days - 1,500 psi
Tensile Adhesion Strength (ASTM C-1583)	28-days - 400 psi
Coefficient of Thermal Expansion (ASTM C-531)	5.5×10^{-6} in./in./F
Permeability to Water Vapor (ASTM E-96)	7 days – 0.06 perms

Table 7-5 Final Epoxy – Sikagard® - 62 Performance Characteristics

Parameter	Performance Characteristic
Abrasion Resistance (ASTM D-1044)	7-days – 0.61 gm (1kg weight, 1,000 cycles)
Tensile Strength (ASTM D-638)	14-days – 5,400 psi
Elongation at Break	14-days – 2.7%
Tensile Adhesion Strength (ASTM 3359)	1-day – 4A
Permeability to Water Vapor (ASTM D-570)	7-days (24-hour immersion) – 0.1%

7.3.2 Concept Arrangement

The concept arrangement does not differ from the existing layout of the RSPS. All concrete surfaces within the wet wells, suction conduits, and discharge conduits would be rehabilitated with epoxy and any preliminary coatings or repairs. As stated in Section 4, the 60-inch raw sewage lines are in good condition and are not recommended to receive epoxy application. The arrangement for Conduits Alternative 2 is shown in Figures 3, 4, and 5 included in Appendix C.

7.3.3 Operational Efficiency and Reliability

Applying epoxy to the RSPS structures is expected to extend the life of the concrete surfaces by providing a protective coating. In locations that experienced concrete mass loss or spalling, mortar can be applied to a greater thickness for structural repair. Epoxy has excellent resistance to H_2S corrosion and abrasion with an expected 75-year service life.

7.3.4 Process Resiliency

This conduits alternative does not change the level of redundancy of the existing system. The smooth surface of the epoxy lowers friction losses in the system, which would allow each side of the RSPS to pass more flow. The cross-sectional area of the conduits may slightly decrease which would slightly increase the velocity through the conduits. The advantage of the smoother surface and disadvantage of the smaller cross-sectional area are both insignificant. As such, the redundancy, or ability to pass flow through one side of the RSPS, is not affected by this conduits alternative.

7.3.5 Sustainability

This conduits alternative extends the life of the concrete structures, which may be a net reduction of materials when compared to future repairs that must address further deterioration of the unprotected structures. This conduits alternative has similar sustainability when compared to other alternatives.

7.3.6 Maintenance Requirements

This conduits alternative lessens the maintenance burden of AlexRenew. If improvements are not made, it is recommended to schedule inspections of the system every five years to assess conditions and evaluate the need for repairs. With improvements, it is recommended to schedule inspections every ten years, especially since the product has an expected life of 75-years.

7.3.7 Maintenance Accessibility/Safety

This conduits alternative does not change the safety or accessibility of the RSPS structures. However, other mechanical upgrades discussed in the Section 6 will improve isolation and safety.

7.3.8 Constructability

Constructing an epoxy coating may include the following steps. The actual procedure is dependent on the selected manufacturer. Most steps are similar to Conduits Alternative 1 and are therefore not repeated; The following steps are unique to Conduits Alternative 2.

1. All surfaces to be coated shall be cleaned and prepared to accept mortar/epoxy. Cleaning and surface preparation may consist of the following. As noted earlier, the actual cleaning and preparation is specific to each manufacturer.
   a. Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be removed in accordance with SSPC-SP 1 – Solvent Cleaning or other suitable method.
   b. Surface preparation method, or combination of methods, that may be used include high-pressure water cleaning, water jetting, abrasive blasting, shot blasting, grinding, scarifying, detergent water cleaning, stem or hot water cleaning and others as referenced in industry standards such as:
      i. SSPC SP-13/NACE No. 6 Surface Preparation for Concrete
      ii. ASTM D-4258 Standard Practice for Surface Cleaning for Concrete and ASTM D-4259 Standard Practice for Abrading Concrete.
2. The surface shall then be etched with a solution of 20% muriatic acid to clean and open the pores of the substrate. The pH must be within an acceptable range (5 to 8.5).
3. After leaks, cracks, spalling, pitting, etc. have been repaired, patched, and given time to cure, a pre-lining inspection shall be conducted to evaluate the quality of preliminary repairs and to determine acceptability of the surface condition to receive epoxy. The surface profile shall be at least a concrete surface profile (CSP) 4 in accordance with International Concrete Repair Institute (ICRI) Technical Guideline No. 03732. The inspection shall be overseen by a manufacturer certified inspector and include the recording of CCTV footage/photos.
4. The epoxy is then applied to the RSPS structures using spray equipment, high-quality brushes, or rollers. Contractor would have to enter the 30-inch wide x 54-inch tall discharge conduits and apply coating to all surfaces to the design thickness. The epoxy behavior is more favorable for applications in small areas than other alternatives.

Total construction duration expected to take six weeks. Each discharge conduit and suction conduit/wet well requires one week for cleaning, preparation, and coating (four weeks total). An additional week is required to rebuild damaged concrete and to apply a preliminary mortar coating to all surfaces. Another week is required for isolation, inspections, and testing.

7.3.9 Maintenance of Plant Operations

Maintenance of plant operations is similar to Conduits Alternative 1, although with different products installed.

AlexRenew operators would need to be mindful of plant flows during bypass operations. The bypass influent flow will not be routed through the coarse screens and may increase solids capture and blinding of the fine screens.

7.3.10 Impact on Other Unit Processes

This conduits alternative does not impact upstream or downstream processes. As stated above, the smoother epoxy surfaces and smaller cross-sectional areas of the structures are insignificant on the raw sewage pumps' performance.

7.3.11 Public Impact

This conduits alternative does not have any negative impacts on the surrounding community.

7.3.12 Adaptability to Future Requirements

This conduits alternative extends the life of the existing structures but does not increase the capacity of the RSPS to accept higher future flows. If more capacity is required in the future, it is recommended that the discharge conduits are upsized to maintain peak velocities within the recommended range for force mains.

7.4 Conduits Alternative 3: Carbon Fiber Wrap

This conduits alternative includes the application of high-strength, high-modulus, non-corrosive biaxial glass fiber. The glass fiber is impregnated with resin/epoxy to form glass fiber reinforced polymer (GFRP). This conduits alternative provides both corrosion resistance and structural rehabilitation to the concrete structures. Similar to Conduits Alternatives 1 and 2, the material would be applied to all concrete surfaces in the wet wells, suction conduits, and discharge conduits.

7.4.1 Description

This conduits alternative is similar in appearance to an epoxy coating but includes structural rigidity with a glass fiber mat. After surface preparation, voids and excess pitted areas would be filled with thickened epoxy. Additional epoxy would be applied for required adhesion of the fiber wrap. A single layer or multiple layers of fiber wrap would be installed with an additional epoxy layer between fiber wrap layers if applicable. A final topcoat of epoxy would be applied at the end. The final product would be a smooth, hard, ceramic like surface on the concrete structures. This barrier protects the existing concrete from chemical attack and abrasion from fluid media. GHD contacted Fyfe Company and QuakeWrap® for budgetary proposals to install the fiber wrap to the RSPS structures. The typical performance characteristics of the fiber wrap recommended by Fyfe Company is presented in Table 7-6. Epoxy performance characteristics are shown to be similar to epoxies discussed in Section 6.2 (Conduits Alternative 2). Figure 7-3 illustrates the two fiber wrap systems.

Table 7-6 QuakeWrap® Performance Characteristics

Parameter	Performance Characteristic
Tensile Strength in Primary Fiber Direction (ASTM D3039)	83,400 psi
Tensile Modulus (ASTM D3039)	3.79×10^6 psi
Elongation at Break (ASTM D3039)	2.2%
Tensile Strength Perpendicular to Primary Fiber Direction (ASTM D3039)	3,750 psi
Flexural Strength (ASTM D790)	80,000 psi
Flexural Modulus (ASTM D790)	3.5×10^6 psi
Laminate Thickness	0.05 inches

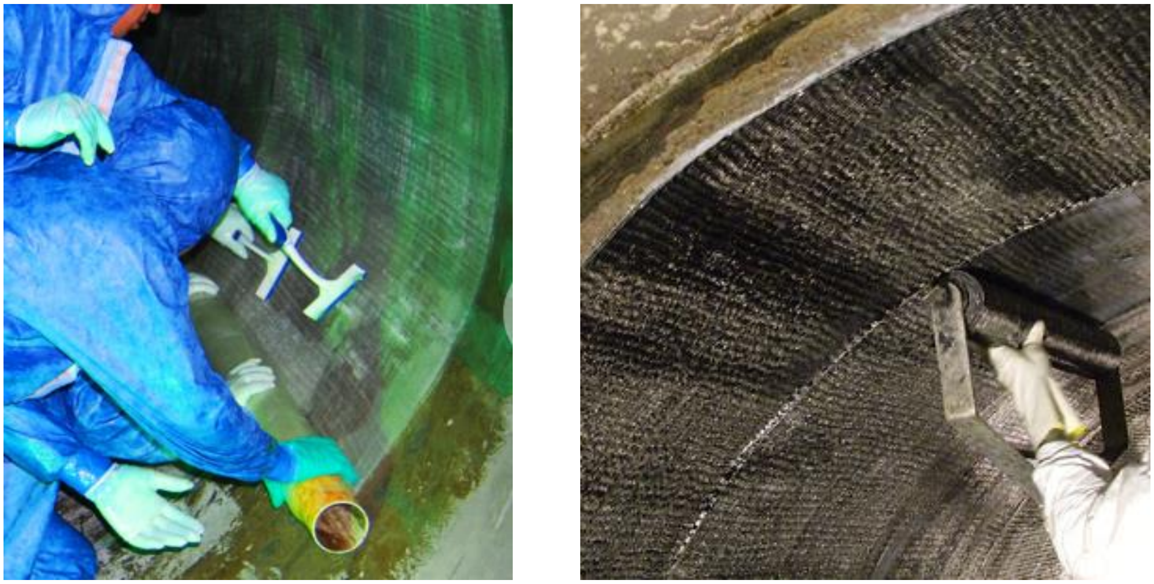


Figure 7-3 Shows representative photos of QuakeWrap® (left) and Fyfe's Tyfo® system (right)

7.4.2 Concept Arrangement

The concept arrangement does not differ from the existing layout of the RSPS. All concrete surfaces within the wet wells, suction conduits, and discharge conduits would be rehabilitated with fiber wrap and any additional epoxy or resin coatings. As stated in Section 4, the 60-inch raw sewage lines are in good condition and are not recommended to receive fiber wrap application. The arrangement for Conduits Alternative 2 is shown in Figures 3, 4, and 5 included in Appendix C.

7.4.3 Operational Efficiency and Reliability

Applying fiber wrap to the RSPS structures is expected to extend the life of the concrete surfaces by providing a protective, structural layer. In locations that experienced mass loss or spalling, the thickened epoxy can be applied to greater thicknesses to fill annular space while the fiber wrap provides structural support. The epoxy/resin impregnated fiber wrap has excellent resistance to H_2S corrosion and abrasion with a like expectancy over 50-years.

7.4.4 Process Resiliency

This conduits alternative does not change the level of redundancy of the existing system. The smooth surface of the fiber wrap lowers friction losses in the system, which would allow each side of the RSPS to pass more flow. The cross-sectional area of the conduits may slightly decrease which would slightly increase the velocity through the conduits. The advantage of the smoother surface and disadvantage of the smaller cross-sectional area are both insignificant. As such, the redundancy, or ability to pass flow through one side of the RSPS, is not affected by this conduits alternative.

7.4.5 Sustainability

This conduits alternative extends the life of the concrete structures, which may be a net reduction of materials when compared to future repairs that must address further deterioration of the unprotected structures. This conduits alternative has similar sustainability when compared to other alternatives.

7.4.6 Maintenance Requirements

This conduits alternative lessens the maintenance burden of AlexRenew. If improvements are not made, it is recommended to schedule inspections of the system every five years to assess conditions and evaluate the need for repairs. With improvements, it is recommended to schedule inspections every ten years, especially since the product has a life expectancy over 50-years.

7.4.7 Maintenance Accessibility/Safety

This conduits alternative does not change the safety or accessibility of the RSPS structures. However, other mechanical upgrades discussed in the Section 6 will improve isolation and safety.

7.4.8 Constructability

Constructing a fiber wrap system may include the following steps. The actual procedure is dependent on the selected manufacturer. Most steps are similar to Conduits Alternative 2 and are therefore not repeated; the following steps are unique to Conduits Alternative 3.

1. The surface shall be profiled to CSP 2/3 as defined by the ICRI surface profile chips.
2. Pitting is filled with a thick layer of epoxy, followed by a tack coat.
3. Installation of one layer of glass fiber mat in the longitudinal direction using high-quality brushes and rollers.
4. Apply an intermediate epoxy layer.
5. Installation of one layer of glass fiber mat in the perpendicular direction using high-quality brushes and rollers.
6. Apply epoxy coat (similar coating as intermediate coat).
7. Apply performance topcoat for corrosion and abrasion resistance.

Total construction duration is expected to take six weeks. Each discharge conduit and suction conduit/wet well requires one week for cleaning, preparation, and fiber wrap coatings (four weeks total). An additional week is required to rebuild damaged concrete. Another week is required for isolation, inspections, and testing.

7.4.9 Maintenance of Plant Operations

Maintenance of plant operations is similar to Conduits Alternatives 1 and 2, albeit with different products installed. Fyfe provides an estimated project duration of four weeks, which includes preparing the surfaces for installation, the preliminary epoxy coating (Repair Type 1) and all other fiber mat and epoxy coatings. Items excluded include cleaning, rebuilding severe spalling, and inspections. These additional items add two week to the construction and bypass duration.

AlexRenew operators would need to be mindful of plant flows during bypass operations. The bypass influent flow will not be routed through the coarse screens and may increase solids capture and blinding of the fine screens.

7.4.10 Impact on Other Unit Processes

This conduits alternative does not impact upstream or downstream processes. As stated above, the smoother fiber wrap surfaces and smaller cross-sectional areas of the structures are insignificant on the raw sewage pumps' performance.

7.4.11 Public Impact

This conduits alternative does not have any negative impacts on the surrounding community.

7.4.12 Adaptability to Future Requirements

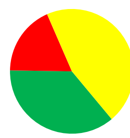
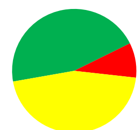
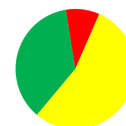
This conduits alternative extends the life of the existing structures but does not increase the capacity of the RSPS to accept higher future flows. If more capacity is required in the future, it is recommended that the discharge conduits are upsized to maintain peak velocities within the recommended range for force mains.

7.5 Evaluation of Raw Sewage Conduits Alternatives

As discussed in Section 4.1, GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost evaluation factors of the three alternatives as shown in Table 7-7.

Table 7-7 Summary of Conduits Upgrade Alternatives

Criteria	Alternative 1	Alternative 2	Alternative 3
	Spray on Geopolymer Liner	Epoxy Coating	Carbon Fiber Wrap
Layout	🟡	🟡	🟡
	Layout unchanged from existing.		
Operational Efficiency and Reliability	🟢	🟢	🟢
	Improved surface protection. Structural support only provided in thick layers. Thicker material with rougher exterior finish than other alternatives.	Improved surface protection. No structural support provided. Smooth, thin, acrylic-like finish.	Improved surface protection and structural support. Smooth, thin, acrylic-like finish.
Process Resiliency	🟡	🟡	🟡
	Unchanged from existing layout.		
Sustainability	🟢	🟢	🟢
	Higher initial materials cost. Less future repairs.		
Maintenance Requirements	🟢	🟢	🟢
	Less maintenance than existing.		
Safety	🟡	🟡	🟡
	Accessing RSPS structures for inspection is difficult.		
Constructability	🔴	🟢	🟡
	Installation most difficult and not recommend by suppliers. Feasibility is questionable and issues during installation could extend schedule. However, baseline schedule is similar between alternatives.	Installation most feasible. The material consistency is easier to handle in tight spaces than the other alternatives. However, the installation schedule is similar between alternatives.	Installation is feasible, but the application of the glass fiber mat is more difficult than applying epoxy alone. However, the installation schedule is similar between alternatives.
Maintenance of Plant Operations	🔴	🔴	🔴
	Bypass pumping required. More solids capture at fine screens.		
Impact on Other Unit Processes	🟡	🟡	🟡
	Same impact to downstream unit processes.		

Criteria	Alternative 1	Alternative 2	Alternative 3
	Spray on Geopolymer Liner	**Epoxy Coating**	**Carbon Fiber Wrap**
Public Impact			
	No expected public impacts.		
Adaptability to Meet Future Requirements			
	Geometry of conduits prevent higher future flows.	Geometry of conduits prevent higher future flows.	Geometry of conduits prevent higher future flows.
Summary			

Conduits Alternative 1 has one more unfavorable “red traffic light” score than Conduits Alternatives 2 and 3 because installation is most difficult with no advantage in protection. Otherwise, all conduits alternatives have a similar unfavorable “red traffic light” score for the high-capacity bypass required during construction. Conduits Alternative 2 has the highest mostly favorable “green traffic light” scores for being the most constructable alternative. Conduits Alternative 3 has the most moderately favorable “yellow traffic light” scores because constructability is between Conduits Alternatives 1 and 2. All other moderately favorable scores are shared between all alternatives when the criterion is unchanged from existing. Overall, Conduits Alternative 2 has the highest number of favorable (“green”) scores and the highest overall score in this analysis. Conduits Alternative 3 is a close second because it provides the most robust chemical and structural protection, but installation is more difficult. Conduits Alternative 1 is the least favorable conduits alternative and is the least constructable.

7.6 Raw Sewage Conduits Alternative Cost Analysis

Each conduits alternative was provided a probable construction cost and life-cycle cost to be considered for selection of the recommended alternative. Section 4.2 outlines the assumptions made based on normal engineering practice. Table 7-8 summarizes the construction cost estimate and life cycle cost of each conduits alternative. Detailed OPCC estimates are included in Appendix H and detailed lifecycle cost calculations are included in Appendix I.

Table 7-8 Opinion of Probable Construction Cost and Life-Cycle Costs for the Raw Sewage Conduits Alternatives

	Alternative 1	Alternative 2	Alternative 3
Construction Cost (-20% to +30% accuracy)	$1,156,000	$1,101,000	$1,493,000
Soft Costs (40%) [1]	$462,000	$440,000	$597,000
2021 Project Cost (without contingency)	**$1,618,000**	**$1,541,000**	**$2,090,000**
20-Yr O&M NPV	$288,000	$288,000	$288,000
Total	**$1,906,000**	**$1,829,000**	**$2,378,000**

Note:
1. Soft costs include project management, engineering, construction management, and project administration costs.

The Life Cycle Costs of the alternatives are presented in Figure 7-4 for comparison.

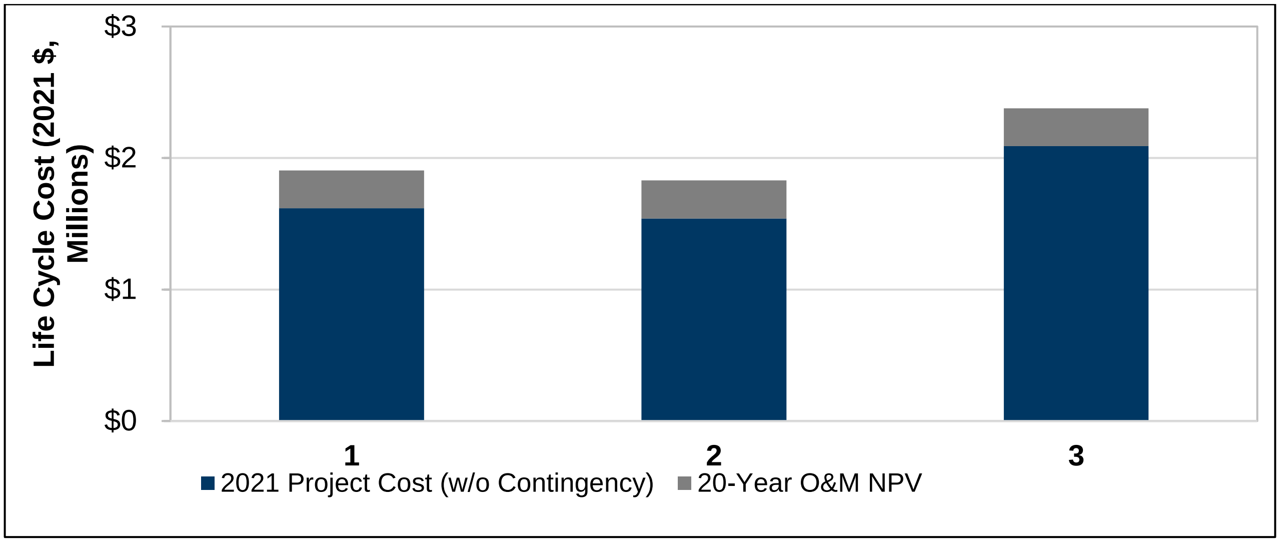


Figure 7-4 Raw Sewage Conduits Life Cycle Cost Comparison

7.7 Recommended Raw Sewage Conduits Alternative

The recommended approach was developed following a holistic consideration of both the cost and non-cost evaluation criteria.

As can be seen with the capital and lifecycle cost comparison shown in Figure 7-4, both the capital and lifecycle costs of Conduits Alternatives 1 and 2 are very similar. This is because both alternatives have similar material costs and onsite construction duration. Conduits Alternative 3 has higher costs because of the superior structural materials.

As previously noted, Conduits Alternatives 2 and 3 scored the highest in the “Traffic Light” Decision Model. However, the capital and lifecycle costs of these two alternatives are quite different. Conduits Alternative 3 is approximately 35% higher in construction costs (without contingency) than Conduits Alternative 2. Therefore, Conduits Alternative 2 is the recommended approach based on a holistic consideration of both the cost and non-cost evaluation criteria. Conduits Alternative 2 is considered to provide the best combination of performance, operations, and maintenance benefits to AlexRenew.

Conduits Alternative 2 includes:

- Bypass pumping, draining, cleaning, and preparing the interior concrete surfaces of the RSPS for rehabilitation.
- Inspecting RSPS structures for concrete mass loss and spalling.
- Filling areas exhibiting concrete mass loss and spalling in accordance with the tiered repair techniques described herein.
- Coating the entirety of the concrete surfaces with a preliminary epoxy/mortar coating.
- Coating the interior surface of the wet wells, suction conduits, and concrete portion of the discharge conduits with epoxy.

It is recommended that the Conduits system improvements be made concurrent or after, improvements to the RSPS system improvement. The RSPS system improvements will also require bypass pumping and may be installed concurrently with the conduits improvements to limit bypass operation costs. The recommended approach is for the new raw sewage pumps to be installed before the conduit system improvements to the suction conduits. This would prevent damage to the new conduit coating that would occur if the floor modifications required for the new raw sewage pumps were made after the conduit improvements. Prior to the finalization of the design scope and criteria, onsite inspection is recommended to field verify conditions of the RSPS structures. The recommended approach is to install the new raw sewage pumps on one side of the RSPS before conduit system improvements are made on the other side. This will allow the RSPS to operate at a higher capacity than existing system and bypass pumping requirements could be reduced.

Conduits Alternative 2 provides the following benefits to AlexRenew that align with the Strategic Outcomes of AlexRenew's 2040 Vision Statement:

- Operational Excellence
  - Provides long-term protection and extended life to existing infrastructure.
- Adaptive Culture
  - Decreases maintenance and mitigates future deterioration risk, which may require emergency repairs. Reduces the need to access RSPS structures, which aligns with AlexRenew safety culture.
- Watershed Stewardship
  - Coating does not negatively affect the process stream.
- Public Trust
  - Does not have any negative impacts on the surrounding community.
- Financial Resilience
  - The selected alternative has less capital and lifecycle costs compared to the other evaluated alternative that provides similar installation feasibility and protectiveness against corrosion.

8. Fine Screening Evaluation

The following fine screening alternatives were developed for the upgrade of the fine screening system:

- Fine Screening Alternative 1: Rehabilitate existing fine screens and washer/compactors
- Fine Screening Alternative 2: Replace existing fine screens (with perforated plate screens); replace washer/compactors
- Fine Screening Alternative 3: Replace existing fine screens with perforated plate screens; replace four existing washer/compactors with two larger washer/compactors, add two new sluices
- Fine Screening Alternative 4: Replace existing fine screens with center flow band screens; replace washer/compactors, add two new short conveyors
- Fine Screening Alternative 5: Replace existing fine screens with center flow band screens; replace four existing washer/compactors with two larger washer/compactors, add two new sluices

All fine screening alternatives will include the following:

- Upgrade of fine screening instrumentation and controls (I&C) with a package provided by the screen manufacturer. The I&C package would include upstream and downstream ultrasonic level sensors for each screen and a differential level-based control system for the new mechanical fine screens.
- Removal and replacement of the coating on the screen channels, and reconnection of the new fine screening equipment with the existing odor control system.
- Evaluation of the existing 4" W3 line during final design to determine if the pipe diameter is sufficient to meet the proposed plant water demands.

8.1 Basis of Design

The Level of Service Goals presented in Table 8-1 were selected as the Basis of Design Criteria for the fine screens upgrade.

Table 8-1 Level of Service Goals for Fine Screening Basis of Design Criteria

Parameters	Basis of Design
Minimum flow	20 MGD
Design average daily flow	54 MGD
Design peak hourly flow	120 MGD
Fine screen capacity, per screen	40 MGD
Screen unit redundancy	Pass peak hour flow with one unit out of service
Washer/Compactor and screw conveyor redundancy	Be able to operate at least two screens with a washer/compactor and/or a screw conveyor out of service
Screen opening size	1/4 inch or 6 mm
Screen element type	Continuous belt with perforated plate screen elements
Average anticipated screenings [1]	9.7 CF / mg
Average anticipated screenings	21.83 CF / hr
Peak hour anticipated screenings [2]	48.5 CF / mg
Peak hour anticipated screenings	109.13 CF / hr
Screw conveyor type (where applicable)	Shaftless screw conveyors
Screening quality	Provide washing and compaction for all screenings
Control automation	Differential level control / high level backup control
Materials of construction	Type 316 SS or equally corrosion resistant material
Odor control	Cover all equipment and channels; connect to existing odor control system
Maintenance Improvement	Ease of maintenance access to critical components

Notes:
1. Average fine screening removed per HOSS field testing for fine screens with 1/4 inch (6 mm) perforated plate opening.
2. Assumed a peaking factor of 5.0.

A summary of the design information of several similar size fine screening facilities in successful operation are presented in Table 8-2. Several fine screen suppliers/manufacturers were also contacted for their input. After careful consideration, the new fine screens are recommended to have a perforated plate opening size of ¼ inch or 6 mm.

Table 8-2 Fine Screens Installations at Large WWTPs

Facility	Location	Screen Supplier	Screen/Grid Type	Peak Flow	Screen Opening
York WWTP	York, PA	HydroDyne	Center Flow / SS Laced Links	33 MGD each	1/8 inch / 3 mm
Canton WRF	Canton, OH	HydroDyne	Center Flow / UHMWPE Perforated Panel	44 MGD each	1/6 inch / 4 mm
Neuse River WWTP	Raleigh, NC	Ovivo	Center Flow / Band Screen	56 MGD each	1/5 inch / 5 mm
Eastern WRF	Orlando, FL	Ovivo	Center Flow / Band Screen	35.6 MGD each	1/5 inch / 5 mm
Nine Springs WWTP	Madison, WI	Ovivo	Center Flow / Band Screen	60 MGD each	1/5 inch / 5 mm
Tomahawk Creek WWTP	Johnson County, KS	Huber	EscaMax	28 MGD each	¼ inch / 6 mm

Facility	Location	Screen Supplier	Screen/Grid Type	Peak Flow	Screen Opening
Bucklin Point WWTP	Providence, RI	HydroDyne	Center Flow / UHMWPE Perforated Panel	48 MGD each	¼ inch / 6 mm
North & South Durham WRF	Durham, NC	Ovivo	Center Flow / Band Screen	30 MGD each	¼ inch / 6 mm
Plum Island WWTP	Charleston, SC	Ovivo	Center Flow / Band Screen	36 MGD each	¼ inch / 6 mm
South District WWTP	Miami-Dade County	Huber	EscaMax	71 MGD each	¼ inch / 6 mm
Blue Plains AWWTP	Washington, DC	Andritz	SS Perforated Plate	296 MGD each	¼ inch / 6 mm

8.2 Fine Screening Alternative 1: Rehabilitate existing fine screens and washer/compactors

The existing fine screens are Parkson continuous self-cleaning moving media screens. The units have 304 stainless steel frames which appear to be in good condition. A discussion with Parkson indicated that they could upgrade the existing screens to improve screenings capture and removal by replacing the filter media and mechanical components while retaining the existing stainless steel frames.

8.2.1 Description

The following options were proposed by Parkson to renovate existing fine screens:

- Option 1: Rebuild existing fine screens with current new stainless steel slotted filter elements
- Option 2: Rebuild existing fine screens with new Ultraclean screen cleaning mechanism (note: this requires the existing screen frames to be extended about 2 ft. higher)
- Option 3: Rebuild existing fine screens with new stainless steel perforated plate filter elements

In each option, the entire screen mechanism except for the frame would be replaced. For all the options, the screen opening size would remain as 6 mm (¼”). However, each of the options would be anticipated to improve the screenings capture rate due to the following:

Under Option 1 the stainless steel slotted screen elements would be less susceptible to damage and breakage than the current plastic screen elements, resulting in less large holes in the screen for solids to pass through.

Under Option 2 the Ultraclean screen cleaning mechanisms would do a better job removing screenings and would result in less screenings carryover downstream.

Under Option 3 replacement of the slotted filter element with perforated plate elements would dramatically reduce the maximum size solids which could pass through the filter elements because the long rectangular ¼” wide openings of the current screen would be replaced by ¼” round holes as shown in Figure 8-1

Figure 8-1 Proposed Style of Stainless Steel Perforated Plate Filter Elements

For the purposes of this fine screening alternative, a combination of the second and third options was selected as this is expected to provide the greatest increase in performance from similar replacements at other wastewater utilities, such as DC Water.

To implement this fine screening alternative, the existing fine screens would need to be removed and cleaned by AlexRenew or its contractors and shipped to Parkson's factory to be rebuilt. The screen would then be returned to the site for reinstallation. The screens could also be re-built on site, but this would pose more disruption for AlexRenew operations with no significant cost saving and is therefore not recommended. Parkson has indicated a rebuild time at the factory of 4 to 5 weeks per unit, not accounting for shipping.

Note that DC Water has this same type of screen in their East and West Screening Facilities at the Blue Plain AWWTP and are currently renovating all 13 of their existing fine screens in the same manner. Two of the screen renovations have been completed to date with future renovations planned one unit at a time. Blue Plains AWWTP does not yet have operating data on the screening capture rate for the new screens. Figure 8-2 shows the existing and newly renovated screens side-by-side at DC Water.

Figure 8-2 Existing (Left) and Renovated (Right) Mechanical Screens at DC Water

As discussed in Section 2.4, the existing washer/compactors are significantly undersized and would be replaced with larger capacity washer/compactors to better handle fine screenings. Screenings conveyors would also be replaced in kind.

The anticipated washwater demand is 25 gpm for each screens spraywater system, and 24 gpm for each washer/compactor.

The anticipated connected motor size for this alternative is 4.0 Hp for each of the four screens, 5.0 Hp for each of the four washer/compactors, and 7.5 Hp for each of the two transfer conveyors.

8.2.2 Concept Arrangement

The concept arrangement for this fine screening alternative would be similar to the existing system with the exception that the washer/compactor discharge chutes would be above the new screening conveyors and the two conveyors would be moved closer together to provide more space for washer/compactors installation. Screens would be repositioned in the channels to provide better maintenance access to equipment. The resulting arrangement would look similar to the arrangement for Alternative 2 which is shown in Figures 3 and 4 (see Appendix D).

8.2.3 Operational Efficiency and Reliability

The change to a perforated plate screen with a more efficient cleaning mechanism is expected to increase the screenings capture rate and reduce screenings carryover. This would make the fine screening process more efficient and benefit downstream unit processes.

In addition, the mechanical reliability of the system would be improved by replacing the plastic screen elements, which are prone to damage, with stainless steel elements which are less likely to be damaged and require maintenance or replacement. Also, the replacement of the existing washer/compactors with higher capacity units should improve the reliability of these units and reduce the number of jams and failures under high screening loading conditions.

8.2.4 Process Resiliency

Like the existing system, this fine screening alternative would maintain a fully redundant fine screen in standby mode while allowing the peak design flow to be treated with just 3 of the 4 fine screens on line.

Each screen has its own screening compactor. If a screening compactor goes out of service, the corresponding screen must also be taken off-line. In emergency conditions, the cover of the screening compactor can be removed to allow uncompacted screenings to spill out onto the floor.

The four screen/compactor pairs discharge to two screenings conveyors. A loss of one of these screening conveyors would allow only the operation of two fine screens. This is adequate for most operating conditions except very high flows (over 80 MGD).

8.2.5 Sustainability

The renovated screens and new screening compactors would wash organics off the screenings and remove excess water. By washing, dewatering, and compacting the screenings, the volume of screenings required for disposal is minimized, so less truck trips are required to haul it resulting in less greenhouse gas emissions and disruptions in operator workflow.

Washwater demand would be higher than the existing system due to the enhanced screen cleaning system and larger washer/compactors, however, washwater use is intermittent and the power use for washwater is not significant.

An increase in motor horsepower for the larger washer/compactor is proposed. However, after reviewing the Building K power requirements, this would result in an insignificant change of power required for the Building K as the fine screening process equipment represents only a small fraction of the power required to operate the facility.

8.2.6 Maintenance Requirements

Routine preventative maintenance requirements are expected to be less for the renovated screen and new washer/compactors compared to the existing units. The main maintenance advantage of the proposed system is that the stainless steel filter elements should not be subject to damage like the existing plastic filter elements and therefore would not require as frequent of inspection of maintenance to replace broken components.

Emergency maintenance requirements are also expected to be less for the renovated screen and new washer/compactor compared to the existing units. This is primarily because the washer/compactor and screw conveyor are not anticipated to clog as frequently as the existing units because larger capacity units would be provided.

8.2.7 Safety

Safety would be improved compared to the existing system because the new washer/compactors are anticipated to be less susceptible to clogging than the existing units. When the existing units clog, the operators must dismantle the hopper feeding the washer/compactors and manually try to prevent the units from clogging and/or manually handle the screenings. Accidents can easily happen during this type of operation as the plant staff is subjected to injury from moving or jammed equipment.

8.2.8 Constructability

The existing fine screens would need to be taken off-line one at a time, shipped back to the factory service center for renovation, and then returned to site. During this time, the plant would not have an installed spare but would still be able to pass peak flows with all remaining units in operation. The units would need to be renovated one at a time, so the renovation process would take an extended time period to complete. If during construction one of the three remaining screens goes down, the empty screen channel can be used as an emergency bypass channel thereby eliminating the need for bypass pumping.

No modifications to the building or channels are anticipated.

No modifications to the odor control system or electrical are anticipated except for replacement in kind of connections to renovated/replaced equipment.

8.2.9 Maintenance of Plant Operation

As noted above, during the course of the renovation process, one screen would be taken out of service at a time, so the plant would need to be vigilant in maintaining the other three screens during this period to ensure system performance under peak flow conditions. During normal operations, only two screens are required so the plant would still have a spare unit for normal operating conditions.

When one of the screening conveyors is replaced, only two screens can be in service. Conveyor replacement would need to be done under dry weather flow conditions and a temporary means to move the screenings may be required while the conveyor is unavailable.

8.2.10 Impact on Other Unit Processes

New fine screens would be able to remove more solids from the wastewater stream due to its improved performance. This would provide improved protection for downstream equipment such as the grit removal system, activated sludge process and the solids handling system.

8.2.11 Public Impact

This fine screening alternative does not have any negative impacts on the surrounding community.

8.2.12 Adaptability to Future Requirements

Better screening capture efficiency would reduce screening material conveyed downstream which can clog equipment. If AlexRenew is required by regulation to improve treatment efficiency, having better fine screening would improve the performance and reliability of downstream treatment systems. Better screening also prevents screening material from getting into the biosolids, which improves the biosolids product quality and makes it more attractive to potential customers.

8.3 Fine Screening Alternative 2: Replace existing fine screens (with perforated plate screens); replace washer/compactors

This fine screening alternative is similar to Fine Screening Alternative 1, with the exception that the existing fine screening equipment would be replaced entirely with new continuous perforated plate filter screens instead of retrofitted. The main advantages of this approach are that it allows competitive pricing from multiple manufacturers, and it could be completed much faster because all four of the new units could ship to the site at the same time instead of being retrofitted back at the factory one unit at a time.

8.3.1 Description

As noted above, this fine screening alternative, once constructed, would provide essentially the same components and features as Fine Screening Alternative 1, with the exception that the existing screens would be replaced instead of renovated. GHD contacted Parkson, Huber, and Andritz for budgetary proposals to replace the existing screens with new continuous perforated plate filter screens.

The anticipated washwater demand is 25 gpm for each screens spraywater system, and 24 gpm for each washer/compactor.

The anticipated connected motor size for this alternative is 4.0 Hp for each of the four screens, 5.0 Hp for each of the two washer/compactors, and 7.5 Hp for each of the two transfer conveyors.

8.3.2 Concept Arrangement

The concept arrangement for this alternative is similar to the current system as shown in Figures 3 and 4 in Appendix D. All of the major equipment would be rehabilitated/replaced in a similar layout arrangement as exists today, including new shaftless screw conveyors. The screen location in the channels would be slightly different than the existing screen locations to create more maintenance access space around the screens and washer/compactors.

8.3.3 Operational Efficiency and Reliability

The improvement to screenings capture rate and system mechanical reliability would be similar to Fine Screening Alternative 1.

8.3.4 Process Resiliency

The process resiliency of this alternative would be similar to Fine Screening Alternative 1.

8.3.5 Sustainability

New screens and new screening compactors would wash organics off the screenings and remove excess water. By washing, dewatering, and compacting the screenings, the volume of screenings required for disposal is minimized, so less truck trips are required to haul it resulting in less greenhouse gas emissions and disruptions in operator workflow.

This fine screening alternative would consume more washwater than Fine Screening Alternative 1 but the additional power usage to pump the water is minimal. The fine screenings would be cleaner than Fine Screening Alternative 1.

8.3.6 Maintenance Requirements

Maintenance requirements for this alternative would be similar to Fine Screening Alternative 1.

8.3.7 Safety

Safety for this fine screening alternative would be similar to Fine Screening Alternative 1.

8.3.8 Constructability

One of the major differences between this fine screening alternative and Fine Screening Alternative 1 is constructability. All of the new screens and related equipment could be manufactured and shipped to the site at the same time. The general contractor would remove one fine screen train at a time and replace it with the new equipment. The duration of onsite construction is expected to be much shorter than Fine Screening Alternative 1, where the existing screens would need to be shipped back to the factory for rehabilitation one unit at a time. Although the overall construction duration may not be shorter (a lengthy period would be required for shop drawing approvals, screen manufacture, and shipping to site), once the units arrive on site this would allow the replacement of all four screens to proceed much faster than Fine Screening Alternative 1, reducing the time that the plant needs to operate with only three screens on-line and reducing the length of time of construction disruption in the fine screenings room.

New screens would be lifted by crane to the outdoor deck of the grit removal system, then brought into the Fine Screen Room through existing overhead doors and installed one unit at a time in the channels.

8.3.9 Maintenance of Plant Operation

Maintenance of plant operation considerations would be similar to Fine Screening Alternative 1, but the length of time that the plant needs to operate with only three fine screens in service would be greatly reduced due to the shorter onsite construction schedule associated with this alternative.

8.3.10 Impact on Other Unit Processes

The impact on other unit processes would be similar to Fine Screening Alternative 1.

8.3.11 Public Impact

This fine screening alternative does not have any negative impacts on the surrounding community.

8.3.12 Adaptability to Future Requirements

Adaptability for future requirements would be similar to Fine Screening Alternative 1.

8.4 Fine Screening Alternative 3: Replace existing fine screens with perforated plate screens; replace four existing washer/compactors with two larger washer/compactors, add two new sluices

This fine screening alternative is similar to Fine Screening Alternative 2, with the exception the screens would all be oriented along the same alignment so that they could discharge to a common sluice.

8.4.1 Description

As noted above, in this fine screening alternative, the screens would discharge to a common sluice. A “sluice” is a U-shaped stainless steel trough where plant process water provides the motive force to “flush” screening materials down the sloped trough. The trough from each set of screens discharges to a washer/compactor which in turn discharges to a shaftless screw conveyor. The sluice troughs would be interconnected so that any of the screens could convey screenings through the sluice to either washer/compactor.

Washwater from the trough is discharged back into the screen effluent channels after being separated by the washer/compactors. See Figure 8-3 for a typical screening sluice installation.

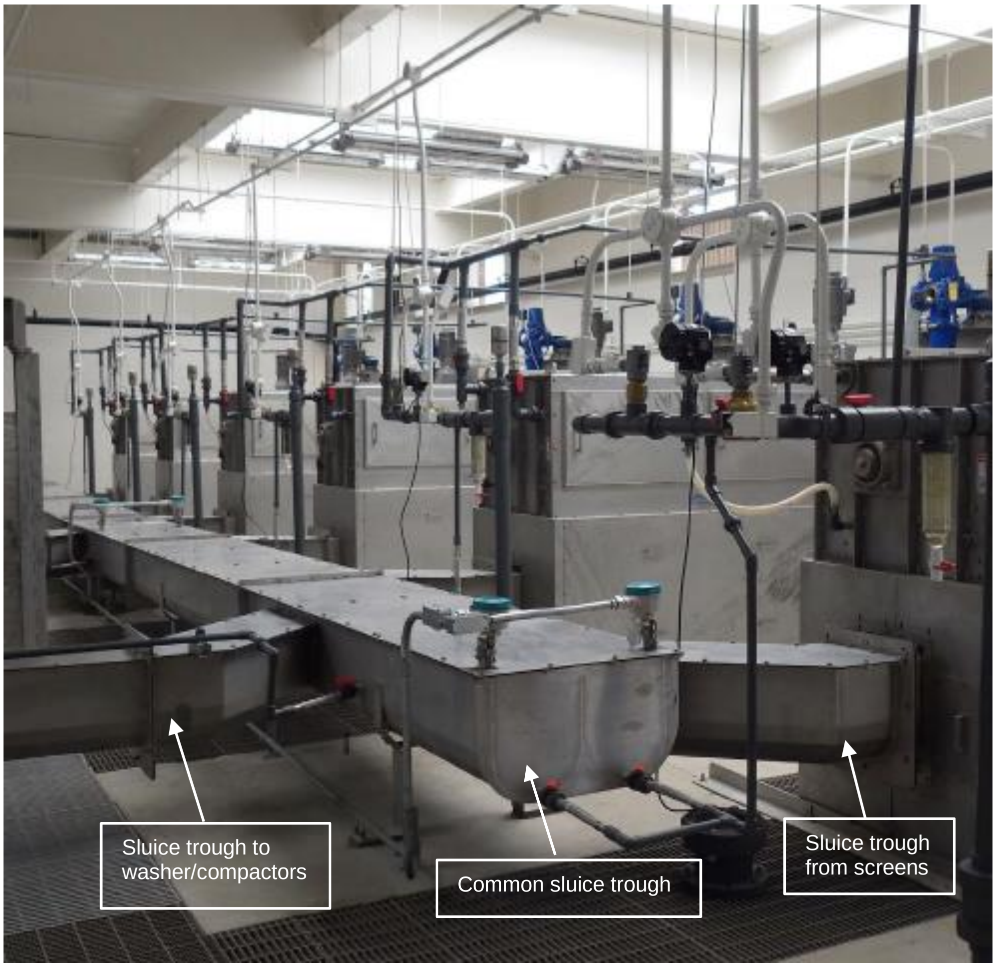


Figure 8-3 Typical Screening Sluice Installation (Courtesy of HydroDyne)

The anticipated washwater demand is approximately 25 gpm for screening spray washwater of each screen, 190 gpm per sluice, and 24 gpm per washer/compactor. The instantaneous peak washwater use would be higher than the existing system, which requires less than half this peak flow. The additional washwater would be provided by the existing plant water system via the plant water pumping system. Note that the washwater will not operate continuously as its operation is typically triggered based on either cumulative screen runtime or cumulative screen triggers. During minimum to average daily flows, washwater to the units and sluice is expected to trigger no more than four times per hour for a couple minutes each cycle. Washwater operation may trigger more often or run continuously during peak flows and high solids loadings.

The anticipated connected motor size for this alternative is 4.0 Hp for each of the four screens, 7.5 Hp for each of the two washer/compactors, and 5.0 Hp for each of the two transfer conveyors. The additional sluice water is estimated to require an equivalent 20 Hp of plant water pumping capacity when in operation and will run approximately 12 minutes per hour.

8.4.2 Concept Arrangement

The concept arrangement for this fine screening alternative is shown in Figures 5 and 6 included in Appendix D. Due to the spacing between the existing channels, there is limited space available around the washer/compactors for maintenance.

8.4.3 Operational Efficiency and Reliability

The improvement to screening capture and system mechanical reliability would be similar to Fine Screening Alternative 1.

8.4.4 Process Resiliency

Like the previous two fine screening alternatives, this fine screening alternative would maintain a fully redundant fine screen in standby mode while allowing the peak design flow to be treated with just three of the four fine screens on line.

Unlike the previous two fine screening alternatives, in this fine screening alternative the washer/compactors are not directly connected to individual screens. Any screen can discharge to either of the two washer/compactors. Therefore, the loss of a washer/compactor does not require the screen coupled with it to be taken off-line which adds operational flexibility and process resiliency. On the other hand, if one of the two washer/compactors goes down, only two screens can be operated until the washer/compactor operation is restored. This is adequate for average flow conditions but not peak flows.

8.4.5 Sustainability

Like the previous fine screening alternative, new screens and new screening compactors would wash organics off the screenings and remove excess water. By washing, dewatering, and compacting the screenings, the volume of screenings required for disposal is minimized, so less truck trips are required to haul it resulting in less greenhouse gas emissions and disruptions in operator workflow.

Electrical power use for this fine screening alternative is also similar to the previous alternatives.

Washwater use for this fine screening alternative is higher than for the previous alternatives due to the relatively high washwater requirements for sluicing the solids. Recycled plant process water is used for this purpose and returned to the wastewater flow, so there is no consumption of potable water. However, pumping of recycled plant process water requires energy use, which is equivalent to approximately 20 Hp when the sluice is operating. Because washwater use is not continuous, the energy use is expected to be relatively small compared to the overall power required to operate Building K.

8.4.6 Maintenance Requirements

Maintenance requirements for this fine screening alternative would be similar to Fine Screening Alternatives 1 and 2. The sluice included with this fine screening alternative is expected to require very little maintenance. This option has only two washer/compactors to maintain compared to four washer/compactors in the previous alternatives. However, as noted above, maintenance access to the washer/compactors is more restricted with this option than Fine Screening Alternatives 1 and 2.

8.4.7 Safety

Safety for this fine screening alternative would be similar to Fine Screening Alternatives 1 and 2.

8.4.8 Constructability

This fine screening alternative offers some of the same constructability benefits as Fine Screening Alternative 2. However, since the new washer compactor and screw conveyor must be installed before the first new screen comes on line, there would be a period of time where only two existing screens can be operated normally. During this time period, a third screen can remain in service as a spare unit to handle high flows, but screenings from it would need to be manually removed by the general contractor as it cannot be connected to the new washer/ compactor until it is installed and the new sluice is in place. The same situation will occur when it is time to remove the second existing conveyor to install the second new washer compactor and screw conveyor set.

8.4.9 Maintenance of Plant Operation

Maintenance of plant operation would require manual removal of screenings from one fine screen during high flow conditions by the general contractor at two points of time during the construction sequence. Otherwise, maintenance of plant operation is similar to Fine Screening Alternative 2.

8.4.10 Impact on Other Unit Processes

The impact on other unit processes would be similar to Fine Screening Alternatives 1 and 2.

8.4.11 Public Impact

This fine screening alternative does not have any negative impacts on the surrounding community.

8.4.12 Adaptability to Future Requirements

Adaptability to future requirements would be similar to Fine Screening Alternatives 1 and 2.

8.5 Fine Screening Alternative 4: Replace existing fine screens with center flow band screens; replace washer/compactors, add two short conveyors

This fine screening alternative is similar to Fine Screening Alternative 2, with the exception that the existing fine screening equipment would be replaced entirely with new center flow band screens. In addition, two short conveyors are provided in such a way to reduce the washer/compactor discharge chute length and minimize clogging. The center flow band screens have a traveling screen belt that is parallel to the influent channels as shown in Figure 8-4. Wastewater enters from the front of the screens and discharges through the two sides. This type of screen has the highest screenings capture rate as it prevents screenings carryover because the mat of collected screenings never passes over the downstream side of the screen.

Figure 8-4 Center Flow Band Screens Ready for Shipment (Courtesy of HydroDyne)

8.5.1 Description

As described above, this fine screening alternative would provide similar components and features as Fine Screening Alternative 2. GHD contacted HydroDyne and Ovivo for budgetary proposals to replace the existing screens with new center flow band screens.

Anticipated washwater use with this fine screening alternative is 106 gpm for each of the screens/washer/compactors.

The anticipated connected motor size for this alternative is 2 Hp for each of the four screens, 5.0 Hp for each of the four washer/compactors, and 5.0 Hp for each of the four screenings conveyors.

8.5.2 Concept Arrangement

The concept arrangement for this fine screening alternative is shown in Figures 7 and 8 included in Appendix D. The spacing around the screens and washer/compactors for maintenance is similar to Fine Screening Alternative 2.

8.5.3 Operational Efficiency and Reliability

Center flow band screens offer the highest screening capture rate and therefore should have the most benefits for preventing screening materials from reaching downstream equipment and unit processes.

The improvement to system mechanical reliability would be similar to the previous alternatives.

8.5.4 Process Resiliency

The process resiliency of this fine screening alternative would be similar to Fine Screening Alternative 2.

8.5.5 Sustainability

Like the previous fine screening alternatives, new screens and new screening compactors would wash organics off the screenings and remove excess water. By washing, dewatering, and compacting the screenings, the volume of screenings required for disposal is minimized, so less truck trips are required to haul it resulting in less greenhouse gas emissions and disruptions in operator workflow.

The sustainability of this fine screening alternative would be an improvement to Fine Screening Alternative 2 due to the elimination of the short sluices. The anticipated wash water demand will be less however additional power is required for the two short conveyors.

8.5.6 Maintenance Requirements

Maintenance requirements for this fine screening alternative would be similar to Fine Screening Alternatives 1 and 2. The layout provides good access to equipment.

8.5.7 Safety

Safety for this fine screening alternative would be similar to the previous fine screening alternatives.

8.5.8 Constructability

Constructability of this fine screening alternative would be similar to Fine Screening Alternative 2.

8.5.9 Maintenance of Plant Operation

Maintenance of plant operation would be similar to Fine Screening Alternative 2.

8.5.10 Impact on Other Unit Processes

The impact on other unit processes would be similar to the previous fine screening alternatives.

8.5.11 Public Impact

This fine screening alternative does not have any negative impacts on the surrounding community.

8.5.12 Adaptability to Future Requirements

As this fine screening alternative provides the highest degree of screenings capture, it would be the most adaptable alternative if treatment or biosolids distribution requirements become more stringent in the future.

8.6 Fine Screening Alternative 5: Replace existing fine screens with center flow band screens; replace four existing washer/compactors with two larger washer/compactors, add two new sluices

This fine screening alternative is similar to Fine Screening Alternative 3, with the exception the screens would be center flow band screens.

8.6.1 Description

This fine screening alternative is similar to Fine Screening Alternative 3 with a common sluice. The four fine screens will discharge screenings via the sluice to two new larger washer/compactors, each with capacity to accommodate peak screenings from two fine screens. One washer/compactor will discharge onto each of two reversible transfer conveyors (M12-3201 and 3202) eliminating the need for screenings conveyors 1 and 2 (M12-3101 and 3102) in the fine screen room.

The anticipated washwater demand (approximately 25 gpm for screening spray washwater of each screen, 190 gpm per sluice, and 24 gpm per washer/compactor) would be similar to Alternative 3.

The anticipated connected motor size for this fine screening alternative is 2 Hp for each of the four screens and 10.0 Hp for each of the two washer/compactors. The additional sluice water is estimated to require an equivalent 20 Hp plant water pumping capacity when in operation and it will run approximately 12 minutes per hour.

8.6.2 Concept Arrangement

The concept arrangement for this fine screening alternative is shown in Figures 9 and 10 included in Appendix D. Compared with Fine Screening Alternative 3, more space can be provided around the washer/compactors for maintenance, and the need for both screw conveyors to convey screenings in between the washer/compactors and the reversable transfer conveyors is eliminated

A similar washer compactor arrangement at the Back River WWTP is shown as an example in Figure 8-5.

Figure 8-5 Side by Side Washer Compactors Fed From a Central Sluice At The Back River WWTP

8.6.3 Operational Efficiency and Reliability

The improvement to screenings capture rate and system mechanical reliability would be similar to Fine Screening Alternative 4, which also uses center flow band screens.

8.6.4 Process Resiliency

The process resiliency of this fine screening alternative would be similar to other fine screening alternatives.

8.6.5 Sustainability

Like the previous fine screening alternatives, new screens and new screening compactors would wash organics off the screenings and remove excess water. By washing, dewatering, and compacting the screenings, the volume of screenings required for disposal is minimized, so less truck trips are required to haul it resulting in less greenhouse gas emissions and disruptions in operator workflow.

The sustainability of this fine screening alternative would be similar to Fine Screening Alternatives 3 and 4, both of which require sluice water.

While the sluice requires more washwater use than the current system does, the sluice itself is expected to be very low maintenance and less susceptible to clogging than the existing washer/compactors. Washwater from the sluice is recycled treated plant effluent, so there is no environmental impact of its use other than the power required to pump it. While this is a drawback, it is noted that the power requirement for the sluice water is intermittent and only a small fraction of the overall power demand of Building K, much less the whole plant operations. Grit pumping and HVAC systems are actually the largest energy uses in Building K, and these would not change with the upgrade of the fine screening equipment to improve performance and reduce equipment failures and maintenance.

8.6.6 Maintenance Requirements

Maintenance requirements for this fine screening alternative would be the lowest of all of the fine screening alternatives, as this has the lowest number of rotating equipment items. The sluice itself should require very little maintenance.

8.6.7 Safety

Safety for this fine screening alternative would be similar to Fine Screening Alternative 3.

8.6.8 Constructability

Constructability would be similar to Fine Screening Alternative 3. Like Fine Screening Alternative 3, it will be necessary to remove one of the existing screw conveyors to install one of the new washer compactors, and during this time only two screens will be able to operate normally. During this time period, a third screen can remain in service as a spare unit to handle high flows, but screenings from it would need to be manually removed by the general contractor as it cannot be connected to the new washer/ compactor until it is installed, and the new sluice is in place. The same situation will occur when it is time to remove the second existing conveyor to install the second new washer compactor.

8.6.9 Maintenance of Plant Operation

Maintenance of plant operation would be similar to Fine Screening Alternative 3, including the need for manual removal of screenings from one fine screen during high flow conditions by the general contractor at two points of time during the construction sequence.

8.6.10 Impact on Other Unit Processes

The impact on other unit processes would be similar to the other fine screening alternatives.

8.6.11 Public Impact

This fine screening alternative does not have any negative impacts on the surrounding community.

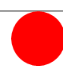
8.6.12 Adaptability to Future Requirements

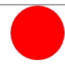
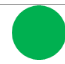
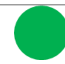
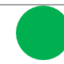
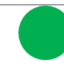
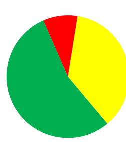
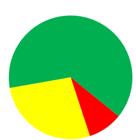
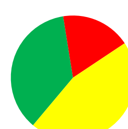
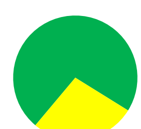
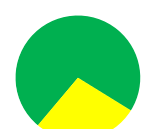
Adaptability to future requirements would be similar to Fine Screening Alternative 4.

8.7 Evaluation of Fine Screening Alternatives

As discussed in Section 4.1, GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost evaluation factors of the five fine screening alternatives as shown in Table 8-3.

Table 8-3 Summary of Fine Screening Upgrade Alternatives

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	Rehabilitate Existing System	**New Perf. Plate Screens**	**New Perf. Plate Screens with Sluice**	**New Center Flow Band Screens**	**New Center Flow Band Screens with Sluice**
Layout					
	Good layout, but long chutes on outside washer/ compactors and longest conveyors.	Good layout, but long chutes on outside washer/ compactors and longest conveyors.	Limited access around washer/ compactors and middle screens.	Good layout, but requires more compactors and conveyors than Alternative 5.	Most efficient layout.
Operational Efficiency and Reliability					
	Improved screenings capture.	Improved screenings capture.	Improved screenings capture.	Best screenings capture.	Best screenings capture.
Process Resiliency					
	Standby screen and washer compactor for all scenarios.	Standby screen and washer compactor for all scenarios.	Standby screen, but need to run both washer/ compactors at peak flow.	Standby screen and washer compactor for all scenarios.	Standby screen, but need to run both washer/ compactors at peak flow.
Sustainability					
	Low additional energy cost.	Low additional energy cost.	Higher additional energy cost due to sluice water requirement.	Higher additional energy cost due to sluice water requirement.	Higher additional energy cost due to sluice water requirement.
Maintenance Requirements					
	Similar maintenance anticipated to current system.	Similar maintenance anticipated to current system.	Poor maintenance access around washer/ compactors.	Similar maintenance anticipated to current system.	Lowest maintenance requirements due to lowest number of rotating equipment items.

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	Rehabilitate Existing System	**New Perf. Plate Screens**	**New Perf. Plate Screens with Sluice**	**New Center Flow Band Screens**	**New Center Flow Band Screens with Sluice**
Safety					
	Safe access for expected O&M.	Safe access for expected O&M..	Safe access for expected O&M	Safe access for expected O&M.	Safe access for expected O&M.
Constructability					
	Longest onsite construction schedule.	Shorter onsite construction schedule.	Shorter onsite construction schedule.	Shorter onsite construction schedule.	Shorter onsite construction schedule.
Maintenance of Plant Operations					
	3 screens available at all times during construction, but manual screenings handling will be required from 3rd screen during peak flows while conveyor is replaced.	3 screens available at all times during construction but manual screenings handling will be required from 3rd screen during peak flows while conveyor is replaced.	3 screens available at all times during construction but manual screenings handling will be required from 3rd screen during peak flows while conveyor is replaced and new washer/ compactor installed.	3 screens available at all times during construction but manual screenings handling will be required from 3rd screen during peak flows while conveyor is replaced.	3 screens available at all times during construction but manual screenings handling will be required from 3rd screen during peak flows while conveyor is replaced and new washer/ compactor installed.
Impact on Other Unit Processes					
	Same impact to downstream unit processes.				
Public Impact					
	No expected public impacts.				
Adaptability to Meet Future Requirements					
	Improved screenings capture.	Improved screenings capture.	Improved screenings capture.	Best screenings capture.	Best screenings capture.
Summary					

Fine Screening Alternatives 1, 2, and 3 have one or more unfavorable “red traffic light” ratings – a long onsite construction schedule for Fine Screening Alternative 1, long washer/compactor chutes and conveyors for Fine Screening Alternative 2, and limited operations and maintenance access to the washer/compactors in Fine Screening Alternative 3. The other two fine screening alternatives have mostly favorable “green traffic light” scores with a few “yellow traffic light” scores indicating moderately favorable ratings. Fine Screening Alternatives 4 and 5 have the highest number of favorable (“green”) ratings and the highest overall score in this analysis.

8.8 Fine Screening Alternative Cost Analysis

Each fine screening alternative was provided a probable construction cost and life-cycle cost to be considered for selection of the recommended fine screening alternative. Section 4.2 outlines the assumptions made based on normal engineering practice. Table 8-4 summarizes the construction cost estimate and life cycle cost of each alternative. Detailed OPCC estimates are included in Appendix H and detailed lifecycle cost calculations are included in Appendix I.

Table 8-4 Opinion of Probable Construction Cost and Life-Cycle Costs for the Fine Screening Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Construction Cost (-20% to +30% accuracy)	$4,655,000	$4,436,000	$4,202,000	$4,439,000	$4,174,000
Soft Costs (40%) [1]	$1,862,000	$1,774,000	$1,681,000	$1,776,000	$1,670,000
2021 Project Cost (without contingency)	**$6,517,000**	**$6,210,000**	**$5,883,000**	**$6,215,000**	**$5,844,000**
20-Yr O&M NPV	$2,786,000	$2,817,000	$2,803,000	$2,796,000	$2,786,000
Total	**$9,303,000**	**$9,027,000**	**$8,686,000**	**$9,011,000**	**$8,630,000**

Note:
1. Soft costs include project management, engineering, construction management, and project administration costs.

The Life Cycle Costs of the fine screening alternatives are presented in Figure 8-6 for comparison.

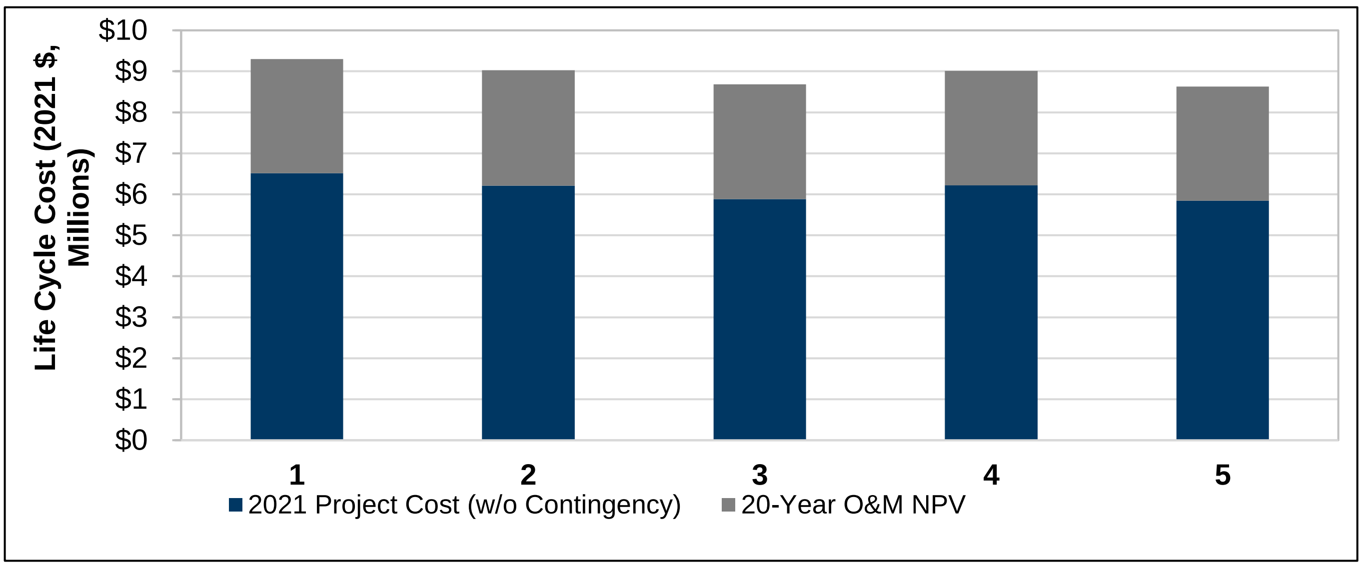


Figure 8-6 Fine Screening Life Cycle Cost Comparison

8.9 Recommended Fine Screening Alternative

The recommended approach was developed following a holistic consideration of both the cost and non-cost evaluation criteria.

As can be seen with the capital and lifecycle cost comparison shown in Figure 8-6, both the capital and lifecycle costs of all of the fine screening alternatives are very similar. This is because all of the alternatives have similar equipment in a similar arrangement in order to fit within the footprint and orientation of the existing fine screening channels and screening and grit loading system.

As previously noted, Fine Screening Alternatives 4 and 5 scored the highest in the “Traffic Light” Decision Model. The capital and lifecycle costs of these two alternatives are essentially equivalent. Fine Screening Alternative 4 is the recommended approach based on a holistic consideration of both the cost and non-cost evaluation criteria. Fine

Screening Alternative 4 is believed the provide the best combination of performance, operations, and maintenance benefits to AlexRenew.

Fine Screening Alternative 4 includes:

– Replacement of the four existing ¼” fine screens with four new ¼” center flow band screens.
– Replacement of the four existing washer/compactors with four new washer/compactors, each with capacity to accommodate peak screenings from one fine screen. The two inner washer/compactor units will discharge onto each of the two fine screenings transfer conveyors 1 and 2 (M12-3101 and 3102) in the fine screen room.
– Replacement of two existing fine screens transfer conveyors.
– Installation of two short fine screenings transfer conveyors to transfer screenings from the two outer screens associated washer/compactor unit to the central fine screenings transfer conveyors for loading and disposal.
– Reconnect new screening equipment to the existing odor control system.
– Upgrade of the fine screening instrumentation and controls (I&C) with a package provided by the screen manufacturer.
– Removal and replacement of the concrete coating on the screen channels.
– Replacement of aluminum gratings where required due to modification of the screen arrangement in the channels.
– Evaluation of existing 4” W3 line during final design to determine if the pipe diameter is sufficient to meet the proposed plant water demands.
– It is recommended that the fine screening system improvements be made after, or concurrent with, improvements to the coarse screening system. The coarse screening improvements recommended in Section 5.9 will reduce the peak solids loading on the new fine screens and therefore reduce the likelihood of clogging.

Fine Screening Alternative 5 provides the following benefits to AlexRenew that align with the Strategic Outcomes of AlexRenew’s 2040 Vision Statement:

– Operational Excellence
  - Ensures robust environmental compliance by improving fine screening removal efficiency, reducing downstream equipment clogging, and improving handling capability for high solids loads.
– Adaptive Culture
  - Increases the operational efficiency and reliability of the fine screening process, reduces maintenance requirements, promotes smarter operations, does not require specialized staff or training, and aligns with AlexRenew safety culture.
– Watershed Stewardship
  - Continues to provide washed and compacted screenings and does not significantly increase energy use at the facility.
– Public Trust
  - Does not have any negative impacts on the surrounding community.
– Financial Resilience
  - The selected alternative has equivalent capital and lifecycle costs to the other evaluated alternatives and minimizes the use of constrained resources.

9. Grit Removal Evaluation

Upgrade of the existing grit removal system is recommended to address the identified issues with equipment age, maintenance challenges, and unsatisfactory performance. Therefore, the following grit removal alternatives were considered for upgrade of the existing grit removal system.

- Grit Removal Alternative 1: Four Enhanced Vortex Grit Separators with Four Standard Grit Pumps with Four Hydrocyclone/Grit Classifier Units
- Grit Removal Alternative 2: Four Enhanced Vortex Grit Separators with Six Standard Grit Pumps with Four Hydrocyclone/Grit Washer Units
- Grit Removal Alternative 3: Three Stacked Tray Grit Removal Units and Two Enhanced Vortex Grit Separators with Five Standard Grit Pumps with Four Hydrocyclone/Grit Washer Units
- Grit Removal Alternative 4: Six Stacked Tray Grit Removal Units with Six Severe-Duty Grit Pumps with Six Hydrocyclone/Grit Washer Units

All grit removal alternatives will include the following:

- New grit separator influent and effluent channel gates.
- Automatic grit pump flushing is proposed for all alternatives to improve the operation of the pump cycle and reduce clogging of the pump and discharge piping. Additionally, any clogging issues in the piping are more likely related to rags getting through the fine screens which the fine screening improvements should address.
- New grit piping, dewatering equipment piping, and reconnection to existing odor control system.

9.1 Basis of Design

The Level of Service Goals presented in Table 9-1 were selected as the Basis of Design Criteria for the grit removal system upgrade.

Table 9-1 Level of Service Goals for Grit Removal Basis of Design Criteria

Parameters	Basis of Design
Minimum flow	20 MGD
Design average daily flow	54 MGD
Design peak hourly flow	120 MGD
Grit separator unit redundancy	Pass peak hour flow with one unit out of service
Grit pump unit redundancy	One pump per grit separator with interconnections between units
Grit dewatering unit redundancy	One dewatering unit per grit separator
Peak flow removal efficiency	95% removal of all grit 106 micron (140 mesh) and larger
Grit yield [1]	5.0 CF / mg
Average anticipated grit	270 CF
Peak anticipated grit [2]	9,000 CF
Dewatering quality	50% total solids or greater
Materials of construction - equipment	Type 316 SS or equally corrosion resistant material
Materials of construction - piping	Plastic or equally corrosion resistant material
Odor control	Cover all equipment and channels; connect to existing odor control system
Maintenance Improvement	Ease of maintenance access to critical components

Notes:
1. Average grit quantities removed per WEF MOP 8 (6th Ed.) pages 11-50 and 11-51.
2. Assumed a peaking factor of 15.0.

9.2 Grit Removal Alternative 1: Four Enhanced Vortex Grit Separators with Four Standard Grit Pumps with Four Hydrocyclone/Grit Classifier Units

9.2.1 Description

This grit removal alternative was developed to provide improvement to the existing grit removal system at the lowest capital cost. The enhanced vortex grit separators would replace the existing units on the grit deck. The enhanced technology will improve influent velocities to provide improved grit removal. The grit pumps and dewatering units would be replaced in kind with new piping.

9.2.2 Concept Arrangement

The concept arrangement for this grit removal alternative would be similar to the existing system. The enhanced vortex grit separators would reuse the existing concrete columns, influent channels, effluent channels, and primary influent lines. The V-Force Baffle technology is an internal component to the vortex grit separator as shown in Figure 9-1.

The V-Force Baffle is claimed to improve flow control in and out of the vortex separator unit. The baffle acts as a "sluice weir" controlling the water level in the separator chamber and influent channel to maintain velocities of 3.5 ft/s at peak flow and 1.6 ft/s at minimum flow. The vendor claims that the influent flow to the grit chamber is spun via axial-flow propeller forcing heavy grit particles to settle to the flat bottom chamber floor and while the lighter organic material remains in suspension. Grit is directed to the lower hopper where the grit is stored prior to removal. The resulting arrangement is shown in Figure 4 in Appendix E.

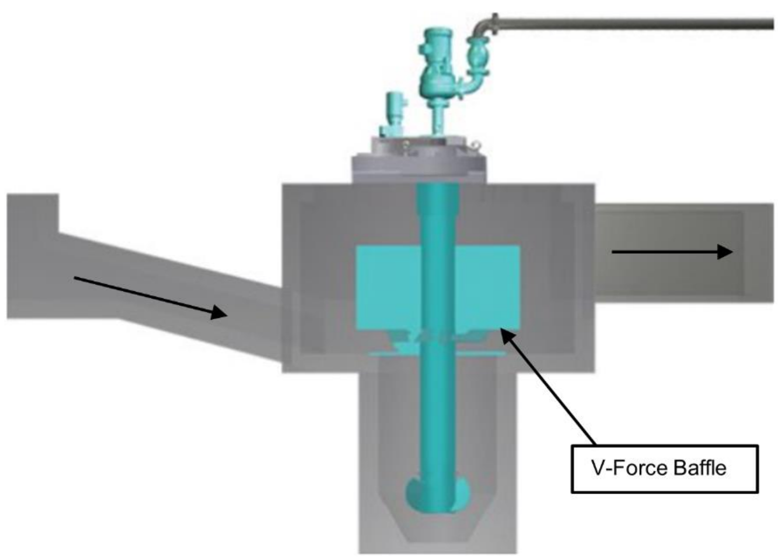


Figure 9-1 Proposed Enhanced Vortex Grit Separator (Source: Smith & Loveless, Inc.)

The standard grit pumps would be located in the basement in a similar configuration to the existing system. The pumps would have a six-inch suction line connecting to the bottom of the grit separator tank and overhead six-inch discharge piping. The resulting arrangement is shown in Figure 5 in Appendix E.

The grit dewatering equipment would also be similar to the existing configuration and would be located in the Cyclone Classifier Room. A new elevated platform with the new grit slurry lines would be installed in the same configuration as the existing system. The resulting arrangement is shown in Figure 11 in Appendix E.

9.2.3 Operational Efficiency and Reliability

GHD is aware of a study undertaken by the Hampton Roads Sanitation District (HRSD) of various options for baffling their vortex grit basins with the aim of improving performance (McNamara et al., 2012)[1]. HRSD ultimately concluded that the best baffling configuration would only result in marginal improvement in performance, and that the performance depends mostly on the surface overflow rate in the grit basin. GHD notes that best baffling configuration studied was similar to the proposed Smith & Loveless V-Force Baffle. The results of this study suggest that improving the performance of the existing separator units from the measured 81% to 95% at almost twice the influent flow per unit through the addition of baffling is unlikely.

GHD is also aware of a study undertaken by the San Francisco Public Utilities Commission (SFPUC) at their 250 MGD headworks facility to compare grit removal technologies, to meet their desired target removal rate of 95% removal of all grit 100 micron and greater (How and Desai, 2017)[2]. The pilot study included testing a PISTA vortex grit separator with the V-Force Baffle and the HeadCell stacked tray grit removal unit to compare the performance of the two technologies. Based on the pilot results from 58 days in which common data was collected and recorded for both units, the overall average grit pass through was 19% and 8% for the PISTA and HeadCell, respectively. The grit pass through observed by the PISTA unit was more than twice the amount observed by the HeadCell unit. Additionally, an independent third party performed grit testing on the pilot units and observed a grit pass through of 22% and 4% on the respective PISTA and HeadCell unit.

GHD is not aware of any studies which conclusively demonstrate performance results of a 360-degree PISTA unit with the added V-Force Baffle. Therefore, with the installation of new PISTA units, GHD would recommends a strong performance guarantee, backed by a performance bond and requirements for performance testing. Based on the Grit Tech sampling results, the HRSD study, and the SFPUC pilot study, GHD does not have information to support that installation of new units with the added V-Force Baffle system will provide improvement in grit removal performance over the existing units. Based on this, GHD will assume the new vortex grit separator units will perform similar to the existing units, 81% removal of all incoming grit 106 micron and greater, which aligns with the grit study performed on-site at AlexRenew.

Table 9-2 presents the grit lost by the separators and dewatering units as well as the total grit disposed at average flow conditions for each alternative. Grit carries over to the downstream unit processes and could potentially damage the equipment. Grit Removal Alternatives 1 and 2 provide similar results as they both utilize the vortex grit separators for grit removal whereas Grit Removal Alternatives 3 and 4 utilize the stacked tray grit removal units for grit removal which have better removal efficiencies. The grit classifiers and dewatering units provide the same removal efficiency however, the grit classifiers disposal product contains more water and organics resulting in a less efficient means of grit disposal because it consumes more capacity in the loading container.

Table 9-2 Total Grit Lost by Separators and Dewatering Equipment

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Grit Separator Capture of 106 Micron	81%	81%	95%	95%
Grit Dewatering Capture of 106 Micron	95%	95%	95%	95%
Dewatered Grit Total Solids [1]	57.5%	90%	90%	90%
Grit Dewatering Disposal Load (wet lb/day)	9,756	6,233	7,310	7,310
Grit Lost at the Separators (dry lb/day)	1,385	1,385	365	365

[1] Brian McNamara, Charles Bott, Mathew Hyre, David Kinnear, and Jeff Layne. 2012. “How to Baffle a Vortex.”, WEFTEC.
[2] Kathy How and Jignesh Desai. 2017. “WW-628 Southeast Plant New Headworks Facility Project – Grit Removal and Grit Washer Equipment Sole Source Recommendation.”, San Francisco Water Power Sewer.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Grit Lost at Dewatering (dry lb/day)	295	295	346	346
Total Grit Lost (dry lb/day)	1,680	1,680	711	711
Total Grit Lost (wet lb/day)	5,600	5,600	2,370	2,370
Total Grit Lost (wet lb/year)	**2,044,000**	**2,044,000**	**865,050**	**865,050**

Note:

1. Solids content and moisture content were provided by grit dewatering equipment manufacturer. An average solids content was assumed when given a range.

Grit Removal Alternatives 3 and 4 capture and remove an additional 3,230 pounds of grit from the waste stream per day to be disposed. The total grit lost by the system carries over to the downstream unit processes and must ultimately be removed.

New standard grit pumps and modified run times will improve the overall operation of the pumping system. GHD recommends continuously pumping from the grit hopper of the units in service and flushing the grit slurry lines once a separator and pump have been removed from service. Continuous pumping and flushing of the lines would prevent grit build up and clogging.

The existing hydrocyclones and grit classifiers are meeting the manufacturer’s claim of 95% removal of all grit greater than or equal to 106 micron as concluded by the grit study. However, the equipment has reached its end of useful life and replacement is recommended. Replacing the aged hydrocyclones and classifiers in-kind would result in effective grit removal similar to the existing system. Overall, the operational efficiency and reliability for this grit removal alternative is the least favorable compared to the other alternatives.

9.2.4 Process Resiliency

The process resiliency for this grit removal alternative would be similar to the existing system.

9.2.5 Sustainability

For this grit removal alternative, the motor size of the enhanced vortex grit separators and dewatering units would remain the same as the existing units. However, the standard grit pumps require a larger motor as they require slightly more energy use than the existing system. Compared to all the alternatives, this system requires the least amount of energy.

The wash water use is continuous for each unit in service and the power required for the wash water is anticipated to be greater than the existing system. Each grit separator requires 20 gpm of continuous water and 5 gpm for each hydrocyclone/classifier unit.

The grit classifier dewatering technology produces a less product with higher moisture content and higher organic content than the grit washer dewatering technology, therefore making this alternative the less sustainable than Grit Removal Alterative 3.

9.2.6 Maintenance Requirements

The maintenance requirements for this grit removal alternative would remain the same as the existing system.

9.2.7 Safety

The safety concerns for this grit removal alternative would remain the same as the existing system.

9.2.8 Constructability

The existing vortex grit separators components including the drive assembly, drive tube, propeller, hopper plates, and fluidizer can be removed from their concrete tanks outside at the grit deck using a crane. The general contractor would remove the existing components one at a time, starting with Grit Separator 2, the unit that is not in service due to mechanical issues. At the same time, the existing grit pumps can be removed from their equipment pads in basement and moved to the pipe gallery. The grit pumps would be hoisted from the basement using the crane located in Building 2. The general contractor would remove the existing units one at a time, starting with Grit Pump 2, the pump associated with the grit separator unit that is not in service due to mechanical issues. During the time of replacement, the plant would have to operate with only three grit separators and three grit pumps online, similar to how they currently operate the plant.

The enhanced vortex grit separator components would be installed the same way, outside at the grit deck using a crane. Confined space entry safety guidance should be followed when installing the new enhanced vortex grit separators. The new standard grit pumps would also be installed similar to how they were removed, a crane would lower the equipment from Building 2 into the basement pipe gallery. The units would then be installed on their concrete equipment pads and new grit piping would be installed.

The replacement of the existing dewatering equipment with new Wemclone and Hydrogritters would consist of installing temporary dewatering equipment to handle all dewatering needs. An additional contract operator would be on site for the duration of construction to maintain the temporary units and ensure adequate performance. Temporary grit slurry piping would be installed from the Truck Bay to the temporary grit dewatering equipment located outside Building K. The temporary dewatering equipment would discharge to temporary disposal containers outside for the duration of construction. During the time of construction, the general contractor would be responsible of the temporary dewatering equipment and disposal of screenings.

Once the temporary grit dewatering equipment is in place, the existing Wemclone and Hydrogritter units would be removed from service one unit at a time. The existing equipment platform and the south wall of the Cyclone Classifier Room would be demolished to remove the existing units and install the new units. The south wall will be replaced with translucent panels for future ease of equipment installation and removal.

9.2.9 Maintenance of Plant Operations

During construction, one grit separator and one grit pump would be taken out of service at a time. Similar to the present operating conditions and unit redundancy, only three grit separator units and three grit pumps would be available at the time of replacement and the plant would need to be vigilant in maintaining the units to ensure system performance under peak flow conditions. During average flow conditions, only two grit separators are required so the plant would still have a spare unit for normal operating conditions. At the conclusion of construction, the plant would have four operational units in service.

One grit dewatering unit would be taken out of service at a time to reconnect the grit slurry lines to temporary piping and dewatering equipment. The plant would need to be vigilant in maintaining the temporary units during the replacement period to ensure adequate performance under average and peak flow conditions. During construction, the dewatering performance would be less than ideal due to the reliance on temporary dewatering equipment.

9.2.10 Impact on Other Unit Processes

As noted in Section 9.2.3, it is unlikely that the enhanced grit separator units would capture any additional grit compared to the existing system. Therefore, the grit separators would provide limited protection for downstream equipment such as the primary settling tanks, activated sludge process, and the solids handling system. Compared to Grit Removal Alternatives 3 and 4, the finer grit particles sized 75-105 micron are not intended to be captured by the grit separators and dewatering units and ultimately carryover to the downstream unit processes.

The downstream dewatering units match the grit removal performance claimed by the grit separator manufacturers and are also expected to capture 95% of all incoming grit 106 micron and larger for disposal. This would provide limited protection for downstream equipment such as the primary settling tanks, activated sludge process, and the solids handling system. However, the moisture content and organic content of the disposal product does not provide any positive impacts compared to the disposal product from a grit washer.

The new standard grit pumps do not have any anticipated impacts on other unit processes. No additional negative impacts on other unit processes are anticipated.

9.2.11 Public Impact

The disposal product from the grit classifiers contains more organic content and is more odorous thus having a negative impact on the surrounding community compared to Grit Removal Alternatives 2, 3, and 4.

9.2.12 Adaptability to Future Requirements

The improved grit removal performance of this grit removal alternative would capture more grit and reduce material carryover to the downstream equipment such as the primary settling tanks. However, this grit removal alternative does not provide the future ability of grit washing should that be a requirement in the future to prevent organics in dewatered grit sent to landfills.

9.3 Grit Removal Alternative 2: Four Enhanced Vortex Grit Separators with Six Standard Grit Pumps with Four Hydrocyclone/Grit Washer Units

9.3.1 Description

This grit removal alternative was developed to provide redundant grit pumping coupled with more sustainable grit dewatering operations. The enhanced vortex grit separators would replace the existing units on the grit deck. The enhanced technology will improve influent velocities to provide improved grit removal. An additional grit pump is provided for each half of the grit removal system to allow for operational flexibility and increased redundancy. The grit washers meet the grit removal performance of the upstream grit removal units and produce a more sustainable disposal product.

9.3.2 Concept Arrangement

The concept arrangement for this grit removal alternative would be similar to the existing system. The enhanced vortex grit separators would reuse the existing concrete columns, influent channels, effluent channels, and primary influent lines. The V-Force Baffle technology is an internal component to the vortex grit separator as described in Section 9.2.2. The resulting arrangement is shown in Figure 4 in Appendix E.

The standard grit pumps would be in the basement of Building K, with an additional third standby unit on each half of the room. There would be three grit pumps in a line in front of Grit Separator 1 and 4 with a common suction line between each pair of separators (Grit Separators 1 and 2 and Grit Separators 3 and 4). The center grit pump in line would be the standby unit used to pump from either unit in the pair of separators. In the event that a grit pump is out of service, or it has undergone maintenance, the standby unit can be utilized to keep the grit separator in service. The discharge line associated with the redundant grit pump can also be sent to either grit washer for the associated pumps. The resulting arrangement is shown in Figure 15 in Appendix E.

The grit dewatering equipment would be in the Cyclone Classifier Room on the finished floor. Each unit would have a dedicated grit slurry line from the basement of Building K, through the Truck Bay to the Cyclone Classifier Room. A new equipment access platform would be installed for the new units. The resulting arrangement is shown in Figure 13 in Appendix E.

9.3.3 Operational Efficiency and Reliability

The operational efficiency and reliability of this alternative would be marginally better than grit removal Alternative 1. This alternative consists of an additional standby standard grit pump on each half of the room. Similar to Grit Removal Alternative 1, the new standard grit pumps and modified run times will improve the overall operation of the pumping system. GHD recommends continuously pumping from the grit hopper of the units in service and flushing the grit slurry lines once a separator and pump have been removed from service. Continuous pumping and flushing of the lines would prevent grit build up and clogging.

The hydrocyclones and grit washers which meet the grit removal performance of the upstream grit separators and produce a more sustainable and drier disposal product compared to classifier units.

9.3.4 Process Resiliency

The process resiliency for this grit removal alternative would be better than the existing system due to the additional redundant grit pumps.

9.3.5 Sustainability

For this grit removal alternative, the motor size of the grit separators would remain the same as the existing units, and the energy consumption would remain low. The grit pumps require a larger motor, requiring slightly more energy per unit than the existing system, in addition to the two redundant units.

The wash water demand for this grit removal alternative would be greater than Grit Removal Alternative 1. The wash water use is continuous for each unit in service and the power required for the wash water is anticipated to be greater than the existing system. Each grit separator removal unit requires 20 gpm of continuous water, and each hydrocyclone/grit washer unit requires 22 gpm of continuous water.

However, the grit washer dewatering technology produces a more sustainable product than the grit classifier dewatering technology, therefore making this grit removal alternative the most sustainable.

9.3.6 Maintenance Requirements

The maintenance requirements for the enhanced vortex grit separators and grit pumps would remain the same as the existing system. Unlike the classifier units, the grit washer requires routine maintenance for agitator drive unit.

9.3.7 Safety

This grit removal alternative does not anticipate any additional safety concerns compared to the existing system.

9.3.8 Constructability

The constructability of the enhanced vortex grit separators and grit pumps would be the same as Grit Removal Alternative 1.

The replacement of the existing dewatering equipment would consist of installing temporary dewatering equipment to handle all dewatering needs. The existing units would be removed from service one set at a time by closing the associated influent valve. Temporary grit slurry piping would be installed from the Truck Bay to the temporary grit dewatering equipment located outside Building K. The temporary dewatering equipment would discharge to temporary disposal containers outside for the duration of construction. During the time of construction, the general contractor would be responsible for the temporary dewatering equipment and disposal of screenings.

Once the temporary dewatering equipment has been installed, the existing equipment platform and the south wall of the Cyclone Classifier Room would be demolished and to remove the existing units and install the new units. The new south wall would have removable translucent panels for future ease of equipment installation and removal.

9.3.9 Maintenance of Plant Operations

The maintenance of plant operations for the enhanced vortex grit separators and grit pumps would be the same as Grit Removal Alternative 1. During construction of the grit washers in the Cyclone Classifier Room, one grit dewatering unit would be taken out of service at a time to reconnect the grit slurry lines to temporary piping and dewatering equipment. The plant would need to be vigilant in maintaining the temporary units during the replacement period to ensure adequate performance under average and peak flow conditions. During construction, the dewatering performance would be less than ideal due to the reliance on temporary dewatering equipment.

9.3.10 Impact on Other Unit Processes

The impact on other unit processes for this alternative would have a more positive impact compared to Grit Removal Alternative 1. As noted in Section 9.2.3, it is unlikely that the enhanced grit separator units would capture any additional grit compared to the existing system. Therefore, the grit separators would provide limited protection for downstream equipment such as the primary settling tanks, activated sludge process, and the solids handling system. Compared to Grit Removal Alternatives 3 and 4, the finer grit particles sized 75-105 micron are not intended to be captured by the grit separators and dewatering units and ultimately carryover to the downstream unit processes.

However, the grit washers will produce a drier product containing less organic material ultimately reducing the volume and odor of the disposal product, allowing for more efficient disposal and hauling operations.

The new grit pumps do not have any anticipated impact on other unit processes. This grit removal alternative does not have any apparent negative impacts on other unit processes.

9.3.11 Public Impact

The disposal product from the grit washers contains less organic content resulting in a less odorous material hauled from the facility compared to Grit Removal Alternative 1.

9.3.12 Adaptability to Future Requirements

The improved grit removal performance of this grit removal alternative would capture more grit and reduce material carryover to the downstream equipment such as the primary settling tanks. This grit removal alternative provides grit washing and can meet future regulations to prevent organics in dewatered grit sent to landfills.

9.4 Grit Removal Alternative 3: Three Stacked Tray Grit Removal Units and Two Enhanced Vortex Grit Separators with Five Standard Grit Pumps with Four Hydrocyclone/Grit Washer Units

9.4.1 Description

This grit removal alternative was developed to provide the best grit removal performance at average flow conditions utilizing the stacked tray grit removal units with two enhanced vortex grit separators utilized during high flow events. The two enhanced vortex units would be located on the west side of the grit deck and the stacked tray units would be located on the east side. Each grit separator unit would have a dedicated grit pump along with interconnections to allow for operational flexibility. The grit washers meet the grit removal performance of the upstream grit removal units and produce a more sustainable disposal product.

9.4.2 Concept Arrangement

The concept arrangement for this grit removal alternative would require the two enhanced vortex grit separators to reuse the existing concrete columns, influent channels, effluent channels, and primary influent lines on the west side of Building K. The V-Force Baffle technology is an internal component to the vortex grit separator as described in Section 9.2.2. The three stacked tray grit removal units would be located on the east side of Building K, sharing a new a common influent and effluent channel. The influent channel is two and a half to three feet wide located on the east end of the grit deck and the effluent channel would be relocated to the center of the grit deck and is also two and a half to three feet wide. The five units would feed to a common drop box to the basement. The resulting arrangement is shown in Figure 9 in Appendix E.

In the basement, the grit effluent dropbox would have two new 30-inch primary influent lines to send flow to the primary clarifiers located in the center of the grit pump room. The new 30-inch pipes would replace the existing lines that were located on the east side of the basement due to the installation of the stacked tray units. All four 30-inch primary influent line would have new 30-inch manual butterfly valves, flow meters, and 30 inch electrically actuated butterfly valves. The four 30-inch lines would re-connect to the existing 48-inch primary influent lines in the basement. The resulting arrangement is shown in Figure 10 in Appendix E.

The standard grit pumps would be in the basement of Building K, with a dedicated unit for each separator for a total of five pumps. The three grit pumps servicing the stacked tray units would be located on the east end of the grit pump room in a gallery. The two grit pumps servicing the enhanced vortex units would be located in a similar configuration to the existing system with a common grit slurry line to the downstream grit washer unit. All pumps would have a new equipment pad installed to provide adequate centerline suction elevation from the separator units as well as new six-inch suction and discharge piping. The plant effluent water piping would be modified to provide flushing water to the grit pumps and to the separator units.

The grit dewatering equipment would be in the Cyclone Classifier Room on the finished floor. There would be a dedicated unit for each of the upstream stacked tray units and the third unit would be dedicated to the two enhanced vortex grit separator units with the option to send the grit slurry to the other 3 units. The grit slurry lines would run along the basement of Building K, through the Truck Bay to the Cyclone Classifier Room to a manifold where the dewatering units would be fed. A new equipment access platform would be installed for the new units. The resulting arrangement is shown in Figure 16 in Appendix E.

9.4.3 Operational Efficiency and Reliability

The operational efficiency and reliability of this grit removal alternative would be better than Grit Removal Alternatives 1 and 2. This grit removal alternative consists of the best grit separation at average flows with the stacked tray units in service and the enhanced vortex separator units to be placed into service during high flow events. The stacked tray grit removal units provide the best grit removal performance, targeting ultra-fine grit particles and capturing an estimated additional 372,000 pounds of grit per year at design average flow conditions.

Similar to Grit Removal Alternative 1, the new standard grit pumps and modified run times will improve the overall operation of the pumping system. GHD recommends continuously pumping from the grit hopper of the units in service and flushing the grit slurry lines once a separator and pump have been removed from service. Continuous pumping and flushing of the lines would prevent grit build up and clogging.

The hydrocyclones and grit washers which meet the grit removal performance of the upstream grit separators and produce a more sustainable and drier disposal product compared to classifier units.

9.4.4 Process Resiliency

The process resiliency for this grit removal alternative would not meet the design criteria of one dewatering unit dedicated to an upstream grit separator, therefore the process resiliency is slightly worse than the existing system.

9.4.5 Sustainability

For this grit removal alternative, the motor size of the grit separators would remain the same as the existing system however there are fewer units, and the energy consumption would still remain low. The grit pumps require a larger motor, requiring slightly more energy per unit than the existing system, as well as accounting for the increased number of grit pumps required for this grit removal alternative.

The wash water demand for this alternative would be greater than Grit Removal Alternative 1. The wash water use is continuous for each unit in service and the power required for the wash water is anticipated to be greater than the existing system. Each grit separator removal unit requires 20 gpm of continuous water, and each hydrocyclone/grit washer unit requires 22 gpm of continuous water.

However, the grit washer dewatering technology produces a more sustainable product than the grit classifier dewatering technology, therefore making this grit removal alternative the most sustainable.

9.4.6 Maintenance Requirements

The maintenance requirements for the enhanced vortex grit separators and grit pumps would remain the same as the existing system. The maintenance requirements for this grit removal alternative would be slightly more than the existing system due to the increased amount of equipment. The required maintenance for the enhanced vortex grit separators and grit pumps would be similar to the existing system. It is important to note that the stacked tray grit removal units have no moving parts and require minimal maintenance. Similar to Grit Removal Alternative 2, the grit washers require routine maintenance for agitator drive unit.

9.4.7 Safety

This grit removal alternative does not anticipate any additional safety concerns compared to the existing system.

9.4.8 Constructability

To construct this grit removal alternative, the west side of the deck would be constructed first followed by the east side. The existing vortex grit separators components including the drive assembly, drive tube, propeller, hopper plates, and fluidizer can be removed from their concrete tanks outside at the grit deck using a crane. The general contractor would remove the existing components one at a time, starting with Grit Separator 2, the unit that is not in service due to mechanical issues. At the same time, the associated grit pumps can be removed from their equipment pads in basement and moved to the pipe gallery. The grit pumps would be hoisted from the basement using the crane located in Building 2. The general contractor would remove the existing units one at a time, starting with Grit Pump 2, the pump associated with the grit separator unit that is not in service due to mechanical issues. During the time of the vortex separator replacement, the plant would have to operate with only three grit separators and three grit pumps online which is similar to how they currently operate the plant.

Once the new grit separator units have been installed on the west side, the construction of the three stacked tray grit removal units can begin. A bypass pipe would be installed at the west side of the fine screen effluent channel and discharge to the existing grit effluent channel to accommodate any flows that exceed 80 MGD for the duration of construction. The newly installed grit separator units would then be placed into service. Grit Separators 3 and 4, the old units located on the east side of Building K, would be removed from service, and stops logs would be inserted in the common grit effluent channel and fine screen effluent channel. The influent and effluent channels of the existing vortex Grit Separators 3 and 4 would be drained and pumped out. The units would be removed from their concrete tanks outside at the grit deck using a crane.

The top slab on the east side of the Grit Deck of Building K and the grit separator concrete tank walls would be demolished all the way to the basement finished floor while maintaining the exterior walls. The horizontal beams in the basement of Building K would remain in place while the rebar is formed. The three new square concrete tanks, influent channels, and effluent channels would then be poured. The three stacked tray units would be installed in the concrete tanks outside at the grit deck using a crane. After the stacked tray units have been installed the associated grit pumps would then be installed.

After the concrete has been poured and the stacked tray grit removal units have been installed, the grit effluent channel drobox would be constructed. The effluent drop box would be poured and core drilled for the new 30-inch primary influent lines. The stop log would still be installed to separate the east and west sides of the effluent channel to allow for the two 30-inch primary influent lines on the east side to be constructed. Once the tanks, channels, and effluent dropbox have been constructed, the new 30-inch primary influent piping would be installed in the basement to be re-connected to the existing 48-inch primary influent lines.

After the construction and reconnection of the new 30 inch to the existing 48-inch lines on the east side drop box, all flow would then be sent through the stacked tray grit removal units and the enhanced vortex grit separators on the west side would be removed from service. While flow is sent through stacked tray grit removal units, the existing primary influent lines would be replaced with two new 30-inch lines to be re-connected to the 48-inch primary influent lines.

The replacement of the existing dewatering equipment would be similar to Grit Removal Alternatives 1 and 2 and would consist of installing temporary dewatering equipment to handle all dewatering needs. The existing units would be removed from service one set at a time by closing the associated influent valve. Temporary grit slurry piping would be installed from the Truck Bay to the temporary grit dewatering equipment located outside Building K. The temporary dewatering equipment would discharge to temporary disposal containers outside for the duration of construction. During the time of construction, the general contractor would be responsible of the temporary dewatering equipment and disposal of screenings.

Once the temporary dewatering equipment has been installed, the existing equipment platform and the south wall of the Cyclone Classifier Room would be demolished and to remove the existing units and install the new units. The new south wall would have removable translucent panels for future ease of equipment installation and removal.

9.4.9 Maintenance of Plant Operations

During construction, one vortex grit separator and one grit pump would be taken out of service at a time. Similar to the present operating conditions and unit redundancy, only three grit separator units and three grit pumps would be available at the time of replacement and the plant would need to be vigilant in maintaining the units to ensure system performance under peak flow conditions. During average flow conditions, only two grit separators are required so the plant would still have a spare unit for normal operating conditions. At the conclusion of construction, the plant would have two operational units in service. A bypass pipe would be installed to handle additional flows greater than 80 MGD during the construction of the stacked tray units.

The maintenance of plant operations for the new grit washer units would be the same as Grit Removal Alternative 2.

9.4.10 Impact on Other Unit Processes

The impact on other unit processes for this grit removal alternative would have a more positive impact compared to Grit Removal Alternative 1. The stacked tray grit removal units would capture more grit, reduce material carryover, and provide better protection to downstream unit processes for average flow conditions. During high flow events, the vortex grit separators would be placed into service to provide additional grit removal. Compared to Grit Removal Alternative 4, the finer grit particles sized 75-105 micron are not intended to be captured by the grit separators and dewatering units and ultimately carryover to the downstream unit processes during high flow events.

Similar to Grit Removal Alternative 2, the grit washers will produce a drier product containing less organic material ultimately reducing the volume of disposal content allowing for more efficient disposal and hauling operations.

The new grit pumps do not have any anticipated impact on other unit processes. This grit removal alternative does not have any apparent negative impacts on other unit processes.

9.4.11 Public Impact

The public impact for this grit removal alternative would be similar to Grit Removal Alternative 2.

9.4.12 Adaptability to Future Requirements

The improved grit removal performance of this grit removal alternative would capture more grit and reduce material carryover to the downstream equipment such as the primary settling tanks. This alternative provides grit washing and can meet future regulations to prevent organics in dewatered grit sent to landfills.

9.5 Grit Removal Alternative 4: Six Stacked Tray Grit Removal Units with Six Severe-Duty Grit Pumps with Six Hydrocyclones/Grit Washer Units

9.5.1 Description

This grit removal alternative was developed to provide most robust grit removal system. The stacked tray grit removal units would replace the existing vortex grit separators on the grit deck. The stacked tray units provide better grit removal performance than the existing system. The severe-duty grit pumps withstand abrasive grit slurries, requiring less maintenance and longer equipment life. The grit washers meet the grit removal performance of the upstream grit removal units and produce a more sustainable disposal product.

9.5.2 Concept Arrangement

The concept arrangement for this grit removal alternative would consist of six stacked tray units located outside on the grit deck which extend to the basement similar to the existing grit separators. There would be three units on the east side and three units on the west side. The three units on each side share a common influent and effluent channel. The influent channels are two and a half to three feet wide located to the east and west ends of the grit deck and the effluent channels would be relocated to the center of the grit deck. The two effluent channels are also two and a half to three feet wide and feed to a common drop box to the basement. The resulting arrangement is shown in Figure 6 and Figure 8 in Appendix E.

In the basement, the grit effluent drobox would have four new 30-inch primary influent lines to send flow to the primary clarifiers located in the center of the grit pump room. Each 30-inch primary influent line has new 30-inch manual butterfly valves, flow meters, and 30 inch electrically actuated butterfly valves. The four 30-inch lines would connect to the existing 48-inch primary influent lines in the basement. The resulting arrangement is shown in Figure 7 in Appendix E.

The severe-duty grit pumps would be located on the east and west ends of the grit pump room each in their own gallery. A new equipment pad would be installed to provide adequate centerline suction elevation from the HeadCell unit. New six-inch discharge piping would be installed to run through the basement of Building K through the Truck Bay to the Cyclone Classifier Room. The plant effluent water piping would be modified to provide flushing water to the grit pumps and HeadCell units. The resulting arrangement is shown in Figure 7 in Appendix E.

The grit washers would be in an expanded Cyclone Classifier Room on the finished floor with access platforms. The room requires expansion to accommodate the additional units. The resulting arrangement is shown in Figure 17 in Appendix E.

9.5.3 Operational Efficiency and Reliability

The operational efficiency and reliability of this grit removal alternative would be the best compared to all alternatives. The stacked tray grit removal units provide the best grit removal performance, targeting ultra-fine grit particles and capturing an estimated additional 372,000 pounds of grit per year at average flow conditions. The severe-duty pumps are robust units designed for extremely abrasive slurries. The pumps will be operated continuously to improve the overall operation of the pumping system and are expected to have a long equipment life compared to the existing grit pumps. The hydrocyclones and grit washers meet the grit removal performance of the upstream stacked tray grit removal units and produce a more sustainable and drier disposal product compared to classifier units.

9.5.4 Process Resiliency

Like the existing system, this grit removal alternative would have at least one fully redundant stacked tray unit with a dedicated grit pump and grit washer unit in standby mode while allowing the peak design flow to be treated. Three stacked tray units can handle the peak flow; however, it is recommended to operate five of the six stacked tray units to maintain adequate grit removal performance.

9.5.5 Sustainability

This grit removal alternative requires the most energy use and wash water due to the increased amount of equipment. The wash water use is continuous for each unit in service and the power required for the wash water is anticipated to be greater than the existing system. Each stacked tray grit removal unit requires 20 gpm of continuous water, and each hydrocyclone/grit washer unit requires 22 gpm of continuous water.

However, the grit washer technology produces a more sustainable product than the grit classifier dewatering technology. The severe-duty pumps are design to withstand abrasive material thus extending the life compared to standard grit pumps. They would have the same size pump motor size with a greater pump efficiency resulting in a more sustainable pump compared to Grit Removal Alternative 1. The sustainability for this alternative is expected to be similar to Grit Removal Alternative 1.

9.5.6 Maintenance Requirements

The maintenance requirements for this grit removal alternative would be slightly more than the existing system due to the increased amount of equipment. It is important to note that the stacked tray grit removal units have no moving parts and the severe-duty grit pumps are anticipated to have less frequent maintenance requirements however they require the most expensive parts. Similar to Grit Removal Alternative 2, the grit washers require routine maintenance for agitator drive unit.

9.5.7 Safety

This grit removal alternative does not anticipate any additional safety concerns in relation to the existing system.

9.5.8 Constructability

The constructability for the stacked tray grit removal units is discussed in detail in Section 8.2.8. The new severe-duty grit pumps would be installed at the same time as the grit separators. The grit pumps would be located on the east and west ends of the basement in pump galleries.

The replacement of the existing dewatering equipment would consist of installing temporary dewatering equipment to handle all dewatering needs. The existing units would be removed from service one set at a time by closing the associated influent valve. Temporary grit slurry piping would be installed from the Truck Bay to the temporary grit dewatering equipment located outside Building K. The temporary dewatering equipment would discharge to temporary disposal containers outside for the duration of construction. During the time of construction, the general contractor would be responsible of the temporary dewatering equipment and disposal of screenings.

Once the temporary dewatering equipment has been installed, the existing equipment platform and the south wall of the Cyclone Classifier Room would be demolished and to remove the existing units and install the new units. The wall will be extended further south from the Cyclone Classifier Room down to the Truck Bay to accommodate the new equipment. The newly extended south wall would have removable translucent panels for future ease of equipment installation and removal.

9.5.9 Maintenance of Plant Operations

During construction of the HeadCell grit removal system, bypass piping would be utilized to temporarily bypass the grit separators from the fine screen effluent channel to the grit effluent channel. Additionally, primary sludge degritting technologies would be implemented downstream of the primary clarifiers to provide temporary grit removal. An operator would be hired to maintain the temporary sludge degritting equipment for the duration of construction. It should be noted that grit removal performance will be less than ideal during construction, however once three HeadCell units and three severe-duty grit pumps are brought online, improved grit removal performance is anticipated.

During construction of the grit washers in the extended Cyclone Classifier Room, one grit dewatering unit would be taken out of service at a time to reconnect the grit slurry lines to temporary piping and dewatering equipment. The plant would need to be vigilant in maintaining the temporary units during the replacement period to ensure adequate performance under average and peak flow conditions. During construction, the dewatering performance would be less than ideal due to the reliance on temporary dewatering equipment.

9.5.10 Impact on Other Unit Processes

The stacked tray grit removal units would capture the most grit captured from the wastewater stream due to its targeted grit performance of finer grit particles. The dewatering units match the grit removal performance of the grit separators upstream and are expected to capture 95% of all incoming grit 75 micron and larger for disposal. This would provide the most improved protection of equipment and downstream processes such as the primary settling tanks, activated sludge process, and the solids handling system from abrasive wear and sedimentation.

Similar to Grit Removal Alternatives 2 and 3, the grit washers will produce a drier product containing less organic material ultimately reducing the volume of disposal content allowing for more efficient disposal and hauling operations.

The new grit pumps do not have any anticipated impact on other unit processes. This grit removal alternative has the greatest positive impact on other unit processes.

9.5.11 Public Impact

This grit removal alternative may have potential public impacts during construction. The public impact for this alternative would be similar to Grit Removal Alternative 2.

9.5.12 Adaptability to Future Requirements

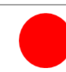
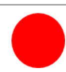
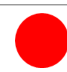
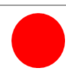
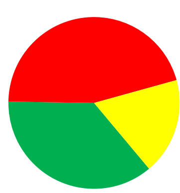
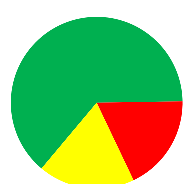
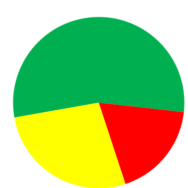
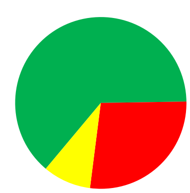
The improved grit removal performance of this grit removal alternative would capture more grit and reduce material carryover to the downstream equipment such as the primary settling tanks. Additionally, this alternative provides grit washing and can meet future regulations to prevent organics in dewatered grit sent to landfills.

9.6 Evaluation of Grit Removal Alternatives

As discussed in Section 4.1, GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost evaluation factors of the three alternatives as shown in Table 9-3.

Table 9-3 Summary of Grit Removal Upgrade Alternatives

Criteria	Alternative 1 **Four Grit Separators, Four Standard Grit Pumps, Four Hydrocyclone/Grit Classifier Units**	Alternative 2 **Four Grit Separators, Six Standard Grit Pumps, Four Hydrocyclone/Grit Washer Units**	Alternative 3 **Three Stacked Tray Units, Two Grit Separators, Five Standard Grit Pumps and Four Hydrocyclone/Grit Washer Units**	Alternative 4 **Six Stacked Tray Units, Six Severe-Duty Grit Pumps, Six Hydrocyclone/Grit Washer Units**
Equipment Layout/Installation	🟢	🟢	🔴	🔴
	Matches existing layout.	Matches grit separator layout, more confined grit pumping and dewatering layout.	Requires significant modification of existing structure; less significant than Alt. 4.	Retrofit layout difficult to accommodate in existing footprint.
Operational Efficiency and Reliability	🔴	🟡	🟢	🟢
	Possible minor improvement in grit removal performance, standard pumps, and standard dewatering performance.	Possible minor improvement in grit removal performance, standard redundant pumps, and enhanced dewatering performance.	Better grit removal performance, standard pumps, enhanced dewatering performance.	Best grit removal performance, robust pumps, enhanced dewatering performance.
Process Resiliency	🟡	🟢	🟡	🟢
	Redundancy similar to existing system.	Enhanced pumping redundancy.	Grit separator and pumping redundancy; lack dewatering redundancy.	Grit separator and dewatering redundancy.
Sustainability	🔴	🟢	🟡	🟡
	Less equipment to power, 132 HP total to power all equipment. Less wash water required. Worst grit removal performance. Grit classifier produces wetter disposal product containing more organic content.	Requires 136 HP total to power all equipment. Slightly more wash water required than Alt. 1. Adequate grit removal performance, cleaner disposal product than Alt.1 due to grit washing.	Requires 162 HP total to power all equipment. Requires more wash water than existing. Better grit removal performance than Alt 1 and 2. Cleaner disposal product than Alt. 1 due to grit washing.	Most equipment in service to power, 161 HP total to power all equipment. Requires most wash water. Best grit removal performance. Cleaner disposal product than Alt. 1 due to grit washing.
Maintenance Requirements	🔴	🔴	🟢	🟢
	Average grit removal performance results in more maintenance on downstream equipment.	Average grit removal performance results in more maintenance on downstream equipment.	Reduces maintenance on downstream equipment due to better grit removal performance.	Reduces maintenance on downstream equipment due to better grit removal performance.
Safety	🟢	🟢	🟢	🟢
	Similar to existing system.	No additional safety concerns anticipated.	No additional safety concerns anticipated.	No additional safety concerns anticipated.

Criteria	Alternative 1 **Four Grit Separators, Four Standard Grit Pumps, Four Hydrocyclone/Grit Classifier Units**	Alternative 2 **Four Grit Separators, Six Standard Grit Pumps, Four Hydrocyclone/Grit Washer Units**	Alternative 3 **Three Stacked Tray Units, Two Grit Separators, Five Standard Grit Pumps and Four Hydrocyclone/Grit Washer Units**	Alternative 4 **Six Stacked Tray Units, Six Severe-Duty Grit Pumps, Six Hydrocyclone/Grit Washer Units**
Constructability	 Can be easily retrofitted.	 Additional pumps installed and washer installation requires complete removal of existing platform.	 Requires building modifications and moderate construction duration.	 Requires major building modification and long construction duration.
Maintenance of Plant Operations	 Can operate three out of four grit separators during construction. Requires temporary dewatering equipment.	 Can operate three out of four grit separators during construction. Requires temporary dewatering equipment.	 Can still operate half of the grit separator system. Requires temporary grit dewatering equipment and bypass pumping.	 Requires temporary grit removal and dewatering methods.
Impact on Other Unit Processes	 Possible minor improvement in grit removal performance.	 Possible minor improvement in grit removal performance.	 Improved grit removal performance at flows over 60 MGD.	 Significant improvement in grit removal performance.
Public Impact	 Odorous disposal product.	 Reduced odor in disposal product.	 Reduced odor in disposal product.	 Reduced odor in disposal product.
Adaptability to Future Requirements	 Adequate grit removal performance and does not provide future ability for grit washing.	 Adequate grit removal performance but provides grit washing for potential future requirements.	 Equipment provides improved grit removal performance and provides grit washing for potential future requirements.	 Equipment provides improved grit removal performance and provides grit washing for potential future requirements.
Summary				

Grit Removal Alternative 2 scored the highest in the Traffic Light Decision Model with the most green (desirable) ratings and the fewest red (undesirable) ratings.

9.7 Grit Removal Alternative Cost Analysis

Each grit removal alternative was provided a probable construction cost and life-cycle cost to be considered for selection of the recommended grit removal alternative. Section 4.2 outlines the assumptions made based on normal engineering practice. Table 9-4 summarizes the construction cost estimate and life cycle cost of each alternative. Detailed OPCC estimates are included in Appendix H and detailed lifecycle cost calculations are included in Appendix I.

These calculations assume that variable amounts of grit get washed downstream of the grit removal process and impact other equipment. To account for this, this estimate assumes additional maintenance on downstream equipment will be required and estimates the value of that maintenance as 1.5% of the capital cost for Grit Removal Alternatives 1 and 2 and 0.5% for Grit Removal Alternatives 3 and 4. The capital cost for the maintenance of the downstream unit process equipment is assumed to be $20,000,000.

Table 9-4 Opinion of Probable Construction Cost and Life-Cycle Costs for the Grit Removal Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Construction Cost (-20% to +30% accuracy)	$5,273,000	$5,988,000	$16,759,000	$30,994,000
Soft Costs (40%) [1]	$2,109,000	$2,395,000	$6,704,000	$12,398,000
2021 Project Cost (without contingency)	**$7,382,000**	**$8,383,000**	**$23,463,000**	**$43,392,000**
20-Yr O&M NPV	$12,646,000	$12,316,000	$6,198,000	$6,778,000
Total	**$20,028,000**	**$20,699,000**	**$29,661,000**	**$50,170,000**

Note:
1. Soft costs include project management, engineering, construction management, and project administration costs.

The Life Cycle Costs of the grit removal alternatives are presented in Figure 9-2 for comparison.

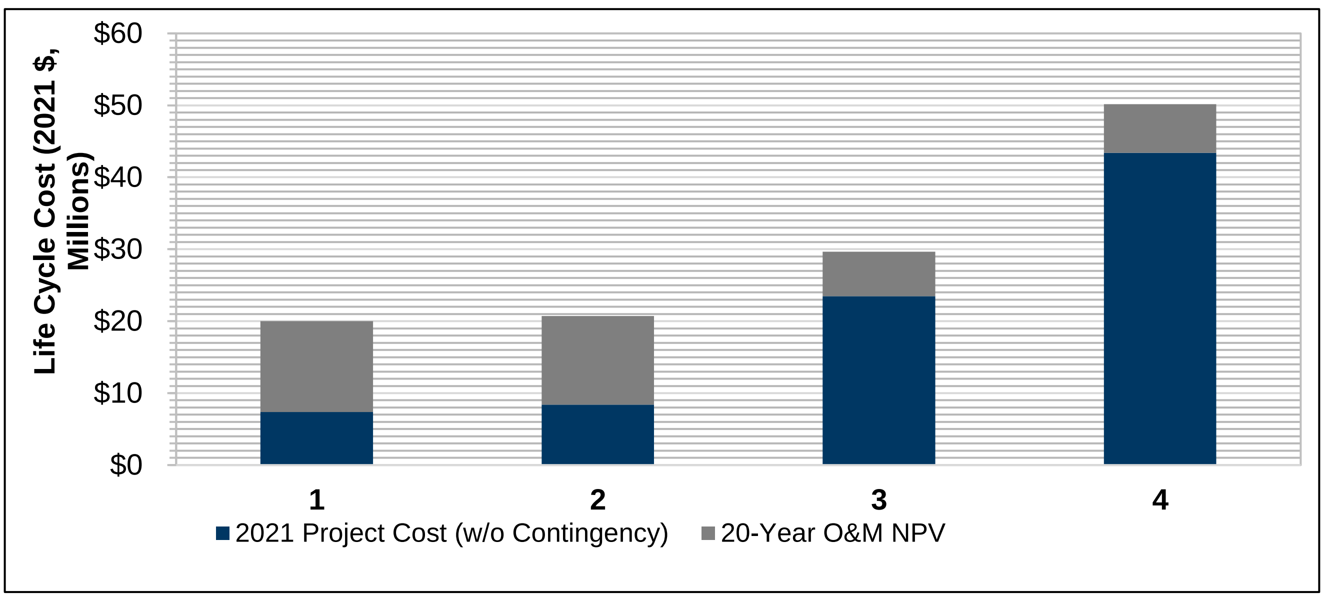


Figure 9-2 Grit Removal Life Cycle Cost Comparison

9.8 Recommended Grit Removal Alternative

GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost factors for each grit removal alternative. Grit Removal Alternative 2 scored the highest in the Traffic Light Decision Model. Grit Removal Alternative 2 has the most green (desirable) ratings and the fewest red (undesirable) ratings.

Following the evaluation of non-cost factors, capital and lifecycle cost estimates were developed for each grit removal alternative. While Grit Removal Alternatives 1 and 2 had the lowest capital and lifecycle costs, these grit removal alternatives had several undesirable ratings which impact operational efficiency, impact on other unit processes and adaptability to future requirements and for these reasons, these grit removal alternatives were not preferred. The capital and lifecycle cost of Grit Removal Alternative 4 was extremely high and therefore not recommended. Grit Removal Alternative 3 had capital and lifecycle costs which were significantly higher than Grit Removal Alternatives 1 and 2, but only about half as much as Grit Removal Alternative 4.

Based on the "Traffic Light" Decision Model, capital and lifecycle costs, and O&M feedback on the developed grit removal alternatives, AlexRenew's Decision Model was then used to compare the two favorable grit removal alternatives, Grit Removal Alternative 2 and Grit Removal Alternative 3. Grit Removal Alternative 3 scored the highest in the AlexRenew Decision Model, indicating that the improved performance outweighs the increase in cost compared to Grit Removal Alternative 2.

Grit Removal Alternative 3 is recommended following a holistic consideration of both the cost and non-cost evaluation criteria. Based on the analysis results, the higher capital cost of this grit removal alternative appears to be justified by the anticipated significant improvement in grit removal performance and reduction of grit carryover to downstream unit processes and the solids handling system. This grit removal alternative will anticipate an additional grit capture of 372,000 pounds of grit per year at design average flow conditions. This grit removal alternative has an estimated AACE Class 3 project cost escalated to mid-point of construction (2025) of $25,879,000 (-20% to +30% range of accuracy).

Grit Removal Alternative 3 includes:

- Replacement of the four existing PISTA vortex grit separators with three stacked tray grit removal units and two enhanced PISTA vortex grit separators with the V-Force Baffle
- Replacement of the existing influent and effluent gates
- Installation of five standard grit pumps and equipment pads
- Installation of four hydrocyclone/grit washer units
- Construction of new dewatering equipment access stairs and platform
- Installation of new grit piping using abrasion resistant materials
- Installation of new W3 piping
- Investigate plumbing system and determine if demolition of existing floor drains and installation of new sediment buckets is required
- Modifications to existing electrical, HVAC, and odor control systems to accommodate the new/replaced equipment

Grit Removal Alternative 3 provides the following benefits to AlexRenew that align with the Strategic Outcomes of AlexRenew's 2040 Vision Statement:

- Operational Excellence
  - Ensures robust environmental compliance by improving grit removal efficiency, implementing robust pumping applications, and producing a cleaner grit disposal waste product.
- Adaptive Culture
  - Increases the efficiency of the grit removal process and improves process reliability for the grit removal system and downstream treatment processes by reducing the grit carryover.

– Watershed Stewardship
  - Does not significantly increase energy use at the facility, while decreasing greenhouse gas emissions by washing and producing a material with less organic matter and moisture content prior to off-site hauling.
– Public Trust
  - Does not have any negative impacts on the surrounding community and decreases the potential of odors associated with the process.
– Financial Resilience
  - This grit removal alternative has the lowest capital and lifecycle costs which meet the performance objectives for this facility.

10. Fine Screening and Grit Loading Evaluation

Four screening and grit loading alternatives were developed for evaluation:

– Fine Screening and Grit Loading Alternative 1: Redundant Screw Conveyor Layout with Combined Material Disposal to Trailers with CCTV and Other Optimizations
– Fine Screening and Grit Loading Alternative 2: Separated Fine Screenings and Grit Screw Conveyor Layout with One Roll-Off Container per Truck Bay on an Automated Rail System
– Fine Screening and Grit Loading Alternative 3: Separated Fine Screenings and Grit Screw Conveyor Layout with Two Self-Leveling Roll-Off Containers Per Truck Bay
– Fine Screening and Grit Loading Alternative 4: Simplified Fine Screenings Screw Conveyor Layout with Direct Washer Discharge to Two Roll-Off Containers Per Truck Bay

10.1 Basis of Design

The Level of Service Goals presented in Table 10-1 were selected as the Basis of Design Criteria for the grit removal system upgrade.

Table 10-1 Level of Service Goals for Fine screenings and Grit Loading Basis of Design Criteria

Parameters	Basis of Design
Minimum flow	20 MGD
Design average daily flow	54 MGD
Design peak hourly flow	120 MGD
Average fine screenings yield [1]	7.5 cf/mg
Peaking factor [2]	5
Fine screenings bulk density [3]	55 lb/cf
Average fine screenings quantity after washer/compactor	156 cf/d
Peak fine screenings quantity after washer/compactor	780 cf/d
Average Grit yield [4]	5 cf/mg
Peaking factor [5]	15
Wet grit bulk density [6]	90 lb/cf
Washed grit bulk density [7]	125 lb/cf
Average grit quantity	270 cf/d

Parameters	Basis of Design
Peak grit quantity	9,000 cf/d
Materials of construction	Type 316 SS troughs; UHMWP liners (where applicable), Hardened steel shafts
Odor control	Cover all equipment and channels; connect to existing odor control system
Maintenance improvement	Ease of maintenance access to critical components

Notes:
1. Average fine screenings quantities removed for fine screen with 0.25” opening per WEF MOP 8 (6th Ed.) page 11-7.
2. Assumed a peaking factor of 5.0.
3. Average fine screenings bulk density per WEF MOP 8 (6th Ed.) page 11-8.
4. Average grit quantities removed per WEF MOP 8 (6th Ed.) pages 11-51.
5. Assumed a peaking factor of 15.0.
6. Average grit bulk density per WEF MOP 8 (6th Ed.) page 11-51.
7. Bulk density of washed grit per Huber Technology, Inc.

It is anticipated that approximately 11,000 pounds of dewatered fine screenings and 7,300 pounds of dewatered grit will need to be disposed per day at the design average influent flow of 54 MGD at rated facility design capacity. This corresponds to the recommended Grit Removal Alternative 3 as outlined in Section 9.8.

10.2 Overview of Fine Screenings and Grit Conveyance Loading and Hauling Systems

10.2.1 Introduction

Dewatered screening and grit are currently loaded into 40 CY open top trailers and hauled by Synagro to Covanta. As part of this planning effort, GHD has considered loading alternatives in which fine screenings and grit would continue to be loaded together into the same container, as well as alternatives in which fine screenings and grit would be loaded into separate containers. Three different types of hauling containers were considered as shown in Table 10-2.

Table 10-2 Virginia Hauling Weight Limits Based on Disposal Container

Equipment Type	Legal Gross Weight (lbs)	Truck Tare (lbs)	Container (lbs)	Container + Truck Tare (lbs)	Available Capacity of Material (lbs)
40 CY Trailer	78,000 [1]	-	-	32,000 [1]	46,000
20 CY Roll-Off Container	64,000 [1]	32,000 [1]	6,500 [2]	38,500	25,500
20 CY Self-Leveling Roll-Off Container	64,000 [1]	32,000 [1]	7,900 [2]	39,900	24,100

Notes:
1. Information provided by Synagro.
2. Information provided by Schwing Bioset, Inc for a 20 CY container.

10.2.2 40 CY Open Top Trailers

Table 10-3 presents the hauling frequency at design conditions for 40 CY open bed trailers.

Table 10-3 Trailer Hauling Operations at Design Conditions

Average Flow Conditions	Material Disposed (lb/day)	Time to Fill One Trailer (days)	Hauls Per Year
Fine Screenings Only	11,095	4.15	89
Grit Only	7,310	6.29	59
Combined Fine Screenings and Grit	18,406	2.50	147

10.2.3 20 CY Open Top Roll-Off Containers

20 CY roll-off containers have lower capacity than 40 CY trailers and thus require more frequent hauling. Table 10-4 presents the hauling frequency at design conditions for 20 CY roll-off containers.

Table 10-4 Roll-Off Container Hauling Operations at Design Conditions

Average Flow Conditions	Material Disposed (lb/day)	Time to Fill One Trailer (days)	Hauls Per Year
Fine Screenings Only	11,095	2.30	159
Grit Only	7,310	3.49	105
Combined Fine Screenings and Grit	18,406	1.39	264

10.2.4 20 CY Covered Self-Leveling Roll-Off Containers

Table 10-5 presents the hauling frequency at design conditions for 20 CY self-leveling roll-off containers.

Table 10-5 Self-Leveling Roll-Off Container Hauling Operations at Design Conditions

Average Flow Conditions	Material Disposed (lb/day)	Time to Fill One Trailer (days)	Hauls Per Year
Fine Screenings Only	11,095	2.17	169
Grit Only	7,310	3.30	111
Combined Fine Screenings and Grit	18,406	1.31	279

10.3 Fine Screening and Grit Loading Alternative 1: Redundant Screw Conveyor Layout with Combined Material Disposal to Trailers with CCTV and Other Optimizations

10.3.1 Description

This loading alternative was developed to provide a fully redundant screw conveyor layout, similar to the existing conveyance system, while providing improved monitoring technology and permanent access platform to manually level the fine screenings and grit piles in the open bed trailers. This loading alternative also allows fine screenings and grit to be disposed together or separately, similar to the existing system.

Fine screenings would be transported from the washer/compactor discharge, through the wall openings in the Screenings Room to the Cyclone Classifier Room via two 3 HP shaftless screw conveyors. Grit would discharge from the associated dewatering equipment to the designated 15 HP shafted screw conveyor. The material would combine at the two 15 HP transfer shafted screw conveyors to transport material to either truck loading screw conveyor. The 15

HP truck loading shafted screw conveyors would accept material from either transfer conveyor then discharge material through the floor to the trailers in the Truck Bay. Each truck loading conveyor will have four discharge points to each trailer to optimize even loading.

Combined grit and fine screenings would be loaded into 38-foot-long trailers located in the Truck Bay below the Cyclone Classifier Room. This would allow for both trailers to utilize all four discharge points to collect material. Additionally closed-circuit television (CCTV) technologies would be installed in the Truck Bay for to reduce the frequency of leveling the piles and optimize loading. Cameras would be installed in each Truck Bay to view the interior of the trailer to improve visual of the piles and allow for AlexRenew to inspect the trailers prior to leveling them. A permanent access platform would be installed between the two Truck Bays to improve maintenance access and provide safer means of manually leveling the piles. Continued trailer rental and hauling would be utilized through Synagro with this alternative.

Note a similar configuration with four roll-off containers could be implemented for this loading alternative.

10.3.2 Concept Arrangement

The concept arrangement for this loading alternative would be similar to the existing system. The new screw conveyors would be in the Cyclone Classifier Room of Building K and one trailer would be in each the east and west sides of the Truck Bay. The resulting arrangement is shown in Figure 3 and Figure 7 in Appendix F.

This loading alternative includes two 38-foot-long trailers onsite to effectively load the trailers utilizing all discharge points. Additionally, new dock bumpers and guide rails in the Truck Bay would be installed to back the trailers up far enough to utilize all discharge points and allow for the trailers to be positioned correctly. A permanent access platform between the two bays would be implemented to provide access to manually level the piles. The resulting arrangement is shown in Figure 3 in Appendix F.

10.3.3 Operational Efficiency and Reliability

Upgrading to larger screw conveyors to handle peak loads of fine screenings and grit will improve the overall operational efficiency and reliability of this loading alternative. Larger motor drives and larger screws will reduce the likelihood of overwhelming the units and prevent material build up. The fully redundant conveyor layout allows for the screw conveyors to discharge fine screenings and grit in separate or together mode, similar to the existing conveyor layout.

Each trailer would have four loading points for even material loading. All four loading gates would be properly located above the trailers for full operation of all discharge points. The addition of CCTV monitoring technology would allow operators to visually inspect the piles and open another discharge gate without having to use the portable stair to access the top of the trailer. Manual leveling of the piles would still be required, however a permanent platform will be installed to provide improved and safer access.

Similar to the hauling operations presently, one trailer would be hauled from the site at once carrying a maximum of 46,000 pounds of material. The trailers require the least number of hauls per year based on the legal hauling weight restrictions presented in Table 10-3. Combined material loading of screening sand grit would result in approximately 108 hauls per year as presented in Table 10-4.

10.3.4 Process Resiliency

Like the existing system, this loading alternative would maintain a reversible transfer screw conveyor to allow fine screenings and grit to be combined or separated in each Truck Bay. The reversing transfer conveyor allows the material to be sent to either Truck Bay, together or separated. The fine screenings and grit screw conveyors will each have two discharge points to each of the two transfer conveyors. Each transfer screw conveyor will have four discharge points, two at each end, with the last one always open to prevent accumulation. The truck loading screw conveyors will have four discharge points to each trailer in the Truck Bay below.

Each trailer would be filled one at time, similar to the operations presently. Once one trailer is full, it will be removed from service and hauled for disposal and the trailer in the other Truck Bay would be placed into service.

10.3.5 Sustainability

All eight screw conveyors will have larger drive units requiring more energy use for operation. Additional power requirements are needed to support the CCTV technology in the Truck Bay. The power required for this loading alternative is anticipated to be more than the existing system and is the most compared to all alternatives.

However, this loading alternative requires the least amount of hauling trips per year which will reduce greenhouse gas emissions for waste transport.

10.3.6 Maintenance Requirements

The maintenance requirements for this loading alternative would be similar to the existing system. The larger screw conveyors require a larger footprint within the Cyclone Classifier Room. Access to dewatering equipment and screw conveyors would be more difficult due to the confined layout. Additionally, this loading alternative would require multiple discharge ports and gates to discharge fine screenings and grit to the transfer conveyors and combined material from the truck loading conveyor to the trailers.

10.3.7 Safety

The overall safety would be an improvement to the existing system. The multi-port discharge chute configuration would create more evenly distributed piles within the trailer and ultimately reduce the operator attention needed to manually level the piles. The additional CCTV technology allows for the operators to visually inspect the inside of the trailers before having to manually level the piles. The piles can be accessed via the new permanent platform between the Truck Bays.

10.3.8 Constructability

The replacement of the existing grit and grit and fine screenings combined conveyor equipment with new screw conveyors would occur at the same time as the replacement of the grit dewatering equipment. During this period, the contractor would provide and operate temporary grit dewatering outside of Building K.

The replacement of the existing screening only conveyors would need to be done one half at a time so that half of the system capacity could be maintained in service at all times. Work in the Truck Bay would therefore also have to be sequences one half at a time.

10.3.9 Maintenance of Plant Operations

As noted above, temporary grit dewatering would be required throughout the construction. The contractor would be responsible for the maintenance and operation of the temporary dewatering system. Only half of the screening conveyor system would be able to be online at once. However, without dewatered grit going into the same conveyor, it is anticipated that one transfer and loadout conveyor can handle the entire normal fine screenings loading to a single trailer. During storm events, manual handling of fine screenings may be required in extreme situations.

10.3.10 Impact on Other Unit Processes

Temporary short-term disruptions of screening and grit loading will occur during construction of these improvements. Contract documents would need to be written to limit allowable shutdown periods and under what circumstances (low flow) they can occur.

10.3.11 Public Impact

This loading alternative requires the lowest number of hauling trips for fine screenings and grit due to the larger size of the trailers, and therefore would have the least public impacts from truck traffic.

10.3.12 Adaptability to Future Requirements

The fine screenings and grit loads can be combined or separated allowing for flexibility for potential future requirements.

10.4 Fine Screening and Grit Loading Alternative 2: Separated Fine Screenings and Grit Screw Conveyor Layout with One Roll-Off Container per Truck Bay on an Automated Rail System

10.4.1 Description

This loading alternative was developed to provide improved operation of the fine screenings and grit conveyance system and eliminate the need to manually level piles in the disposal containers. This alternative conveys and discharges the fine screenings and grit separately, to either Truck Bay, ultimately eliminating the need for combined material conveyors and reducing the points of failure in the conveyance system. Fine screenings and grit could be disposed of in the same container, however they would each have dedicated conveyors to transport the material. Additionally, the automated rail system used to collect fine screenings and grit in the roll-off containers would reduce operator labor required to level the piles.

Fine screenings would be transported from the washer/compactor discharge, through the wall openings in the Screenings Room to the Cyclone Classifier Room via two 3 HP shaftless screening screw conveyors. The fine screenings screw conveyors would discharge onto two 3 HP shaftless fine screenings transfer conveyors to the east and west sides of the Cyclone Classifier Room. The material would then discharge onto two 3 HP shaftless fine screenings loading conveyors. The fine screenings loading conveyors would each have one discharge point to load material into either roll-off container located in the Truck Bay below. Grit would discharge from the associated dewatering equipment in the Cyclone Classifier Room to two 15 HP shafted grit screw conveyors. The grit screw conveyors would each have one discharge point to load material into either roll-off container located in the Truck Bay.

10.4.2 Concept Arrangement

The concept arrangement for this loading alternative would have the same number of conveyors as the existing system however, the units are shorter, easier to access, and with less discharge points and gates. Additionally, fine screenings and grit would be conveyed and disposed of separately to either Truck Bay. The new screw conveyors would be in the Cyclone Classifier Room of Building K and two roll-off containers would be in the east and west sides of the Truck Bay. The resulting arrangement is shown in Figure 6, Figure 8, and Figure 9 in Appendix F.

This loading alternative would consist of one roll-off container on an automated chain drive rail system for even distribution of material per Truck Bay. The automated rail operation would move the container from the north most end of the Truck Bay to the south towards the roll up doors based on the material level in the container.

Figure 10-1 shows an example installation of a two-bay arrangement with the roll-off containers in different positions, similar to what is recommended.

Figure 10-1 Example Automated Rail System Installation (Courtesy D.R. Cordell, Dumpster-Veyor System)

10.4.3 Operational Efficiency and Reliability

Shorter screw conveyors and larger drive units to handle the separated fine screenings and grit load will reduce the likelihood of overwhelming the conveyors and improve operations at average and peak flows. The grit conveyors are required in exchange for central loading and leveling of the material via roll-off containers on an automated rail system. There would be one central discharge point in each Truck Bay for fine screenings and grit. The material would be conveyed to the central discharge port and drop to the roll-off container below.

The operational efficiency and reliability of the automated rail system to load the roll-off containers would be an improvement to Loading Alternative 1. The system can be automated using level sensors to move the container to evenly distribute the pile and avoid the need for operators to have to hand rake the material to level it. Load cells can be added to the carrier drive system, if desired, to indicate the total weight of material in the roll-off container.

10.4.4 Process Resiliency

Two parallel fine screenings transfer and loading conveyors have full redundancy.

Dewatered grit from two washer units discharges into each of two grit loading conveyors, so that the half the system grit loading capacity is maintained with one conveyor out of service.

10.4.5 Sustainability

The power required for this loading alternative is less than Loading Alternatives 1 and 3. However, this alternative requires about double the number of hauling trips per year compared to Loading Alternative 1.

10.4.6 Maintenance Requirements

Maintenance requirements for this loading alternative would be expected to be less than Loading Alternative 1 due to shorter, dedicated fine screenings and dedicated grit conveyors with less knife gates and discharge points. Dedicated conveyors for fine screenings and grit require a smaller footprint within the Cyclone Classifier Room. Access to dewatering equipment and screw conveyors would be improved. The chain drive system of the automated rail would require periodic maintenance to ensure the system is operating correctly.

10.4.7 Safety

The safety concerns regarding access to equipment for routine maintenance would be an improvement compared to Loading Alternative 1. Shortening the grit conveyors creates more space to access the dewatering equipment and fine screenings screw conveyors. The automated rail system has a warning alarm to alert nearby operators prior to container movement. The moving containers eliminate operator labor needed to manually level the piles in the containers and the lower height of the roll-off containers mean that a portable stairway would no longer be needed to see into the containers.

10.4.8 Constructability

The constructability for this loading alternative would be similar to Loading Alternative 1. Modifications to the Truck Bay floor are required to accommodate the automated rail system, however, this can be done one bay at a time in coordination with the replacement of the truck loading conveyors above.

10.4.9 Maintenance of Plant Operations

The maintenance of plant operations for this loading alternative would be similar to Loading Alternative 1.

10.4.10 Impact on Other Unit Processes

There are no apparent impacts on other unit processes for this loading alternative.

10.4.11 Public Impact

This loading alternative would have more frequent hauling trips than Loading Alternative 1. This will have a small impact on the public, although the increase in traffic is relatively small and not likely to be noticed.

10.4.12 Adaptability to Future Requirements

The fine screenings and grit loads can be combined or separated allowing for flexibility for potential future requirements.

10.5 Fine Screening and Grit Loading Alternative 3: Separated Fine Screenings and Grit Screw Conveyor Layout with Two Self-Leveling Roll-Off Containers Per Truck Bay

10.5.1 Description

Similar to Loading Alternative 2, this loading alternative was developed to provide improved operation of the fine screenings and grit conveyance system and eliminate the need to manually level piles in the disposal containers. This loading alternative conveys and discharges the fine screenings and grit separately. This ultimately eliminates the need for combined material conveyors and reduces the points of failure in the conveyance system.

Fine screenings would be transported from the washer/compactor discharge, through the wall openings in the Screenings Room to the Cyclone Classifier Room via two 3 HP shaftless screening screw conveyors. The fine screenings screw conveyors would discharge onto two 3 HP shaftless fine screenings transfer conveyors to the east side of the Cyclone Classifier Room. The material would then discharge onto two 3 HP shaftless fine screenings loading conveyors. The fine screenings loading conveyors would each have one discharge point to load material into each self-leveling roll-off container located in east side of the Truck Bay. Grit would discharge from the associated dewatering equipment in the Cyclone Classifier Room to two 15 HP grit screw conveyors. The grit screw conveyors would each have one discharge point to load material into each self-leveling roll-off container located in the Truck Bays.

10.5.2 Concept Arrangement

The concept arrangement for this loading alternative would have the same number of conveyors as the existing system however, the units are shorter and easier to access. Similar to Loading Alternative 2, the fine screenings and grit would be conveyed and disposed of separately. The new screw conveyors would be in the Cyclone Classifier Room of Building K and two self-leveling roll-off containers would be in the east and west sides of the Truck Bay. The resulting arrangement is shown in Figure 5, Figure 10, and Figure 11 in Appendix F.

Each self-leveling container will have one port to accept fine screenings and grit to the internal screw. Figure 10-2 shows a sample installation of two self-leveling roll-off containers.

Figure 10-2 Self-Leveling Roll-Off Container Installation (Courtesy Schwing Bioset)

10.5.3 Operational Efficiency and Reliability

Shorter screw conveyors with larger drive units and separated fine screenings and grit material reduce the likelihood of overwhelming the conveyors and improve operations at average and peak flows. The grit conveyors are required in exchange for automated leveling of the dumpster piles via self-leveling roll-off containers.

The self-leveling roll-off containers are shorter in length compared to the trailers so two units will be located on each side of the Truck Bay for a total of four units. Each self-leveling roll-off container would have one discharge point for material loading to the internal screw conveyor.

Fine screenings and grit are fed directly to the internal screw of the dedicated roll-off container to provide optimal container filling without the need for operators to manually level the piles. The internal leveling screw would be shafted for grit material disposal and shaftless for fine screenings material disposal. However, because the self-leveling containers are hauled with their lids on, the amount of material hauled per container is less resulting in the most frequent hauling trips compared to Loading Alternatives 1, 2, and 4. Additionally, there is a risk of damage to the container lids by the hauling contractor when the containers are removed from the Truck Bay for material disposal.

Syangro does not have the capability of hauling self-leveling roll-off containers, therefore Synagro would sub-contract a self-leveling roll-off container hauling company or a new hauling contract would be established. For the purposes of cost estimating, a budgetary quote from Barrett Trucking, Inc. for hauling the self-leveling roll-off containers to Covanta Fairfax was provided and a markup was applied for continuous hauling operations through Synagro.

10.5.4 Process Resiliency

Two parallel fine screenings transfer and loading conveyors have full redundancy.

Dewatered grit from two washer units discharges into each of two grit loading conveyors, so that the half the system grit loading capacity is maintained with one conveyor out of service.

There are two self-leveling containers per Truck Bay creating redundancy within the container loading system.

10.5.5 Sustainability

The power required for this loading alternative is less than Loading Alternative 1, but more than the other loading alternatives.

This loading alternative requires about double the number of hauling trips per year compared to Loading Alternative 1.

10.5.6 Maintenance Requirements

Maintenance requirements for this loading alternative would be similar to Loading Alternative 1 however it is expected to be less frequent due to shorter, dedicated fine screenings and dedicated grit conveyors. Additionally, routine maintenance is required for the self-leveling roll-off containers. Access hatches are available along the screw conveyor of the self-leveling roll-off containers for maintenance access.

The routine maintenance requirements for this loading alternative would increase due to the added screw conveyors located inside the roll-off container. The screw can be accessed by opening the covers as needed and shown in Figure 10-3.

Figure 10-3 Self-Leveling Roll-Off Containers Maintenance Access (Courtesy Schwing Bioset)

10.5.7 Safety

The safety concerns regarding access to equipment for routine maintenance would be an improvement compared to Loading Alternative 1. Shortening the grit conveyors creates more space to access the dewatering equipment and fine screenings screw conveyors. The self-leveling roll-off containers are a significant improvement to the existing trailer loading operation as it is an enclosed system and ultimately eliminate the need to manually level the piles.

10.5.8 Constructability

The constructability for this loading alternative would be similar to Loading Alternative 2.

10.5.9 Maintenance of Plant Operations

The maintenance of plant operations for this loading alternative would be similar to Loading Alternative 1.

10.5.10 Impact on Other Unit Processes

There are no apparent impacts on other unit processes for this loading alternative.

10.5.11 Public Impact

This loading alternative would have more frequent hauling trips than Loading Alternative 1. This will have a small impact on the public, although the increase in traffic is relatively small and not likely to be noticed.

10.5.12 Adaptability to Future Requirements

The fine screenings and grit material would be disposed separately to allow for adaptability to potential future requirements.

10.6 Fine Screening and Grit Loading Alternative 4: Simplified Fine Screenings Screw Conveyor Layout with Direct Washer Discharge to Two Roll-Off Containers Per Truck Bay

10.6.1 Description

This loading alternative was developed to provide improved equipment access to the upgraded fine screenings conveyance system, eliminate the need for grit conveyors, and discharge material to the roll-off containers in the Truck Bay below. Manual leveling of piles is still required for this loading alternative, however the access to the roll-off containers is much better access than the existing trailers. This loading alternative conveys and discharges the fine screenings and grit separately. This ultimately eliminates the need for combined material conveyors and reduces the points of failure in the conveyance system.

Fine screenings would be transported from the washer/compactor discharge, through the wall openings in the Screenings Room to the Cyclone Classifier Room via two 3 HP shaftless screening screw conveyors. The fine screenings screw conveyors would discharge onto two 3 HP shaftless fine screenings transfer conveyors to travel to the east side of the Cyclone Classifier Room and Truck Bay. The material would then discharge onto two 3 HP shaftless fine screenings loading conveyors. The fine screenings loading conveyors would have two discharge points to load material into the east-side roll-off containers located in the Truck Bay. Grit would discharge from the associated dewatering equipment in the Cyclone Classifier Room through the floor directly to the roll-off containers on the west side of the Truck Bay.

10.6.2 Concept Arrangement

The concept arrangement for this loading alternative would be reduce the overall number of conveyors and dispose of fine screenings and grit separately. The new screw conveyors would be in the Cyclone Classifier Room of Building K and two roll-off containers would be on each the east and west sides of the Truck Bay for a total of four units. The resulting arrangement is shown in Figure 4, Figure 12, and Figure 13 in Appendix F.

10.6.3 Operational Efficiency and Reliability

The operational efficiency and reliability of this loading alternative is a significant improvement to Loading Alternative 1 due to the reduced number of equipment. Grit would discharge directly to the roll-off containers from the washers, eliminating the need for grit conveyors and ultimately reducing the potential points of failure in the conveyance system. Fewer screw conveyor units and separate material loading will reduce the likelihood of overwhelmed and clogged conveyors.

The roll-off containers are shorter in length compared to the trailers so two units will be located on each side of the Truck Bay for a total of four units. Each fine screenings roll-off container and each grit roll-off container would have two discharge points for material loading. Because the containers are shorter in length and lower to the floor, the piles are not anticipated to be as large and will be easier to access to manually level.

10.6.4 Process Resiliency

Two parallel fine screenings transfer and loading conveyors have full redundancy.

Dewatered grit from grit washers drops directly down to the Truck Bay below, eliminating a grit conveyor as a potential point of failure.

10.6.5 Sustainability

The hauling frequency for this loading alternative would be the same as Loading Alternative 2 and less frequent compared to Loading Alternative 3. Additionally, this loading alternative would require the least amount energy making it the most sustainable alternative.

10.6.6 Maintenance Requirements

Maintenance requirements for this loading alternative would be least due to the reduced number of conveyors. Routine maintenance would be required for the fine screenings conveyors.

10.6.7 Safety

The safety concerns regarding access to equipment for routine maintenance would be an improvement compared to Loading Alternative 1. Eliminating the grit conveyors creates more space to access the dewatering equipment and the fine screenings screw conveyors. Additionally, the roll-off containers are lower to the ground compared to the trailers, allowing for the operators to see the material loading from the Truck Bay floor. Similar to Loading Alternative 3, the wheel plates and guide rails for the containers create a potential tripping hazard, however the roll-off containers still require manually leveling of the piles but the containers provide safer access to the piles.

10.6.8 Constructability

The constructability for this loading alternative would be similar to Loading Alternative 2.

10.6.9 Maintenance of Plant Operations

The maintenance of plant operations for this loading alternative would be similar to Loading Alternative 1.

10.6.10 Impact on Other Unit Processes

There are no apparent impacts on other unit processes for this loading alternative.

10.6.11 Public Impact

This loading alternative would have more frequent hauling trips than Loading Alternative 1. This will have a small impact on the public, although the increase in traffic is relatively small and not likely to be noticed.

10.6.12 Adaptability to Future Requirements

The fine screenings and grit material would be disposed separately to allow for adaptability to potential future requirements.

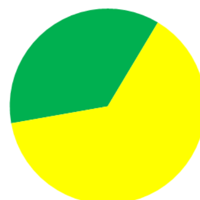
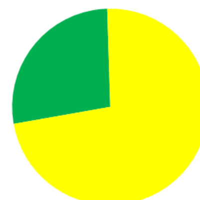
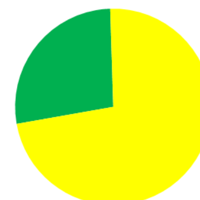
10.7 Evaluation of Fine Screening and Grit Loading Alternatives

As discussed in Section 4.1, GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost evaluation factors of the four loading alternatives as shown in Table 10-6.

Table 10-6 Summary of Screening and Grit Loading Alternatives

Criteria	**Alternative 1** **Redundant Screw Conveyor Layout with Combined Material Disposal to Trailers with CCTV and Other Optimizations**	**Alternative 2** **Separated Fine Screenings and Grit Screw Conveyor Layout with One Roll-Off Container per Truck Bay on an Automated Rail System**	**Alternative 3** **Separated Fine Screenings and Grit Screw Conveyor Layout with Two Self-Leveling Roll-Off Containers Per Truck Bay**	**Alternative 4** **Simplified Fine Screenings Screw Conveyor Layout with Direct Washer Discharge to Two Roll-Off Containers Per Truck Bay**
Equipment Layout/Installation				
	Difficult maintenance access to conveyors and classifiers due to space constraints. Similar footprint in the Truck Bay as existing.	Layout provides improved equipment access due to shorter conveyors. Reduced footprint in the Truck Bay.	Conveyor layout provides improved equipment access. Confined footprint in the Truck Bay due to four self-leveling roll-off containers.	Layout provides most improved equipment access due to two less conveyors. Confined footprint in the Truck Bay due to four roll-off containers.
Operational Efficiency and Reliability				
	Multiple conveyors with combined material result in greater likelihood of failure. Manual leveling of piles required but permanent access platform improves access.	Shorter conveyors with separated material resulting in less likelihood of conveyor jam. Eliminate need to manually level piles.	Shorter conveyors with separated material resulting in less likelihood of conveyor jam. Eliminate need to manually level piles.	Fewer conveyors with separated material and direct grit discharge. Manual leveling of piles required but shorter roll-off containers can be accessed without portable ladder.
Process Resiliency				
	Grit and fine screenings can be sent to either Truck Bay and does not require system shutdown to move containers.	Grit and fine screenings material is combined in the container. Loading is continuous and does not require system	Dedicated Truck Bays for grit and fine screenings. Loading is continuous and does not require system	Dedicated Truck Bays for grit and fine screenings. Loading is continuous and does not require system

Criteria	Alternative 1 Redundant Screw Conveyor Layout with Combined Material Disposal to Trailers with CCTV and Other Optimizations	Alternative 2 Separated Fine Screenings and Grit Screw Conveyor Layout with One Roll-Off Container per Truck Bay on an Automated Rail System	Alternative 3 Separated Fine Screenings and Grit Screw Conveyor Layout with Two Self-Leveling Roll-Off Containers Per Truck Bay	Alternative 4 Simplified Fine Screenings Screw Conveyor Layout with Direct Washer Discharge to Two Roll-Off Containers Per Truck Bay
		shutdown to move containers.	shutdown to move containers.	shutdown to move containers.
Sustainability	🟢	🟡	🟡	🟡
	Least number of hauled trips due to larger trailer capacity.	Requires twice as much hauling trips than Loading Alternative 1.	Requires twice as much hauling trips than Loading Alternative 1.	Requires twice as much hauling trips than Loading Alternative 1.
Maintenance Requirements	🔴	🟡	🟡	🟢
	Combined material conveyors will likely experience greater maintenance issues than separate conveyor systems.	Routine maintenance required for screw conveyors and automated rail system.	Routine maintenance required for screw conveyors and self-leveling roll-off containers.	Least number of conveyors and no screw conveyors handling combined material.
Safety	🟡	🟢	🟢	🟡
	Improved access to equipment. Manual leveling of open trailers with permanent access platform.	Improved access to equipment. Automated leveling of open roll-off containers. Moving container may start automatically.	Improved access to equipment. Automated leveling in enclosed self-leveling roll-off containers.	Improved access to equipment. Manual leveling of open roll-off containers but does not require portable stairs.
Constructability	🟡	🟡	🟡	🟡
	Similar construction constraints and schedule as other alternatives.	Similar construction constraints and schedule as other alternatives.	Similar construction constraints and schedule as other alternatives.	Similar construction constraints and schedule as other alternatives.
Maintenance of Plant Operations	🟡	🟡	🟡	🟡
	Similar MOPO needs to other alternatives (screening loading sequencing constraints and temporary grit dewatering).	Similar MOPO needs to other alternatives (screening loading sequencing constraints and temporary grit dewatering).	Similar MOPO needs to other alternatives (screening loading sequencing constraints and temporary grit dewatering).	Similar MOPO needs to other alternatives (screening loading sequencing constraints and temporary grit dewatering).
Impact on Other Unit Processes	🟡	🟡	🟡	🟡
	No significant impact.	No significant impact.	No significant impact.	No significant impact.
Public Impact	🟢	🟡	🟡	🟡
	Least frequent hauling trips.	More hauling trips than Loading Alternative 1.	More hauling trips than Loading Alternative 1.	More hauling trips than Loading Alternative 1.

Criteria	Alternative 1 Redundant Screw Conveyor Layout with Combined Material Disposal to Trailers with CCTV and Other Optimizations	Alternative 2 Separated Fine Screenings and Grit Screw Conveyor Layout with One Roll-Off Container per Truck Bay on an Automated Rail System	Alternative 3 Separated Fine Screenings and Grit Screw Conveyor Layout with Two Self-Leveling Roll-Off Containers Per Truck Bay	Alternative 4 Simplified Fine Screenings Screw Conveyor Layout with Direct Washer Discharge to Two Roll-Off Containers Per Truck Bay
Adaptability to Future Requirements				
	Fine screenings and grit can be combined or separated.	Fine screenings and grit can be combined or separated.	Separated fine screenings and grit disposal.	Separated fine screenings and grit disposal.
Summary				

Loading Alternative 2 scored the highest, with the most green (favorable) ratings and no red (unfavorable) ratings. Loading Alternatives 3 and 4 scored next highest. Loading Alternative 1 scored the lowest with several red (unfavorable) ratings.

10.8 Fine Screening and Grit Loading Alternative Cost Analysis

Each loading alternative was provided a probable construction cost and life-cycle cost to be considered for selection of the recommended alternative. Section 4.2 outlines the assumptions made based on normal engineering practice. Table 10-7 summarizes the construction cost estimate and life cycle cost of each alternative. Detailed OPCC estimates are included in Appendix H and detailed lifecycle cost calculations are included in Appendix I.

Table 10-7 Opinion of Probable Construction Cost and Life-Cycle Costs for the Grit Removal Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Construction Cost (-20% to +30% accuracy)	$1,817,000	$1,760,000	$2,085,000	$936,000
Soft Costs (40%) [1]	$727,000	$704,000	$834,000	$374,000
2021 Project Cost (without contingency)	**$2,544,000**	**$2,464,000**	**$2,919,000**	**$1,310,000**
20-Yr O&M NPV	$4,585,000	$3,488,000	$3,730,000	$3,782,000
Total	**$7,129,000**	**$5,952,000**	**$6,649,000**	**$5,092,000**

Note:
1. Soft costs include project management, engineering, construction management, and project administration costs.

The Life Cycle Costs of the loading alternatives are presented in Figure 10-4 for comparison.

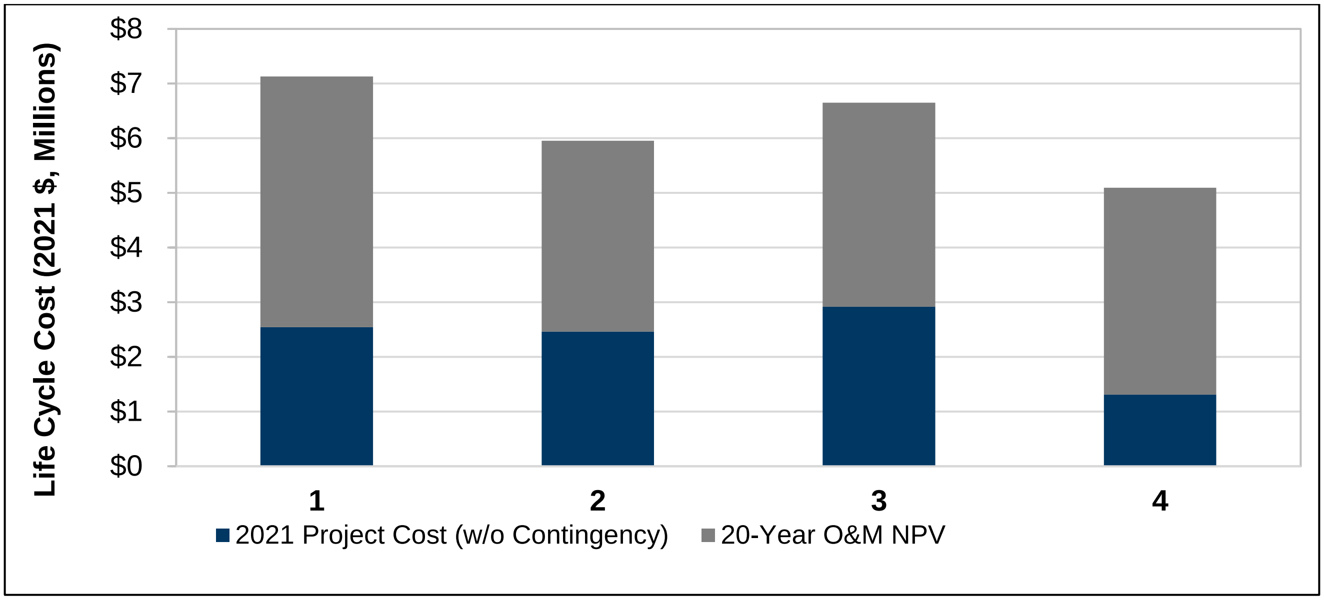


Figure 10-4 Fine Screening and Grit Loading Life Cycle Cost Comparison

10.9 Recommended Fine Screening and Grit Loading Alternative

GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost factors for each loading alternative. Loading Alternative 2 scored the highest, with the most green (favorable) ratings and no red (unfavorable) ratings.

Following the evaluation of non-cost factors, capital and lifecycle cost estimates were developed for each loading alternative. Loading Alternative 4 had the lowest capital and life cycle costs.

Loading Alternative 2 was selected following a holistic consideration of both the cost and non-cost evaluation criteria. This loading alternative has an estimated AACE Class 3 project cost escalated to mid-point of construction (2025) of $1,354,000 (-20% to +30% range of accuracy).

Loading Alternative 2 includes:

- Replacement of the two existing fine screenings conveyors with two new shaftless screw conveyors that discharge material to the fine screenings transfer conveyors
- Installation of two new shaftless fine screenings transfer screw conveyors
- Installation of two new shaftless fine screenings loading screw conveyors
- Installation of two new shafted grit screw conveyors
- Use of two roll-off containers on an automated rail system for fine screening and grit loading
- Installation of new dock bumpers for the Truck Bay
- Installation of new discharge ports to the Truck Bay in the Cyclone Classifier Room from the fine screenings loading conveyors and grit conveyors
- Investigate plumbing system and determine if demolition of existing floor drains and installation of new sediment buckets is required
- Modifications to existing electrical, HVAC, and odor control systems to accommodate the new/replaced equipment

Loading Alternative 2 provides the following benefits to AlexRenew that align with the Strategic Outcomes of AlexRenew's 2040 Vision Statement:

- Operational Excellence
  - Ensures robust environmental compliance through enhanced conveyance operations and improved loading methods and provides the flexibility to meet future environmental requirements.
- Adaptive Culture
  - Reduces the potential points of failure within the conveyance system, improves the reliability of the fine screenings and grit loading system, and reduces the current safety hazards associated with maintenance of the existing trailers.
- Watershed Stewardship
  - Does not significantly increase energy use at the facility and provides more efficient hauling operations due to increased material capture and disposal.
- Public Trust
  - Increases the number of off-site disposal hauls per week due to the improved grit and fine screenings capture however the impact to the surrounding community is minimal.
- Financial Resilience
  - This loading alternative has the lowest lifecycle costs which meet the performance objectives for this facility.

11. Primary Settling Evaluation

The Primary Weir Observation House (PWOH) is need of repairs due to corrosion of building components and electrical systems due to the humid conditions. Therefore, the following three alternatives were developed for the upgrade of the PWOH:

- Primary Settling Alternative 1: Refurbishment of the PWOH (as well as modification of the scum trough access crosswalk)
- Primary Settling Alternative 2: Replacement of the PWOH with flat, aluminum covers (as well as modification of the scum trough access crosswalk)
- Primary Settling Alternative 3: Replacement of the PWOH with retractable reinforced geomembrane covers (as well as modification of the scum trough access crosswalk)

11.1 Basis of Design

The Level of Service Goals presented in Table 11-1 were selected as the Basis of Design Criteria for the primary settling system.

Table 11-1 Level of Service Goals for Primary Settling Basis of Design Criteria

Parameters	Basis of Design
Primary influent flow	
Minimum flow	20 MGD
Design average daily flow	54 MGD
Design peak hourly flow	125 MGD
Target performance [1]	
Primary Effluent TSS	100-150 mg/L
Primary Effluent BOD_5	100-180 mg/L
Primary sludge pumping	

Parameters	Basis of Design
Pump type	Centrifugal (recessed impeller)
Primary sludge pumping rate	2,800 gpm (with all settling tanks in service)
Primary scum removal	
Scum skimmer type	Rotating scum troughs equipped with electric actuators
Primary scum pumping rate	100 gpm (per pump); 2 pumps available
Control automation	Scum directed to scum handling equipment based on level controls within the dilute scum pit; dilute scum is transferred intermittently. Scum recirculated to prevent solidification.
Materials of construction for new equipment	Type 316 SS, aluminum, or fiberglass unless otherwise noted
Area electrical classification [2] Primary Weir Observation House Primary Settling Tanks Primary Sludge Pump Gallery Dilute Scum Wet Wells	Class I, Division 1, Group D (may be de-rated C1/D2 if continuously ventilated at a rate of 12 air changes per hour or more) Class I, Division 2, Group D (Open to atmosphere) Class I, Division 2, Group D (may be unclassified if continuously ventilated at a rate of 6 air changes per hour or more) Class I, Division 1, Group D
Odor control	Cover effluent weirs and connect to existing odor control system
Effluent weir access	Allow easy access for personnel to observe water quality passing over effluent weirs and to wash down the weirs for algae removal
Scum trough access	Allow easy access for personnel to observe rotating scum trough and to wash down the scum trough

Notes:
1. Virginia SCAT regulation (9VAC25-790-460).
2. NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities, 2020 Edition.

11.2 Primary Settling Tank Influent Flow Distribution

As discussed in the TM, except for Primary Settling Tanks 7 and 8, CFD modeling results indicate that wastewater is distributed more equally to the primary settling tanks when the tanks are operated in pairs with stop logs inserted in the primary influent channels to isolate flow from the four primary influent lines. GHD recommends that AlexRenew consider operating in this manner except in rare circumstances when high flow conditions occur during the time when one primary settling tank is out of service for maintenance or repairs. Under current daily average flow conditions, six primary settling tanks would be in service. Three primary influent lines would be used to convey wastewater to three pairs of primary settling tanks. Valves on the three primary influent lines would be used to distribute approximately one-third of the total flow to the three pairs of primary settling tanks in service. The control valve on the fourth primary influent line to the two remaining primary settling tanks would be closed until such time as high flow conditions require additional tanks in service. At that time, the control valve on the fourth primary influent line would be opened and all four control valves adjusted to distribute approximately one-quarter of the total flow to the four pairs of primary settling tanks in service.

To address the unequal flow distribution between Primary Settling Tanks 7 and 8 that the CFD modeling results indicates even when the stop logs are installed in the primary influent flow channels, GHD recommends installation of a flow control device in the primary influent channel to Primary Settling Tank No. 8.

In addition, GHD recommends that AlexRenew replace the stop logs used to isolate the primary influent channels with aluminum or stainless steel slide gates equipped with electric actuators. Replacing the stop logs with slide gates will significantly reduce the effort required to remove the stop logs when the need for maintenance prevents operation of the primary settling tanks in pairs.

11.3 Primary Sludge Pumping Modifications

As noted in Section 2.7, operators at the AlexRenew WRRF have experienced issues with ragging and plugging of the primary sludge pumps with debris not intercepted by the plant Headworks. Figure 11-1 illustrates the quantity of material currently removed from the plant primary sludge pumps by plant operators. As previously mentioned, proposed upgrades to wastewater screening and grit removal systems are anticipated to improve the capture and removal of screenings and debris from the incoming raw wastewater. As a contingency, however still, installation of inline sludge grinders on the suction side of the primary sludge pumps offers the opportunity to further reduce the likelihood of pump ragging and reduce the likelihood of primary sludge piping blockages.

As previously mentioned, the AlexRenew WRRF primary sludge pumps are configured in four groups of 3 pumps (2 duty, 1 standby). Each grouping of 3 pumps serves two primary settling tanks. Primary Settling Tanks 5 and 6 as well as Primary Settling Tanks 7 and 8 also currently include a standby plunger type sludge pump; however, GHD understands that these pumps are no longer operational.

Figure 11-1 Solids Removed from Primary Sludge Pumps

To accommodate inline sludge grinders such as those shown in Figure 11-2, the primary sludge pump suction piping must be reconfigured and in certain cases the position of the primary sludge pumps adjusted. Additionally, to create space for the primary sludge pumps and grinders, GHD proposes that the existing plunger pumps be fully decommissioned and removed. The proposed configuration for the addition of inline grinders for the primary sludge pumps in shown in Figure 6 in Appendix G.

Figure 11-2 Example Inline Primary Sludge Grinder (image courtesy of JWC Environmental)

As shown in Figure 6 in Appendix G, the positions of the primary sludge pumps have been adjusted to allow an inline grinder to be installed on the suction side. All primary sludge pumps will include an inline grinder thereby providing total redundancy for primary sludge grinding and pumping capability. Each grinder rated for flows up to 550 GPM will include a 3 HP motor and local control panel which includes jam sensing instrumentation and preprogrammed sequences of operation. To allow for a more overall compact footprint, GHD proposes that the existing suction side isolation plug valves for the primary sludge pumps be removed and replaced with knife gate isolation valves. An isolation valve will also be configured between the sludge grinders.

GHD notes that the raised pump platforms currently used for primary sludge pumps 7-12 have limited available footprint. GHD has developed a conceptual arrangement for the layout of these pumps with suction inline grinders based on record drawings provided for the AlexRenew WRRF. Additional field investigations and dimension verification is necessary to confirm the layout concept for the pumps in these areas. The addition of a grinder to these elevated platforms increases the amount of equipment that must be serviced by plant staff. GHD believes it may be warranted to integrate some type of lifting apparatus (such as monorails) to assist with removing the equipment from the platforms for maintenance.

The primary sludge pumps are all located in Gallery 5 of the AlexRenew WRRF. The gallery is the location of the primary sludge pumps and associated sludge headers. As such, GHD would consider the space to be rated as a Class I, Division 2, Group D space (per Table 6.2.2(a), Row 9a of NFPA 820, 2020 Edition). The space may be unclassified if the gallery is continuously ventilated at rate of 6 air changes per hour or more. From available record drawings, GHD is unable to confirm whether this amount of ventilation is currently being provided for the gallery. During site visits to the AlexRenew WRRF, GHD personnel observed many components within the gallery that do not appear to be rated for use in a Class I, Division 2, Group D area. To develop a conservative opinion of probable construction costs for the addition of grinders to the primary sludge pumps, GHD has assumed new equipment must be rated for the potentially explosive atmosphere. GHD recommends that the implications of hazardous area classification for Gallery 5 be further investigated during design.

During initial workshops with staff from the AlexRenew WRRF, GHD identified the potential to change the mode of operation of the plant primary sludge pumps. As mentioned previously, two primary sludge pumps operate continuously at constant speed for each grouping of 3 primary sludge pumps. One pump is valved to withdraw sludge from each primary settling tank and one pump serves as an installed standby ready to be put in service when needed. This mode of operation assists in keeping the sludge blanket levels of the primary settling tanks low as well as keeping the solids concentration of the primary sludge typically less than 0.5% by weight. The primary sludge is pumped to gravity sludge thickeners which increase the solids content of the primary sludge prior to pumping to the anerobic digesters.

In other wastewater treatment facilities, which do not have the benefit of gravity sludge thickeners, GHD has observed various pumping modes of operation to increase the % solids of the primary sludge and minimize the volume of water conveyed to the anaerobic digesters. Such modes of operation include: (1) intermittent operation of primary sludge pumps based on timer settings; (2) variable speed modes of operations (sludge pumps operating on variable frequency drives); and (3) dynamic operation of the primary sludge pumps to achieve a target primary sludge solids concentration (as measured by online sludge density meters) or sludge blanket level sensors. Alteration of existing primary sludge pumps to include VFDs or online instrumentation to monitor the thickness of the primary sludge or sludge blankets is possible for the primary sludge systems of AlexRenew. However, GHD does not believe that the cost is justified given that the plant includes systems already to regulate and increase the solids concentration of primary sludge prior to anaerobic digestion.

11.4 Primary Sludge Grinders

As noted previously, the AlexRenew operators report periodic problems with primary sludge pumps clogging primarily in connection with high solids loads received during wet weather operating conditions. Although the frequency and magnitude of high solids loads received by the primary settling tanks is expected to be reduced with the implementation of improvements to wastewater screening and grit removal systems, AlexRenew may want to consider installing in-line sludge grinders in the pump suction piping as an additional measure to reduce pump clogging. Furthermore, the installation of grinders on the suction side of the primary sludge pumps provides the opportunity to reduce operation and maintenance efforts on the primary sludge pumps as well as potentially improving biosolids quality by reducing the chance of large debris getting into the solids train.

11.5 Miscellaneous Improvements

GHD recommends other miscellaneous primary settling tank improvements, including:

- Replace the scum skimming mechanisms and associated electric actuators for skimming floating solids and FOG from the surface of the primary settling tanks, reroute power feed to the actuators, demolish the existing unused NEC Class 1, Division 2 scum control panels, provide timed spray header in front of each scum trough to push scum toward trough prior to actuation, provide automated scum trough flushing system for cleaning trough and channel after each use, and provide new plant water hose bibs adjacent to each pair of scum skimming mechanisms.
- Replace the grinder and two recirculating chopper pumps in the scum well with larger capacity units designed for pumping to the new mechanical scum screens in Building K. Replace mixing/flushing valves and piping, telescoping valve, drain valve, and controls for the grinders and chopper pumps.
- Replace wood primary settling tank scum baffle boards with new FRP or SS baffle boards.
- Replace the primary settling tank influent baffles with new FRP or SS baffles.
- Replace handrail sections around the primary settling tanks which are below code height.
- Drain and inspect each primary settling tank and repair any observed leaks in the concrete walls.
- Replace the influent stop plates to each of the primary settling tanks with manual stop gates.
- Demolish abandoned primary sludge pumps.
- Replace old sludge and drain valves within PST pipe gallery (some have already been replaced).
- Evaluate lighting and HVAC in the primary settling tank pipe gallery for NFPA 820 compliance.
- Evaluate extension of the odorous air piping to pull foul air from the covered primary settling tank effluent channel if existing odor control system is determined to have available capacity.
- Repair or replace degraded concrete and metal supports for the primary settling tanks effluent channel.

11.6 Primary Settling Alternative 1 – Renovate Primary Weir Observation House

11.6.1 Description

This primary settling alternative involves renovating the PWOH for continued long-term use. Proposed renovations include replacement of corroded metal roof panels, repainting of corroded structural steel supports and other steel components, and replacement of corroded building lighting and electrical equipment and conduits. Corrosion of the existing odorous air piping was also observed and thus it is recommended that this piping be replaced as well. Should this alternative be selected, a more detailed structural assessment of the PWOH may be prudent to further refine the extent of building renovations.

This primary settling alternative also involves replacing the existing walkway that spans across all eight primary settling tanks and is located immediately outside the PWOH building upstream of the primary settling tank effluent weir area. A new walkway would be constructed at a location that provides better access for periodic maintenance cleaning of the rotating scum skimmer pipe. The new walkway will maintain access to electric actuators currently located along the PWOH east wall (exterior) for operation of the scum skimming mechanisms.

Figure 11-3 Primary Weir Observation House Corrosion

11.6.2 Concept Arrangement

This primary settling alternative is essentially identical to the arrangement of the existing PWOH, except for replacement of the existing cross walkway located outside of the PWOH with a new cross walkway allowing improved access for periodic maintenance cleaning of the rotating scum skimmer pipe. Periodic cleaning of the scum skimmer pipe is necessary because solids tend to accumulate in the pipe over time, particularly at the end furthest from the scum well. Cleaning the scum skimmer pipe is accomplished by AlexRenew staff using a hose from a cross walkway located immediately outside the PWOH and upstream of the effluent weir area. The existing cross walkway is located directly over the scum skimmer pipe, which makes access for cleaning difficult. Operators must lean out over the access walkway handrail to direct hose spray to the scum skimmer pipe below. As noted above, access to the scum trough actuators must be maintained with the proposed new cross walkway. The proposed new cross walkway arrangement for the exterior of the PWOH adjacent to the existing scum trough is shown in Figure 1 in Appendix G.

11.6.3 Operational Efficiency and Reliability

Implementation of this primary settling alternative is not expected to result in any significant change to operational efficiency and/or reliability other than improved access to the scum trough may alleviate accumulation and solidification of scum in the trough by allowing operators to clean the trough more easily and effectively.

11.6.4 Process Resiliency

This primary settling alternative is not expected to improve the resiliency of the primary treatment process in any significant way. Minor improvement may be realized due to improved operator accessibility to the scum skimmer pipe for maintenance cleaning.

11.6.5 Sustainability

Compared to the other primary settling alternatives being considered for the PWOH, this primary settling alternative generates the least construction waste and requires the least new materials. On the other hand, this primary settling alternative requires the most volume of air to be continuously ventilated and treated for odor control. This requires significantly higher energy and chemical use for odor control than the other primary settling alternatives.

11.6.6 Maintenance Requirements

In this primary settling alternative, current access would be maintained for maintenance cleaning of the primary settling tank effluent weirs and troughs. In addition, relocation of the cross walkway outside the PWOH would improve access to the rotating scum skimmer for maintenance cleaning to convey solids that accumulate in the skimmer pipe to the scum pumping station for processing. Thus, overall maintenance effort is reduced by this alternative. Operation and maintenance effort and costs will continue to be necessary for upkeep of the PWOH. Based on discussion with AlexRenew WRRF staff, the effort and cost for upkeep of the PWOH is minimal.

11.6.7 Safety

Operator safety would be improved under this primary settling alternative due to improved access for maintenance cleaning of the rotating scum skimmer pipes. Operators would no longer be required to reach beyond the limits of the existing cross walk and fall protection railing for hosing the existing rotating scum trough.

11.6.8 Constructability

All primary settling alternatives considered for the upgrading of the PWOH pose constructability challenges due to the need for significant renovation or demolition of the PWOH building. Renovations to the PWOH and replacement of the across tank walkway will need to be executed in a staged manner to allow at least six primary settling tanks to remain in service. This is discussed further in Section 11.1.9.

Temporary cover measures will need to be employed so that construction debris is prevented from falling into the weir areas of the primary tanks during selective demolition of the PWOH roofing materials and surface preparation of rusting steel building components in preparation for repainting. Similarly, temporary measures (such as covers) may need to be employed during the replacement of the across tank walkway currently located over the scum trough.

11.6.9 Maintenance of Plant Operation

As previously mentioned, the execution of the refurbishment works on the PWOH and the crosswalk upstream of the scum trough will need to be executed in a staged manner to allow the primary treatment systems of the AlexRenew WRRF to remain operational during construction. As mentioned previously, the plant typically operates with only 6 primary settling tanks in service. The remaining two tanks are put into service only as needed to accommodate higher wet weather flows.

Renovations to the PWOH and replacement of the across tank access walkway will need to be sequenced such that the works are only completed over or within the tanks that are currently offline. Construction activities may prevent operation of more than six primary settling tanks when the plant experiences high flows (for example when scaffolding is installed within a tank). Thus, there may be times when the primary settling tanks in service may need to operate at higher than desired surface overflow rates. The implications of this operational scenario are further discussed in Section 11.1.10. Concerns associated with operating primary settling tanks at surface overflow rates higher than normal may be alleviated to some extent by limiting construction to times of the year when the plant is less likely to receive peak wet weather flows.

11.6.10 Impact on Other Unit Processes

Except for possible short-term impacts during construction of the proposed renovations, implementation of this primary settling alternative represents no significant change to current operating conditions and is not expected to impact other unit processes at the WRRF. During construction of the proposed renovations, some primary settling tanks will need to be removed from service. During wet weather operating conditions, this may result in times when the “in service” primary settling tanks may need to operate at surface overflow rates above desired limits (as detailed in Table 4-1). During such periods, downstream wastewater treatment systems may receive increased solids and BOD loadings. Short duration increases in solids and BOD loadings are not expected to adversely affect overall plant effluent quality.

11.6.11 Public Impact

Potential public impact is expected to be less than the other two primary settling alternatives, which may have short-term periods when continuous odor control of the primary weirs cannot be provided. With this primary settling alternative, it should be possible to maintain ventilation of the PWOH and primary settling tank effluent weir area to the odor control system with either no, or limited, interruption during construction.

11.6.12 Adaptability to Future Requirements

This primary settling alternative is not expected to have any adverse or beneficial impact on AlexRenew’s ability to adapt to future requirements.

11.7 Primary Settling Alternative 2 – Demolish PWOH and Install Flat Plate Aluminum Covers for Odor Control

11.7.1 Description

This primary settling alternative involves demolishing the PWOH and installing flat plate aluminum covers for odor control over the effluent weir area of each primary settling tank (see Figure 11-4 for example). The aluminum covers would be equipped with access hatches to allow for observation of the primary settling tank effluent weir area and periodic maintenance hosing of the effluent weirs and troughs. As with Primary Settling Alternative 1, this primary settling alternative also includes replacement of the across tank access walkway currently located outside the PWOH and over the primary settling tank scum skimmer pipe. The existing walkway would be replaced with a new walkway better located to facilitate improved access for cleaning of the scum skimmer pipe.

Figure 11-4 Flat Plate Aluminum Covers

11.7.2 Concept Arrangement

This primary settling alternative involves demolishing the existing PWOH and installing flat plate aluminum covers over the primary settling tank effluent weir trough area (shown in Figure 2 in Appendix G). The cover plates will integrate a tie point for ventilation of odorous air (OA) from under the covers to the plant odor control system. The OA collection later will connect to a new OA common header which will run the length of the primary effluent channel and connect to the existing 60" OA header (which connects to the existing centralized odor collection and treatment system at Building L). The flat aluminum covers will include access/inspection hatches at key locations allowing operators to observe primary settling tank effluent quality and perform periodic cleaning of the effluent weir troughs. GHD notes that the expected requirement for weir flushing may be reduced in this configuration due to the reduced sunlight that will reach the weirs. Reduced sunlight exposure is expected the reduce the likelihood of algae growth on the weirs.

The aluminum cover plates will be designed to accommodate personnel loads allowing operators to walk on the covers) however. However, GHD recommends that the railings around the covers to provide fall protection if the covers need to be temporarily removed for maintenance access. GHD proposes that the existing walkways just above the covers be preserved. Sections of removable railing (or chained access points) are proposed to allow operators to step onto the aluminum covers. A portable gantry system (or other lifting apparatus) will need to be employed to completely remove the aluminum panel sections (~150 lbs. each).

Given that the weir area will no longer benefit from the lighting in the PWOH, new exterior lighting will be necessary for safe access to the cover area during night and low light conditions. GHD has carried an allowance for exterior lighting in the capital costs considered. However, development of a lighting plan will be required during detailed design if AlexRenew decides to implement this primary settling alternative.

11.7.3 Operational Efficiency and Reliability

This primary settling alternative requires greater operational effort due to the need for operators to open hatches to observe the effluent weirs and washdown the weir troughs should solids be observed to have accumulated. Additionally, all activities (inspection, cleaning) would be executed outdoors exposed to the elements. Such activities will be more challenging during inclement weather or low light conditions. Effort to operate and maintain the PWOH, however, would be eliminated.

As for Primary Settling Alternative 1, this concept (which includes modification to the across tank access walkway) may improve reliability of the scum collection system by reducing the likelihood of scum accumulation in the trough through reduced operator effort to hose out the troughs.

11.7.4 Process Resiliency

This primary settling alternative is not expected to have any significant impact on resiliency of the primary treatment process. Minor beneficial impact may be possible due to improved accessibility for scum skimmer pipe cleaning associated with replacement of the across tank access walkway.

11.7.5 Sustainability

Primary Settling Alternative 2 will have more construction waste and require more new construction materials than Primary Settling Alternative 1. However, this primary settling alternative does provide opportunity for energy savings in that the PWOH will no longer require heating and ventilation. Furthermore, installing covers directly over the effluent weir trough area provides opportunity to substantially reduce the volume of air that must be treated by the plant odor control system. The reduction in odorous air volume that must be managed also contributes to opportunity to reduce energy and chemical requirements for odorous air ventilation and treatment.

11.7.6 Maintenance Requirements

This primary settling alternative will increase labor required for maintenance cleaning of primary settling tank effluent weirs and troughs as operators will need to open hatches for access. It will however reduce the effort associated with cleaning of the primary tank scum trough (periodic hose down). Additionally, maintenance of the PWOH and associated heating and ventilation systems would be eliminated.

11.7.7 Safety

Operator safety would be improved by constructing a new across tank access walkway that provides better access to the rotating scum skimmer pipes for periodic maintenance cleaning. On the other hand, the proposed aluminum covers are heavy and lifting them manually for removal could present added risk for back injury. To mitigate this risk, use of a rolling gantry crane and hoist is recommended for removing the covers.

11.7.8 Constructability

This primary settling alternative requires demolition of the PWOH, which is in a highly congested area of the plant between the primary and secondary settling tanks. Demolition of the PWOH will have to be executed in a highly sequenced and controlled manner to minimize the potential for demolition debris entering the primary or secondary settling tanks or adjacent channels. Temporary measures such as the use of covers (plywood, netting) over the weir areas, as well as areas adjacent to the scum trough cross tank access walkway, will need to be employed. It is recommended that the treatment tanks surrounding the active demolition areas and new cover install and crosswalk modifications be taken out of service during such works.

11.7.9 Maintenance of Plant Operations

This primary settling alternative will require primary settling tanks to be taken out of service for constructing the proposed renovations. Demolition of the PWOH and replacement of the across tank access walkway will need to be sequenced such that construction is performed over or within only the tanks that are currently out of service. Construction activities may not allow more than six primary settling tanks to be in service when the plant experiences high flows (for example if there is scaffolding within a tank). Thus, there may be times when primary settling tanks may need to operate at higher than desired surface overflow rates. As previously discussed, concerns associated with operating at higher surface overflow rates may be alleviated by scheduling construction activities during periods of the year with the plant is less likely to receive peak wet weather flows.

11.7.10 Impact on Other Unit Processes

Since the effluent weir area of the primary settling tanks will be covered, deterioration of primary settling tank effluent quality will be less readily observable by the operators of the facility. GHD assumes that plant operators will continue to utilize primary effluent sampling data to track primary settling tank effluent quality. As with Primary Settling Alternative 1, the need to take primary settling tanks out of service during construction may result in a short duration increase in TSS and BOD_5 loadings to downstream wastewater treatment systems.

11.7.11 Public Impact

Construction provisions for sequencing and temporary odor control piping connections will be needed to minimize the release of potentially odorous air from the primary effluent weirs during construction. Once the project is built there should be no adverse public impact.

11.7.12 Adaptability to Future Requirements

This primary settling alternative is not expected to impact AlexRenew's ability to adapt to future requirements.

11.8 Primary Settling Alternative 3 – Demolish PWOH and Install Retractable Fabric Covers for Odor Control

11.8.1 Description

As with Primary Settling Alternative 2, this primary settling alternative involves demolishing the PWOH and installing a new cover system for odor control over the effluent weir area of each primary settling tanks. In this primary settling alternative, rather than using flat plate aluminum covers, geomembrane over aluminum frame covers is proposed. The geomembrane covers are retractable and can be opened manually allowing operator access for inspection of primary settling tank effluent quality and periodic cleaning of the effluent weir troughs. An example of the proposed geomembrane covers is shown in Figure 11-5. As with Primary Settling Alternative 2, this primary settling alternative also includes modification of the crosswalk currently over the primary tank scum through to facilitate improved access for cleaning of the trough.

Figure 11-5 Retractable Fabric Covers (Cox Creek WRF, Anne Arundel County MD)

11.8.2 Concept Arrangement

Like Primary Settling Alternative 2, this primary settling alternative involves demolition of the PWOH. For continued odor control, the primary settling tank effluent weir trough areas will be covered with structurally supported, retractable geomembrane covers shown in Figure 3 in Appendix G. Due to the retractable nature of these covers, it is possible to expose the entire weir area under the cover. Unlike the flat plate aluminum covers, however, operations personnel will not be able to walk on the covers.

The geomembrane covers will include a pipe connection for collection and ventilation of odorous air (OA) to the plant odor control system. A rigid aluminum end section of the cover provides a location for odor collection. This connection is shown in Figure 3 in Appendix G. The OA collection pipes from each cover will connect to a new OA common header which will run the length of the primary effluent channel and connect to the existing 60-inch diameter OA header which connects to the plant odor control system at Building L.

As previously mentioned, the geomembrane covers will not be able to support personnel loads. Therefore, GHD recommends that railings be provided around the weir covers. GHD proposes that existing walkways be preserved to allow operators to continue to walk between and around the weir areas currently located within the PWOH.

As with the new flat aluminum cover plate alternative, new exterior lighting will be needed for the primary tank weir area to allow safe access to the geomembrane covers during night and low light conditions. GHD has carried an allowance for exterior lighting in the capital costs considered for this alternative. If AlexRenew selects this primary settling alternative for implementation, a lighting design will need to be developed during detailed design.

Figure 11-6 Conceptual Layout for Retractable Fabric Covers

11.8.3 Operational Efficiency and Reliability

This primary settling alternative involves greater operational complexity due to the need for operators to manually retract the geomembrane covers to observe the primary settling tank effluent quality and periodically clean the effluent weir troughs when necessary. The ability to fully retract the geomembrane covers provides greater ability for the operators to inspect the weirs and weir troughs compared to fixed aluminum covers which restrict inspection and cleaning to access hatch locations. As with Primary Settling Alternative 2, inspection and cleaning will be performed outdoors. Such activities may be more challenging during inclement weather or low light conditions.

As with Primary Settling Alternative 2, this concept, which includes modification to the across tank access walkway in the vicinity of the primary settling tank scum skimming mechanisms, may improve reliability to some extent by reducing operator effort necessary for cleaning the scum skimming pipes.

11.8.4 Process Resiliency

As with Primary Settling Alternative 2, this alternative is not expected to have any significant impact on resiliency of the primary treatment process. Minor beneficial impact may be possible, however, due to improved accessibility for cleaning the primary scum skimming pipes.

11.8.5 Sustainability

Sustainability aspects of this alternative will be like Primary Settling Alternative No. 2; however, the volume of odors may be slightly higher than Primary Settling Alternative 2.

11.8.6 Maintenance Requirements

This primary settling alternative requires a greater amount of labor for maintenance cleaning of primary settling tank effluent weirs and troughs as operators will need to manually remove the retractable geomembrane covers. These upgrades will however reduce the effort associated with cleaning of the primary tank scum trough. Additionally, elimination of the PWOH offers opportunity to reduce maintenance associated with maintaining the PWOH building and associated heating and ventilation systems. It is anticipated that the structurally supported geomembrane covers will be more maintenance intensive (replacement/repair of the geomembrane) than aluminum covers.

11.8.7 Safety

Operator safety would be improved by constructing a new across tank access walkway that provides better access to the rotating scum skimmer pipes for periodic maintenance cleaning. However, the installation of retractable fabric covers over the primary settling tank effluent weir area will, to some extent, inhibit operator access for maintenance cleaning of the effluent weirs and troughs compared to accessibility afforded by the PWOH. Unlike the heavy aluminum covers, the light retractable fabric covers can be retracted or replaced easily by two persons without any added safety risk for injury.

11.8.8 Constructability

Like Primary Settling Alternative 2, this primary settling alternative involves demolishing the PWOH, which is in a highly congested area of the plant between the primary and secondary settling tanks. Demolition of the PWOH will have to be executed in a highly sequenced and controlled manner to keep demolition debris from entering the primary or secondary settling tanks and associated wastewater flow channels. Temporary measures such as the use of covers (plywood, netting) over the effluent weir areas (as well as areas adjacent to the scum trough cross walk) will need to be employed. It is recommended that the treatment tanks surrounding the active demolition areas (and new cover install and crosswalk modifications) be taken out of service, when possible, during such work.

11.8.9 Maintenance of Plant Operations

As with Primary Settling Alternative 2 and as described above, this alternative will require primary settling tanks to be taken out of service to execute the required demolition and upgrade works. Demolition of the PWOH and replacement of the across tank access walkway will need to be staggered such that construction activities are performed only over or within the tanks that are taken out of service. Construction activities may not allow additional primary settling tanks to be brought back into service quickly when the plant experiences high flows (for example if there is scaffolding within a tank). Therefore, there may be times when the primary settling tanks may need to operate at higher than desired surface overflow rates. As previously mentioned, concerns associated with operating primary settling tanks at high surface overflow rates may be alleviated to some extent by scheduling demolition of the PWOH and replacement of the scum trough across tank access walkway during times of the year when the plant is less likely to receive peak wet weather flows.

11.8.10 Impact on Other Unit Processes

This primary settling alternative may have detrimental impacts on downstream wastewater treatment systems like the impacts previously described for Primary Settling Alternative 2 (installation of flat plate aluminium covers with access hatches over the effluent weir area of each primary settling tank).

11.8.11 Public Impact

Construction provisions for sequencing and temporary odor control piping connections will be needed to minimize the release of potentially odorous air from the primary effluent weirs during construction. Once the project is built there should be no adverse public impacts.

11.8.12 Adaptability to Future Requirements

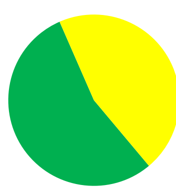
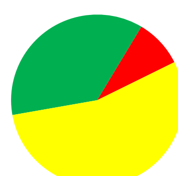
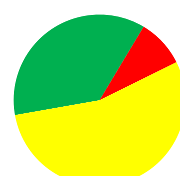
This primary settling alternative is not expected to have any adverse or beneficial impact on AlexRenew's ability to adapt to future requirements.

11.9 Evaluation of Primary Weir Observation House Alternatives

As discussed in Section 4.1, GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost evaluation factors of the four alternatives as shown in Table 11-2.

Table 11-2 Summary of Primary Weir Observation House Alternatives

Criteria	Alternative 1 Renovate PWOH Building	Alternative 2 Install Aluminum Covers	Alternative 3 Install Geomembrane Covers
Equipment Layout/Installation	Requires limited change to the current layout of the PWOH beyond the modifications to the across tank access walkway for improved cleaning of the primary settling tank scum skimmer mechanism.	Requires demolition of the PWOH; replacement of the across tank access walkway east of the PWOH to improve access for cleaning the existing scum skimmer mechanism.	Requires demolition of the PWOH; replacement of the across tank access walkway east of the PWOH to improve access for cleaning the existing scum skimmer mechanism.
Operational Efficiency and Reliability	The current configuration of the PWOH allows for easiest access to the primary tank weirs to evaluate primary effluent quality and clean weirs as required.	Covering of the weir areas with aluminum covers is anticipated to increase operations effort for inspection and cleaning of the weirs.	Covering of the weir areas with geomembrane covers is anticipated to increase operations effort for inspection and cleaning of the weirs.
Process Resiliency	Alternative not expected to significantly impact process resiliency beyond improved scum trough cleaning access.	Alternative not expected to significantly impact process resiliency beyond improved scum trough cleaning access.	Alternative not expected to significantly impact process resiliency beyond improved scum trough cleaning access.
Sustainability	While this alternative is least intensive from a waste generation/new material requirement perspective, this alternative will require the highest volume of odorous air ventilation rates and treatment and will also require heating and ventilation of the PWOH building following refurbishment.	This alternative offers the opportunity to reduce the volume of odorous air requiring treatment as well as heating and ventilation of the PWOH.	This alternative offers the opportunity to reduce the volume of odorous air requiring treatment as well as heating and ventilation of the PWOH.
Maintenance Requirements	While the continued use of the PWOH allows for easiest access to the weirs and weir troughs, refurbishing the PWOH will require the continued maintenance of the building and associated heating and ventilation systems.	While access to the weirs may be hindered, the installation of covers is expected to reduce maintenance requirements through preventing algae growth on the weirs. The cover system will have limited maintenance requirements.	While access to the weirs may be hindered, the installation of covers is expected to reduce maintenance requirements through preventing algae growth on the weirs. The cover system will have limited maintenance requirements.
Safety	Improved access to the scum trough for cleaning reduces safety concerns with needing to lean over railing to hose the scum trough.	Operators would not have direct access to the weirs as they currently do and would need to walk on covers to perform	Opening of the covers may pose some safety concerns as compared to current configuration.

Criteria	Alternative 1 Renovate PWOH Building	Alternative 2 Install Aluminum Covers	Alternative 3 Install Geomembrane Covers
		inspection and maintenance activities.	
Constructability			
	Construction will be challenging to achieve controlled demolition and upgrading of the PWOH. Work on the crosswalk will require PSTs to be offline.	Controlled (complete) demolition of the PWOH will be challenging given how congested the area of the plant is.	Controlled (complete) demolition of the PWOH will be challenging given how congested the area of the plant is.
Maintenance of Plant Operations			
	Select PSTs will need to be taken out of service for construction.	Select PSTs will need to be taken out of service for construction.	Select PSTs will need to be taken out of service for construction.
Impact on Other Unit Processes			
	Impacts not expected to be significant, some potential for temporary increased loading to downstream processes.	Impacts not expected to be significant, some potential for temporary increased loading to downstream processes.	Impacts not expected to be significant, some potential for temporary increased loading to downstream processes.
Public Impact			
	Controlled work on the PWOH should mitigate release of OA.	Some potential for fugitive odor emissions during demolition of PWOH.	Some potential for fugitive odor emissions during demolition of PWOH.
Adaptability to Future Requirements			
	Upgrades not expected to significant affect ability to meet future requirements.	Upgrades not expected to significant affect ability to meet future requirements.	Upgrades not expected to significant affect ability to meet future requirements.
Summary			

11.10 Primary Weir Observation House Alternative Cost Analysis

Each Primary Weir Observation House alternative was provided a probable construction cost and life-cycle cost to be considered for selection of the recommended alternative. Section 4.2 outlines the assumptions made based on normal engineering practice. Table 11-3 summarizes the construction cost estimate and life cycle cost of each alternative. Detailed OPCC estimates are included in Appendix H and detailed lifecycle cost calculations are included in Appendix I.

Table 11-3 Opinion of Probable Construction Cost and Life-Cycle Costs for the Primary Weir Observation House Alternatives

	Alternative 1	Alternative 2	Alternative 3	General Improvements and Flow Distribution
Construction Cost (-20% to +30% accuracy)	$2,467,000	$3,203,000	$3,899,000	$3,011,000
Soft Costs (40%) [1]	$987,000	$1,281,000	$1,560,000	$1,204,000
2021 Project Cost (without contingency)	**$3,454,000**	**$4,484,000**	**$5,459,000**	**$4,215,000**
20-Yr O&M NPV	$1,774,000	$644,000	$863,000	N/A
Total	**$5,228,000**	**$5,128,000**	**$6,322,000**	**$4,215,000**

Note:
1. Soft costs include project management, engineering, construction management, and project administration costs.

The Life Cycle Costs of the Primary Weir Observation House alternatives are presented in Figure 11-7 for comparison.

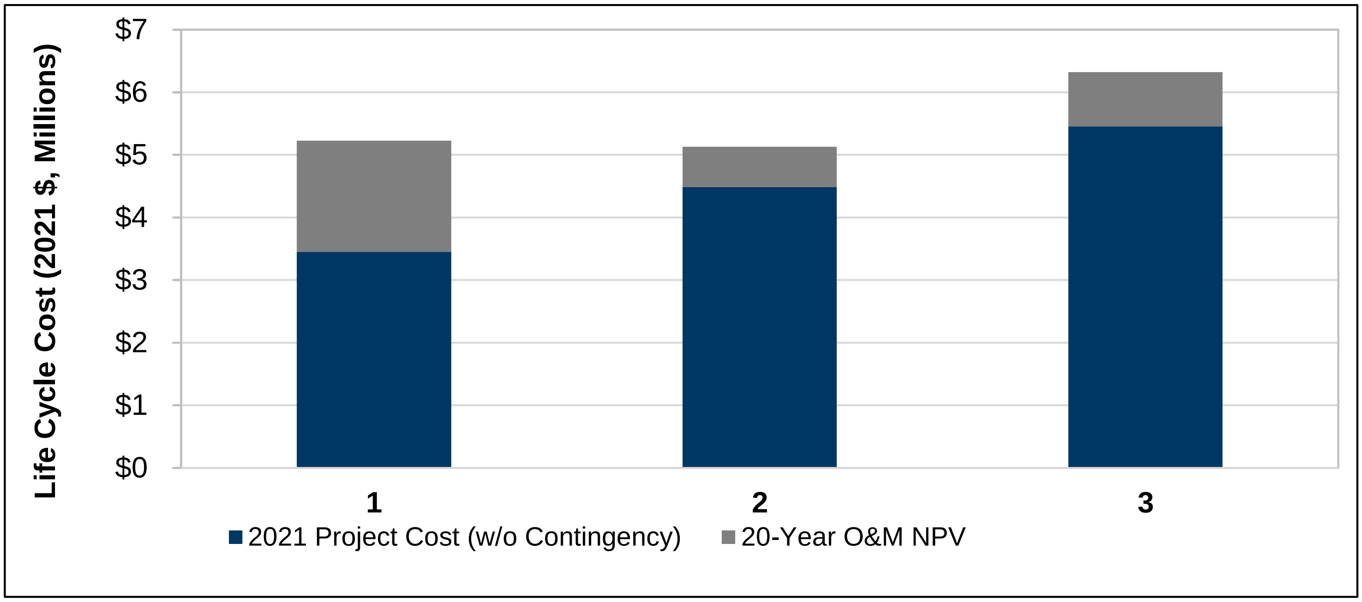


Figure 11-7 Primary Settling Life Cycle Cost Comparison

11.11 Recommended Primary Weir Observation House Alternative

GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost factors for each primary settling alternative. Primary Weir Observation House Alternative 1 scored the highest, with the most green (favorable) ratings and no red (unfavorable) ratings.

Following the evaluation of non-cost factors, capital and lifecycle cost estimates were developed for each primary settling alternative. Primary Weir Observation House Alternative 1 had the lowest capital costs while Primary Settling Alternative 2 had the lowest life cycle costs.

Primary Weir Observation House Alternative 1 was selected following a holistic consideration of both the cost and non-cost evaluation criteria. This primary settling alternative has an estimated AACE Class 3 project cost escalated to mid-point of construction (2025) of $3,810,000 (-20% to +30% range of accuracy).

Primary Weir Observation House Alternative 1 includes:

- – Refurbishment of the PWOH building including replacement of corroded metal roof panels, cleaning and recoating of corroded structural steel supports and other steel components, replacement of corroded building lighting, electrical equipment and conduits, replacement of corroded odorous air piping, replacement and relocation of the odorous air fan to improve maintenance access, replacement of corroded fire alarm components, increase size of plant water line to PWOH to 1.5”, and evaluate means of improving dehumidification in the building.
- – Replacement of the existing walkway upstream of the PWOH building to provide better access to the rotating scum skimmer mechanisms.
- – Given the proposed enhancements to the plant influent screening systems, GHD does not recommend addition of inline grinders for the primary sludge pumps at this time, refer to Section 11.3.
- – Given the use of gravity thickeners for increasing of primary sludge percent solids, GHD does not recommend executing any changes to the mode of operation of the primary sludge pumps as discussed in Section 11.8.
- – In addition to the PWOH improvements, GHD recommends proceeding with primary settling tank influent flow distribution and other miscellaneous primary settling tank improvements as outlined in Section 11.2 and Section 11.5.

Primary Weir Observation House Alternative 1 provides the following benefits to AlexRenew that align with the Strategic Outcomes of AlexRenew’s 2040 Vision Statement:

- – Operational Excellence
  - Ensures complete capture of odorous air from weir areas. Retention of the PWOH structure allows for greatest access to the weirs for inspection and cleaning.
- – Adaptive Culture
  - High level of operational safety.
- – Watershed Stewardship
  - Allows operators to most readily monitor primary effluent quality.
- – Public Trust
  - Continues to allow for effective odor control.
- – Financial Resilience
  - This selected primary settling alternative has lowest lifecycle costs as compared to the other primary settling alternatives assessed.

12. Primary Scum Handling Evaluation

The following two primary scum handling alternatives were identified for renovating the primary scum handling system:

- – Primary Scum Handling Alternative 1: In-Kind Replacement of Existing Primary Scum Handling Equipment with off-site co-disposal or concentrated scum with dewatered fine screenings and grit or pumping of concentrated scum to the anaerobic digesters
- – Primary Scum Handling Alternative 2: Replacement of Existing Equipment with a Scum Screen and Concentrator (separate off-site disposal of concentrated scum)

12.1 Basis of Design

Table 12-1 summarizes level of service goals selected as the Basis of Design Criteria for upgrades to the scum handling system.

Table 12-1 Level of Service Goals for Primary Scum Handling Basis of Design Criteria

Parameters	Basis of Design
Primary dilute scum pumping rate	100 gpm (average); 200 gpm (peak)
Concentrated scum pumping rate	10 gpm (if conveyed as a concentrated slurry); 160 ft^3/hr (if conveyed as screened/dewatered residual)
Concentrated scum	No free water (paint filter test)
Scum disposal	Provide means for discharging concentrated scum to truck bay for off-site co-disposal with wastewater screenings and grit or provide an alternate means for separate off-site disposal; alternatively provide option for discharge of concentrated scum to plant anaerobic digesters
Area electrical classification	NEC Class I, Division 2, Group D hazardous area (unclassified if continuously ventilated at a rate of 12 air changes per hour or more) [1]
Odor control	Cover scum concentration equipment and vent to odor control system (existing equipment currently connected to centralized odor control system)

Note:
1. NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities, 2020 Edition.

12.2 Primary Scum Handling Alternative 1 – In-Kind Replacement of Existing Primary Scum Handling Equipment (Off-Site Co-Disposal with Dewatered Fine Screenings and Grit)

12.2.1 Description

Dilute scum skimmed from the surface of the primary settling tanks by the actuated scum skimmer mechanism flows by gravity to the scum pumping station. The scum pumping station includes two submersible chopper pumps. One pump is normally used to recirculate the contents of the wet well to keep the scum mixed and fluidized for pumping. The second pump is normally used to pump the dilute scum to the scum concentrator system in Building K at a rate of 100 gpm.

The scum concentrator system consists of a scum separation/concentrator unit and a heated/agitated concentrated scum holding tank manufactured by Tenco-Hydro. In the scum separator/concentrator unit, dilute scum floats to the surface where it concentrates as it is removed by a surface skimmer mechanism for transfer to the heated holding tank. Historically, concentrated scum is periodically pumped from the heated holding tank and discharged to loading bins in the truck bays of Building K. As originally designed, the system also included provisions to pump the concentrated scum to the anaerobic sludge digesters or recirculated back into the heated tank to assist in keeping the material fluidized. Conveyance of the concentrated scum within the heated holding tank is achieved by a single progressive cavity pump.

AlexRenew staff report that the existing scum concentrator system has been maintenance intensive. When the concentrator is out of service, scum is currently allowed to overflow the scum concentrator unit for drainage back to the WRRF influent. The heated holding tank was originally equipped with a mechanical mixer that would frequently fail due to the high solids content of the concentrated scum. Mixing of the heated holding tank is currently achieved by recirculating concentrated scum using the concentrated scum pump. Figure 12-1 includes several photos of the existing scum concentrator system.

Figure 12-1 Primary Scum Concentrating System

This primary scum handling alternative involves replacement of the existing scum concentrator system, which has reached the end of its useful life, with similar equipment including a new scum concentrator, new heated concentrated scum holding tank, new concentrated scum transfer pump, and appurtenant piping, instrumentation and controls.

12.2.2 Concept Arrangement

As previously mentioned, this primary scum handling alternative involves complete replacement of the existing equipment with a similar scum concentrating system. The new scum concentrator unit will be sized to accommodate an average dilute scum influent flow of 100 gpm and an instantaneous peak flow of 200 gpm. The scum concentrator unit will include a separation area of approximately 50 ft^2 and will allow for a surface loading rate of approximately 2 gpm/ft^2 at the design average influent flow of 100 gpm.

Manufacturers of scum concentrators generally recommend employing scum concentrators which operate at a loading rate of 3 gpm/ft^2 or less. At the design average scum flow, the hydraulic residence time within the scum concentrator will be approximately 6.5 minutes. The scum concentrator will include a variable speed scum skimmer that will transfer concentrated scum to a new heated scum tank. Water separated from the dilute scum will drain by gravity back to the head of the plant as occurred with the original installation.

GHD proposes that the new scum concentrator unit be installed on the upper level of Building K in a similar location to the current unit. This will allow drainage of water from the new scum concentrator and gravity discharge of concentrated scum to a new day tank on the ground floor. The proposed new scum concentrator configuration is shown in Figure 4 in Appendix G.

As mentioned previously, concentrated scum will be discharged to a new 5 feet diameter, heated holding tank on the ground floor of Building K. The tank will have a maximum storage capacity of approximately 650 gallons and will be continuously mixed by a top entry mixer. The tank contents must be heated and mixed continuously to prevent the concentrated scum from solidifying. The concentrated scum holding tank will include a hot water heating jacket that will receive hot water from a hot water supply/recirculation skid supplied by the scum concentrator system vendor. The hot water skid will require a source of potable or non-potable water for makeup purposes.

The contents of the concentrated scum holding tank will be pumped out periodically using a single progressive cavity concentrated scum transfer pump located directly under the heated holding tank. The transfer pump will operate at a discharge rate of 10 gpm and will be configured to convey concentrated scum to new load out containers (for screenings and grit) in the proposed truck bay expansion in Building K further discussed in the technical memos for the fine screening and grit removal systems. The concentrated scum transfer pump will also be able to recirculate the contents of the concentrated scum tank as with the existing installation. In addition, piping and valves will be provided to allow for future pumping of concentrated scum to the anaerobic digesters. Upgrades to influent wastewater screening and grit removal systems will significantly reduce contaminants (plastics and other inorganic matter) currently present in the concentrated scum and may allow pumping to the digesters without causing concern for contaminating the Class “A” biosolids generated.

The ultimate configuration of the scum discharge will be finalized when the new load out arrangement for screenings and grit is determined. Concentrated scum will be a highly viscous “peanut butter like” material containing minimal free water. The frequency of concentrated scum pump-out will depend on the volume of scum generated and performance of the scum concentrator unit. However, it is expected that the tank will need to be emptied at least daily. To provide flexibility for off-site disposal of the concentrated scum, GHD suggests that a camlock connection on the exterior of Building K be provided to allow liquid waste haulers to potentially collect the material for recovery of its high chemical energy content at off-site energy recovery facilities. To minimize fouling/plugging of any concentrated scum transfer lines, GHD recommends glass-lined ductile iron pipe and fittings with insulation and heat trace. Multiple flushing points will be provided to allow for flushing of the piping. Hot water flushing is recommended.

As with the original scum concentrator system, the concentrator tank and concentrated scum day tank will both be connected and ventilated to the odor control system for the plant to mitigate release of odors in Building K. The headspace of these tanks will be maintained under slight negative pressure. GHD believes the scum handling area in Building K may be rated as a Class I, Division 2, Group D hazardous area as GHD has been unable to confirm that the area is ventilated at 12 air changes per hour or more. For this assignment, equipment has been selected to be suitable for this hazard rating. GHD recommends that Building K ventilation systems be further inspected during subsequent design stages to confirm whether ventilation is sufficient to declassify the hazard rating. GHD has observed that there appear to be electrical components within the scum handling area that are not rated for use in a Class I, Division 2 Group D hazardous environment.

12.2.3 Operational Efficiency and Reliability

Replacement of the existing scum concentrator is expected to significantly improve the ability to process captured scum thus preventing it from returning to the liquid treatment train. GHD understands that the existing scum concentrator system is maintenance intensive. This is believed to be the result of the equipment approaching the end of its operational life. The new scum concentrator system is expected to be more reliable and less operator intensive.

12.2.4 Process Resiliency

The proposed in-kind replacement of the existing scum concentrator system is not expected to significantly improve process resiliency of the plant scum handling system beyond improving reliability as mentioned previously.

12.2.5 Sustainability

The proposed in-kind replacement of the existing scum concentrator system is not expected to substantially improve the overall sustainability of this residual management process. The exception to this statement is the ability to dispose of the concentrated scum at an off-site energy recovery facility provides opportunity for beneficial reuse of this wastewater treatment residual to produce biogas from which energy may be recovered in several ways.

12.2.6 Maintenance Requirements

As noted previously, GHD understands that historically the scum concentrator system has been very maintenance intensive as it approached the end of its useful life. The proposed replacement scum concentrator system will require less maintenance initially but will have similar routine maintenance requirements as compared to the existing system over its service life to maintain functionality. The new scum concentrator will include similar components to the original scum concentrator system that will require routine preventative maintenance activities such as lubrication and wear component replacement.

12.2.7 Safety

In-kind replacement of the scum concentrator system is not expected to change safety conditions with the plant scum handling system.

12.2.8 Constructability

Replacement the existing scum concentrator system in Building K will be a substantial construction effort. Removal of existing equipment and concentrated scum piping may be completed by dismantling existing components and cutting up of existing steel tanks (concentrator, holding tank) to allow for the equipment to be removed through doors on the upper and lower levels of Building K. Installing the new equipment will be more challenging, however, as the equipment will be too large to pass through the existing doors. It will be necessary to create a temporary larger opening into the scum rooms on the upper and lower levels of Building K.

Furthermore, during demolition of the existing scum concentrator system, no equipment will be available to process the dilute scum collected from the primary and secondary settling tanks. During the upgrading of the scum management system, it will be necessary to employ temporary systems, such as a temporary dissolved air floatation system or a scum screen system, to handle and dispose of scum while the scum systems are being upgraded. Alternatively, the dilute scum could be hauled off site for disposal while the scum concentrator systems are upgraded. In this scenario, liquid scum would be collected from the scum wet well by vac truck.

12.2.9 Maintenance of Plant Operation

In-kind replacement of the scum concentrator system is not expected to have any impact on maintaining of the performance of downstream treatment systems unless measures are not taken to temporarily manage dilute scum while the scum concentrator system is being replaced. If scum is not effectively managed by hauling of the dilute scum or temporary scum processing equipment, scum may propagate to downstream treatment processes and negatively affect plant effluent quality.

12.2.10 Impact on Other Unit Processes

As mentioned previously, upgrading of the scum handling system has potential to affect downstream treatment operations if temporary measures are not employed during construction. Following completion of the upgrades, the new scum concentrator system is not expected to have any significant impact on other plant systems.

12.2.11 Public Impact

This primary scum handling alternative is not expected to have any significant impact, either positive or negative impact, on the public.

12.2.12 Adaptability to Future Requirements

This primary scum handling alternative is not expected to have any significant adverse or beneficial impact on AlexRenew’s ability to adapt to future requirements. The exception to this statement is the integration of a camlock load out station on the exterior of Building K, which would allow a liquid waste hauler to collect and remove concentrated scum for processing and energy recovery. Such flexibility provides an alternate disposal mechanism (other than co-disposal with screenings/grit) should concentrated scum no longer be accepted in landfills.

12.3 Primary Scum Handling Alternative 2 – Replace Scum Handling Equipment with Scum Screen and Concentrator

12.3.1 Description

This primary scum handling alternative involves replacing the existing scum concentrator and concentrated scum tank with two fine, wedgewire scum screens and scum screening dewatering presses. Dewatered scum screenings would be disposed of as a dewatered residual independently from wastewater screenings and dewatered grit. An example scum screen and dewatering press arrangement is shown in Figure 12-2.

Figure 12-2 Scum Screen and Dewatering Press at the Cox Creek WRF, Anne Arundel County, MD

12.3.2 Concept Arrangement

As mentioned previously, this primary scum handling alternative involves the installation of two wedgewire drum screens (0.060-inch opening size) capable of treating dilute scum flows up to 200 gpm. One unit provides capacity equivalent to the capacity of the existing scum concentrator. The second unit provides additional processing capacity, if needed, and when not needed will serve as a redundant unit ready to be placed into service when preventive maintenance or emergency repair is required for the other unit.

The proposed scum screens would be installed in the upper scum management room of Building K allowing for easy integration of the screen with existing dilute scum feed lines (currently routed to scum concentrator). Installation of the scum screens on the upper level of the scum management area in Building K also allows for drainage of filtrate from the scum screen to the plant influent for treatment. The scum screen will require hot water to assist in separating scum and associated solids from the wedgewire openings. Scum solids removed as the scum passes through the wedgewire screen are typically in the concentration range of 5-10% solids by weight.

Screened scum solids are discharged from the scum screen to the dewatering press. The dewatering press further facilitates removal of free water from the scum solids by conveying the material up an inclined auger trough with a perforated bottom. Scum solids processed in the dewatering press can achieve total solids concentrations of approximately 20%. The processed scum solids would be disposed of in the same manner as the dewatered screenings and grit. The final length and configuration of the dewatering press is to be finalized based on the selected configuration of the new truck bay for Building K as further discussed in the technical memos for the fine screening and grit removal systems. Alternatively, the processed scum solids can be deposited in a dedicated dumpster for subsequent removal (this alternative is shown in Appendix G).

The proposed configuration of the scum screen alternative is illustrated in Figure 5 in Appendix G. With this alternative, future pumping of concentrated scum to the anaerobic digesters will not be possible. At the request of the AlexRenew maintenance staff, GHD investigated the feasibility of locating the scum screens and scum screenings compactors on the ground floor level of Building K. Space constraints, however, will prevent installing two scum screens and scum screenings compactors in that area. GHD believes installing a second (redundant) scum screen and scum screening compactor is a significant benefit and therefore recommends installing the units on the upper level of the building in the room currently occupied by the scum concentrator.

As for Alternative 1, GHD has assumed that the scum handling area of Building K may be rating rated as a Class I, Division 2, Group D hazardous area. Equipment has been selected suitable for this hazard rating. GHD recommends that the existing scum room ventilation systems be further evaluated during design to confirm whether the scum rooms may be declassified) by ventilation at a rate of at least 12 air changes per hour. GHD has observed electrical components located in the scum handling area that do not appear to be suitable for use in a Class I, Division 2, Group D hazardous environment.

12.3.3 Operational Efficiency and Reliability

As for Primary Scum Handling Alternative 1, replacement of the existing scum concentrator (which is unreliable and maintenance intensive) is expected to significantly improve scum handling and disposal thereby preventing scum from returning to the liquid treatment train. Based on GHD's experience with this scum handling technology, the proposed scum screen system is expected to operate far more efficiently and reliably.

12.3.4 Process Resiliency

Replacement of the existing scum concentrator system with a scum screen system is expected to improve the reliability in the dewatering and disposal of dilute scum.

12.3.5 Sustainability

Replacement of the existing scum concentrator system with a scum screen system is not expected to substantially improve the overall sustainability of this residual management process.

12.3.6 Maintenance Requirements

Based on GHD's experience with this scum handling technology, maintenance requirements are expected to be less intensive than the existing scum concentrator system. As previously mentioned, use of hot water for cleaning of the screen wedgewire openings is essential to maintain porosity. Periodic scrubbing of the screening elements may be necessary to remove material that cannot be removed by hot water spray nozzles.

12.3.7 Safety

As for Primary Scum Handling Alternative 1, this alternative is not expected to change safety conditions with the scum handling system.

12.3.8 Constructability

This primary scum handling alternative includes similar constructability challenges as previously described for Alternatives 1 and 2 (i.e.., issues with replacing equipment given limited access to the existing scum concentrator rooms in Building K, need for temporary scum management systems, etc.). Furthermore, the configuration of screenings dewatering press may require complicated construction if the press must discharge into an adjacent truck bay area.

12.3.9 Maintenance of Plant Operation

As previously described for Primary Scum Handling Alternatives 1 and 2, replacement of the scum concentrator system with a new scum screen system is not expected to have any significant impact on maintaining performance of downstream wastewater treatment systems unless measures are not taken to temporarily manage dilute scum while the scum handling equipment is being replaced. If the scum is not effectively handled by temporary hauling and disposal of dilute scum or by temporary scum handling equipment, scum may propagate to downstream wastewater treatment processes and negatively affect plant effluent quality.

12.3.10 Impact on Other Unit Processes

As mentioned previously, upgrading the scum handling system may potentially affect downstream wastewater treatment systems if temporary measures are not employed during execution of the upgrades. Following completion of construction, the new scum concentrator system is not expected to have a significant impact, either positive or negative affect, on other wastewater treatment systems.

12.3.11 Public Impact

This proposed primary scum handling alternative is not expected to have any significant impact, either positive or negative impact, on the public.

12.3.12 Adaptability to Future Requirements

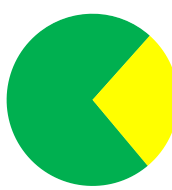
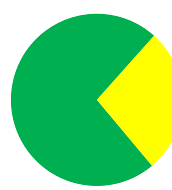
This primary scum handling alternative is not expected to significantly improve the adaptability of the scum handling system to accommodate changes in future disposal requirements.

12.4 Evaluation of Primary Scum Handling Alternatives

As discussed in Section 4.1, GHD's "Traffic Light" Decision Model was used as a tool to compare the non-cost evaluation factors of the four alternatives as shown in Table 12-2.

Table 12-2 Summary of Primary Scum Handling Alternatives

Criteria	Alternative 1 In-Kind Equipment Replacement	Alternative 2 Replacement with Scum Screen and Press
Equipment Layout/Installation		
	Very similar layout to existing system.	Very similar layout to existing system; more compact footprint to existing system.
Operational Efficiency and Reliability		
	In kind replacement expected to operate more reliably as compared to the existing system due to new equipment.	Scum screen expected to operate more reliably and efficiently as compared to the existing system.
Process Resiliency		
	Proposed configuration will have equal or greater process resilience as compared to the existing scum management system.	Proposed configuration will have equal or greater process resilience as compared to the existing scum management system.
Sustainability		
	Substantial demolition (waste) as well as new installation efforts associated with this alternative. Energy associated with incineration of scum is recouped by private entity not AlexRenew.	Substantial demolition (waste) as well as new installation efforts associated with this alternative. Energy associated with incineration of scum is recouped by private entity not AlexRenew.
Maintenance Requirements		

Criteria	Alternative 1 In-Kind Equipment Replacement	Alternative 2 Replacement with Scum Screen and Press
	Proposed alternative expected to be less maintenance intensive as compared to the existing scum concentrator system.	Proposed alternative expected to be less maintenance intensive as compared to the existing scum concentrator system.
Safety		
	Proposed alternative expected to be equally or safer as compared to the existing scum concentrator system.	Proposed alternative expected to be equally or safer as compared to the existing scum concentrator system.
Constructability		
	Accessibility to the scum rooms in Building K will increase the level of complexity of installation with this alternative.	The size of the equipment associated with the scum screen option will be able to be more easily installed due to greater ability to move through existing man doors.
Maintenance of Plant Operations		
	The scum system will need to be taken offline to achieve upgrades. Temporary scum management systems must be employed.	The scum system will need to be taken offline to achieve upgrades. Temporary scum management systems must be employed.
Impact on Other Unit Processes		
	Beyond the installation period, this alternative is not expected to impact downstream wastewater treatment processes.	Beyond the installation period, this alternative is not expected to impact downstream wastewater treatment processes.
Public Impact		
	This alternative is not expected to adversely affect the public.	This alternative is not expected to adversely affect the public.
Adaptability to Future Requirements		
	Proposed configuration provides options for scum disposal.	This proposed alternative is not expected to significantly change the ability of the scum management system to accommodate changes in future requirements.
Summary		

12.5 Primary Scum Handling Alternative Cost Analysis

Each primary scum handling alternative was provided a probable construction cost and life-cycle cost to be considered for selection of the recommended alternative. Section 4.2 outlines the assumptions made based on normal engineering practice. Table 12-3 summarizes the construction cost estimate and life cycle cost of each alternative.

Detailed OPCC estimates are included in Appendix H and detailed lifecycle cost calculations are included in Appendix I.

Table 12-3 Opinion of Probable Construction Cost and Life-Cycle Costs for the Primary Scum Handling Alternatives

	Alternative 1	Alternative 2
Construction Cost (-20% to +30% accuracy)	$1,459,000	$823,000
Soft Costs (40%) [1]	$584,000	$329,000
2021 Project Cost (without contingency)	**$2,043,000**	**$1,152,000**
20-Yr O&M NPV	$934,000	$372,000
Total	**$2,977,000**	**$1,524,000**

Note:
1. Soft costs include project management, engineering, construction management, and project administration costs.

The Life Cycle Costs of the primary scum handling alternatives are presented in Figure 12-3 for comparison.

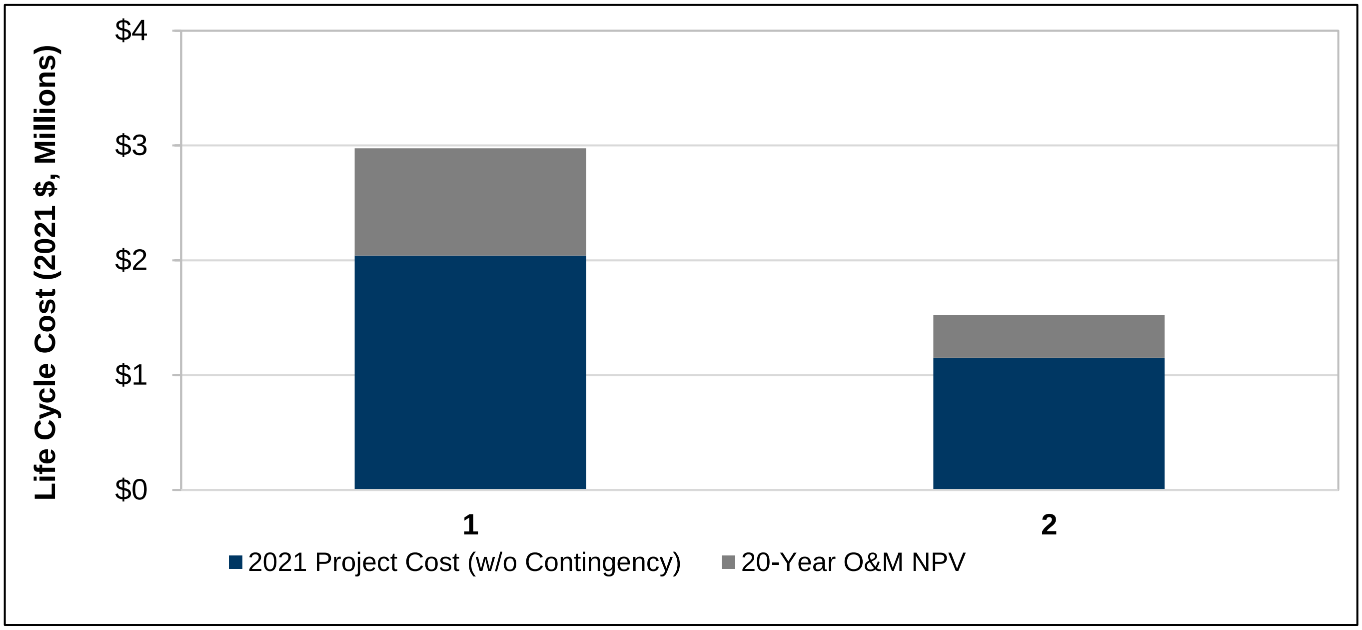


Figure 12-3 Primary Scum Handling Life Cycle Cost Comparison

12.6 Recommended Primary Scum Handling Alternative

GHD's "Traffic Light" Decision Model was used as a tool to evaluate non-cost factors for each of the three alternatives for scum handling system renovations. Based on our evaluation, Primary Scum Handling Alternatives 1 and 2 were similarly ranked.

Following the evaluation of non-cost factors, capital and 20-year life cycle cost estimates were developed for each scum handling system upgrade alternative. Primary Scum Handling Alternative 2 had the lowest opinion of probable capital cost and 20-year lifecycle cost.

Primary Scum Handling Alternative 2 was selected following a holistic consideration of both the cost and non-cost evaluation criteria for upgrading of the scum handling systems. This primary scum handling alternative has an estimated AACE Class 3 project cost escalated to mid-point of construction (2025) of $1,270,000 (-20% to +30% range of accuracy).

Primary Scum Handling Alternative 2 includes:

- Demolition of existing scum concentration system (scum concentrator and concentrated scum day tank and transfer pump)
- Installation of a new scum screens and scum dewatering conveyors.

Primary Scum Handling Alternative 2 provides the following benefits to AlexRenew that align with the Strategic Outcomes of AlexRenew's 2040 Vision Statement:

- Operational Excellence
  - Ensures robust environmental compliance by optimizing the retention of scum and solids associated with scum intercepted by the primary and secondary settling tanks.
- Adaptive Culture
  - Increases the operational efficiency and reliability of the scum management and reduces maintenance requirements.
- Watershed Stewardship
  - Ensures high retention of intercepted dilute scum and allows for disposal of processed scum off-site.
- Public Trust
  - No negative impact on the surrounding community as compared to current configuration for concentrated scum disposal.
- Financial Resilience
  - This selected primary scum handling alternative has lowest lifecycle costs as compared to the other alternatives assessed.

13. Recommended Delivery Program

GHD led three workshops related to project delivery: Prioritization/Bundling Workshop held January 27, 2023, the Phase 2 Sequencing Workshop held on March 13, 2023, and the PPSU Construction Manager at Risk (CMAR) Discussion Workshop held on August 29, 2023, to discuss the proposed project bundling, sequencing, and project delivery/schedule. At the Prioritization/Bundling Workshop, GHD presented the initial results of the risk assessment used to rank the capital projects by priority. During the workshop, it was determined that the project would be split into two phases with the Primary Settling Tank upgrades outlined in Section 11.11 occurring in Phase 1 of the PPSU project sequence followed by the remaining unit process upgrades in Phase 2. Additionally, it was decided that the primary effluent channel upgrades included in the Condition Assessment and Proposed Repair Plan Technical Memorandum from October 2022 will be included in Phase 1.

The Phase 2 Sequencing Workshop discussed the sequencing and schedule of the projects included in Phase 2. The results from the workshop are included in the subsequent sections.

Following the two initial workshops, GHD and AlexRenew agreed to discuss the possibility of delivering the PPSU program via CMAR rather than the traditional Design-Bid-Build (DBB) approach. The results of the workshop determined that the entire PPSU program would be delivered via CMAR in three phases. Phase 1 remained unchanged, which includes the Primary Settling Tank upgrades outlined in Section 11.11 as well as the primary effluent channel upgrades included in the Condition Assessment and Proposed Repair Plan Technical Memorandum from October 2022. Phase 2 as presented at the Phase 2 Sequencing Workshop, will be split into two phases, further detailed in Section 13.4 and Section 13.5 for a total of three CMAR phases. It was determined that the three-phase CMAR delivery would reduce the overall project schedule, allow for quality-based contractor selection, offer collaborative design between GHD and the CMAR, provide earlier price certainty, and reduce change orders and request for information during construction.

13.1 Summary of Unit Process Recommendations

A summary of the individual unit process recommendations is shown in Table 13-1. Each unit process recommendation was given an identification number used to identify the projects shown on the site plan in Figure 13-1.

Table 13-1 Summary of Recommend PPSU Projects

Unit Process	Recommended Alternative	Recommended Capital Project Description	No.
Coarse Screening	Alternative 4	Construction of a third coarse screen channel	CS-1
Coarse Screening	Alternative 4	Replacement of existing coarse screens and building improvements	CS-2
RSPS	Alternative 3	RSPS pump replacement	R-1
RSPS	Alternative 3	Wet well and pump room enhancements	R-2
Conduits	Alternative 2	Coat wet wells, suction conduits, and concrete portion of discharge conduits	C-1
Conduits	Alternative 2	Remaining conduit inspection/rehabilitation	C-2
Fine Screening	Alternative 4	Fine screening upgrades	FS-1
Grit Removal	Alternative 3	Replacement of existing grit separators and pumps	G-1
Grit Removal	Alternative 3	Installation of new grit separators and pumps	G-2
Grit Removal	Alternative 3	Installation of new grit washers	G-3
Loading	Alternative 2	Roll off container rail system for each Truck Bay	L-1
Loading	Alternative 2	Conveyor replacement	L-2
Primary Settling	Alternative 1	Refurbishment of PWOH and improve scum skimmer access	P-1
Primary Scum	Alternative 2	Primary scum, sludge pumping upgrades, and PST pipe gallery work	P-2
Primary Settling	Alternative 1	PST baffles, gates, scum skimmer, and handrail replacement	P-3
Primary Settling	N/A	Repair or replace degraded concrete and metal supports for the primary settling tanks effluent channel [1]	P-4

Note:
1. Recommended upgrades based on the Condition Assessment and Proposed Repair Plan Technical Memorandum from October 2022.

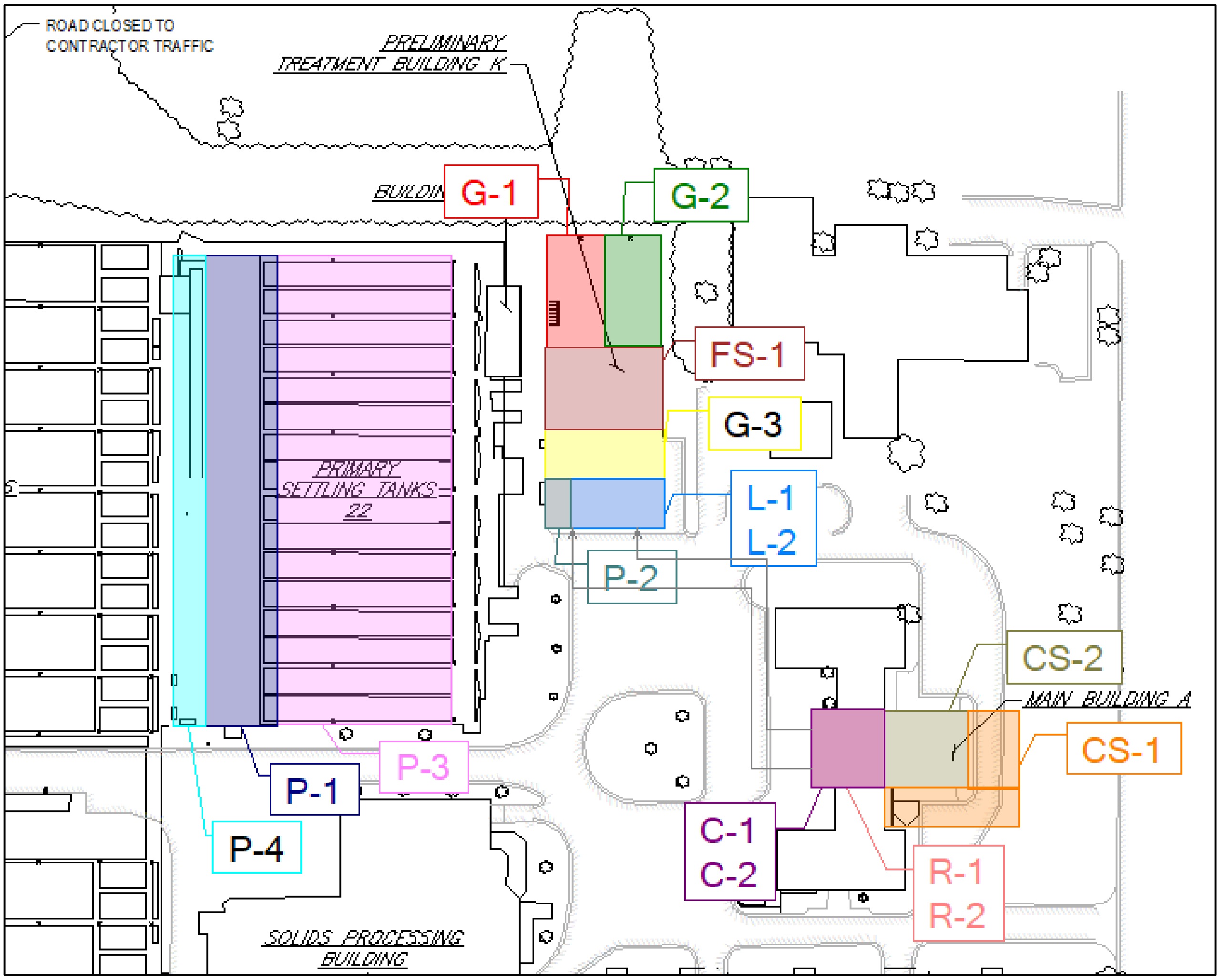


Figure 13-1 Partial Site Plan Showing All PPSU Recommended Projects

13.2 Recommended Project Sequence

It is recommended that the project be split into three phases with the primary settling tank and primary effluent channel upgrades in Phase 1, the Building A unit process upgrades in Phase 2, and the remaining Building K process upgrades in Phase 3. The phasing recommendations are based on a qualitative assessment of anticipated construction sequencing constraints, the need to maintain plant operations during construction and the input from AlexRenew staff during the Prioritization/Bundling, the Phase 2 Sequencing, and PPSU CMAR Discussion Workshops. The three-phase CMAR program delivery allows for the entire project to benefit from the CMAR involvement, provides smaller, staggered review packages with improved cost control, and reduces the schedule by one year from the baseline two-phase DBB delivery. Each project phase will have a dedicated design, guaranteed maximum price (GMP), and construction phase. The recommended project phases are summarized below.

13.3 Phase 1

Due to the limited design work, permitting, and temporary facilities (bypass pumping) required, AlexRenew's desire to complete the work by 2025, and location of the capital projects, it is recommended that the projects are bundled together in Phase 1 as shown in Table 13-2.

Table 13-2 Phase 1 Recommended Capital Projects

Unit Process	Recommended Alternative	Recommended Capital Project Description	Project Phase	No.
Primary Settling	Alternative 1	Refurbishment of PWOH and improve scum skimmer access	1	P-1
Primary Settling	Alternative 1	PST baffles, gates, scum skimmer, and handrail replacement	1	P-3
Primary Settling	N/A	Repair or replace degraded concrete and metal supports for the primary settling tanks effluent channel [1]	1	P-4

Note:

1. Recommended upgrades based on the Condition Assessment and Proposed Repair Plan Technical Memorandum from October 2022.

Figure 13-2 shows the AlexRenew site plan with respect to the impacts Phase 1 will have during construction. During Phase 1 construction, there will be minimal impact to the current access routes to the Primary Settling Tanks, Building A, and Building K.

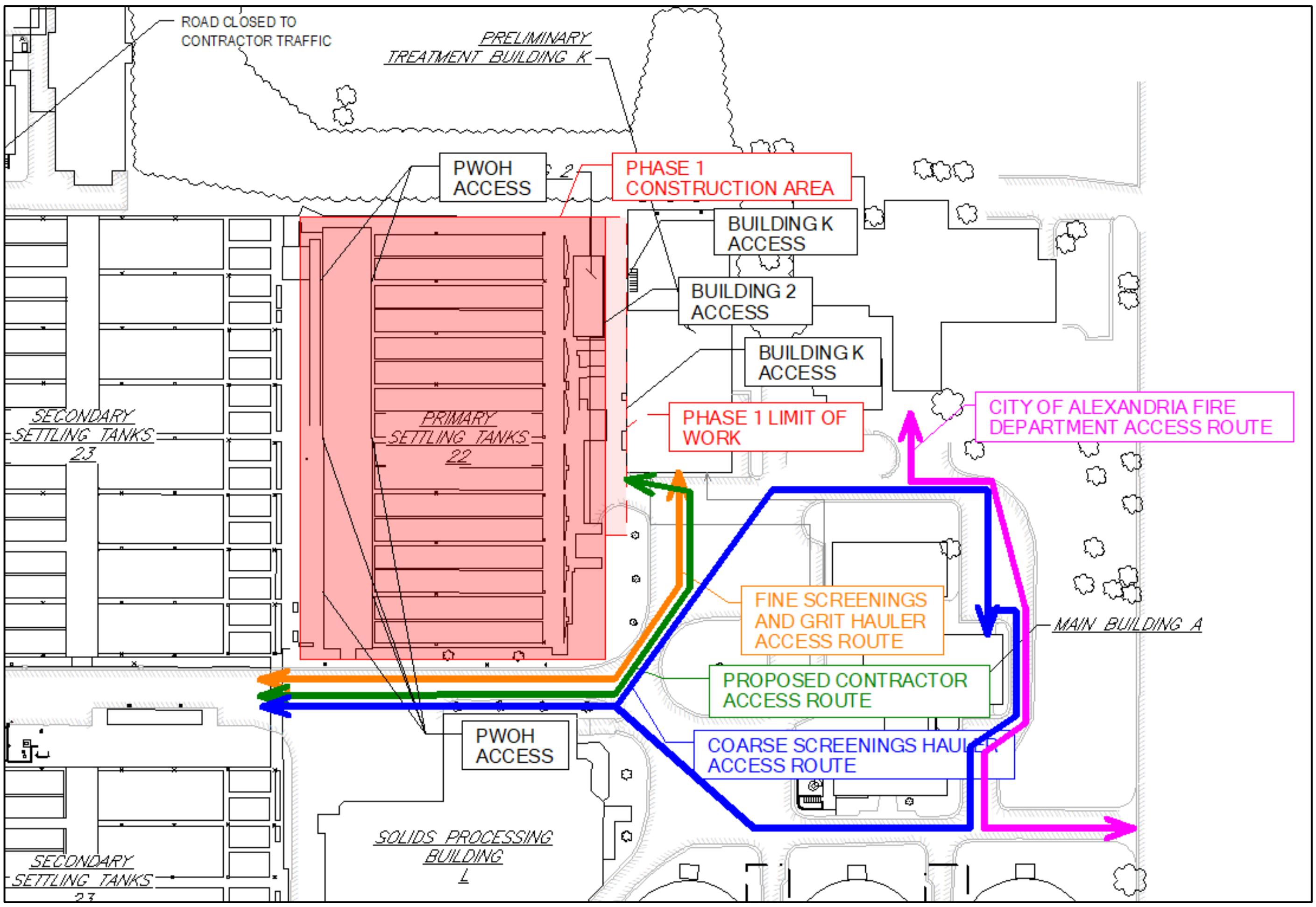


Figure 13-2 Partial Site Plan of Phase 1 Construction Impacts

13.4 Phase 2

The Phase 2 capital projects consist of the upgrades in Building A as shown in Table 13-3. These projects were bundled together into one phase to reduce the overall duration of construction for the PPSU project.

Additional sequence of construction and maintenance of plant operations considerations for the Phase 2 work were considered. Bypass pumping is required for construction of the third coarse screen channel as well as for the RSPS and conduit work. Due to the need of bypass pumping for these upgrades as well as the location to one another, it is recommended that the projects are sequenced together to reduce the duration of bypass pumping at Building A.

Table 13-3 Phase 2 Recommended Capital Projects

Unit Process	Recommended Alternative	Recommended Capital Project Description	Project Phase	No.
Coarse Screening	Alternative 4	Construction of a third coarse screen channel	2	CS-1
Coarse Screening	Alternative 4	Replacement of existing coarse screens and building improvements	2	CS-2
RSPS	Alternative 3	RSPS pump replacement	2	R-1
RSPS	Alternative 3	Wet well and pump room enhancements	2	R-2
Conduits	Alternative 2	Coat wet wells, suction conduits, and concrete portion of discharge conduits	2	C-1
Conduits	Alternative 2	Remaining conduit inspection/rehabilitation	2	C-2

Figure 13-3 shows the AlexRenew site plan with respect to the impacts Phase 2 will have during construction. During Phase 2 construction it is anticipated that the City of Alexandria Fire Department would have to access their facility via the west side of Building A during construction of the third coarse screen channel (CS-1). Once the channel has been constructed and the bypass pumping equipment has been removed, the City of Alexandria Fire Department can utilize their existing access route to their facility.

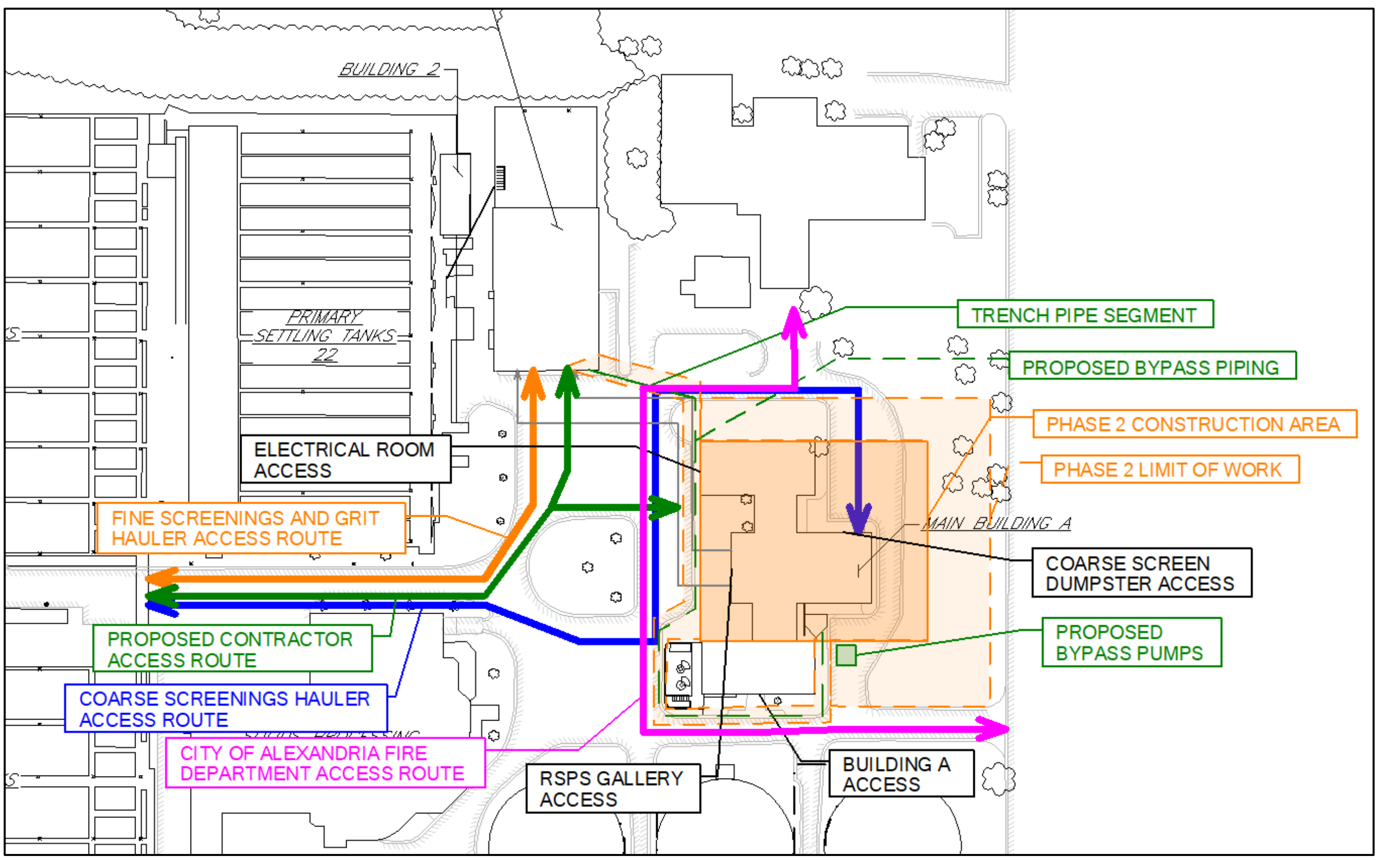


Figure 13-3 Partial Site Plan of Phase 2 Construction Impacts

13.5 Phase 3

The Phase 3 capital projects are the six remaining upgrades in Building K which involve the grit removal, fine screening, loading, and primary scum unit processes as shown in Table 13-4.

Bypass pumping is required for replacement of the existing grit separators and associated grit pumping as well as construction of the three new grit separator units and associated pumping at Building K. Due to the need of bypass pumping for these upgrades as well as the location to one another, it is recommended that the projects are sequenced together to reduce the duration of bypass pumping at Building K.

Table 13-4 Phase 3 Recommended Capital Projects

Unit Process	Recommended Alternative	Recommended Capital Project Description	Project Phase	No.
Fine Screening	Alternative 4	Fine screening upgrades	3	FS-1
Loading	Alternative 2	Roll off container rail system for each Truck Bay	3	L-1
Loading	Alternative 2	Conveyor replacement	3	L-2
Primary Scum	Alternative 2	Primary scum, sludge pumping upgrades, and PST pipe gallery work	3	P-2
Grit Removal	Alternative 3	Replacement of existing grit separators and pumps	3	G-1
Grit Removal	Alternative 3	Installation of new grit separators and pumps	3	G-2
Grit Removal	Alternative 3	Installation of new grit washers	3	G-3

Figure 13-4 shows the AlexRenew site plan with respect to the impacts Phase 3 will have during construction. It is anticipated that Phase 2 and Phase 3 construction will overlap which is further detailed in Section 13.7. Given that construction at Building A and Building K will overlap, like Phase 2, the City of Alexandria Fire Department would have to access their facility via the west side of Building A during construction of the third coarse screen channel (CS-1). Once the channel has been constructed and the bypass pumping equipment has been removed, the City of Alexandria Fire Department can utilize their existing access route to their facility. Additionally, there will be minimal impact to the fine screenings and grit hauler current access route to Building K.

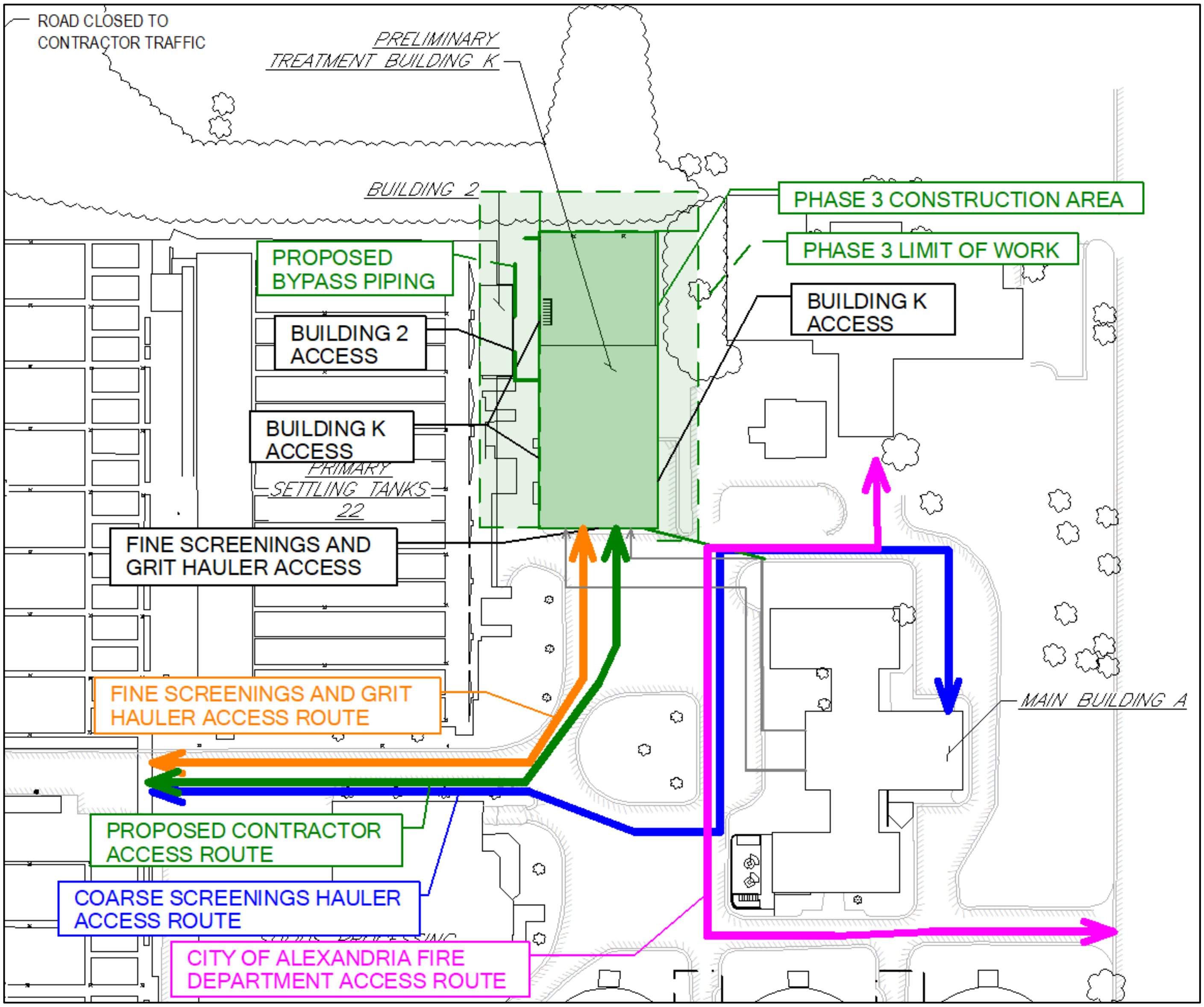


Figure 13-4 Partial Site Plan of Phase 3 Construction Impacts

13.6 Construction Sequencing

Site constraints, project footprint, maintenance of plant operations, and construction sequencing were considered when developing the recommended capital project bundles and associated project phases. Table 13-5 presents the sequencing constraints for each project phase.

Table 13-5 Project Phase Sequencing Constraints

Project Phase	Location	Construction Sequencing Considerations
Phase 1	Primary Weir Observation House, PSTs, and PST Effluent Channel	– Most work can proceed while at least 7 PST remain in service. – Temporary shutdown of PWOH odor control system will be required during refurbishment.

Project Phase	Location	Construction Sequencing Considerations
Phase 2	Building A	– Construction of third coarse channel requires bypassing from upstream manhole on both Commonwealth Interceptor and Potomac Interceptor and bypassing last segment of Potomac Yards Trunk Sewer. – Construction of third coarse screen channel should be done before replacement of two existing screens. – Coarse screening improvements require bypassing; however the bypassed flow will be screened. – RSPS wetwell improvements require bypassing of RSPS process, one wet well will be isolated at a time. – Conduit repairs require peak flow bypassing to Building K. – All bypass operations above can be combined to allow all work within Building A to proceed concurrently, minimizing other sequence constraints. – Bypass piping layout needs to allow continuous access for Building A O&M activities, contracted screenings hauling, and City of Alexandria Fire Department facility.
	Building K, and Building 2/Pipe Gallery	– Fine screen improvements can be done one unit at a time. – Upgrades to two existing vortex grit separators must be done before demolition of other two existing vortex grit separators to replace with three stacked tray units. – Peak flow bypassing is required during time periods with only two existing vortex grit separators online. – Replacement of grit dewatering equipment and screening and grit loading systems requires temporary dewatering and loading system located outside Building K. – Replacement of scum handling system requires temporary scum handling system.

13.7 Recommended Project Schedule

AlexRenew provided a list of the anticipated construction projects based on the draft Capital Improvement Plan (CIP) to be considered when determining the prioritization, sequencing, and bundling of the PPSU capital projects. AlexRenew has many ongoing projects and coordination is critical. The upcoming projects at AlexRenew are the following:

- RiverRenew (to be complete by September 2025)
- Tertiary filter upgrades/repairs (planning phase, FY25-FY28)
- Tertiary Settling Tank (TST) rehab (planning phase, FY25-FY29)
- Solids Process upgrades (planning/scoping phase, FY23 – FY31)
- Secondary Settling Tank (SST) rehab (FY24)
- Centrate Pretreatment (CPT) facility improvements (FY26-28)
- Various IT/PLC projects (ongoing)
- City of Alexandria Burn Building (September 2024 - December 2025)

Table 13-6 summarizes the CMAR design and construction durations for each project phase. The anticipated permitting requirements outlined in Section 13.8 will impact the project schedule and the permit applications will need to be submitted in parallel with draft design submissions. GHD also developed a preliminary multi-phase project schedule included in Appendix J which considers the other the upcoming projects at AlexRenew and the associated plant impacts and includes the following assumptions:

- Six months for CMAR procurement
- Ideal CMAR engagement for Phase 1 is at 60% design review and at 30% design review for Phase 2 and Phase 3.
- Phase 2 begins after Phase 1 95% design is complete.

- Phase 3 begins six months after Phase 2 30% design is complete.
- Two week design review for AlexRenew for Phase 1 30% design since the CMAR is not engaged yet.
- Four week design review for AlexRenew and CMAR for Phase 1 60%-95% design and Phase 2 and Phase 3 30%-95% design.
- GMP at 95% design.
- Ten weeks for GMP development and approval.
- Phases overlap during construction to minimize gaps between projects.

Table 13-6 Project Phase Schedule Summary

	Design	Construction	Total
Phase 1 – PST	16 months	18 months	6 years, 1 month
Phase 2 – Building A	16.5 months	34 months (6 months concurrent with Phase 1)	
Phase 3 – Building K	16.5 months	36 months (28 months concurrent with Phase 2)	

13.8 Regulatory Requirements

13.8.1 Permit Summary

A review of the anticipated permitting requirements for the project has been undertaken. Applications for these permits would occur during the Design Phase of the project. Permit applications will need to be submitted in parallel with draft design submissions. It is anticipated that these permit applications will be finalized at the same time as the projected design phase activities shown in Table 13-6.The following permitting process is anticipated for each phase of the AlexRenew PPSU project.

13.8.1.1 Phase 1

It is anticipated that the roof work, electrical work, HVAC replacement, and concrete rehabilitation will be performed via Building Permit through the City of Alexandria.

13.8.1.2 Phase 2 and Phase 3

- A Stage 1 Concept Plan followed by a Stage 2 Concept Plan will be submitted to the City of Alexandria. Once the Stage 1 and Stage 2 Concept Plans are approved, a Preliminary Site Plan will be submitted to the City of Alexandria. During the review period, it will be determined if a Major or Minor Site Plan Amendment is required for Phase 2.
- Following the Preliminary Site Plan review, a Final Site Plan will be submitted to the City of Alexandria and must be approved prior to release of any permits and the beginning of construction. The following permits are likely required for the Phase 2 project:
  - Stormwater Management – the permitting process is coordinated through the City of Alexandria.
  - Sediment and Erosion Control – the permitting process is coordinated through the City of Alexandria.
  - Building Permit – the permitting process is coordinated through the City of Alexandria.
  - Floodplain – the PPSU project area is not located in the floodplain therefore permitting is not anticipated.

13.8.2 DEQ Requirements

The following requirements will need to be met to satisfy the requirements of the Virginia Department of Environmental Quality (VADEQ).

- VADEQ Certificate to Construct – this is needed whether or not loan or grant money is obtained. However, it is the understanding of GHD that if no loan or grant money is pursued, that the review time is greatly reduced prior to issuance of the certificate. A final design is required to be submitted with the application for the Certificate to Construct.
- VADEQ Certificate to Operate – After construction has been completed, the VADEQ will review the construction of the PPSU upgrades and issue the Certificate to Operate.

14. Cost Estimates

14.1 Overall Construction Cost Estimates

Each unit process recommended upgrade was provided a probable construction cost and life-cycle cost which were previously presented. Assumptions for the opinion of probable construction costs are outlined in Section 4.2. Table 14-1 combines the construction cost estimates for projects to be included in Phase 1 recommended by GHD. The construction cost listed in Table 14-1 is the sum of the construction cost subtotal for each recommended project included in Phase 1. The soft costs and contingency are a percentage of the construction cost subtotal presented below.

Table 14-1 GHD Recommended Phase 1 Estimate of Probable Construction Costs

	GHD Recommended Phase 1 Costs
Construction Cost (-20% to +30% accuracy)	$5,478,000
Soft Costs (40%)	$2,191,000
Contingency (30%)	$1,643,000
2021 Project Cost (-20% to +30% accuracy)	**$9,312,000**
2025 Project Cost (-20% to +30% accuracy) [1]	**$10,271,000**

Note:

1. Project cost escalated to 2025 for midpoint of construction.

Table 14-2 includes the construction cost estimates for the primary effluent channel rehabilitation as outlined in the Condition Assessment Plan Technical Memorandum from October 2022. As previously mentioned, it was agreed that the primary effluent channel rehabilitation will be included in Phase 1 of the PPSU project.

Table 14-2 Primary Effluent Channel Rehabilitation Estimate of Probable Construction Costs

	Primary Effluent Channel Rehabilitation Costs
Construction Cost [1]	$1,796,000
Soft Costs (40%)	$718,000
2021 Project Cost (-20% to +30% accuracy)	**$2,514,000**
2025 Project Cost (-20% to +30% accuracy)	**$2,773,000**

Note:

1. The estimated construction cost includes the cost for PST effluent channel repairs from the Condition Assessment and Proposed Repair Plan Technical Memorandum from October 2022. The cost includes a 20% design/construction contingency, an 8.44% escalation markup (5.0% annual, assuming mid-point of construction date of July 2023), and a 5.0% market volatility adjustment.

Table 14-3 summarizes the total construction cost estimate for the recommended projects included in Phase 1 as mentioned in Section 13.3. The costs are presented in both the current year dollars at the time the TMs were completed and also the dollars at the anticipated midpoint of construction.

Table 14-3 Phase 1 Estimate of Probable Construction Costs

	Phase 1 Costs
2021 Project Cost (-20% to +30% accuracy)	**$11,826,000**
2025 Project Cost (-20% to +30% accuracy) [1]	**$13,044,000**

Note:
1. Project cost escalated to 2025 for midpoint of construction.

The construction cost listed in Table 14-4 is the sum of the construction cost subtotal for each recommended project included in Phase 2 as mentioned in Section 13.4. The soft costs and contingency are a percentage of the construction cost subtotal presented below. The overall Phase 2 opinion of probable construction costs are summarized below. The costs are presented in both the current year dollars at the time the TMs were completed and also the dollars at the anticipated midpoint of construction.

Table 14-4 Phase 2 Estimate of Probable Construction Costs

	Phase 2 Costs
Construction Cost (-20% to +30% accuracy)	$16,407,000
Soft Costs (40%)	$6,563,000
Contingency (30%)	$4,922,000
2021 Project Cost (-20% to +30% accuracy)	**$27,892,000**
2027 Project Cost (-20% to +30% accuracy) [1]	**$32,308,000**

Note:
1. Project cost escalated to 2027 for midpoint of construction.

The construction cost listed in Table 14-5 is the sum of the construction cost subtotal for each recommended project included in Phase 3 as mentioned in Section 13.5. The soft costs and contingency are a percentage of the construction cost subtotal presented below. The overall Phase 3 opinion of probable construction costs are summarized below. The costs are presented in both the current year dollars at the time the TMs were completed and also the dollars at the anticipated midpoint of construction.

Table 14-5 Phase 3 Estimate of Probable Construction Costs

	Phase 3 Costs
Construction Cost (-20% to +30% accuracy)	$23,781,000
Soft Costs (40%)	$9,512,000
Contingency (30%)	$7,134,000
2021 Project Cost (-20% to +30% accuracy)	**$40,427,000**
2027 Project Cost (-20% to +30% accuracy) [1]	**$46,828,000**

Note:
1. Project cost escalated to 2027 for midpoint of construction.

14.2 Overall 20-Year Present Worth Cost

Each unit process recommended upgrade was provided a probable construction cost and life-cycle cost which were previously presented. The assumptions for the opinion of probable construction costs and 20-year net present worth costs are outlined in Section 4.2. Table 14-6 combines the 2021 construction cost estimate and the 20-year net present value from 2021 for the associated projects included in Phase 1.

Table 14-6 Lifecycle Cost of Phase 1

	Phase 1 Costs
2021 Construction Cost Estimate (w/o Contingency)	$10,183,000
20-Yr O&M NPV	$1,774,000
Total (-20% to +30% accuracy)	**$11,957,000**

Similarly, Table 14-7 combines the 2021 construction cost estimate and the 20-year net present value from 2021 for the associated projects included in Phase 2.

Table 14-7 Lifecycle Cost of Phase 2

	Phase 2 Costs
2021 Construction Cost Estimate (w/o Contingency)	$22,970,000
20-Yr O&M NPV	$22,445,000
Total (-20% to +30% accuracy)	**$45,415,000**

Similarly, Table 14-8 combines the 2021 construction cost estimate and the 20-year net present value from 2021 for the associated projects included in Phase 3.

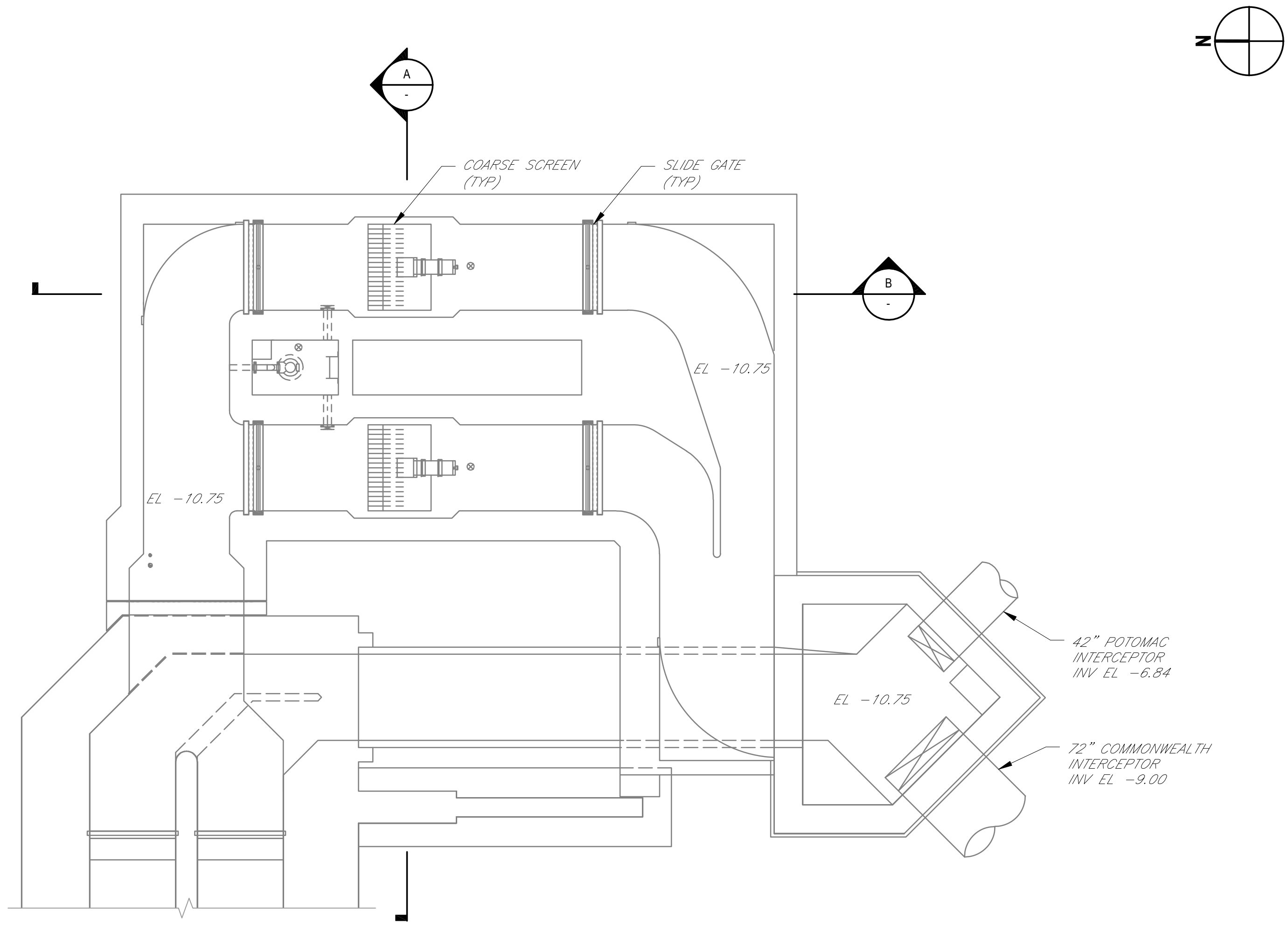
Table 14-8 Lifecycle Cost of Phase 3

	Phase 3 Costs
2021 Construction Cost Estimate (w/o Contingency)	$33,293,000
20-Yr O&M NPV	$54,875,000
Total (-20% to +30% accuracy)	**$88,168,000**

Appendices

Appendix A

Conceptual Layouts – Coarse Screens



1 LOWER PLAN

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN EXISTING LOWER PLAN

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 1

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-1 coarse screen NEW.dwg
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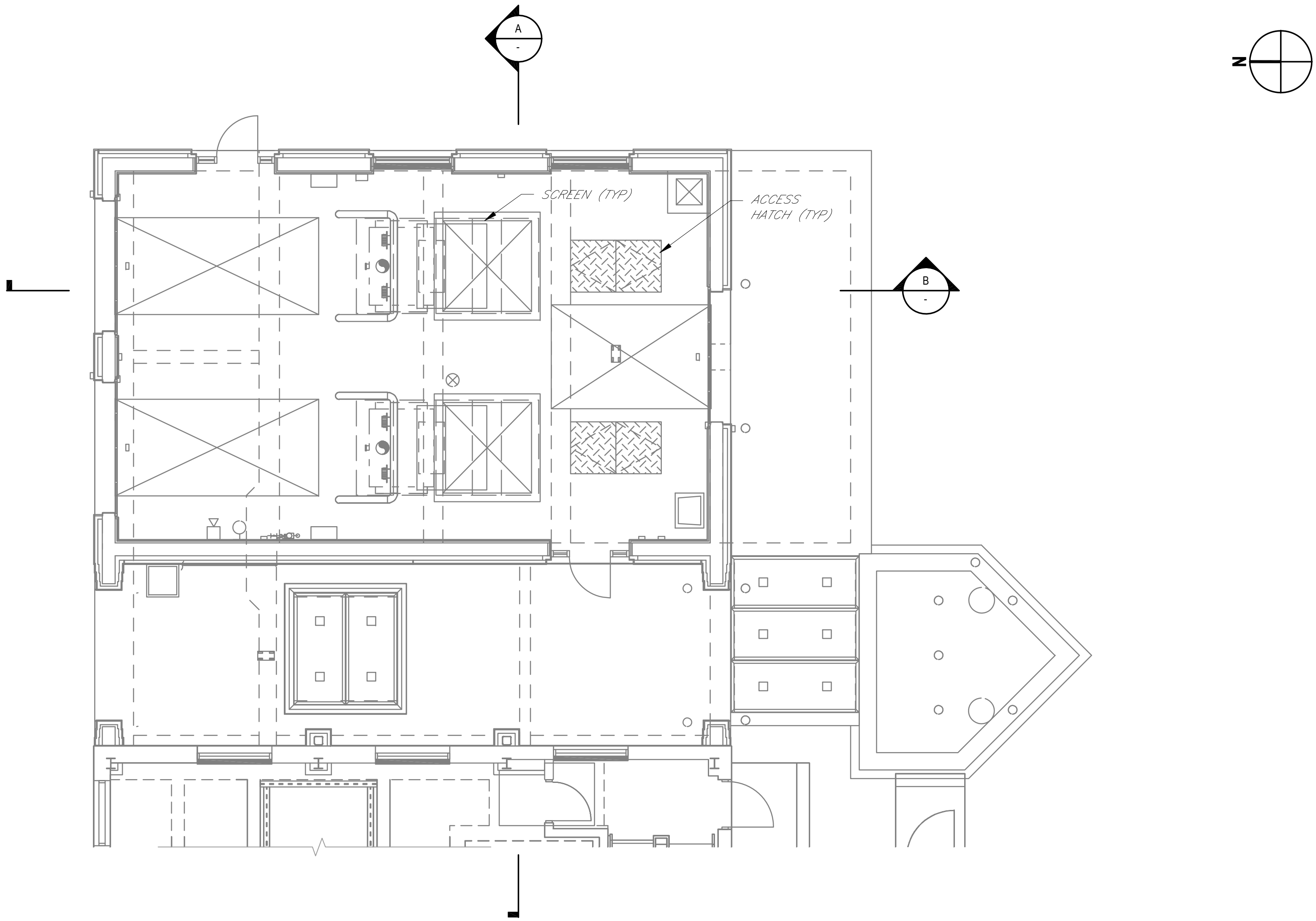

1 UPPER PLAN
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN EXISTING UPPER PLAN

Project No. 11217618
Report No. N/A
Date 05/2022

FIGURE 2

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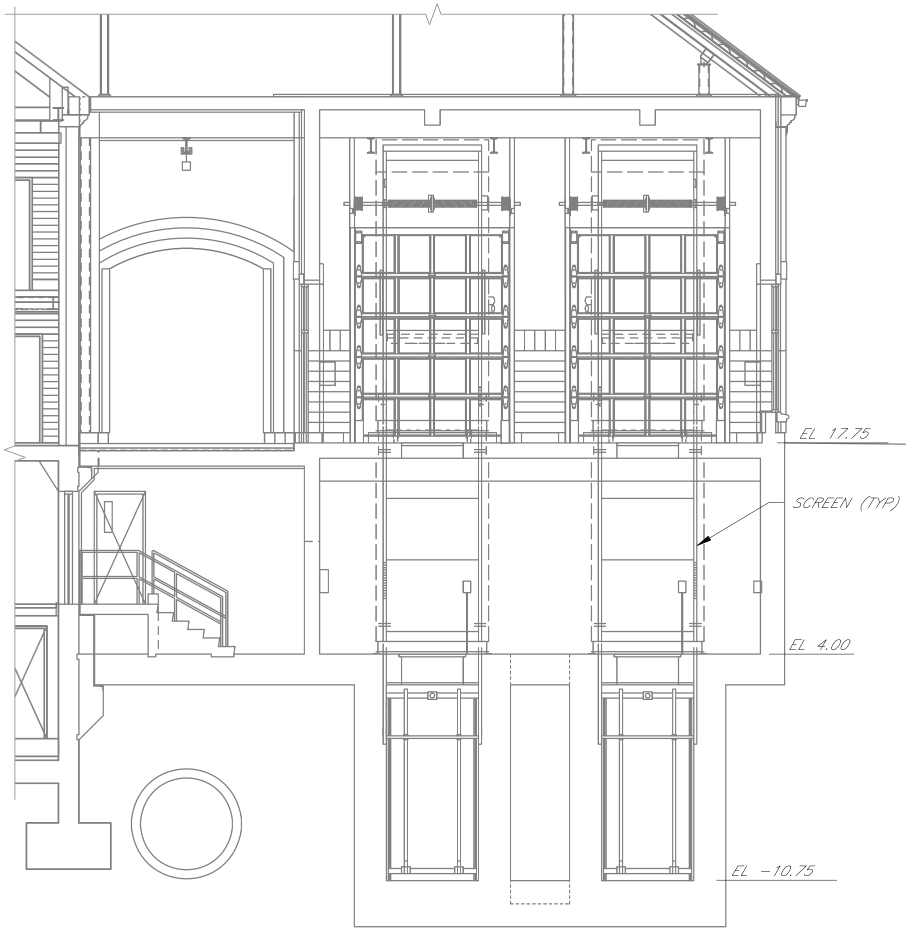

A
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SECTION
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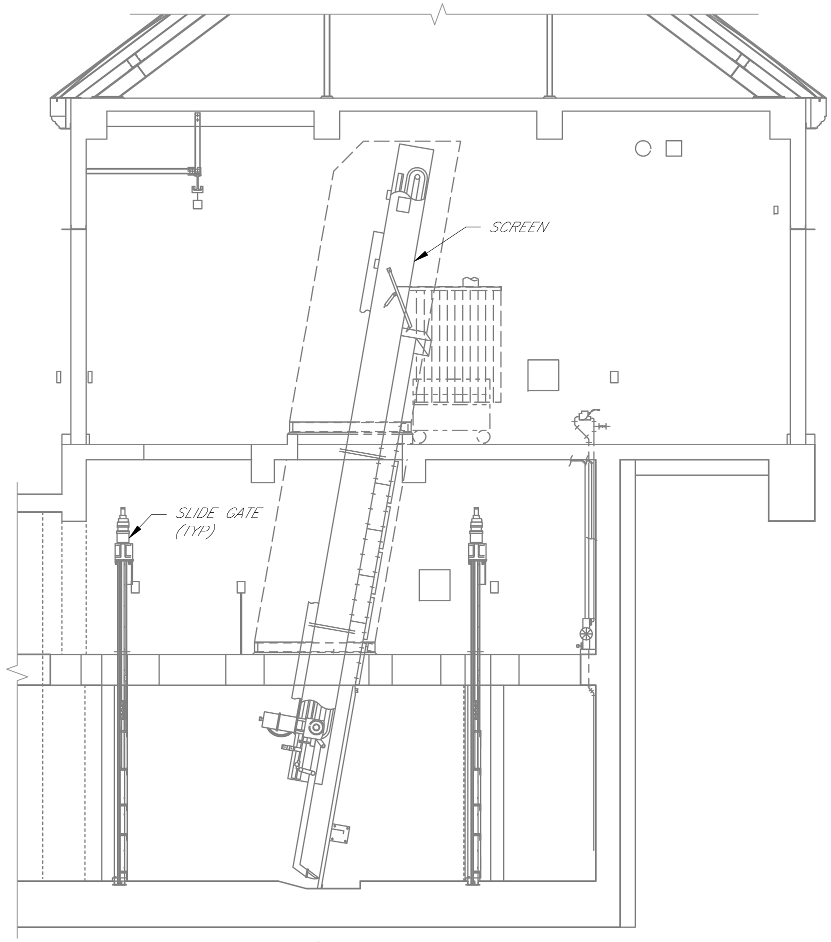

B
-
SECTION
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN EXISTING SECTIONS

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 3

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-3 coarse screen NEW.dwg
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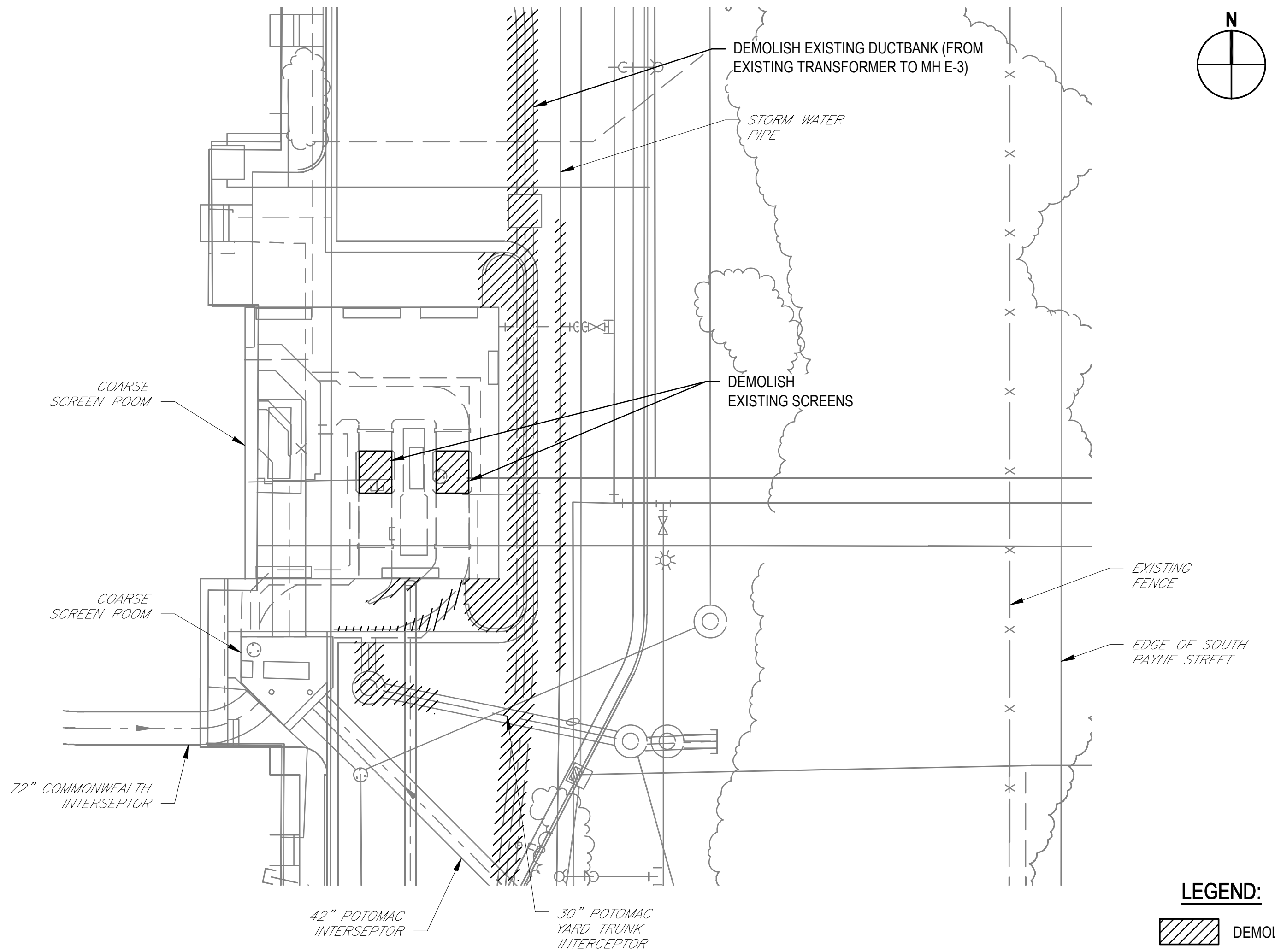

LEGEND:

DEMOLISH

1 DEMOLITION SITE PLAN

1"=20'-0"

0 8' 16' 24' 32' 40'

SCALE 1"=20' AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE
DEMOLITION PLAN

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 4

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-4 coarse screen NEW.dwg
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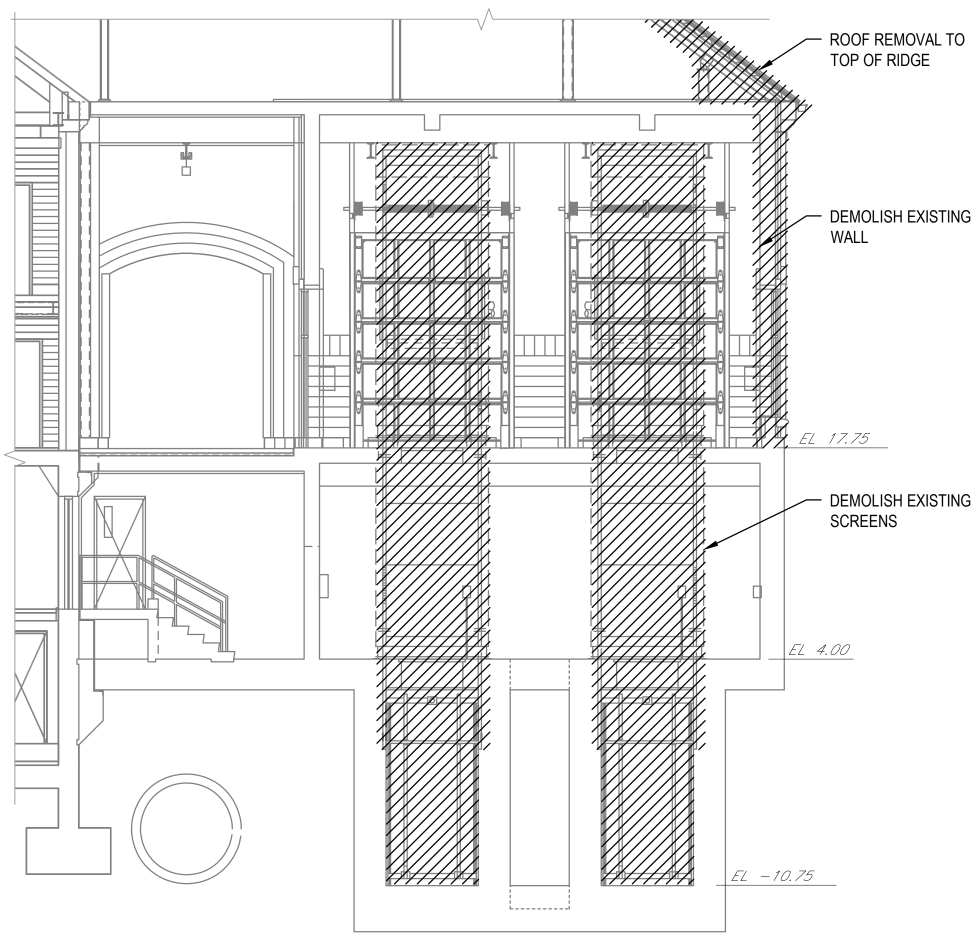

A
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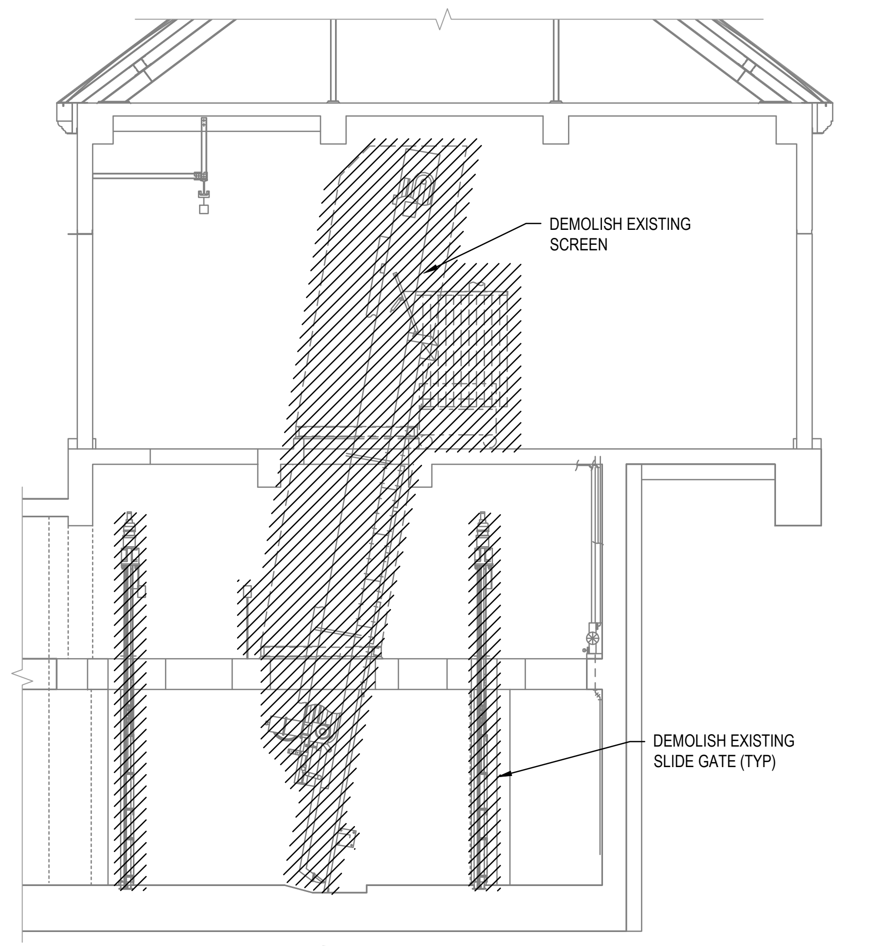

B
-
SECTION
1/8"=1'-0"

LEGEND:

DEMOLISH

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE
DEMOLITION SECTIONS

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 5

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-5 coarse screen NEW.dwg
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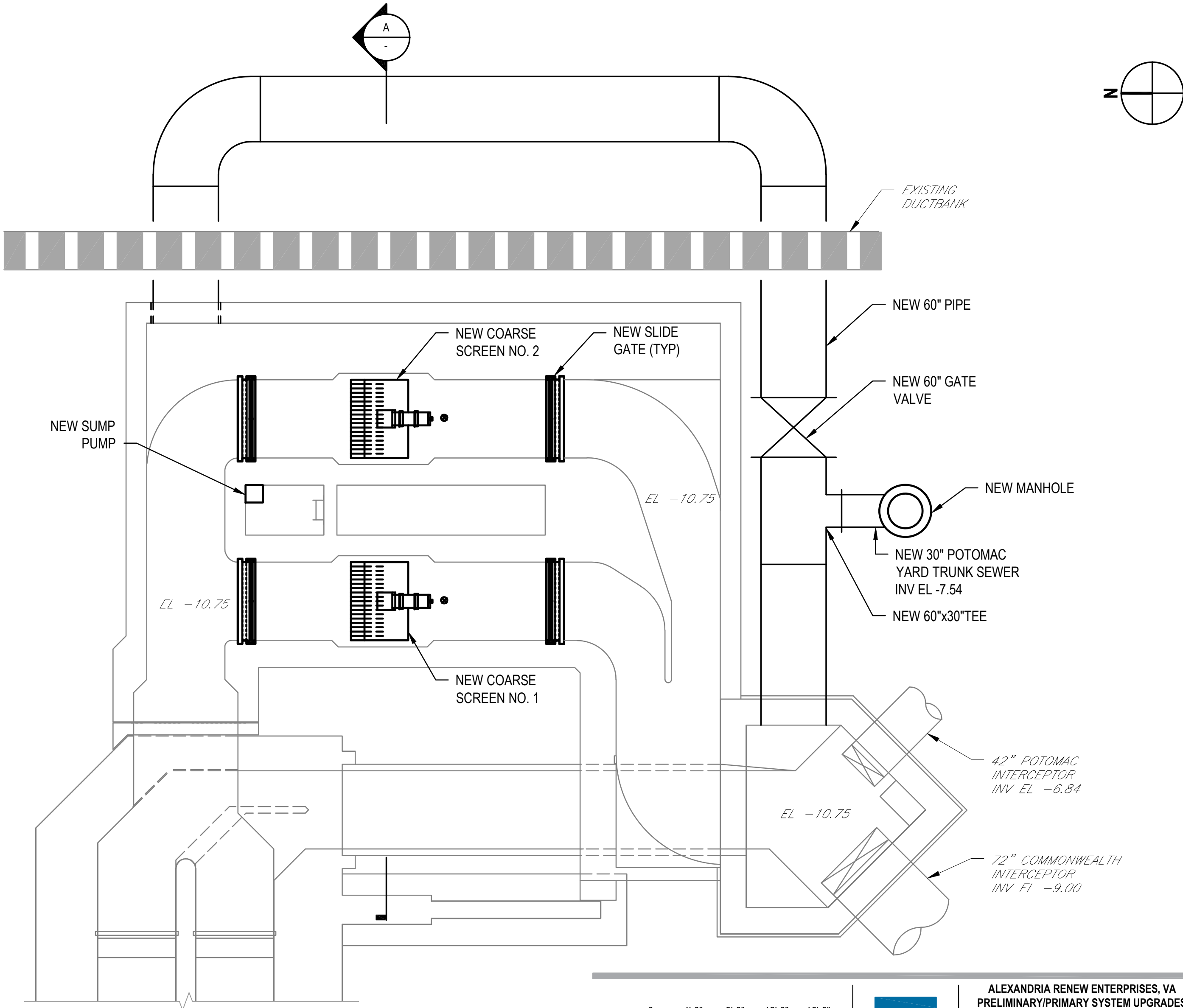

1 LOWER PLAN

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE
SUB-ALTERNATIVE B1: TWO SCREENS AND BYPASS CONDUIT PLAN

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 6

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-6 coarse screen NEW.dwg
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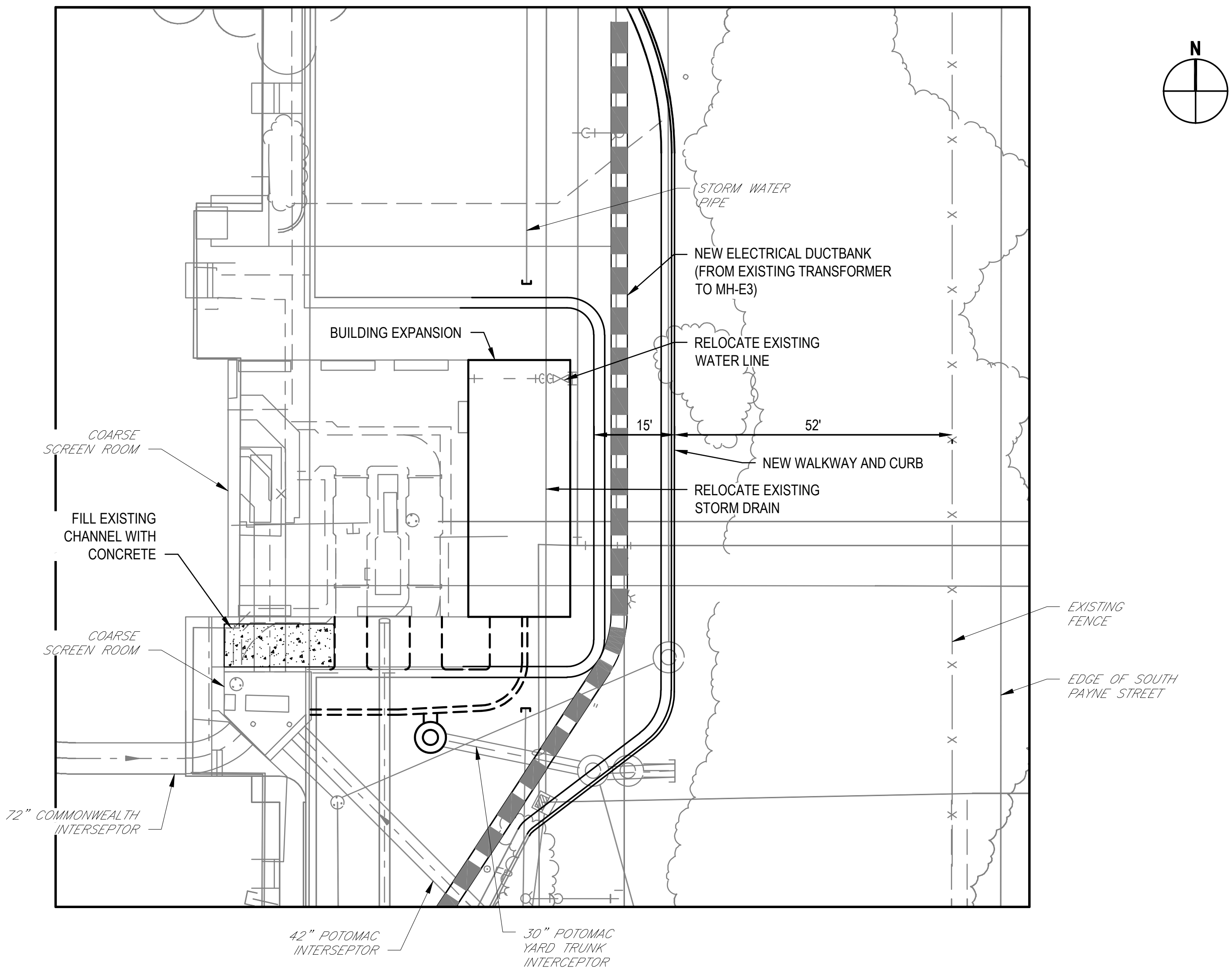

1 UPGRADE SITE PLAN

1"=20'-0"

0 8' 16' 24' 32' 40'

SCALE 1"=20' AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY UPGRADES

COARSE SCREEN UPGRADE
SUB-ALTERNATIVES B2 AND B3
SITE PLAN

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 7

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-7 coarse screen NEW.dwg
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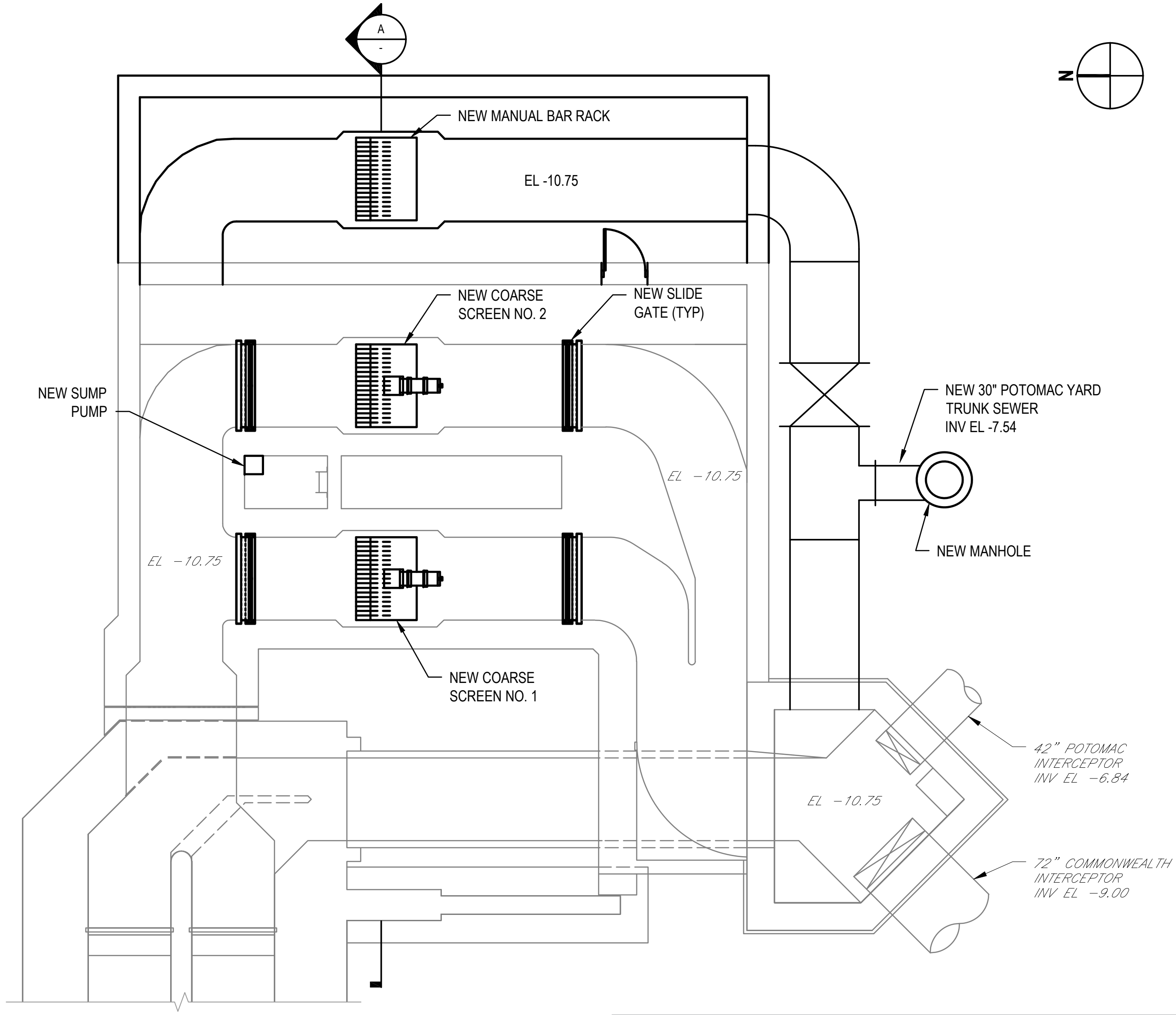

1 LOWER PLAN

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE
SUB-ALTERNATIVE B2: THIRD SCREEN CHANNEL WITH MANUAL BAR RACK - PLAN

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 8

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-8 coarse screen NEW.dwg
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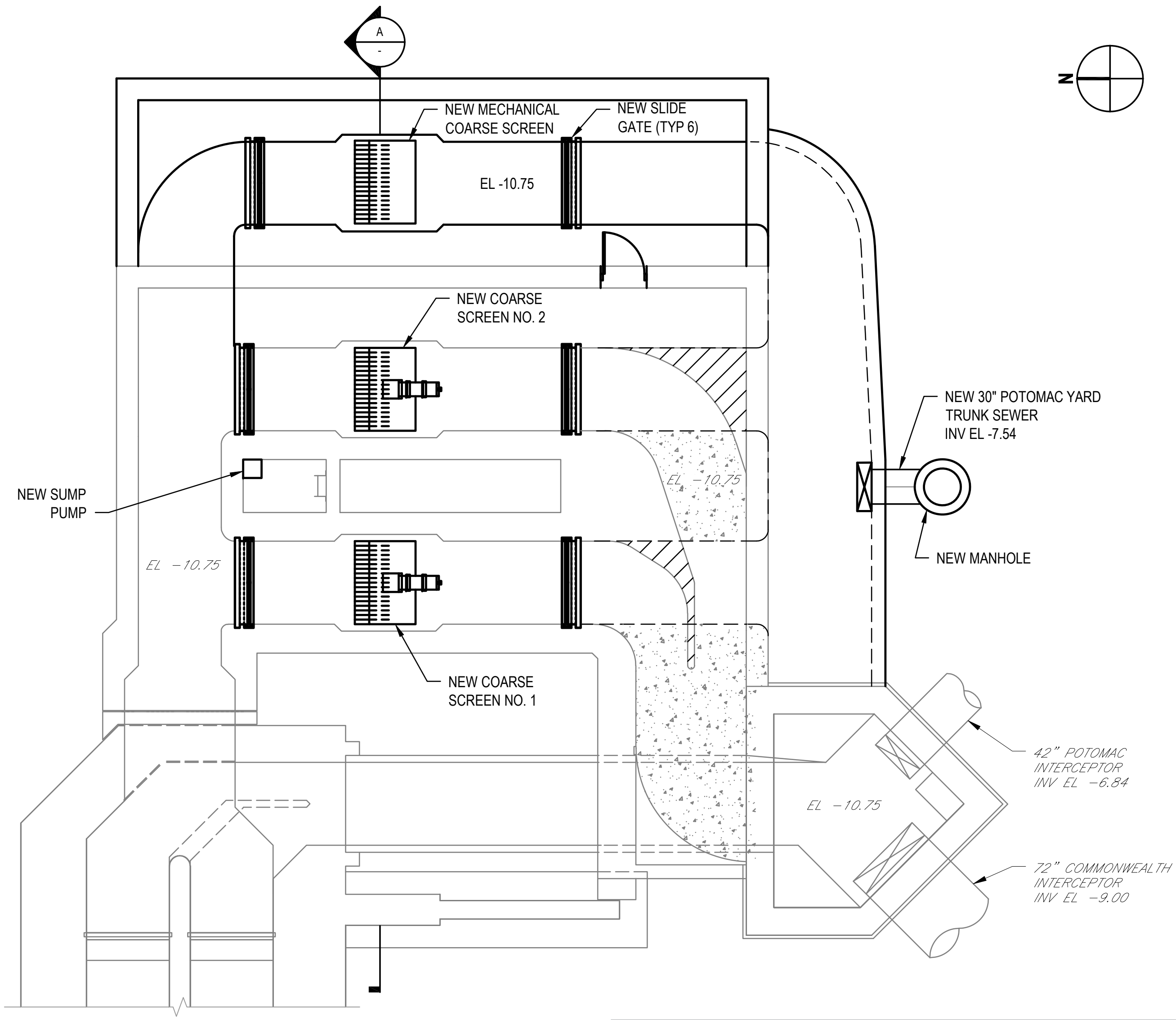

1 LOWER PLAN

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE
SUB-ALTERNATIVE B3: THIRD SCREEN
CHANNEL WITH MECHANICAL COARSE
SCREEN - PLAN

Project No. 11217618
Report No. N/A
Date 05/2022

FIGURE 9

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-9 coarse screen NEW.dwg
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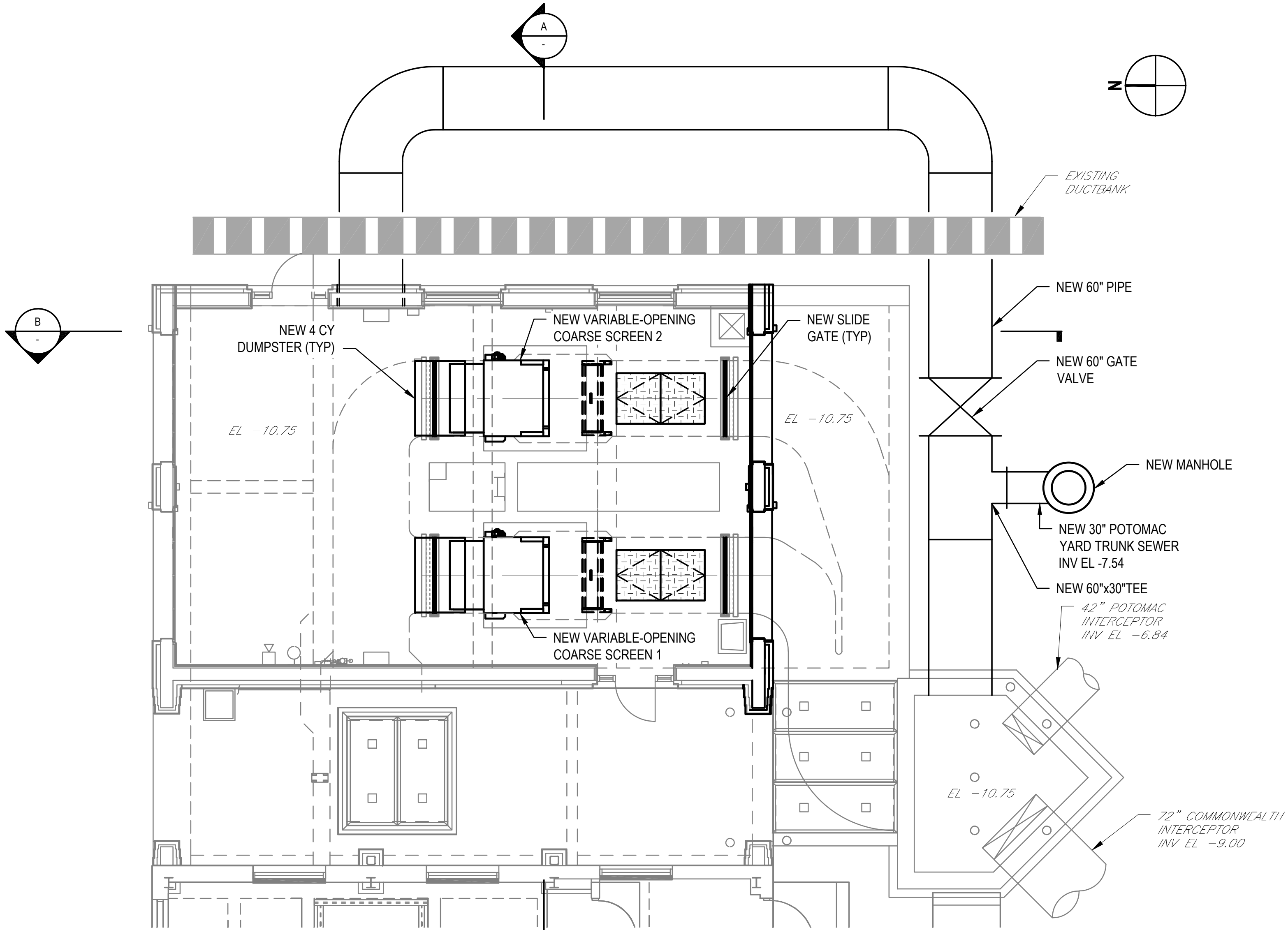

1 **UPPER PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE 1:
TWO 1" TO 2.25" VARIABLE - OPENING
FLEX-RAKE SCREENS AND BYPASS CONDUIT
AND TWO 4 CY DUMPSTERS - PLAN

Project No. 11217618
Report No. N/A
Date 05/2022

FIGURE 10

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-10 coarse screen NEW.dwg
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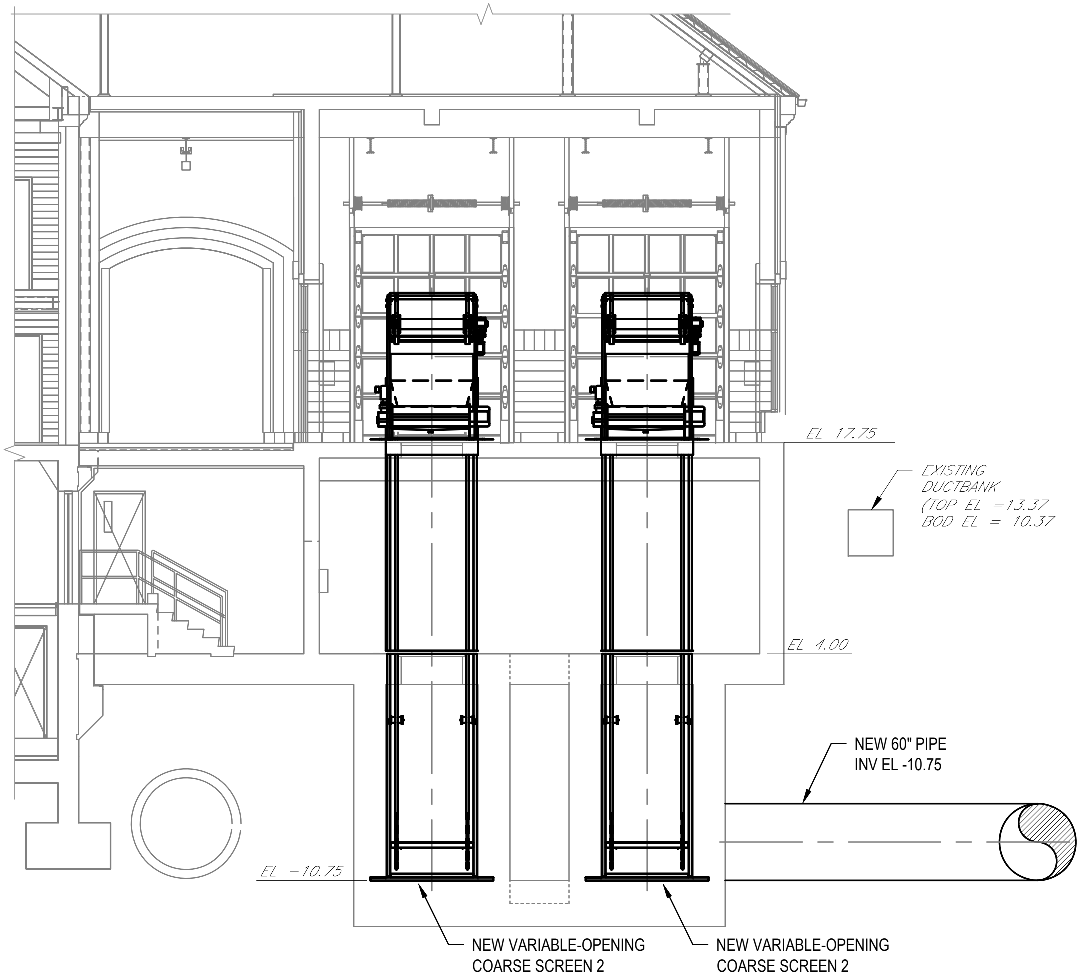

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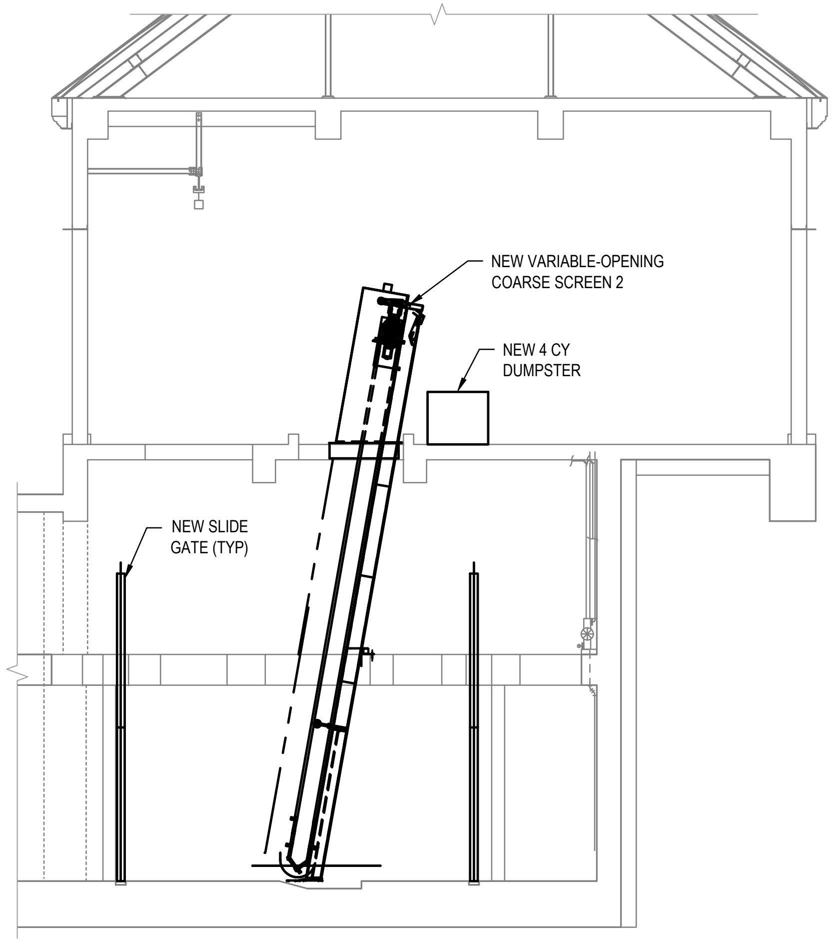

B
-
SECTION
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE 1:
TWO 1" TO 2.25" VARIABLE-OPENING
FLEX-RAKE SCREENS AND BYPASS CONDUIT
AND TWO 4 CY DUMPSTERS - SECTION

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 11

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-11 coarse screen NEW.dwg
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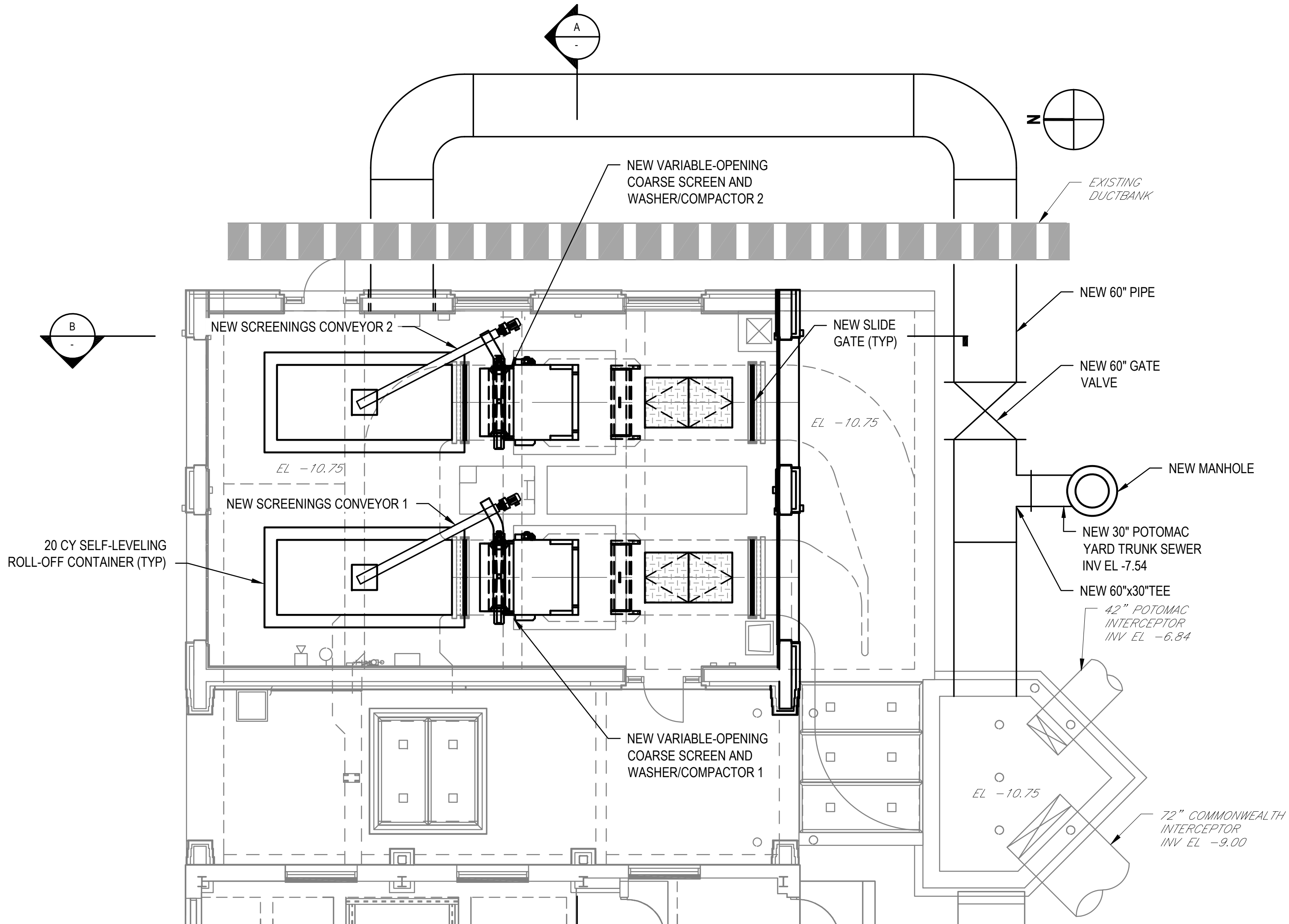

1 UPPER PLAN

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE 2: TWO 1" TO 2.25" VARIABLE-OPENING FLEX-RAKE SCREENS AND BYPASS CONDUIT AND TWO WASHER/COMPACTORS AND TWO 20 CY SELF-LEVELING ROLL-OFF CONTAINERS - PLAN

Project No. 11217618
Report No. N/A
Date 05/2022

FIGURE 12

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-12 coarse screen NEW.dwg
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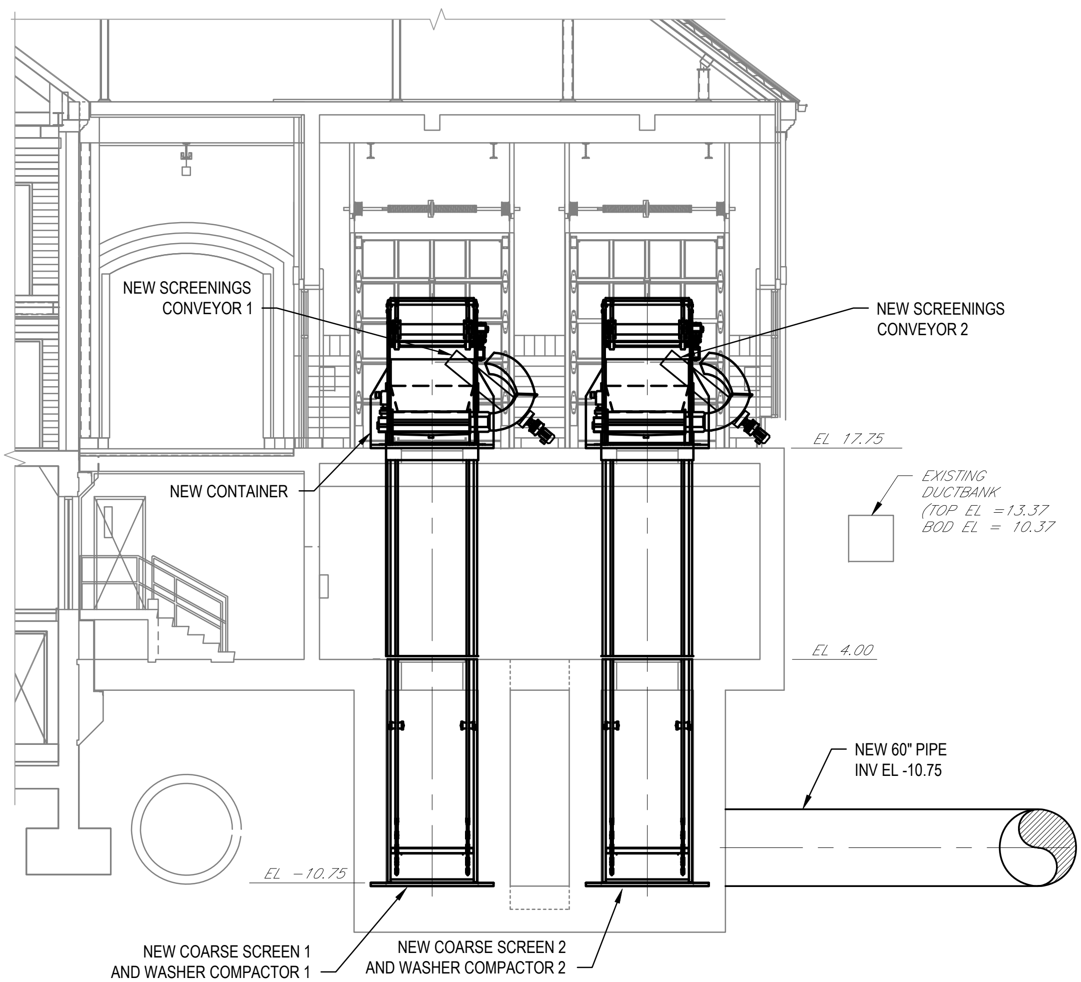
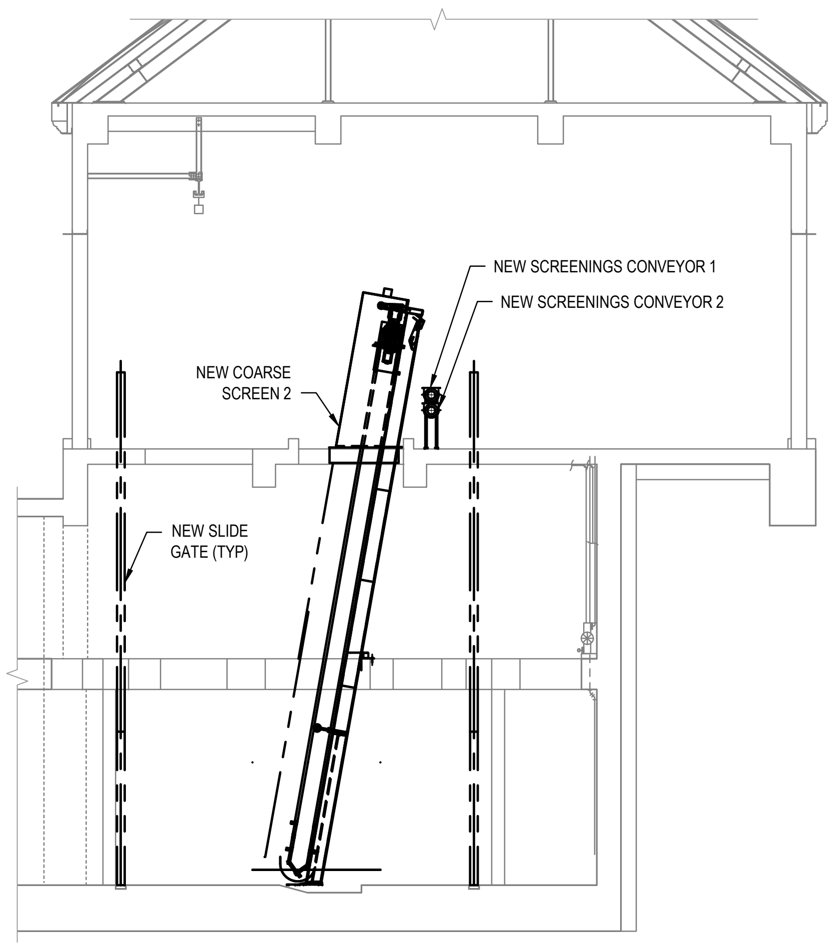


SECTION A / - 1/8"=1'-0"



SECTION B / - 1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE 2: TWO 1" TO 2.25" VARIABLE-OPENING FLEX-RAKE SCREENS AND BYPASS CONDUIT AND TWO WASHER/COMPACTORS AND TWO 20 CY SELF-LEVELING ROLL-OFF CONTAINERS - SECTION

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 13

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-13 coarse screen NEW.dwg
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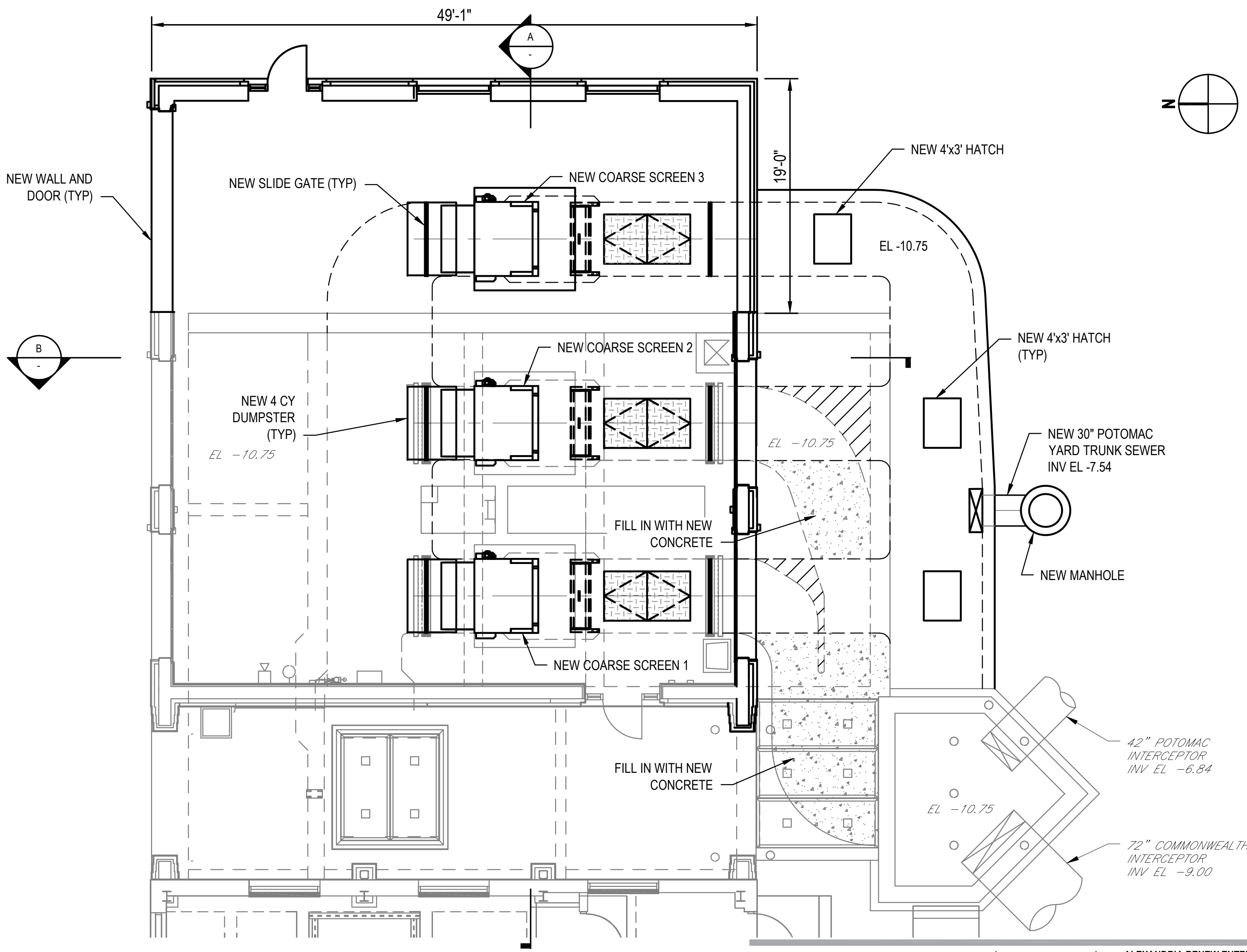

1 UPPER PLAN

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE 3: THREE 1" FLEX-RAKE SCREENS AND 4 CY DUMPSTERS - PLAN

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 14

Source:

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-14 coarse screen NEW.dwg
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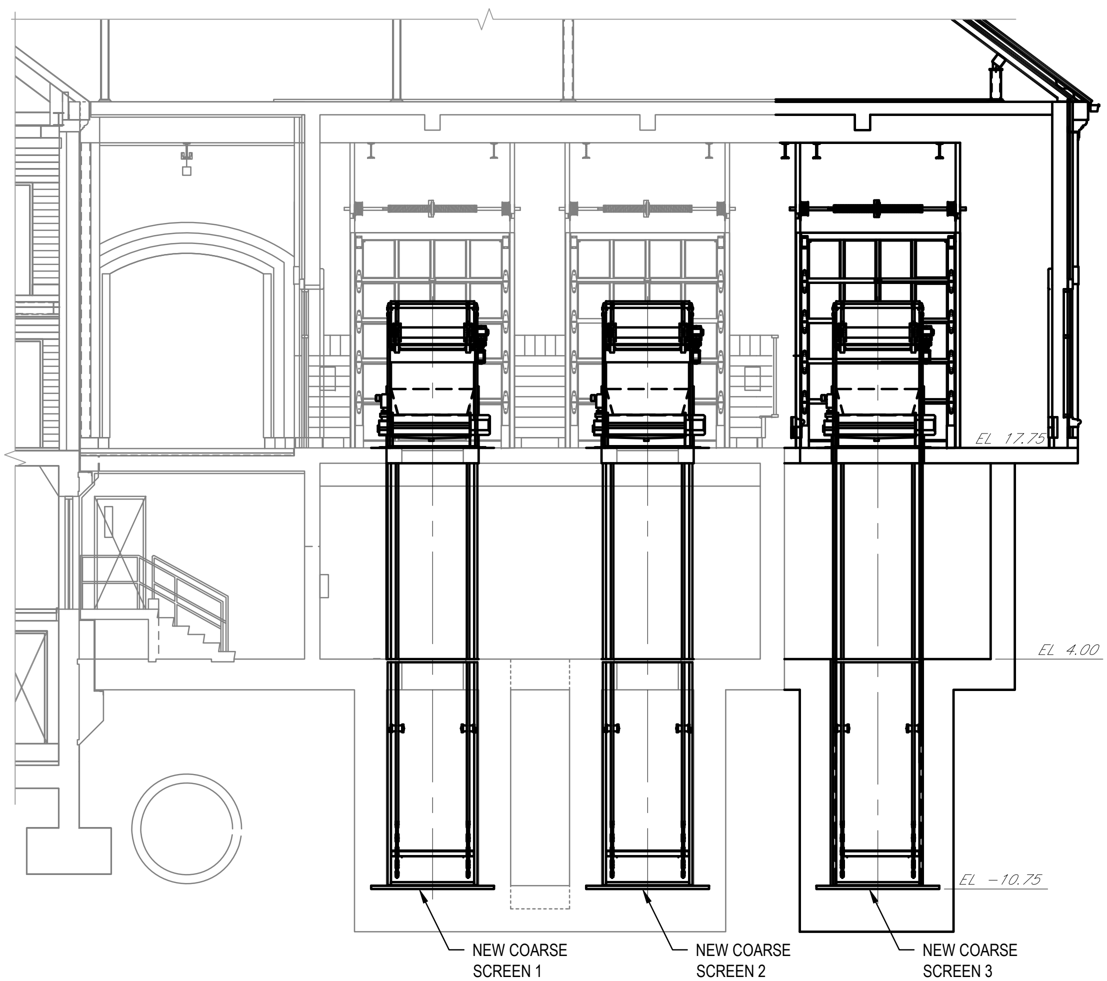

A
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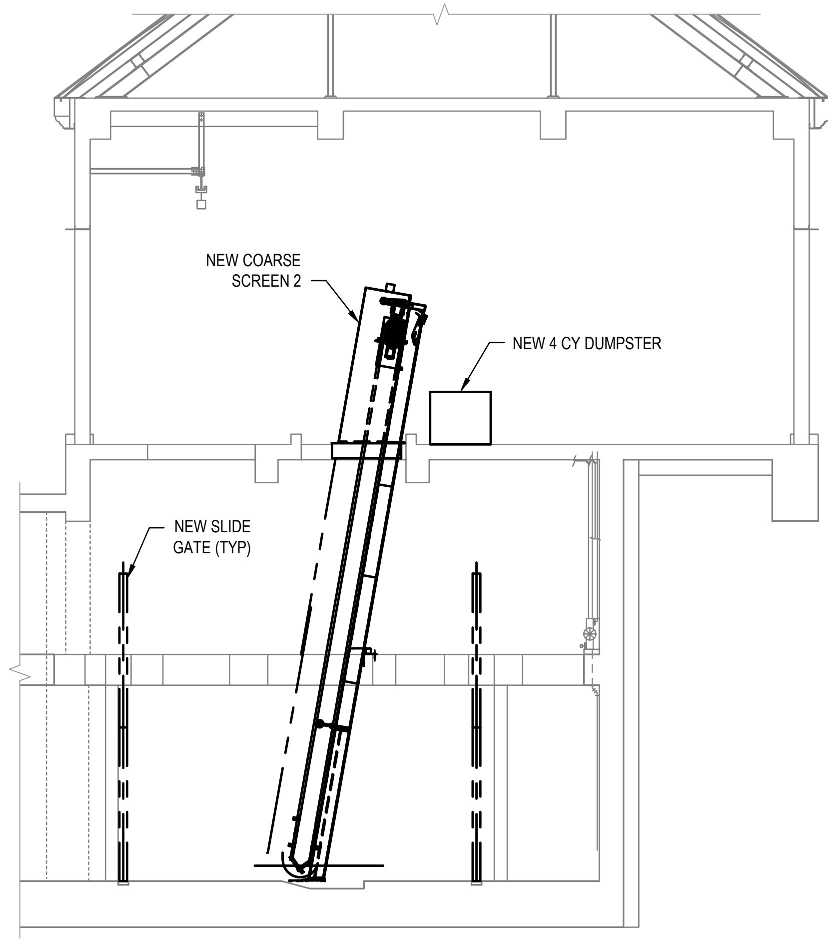

B
-
SECTION
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE 3: THREE 1" FLEX-RAKE SCREENS AND 4 CY DUMPSTERS - SECTIONS

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 15

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-15 coarse screen NEW.dwg
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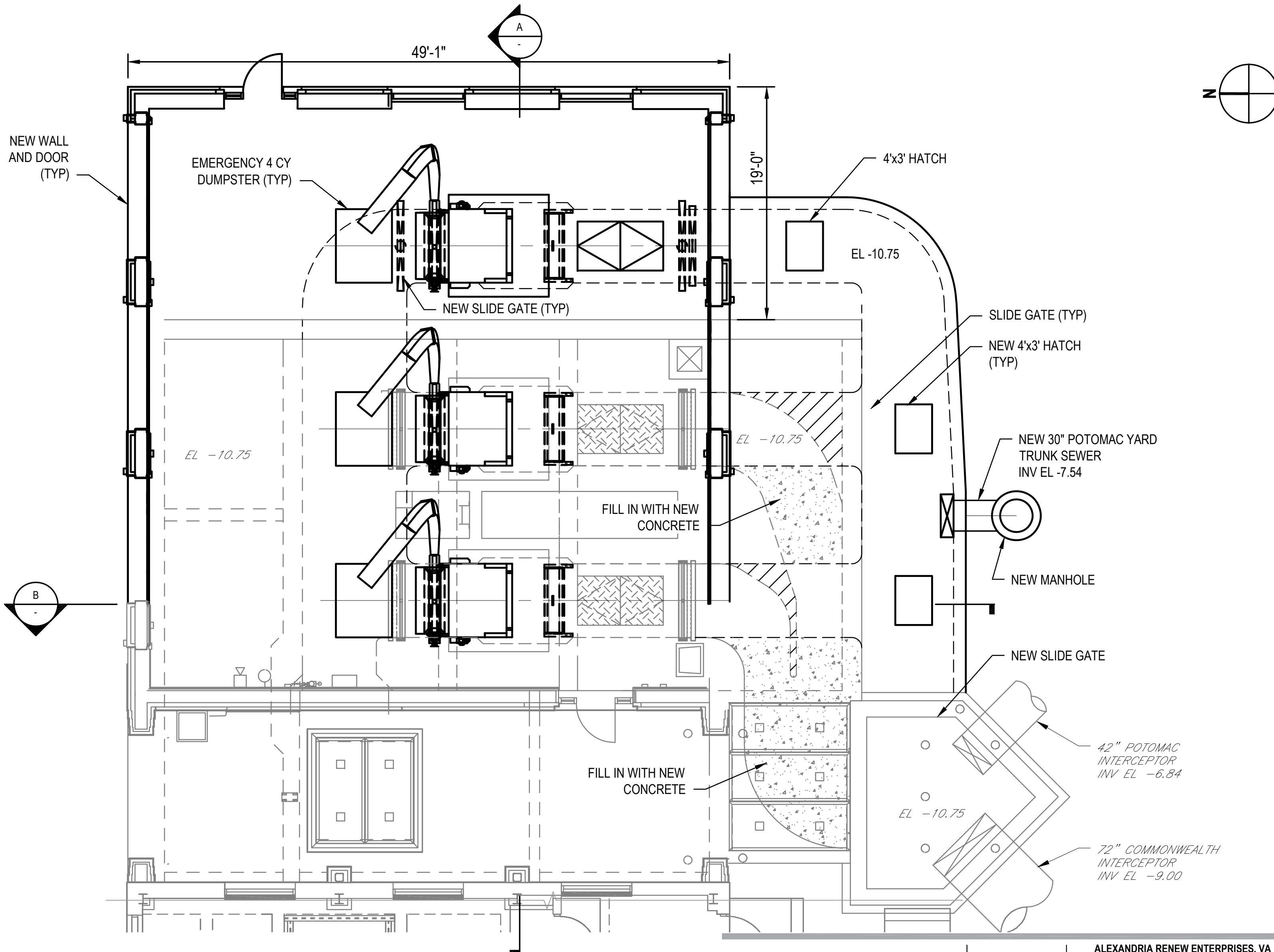

1 **UPPER PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE 4: THREE 3/4" FLEX-RAKE SCREENS AND THREE WASHER/COMCACTORS AND THREE 4 CY DUMPSTERS - PLAN

Project No. 11217618
Report No. N/A
Date 05/2022

FIGURE 16

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-16 coarse screen NEW.dwg
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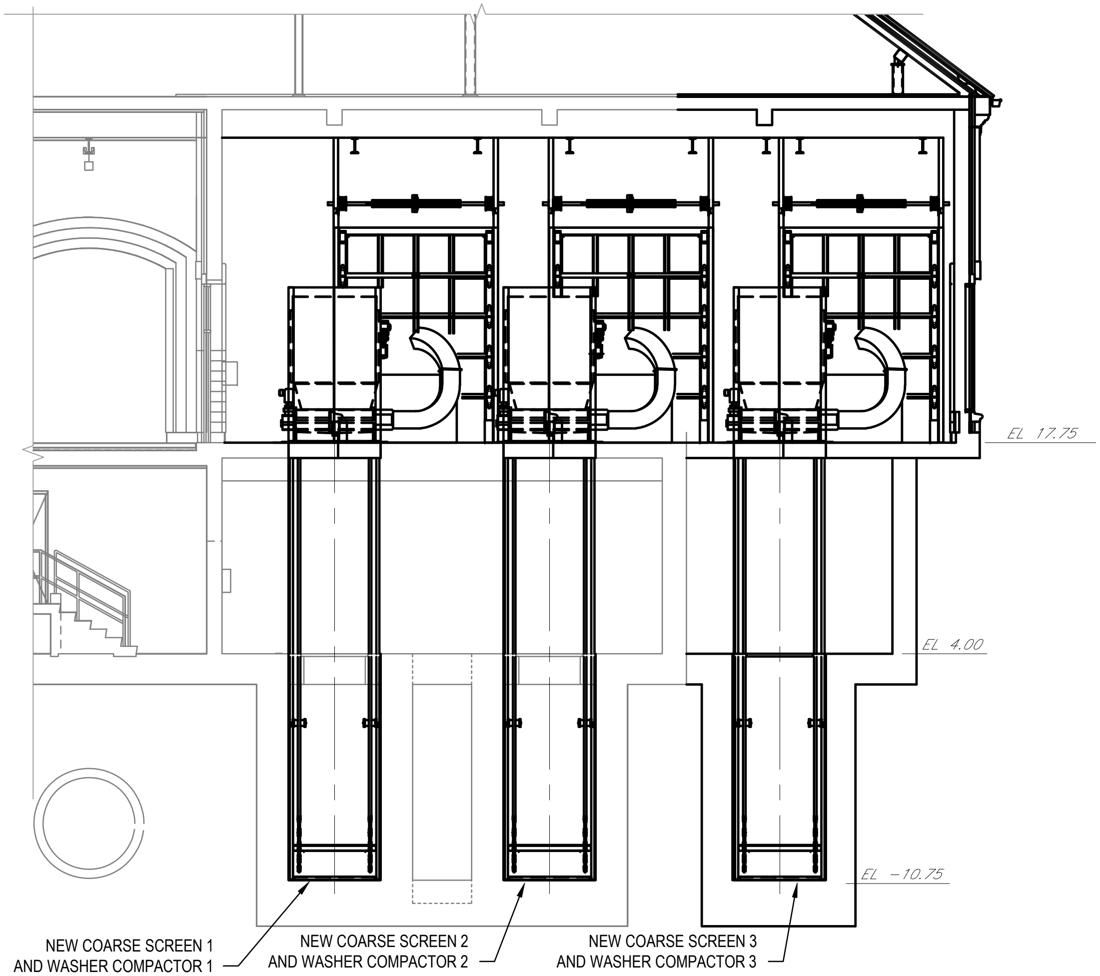

SECTION A -

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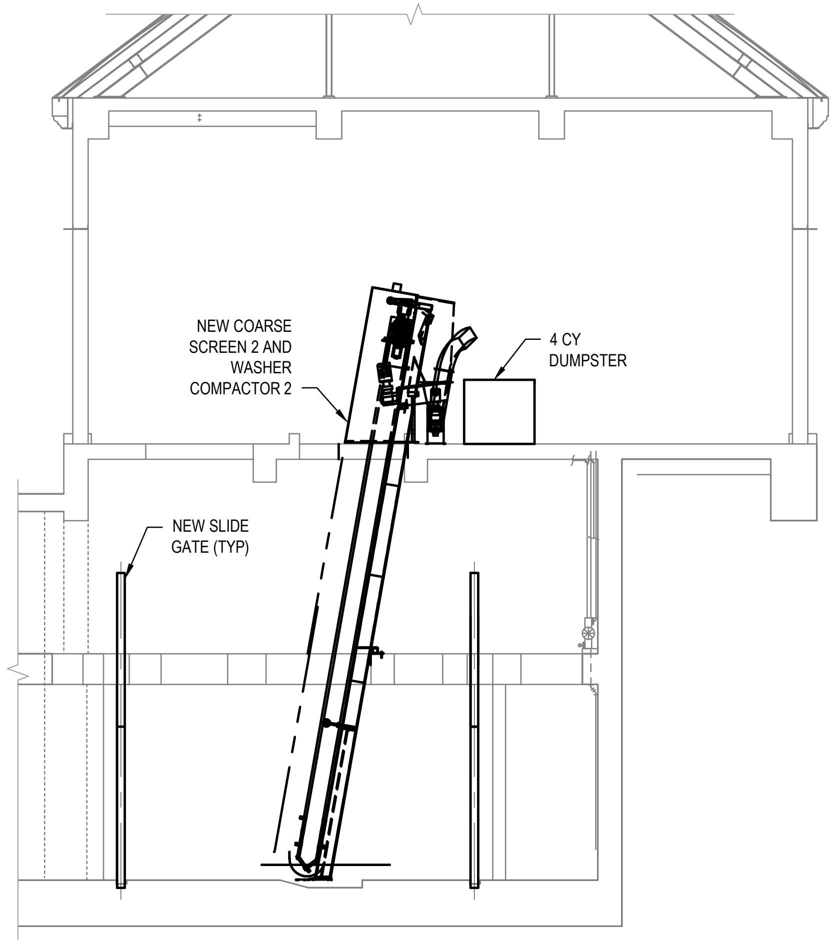

SECTION B -

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE 4:
THREE 3/4" FLEX-RAKE SCREENS AND
THREE WASHER/COMCACTORS AND THREE
4 CY DUMPSTERS - SECTIONS

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

FIGURE 17

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-17 coarse screen NEW.dwg
Plot Date: 25 May 2022 - 1:36 PM

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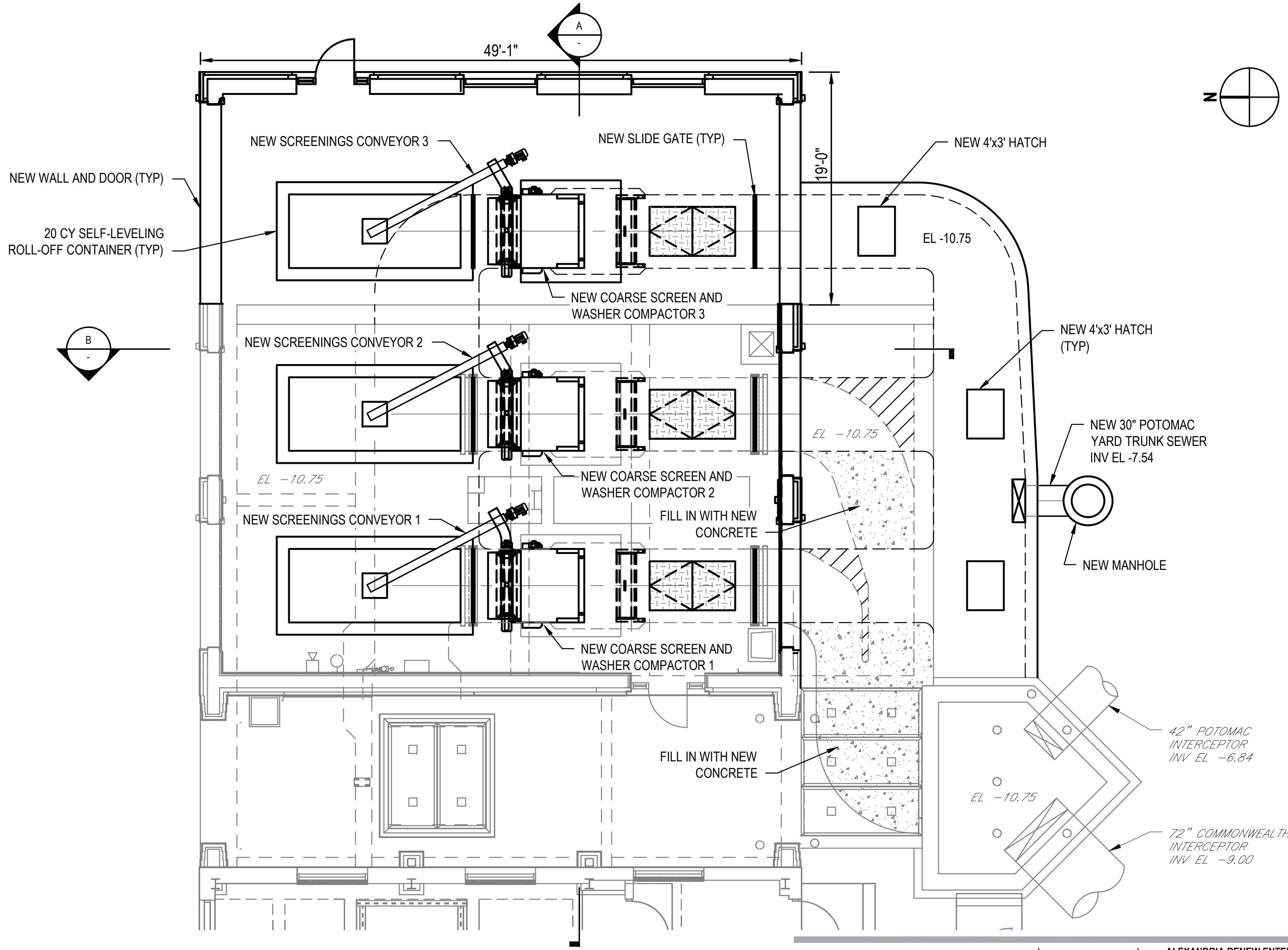


1 **UPPER PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

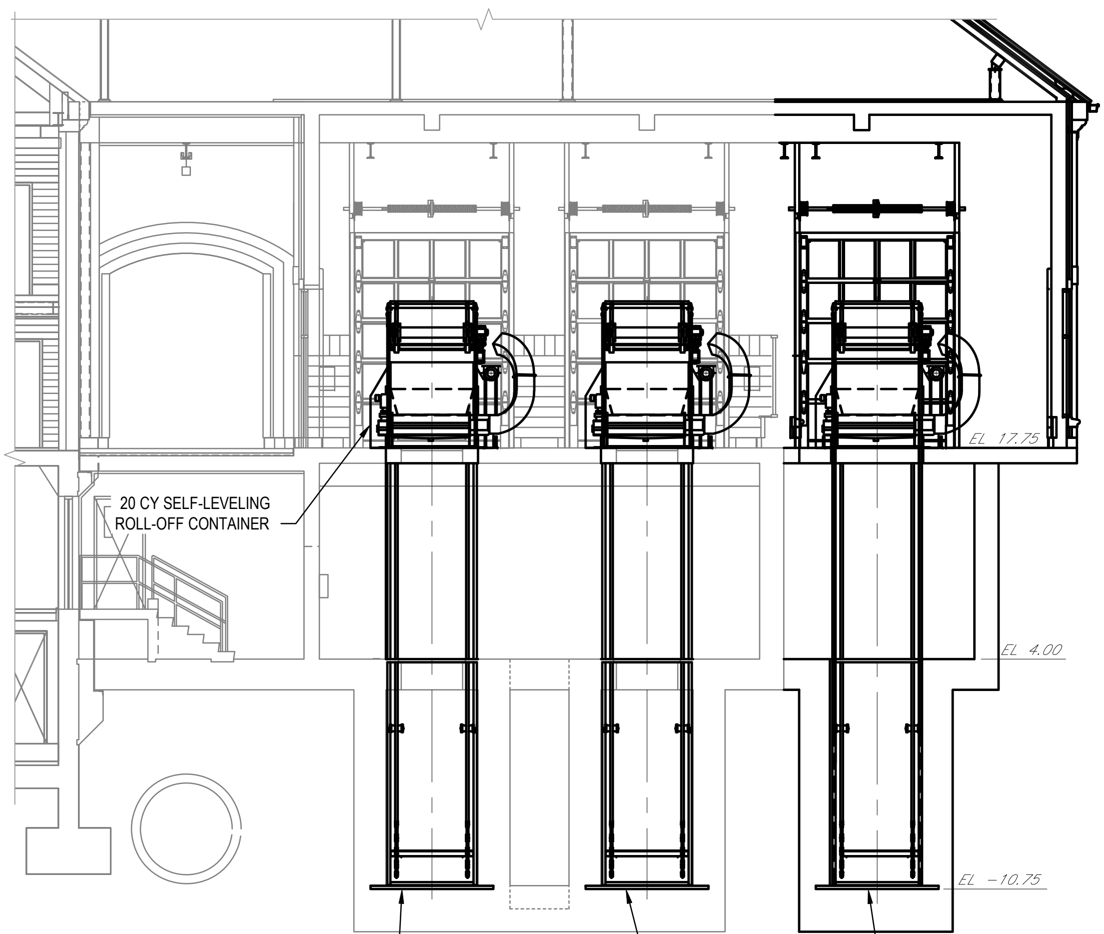
COARSE SCREEN UPGRADE ALTERNATIVE 5: THREE 3/4" FLEX-RAKE SCREENS AND THREE WASHER/COMPACTORS AND THREE 20 CY SELF-LEVELING ROLL-OFF CONTAINERS - PLAN

Project No. **11217618**
Report No. **N/A**
Date **05/2022**

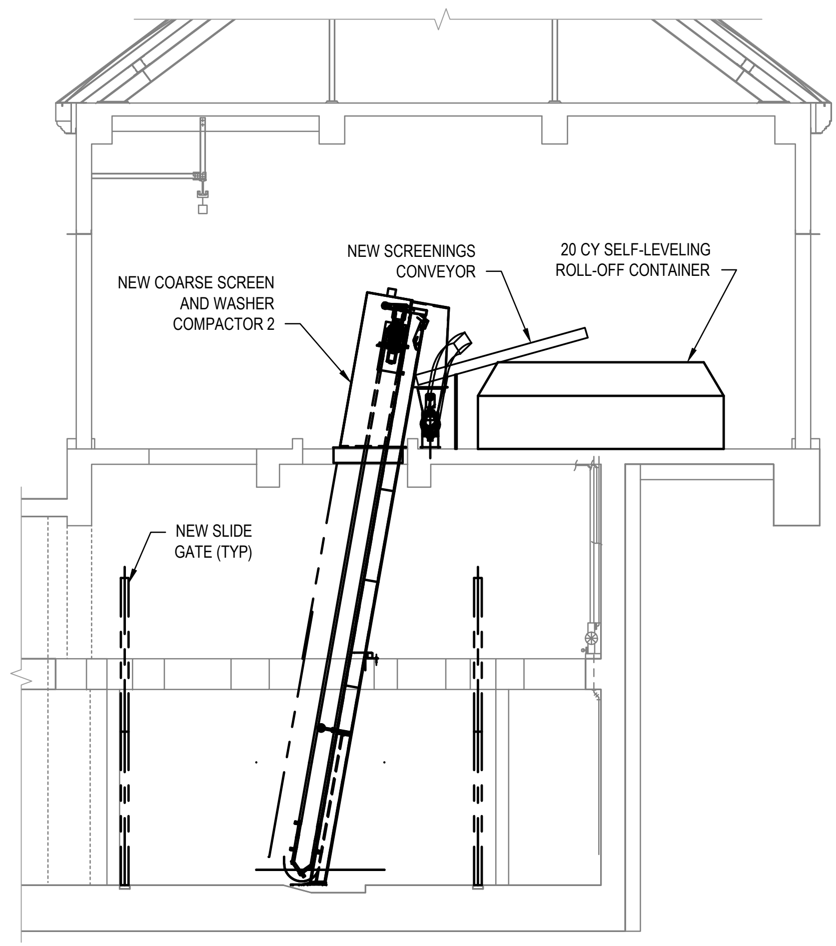
FIGURE 18

Source:

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-18 coarse screen NEW.dwg
Plot Date: 25 May 2022 - 1:16 PM



A
-
SECTION
1/8"=1'-0"



B
-
SECTION
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

COARSE SCREEN UPGRADE ALTERNATIVE 5: THREE 3/4" FLEX-RAKE SCREENS AND THREE WASHER/COMPACTORS AND THREE 20 CY SELF-LEVELING ROLL-OFF CONTAINERS-SECTIONS

Project No. 11217618
Report No. N/A
Date 05/2022

FIGURE 19

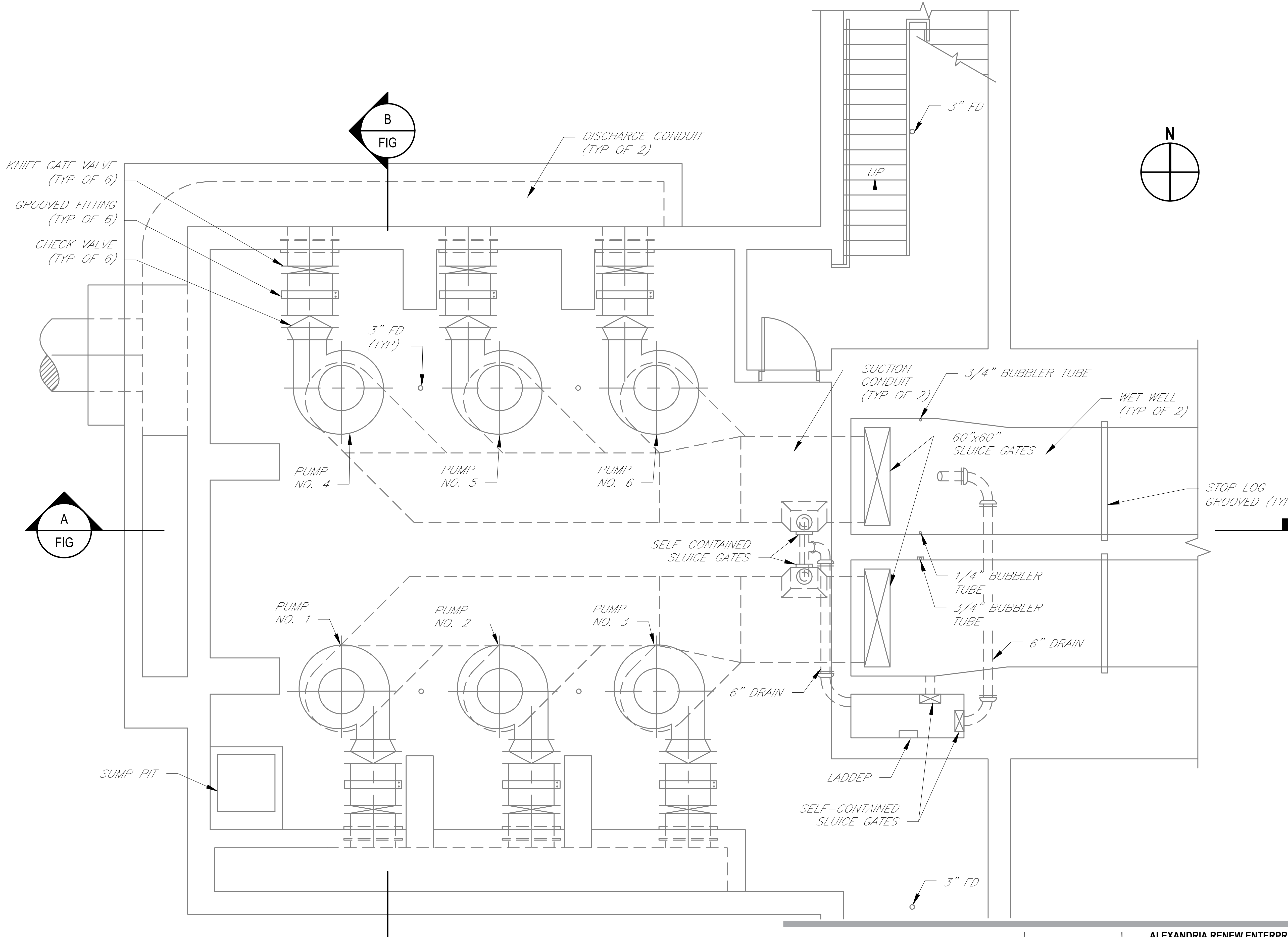
Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Coarse Screens\NEW FINAL FIGURES\FIG-19 coarse screen NEW.dwg
Plot Date: 25 May 2022 - 1:36 PM

Source:


Alexandria Renew Enterprises
Fire Department Training Facility
Building K
South Payne Street
Building A
Proposed construction area
South Payne St.

Appendix B

Conceptual Layouts – Raw Sewage Pump Station



1 **PLAN**
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

EXISTING LOWER PLAN

Project No. **11217618**
Report No. **N/A**
Date **10/2021**

RSPS UPGRADE

FIGURE 1

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-1 EXIST LOWER PLAN.dwg
Plot Date: 20 October 2021 - 1:41 PM

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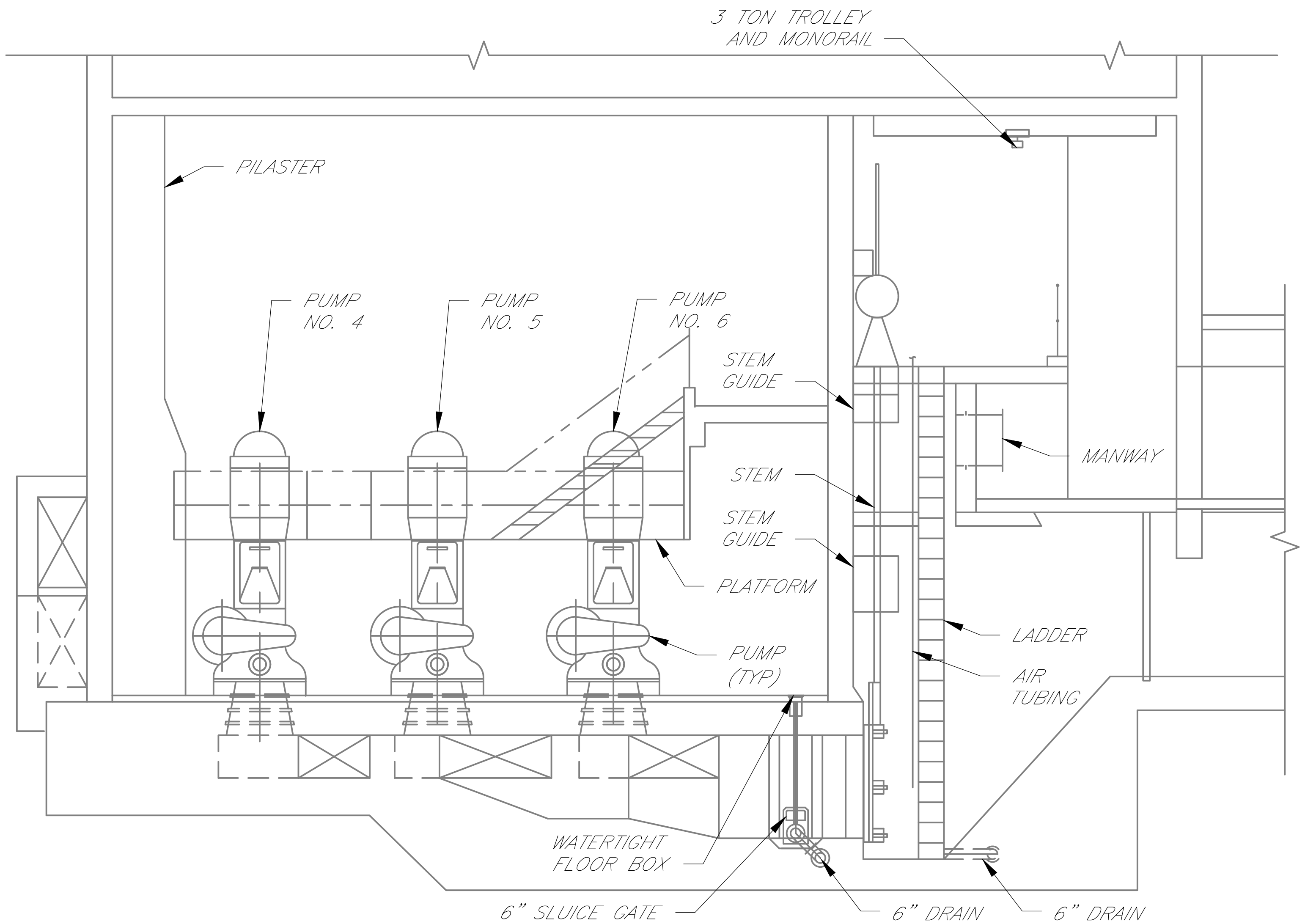
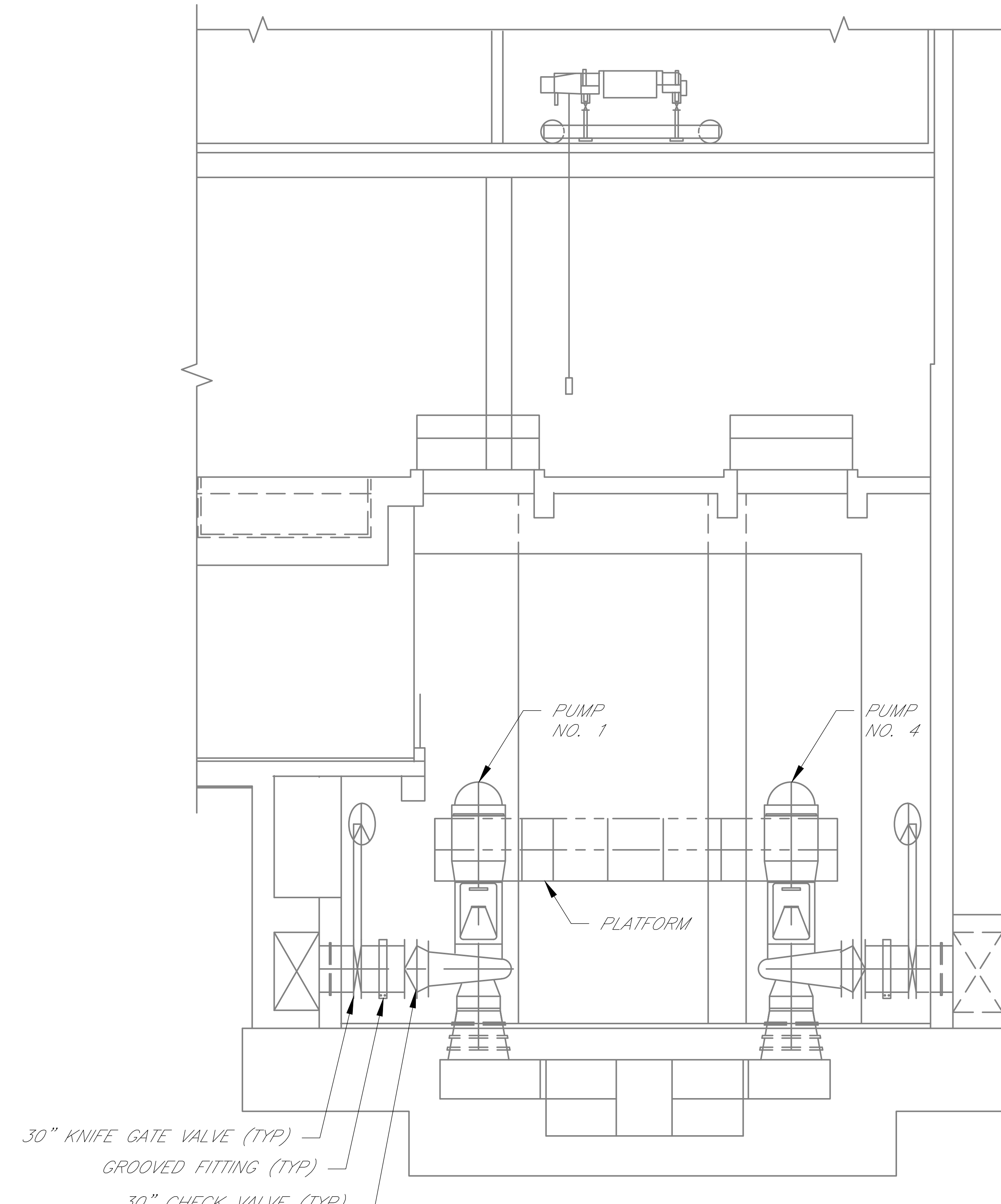


A
FIG
SECTION
SCALE: 1/8"=1'-0"



B
FIG
SECTION
SCALE: 1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

EXISTING SECTIONS

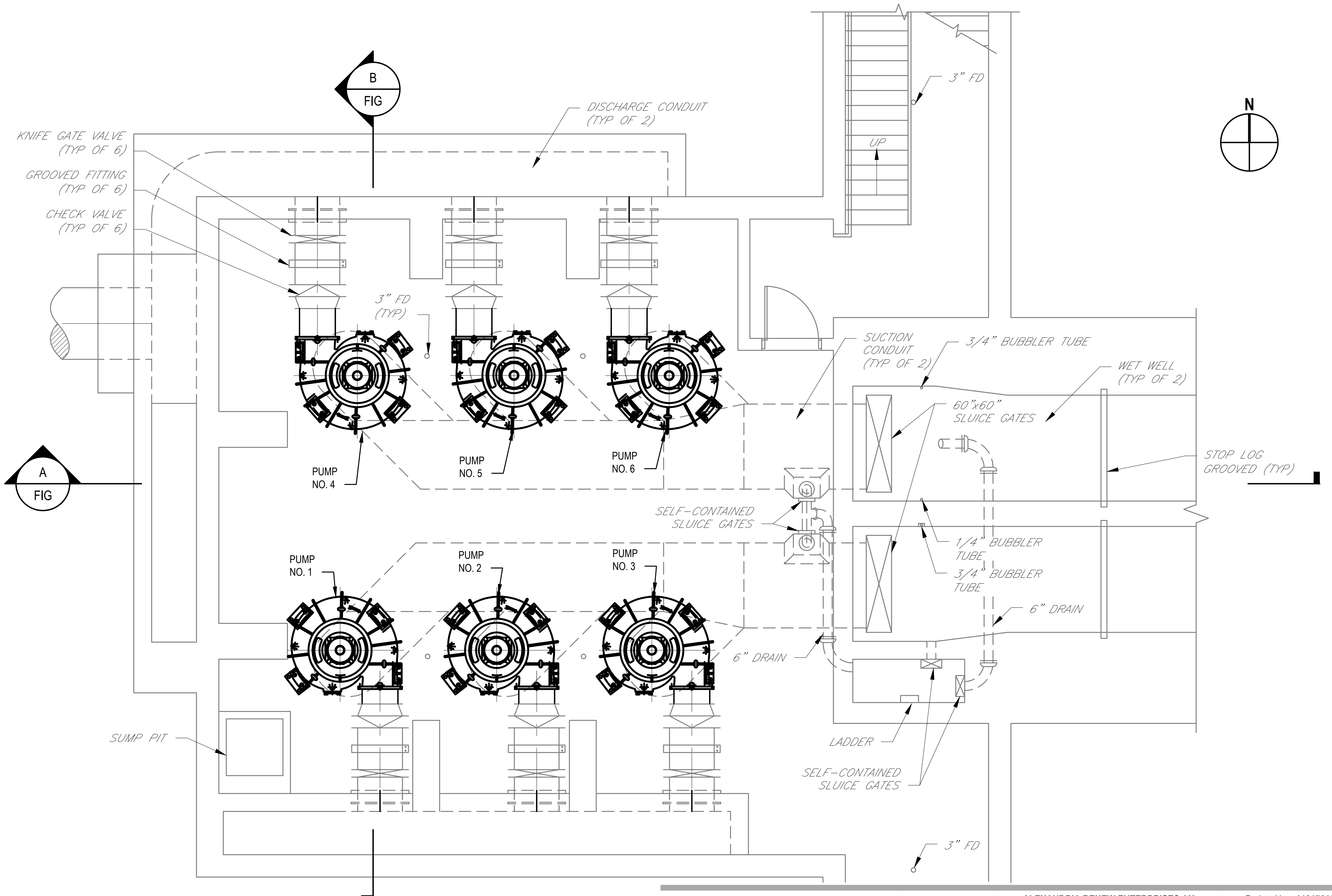
Project No. **11217618**
Report No. **N/A**
Date **10/2021**

RSPS UPGRADE

FIGURE 2

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-2 EXST SECTIONS.dwg
Plot Date: 20 October 2021 - 1:41 PM

Source:



1 PLAN
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

ALTERNATIVE 2 LOWER PLAN

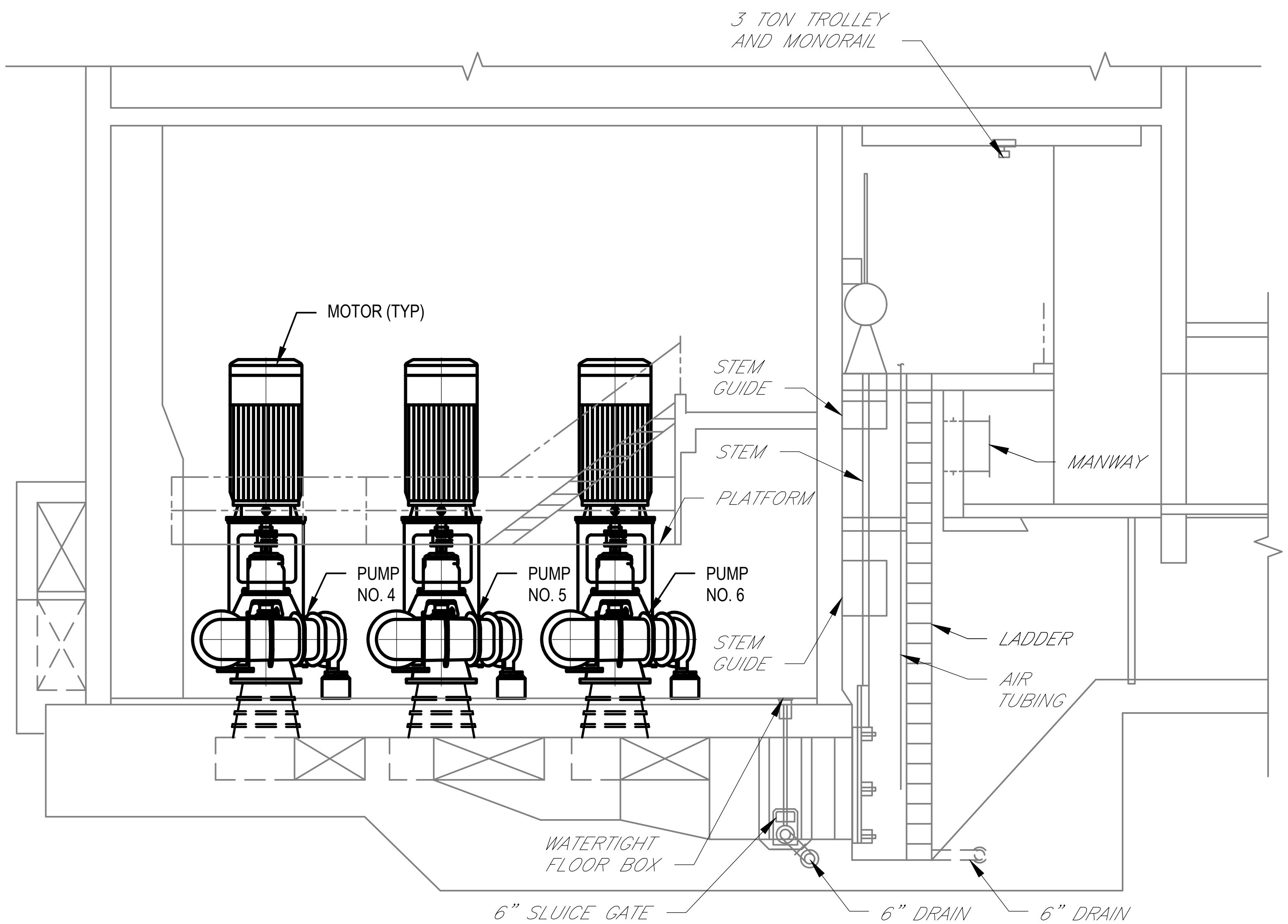
Project No. 11217618
Report No. N/A
Date 10/2021

RSPS UPGRADE

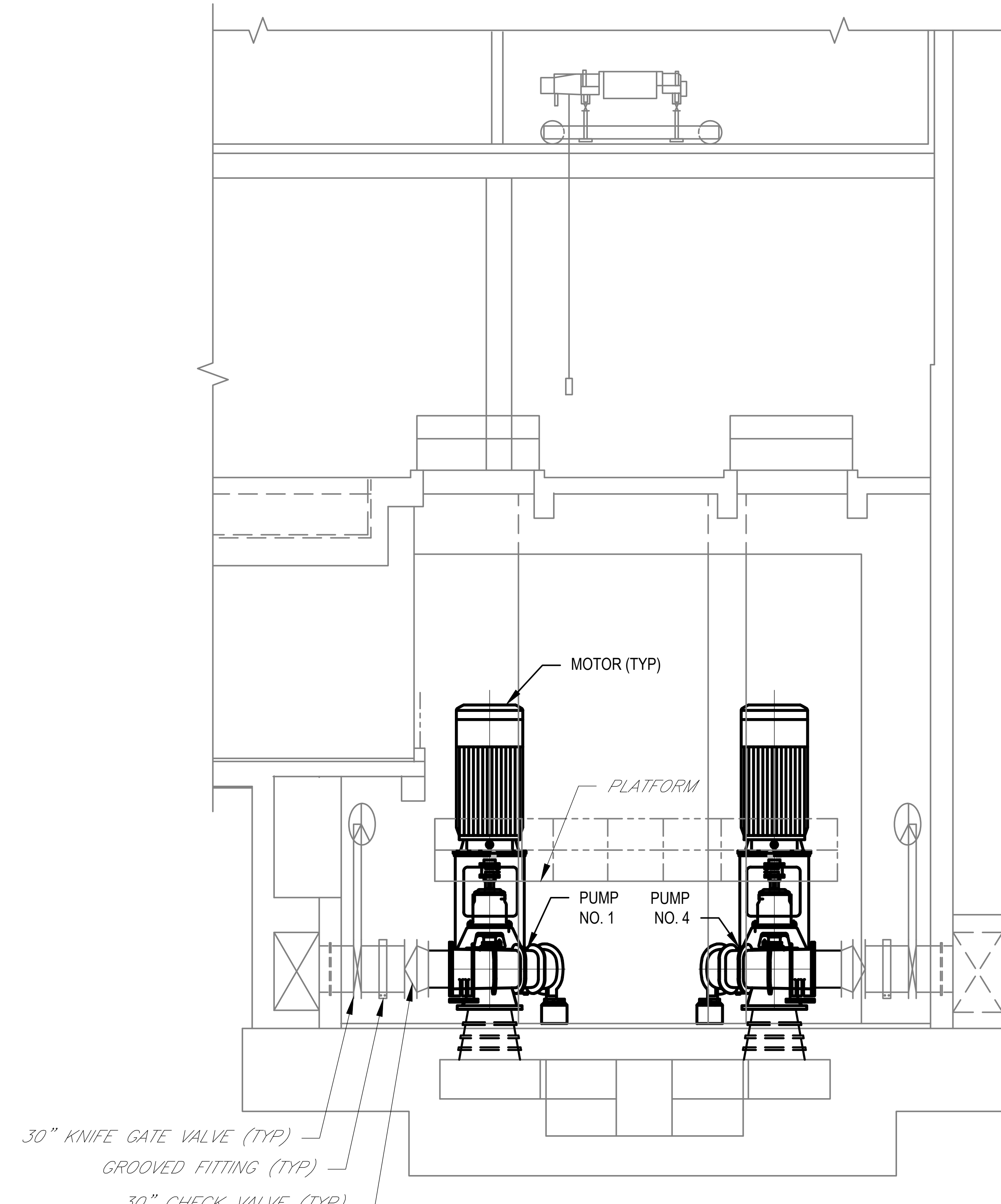
FIGURE 3

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-3 ALTER 2 LOWER PLAN.dwg
Plot Date: 20 October 2021 - 1:41 PM

Source:



A
FIG
SECTION
SCALE: 1/8"=1'-0"



A
FIG
SECTION
SCALE: 1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

ALTERNATIVE 2 - SECTIONS

Project No. 11217618
Report No. N/A
Date 10/2021

RSPS UPGRADE

FIGURE 4

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-4 ALTER 2 SECTIONS.dwg
Plot Date: 20 October 2021 - 1:41 PM
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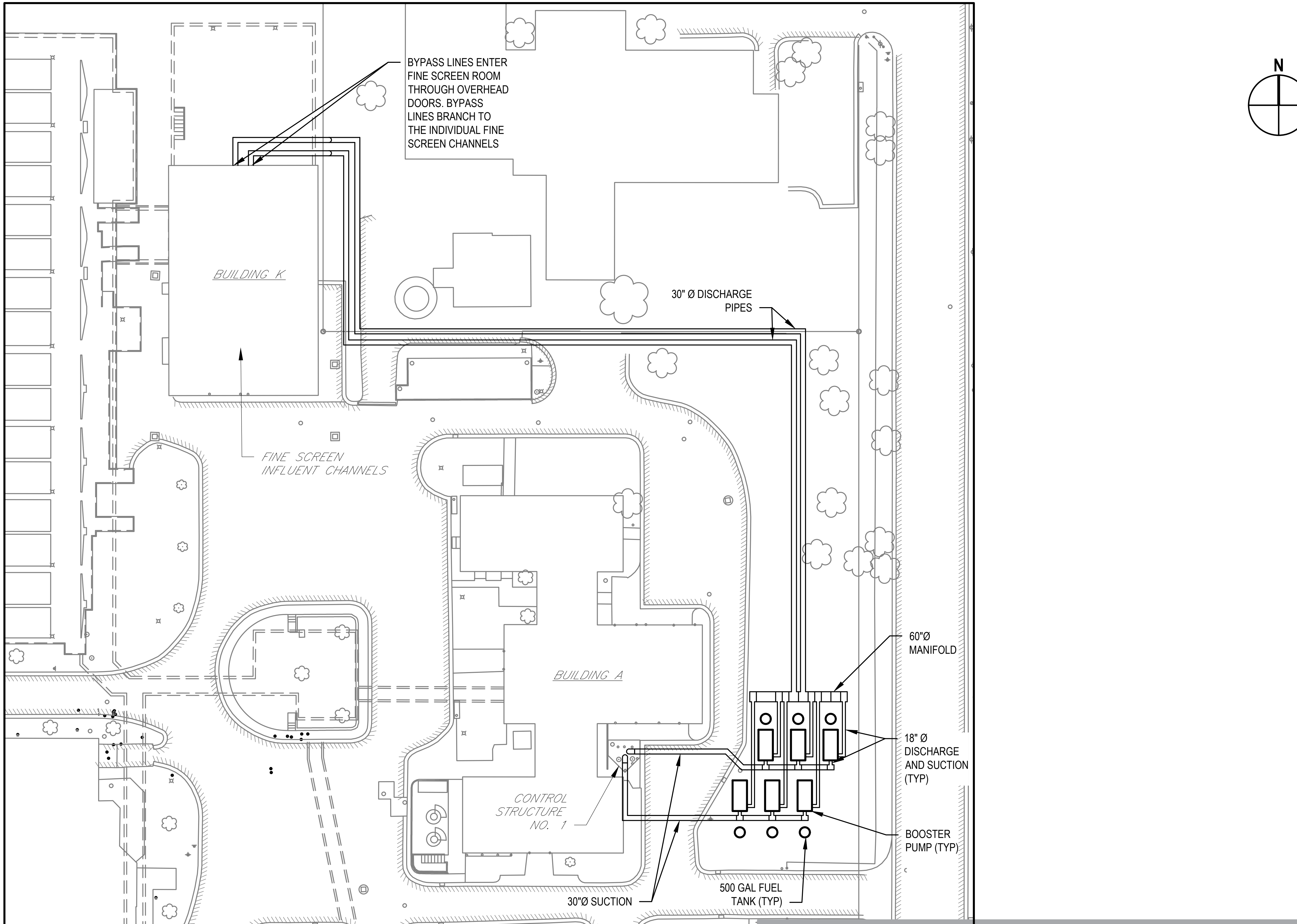

1 BYPASS PUMPING SITE PLAN

1"=50'-0"

0 20' 40' 60' 80' 100'

SCALE 1"=50' AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

BYPASS PUMPING SITE PLAN

Project No. 11217618
Report No. N/A
Date 10/2021

RSPS UPGRADE

FIGURE 5

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-5 RSPS BYPASS SITE PLAN.dwg
Plot Date: 20 October 2021 - 1:41 PM

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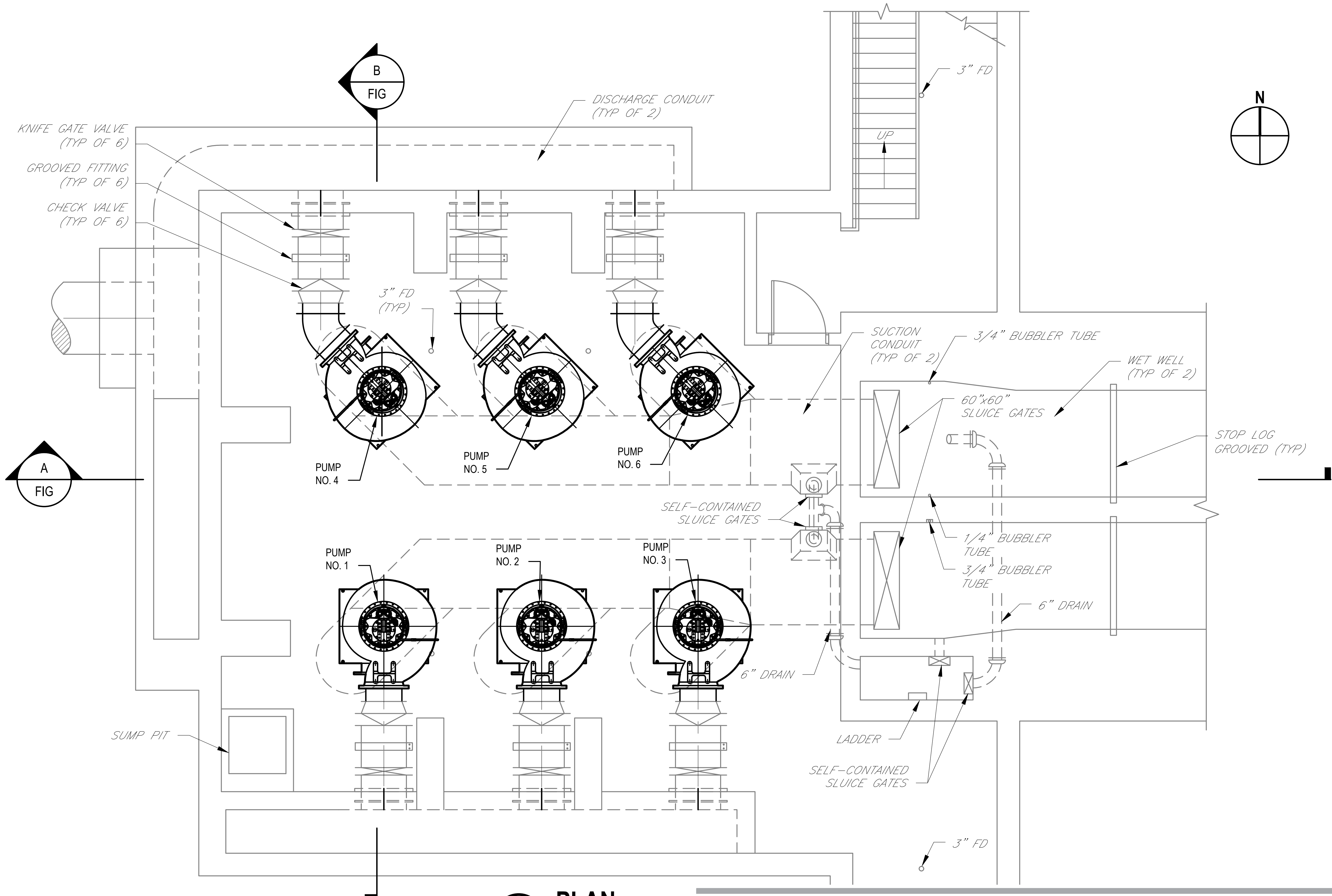

1 **PLAN**
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

ALTERNATIVE 3 - LOWER PLAN

Project No. **11217618**
Report No. **N/A**
Date **10/2021**

RSPS UPGRADE

FIGURE 6

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-6 ALTER 3 LOWER PLAN.dwg
Plot Date: 20 October 2021 - 1:41 PM

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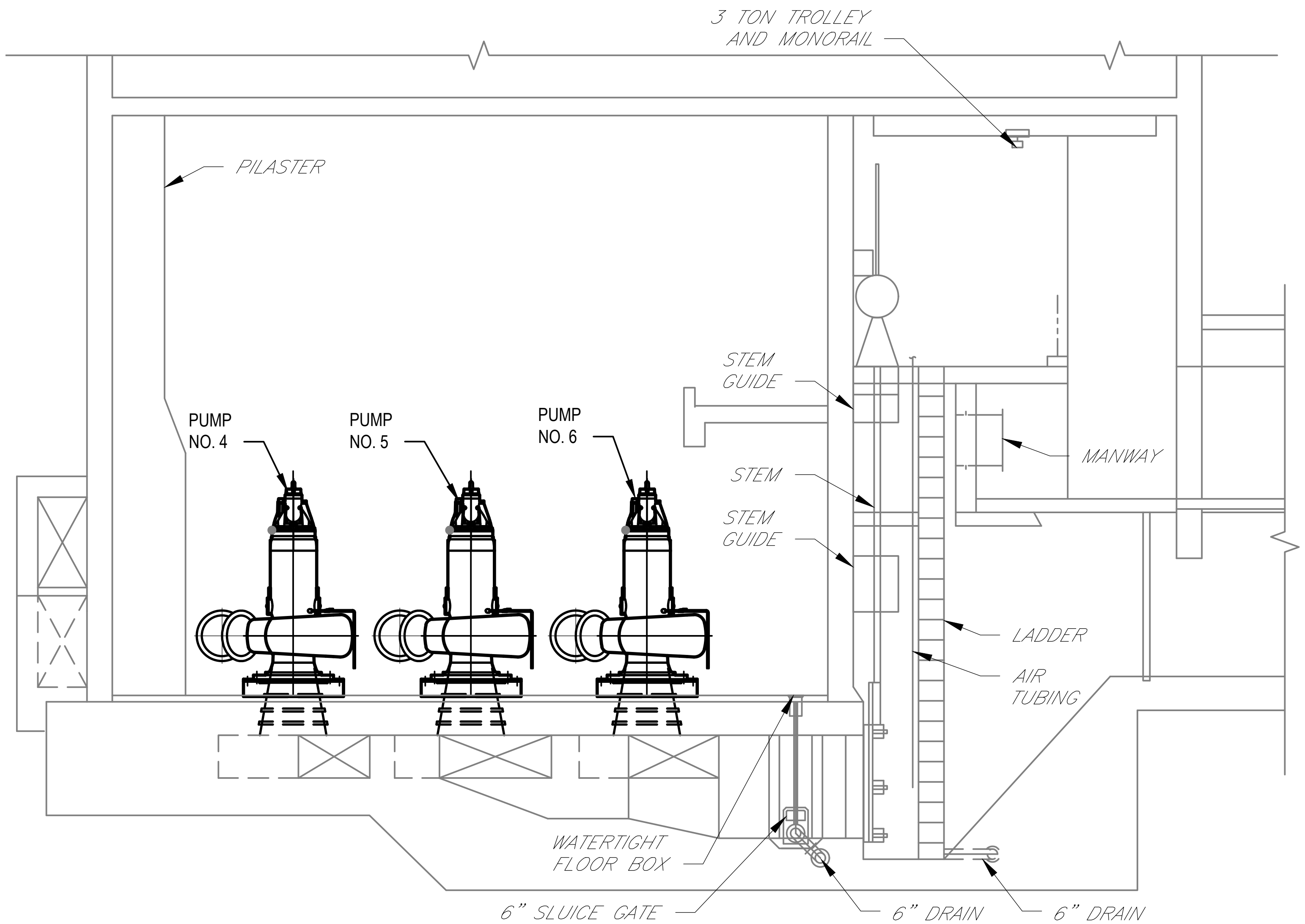
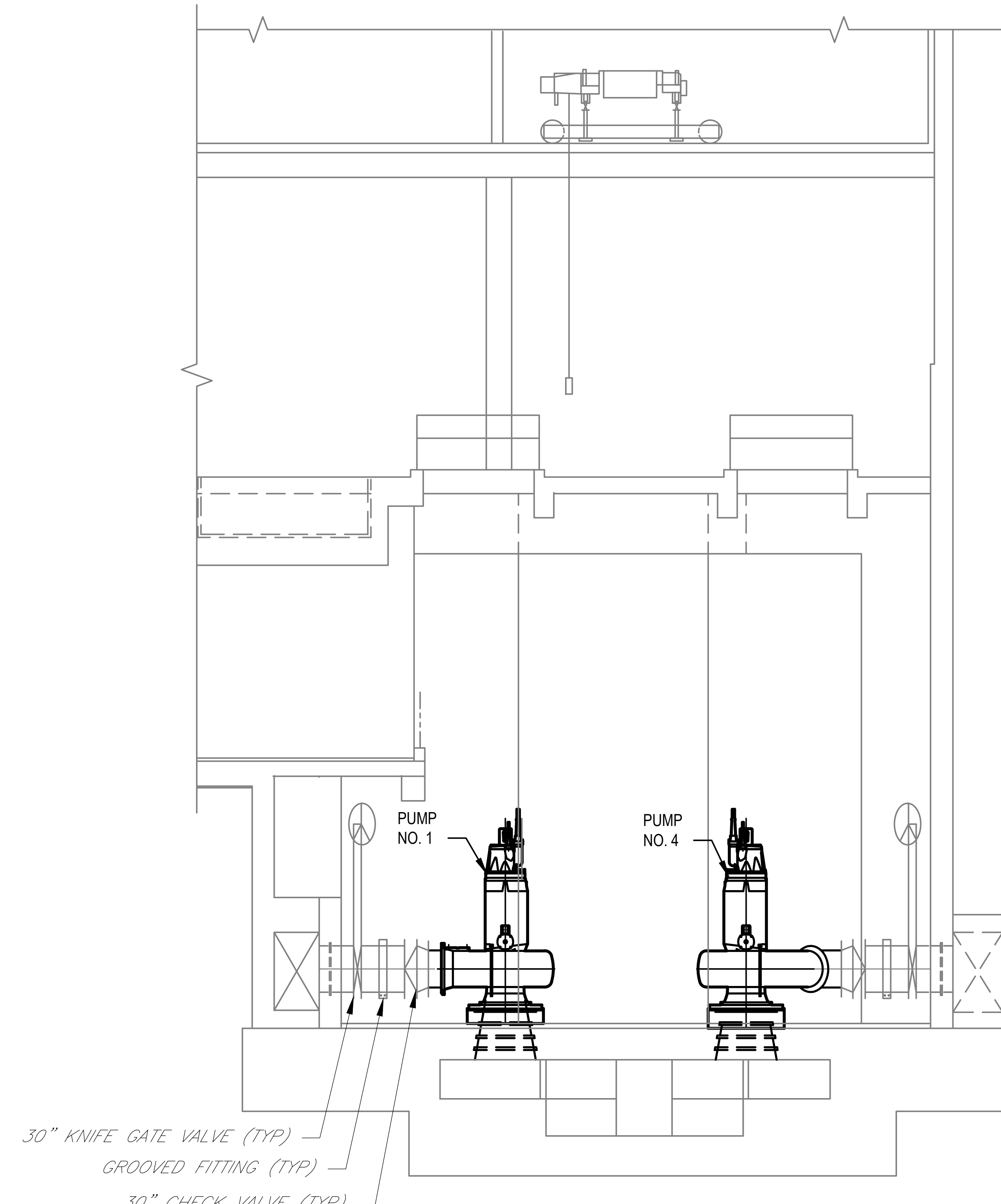


A
FIG
SECTION
SCALE: 1/8"=1'-0"



A
FIG
SECTION
SCALE: 1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

ALTERNATIVE 3 - SECTIONS

Project No. **11217618**
Report No. **N/A**
Date **10/2021**

RSPS UPGRADE

FIGURE 7

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-7 ALTER 3 SECTIONS.dwg
Plot Date: 20 October 2021 - 1:41 PM

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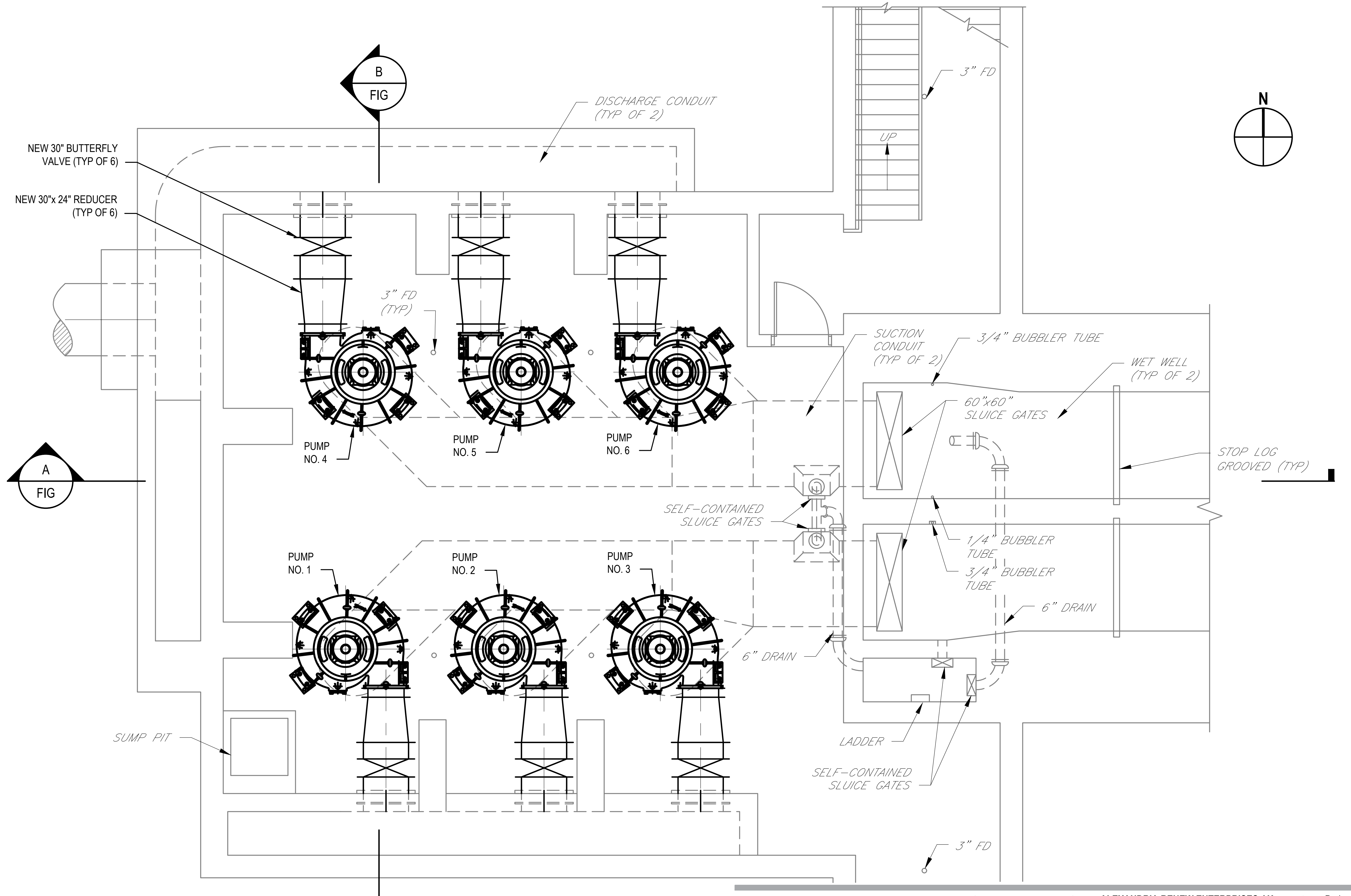

1 **PLAN**
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"

SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

ALTERNATIVE 2 - LOWER PLAN
(WITH BUTTERFLY VALVE ARRANGEMENT)

Project No. **11217618**
Report No. **N/A**
Date **10/2021**

RSPS UPGRADE

FIGURE 8

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-8 ALTER 2 LOWER PLAN BFV.dwg
Plot Date: 20 October 2021 - 1:41 PM

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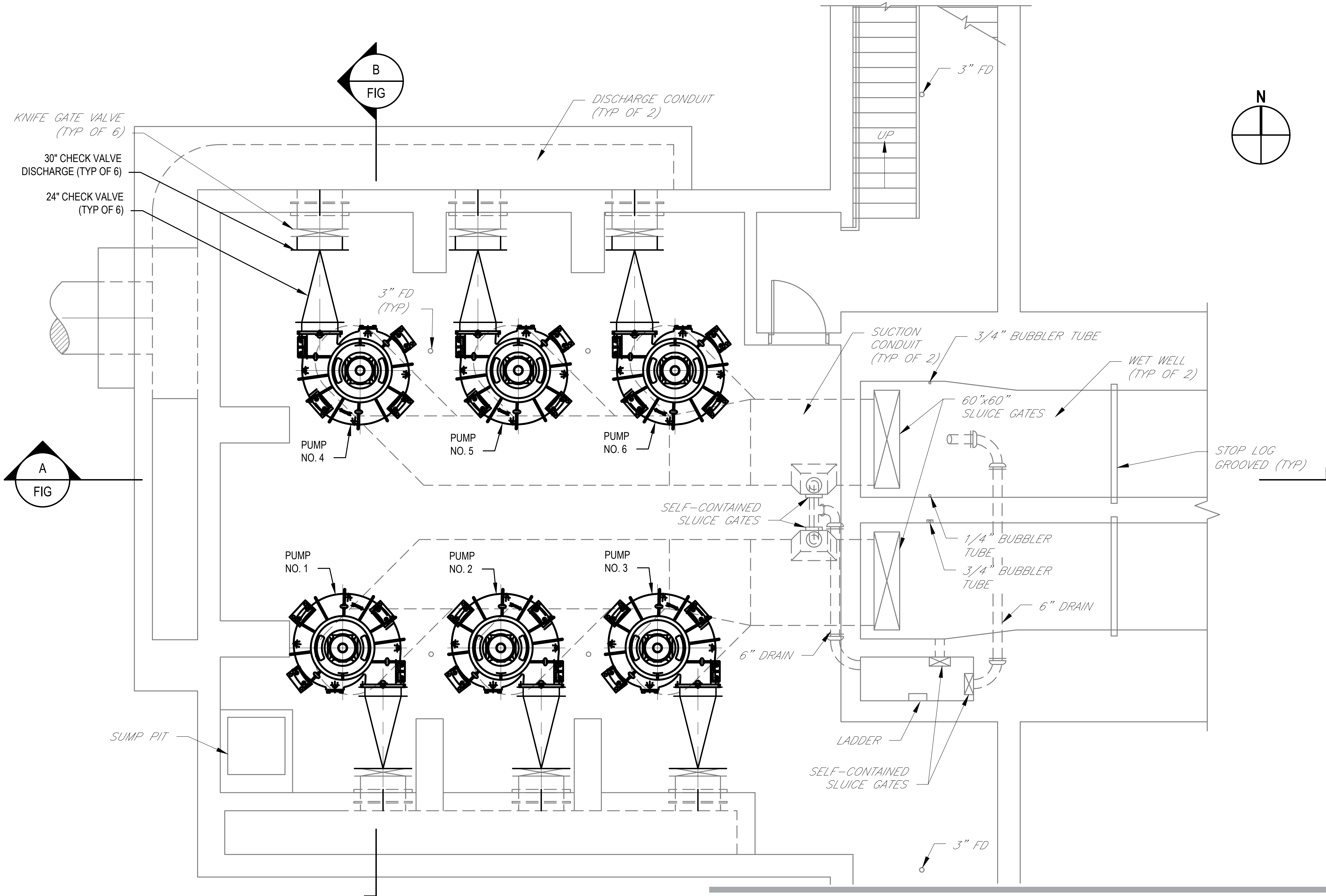


1 PLAN
3/16"=1'-0"

0	4'-0"	8'-0"	12'-0"

SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

ALTERNATIVE 2 - LOWER PLAN
(WITH CHECK VALVE ARRANGEMENTS)

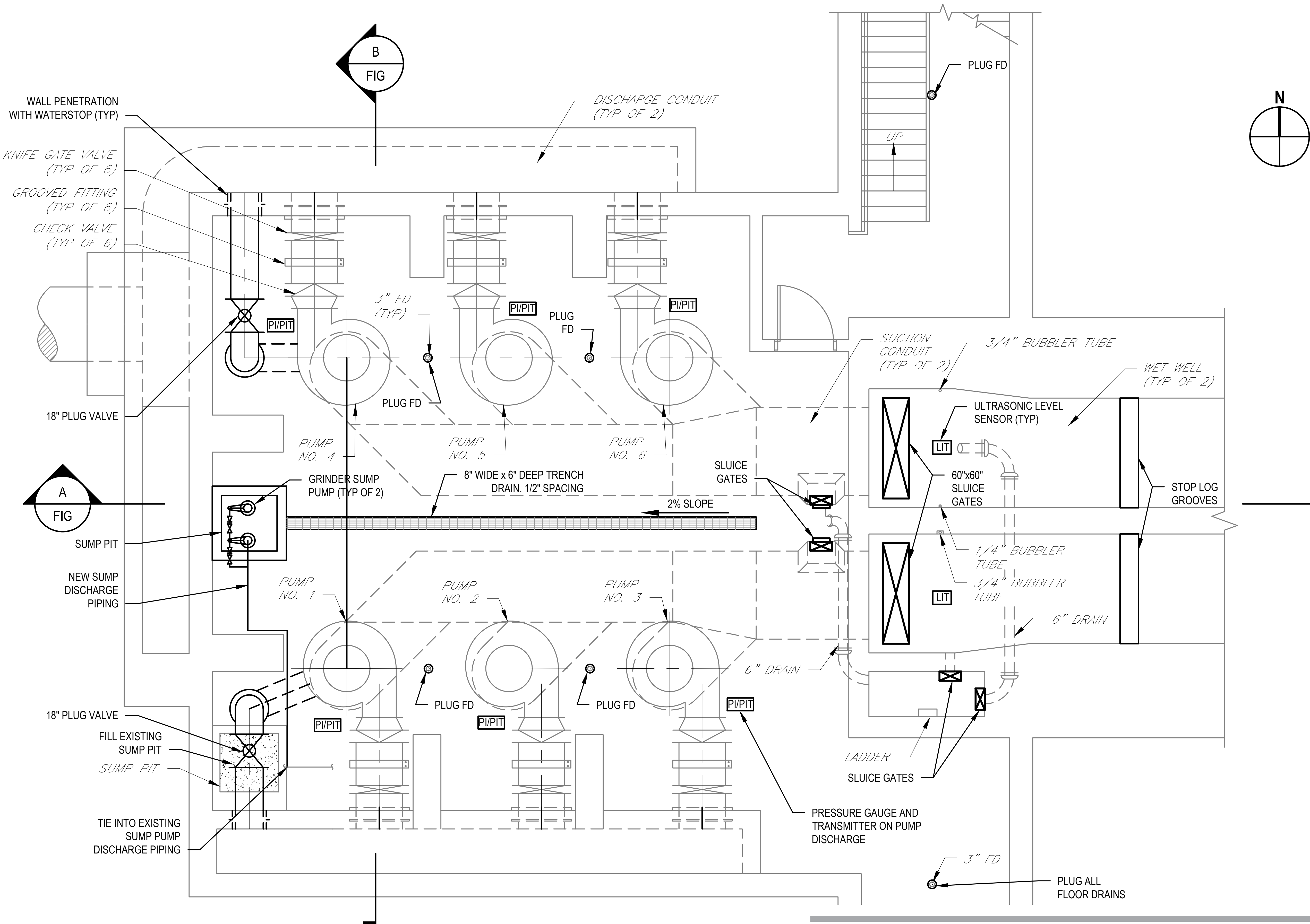
Project No. **11217618**
Report No. **N/A**
Date **09/2021**

RSPS UPGRADE

FIGURE 9

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-9 ALTER 2 LOWER PLAN CV.dwg
Plot Date: 20 October 2021 - 1:41 PM

Source:



1 **PLAN**
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

MISCELLANEOUS - LOWER PLAN

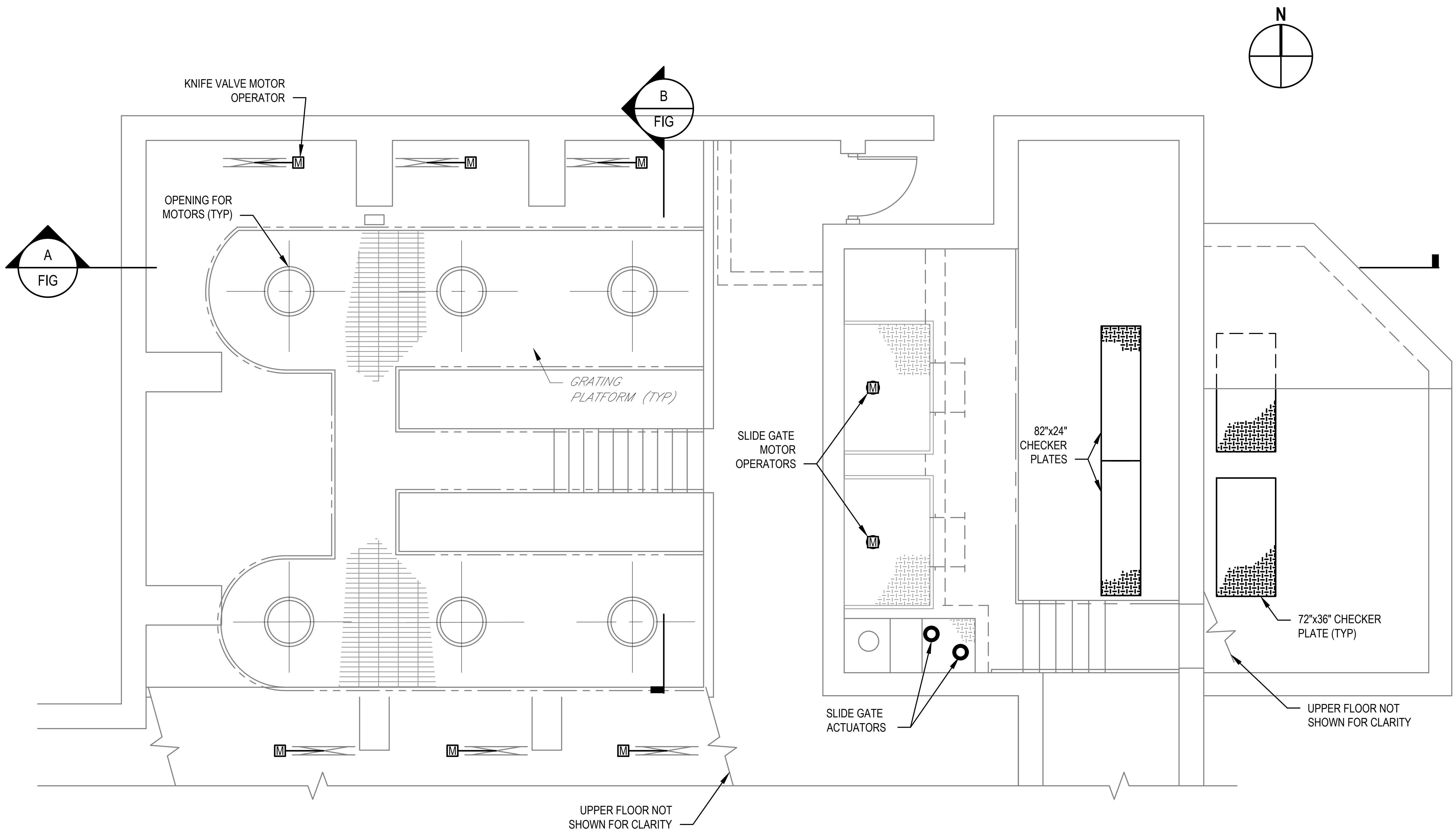
Project No. **11217618**
Report No. **N/A**
Date **10/2021**

RSPS UPGRADE

FIGURE 10

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-10 MISCEL LOWER PLAN.dwg
Plot Date: 20 October 2021 - 1:41 PM

Source:



1 **PLAN**
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

MISCELLANEOUS - UPPER PLAN

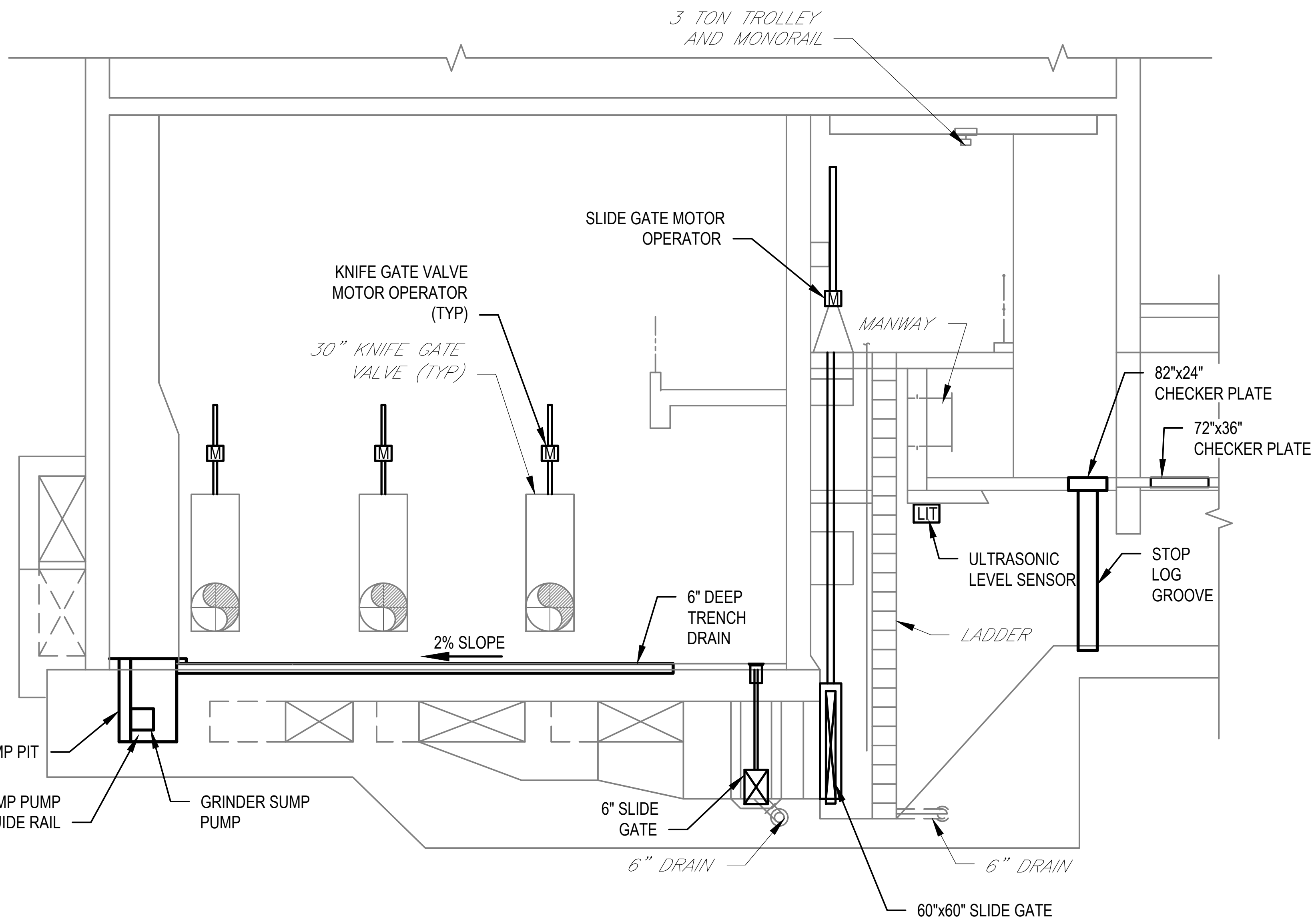
Project No. **11217618**
Report No. **N/A**
Date **10/2021**

RSPS UPGRADE

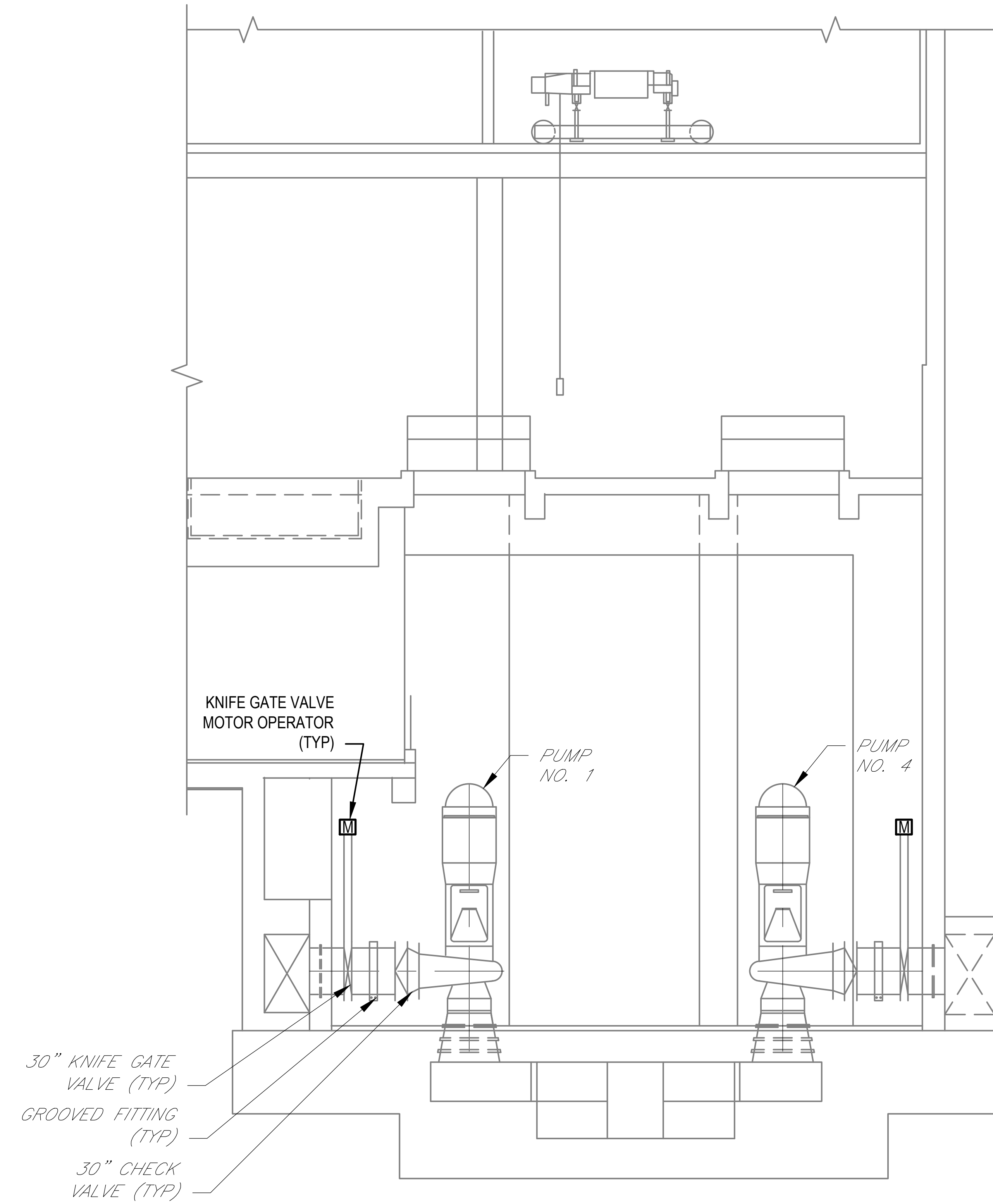
FIGURE 11

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-11 MISCEL UPPER PLAN.dwg
Plot Date: 20 October 2021 - 1:41 PM

Source:



A
FIG
SECTION
SCALE: 1/8"=1'-0"



A
FIG
SECTION
SCALE: 1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

MISCELLANEOUS - SECTIONS

Project No. **11217618**
Report No. **N/A**
Date **10/2021**

RSPS UPGRADE

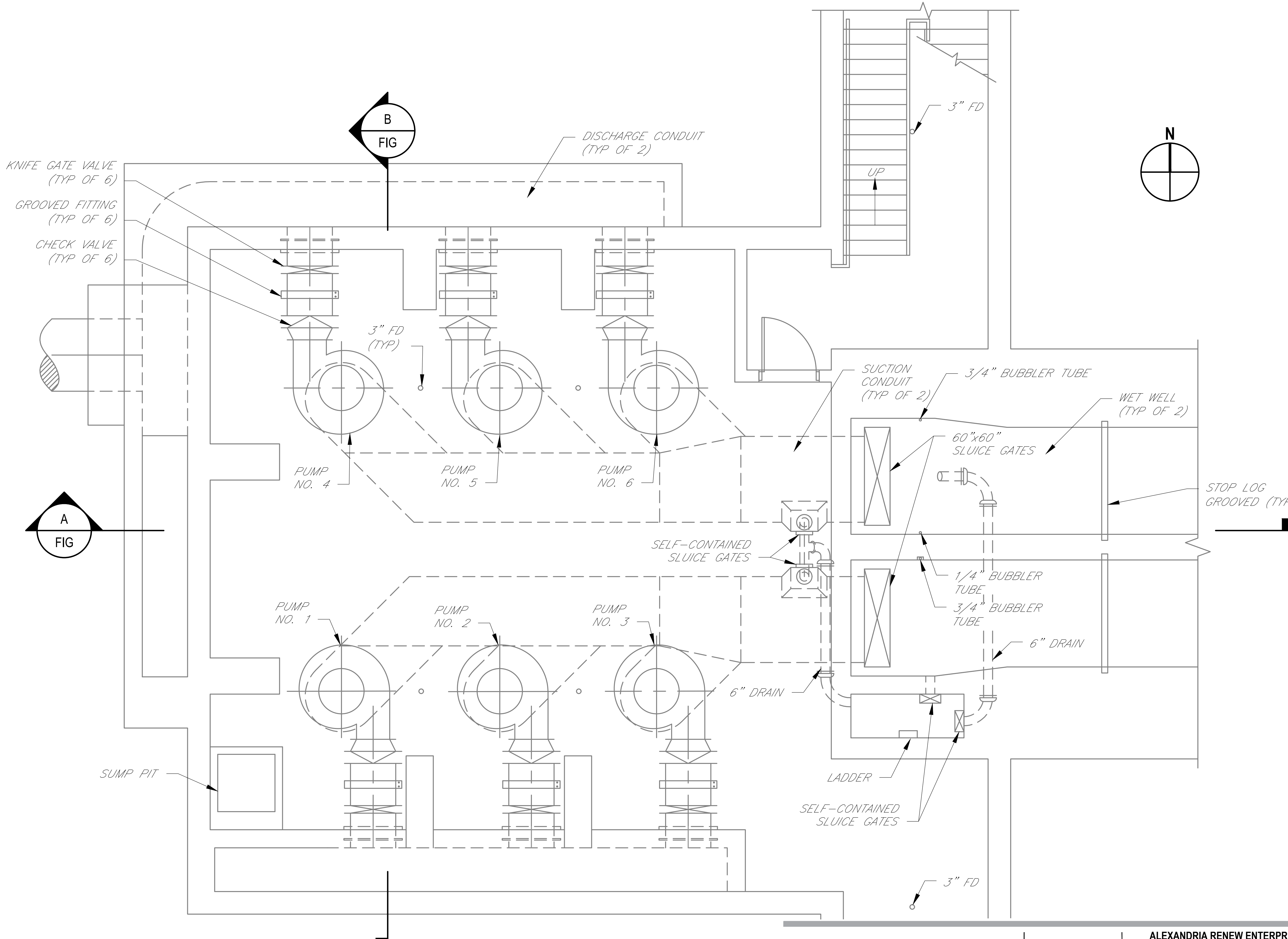
FIGURE 12

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-12 MISCEL SECTIONS.dwg
Plot Date: 20 October 2021 - 1:41 PM

Source:

Appendix C

Conceptual Layouts – Raw Sewage Conduits



1 PLAN
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

LOWER PLAN EXISTING

Project No. 11217618
Report No. N/A
Date 10/2021

CONDUIT UPGRADE

FIGURE 1

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-1 COND-P1 EXST.dwg
Plot Date: 20 October 2021 - 11:18 AM

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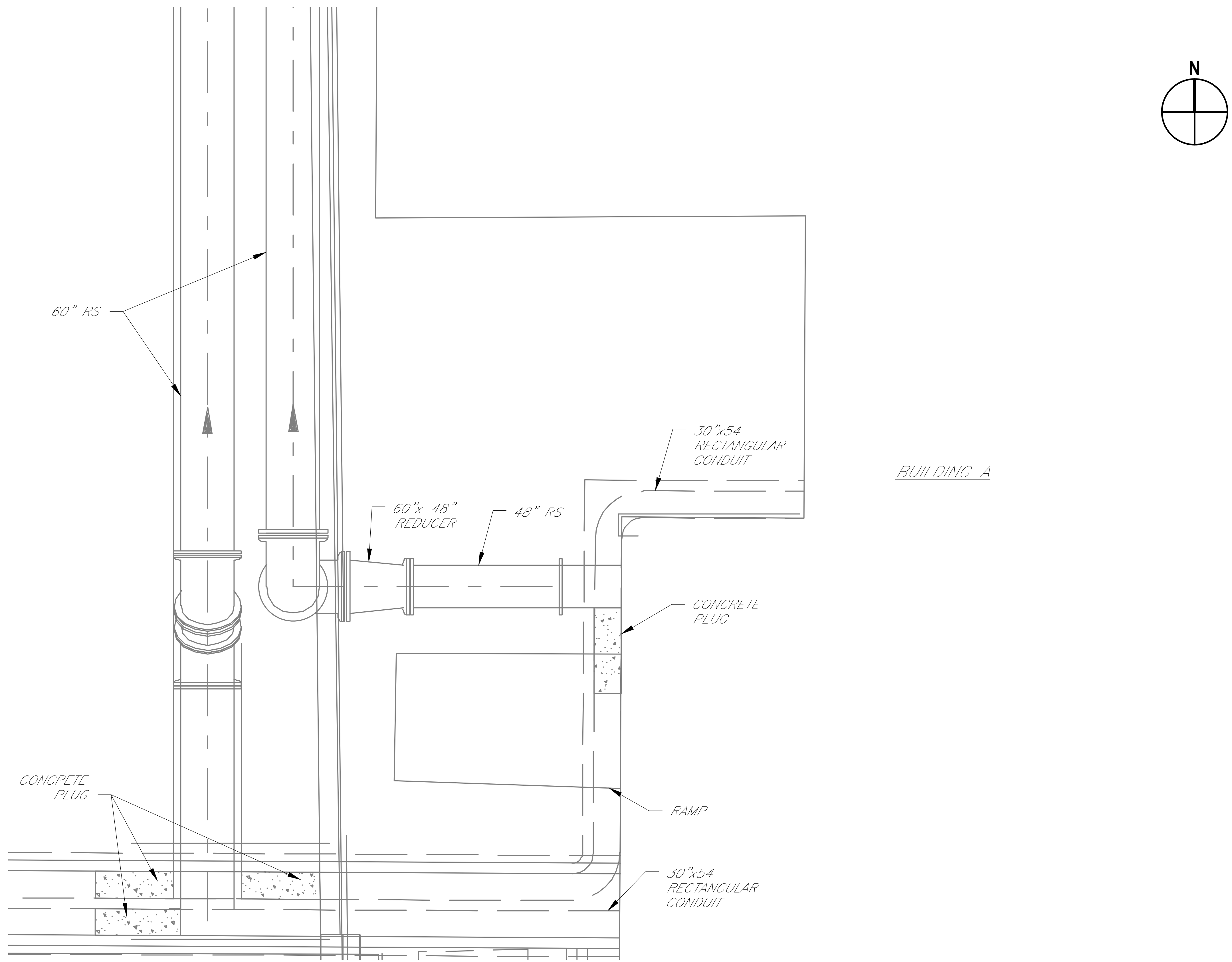

1 EXISTING SITE PLAN

1"=10'-0"

0 4' 8' 12' 16' 20'

SCALE 1" = 10' AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

CONDUITS EXISTING YARD PLAN

Project No. **11217618**
Report No. **N/A**
Date **10/2021**

CONDUIT UPGRADE

FIGURE 2

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-2 COND-EXST SITE.dwg
Plot Date: 20 October 2021 - 11:18 AM

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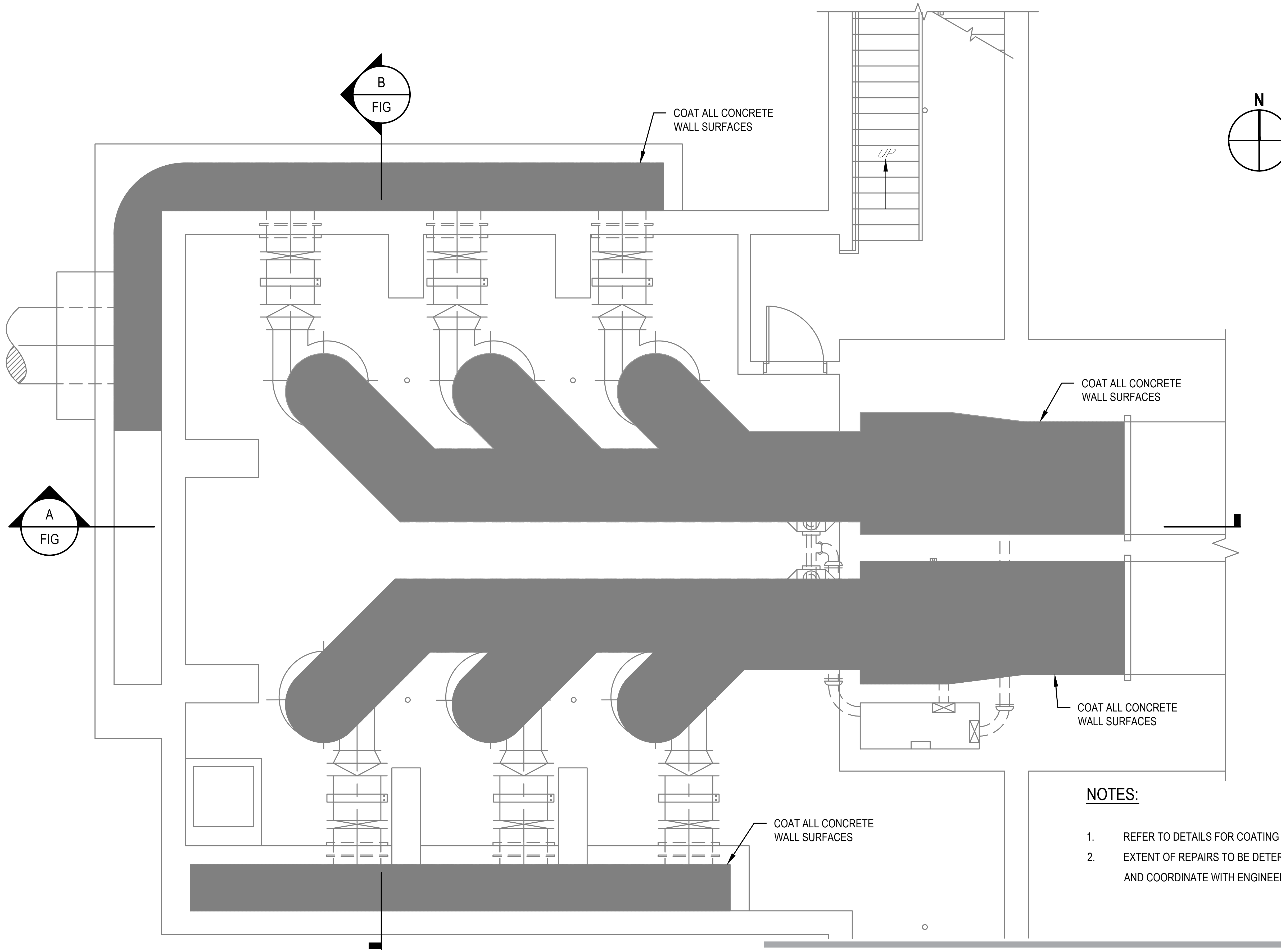

NOTES:

1. REFER TO DETAILS FOR COATING OPTIONS.
2. EXTENT OF REPAIRS TO BE DETERMINED AND RECORDED BY CONTRACTOR AND COORDINATE WITH ENGINEER.

1 **PLAN**
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

CONCRETE REPAIR AND PROTECTIVE COATING PLAN

Project No. **11217618**
Report No. **N/A**
Date **10/2021**

CONDUIT UPGRADE

FIGURE 3

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-3 COND-P1 NEW.dwg
Plot Date: 20 October 2021 - 11:18 AM

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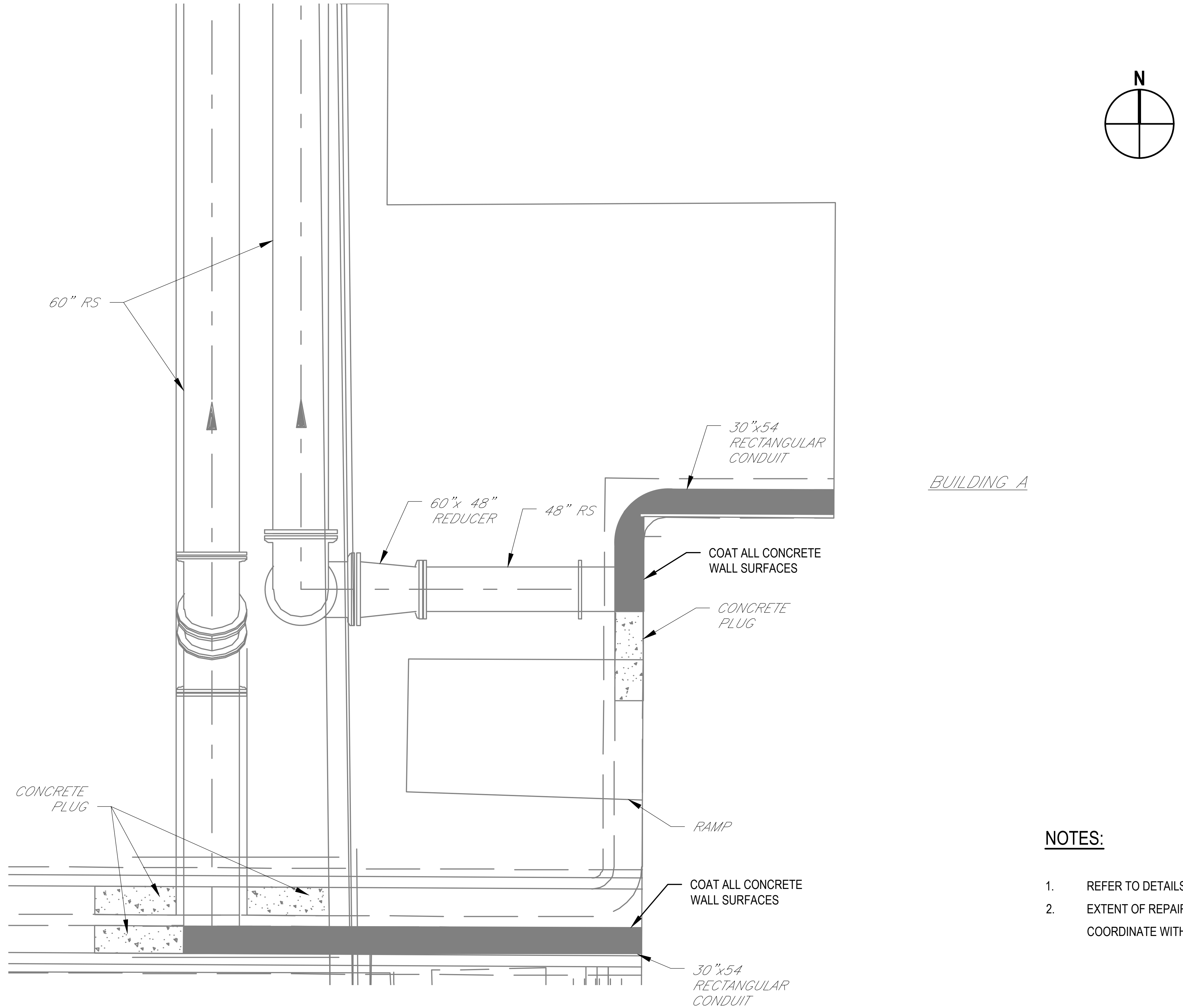


1 NEW YARD PLAN

1"=10'-0"

NOTES:

1. REFER TO DETAILS FOR COATING OPTIONS.
2. EXTENT OF REPAIRS TO BE DETERMINED AND RECORDED BY CONTRACTOR AND COORDINATE WITH ENGINEER.

0 4' 8' 12' 16' 20'

SCALE 1" = 10' AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

CONCRETE REPAIR AND PROTECTIVE COATING PLAN

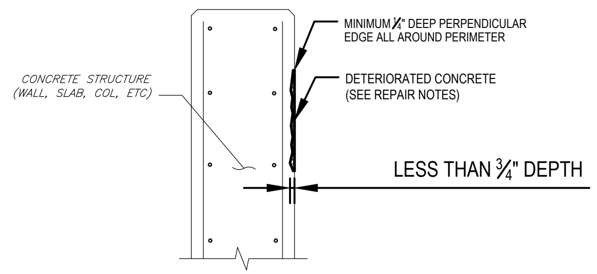
Project No. **11217618**
Report No. **N/A**
Date **10/2021**

CONDUIT UPGRADE

FIGURE 4

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-4 COND-NEW SITE.dwg
Plot Date: 20 October 2021 - 11:18 AM

Source:



SECTION

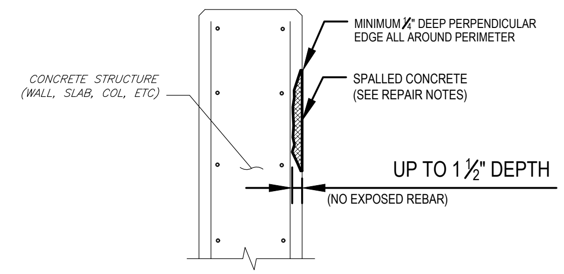
REPAIR NOTES:

1. CONCRETE SURFACE SHALL BE CLEANED AND PREPARED IN ACCORDANCE WITH GENERAL NOTES 1 THROUGH 7.
2. REPAIR CONCRETE BY PATCHING WITH MANUFACTURER APPROVED MORTAR, FLOWABLE FILL, HYDRAULIC CEMENT, OR EPOXY.
3. PROVIDE FINAL COATING(S) OF GEOPOLYMER, EPOXY, OR GLASS FIBER.

AREA WITH MINOR DAMAGE LESS THAN ¾" DEPTH
(CONCRETE SURFACE DETERIORATED WITHOUT SPALLING)

1 REPAIR DETAIL - "TYPE 1"

NOT TO SCALE



SECTION

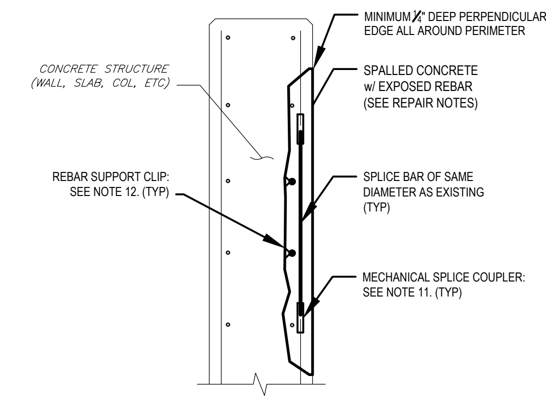
REPAIR NOTES:

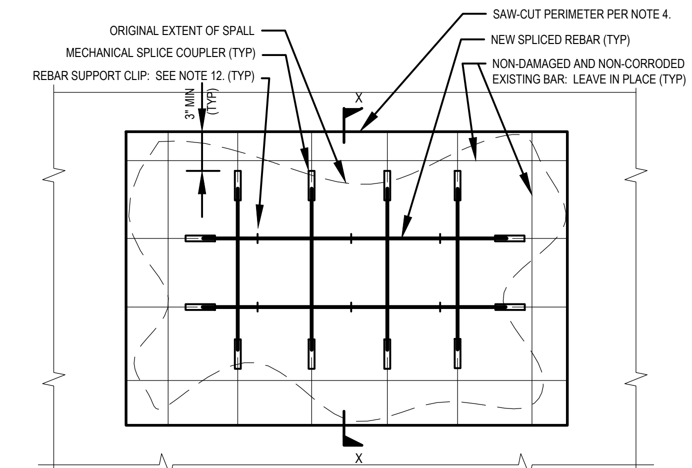
1. CONCRETE SURFACE SHALL BE CLEANED AND PREPARED IN ACCORDANCE WITH GENERAL NOTES 1 THROUGH 7.
2. REPAIR CONCRETE BY PATCHING WITH MANUFACTURER APPROVED MORTAR, FLOWABLE FILL, HYDRAULIC CEMENT. PROVIDE MULTIPLE LIFTS OF PATCH MATERIAL AS REQUIRED TO BUILD A FLUSH SURFACE WITH EXISTING. TAMP INTO PLACE; DO NOT FEATHER EDGES.
3. PROVIDE FINAL COATING(S) OF GEOPOLYMER, EPOXY, OR GLASS FIBER.

SPALLED CONCRETE LESS THAN 1 1/2" DEPTH
(REINFORCING STEEL NOT EXPOSED)

2 S008 REPAIR DETAIL - "TYPE 2"

NOT TO SCALE





ELEVATION

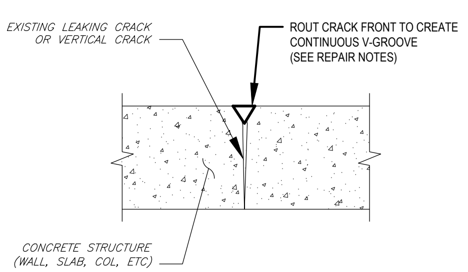
REPAIR NOTES:

1. DETAILS SHOWN ABOVE ARE FOR REPAIR METHOD USING MECHANICAL SPLICE COUPLERS. OTHER APPROVED SPLICING METHODS ARE ALLOWABLE.
2. AREA TO BE REPAIRED SHALL BE PROVIDED WITH ADEQUATE SHORING PRIOR TO START OF REPAIR WORK. WHERE DIRECTED BY THE ENGINEER, CONTRACTOR SHALL SUBMIT SHORING PLANS AND DETAILS, SIGNED AND SEALED BY A REGISTERED DELAWARE PROFESSIONAL ENGINEER, TO THE ENGINEER OF RECORD FOR REVIEW AND APPROVAL.
3. CONCRETE SURFACE SHALL BE CLEANED AND PREPARED IN ACCORDANCE WITH GENERAL NOTES 1 THROUGH 7.
4. PREPARE REPAIR AREA BY SAW-CUTTING MINIMUM ¼" DEEP RECTANGULAR CONCRETE PERIMETER AROUND EXTENT OF SPALL.
5. REMOVE MINIMUM 3" DEPTH OF CONCRETE TO EXPOSE DAMAGED AND CORRODED REBAR.
6. FURTHER REMOVE LOOSE OR DEGRADED MATERIALS AS REQUIRED UNTIL SOUND CONCRETE IS OBTAINED.
7. DETERMINE EXTENT OF DAMAGED OR CORRODED REBAR, THEN CUT AND REMOVE.
8. REMOVE ADDITIONAL CONCRETE BEYOND FACE OF CUT REBAR TO PROVIDE ROOM FOR SPLICING NEW REBAR.
   8.1. IF LAP SPLICE METHOD IS USED, ADDITIONAL CONCRETE MUST BE REMOVED TO A DISTANCE REQUIRED FOR LAP LENGTH OF BARS, PLUS 3" IN ALL DIRECTIONS.
   8.2. IF MECHANICAL SPLICE COUPLER IS USED, ADDITIONAL CONCRETE MUST BE REMOVED TO FACILITATE COUPLER, PLUS 3" IN ALL DIRECTIONS.
9. WHERE EXISTING OR NEW REBAR IS LOCATED, CONCRETE MUST BE REMOVED TO ALLOW AT LEAST ¾" CLEARANCE ALL AROUND BAR. AT COUPLER LOCATIONS, PROVIDE AT LEAST 1½" CLEARANCE.
10. PRESSURE CLEAN EXPOSED AREAS WHERE DAMAGED CONCRETE WAS REMOVED.
11. SPLICE NEW REBAR WITH EXISTING REBAR USING CHOSEN METHOD.
12. PROVIDE SUPPORT FOR NEW REINFORCEMENT AT 12" ON CENTER, MAX, USING HILTI "GUNITE CLIPS X-GCZF37", OR APPROVED EQUAL.
13. REPAIR THE CONCRETE BY PATCHING WITH MANUFACTURER APPROVED MORTAR, FLOWABLE FILL, OR HYDRAULIC CEMENT. PROVIDE MULTIPLE LIFTS OF PATCH MATERIAL AS REQUIRED TO BUILD A FLUSH SURFACE WITH EXISTING. TAMP INTO PLACE; DO NOT FEATHER EDGES.
14. PROVIDE FINAL COATING(S) OF GEOPOLYMER, EPOXY, OR GLASS FIBER.

SPALLED CONCRETE (REINFORCING STEEL EXPOSED)

3 S008 REPAIR DETAIL - "TYPE 3"

NOT TO SCALE



SECTION

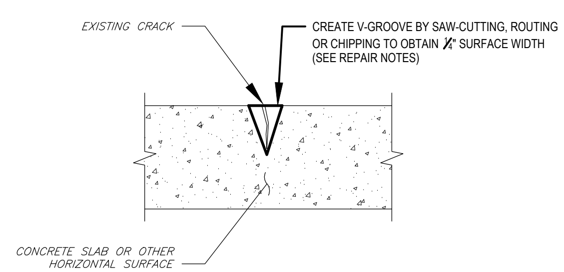
REPAIR NOTES:

1. CONCRETE SURFACE SHALL BE CLEANED AND PREPARED IN ACCORDANCE WITH GENERAL NOTES 1 THROUGH 7.
2. REMOVE LOOSE MATERIAL AND FORM V-GROOVE ALONG CRACK FRONT TO REACH SOUND CONCRETE.
3. PRESSURE CLEAN THE RESULTING V-GROOVE WITH AIR-BLAST FOR DRY CRACK OR WATER-BLAST FOR LEAKING CRACK.
4. PRESSURE-INJECT APPROVED MATERIAL INTO CRACK.
5. CRACKS WIDER THAN ¼" SHALL BE TREATED AS SPALLS, EXCEPT LEAKING CRACKS SHALL BE PRESSURE-INJECTED IN ADDITION TO SPALL REPAIR. REPAIR USING EITHER "TYPE 2" OR "TYPE 3" REPAIR DETAILS, AS APPLICABLE.

LEAKING CRACK OR VERTICAL CRACK LESS THAN ¼" WIDE

4 REPAIR DETAIL - VERTICAL OR LEAKING CRACK

NOT TO SCALE



SECTION

REPAIR NOTES:

1. CONCRETE SURFACE SHALL BE CLEANED AND PREPARED IN ACCORDANCE WITH GENERAL NOTES 1 THROUGH 7.
2. REMOVE LOOSE MATERIAL AND FORM V-GROOVE ALONG CRACK FRONT TO REACH SOUND CONCRETE.
3. PRESSURE CLEAN THE RESULTING V-GROOVE WITH AIR-BLAST.
4. GRAVITY FEED APPROVED MATERIAL INTO CRACK.
5. CRACKS WIDER THAN ¼" SHALL BE TREATED AS SPALLS. REPAIR USING EITHER "TYPE 2" OR "TYPE 3" REPAIR DETAILS, AS APPLICABLE.

DRY HORIZONTAL SURFACE CRACK LESS THAN ¼" WIDE

5 REPAIR DETAIL - NON-LEAKING HORIZONTAL CRACK

NOT TO SCALE

GENERAL REPAIR NOTES:

1. PRIOR TO THE START OF ANY CONCRETE REPAIRS, ALL CONCRETE SURFACES SHALL BE CLEANED AND PREPARED TO ACCEPT REPAIRS. THE FOLLOWING NOTES ARE GENERAL; ACTUAL CLEANING AND SURFACE PREPARATION SHALL BE IN ACCORDANCE WITH SPECIFIC MANUFACTURER RECOMMENDATIONS.
2. EXCESSIVE DEBRIS, SEDIMENT, OR OTHER FOREIGN MATERIALS WHICH MAY IMPACT THE EFFECTIVENESS OF THE SURFACE PREPARATION PROCESS SHALL BE REMOVED PRIOR TO PROCEEDING.
3. OILS, GREASE, INCOMPATIBLE EXISTING COATINGS, WAXES, FORM RELEASE, CURING COMPOUNDS, EFFLORESCENCE, SEALERS, SALTS, OR OTHER CONTAMINANTS WHICH MAY AFFECT THE PERFORMANCE AND ADHESION OF THE COATING TO THE SUBSTRATE SHALL BE ADDRESSED PER MANUFACTURERS' RECOMMENDATIONS.
4. SURFACE PREPARATION METHOD, OR COMBINATION OF METHODS, THAT MAY BE USED INCLUDE HIGH-PRESSURE WATER CLEANING (MINIMUM 3,500 PSI), WATER JETTING, ABRASIVE BLASTING, GRINDING OR SCARIFYING. WHEN GREASE OR OIL ARE PRESENT WITHIN THE HOST INFRASTRUCTURE, STEAM, HEATED WATER (UP TO 200°F) OR A DETERGENT APPROVED BY OWNER MAY BE ADDED TO THE WATER AND USED INTEGRALLY WITH THE HIGH-PRESSURE WATER CLEANING AND OTHER METHODS AS REFERENCED IN INDUSTRY ACCEPTED STANDARDS. STANDARDS MAY INLUDE SSPC SP-13/NACE NO. 6 SURFACE PREPARATION FOR CONCRETE, ASTM D-4258 STANDARD PRACTICE FOR SURFACE CLEANING FOR CONCRETE, AND ASTM D-4259 STANDARD PRACTICE FOR ABRADING CONCRETE.
5. LOOSE DEBRIS MATERIALS RESULTING FROM THE CLEANING OF THE STRUCTURE SHALL BE REMOVED.
6. THE SURFACE SHALL THEN BE ETCHED WITH A SOLUTION OF 20% MURIATIC ACID TO CLEAN AND AND OPEN THE PORES OF THE SUBSTRATE. pH MUST BE WITHIN AN ACCEPTABLE RANGE (5 TO 8.5).
7. THE SURFACE PROFILE SHALL BE AT LEAST A CSP 2,3, OR 4 IN ACCORDANCE WITH ICRI TECHNICAL GUIDELINES.

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

CONDUITS DETAILS

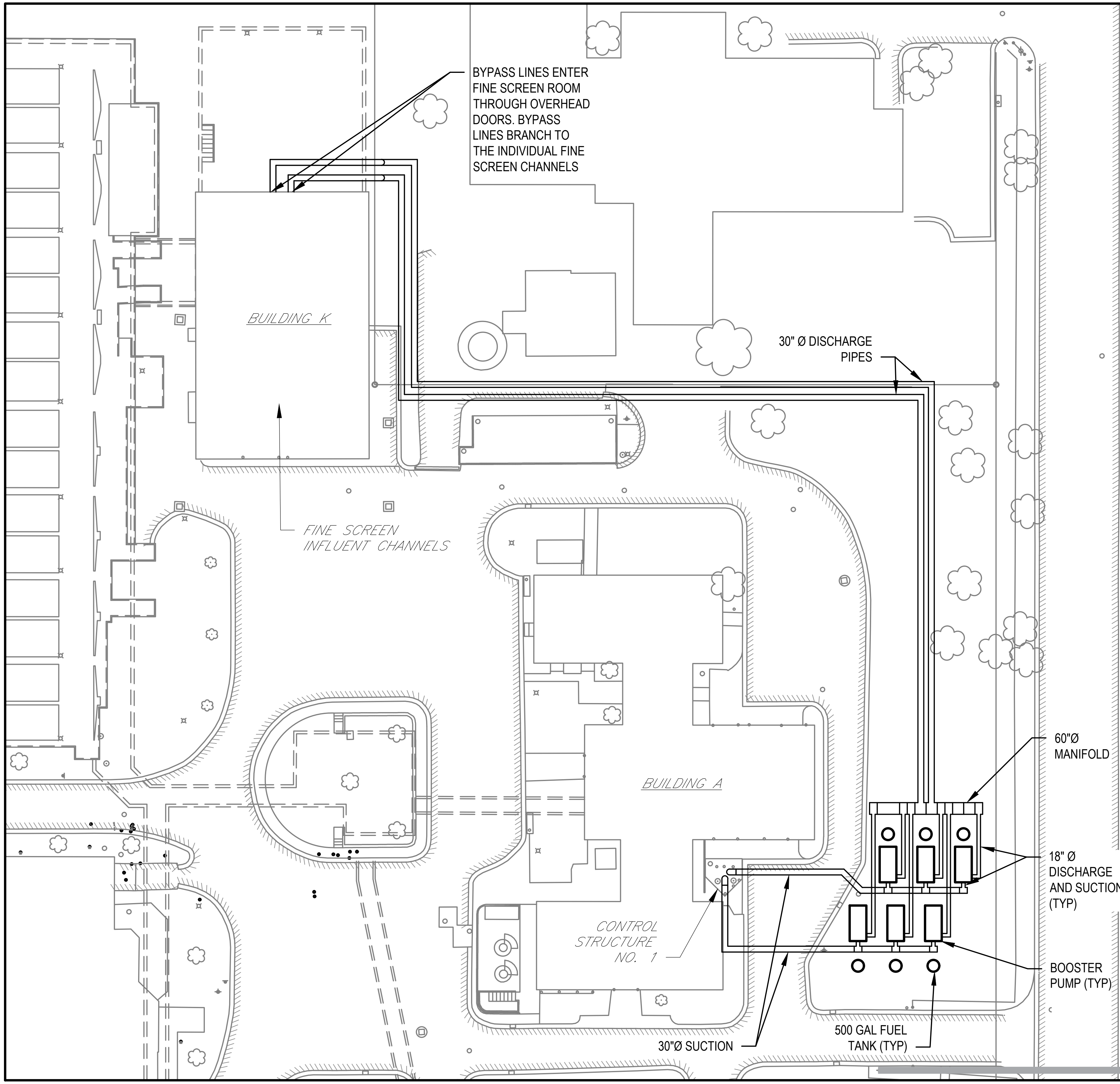
Project No. 11217618
Report No. N/A
Date 10/2021

CONDUIT UPGRADE

FIGURE 5

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-5 COND-DETAILS.dwg
Plot Date: 20 October 2021 - 11:18 AM

Source:



1 **BYPASS PUMPING SITE PLAN**

1"=50'-0"

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

BYPASS PUMPING SITE PLAN

Project No. 11217618
Report No. N/A
Date 10/2021

CONDUIT UPGRADE

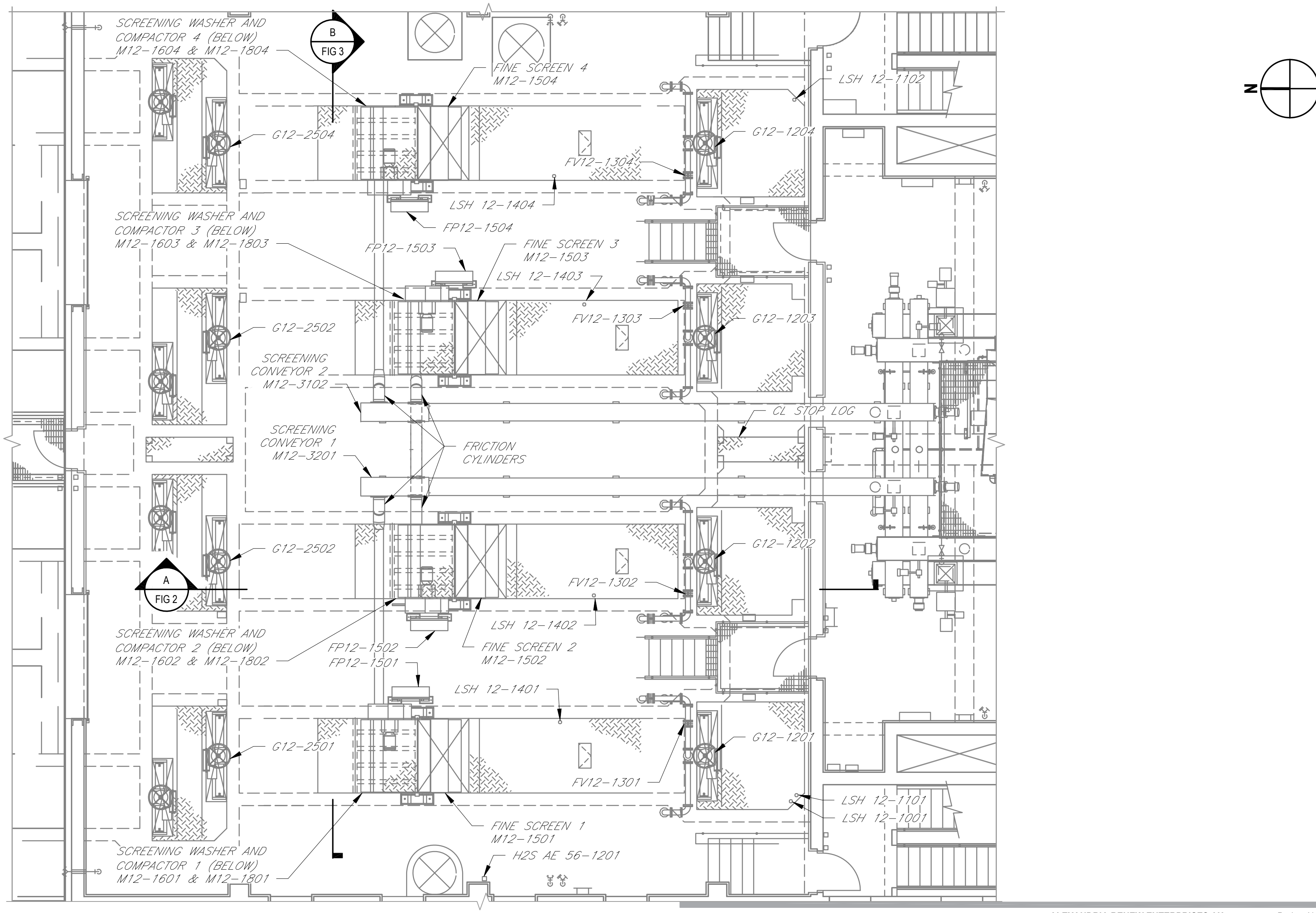
FIGURE 6

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\RSPS & CONDUITS\112-17618-FIG-6 COND BYPASS SITE PLAN.dwg
Plot Date: 20 October 2021 - 11:18 AM

Source:

Appendix D

Conceptual Layouts – Fine Screening



1 EXISTING PLAN

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

EXISTING FINE SCREEN
AREA PLAN

Project No. 11217618
Report No. N/A
Date 03/2021

FIGURE 1
FINE SCREEN UPGRADE
EXISTING SYSTEM

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-1 EXIS-PLAN.dwg
Plot Date: 2 June 2021 - 9:11 AM

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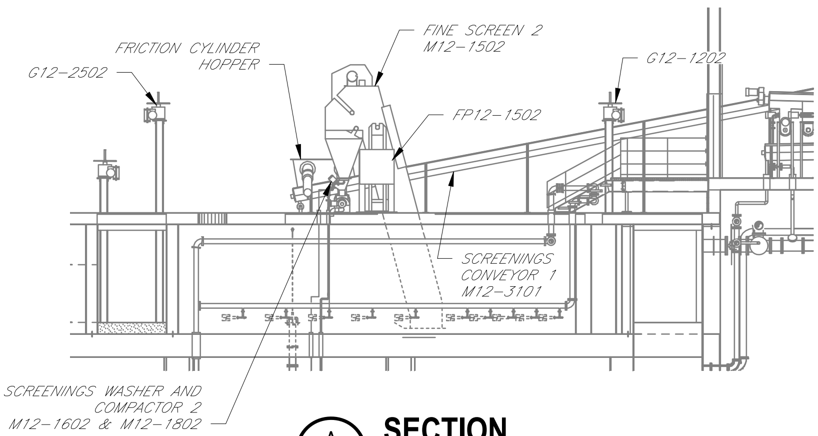
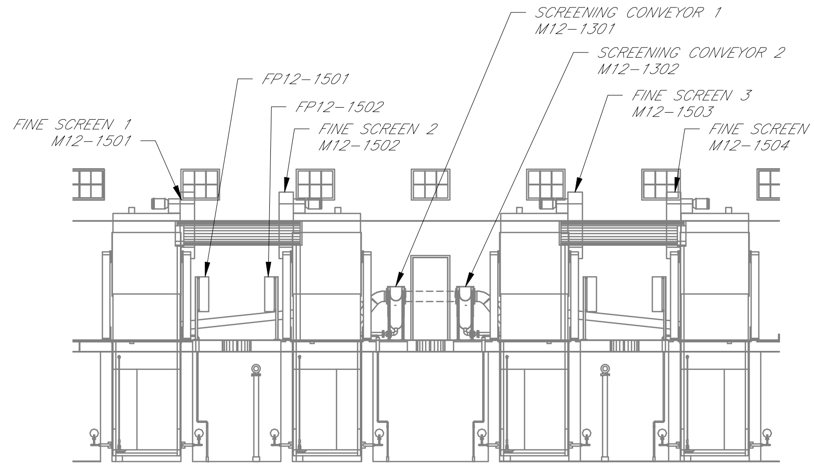


A FIG SECTION
SCALE: 1/8"=1'-0"



B FIG SECTION
SCALE: 1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

EXISTING FINE SCREEN
AREA SECTIONS

Project No. 11217618
Report No. N/A
Date 02/2021

FIGURE 2
FINE SCREEN UPGRADE
EXISTING SYSTEM

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-2 EXIS-SEC_1.dwg
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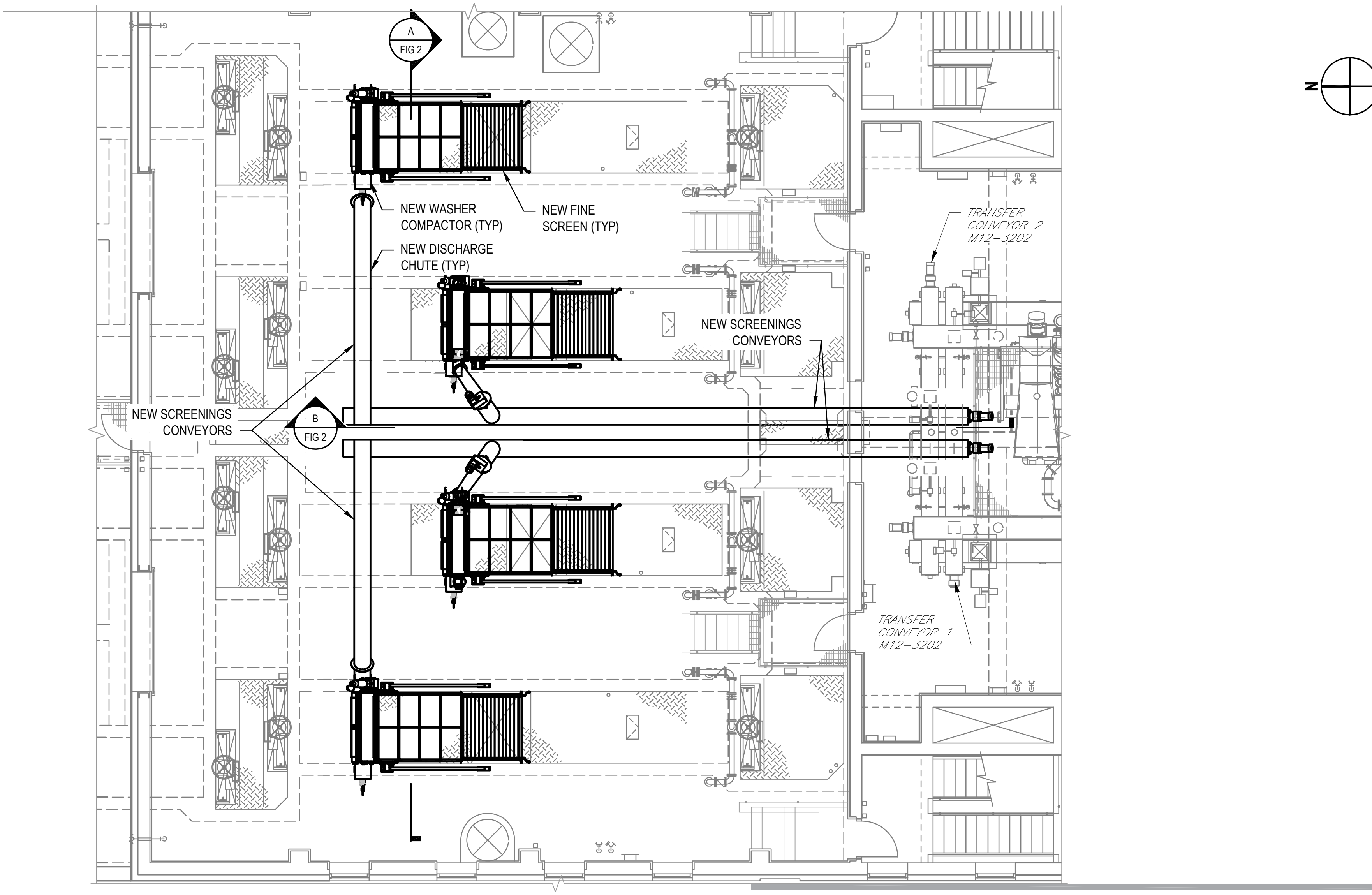

1 **PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES
REHABILITATE EXISTING FINE SCREENS AND WASHER/COMPACTORS REPLACE EXISTING FINE SCREENS WITH PERFORATED PLATE SCREENS & REPLACE FOUR WASHER/COMPACTORS
PLAN

Project No. 11217618
Report No. N/A
Date 03/2021

FIGURE 3
FINE SCREEN UPGRADE ALTERNATIVES 1&2

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-3 ALT1&2-PLAN.dwg
Plot Date: 29 July 2022 - 12:19 PM
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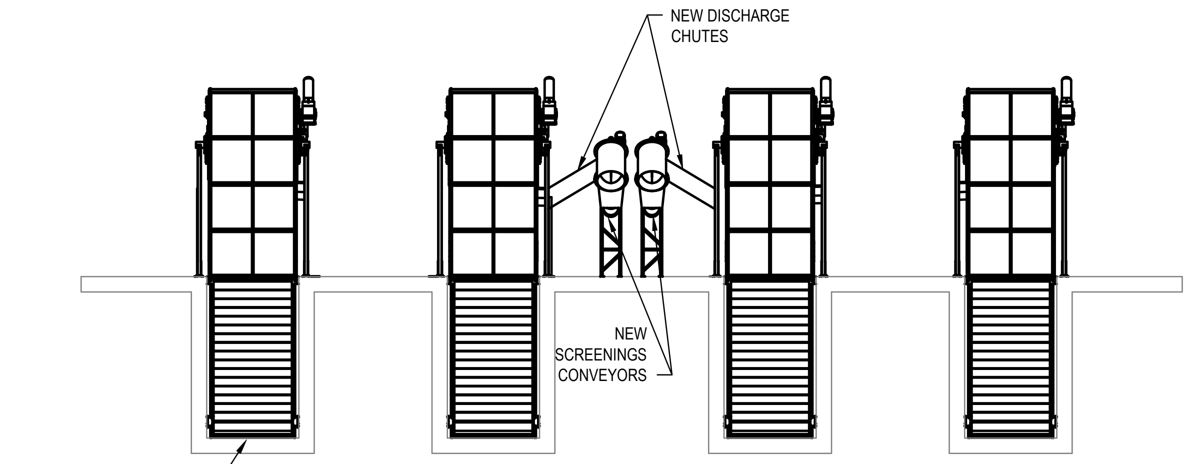
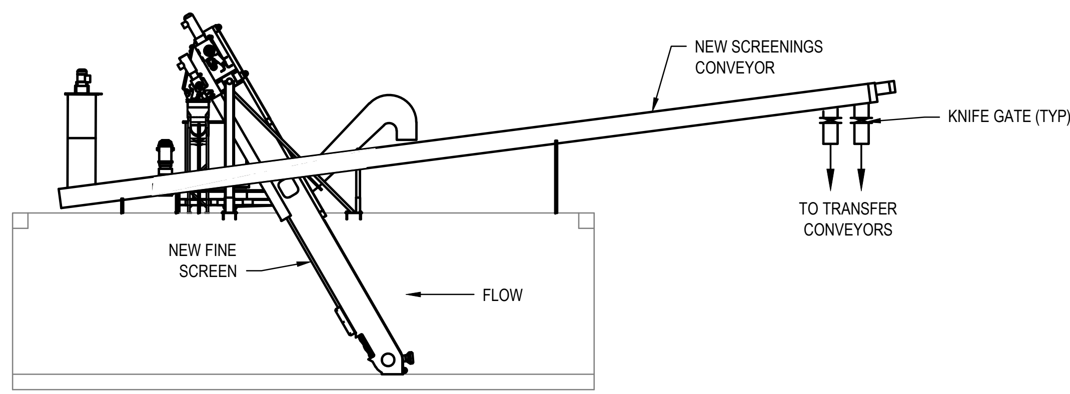


A
FIG 3
SECTION
1/8"=1'-0"



B
FIG 3
SECTION
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

REHABILITATE EXISTING FINE SCREENS AND WASHER/COMPACTORS REPLACE EXISTING FINE SCREENS WITH PERFORATED PLATE SCREENS & REPLACE FOUR WASHER/COMPACTORS
SECTIONS

Project No. 11217618
Report No. N/A
Date 03/2021

FIGURE 4
FINE SCREEN UPGRADE ALTERNATIVES 1 &2

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-4 ALT1&2-SECTION.dwg
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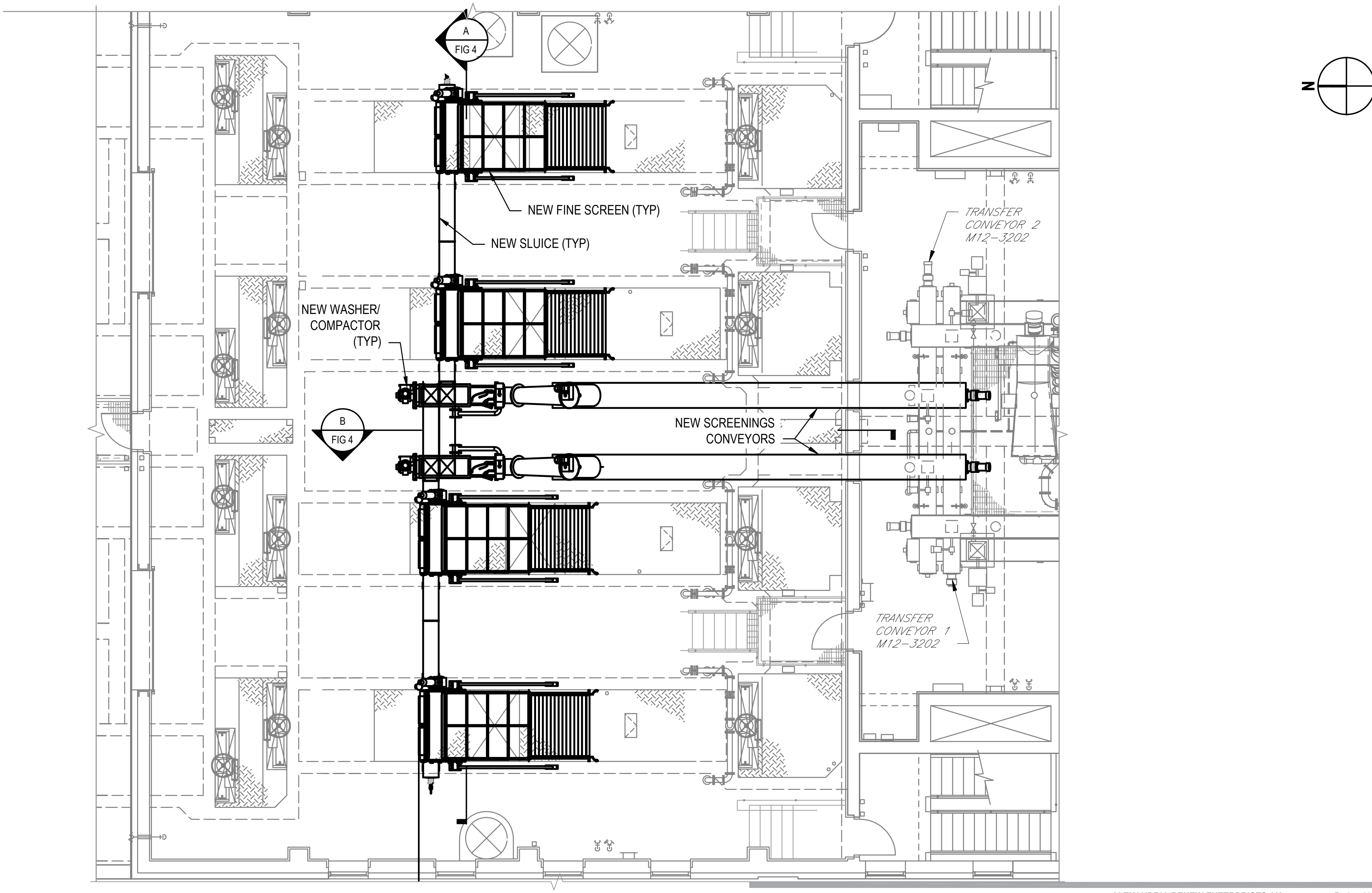

1 **PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

REPLACE EXISTING FINE SCREENS WITH PERFORATED PLATE SCREENS; REPLACE FOUR WASHER/COMPACTORS WITH TWO LARGER WASHER/COMPACTORS; ADD TWO NEW SLUICES
PLAN

Project No. **11217618**
Report No. **N/A**
Date **03/2021**

FIGURE 5
FINE SCREEN UPGRADE
ALTERNATIVE 3

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-5 ALT3-PLAN.dwg
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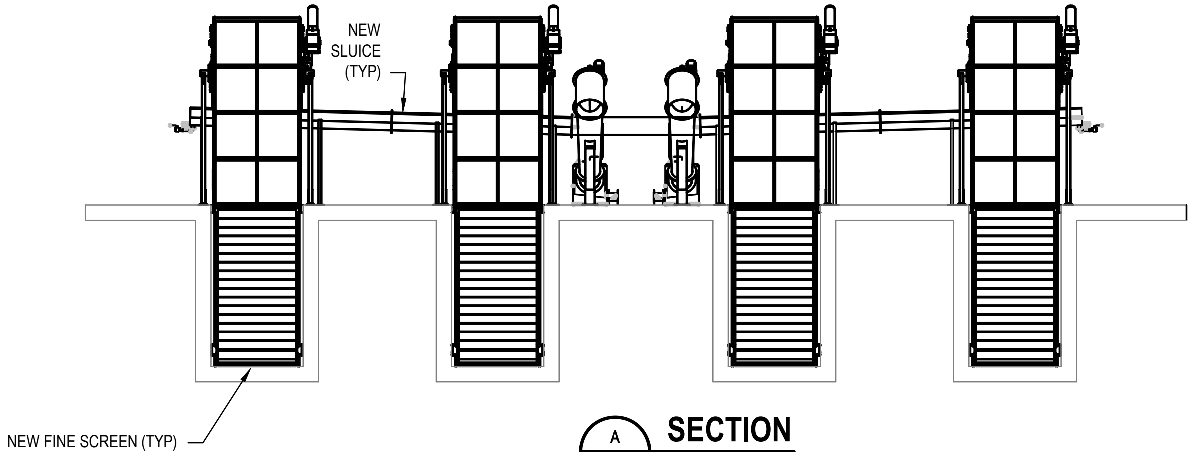
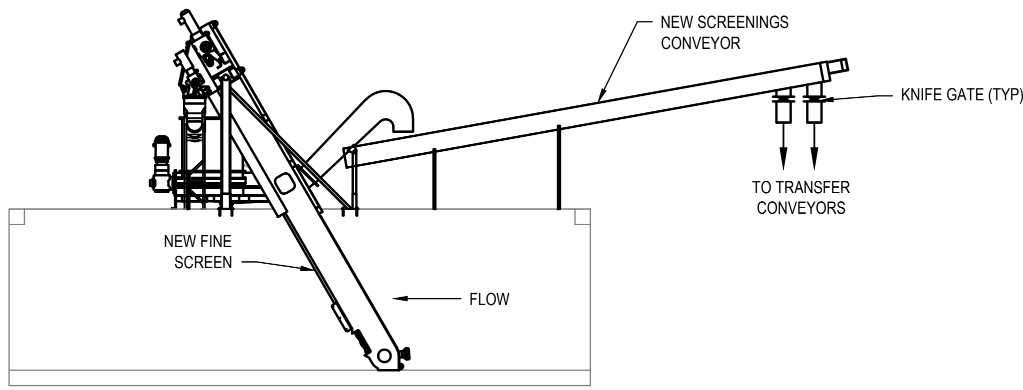


A
FIG 3
SECTION
1/8"=1'-0"



B
FIG 3
SECTION
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

REPLACE EXISTING FINE SCREENS WITH PERFORATED PLATE SCREENS; REPLACE FOUR WASHER/COMPACTORS WITH TWO LARGER WASHER/COMPACTORS; ADD TWO NEW SLUICES
SECTIONS

Project No. **11217618**
Report No. **N/A**
Date **03/2021**

FIGURE 6
FINE SCREEN UPGRADE ALTERNATIVE 3

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-6 ALT3-SECTION.dwg
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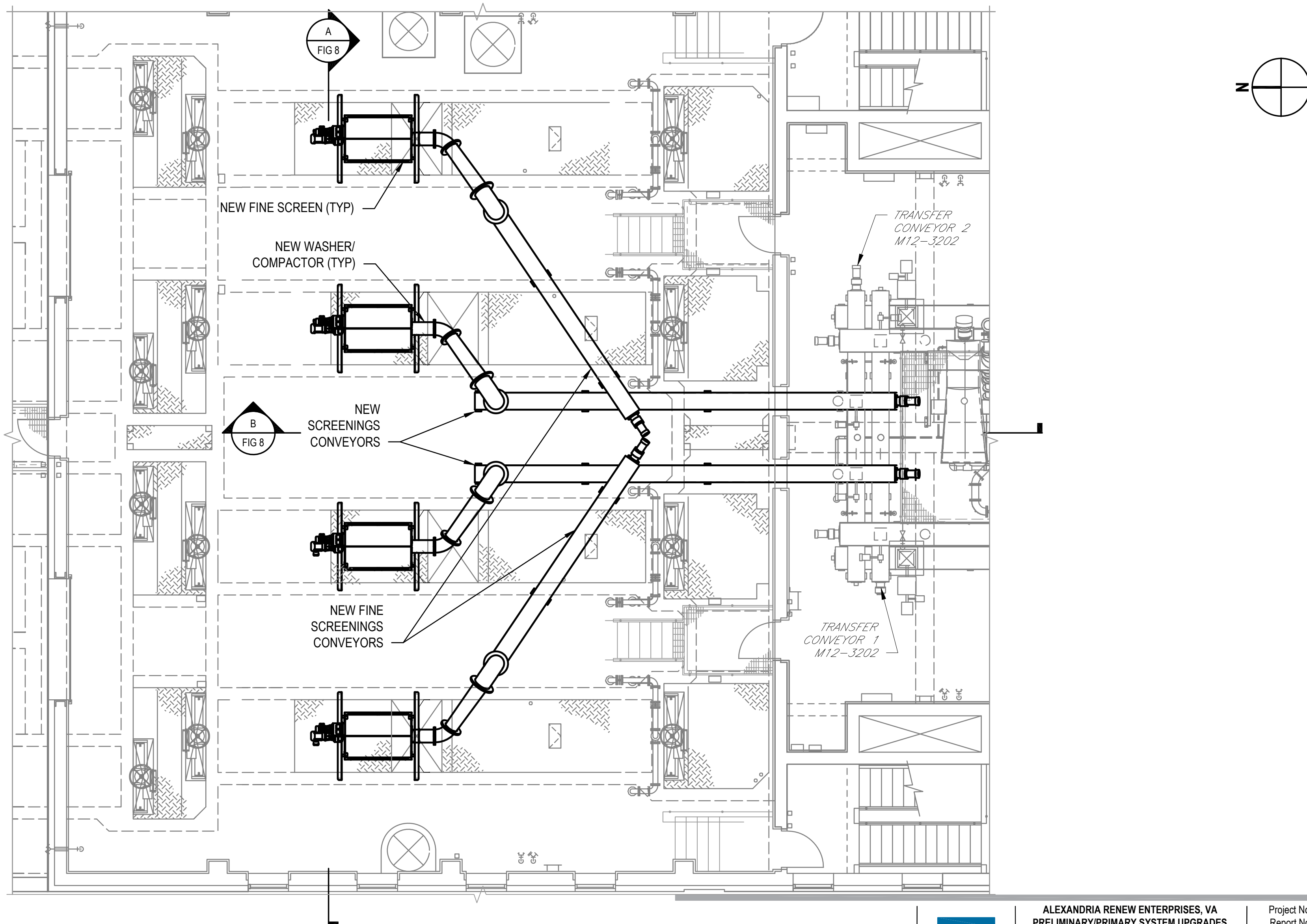

1 PLAN
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

REPLACE EXISTING FINE SCREENS WITH CENTER FLOW BAND SCREENS; REPLACE WASHER/COMPACTORS; ADD FOUR NEW CONVEYORS PLAN

Project No. 11217618
Report No. N/A
Date 02/2021

FIGURE 7
FINE SCREEN UPGRADE
ALTERNATIVE 4

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-7 ALT4-PLAN.dwg
Plot Date: 1 February 2023 - 9:02 AM

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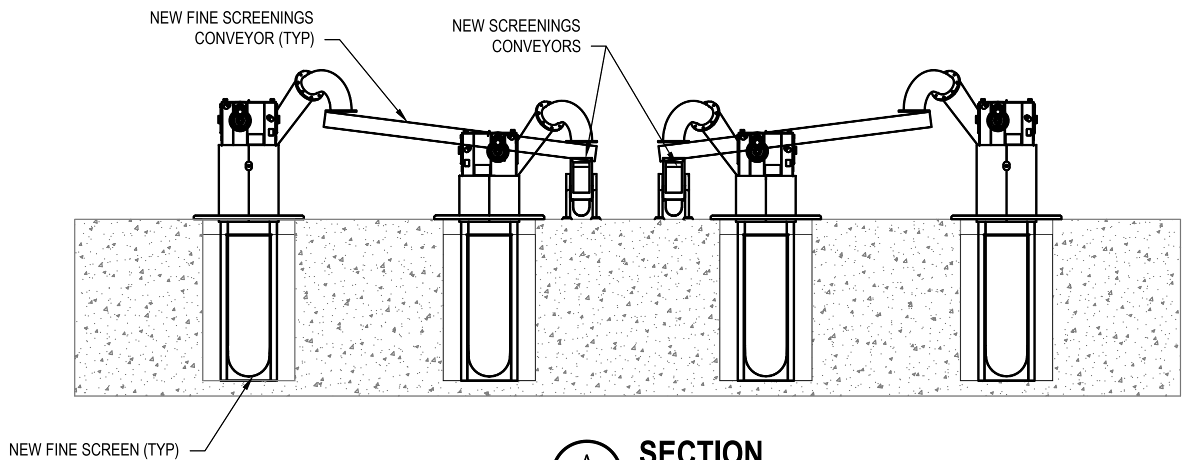
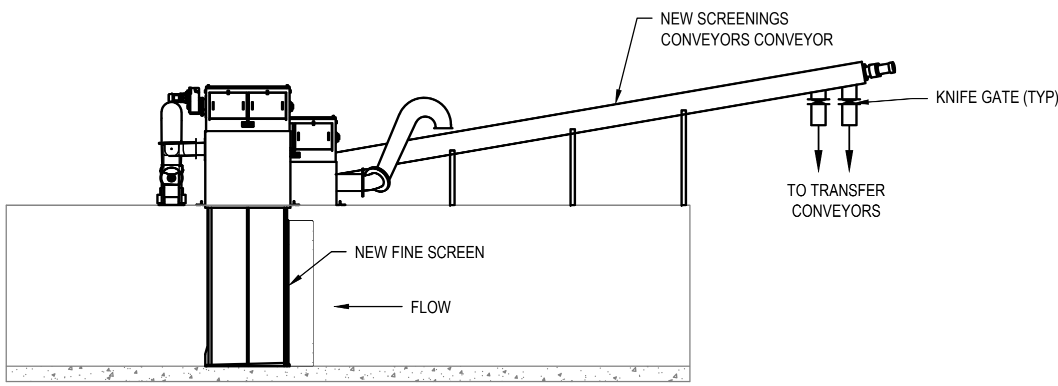


A
FIG 5
SECTION
1/8"=1'-0"



B
FIG 5
SECTION
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

REPLACE EXISTING FINE SCREENS WITH CENTER FLOW BAND SCREENS; REPLACE WASHER/COMPACTORS; ADD FOUR NEW CONVEYORS SECTIONS

Project No. **11217618**
Report No. **N/A**
Date **03/2021**

FIGURE 8
FINE SCREEN UPGRADE ALTERNATIVE 4

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-8 ALT4-SECTIONS.dwg
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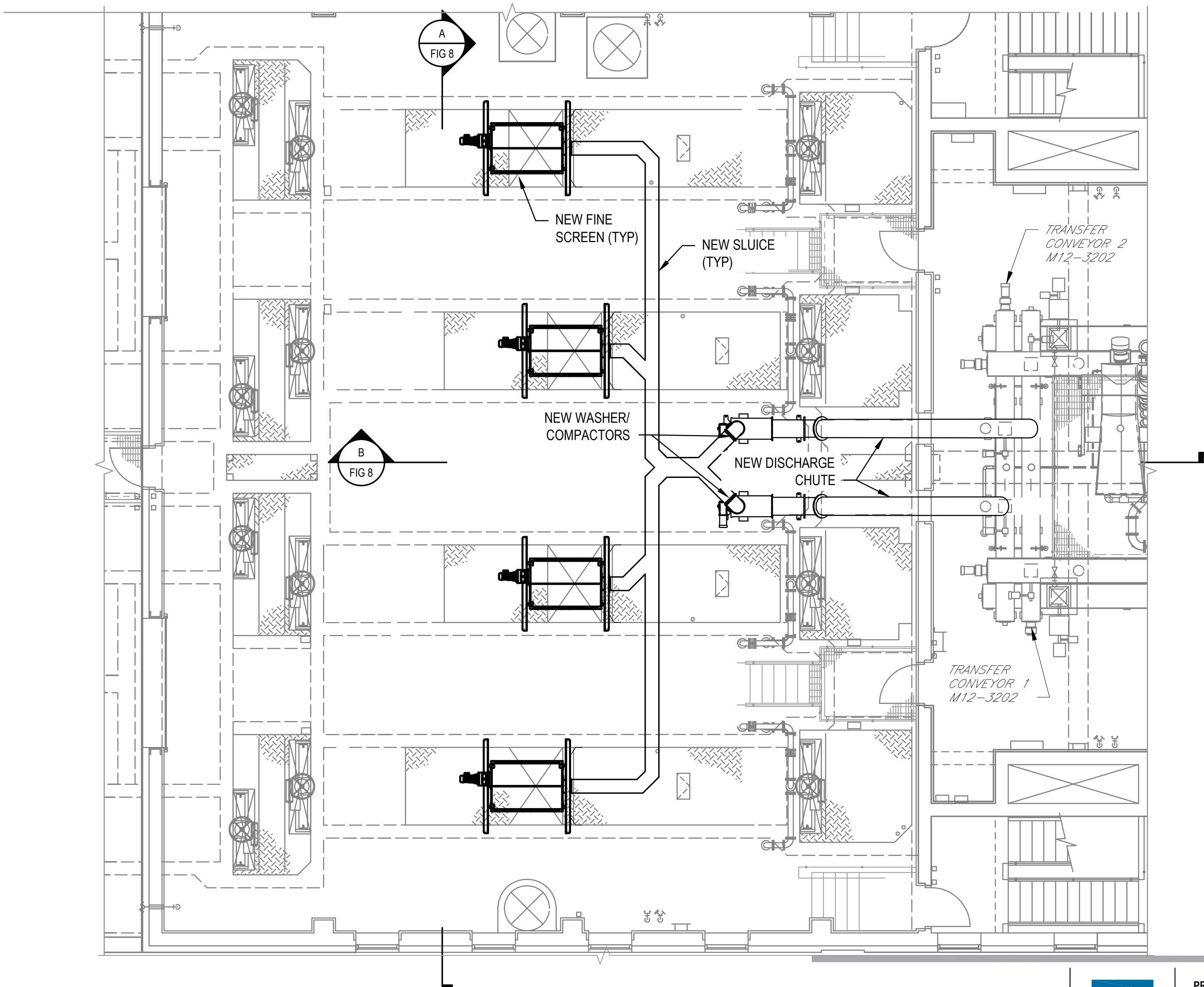

1 **PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES
REPLACE EXISTING FINE SCREENS WITH CENTER FLOW BAND SCREENS; REPLACE FOUR WASHER/COMPACTORS WITH TWO LARGER WASHER/COMPACTORS; ADD TWO NEW SLUICES
PLAN

Project No. 11217618
Report No. N/A
Date 02/2021
FIGURE 9
FINE SCREEN UPGRADE ALTERNATIVE 5

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-9 ALT5-PLAN.dwg
Plot Date: 3 June 2021 - 3:17 PM
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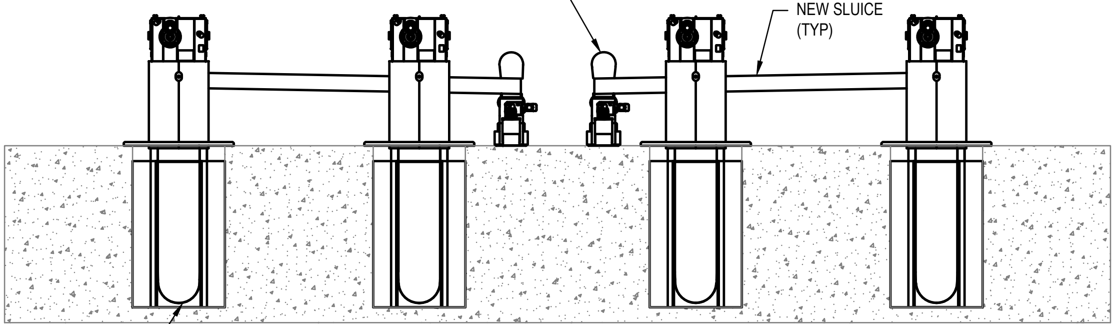
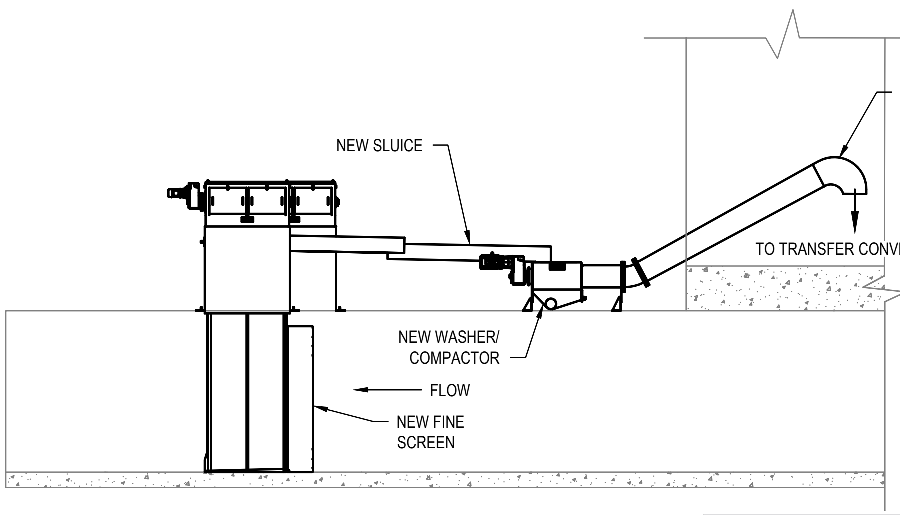


A
FIG 7
SECTION
1/8"=1'-0"



B
FIG 7
SECTION
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

REPLACE EXISTING FINE SCREENS WITH CENTER FLOW BAND SCREENS; REPLACE FOUR WASHER/COMPACTORS WITH TWO LARGER WASHER/COMPACTORS; ADD TWO NEW SLUICES
SECTIONS

Project No. 11217618
Report No. N/A
Date 03/2021

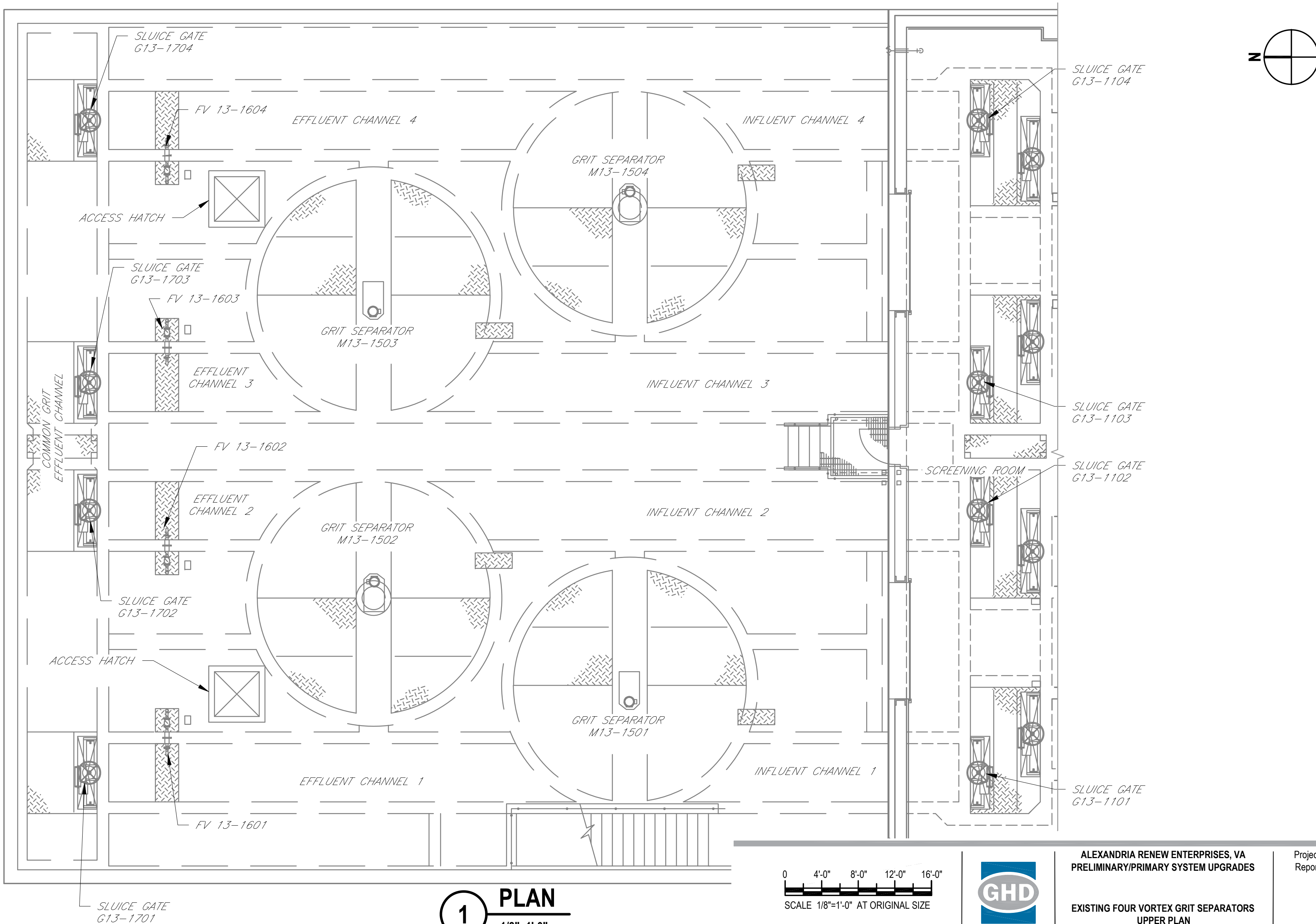
FIGURE 10
FINE SCREEN UPGRADE ALTERNATIVE 5

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Fine Screens\112-17618-FIG-10 ALT5-SECTIONS.dwg
Plot Date: 7 June 2021 - 9:00 AM

Source:

Appendix E

Conceptual Layouts – Grit Removal



1 **PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

EXISTING FOUR VORTEX GRIT SEPARATORS
UPPER PLAN

Project No. **11217618**
Report No. **N/A**
Date **01/2022**

FIGURE 1

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-1.dwg
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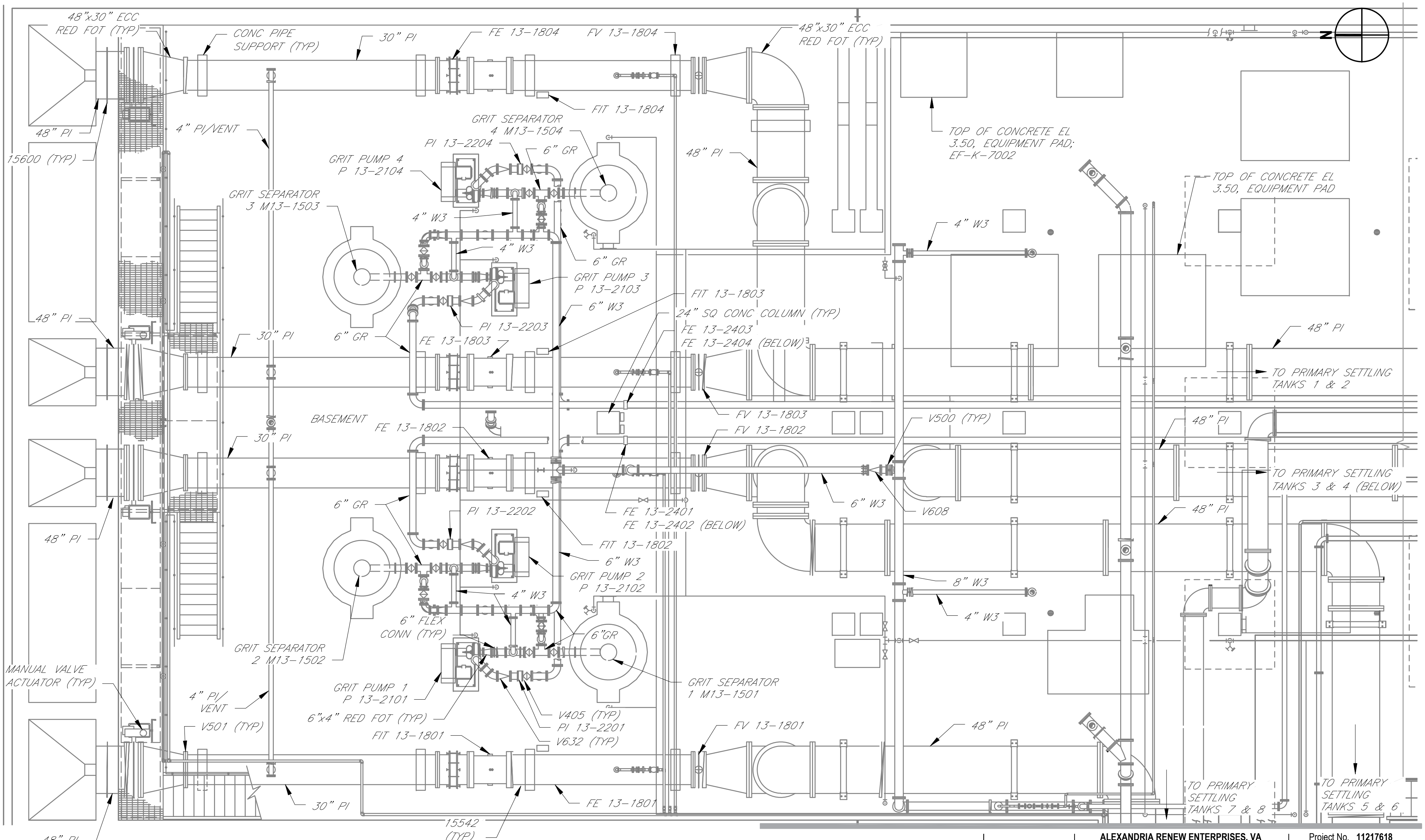

1 **PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

EXISTING VORTEX GRIT SEPARATORS
LOWER PLAN

Project No. **11217618**
Report No. **N/A**
Date **01/2022**

FIGURE 2

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-2.dwg
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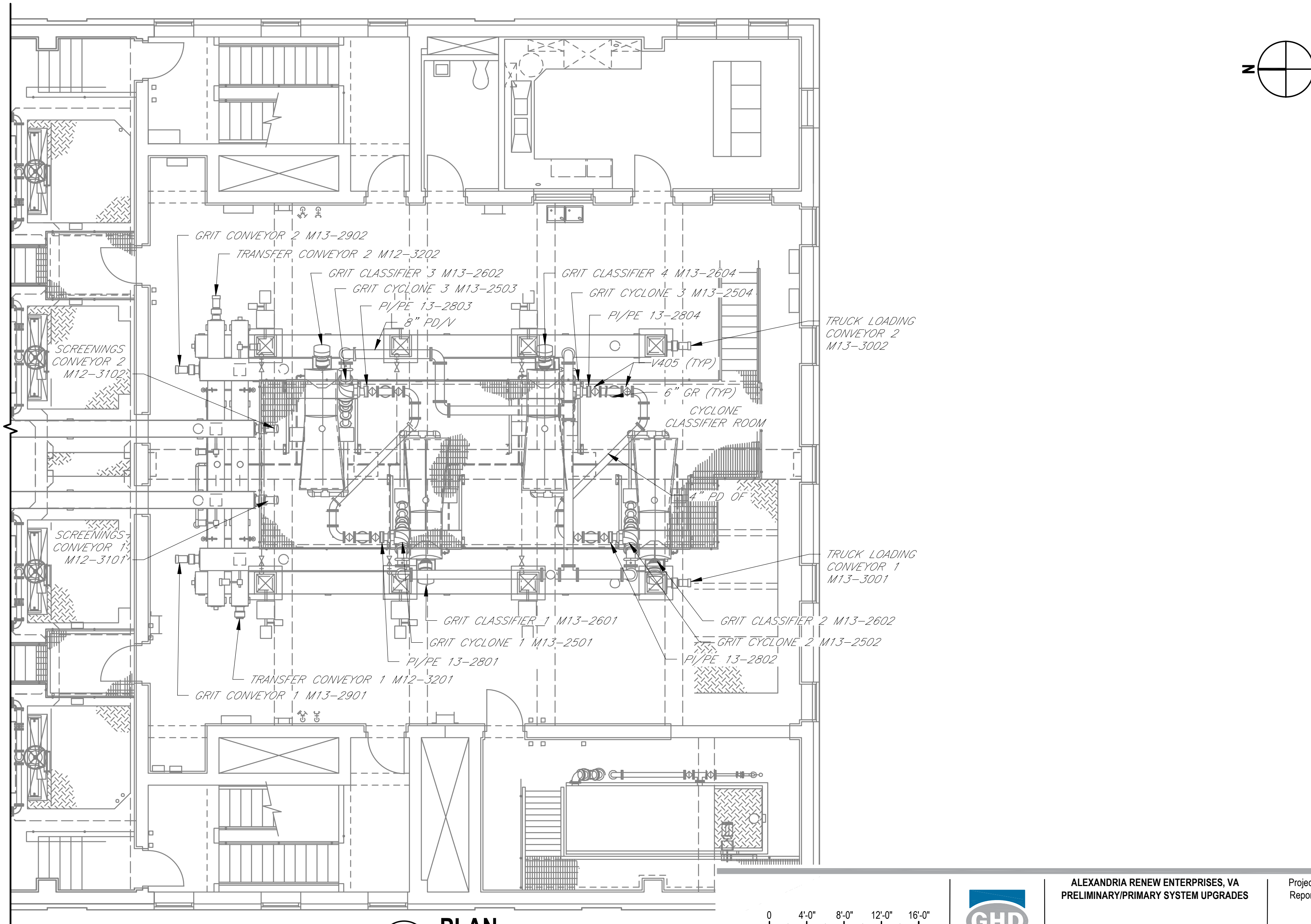

1 **PLAN**

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

EXISTING HYDROCYCLONE/GRIT CLASSIFIER UNITS

Project No. **11217618**
Report No. **N/A**
Date **01/2022**

FIGURE 3

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-3.dwg
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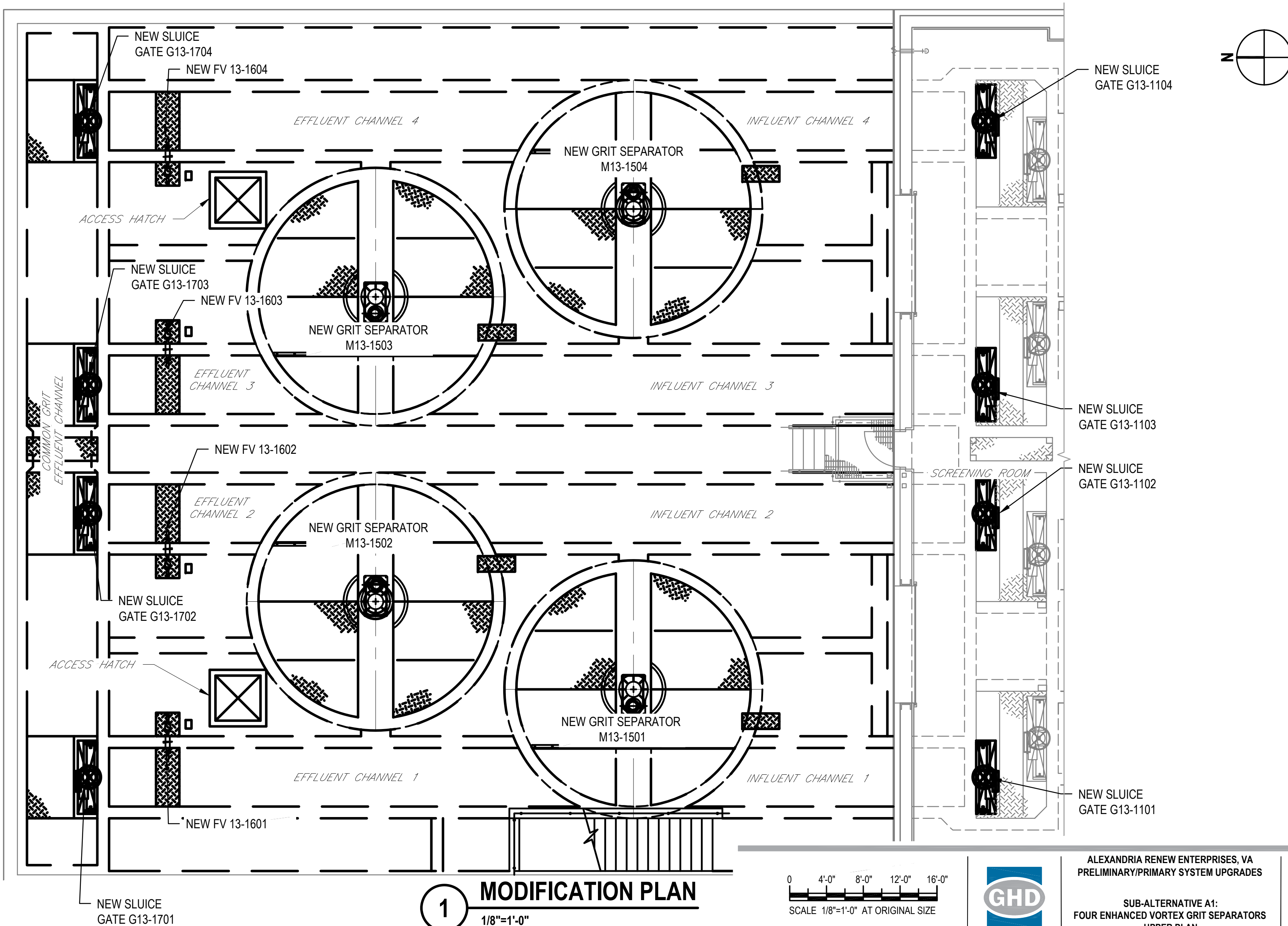

1 MODIFICATION PLAN
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE A1:
FOUR ENHANCED VORTEX GRIT SEPARATORS
UPPER PLAN

Project No. 11217618
Report No. N/A
Date 01/2022

FIGURE 4

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-4.dwg
Plot Date: 17 March 2022 - 9:22 AM

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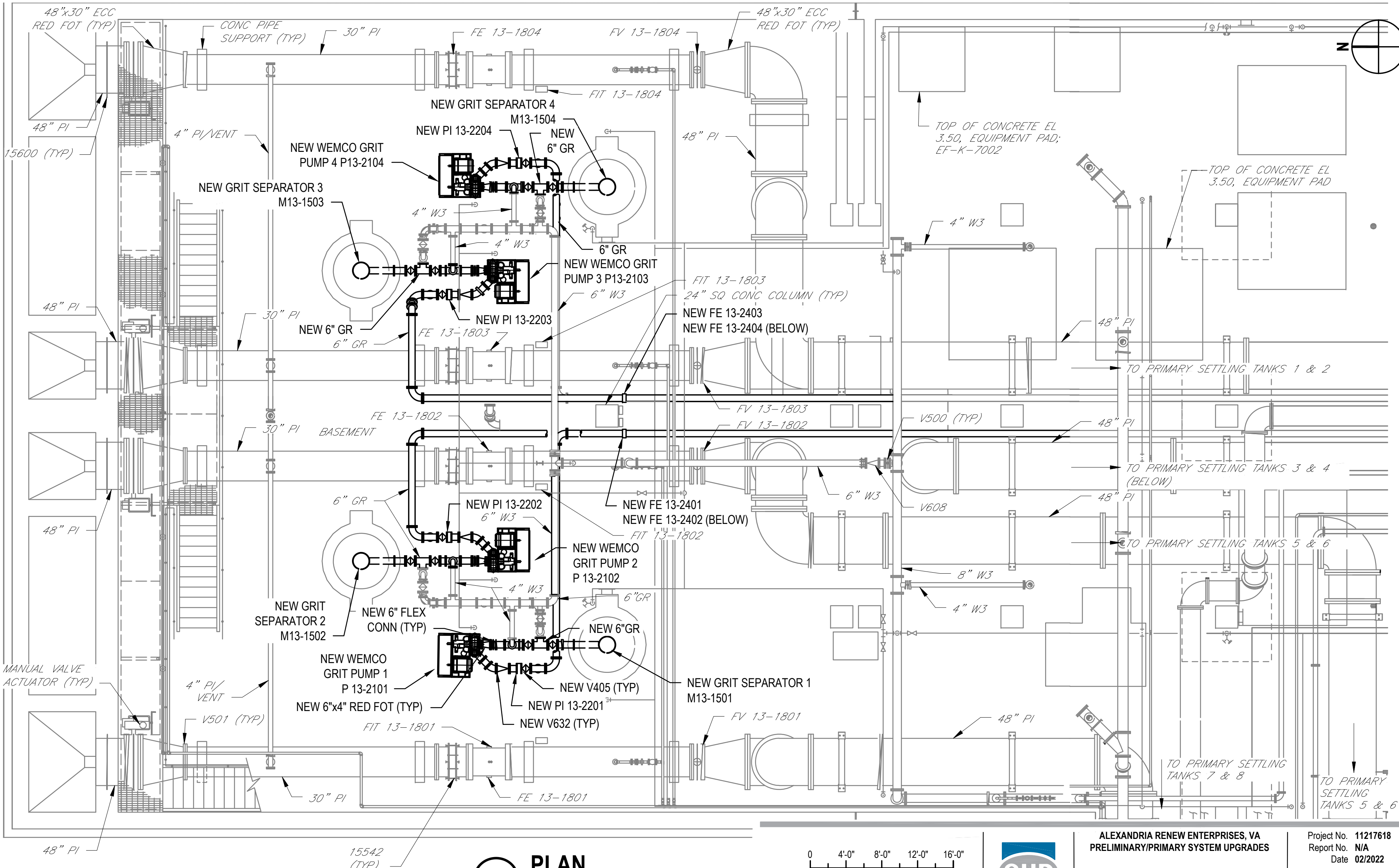

1 PLAN
1/8"=1'-0"

0 | 4'-0" | 8'-0" | 12'-0" | 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE B1:
FOUR ENHANCED VORTEX GRIT SEPARATORS
LOWER PLAN

Project No. 11217618
Report No. N/A
Date 02/2022

FIGURE 5

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-5.dwg
Plot Date: 17 March 2022 - 9:22 AM

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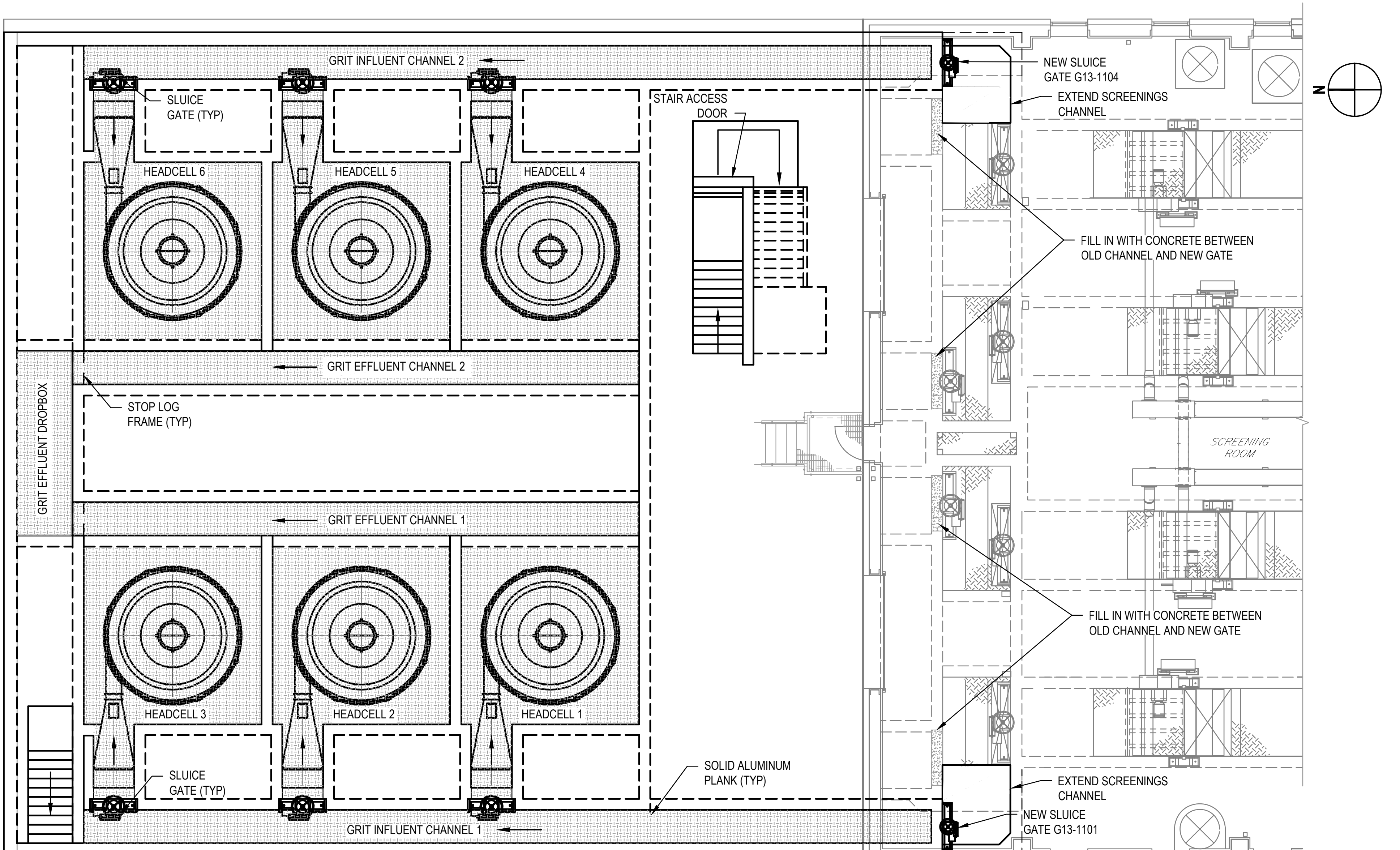

1 **MODIFICATION PLAN**
1/8"=1'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE A2:
SIX STACKED TRAY GRIT REMOVAL UNITS
UPPER PLAN

Project No. 11217618
Report No. N/A
Date 01/2022

FIGURE 6

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-6.dwg
Plot Date: 17 March 2022 - 9:32 AM

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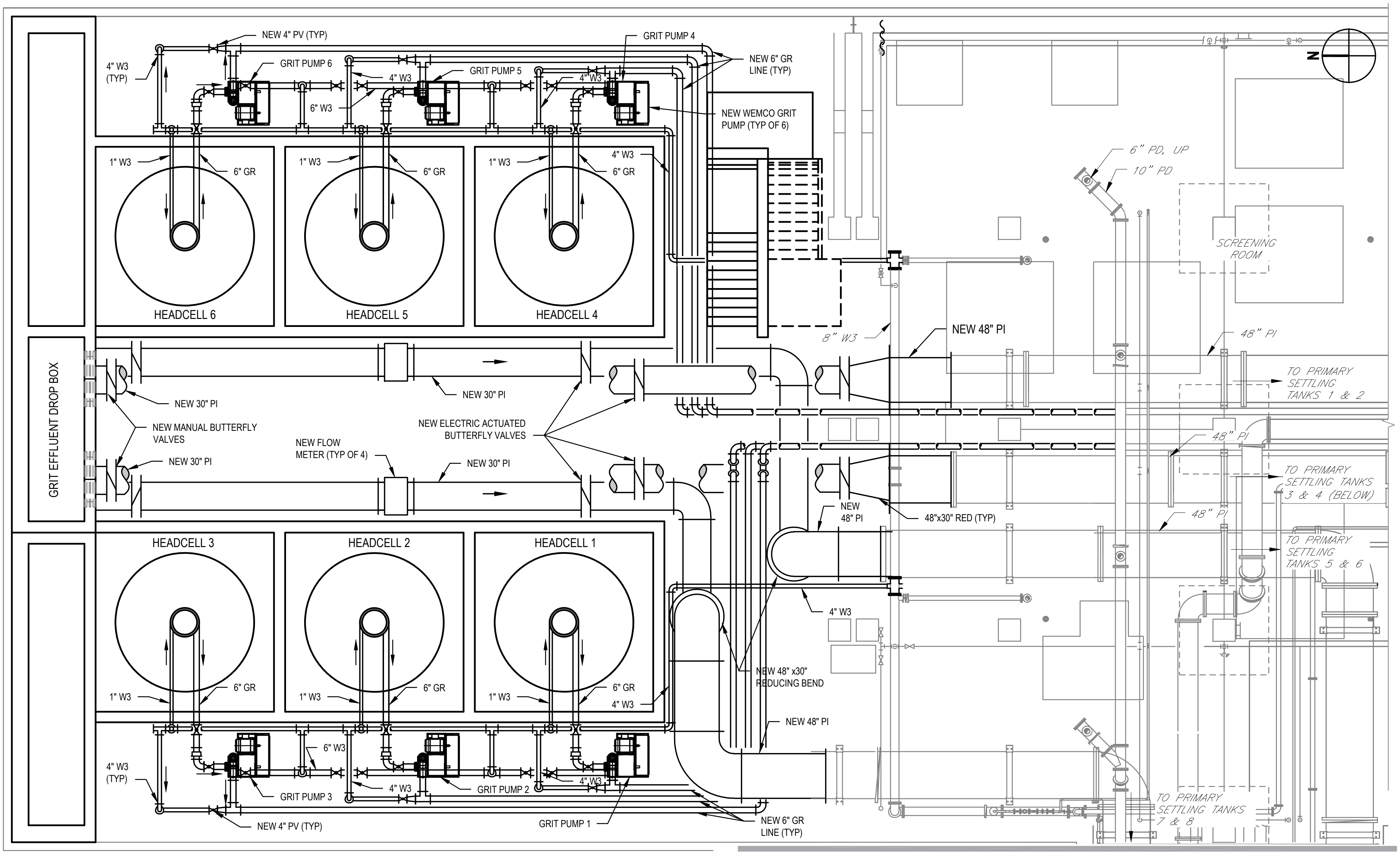

1 MODIFICATION PLAN

1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE A2:
SIX STACKED TRAY GRIT REMOVAL UNITS
LOWER PLAN

Project No. 11217618
Report No. N/A
Date 01/2022

FIGURE 7

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-7.dwg
Plot Date: 17 March 2022 - 9:32 AM

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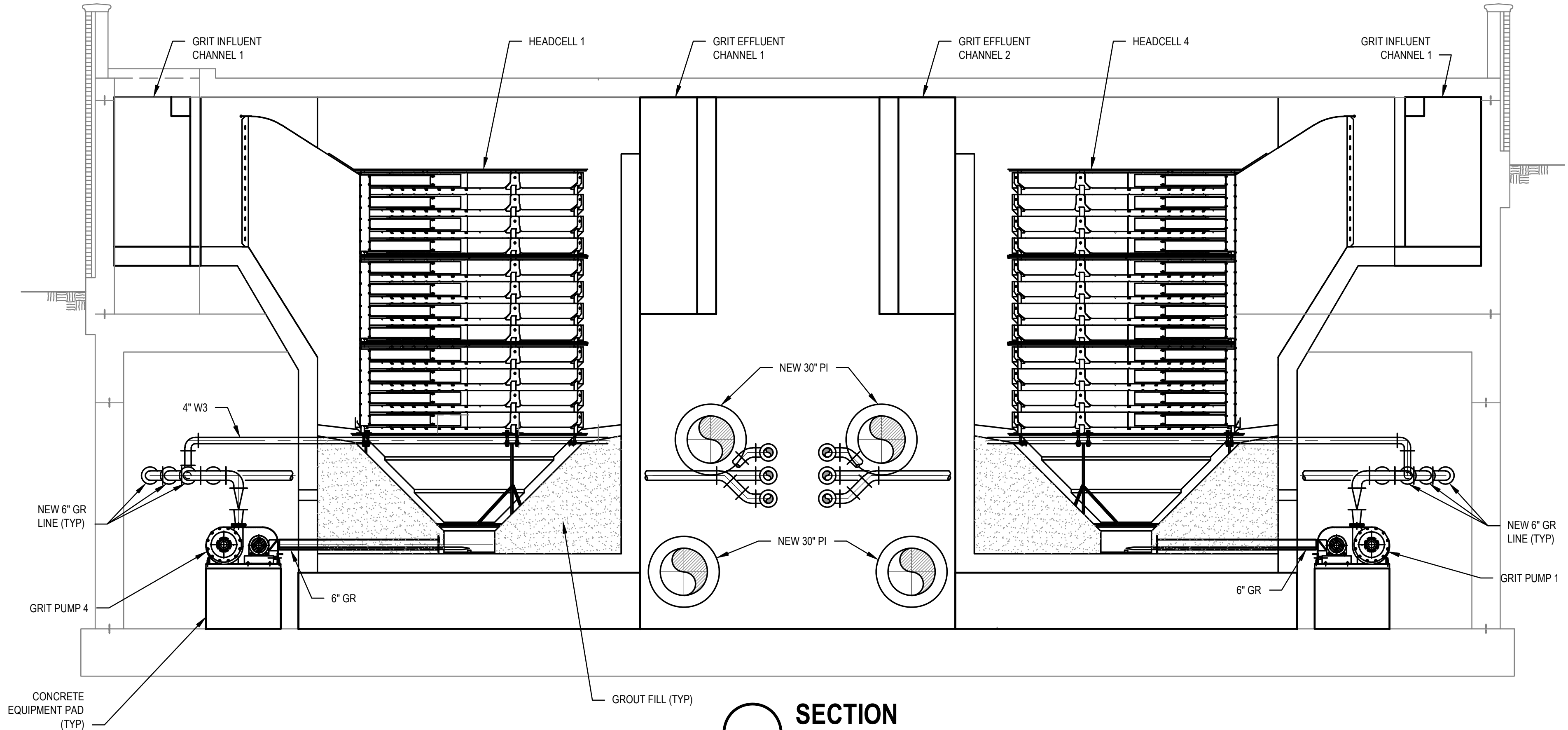

SECTION

FIG

SCALE: 3/16"=1'-0"

SCALE 3/16"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE A2:
SIX STACKED TRAY GRIT REMOVAL UNITS
SECTION

Project No. **11217618**
Report No. **N/A**
Date **01/2022**

FIGURE 8

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-8.dwg
Plot Date: 17 March 2022 - 9:33 AM

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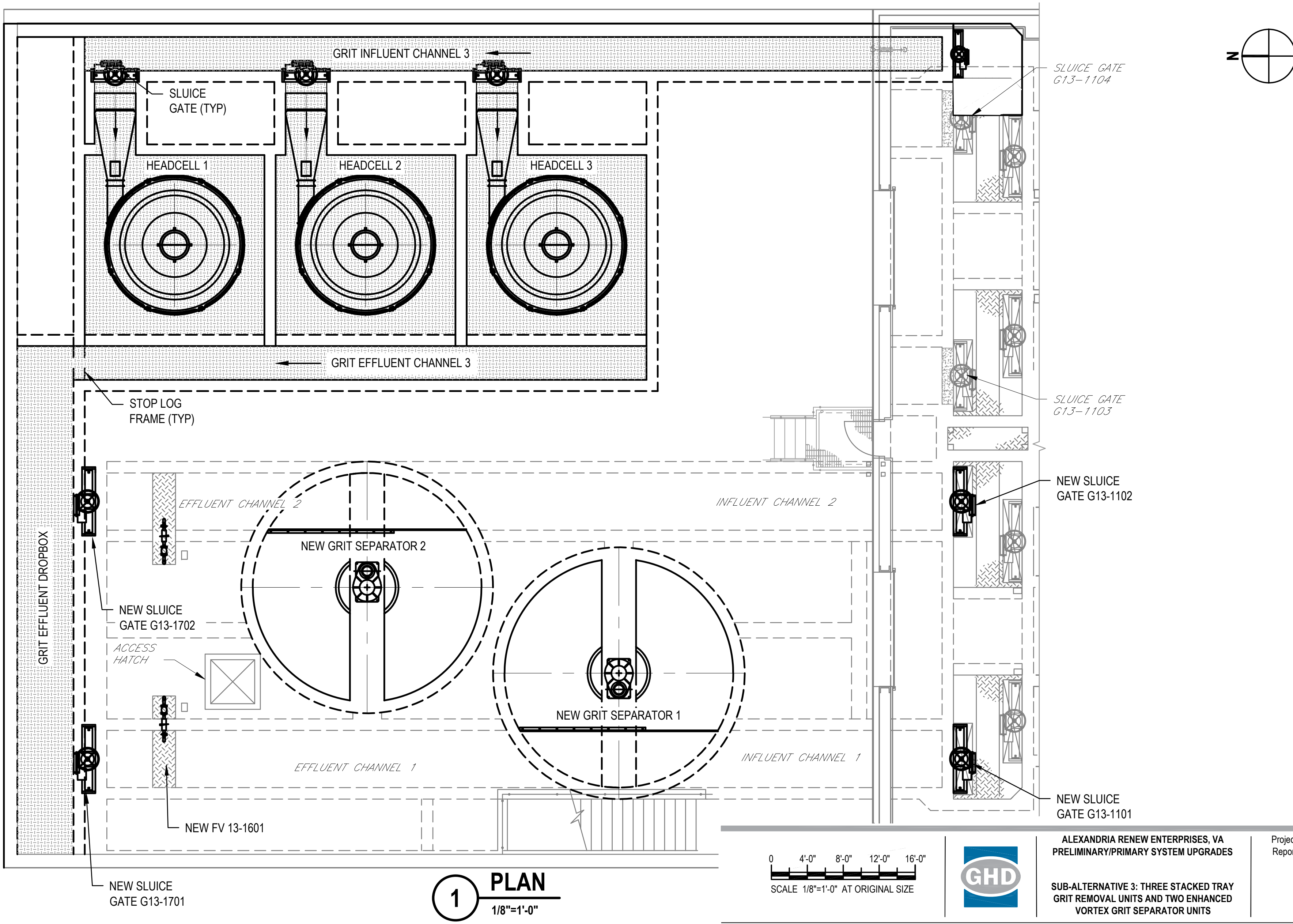

1 **PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE 3: THREE STACKED TRAY GRIT REMOVAL UNITS AND TWO ENHANCED VORTEX GRIT SEPARATOR UNITS

Project No. 11217618
Report No. N/A
Date 032022

FIGURE 9

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-9.dwg
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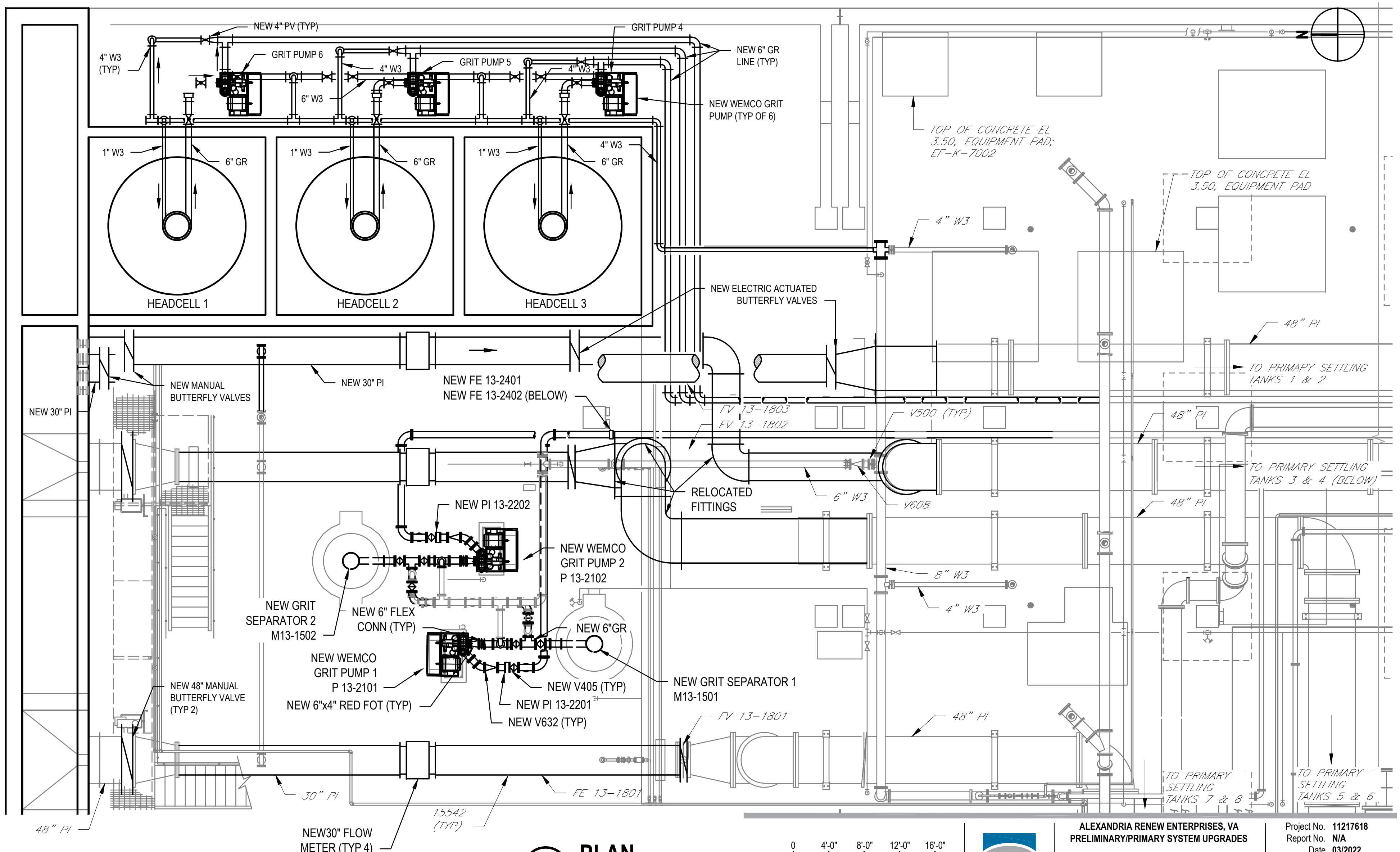

1 PLAN
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE 3: THREE STACKED TRAY GRIT REMOVAL UNITS AND TWO ENHANCED VORTEX GRIT SEPARATOR UNITS

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 10

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-10.dwg
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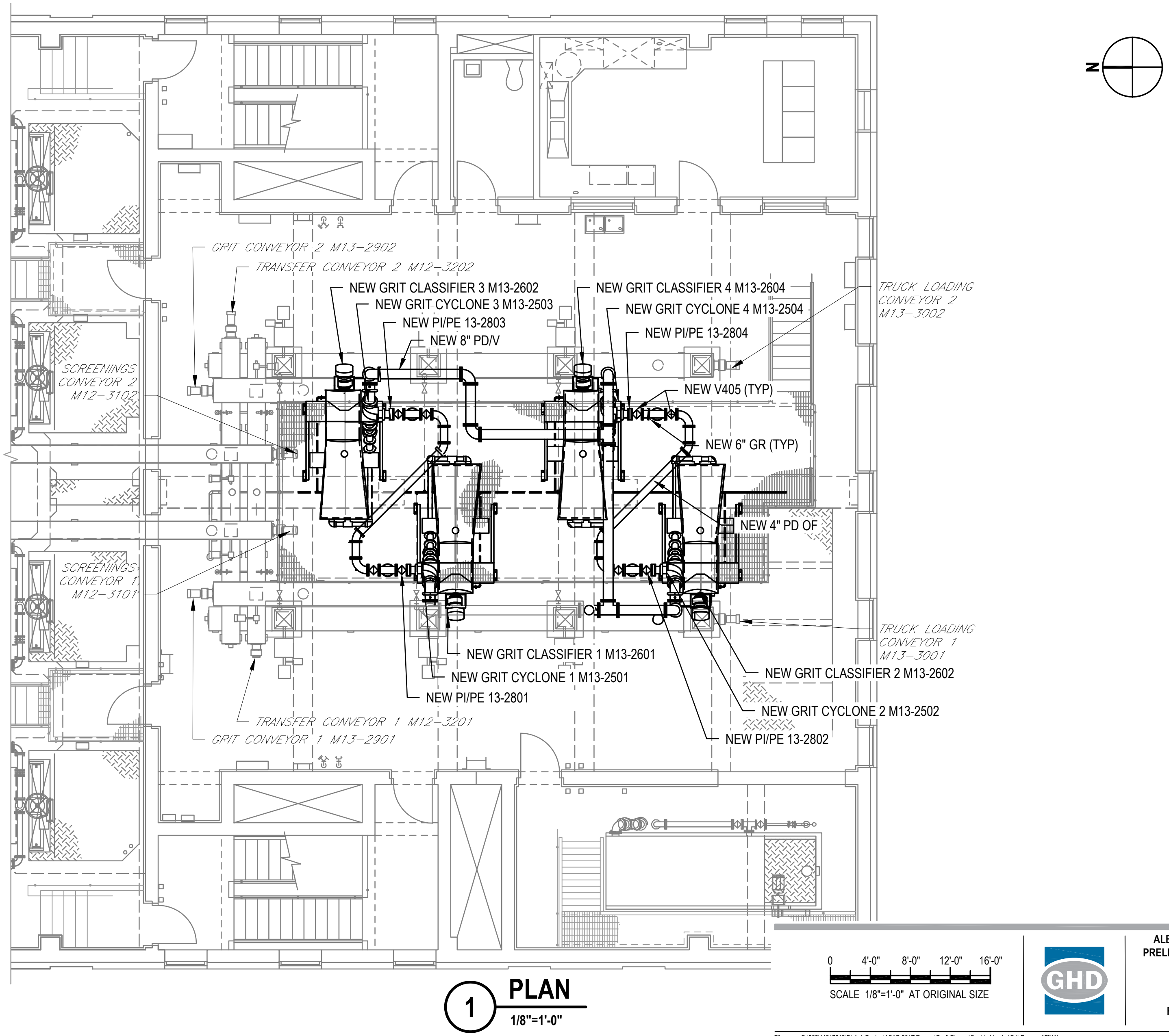

1 PLAN
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE C1:
FOUR NEW HYDROCYCLONE/GRIT CLASSIFIER UNITS IN-KIND

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 11

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-11.dwg
Plot Date: 17 March 2022 - 9:35 AM

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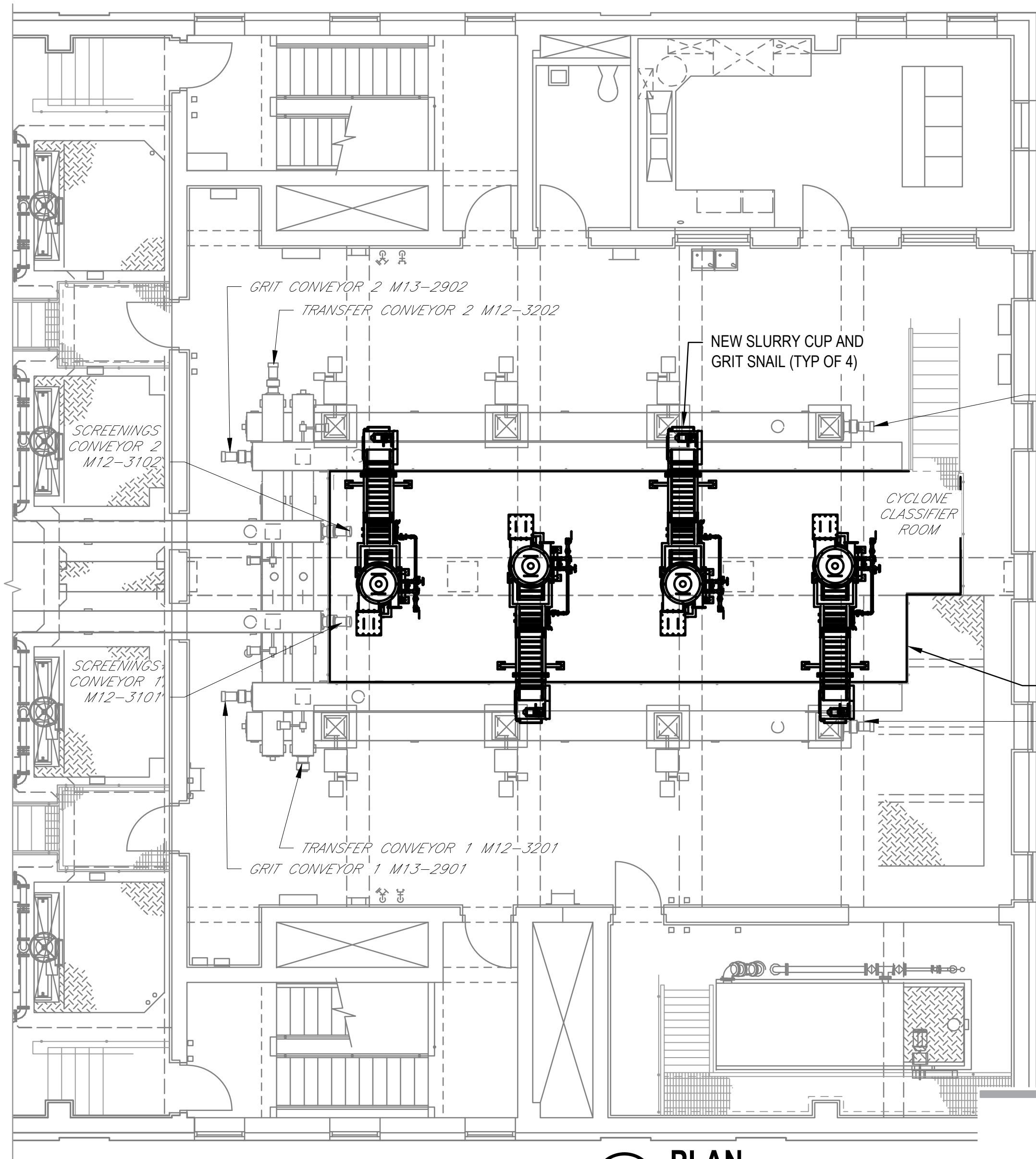

1 PLAN
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE C2:
FOUR NEW HYDROCYCLONE/GRIT CLASSIFIER UNITS

Project No. **11217618**
Report No. **N/A**
Date **032022**

FIGURE 12

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-12.dwg
Plot Date: 17 March 2022 - 9:35 AM

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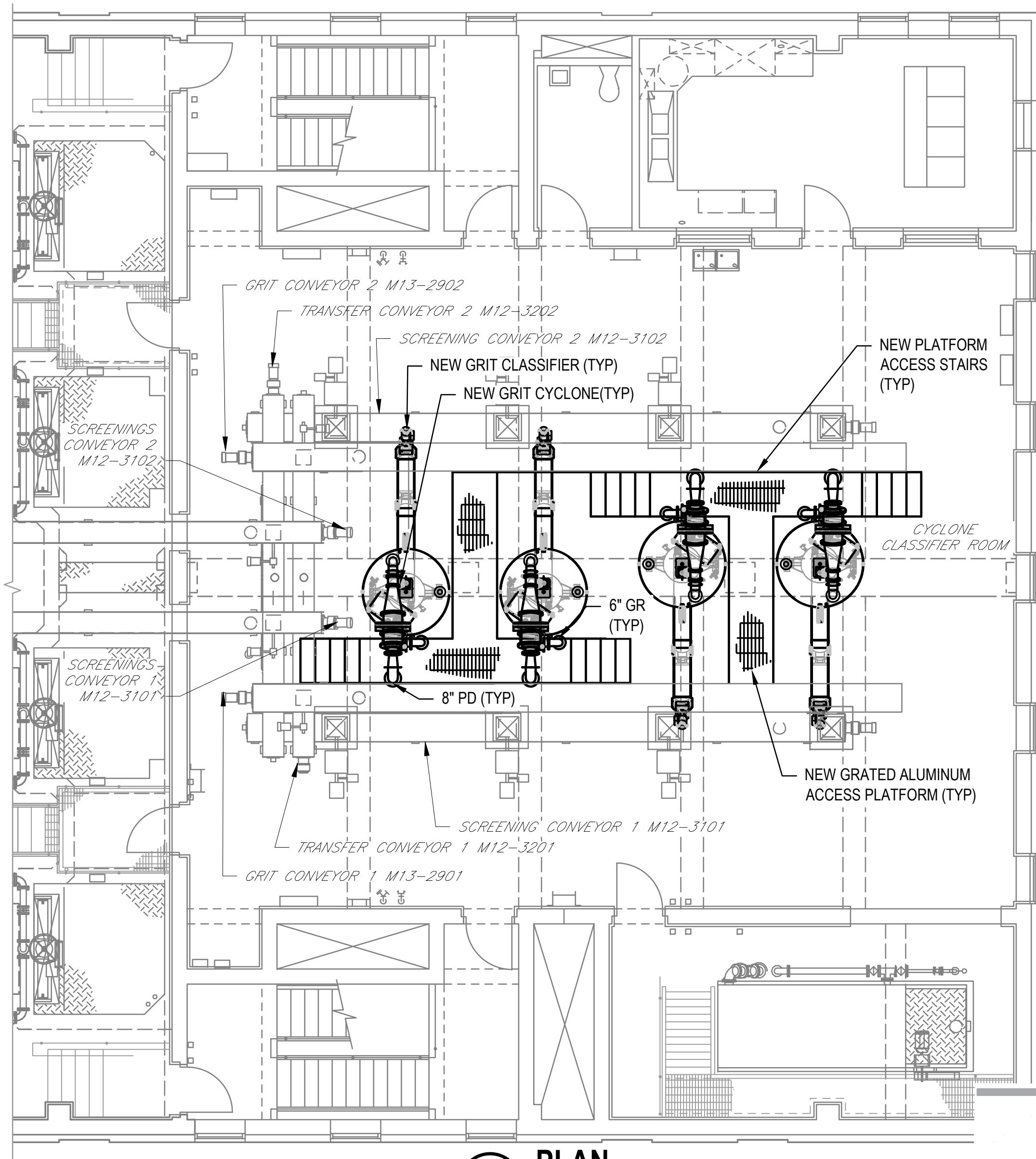

1 PLAN
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE C3:
FOR NEW HYDROCYCLONE/CONICAL GRIT WASHER UNITS

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 13

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-13.dwg
Plot Date: 17 March 2022 - 9:37 AM

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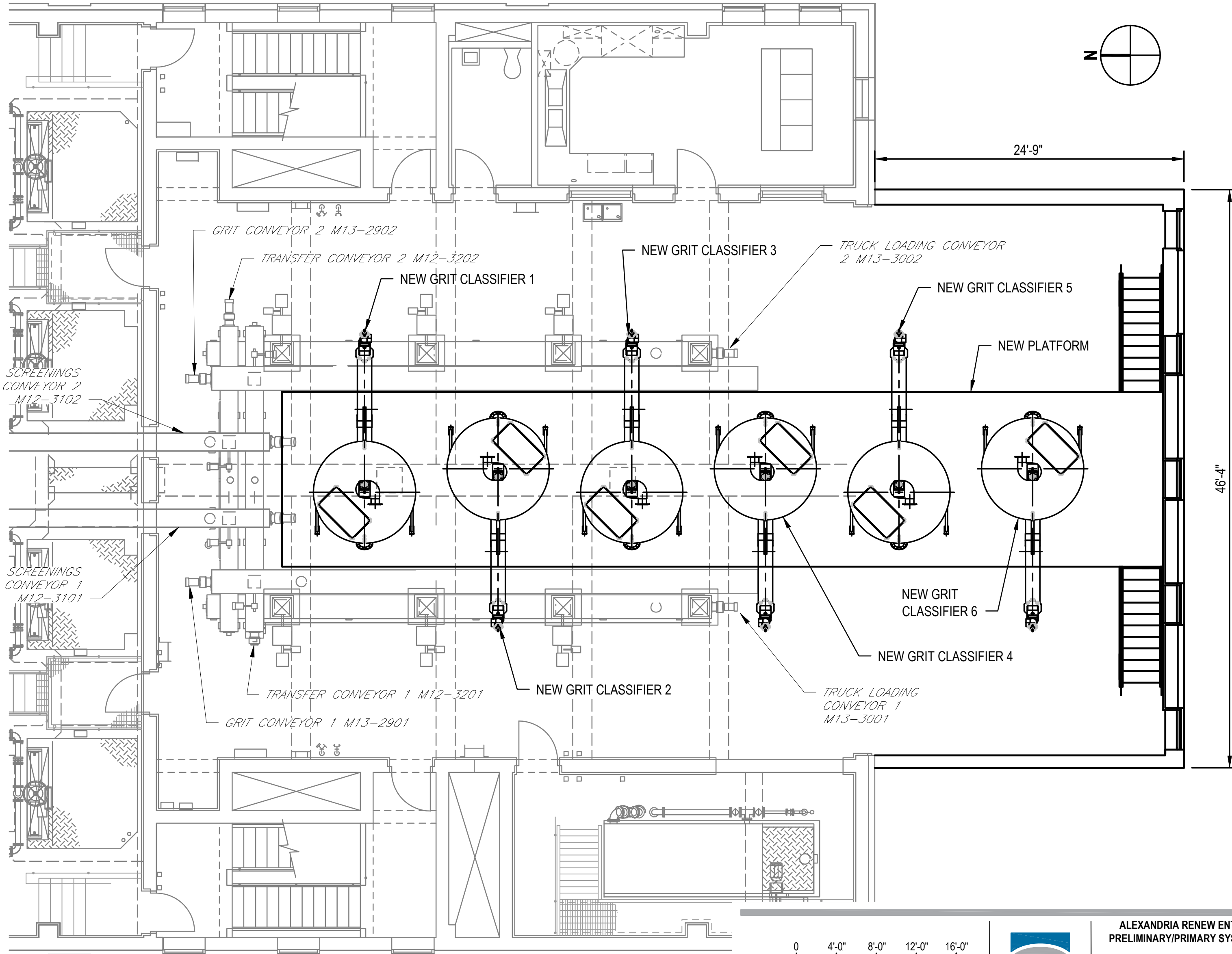

1 **PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SUB-ALTERNATIVE C4:
SIX NEW FULL-FLOW GRIT WASHER UNITS
AND NO HYDROCYCLONES

Project No. **11217618**
Report No. **N/A**
Date **03/2022**

FIGURE 14

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-14.dwg
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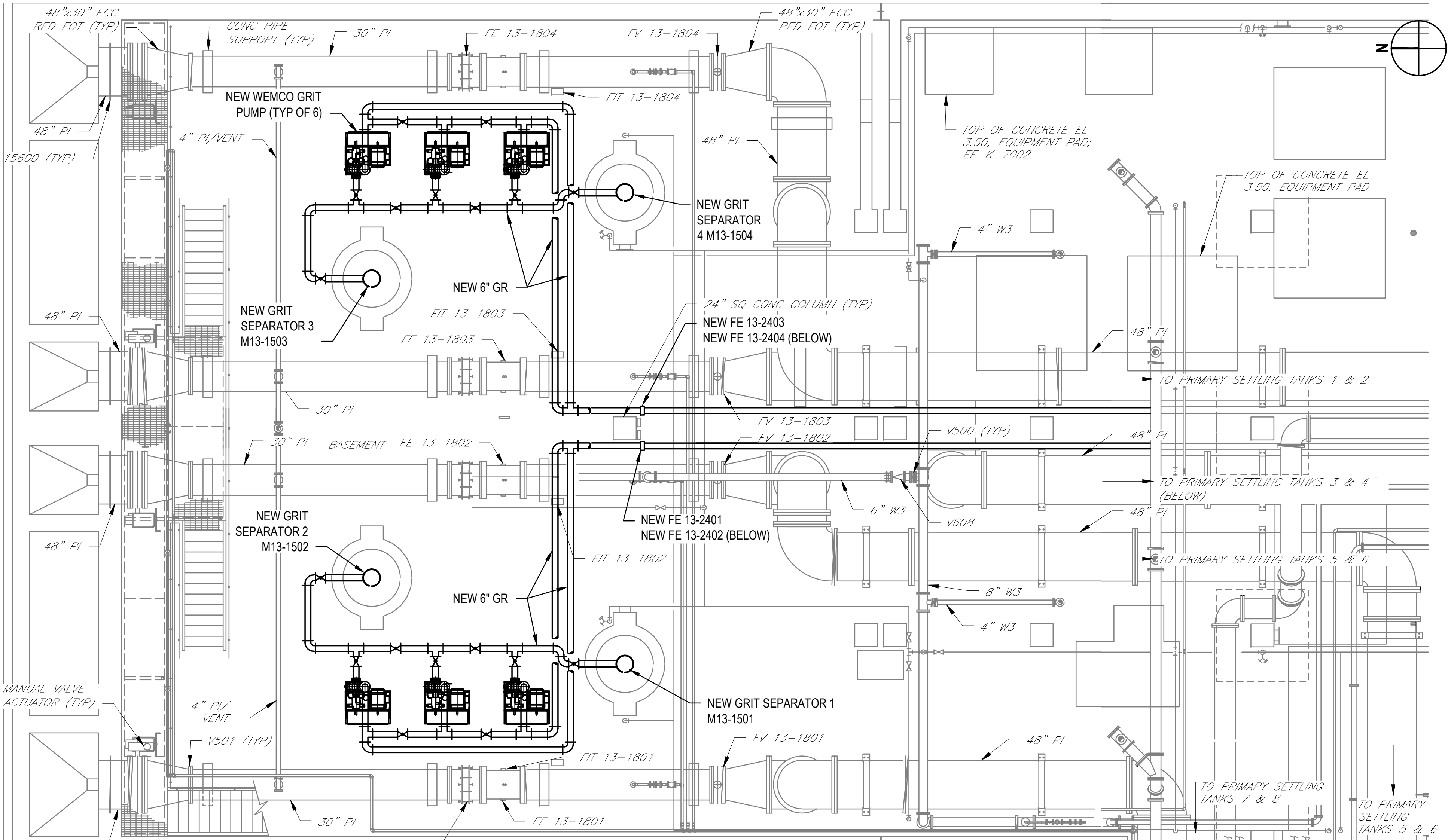

1 **PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

ALTERNATIVE 2:
FOUR ENHANCED VORTEX GRIT SEPARATORS WITH SIX STANDARD GRIT PUMPS WITH FOUR HYDROCYCLONE/GRIT WASHER UNITS

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 15

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-15.dwg
Plot Date: 17 March 2022 - 9:38 AM

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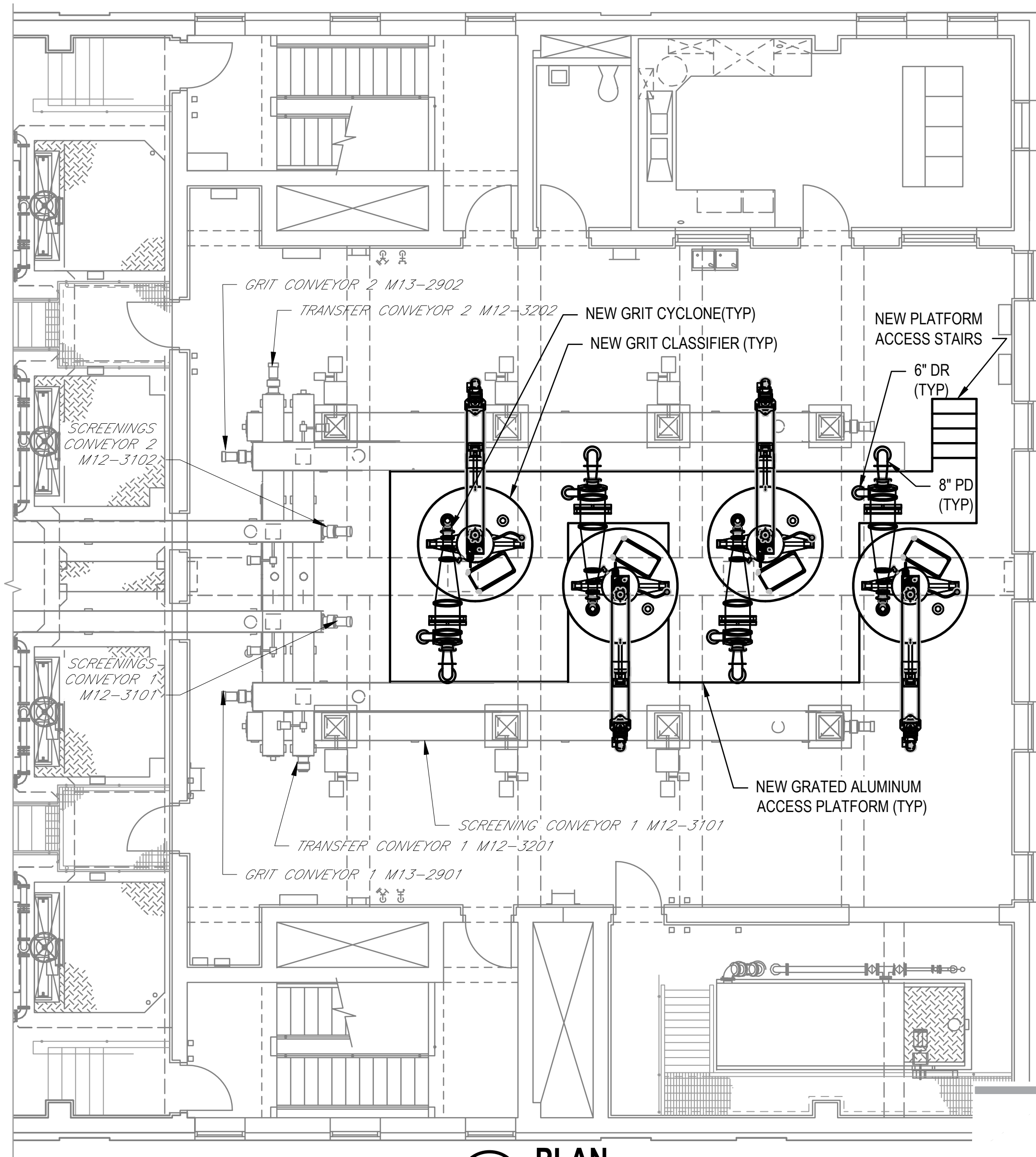

1 PLAN
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

ALTERNATIVE 3: THREE STACKED TRAY GRIT REMOVAL UNITS AND TWO ENHANCED VORTEX GRIT SEPARATORS WITH FIVE STANDARD GRIT PUMPS WITH FOUR HYDROCYCLONE/GRIT WASHER UNITS

Project No. **11217618**
Report No. **N/A**
Date **03/2022**

FIGURE 16

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-16.dwg
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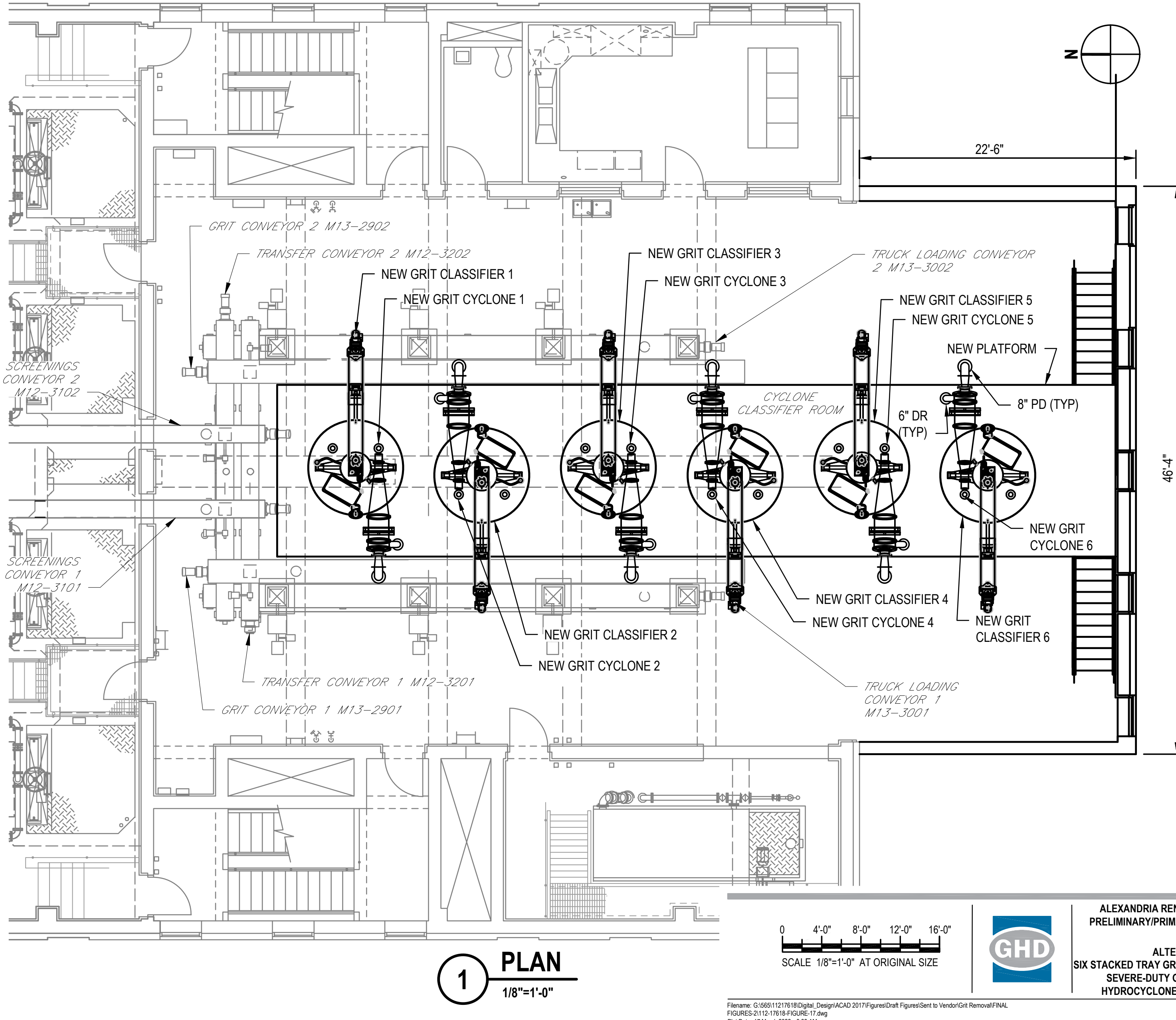


1 PLAN
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

ALTERNATIVE 4:
SIX STACKED TRAY GRIT REMOVAL UNITS WITH SIX SEVERE-DUTY GRIT PUMPS WITH SIX HYDROCYCLONE/ GRIT WASHER UNITS

Project No. 11217618
Report No. N/A
Date 03/2022

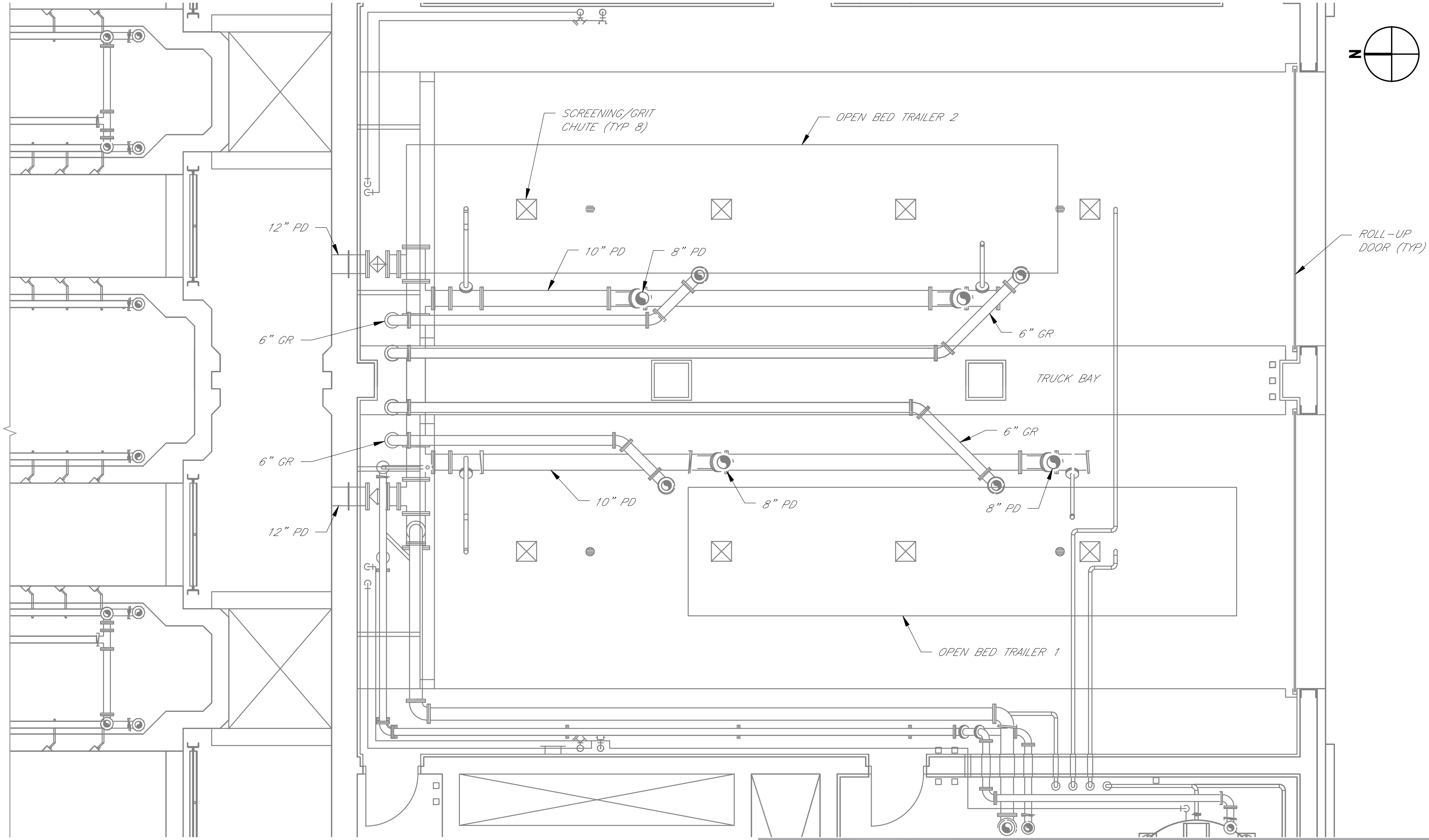
FIGURE 17

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-2\112-17618-FIGURE-17.dwg
Plot Date: 17 March 2022 - 9:39 AM

Source:

Appendix F

Conceptual Layouts – Fine Screening and Grit Loading



1 PLAN
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING AND GRIT LOADING
EXISTING PLAN

Project No. 11217618
Report No. N/A
Date 12/2021

FIGURE 1

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-2.dwg
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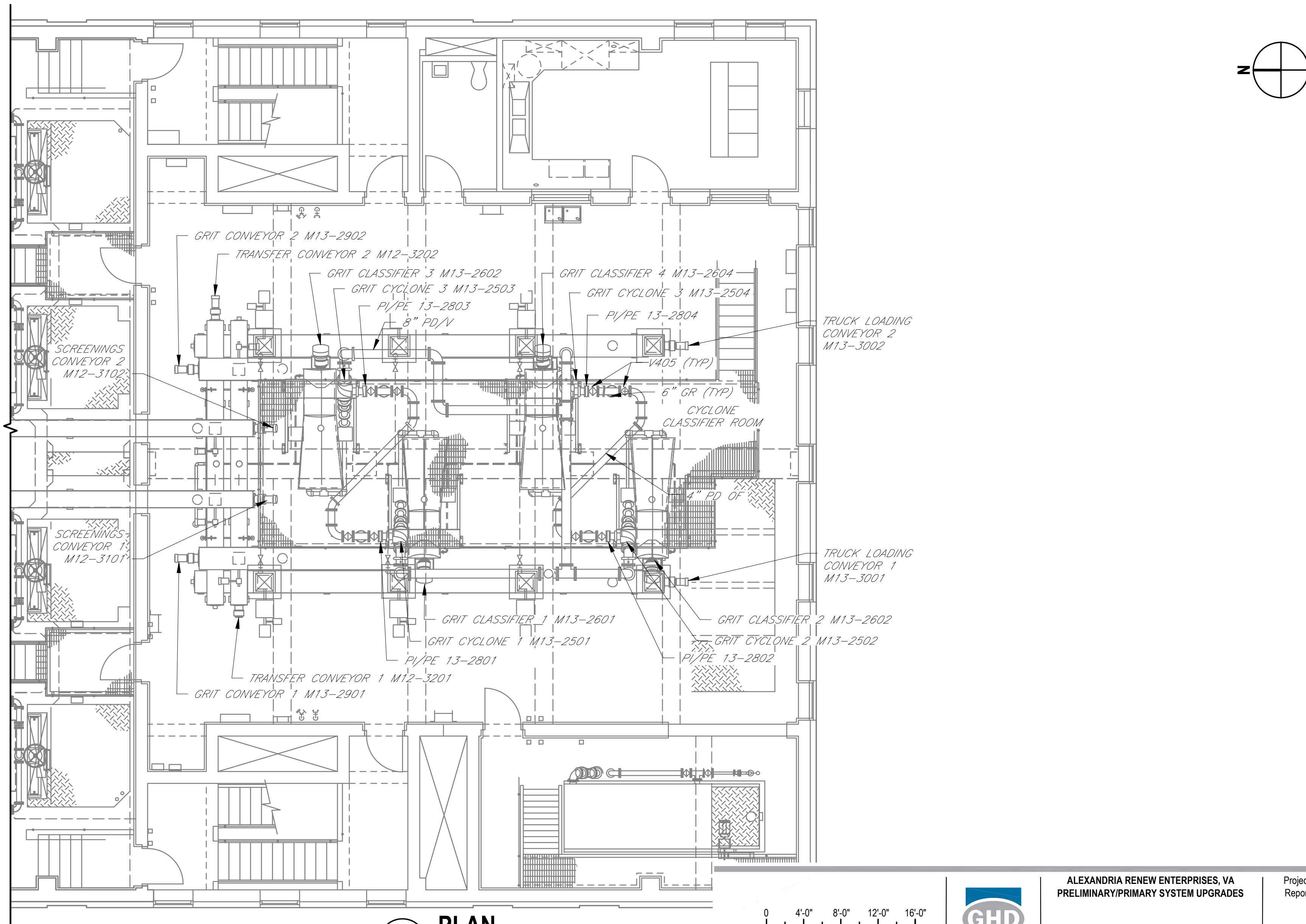

1 **PLAN**
1/8"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

GRIT DEWATERING AND SCREENING AND GRIT CONVEYANCE EXISTING SYSTEM

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 2

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-1.dwg
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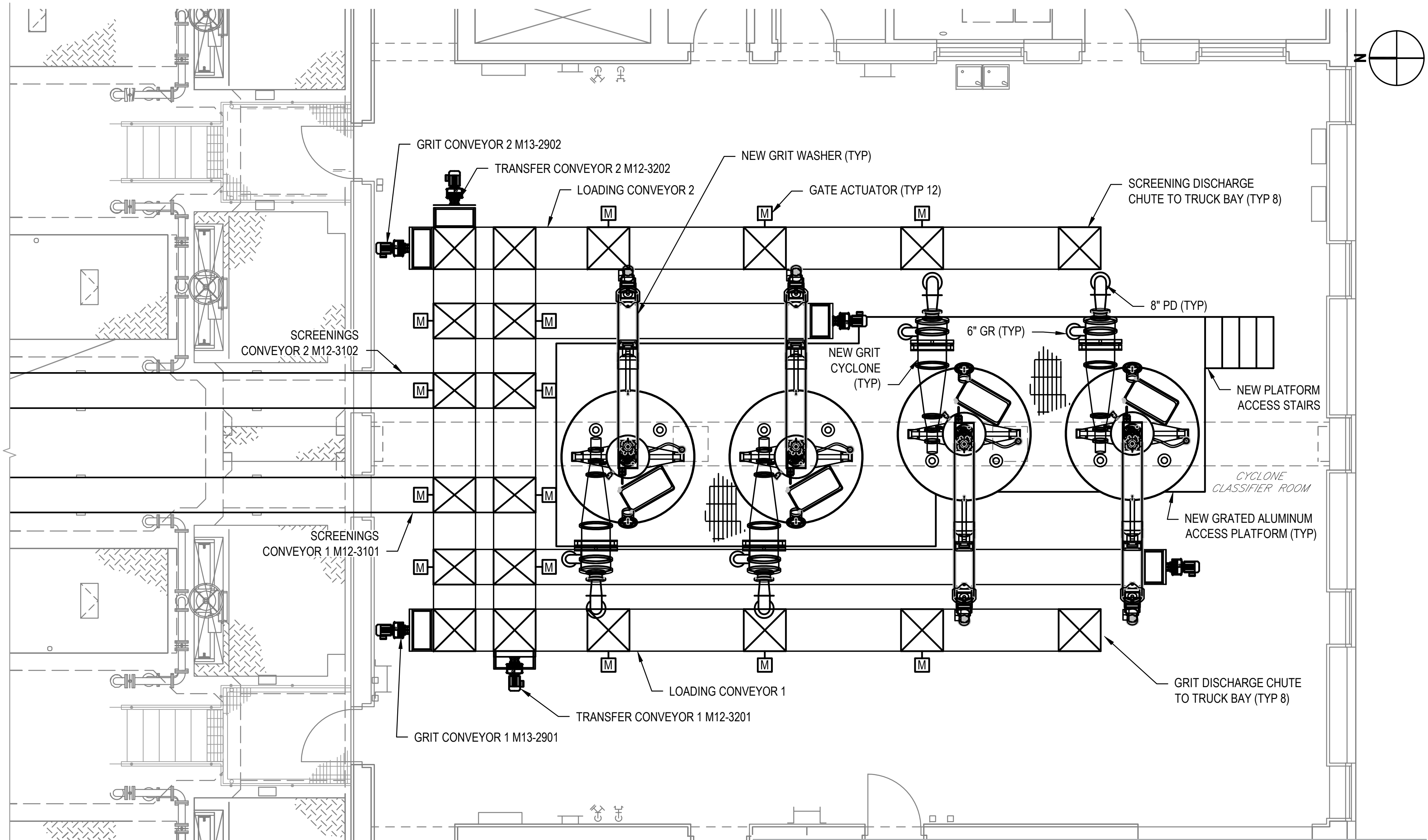

1 PLAN
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING AND GRIT LOADING
ALTERNATIVE 1 - UPPER PLAN

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 3

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-3.dwg
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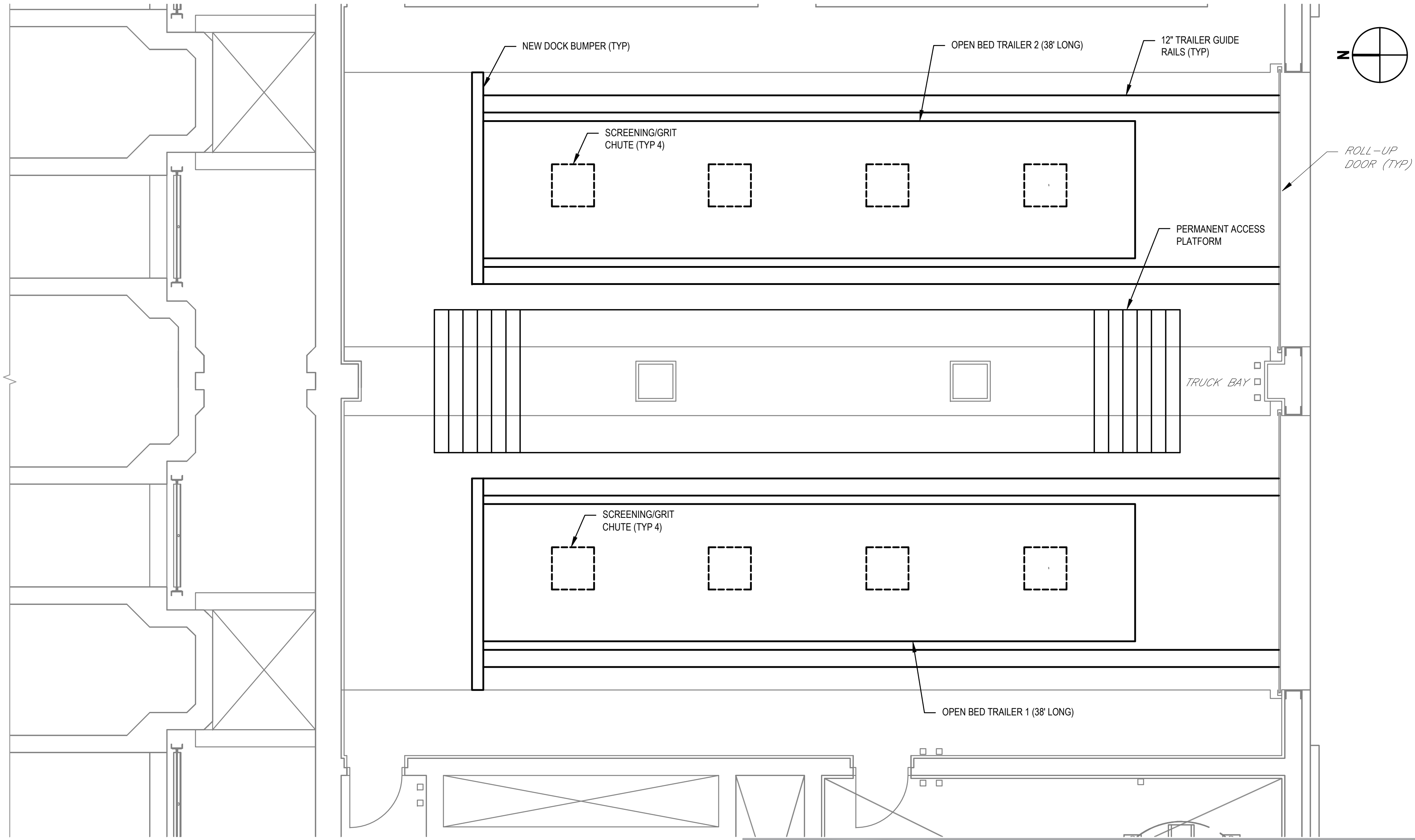

1 PLAN
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING AND GRIT LOADING
SUB-ALTERNATIVE 1 - LOWER PLAN

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 4

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-4.dwg
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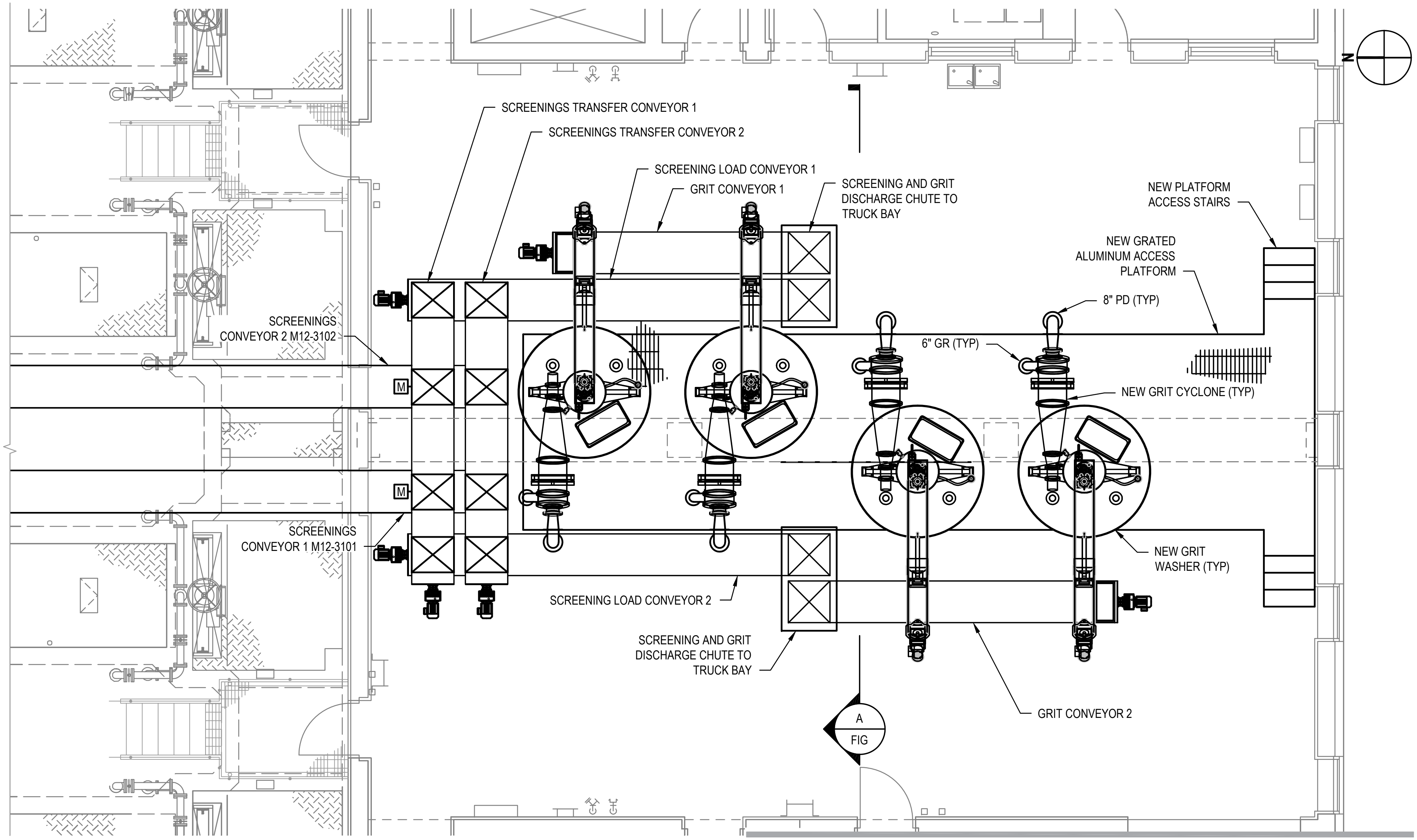

1 PLAN
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING AND GRIT LOADING
ALTERNATIVE 2 - UPPER PLAN

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 5

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-5.dwg
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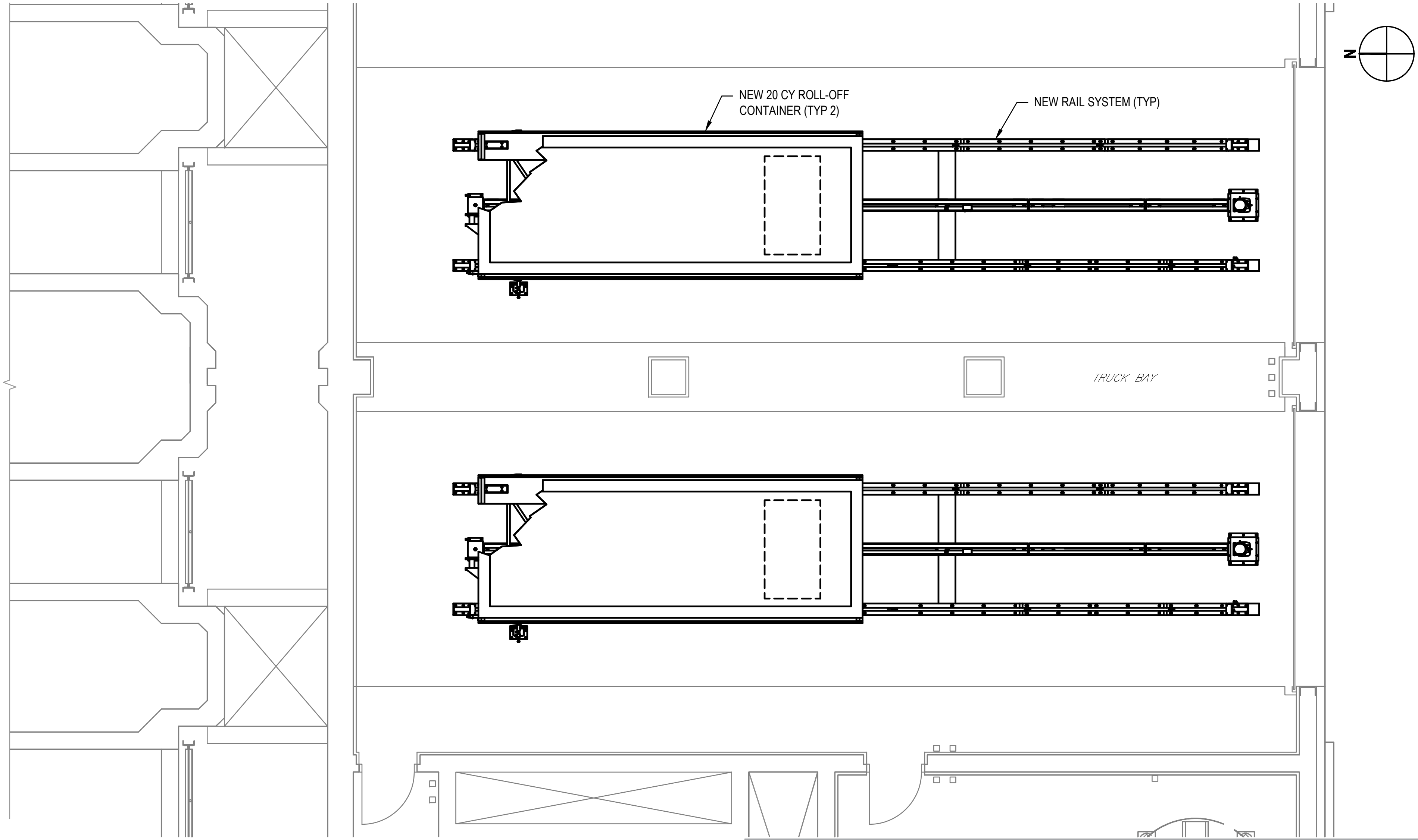

1 PLAN
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING & GRIT LOADING
ALTERNATIVE 2 - LOWER PLAN

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 6

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-6.dwg
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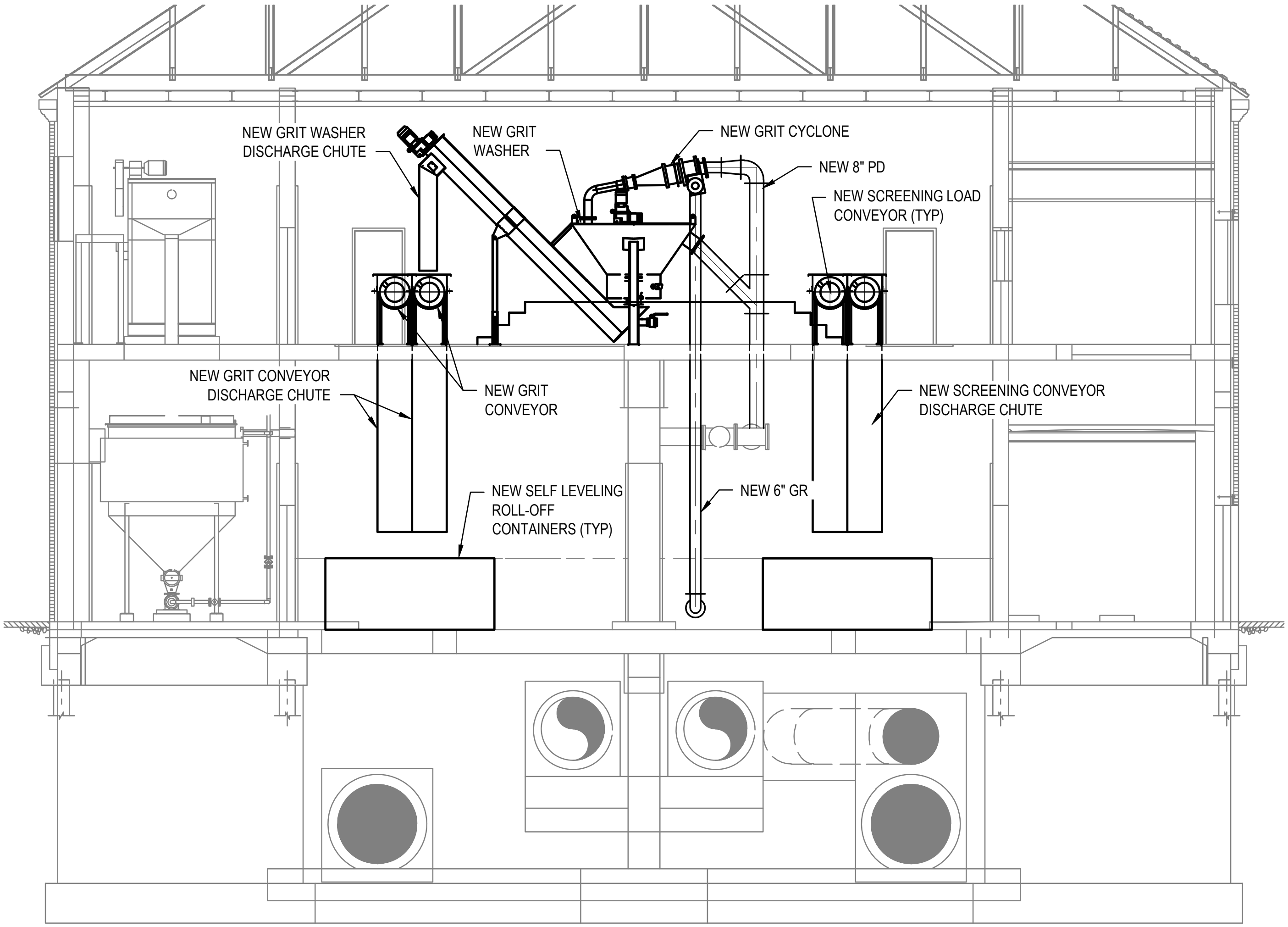

A
FIG

SECTION
SCALE: 3/16"=1'-0"

SCALE 3/16"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING & GRIT LOADING
ALTERNATIVE 2- SECTION

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 7

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-7.dwg
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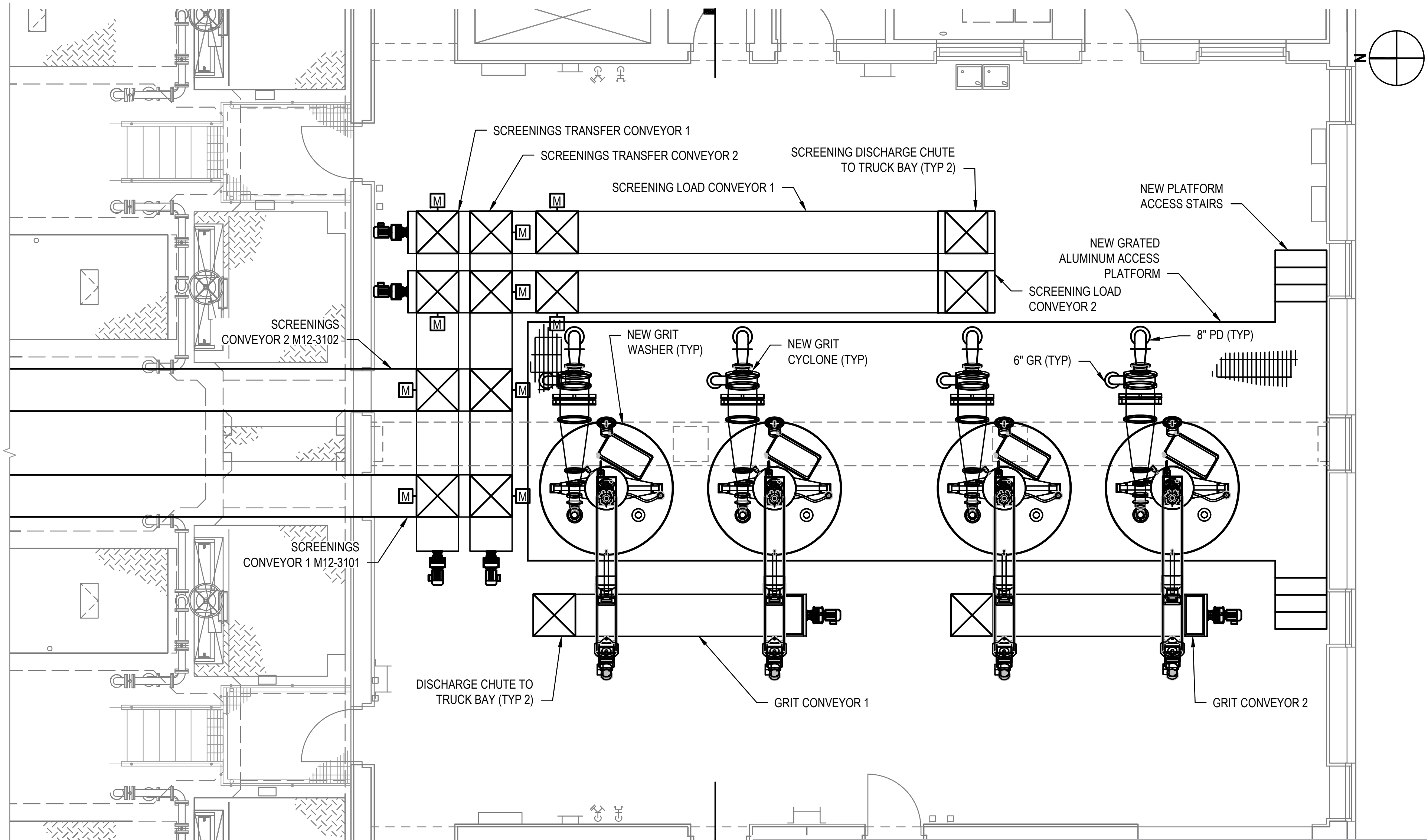

1 **PLAN**
3/16"=1'-0"

A
FIG

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING AND GRIT LOADING
ALTERNATIVE 3 - UPPER PLAN

Project No. **11217618**
Report No. **N/A**
Date **03/2022**

FIGURE 8

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-8.dwg
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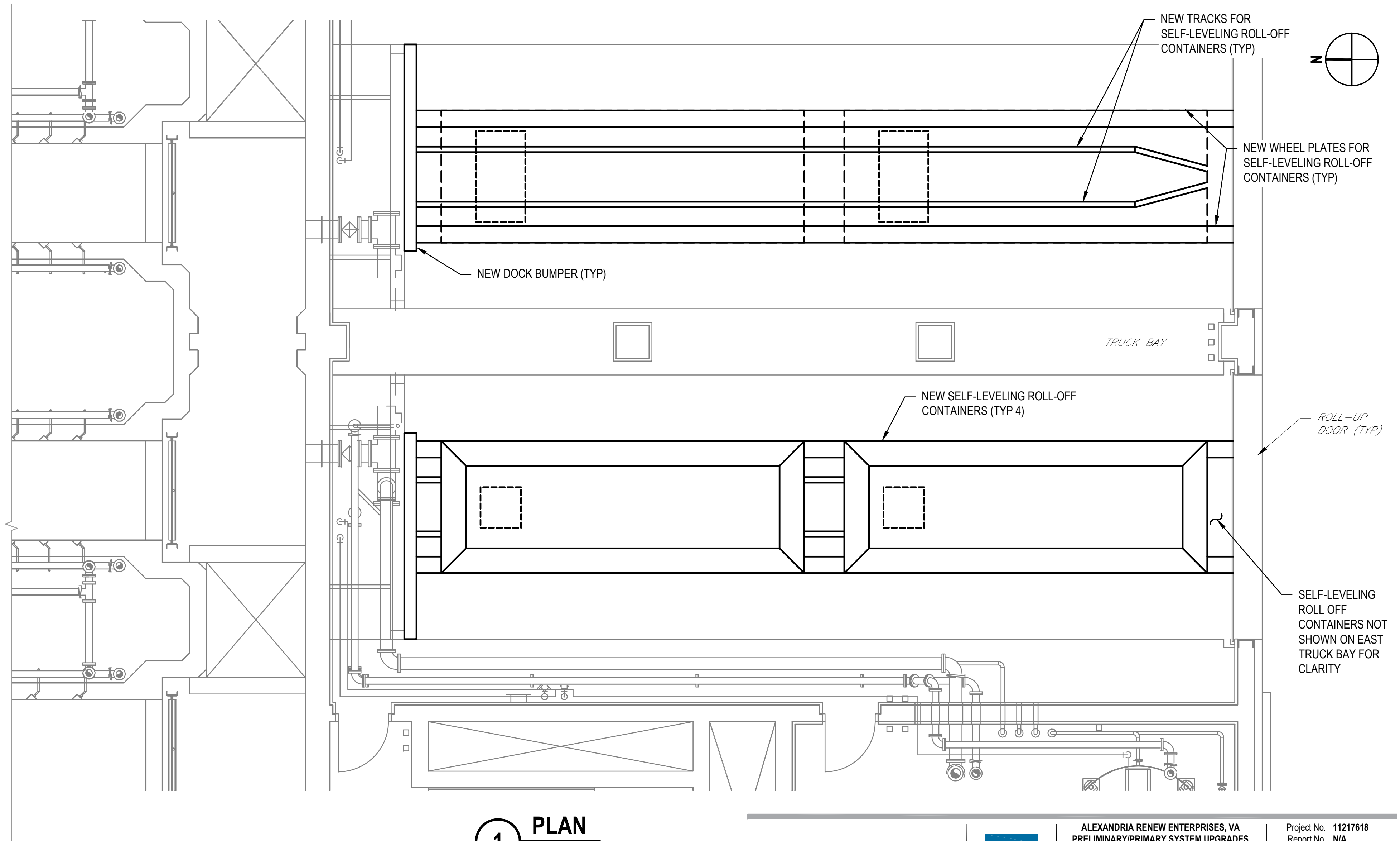

1 PLAN
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING AND GRIT LOADING
ALTERNATIVE 3 - LOWER PLAN

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 9

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-11112-17618-FIG-9.dwg
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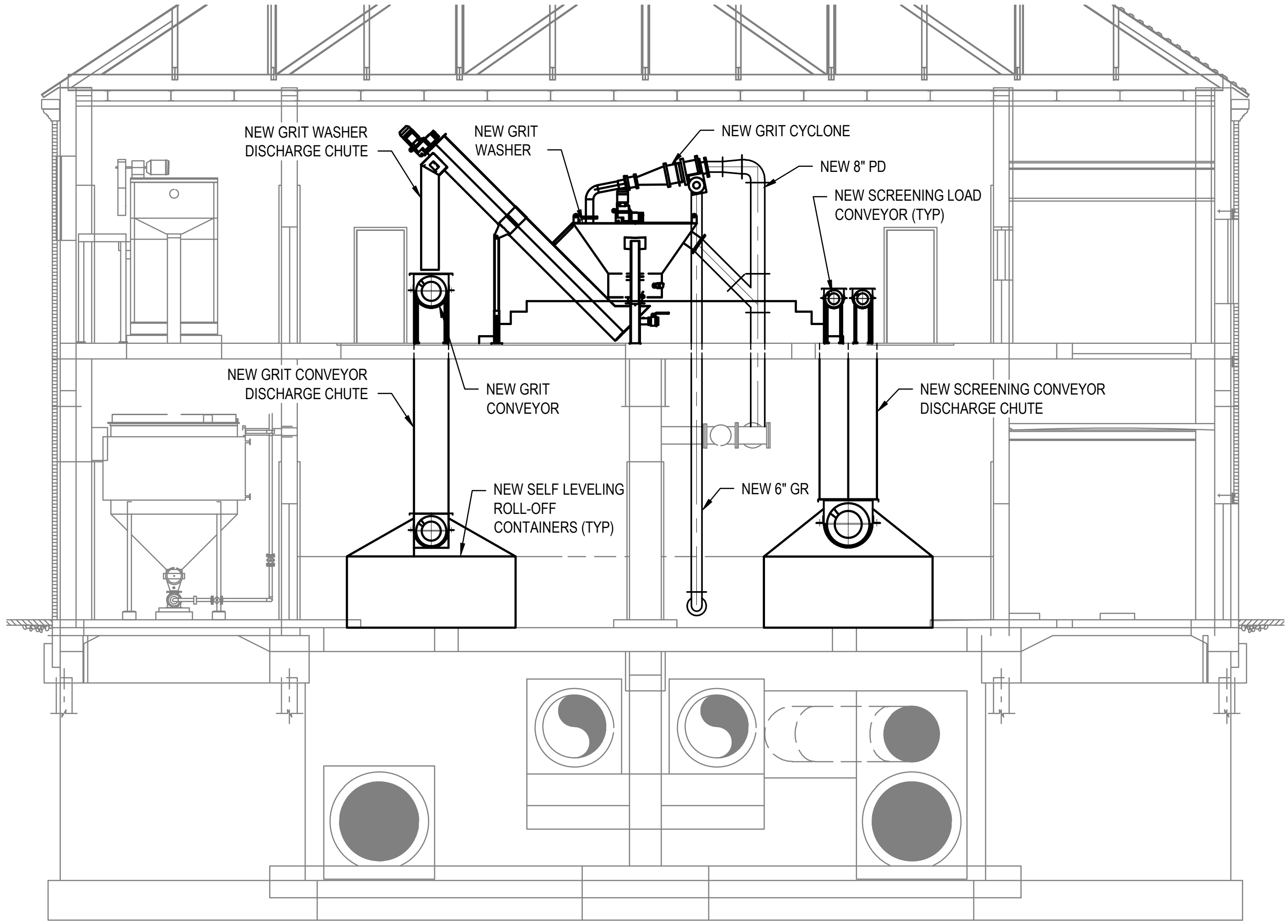

A / FIG **SECTION**

SCALE: 3/16"=1'-0"

SCALE 3/16"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING & GRIT LOADING
ALTERNATIVE 3 - SECTION

Project No. **11217618**
Report No. **N/A**
Date **03/2022**

FIGURE 10

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-10.dwg
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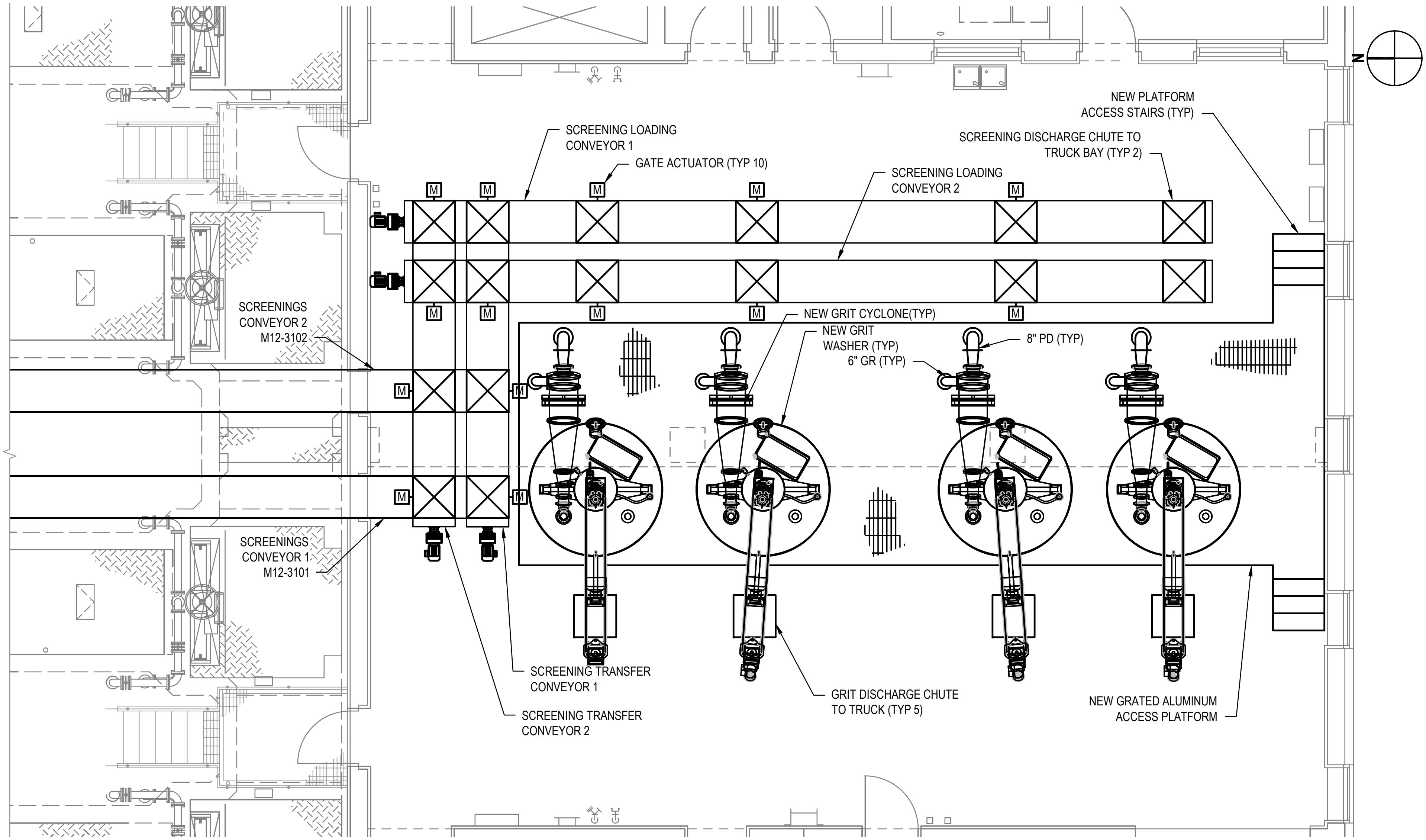

1 PLAN
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING & GRIT LOADING
ALTERNATIVE 4 - UPPER PLAN

Project No. 11217618
Report No. N/A
Date 03/2022

FIGURE 11

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-11.dwg
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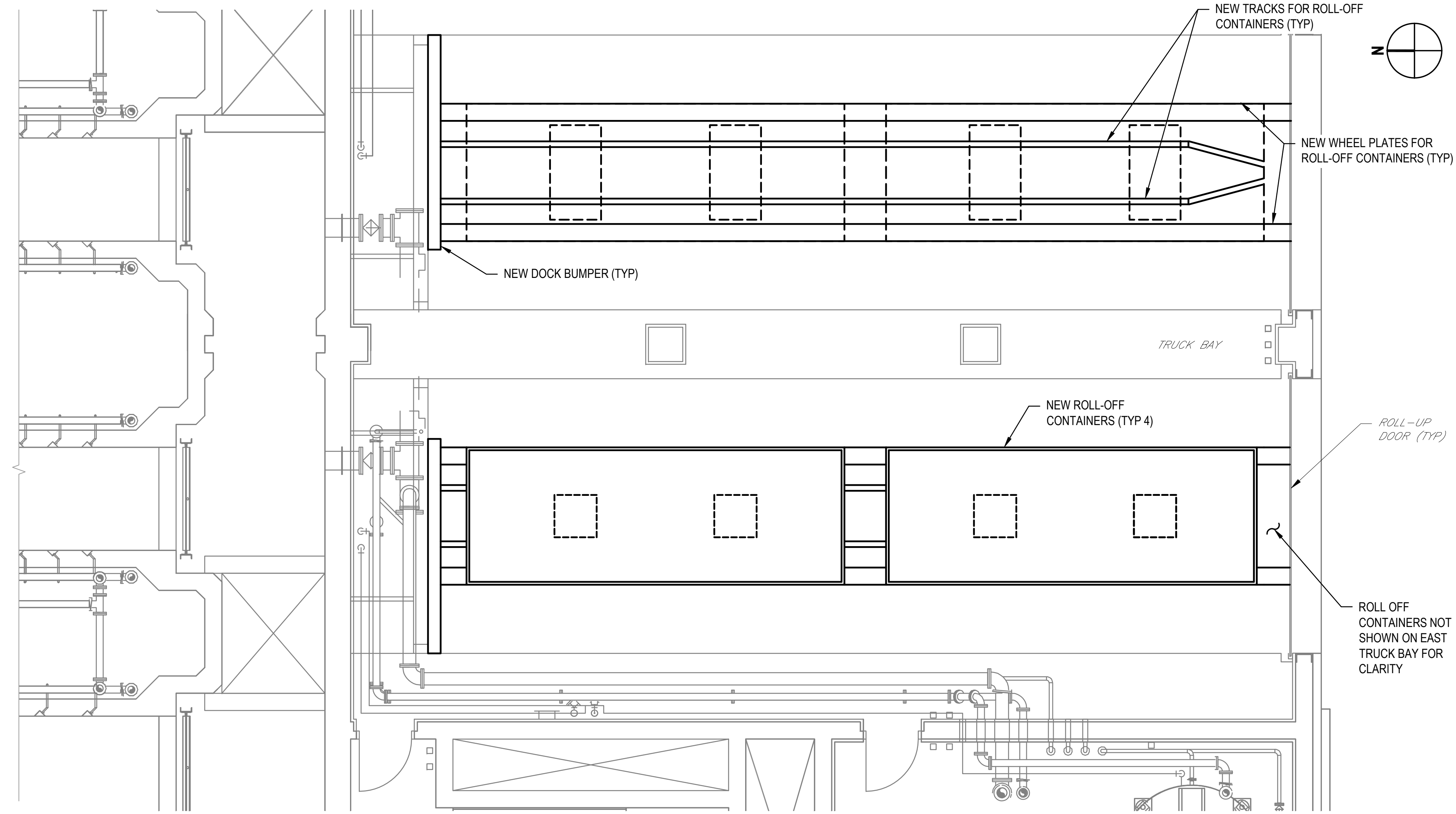

1 **PLAN**
3/16"=1'-0"

0 4'-0" 8'-0" 12'-0"
SCALE 3/16"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING AND GRIT LOADING
ALTERNATIVE 4 - LOWER LPAN

Project No. **11217618**
Report No. **N/A**
Date **03/2022**

FIGURE 12

Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-12.dwg
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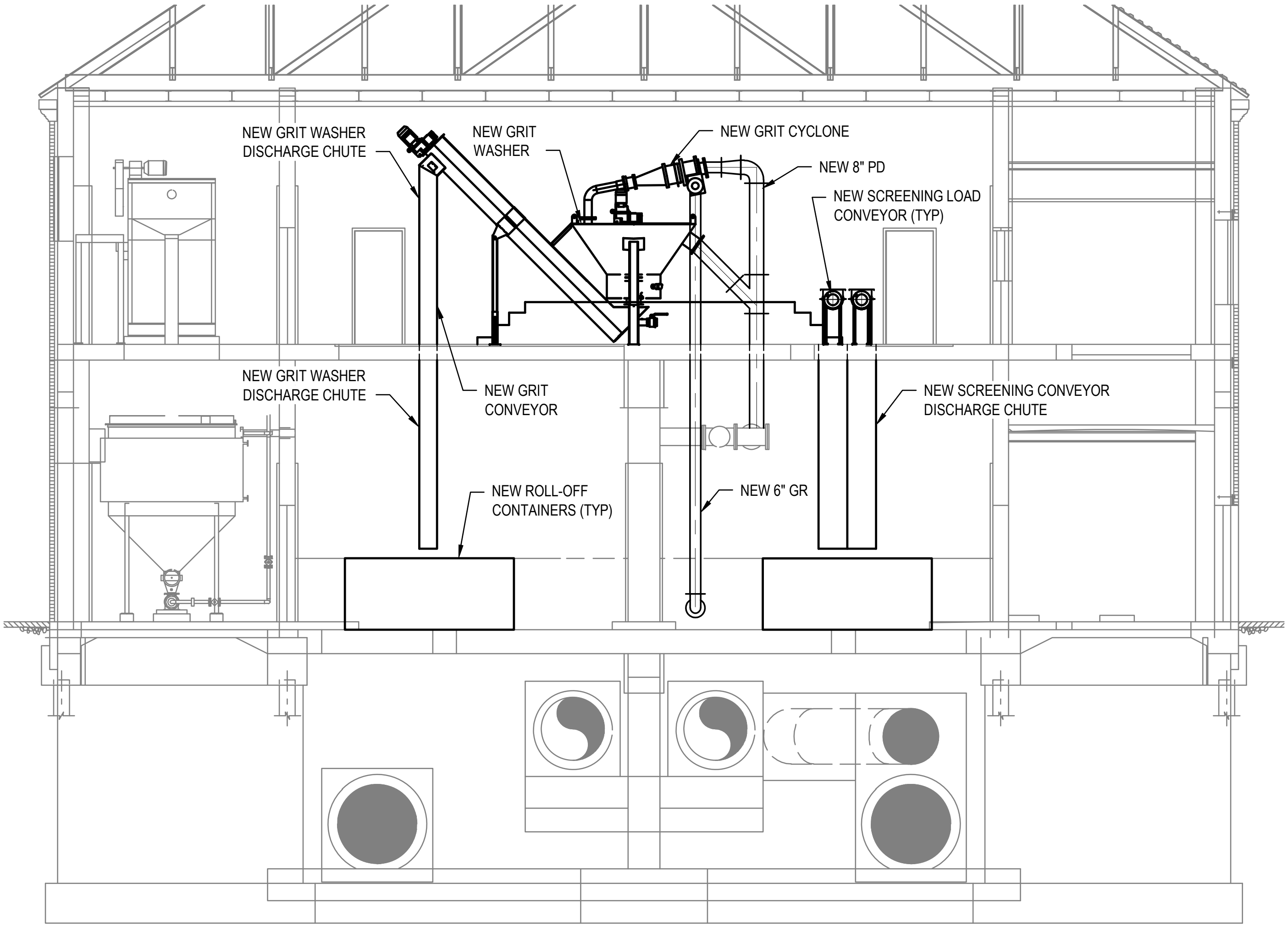


A FIG **SECTION**
SCALE: 3/16"=1'-0"

SCALE 3/16"=1'-0" AT ORIGINAL SIZE

ALEXANDRIA RENEW ENTERPRISES, VA
PRELIMINARY/PRIMARY SYSTEM UPGRADES

SCREENING & GRIT LOADING ALTERNATIVE 4 - SIMPLIFIED SCREENINGS SCREW CONVEYOR LAYOUT WITH DIRECT WASHER DISCHARGE TO TWO ROLL-OFF CONTAINERS PER TRUCK BAY

Project No. 11217618
Report No. N/A
Date 03/2022

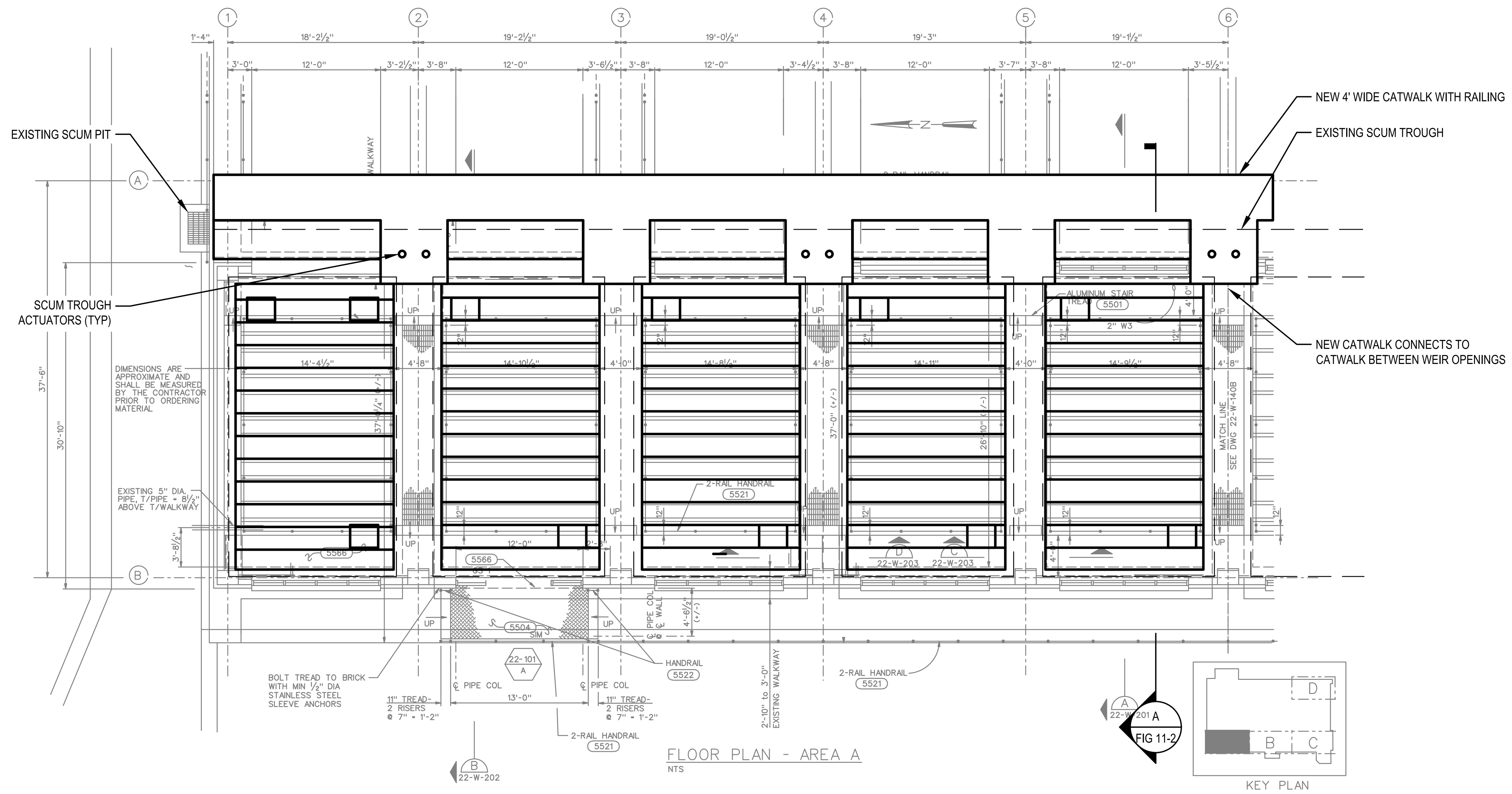
FIGURE 13

Source:

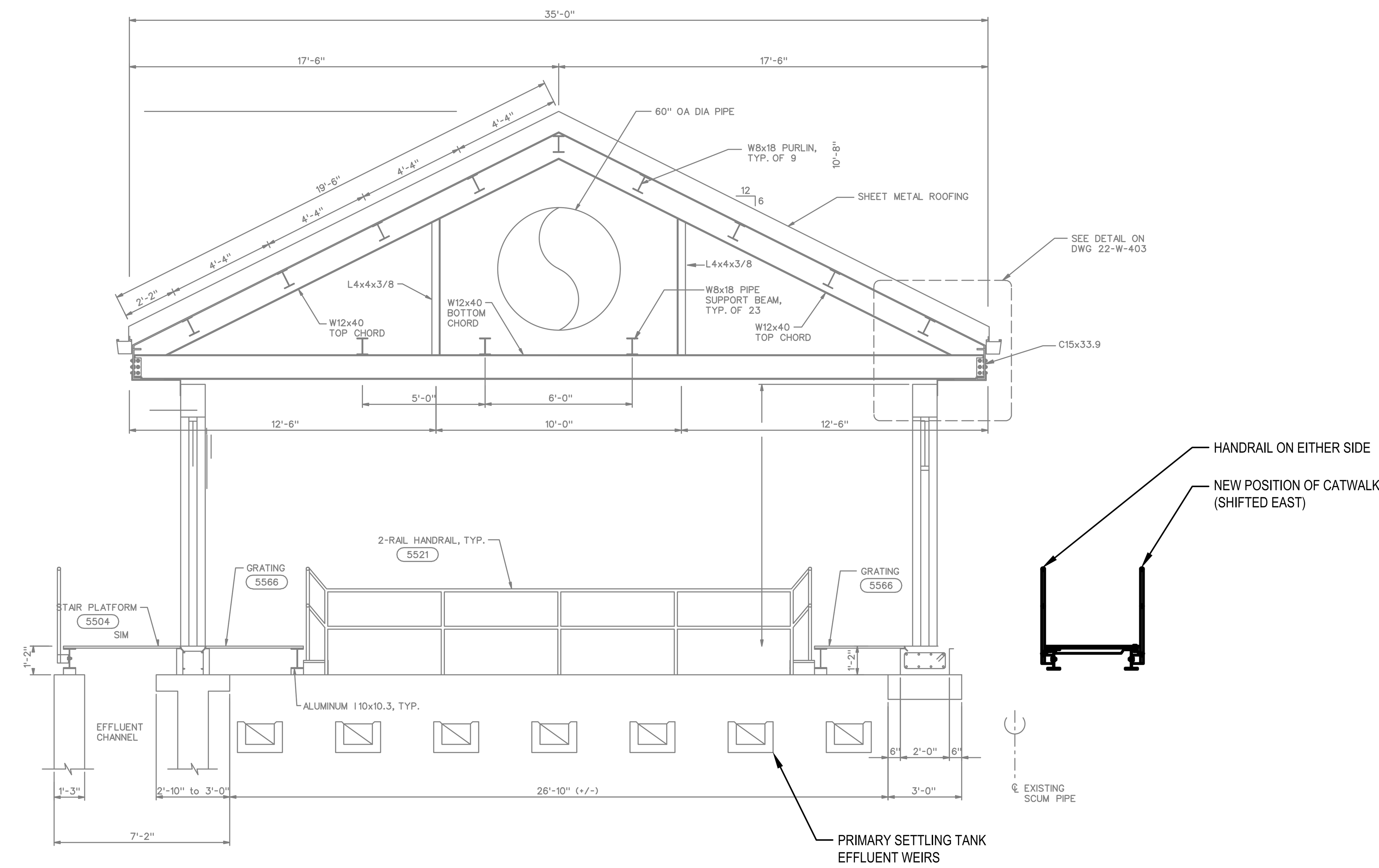
Filename: G:\565\11217618\Digital_Design\ACAD 2017\Figures\Draft Figures\Sent to Vendor\Grit Removal\FINAL FIGURES-1\112-17618-FIG-13.dwg
Plot Date: 18 August 2022 - 10:33 AM

Appendix G

Conceptual Layouts – Primary Settling



1 **PLAN**
1/4" = 1'-0"



A FIG 11-2 **SECTION**
1/2" = 1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"	
SCALE 1/8"=1'-0" AT ORIGINAL SIZE	

GHD

ALEXANDRIA RENEW PPSU
PWOH RENOVATIONS ALTERNATIVE 1

RENOVATE PRIMARY WEIR OBSERVATION HOUSE: CONSTRUCT NEW CROSS TANK ACCESS WALKWAY

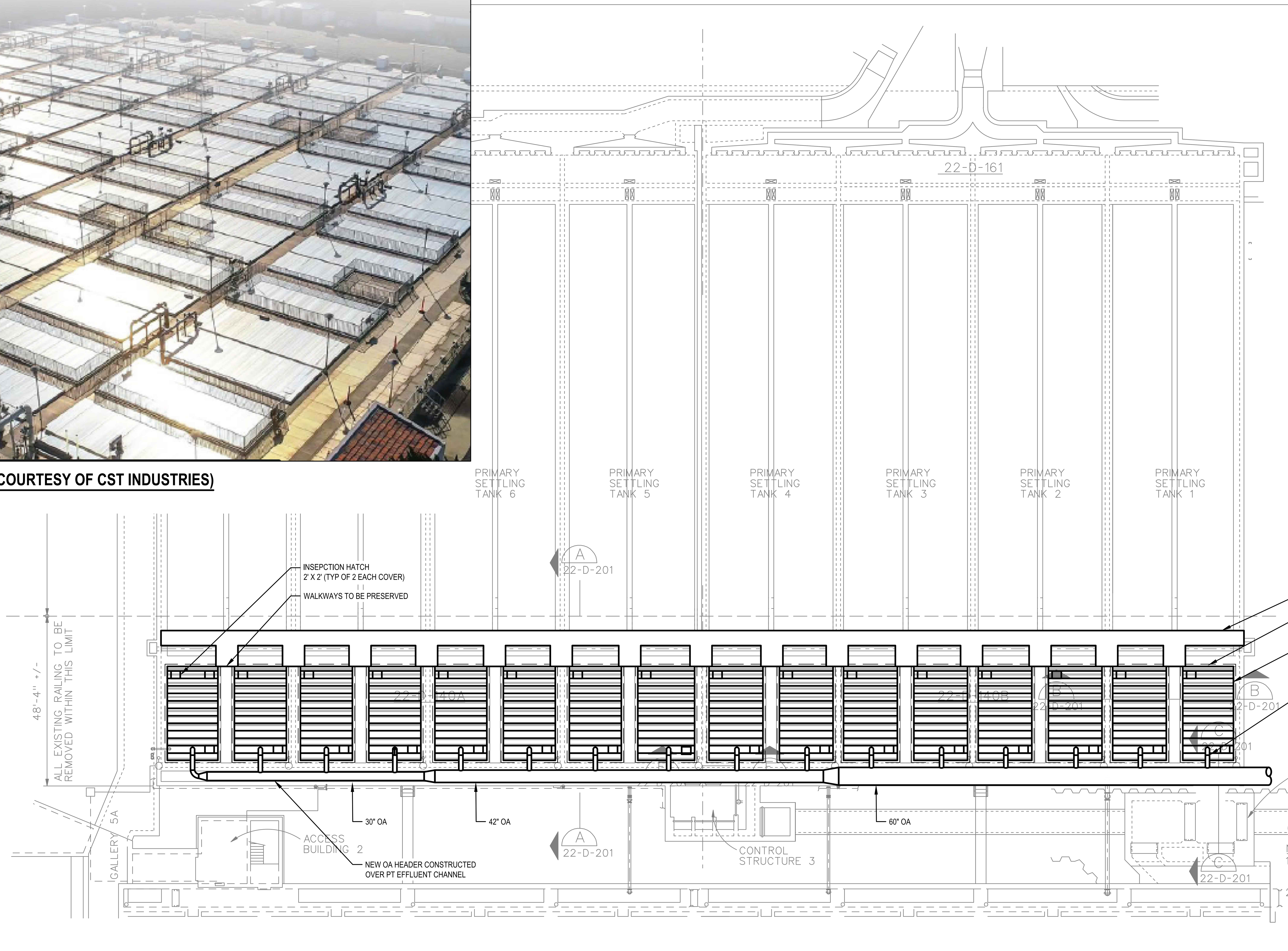
Project No. **11217618**
Report No. **N/A**
Date **10/1/2021**

FIGURE 1

Source:

Filename:
N:\CA\Waterloo\Legacy\CAD\drawings\11217000s\11217618\11217618-PRES\11217618-00(PRES001)\11217618-00(PRES001)ME\11217618-00(PRES001)ME-WA001.dwg
Plot Date: 8 October 2021 - 12:16 PM

EXAMPLE OF ALUMINUM COVER SYSTEM (IMAGE COURTESY OF CST INDUSTRIES)



1 PRIMARY SETTLING TANKS - PLAN
1/4" = 1'-0"

0 4'-0" 8'-0" 12'-0" 16'-0"

SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW PPSU
PWOH RENOVATION ALTERNATIVE 2

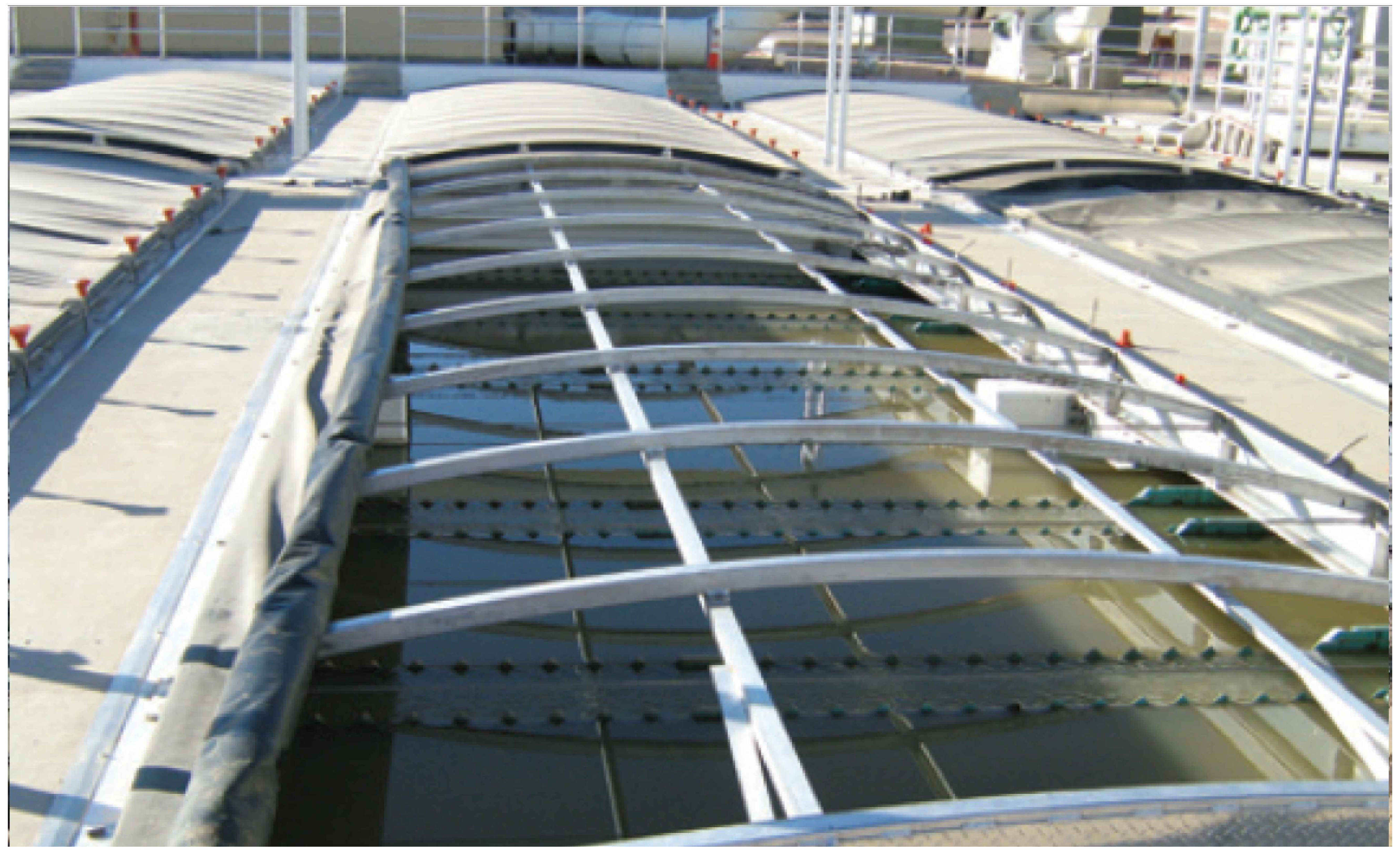
DEMOLISH PWOH BUILDING ; INSTALL ALUMINUM COVERS OVER WEIR AREA ; CONSRUCT NEW CROSS TANK ACCESS WALKWAY

Project No. 11217618
Report No. N/A
Date 10/1/2021

FIGURE 2

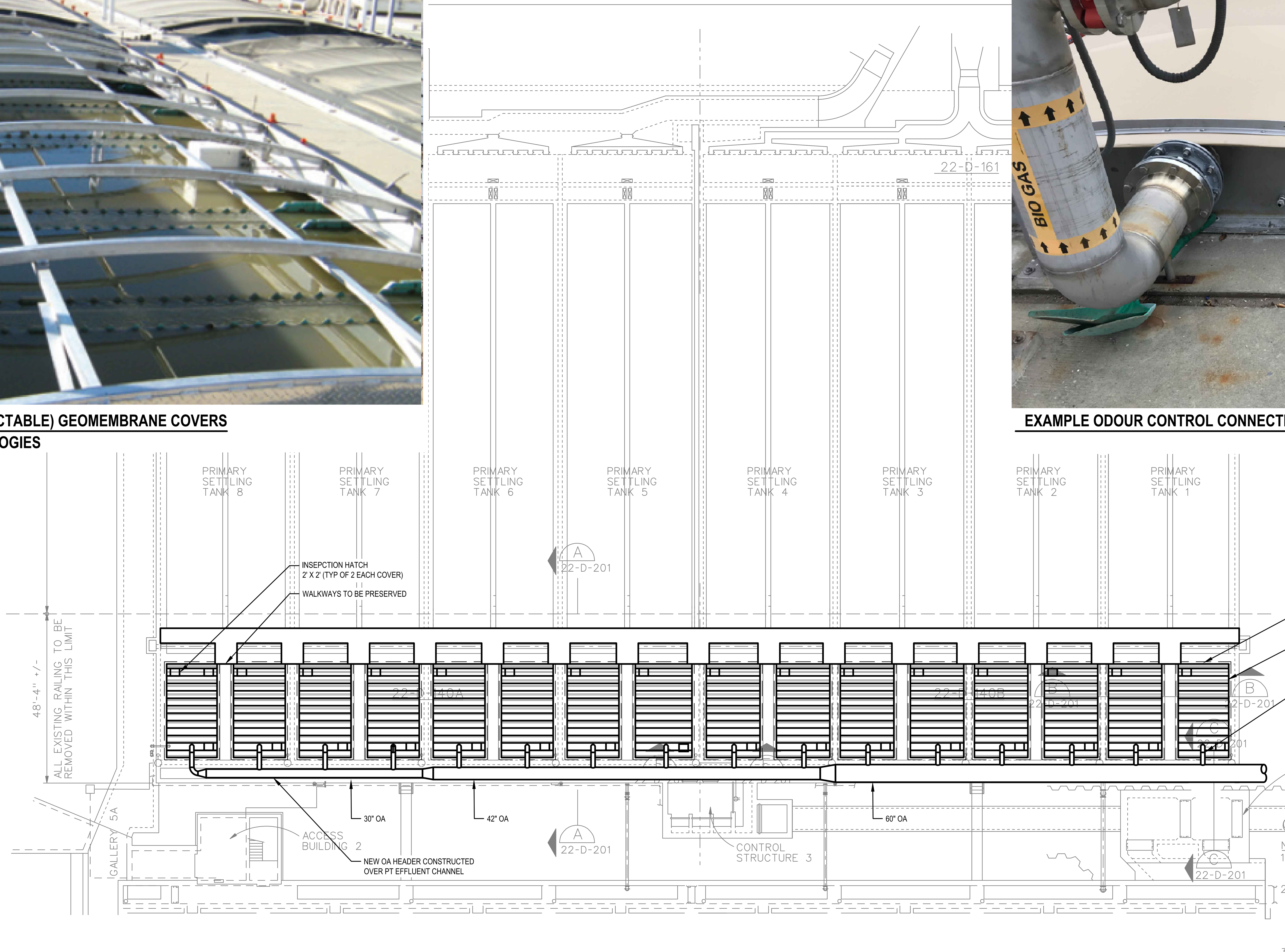
Source:

Filename:
N:\CA\Waterloo\Legacy\CAD\drawings\11217000s\11217618\11217618-PRES\11217618-00(PRES001)\11217618-00(PRES001)ME\11217618-00(PRES001)ME-WA001.dwg
Plot Date: 7 October 2021 - 10:17 AM



EXAMPLE OF STRUCTURAL REINFORCED (RETRACTABLE) GEOMEMBRANE COVERS
(IMAGE COURTESY OF EVOQUA WATER TECHNOLOGIES

EXAMPLE ODOUR CONTROL CONNECTION FOR GEOMEMBRANE COVERED TANKS



1 **PRIMARY SETTLING TANKS - COVER OPTION 2 - GEOMEMBRANE COVERS**
1/4" = 1'-0"

GHD Ltd.
455 Phillip Street
Waterloo, Ontario N2L 3X2 Canada
T 1 519 884 0510 F 1 519 884 0525

0 4'-0" 8'-0" 12'-0" 16'-0"
SCALE 1/8"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW PPSU
PWOH RENOVATION ALTERNATIVE 3

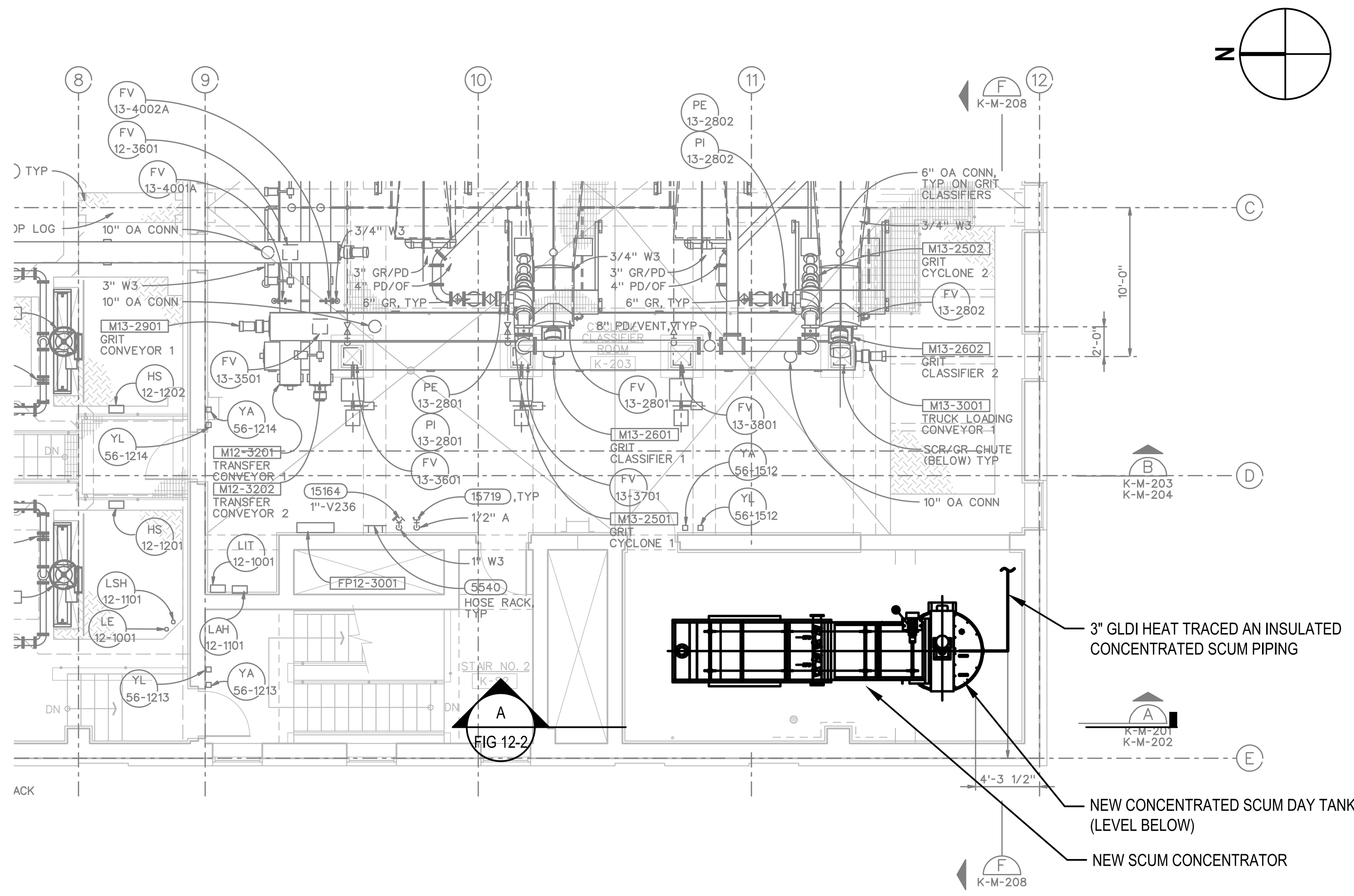
DEMOLISH PWOH BUILDING ; INSTALL
RETRACTABLE FABRIC COVERS OVER WEIR AREA;
CONSTRUCT NEW CROSS TANK ACCESS WALKWAY

Project No. 11217618
Report No. N/A
Date 10/1/2021

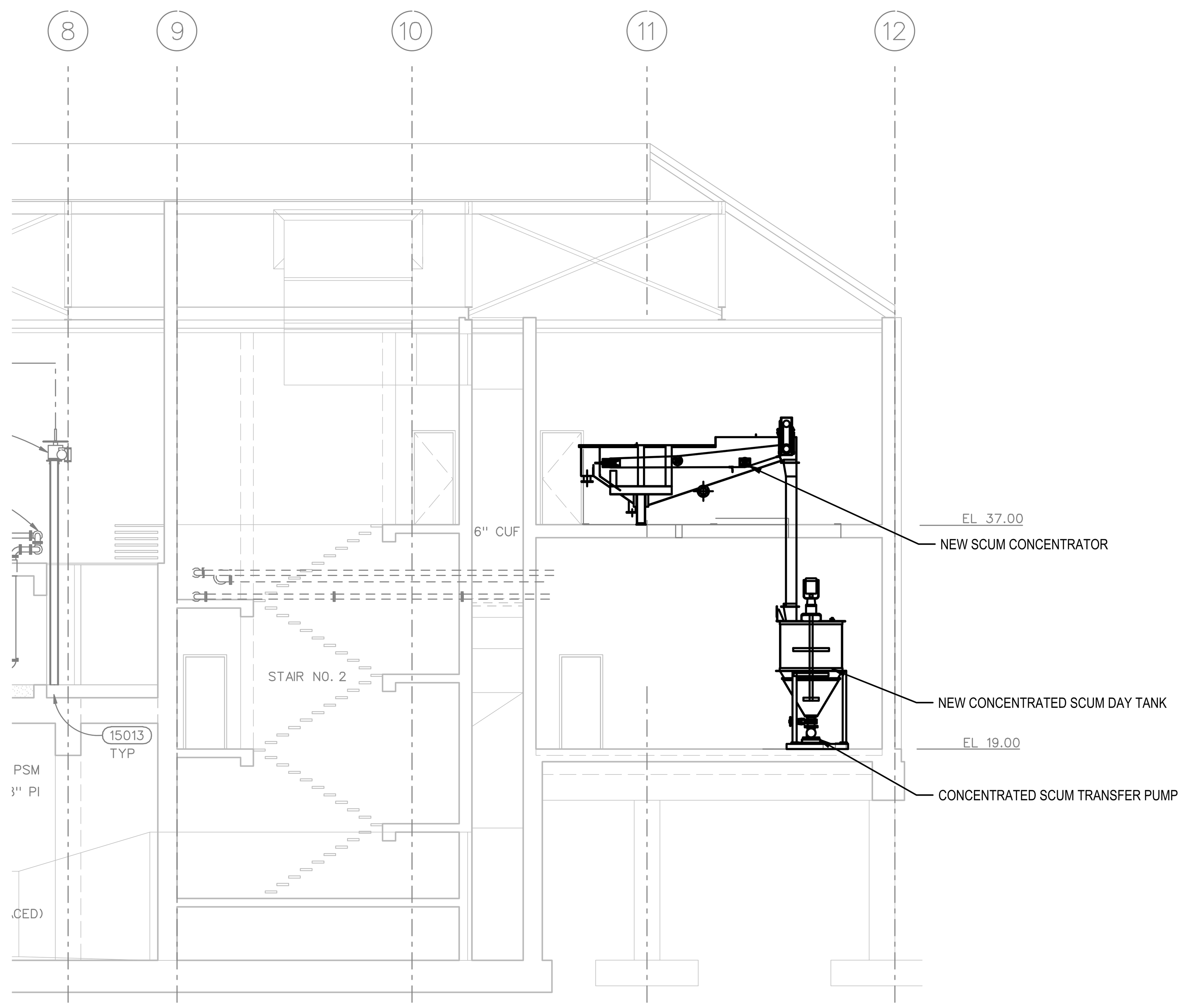
FIGURE 3

Source:

Filename:
N:\CA\Waterloo\Legacy\CAD\drawings\11217000s\11217618\11217618-PRES\11217618-00(PRES001)\11217618-00(PRES001)ME\11217618-00(PRES001)ME-WA001.dwg
Plot Date: 7 October 2021 - 10:17 AM



1 PLAN
1/4" = 1'-0"



A FIG 12-2 SECTION
1/4" = 1'-0"

NOTES:

1. SECTIONS OF SCUM ROOM WALLS WILL NEED TO BE REMOVED TO FACILITATE EXISTING SCUM EQUIPMENT REMOVAL AND INSTALLATION OF NEW SCUM CONCENTRATOR SYSTEM.

0 1'-0" 2'-0"
SCALE 1"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW PPSU
SCUM HANDLING RENOVATIONS ALTERNATIVE 1

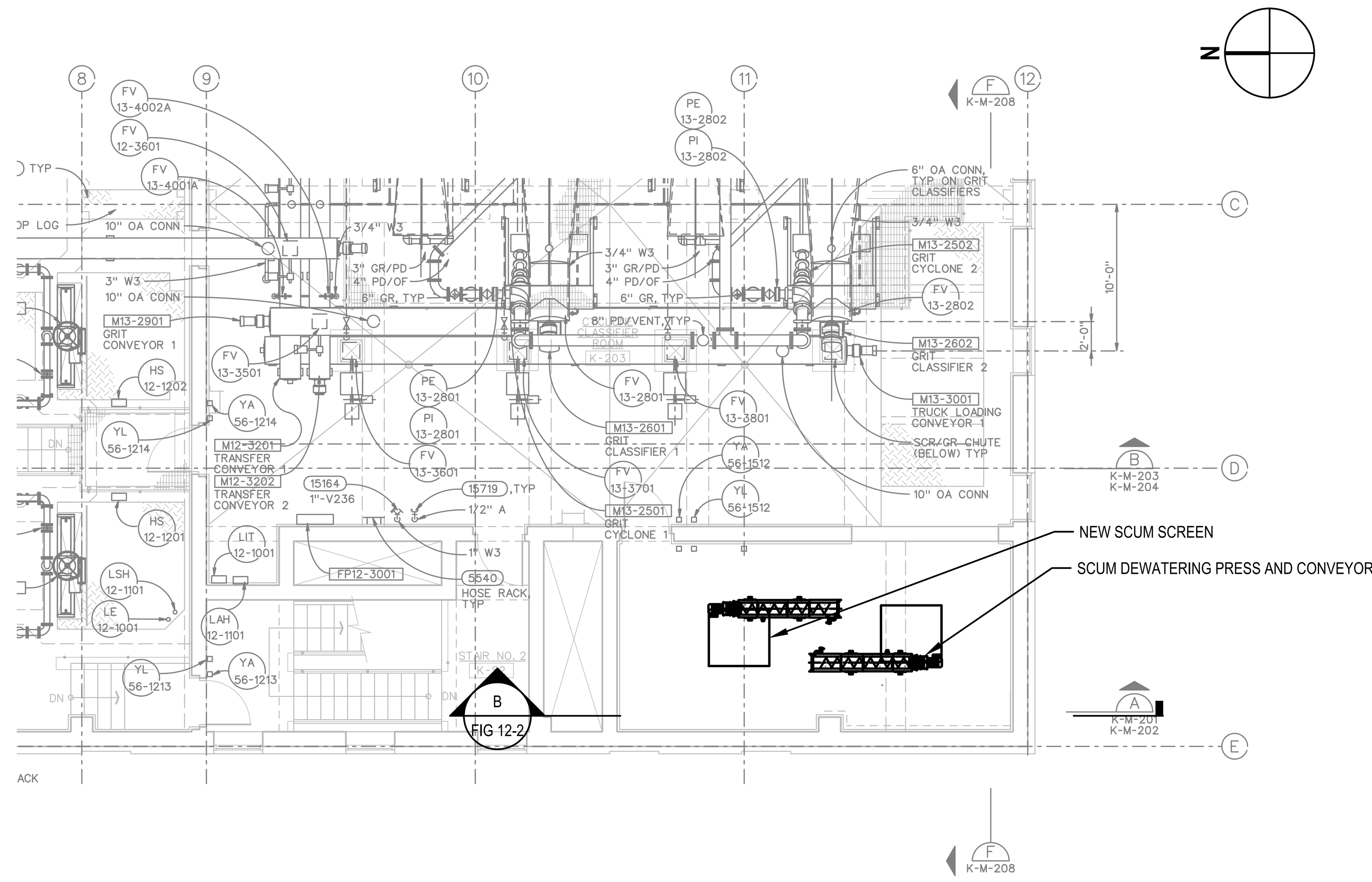
REPLACE SCUM CONCENTRATOR, DAY TANK AND TRANSFER PUMP WITH IN-KIND EQUIPMENT

Project No. **11217618**
Report No. **N/A**
Date **09/2021**

FIGURE 4

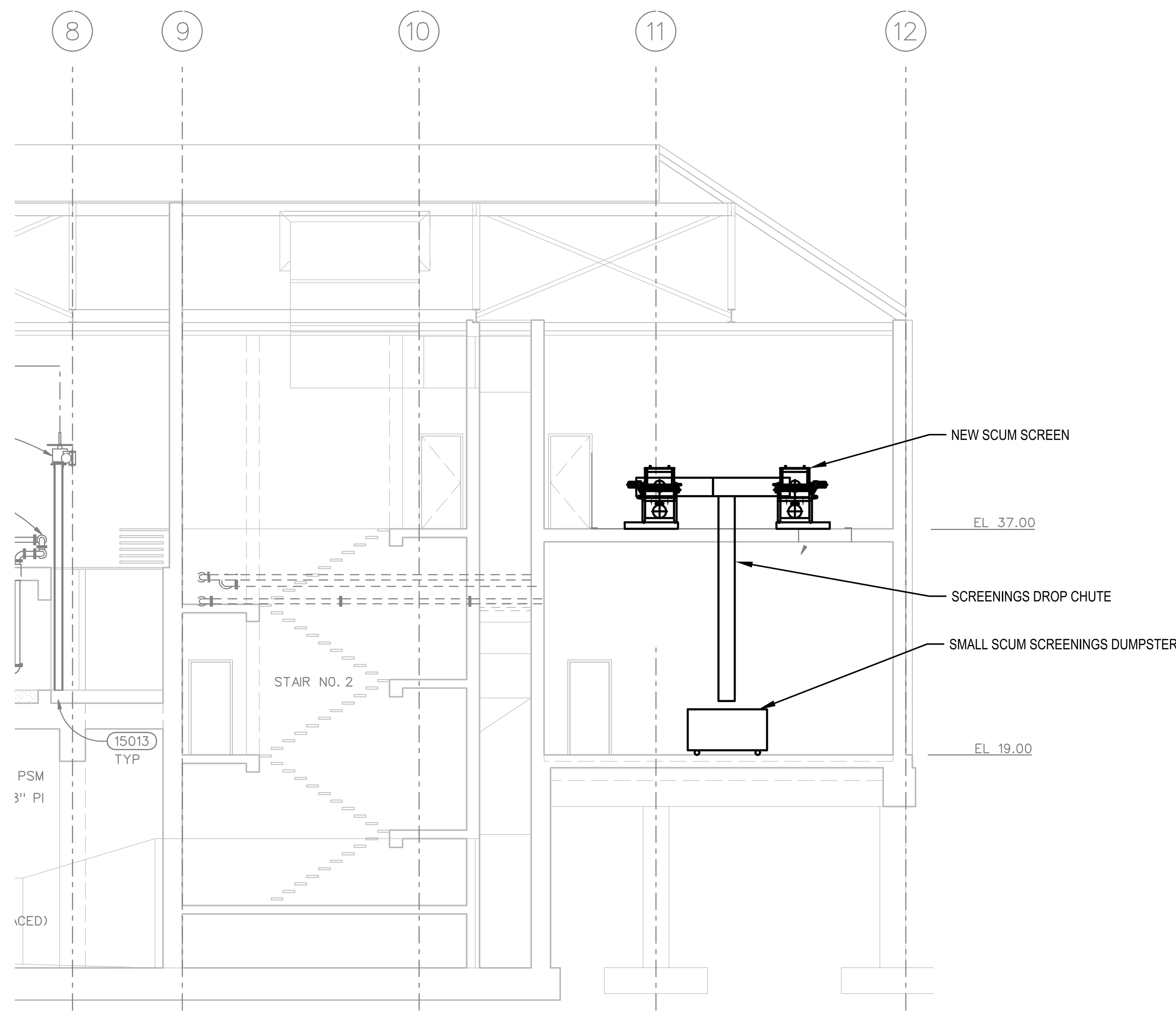
Filename:
P:\drawings\11217000s\11217618\11217618-PRES\11217618-00(PRES001)\11217618-00(PRES001)\ME\11217618-00(PRES001)ME-WA001.dwg
Plot Date: 14 October 2021 - 10:52 AM

Source:



2 PLAN

1/4" = 1'-0"



B FIG 12-2 SECTION

1/4" = 1'-0"

NOTES:

1. SECTIONS OF SCUM ROOM WALLS WILL NEED TO BE REMOVED TO FACILITATE EXISTING SCUM EQUIPMENT REMOVAL AND INSTALLATION OF NEW SCUM CONCENTRATOR SYSTEM.

0 1'-0" 2'-0"

SCALE 1"=1'-0" AT ORIGINAL SIZE

GHD

ALEXANDRIA RENEW PPSU
SCUM HANDLING RENOVATIONS ALTERNATIVE 2

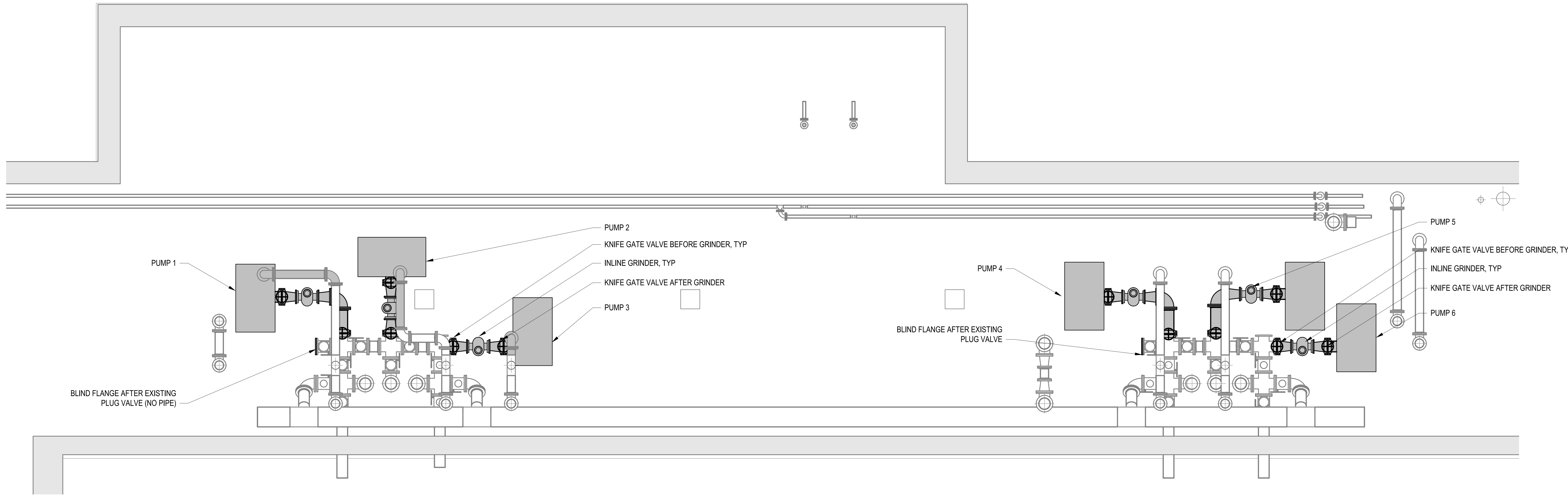
REPLACE SCUM CONCENTRATOR, DAY TANK AND TRANSFER PUMP WITH SCUM SCREEN AND SCUM SCREENINGS COMPACTOR

Project No. **11217618**
Report No. **N/A**
Date **09/2021**

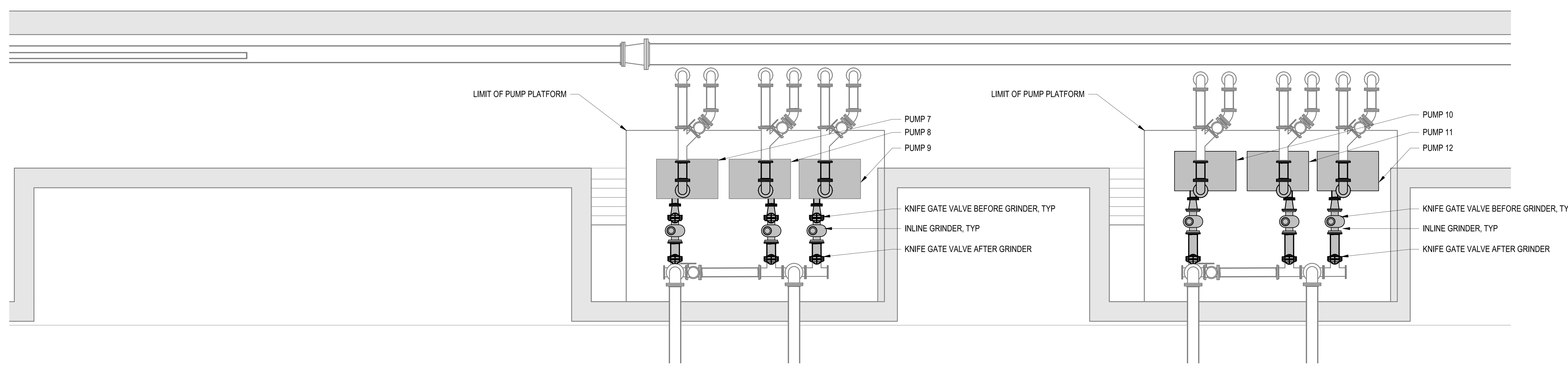
FIGURE 5

Source:

Filename:
P:\drawings\11217000s\11217618\11217618-PRES\11217618-00(PRES001)\11217618-00(PRES001)ME\11217618-00(PRES001)ME-WA001.dwg
Plot Date: 14 October 2021 - 11:11 AM



1 PARTIAL PLAN
1/4" = 1'-0"



2 PARTIAL PLAN
1/4" = 1'-0"

NOTES:

1. PIPING AND EQUIPMENT SHOWN IN GRAY IS NEW OR MODIFIED

2. POSITION OF EXISTING EQUIPMENT AND PIPING BASED ON RECORD AS BUILT INFORMATION. FIELD VERIFICATION OF DIMENSIONS REQUIRED TO FINALIZE LAYOUT

Graphics scale, north arrow, client logo, etc.

ALEXANDRIA RENEW PPSU

PRIMARY SLUDGE PUMPING RENOVATIONS

MODIFY PRIMARY SLUDGE PUMPS AND PIPING FOR INSTALLATION OF SLUDGE GRINDERS

Job Number	11217618
Revision	-
Date	10/1/2021

Figure 6

Appendix H

Opinion of Probable Construction Costs

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Coarse Screen - Alternative 1

Updated By: L. Musselman
Date: 8/18/2022
Checked By: TY
Date: 8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 615,676.85	$ 615,676.85
Mobilization/Demobilization	1	LS	$ 141,453.78	$ 141,453.78
Temporary Facilities				
Bypass Pumping:				
Bypass Pump and Pipe Rental (3 x 30 mgd for 3 months)	1	LS	$ 540,000.00	$ 540,000.00
Delivery/Installation	1	LS	$ 150,000.00	$ 150,000.00
Removal	1	LS	$ 100,000.00	$ 100,000.00
Operation & Maintenance	1	LS	$ 50,000.00	$ 50,000.00
Temporary Bulkheads in Infl and Eff Channel	2	EA	$ 25,000.00	$ 50,000.00
Temporary Access Road	1	LS	$ 15,000.00	$ 15,000.00
Civil/Site				
Sidewalk Demolition	40	SY	$ 50.00	$ 2,000.00
Curb Demolition	50	LF	$ 20.00	$ 1,000.00
Pavement Demolition	250	SY	$ 10.00	$ 2,500.00
Sidewalk Replacement	40	SY	$ 70.00	$ 2,800.00
Curb Replacement	50	LF	$ 25.00	$ 1,250.00
Paving Replacement	250	SY	$ 50.00	$ 12,500.00
New Manhole for 30" Sewer	1	EA	$ 15,600.00	$ 15,600.00
Pipe Reconnection	1	EA	$ 5,000.00	$ 5,000.00
Architectural				
Coarse Screen Room:				
Exterior South Wall Demo and Rebuild for Roll-Up Doors	600	SF	$ 54.00	$ 32,400.00
New Roll-Up Doors	4	EA	$ 26,776.13	$ 107,104.53
Structural				
Concrete Cut in Existing Channel (Confined Space)	2	EA	$ 60,000.00	$ 120,000.00
Excavation and Backfill	1,000	CY	$ 68.40	$ 68,400.00
Excavation Shoring	2,700	SF	$ 91.20	$ 246,240.00
Metals:				
Channel Cover Modification at New Gates	1	LS	$ 30,000.00	$ 30,000.00
Access Hatches:				
Main Level Access Hatch 48" x 36" - Forklift Rated	4	EA	$ 7,800.00	$ 31,200.00
Lower Level Channel Access Hatches (21" x 24")	7	SF	$ 468.00	$ 3,276.00
Lower Level Channel Access Hatches (52" x 48")	106	SF	$ 312.00	$ 33,072.00
Lower Level Channel Access Hatches (24" x 48")	16	SF	$ 468.00	$ 7,488.00
Mechanical/Process				
Equipment:				
Existing Screens Demolition	2	EA	$ 50,000.00	$ 100,000.00
Variable-Opening Flex-Rake Screens	2	EA	$ 866,040.00	$ 1,732,080.00
Slide Gates with Electrical Motors (6' W x 9' H)	6	EA	$ 90,994.80	$ 545,968.80
Piping:				
Existing Stormwater Pipe Demolition	1	LS	$ 10,000.00	$ 10,000.00
60" Pipe	120	LF	$ 1,000.00	$ 120,000.00
HVAC				
Reconnection of Odor Control System	1	LS	$ 30,000.00	$ 30,000.00

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	8/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	TY
Coarse Screen - Alternative 1		Date:	8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
Plumbing				
Plant Water System Connection to Washer/Compactors	0	EA	$ 24,000.00	$ -
Connect Floor Drains to Process Drain	1	LS	$ 10,000.00	$ 10,000.00
Replacement of Sump Pump and Valves	1	LS	$ 10,000.00	$ 10,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 804,307.33	$ 804,307.33
Subtotal (rounded to nearest $1,000):				$ 5,746,000.00
Contingency (rounded to nearest $1,000):				$ 1,724,000.00
Total (rounded to nearest $1,000):				$ 7,470,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 25% of the subtotal project cost.
6 Estimated costs were rounded to the nearest thousand dollars.
7 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
8 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	8/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	TY
Coarse Screen - Alternative 2		Date:	8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 774,605.96	$ 774,605.96
Mobilization/Demobilization	1	LS	$ 163,273.11	$ 163,273.11
Temporary Facilities				
Bypass Pumping:				
Bypass Pump and Pipe Rental (3 x 30 mgd for 3 months)	1	LS	$ 540,000.00	$ 540,000.00
Delivery/Installation	1	LS	$ 150,000.00	$ 150,000.00
Removal	1	LS	$ 100,000.00	$ 100,000.00
Operation & Maintenance	1	LS	$ 50,000.00	$ 50,000.00
Temporary Bulkheads in Infl and Eff Channel	2	EA	$ 25,000.00	$ 50,000.00
Temporary Access Road	1	LS	$ 15,000.00	$ 15,000.00
Civil/Site				
Sidewalk Demolition	40	SY	$ 50.00	$ 2,000.00
Curb Demolition	50	LF	$ 20.00	$ 1,000.00
Pavement Demolition	250	SY	$ 10.00	$ 2,500.00
Sidewalk Replacement	40	SY	$ 70.00	$ 2,800.00
Curb Replacement	50	LF	$ 25.00	$ 1,250.00
Paving Replacement	250	SY	$ 50.00	$ 12,500.00
New manhole for 30" sewer	1	EA	$ 15,600.00	$ 15,600.00
Pipe Reconnection	1	EA	$ 5,000.00	$ 5,000.00
Architectural				
Coarse Screen Room:				
Exterior South Wall Demo and Rebuild for Roll-Up Doors	600	SF	$ 54.00	$ 32,400.00
New Roll-Up Doors	4	EA	$ 26,776.13	$ 107,104.53
Structural				
Concrete Cut in Existing Channel (Confined Space)	2	EA	$ 60,000.00	$ 120,000.00
Excavation and Backfill	1,000	CY	$ 68.40	$ 68,400.00
Excavation Shoring	2,700	SF	$ 91.20	$ 246,240.00
Metals:				
Channel Cover Modification at New Gates	1	LS	$ 30,000.00	$ 30,000.00
Access Hatches:				
Main Level Access Hatch 48" x 36" - Forklift Rated	4	EA	$ 7,800.00	$ 31,200.00
Lower Level Channel Access Hatches (21" x 24")	7	SF	$ 468.00	$ 3,276.00
Lower Level Channel Access Hatches (52" x 48")	106	SF	$ 312.00	$ 33,072.00
Lower Level Channel Access Hatches (24" x 48")	16	SF	$ 468.00	$ 7,488.00
Mechanical/Process				
Equipment:				
Existing Screens Demolition	2	EA	$ 50,000.00	$ 100,000.00
Variable-Opening Flex-Rake Screens	2	EA	$ 866,040.00	$ 1,732,080.00
Washer/Compactors	2	EA	$ 171,600.00	$ 343,200.00
Conveyors	2	EA	$ 71,760.00	$ 143,520.00
Self-Leveling Roll-Off Containers	2	EA	$ 321,594.00	$ 643,188.00
Slide Gates with Electrical Motors (6' W x 9' H)	6	EA	$ 90,994.80	$ 545,968.80
Piping:				
Existing Stormwater Pipe Demolition	1	LS	$ 10,000.00	$ 10,000.00
60" Pipe	120	LF	$ 1,000.00	$ 120,000.00

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	8/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	TY
Coarse Screen - Alternative 2		Date:	8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
HVAC				
Reconnection of Odor Control System	1	LS	$ 30,000.00	$ 30,000.00
Plumbing				
Plant Water System Connection to Washer/Compactors	2	EA	$ 24,000.00	$ 48,000.00
Connect Floor Drains to Process Drain	1	LS	$ 10,000.00	$ 10,000.00
Replacement of Sump Pump and Valves	1	LS	$ 10,000.00	$ 10,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 928,989.20	$ 928,989.20
			Subtotal (rounded to nearest $1,000):	$ 7,230,000.00
			Contingency (rounded to nearest $1,000):	$ 2,169,000.00
			Total (rounded to nearest $1,000):	$ 9,399,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 25% of the subtotal project cost.
6 Estimated costs were rounded to the nearest thousand dollars.
7 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
8 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	8/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	TY
Coarse Screen - Alternative 3		Date:	8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 1,137,866.24	$ 1,137,866.24
Mobilization/Demobilization	1	LS	$ 268,408.36	$ 268,408.36
Temporary Facilities				
Bypass Pumping:				
Bypass Pump and Pipe Rental (3 x 30 mgd for 6 months)	1	LS	$ 1,080,000.00	$ 1,080,000.00
Delivery/Installation	1	LS	$ 150,000.00	$ 150,000.00
Removal	1	LS	$ 100,000.00	$ 100,000.00
Operation & Maintenance	1	LS	$ 100,000.00	$ 100,000.00
Bypass Pumping for 30" Sewer (10 mgd for 1 month)	1	LS	$ 50,000.00	$ 50,000.00
Temporary Bulkheads in Infl and Eff Channel	2	EA	$ 25,000.00	$ 50,000.00
Temporary Access Road	1	LS	$ 15,000.00	$ 15,000.00
Civil/Site				
Sidewalk Demolition	80	SY	$ 50.00	$ 4,000.00
Curb Demolition	50	LF	$ 20.00	$ 1,000.00
Pavement Demolition	500	SY	$ 10.00	$ 5,000.00
Existing Ductbank Relocation	1	LS	$ 350,000.00	$ 350,000.00
Sidewalk Replacement	80	SY	$ 70.00	$ 5,600.00
Curb Replacement	50	LF	$ 25.00	$ 1,250.00
Paving Replacement	500	SY	$ 50.00	$ 25,000.00
30" Sewer Demolition	20	LF	$ 100.00	$ 2,000.00
30" Sewer Manhole Demolition	1	LS	$ 5,000.00	$ 5,000.00
30" Sewer Replacement	15	LF	$ 641.59	$ 9,623.89
New Manhole for 30" Sewer	1	EA	$ 10,000.00	$ 10,000.00
Pipe Reconnection	1	EA	$ 5,000.00	$ 5,000.00
Existing Stormwater Pipe Demolition	1	LS	$ 10,000.00	$ 10,000.00
Architectural				
Coarse Screen Room:				
Exterior South Wall Demo and Rebuild for Roll-Up Doors	600	SF	$ 54.00	$ 32,400.00
New Roll-Up Doors	6	EA	$ 26,776.13	$ 160,656.79
Partial Roof Demolition to Receive New	1	LS	$ 24,000.00	$ 24,000.00
New Base Building with Foundation, Exterior Walls, Roof with M	680	SF	$ 360.00	$ 244,800.00
New Windows	108	SF	$ 130.87	$ 14,133.88
New Door	1	EA	$ 4,860.86	$ 4,860.86
Structural				
Existing Wall Demolition	1	LS	$ 20,000.00	$ 20,000.00
Concrete Cut in Existing Channel (Confined Space)	4	EA	$ 60,000.00	$ 240,000.00
Concrete Fill Existing Infl. Channel	1	LS	$ 12,000.00	$ 12,000.00
Excavation and Backfill	2,000	CY	$ 68.40	$ 136,800.00
Excavation Shoring	5,400	SF	$ 91.20	$ 492,480.00
Piles	1	LS	$ 180,000.00	$ 180,000.00
Concrete	520	CY	$ 1,872.00	$ 973,440.00
Metals:				
Channel Cover Modification at New Gates	1	LS	$ 30,000.00	$ 30,000.00
Support Beam for Roof	2	EA	$ 28,800.00	$ 57,600.00
Access Hatches:				
Main Level Access Hatch 48" x 36" - Forklift Rated	6	EA	$ 7,800.00	$ 46,800.00

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	8/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	TY
Coarse Screen - Alternative 3		Date:	8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
Lower Level Channel Access Hatches (21" x 24")	11	SF	$ 468.00	$ 4,914.00
Lower Level Channel Access Hatches (52" x 48")	159	SF	$ 312.00	$ 49,608.00
Lower Level Channel Access Hatches (24" x 48")	24	SF	$ 468.00	$ 11,232.00
Mechanical/Process				
Equipment:				
Existing Screens Demolition	2	EA	$ 50,000.00	$ 100,000.00
Mechanical Screens (1" Flex-Rake)	3	EA	$ 706,160.00	$ 2,118,480.00
Slide Gates with Electrical Motors (3' W x 3' H)	1	EA	$ 23,400.00	$ 23,400.00
Slide Gates with Electrical Motors (6' W x 9' H)	6	EA	$ 90,994.80	$ 545,968.80
HVAC				
Reconnection of Odor Control System	1	LS	$ 30,000.00	$ 30,000.00
Extend Odor Control Piping to New Screen	1	LS	$ 12,000.00	$ 12,000.00
Coarse Screen Room HVAC System Upgrade	1	LS	$ 60,000.00	$ 60,000.00
Coarse Screen Basement HVAC Upgrade	1	LS	$ 60,000.00	$ 60,000.00
Plumbing				
Plant Water System Connection to Washer/Compactors	0	EA	$ 24,000.00	$ -
Connect Floor Drains to Process Drain	1	LS	$ 10,000.00	$ 10,000.00
Replacement of Sump Pump and Valves	1	LS	$ 10,000.00	$ 10,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 1,529,762.05	$ 1,529,762.05
Subtotal (rounded to nearest $1,000):				$ 10,620,000.00
Contingency (rounded to nearest $1,000):				$ 3,186,000.00
Total (rounded to nearest $1,000):				$ 13,806,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 25% of the subtotal project cost.
6 Estimated costs were rounded to the nearest thousand dollars.
7 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
8 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Coarse Screen - Alternative 4

Updated By: L. Musselman
Date: 8/18/2022
Checked By: TY
Date: 8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 1,225,837.10	$ 1,225,837.10
Mobilization/Demobilization	1	LS	$ 293,198.86	$ 293,198.86
Temporary Facilities				
Bypass Pumping:				
Bypass Pump and Pipe Rental (3 x 30 mgd for 6 months)	1	LS	$ 1,080,000.00	$ 1,080,000.00
Delivery/Installation	1	LS	$ 150,000.00	$ 150,000.00
Removal	1	LS	$ 100,000.00	$ 100,000.00
Operation & Maintenance	1	LS	$ 100,000.00	$ 100,000.00
Bypass Pumping for 30" Sewer (10 mgd for 1 month)	1	LS	$ 50,000.00	$ 50,000.00
Temporary Bulkheads in Infl and Eff Channel	2	EA	$ 25,000.00	$ 50,000.00
Temporary Access Road	1	LS	$ 15,000.00	$ 15,000.00
Civil/Site				
Sidewalk Demolition	80	SY	$ 50.00	$ 4,000.00
Curb Demolition	50	LF	$ 20.00	$ 1,000.00
Pavement Demolition	500	SY	$ 10.00	$ 5,000.00
Existing Ductbank Relocation	1	LS	$ 350,000.00	$ 350,000.00
Sidewalk Replacement	80	SY	$ 70.00	$ 5,600.00
Curb Replacement	50	LF	$ 25.00	$ 1,250.00
Paving Replacement	500	SY	$ 50.00	$ 25,000.00
30" Sewer Demolition	20	LF	$ 100.00	$ 2,000.00
30" Sewer Manhole Demolition	1	LS	$ 5,000.00	$ 5,000.00
30" Sewer Replacement	15	LF	$ 641.59	$ 9,623.89
New Manhole for 30" Sewer	1	EA	$ 10,000.00	$ 10,000.00
Pipe Reconnection	1	EA	$ 5,000.00	$ 5,000.00
Existing Stormwater Pipe Demolition	1	LS	$ 10,000.00	$ 10,000.00
Architectural				
Coarse Screen Room:				
Exterior South Wall Demo and Rebuild for Roll-Up Doors	600	SF	$ 54.00	$ 32,400.00
New Roll-Up Doors	6	EA	$ 26,776.13	$ 160,656.79
Partial Roof Demolition to Receive New	1	LS	$ 24,000.00	$ 24,000.00
New Base Building with Foundation, Exterior Walls, Roof with M	680	SF	$ 360.00	$ 244,800.00
New Windows	108	SF	$ 130.87	$ 14,133.88
New Door	1	EA	$ 4,860.86	$ 4,860.86
Structural				
Existing Wall Demolition	1	LS	$ 20,000.00	$ 20,000.00
Concrete Cut in Existing Channel (Confined Space)	4	EA	$ 60,000.00	$ 240,000.00
Concrete Fill Existing Infl. Channel	1	LS	$ 12,000.00	$ 12,000.00
Excavation and Backfill	2,000	CY	$ 68.40	$ 136,800.00
Excavation Shoring	5,400	SF	$ 91.20	$ 492,480.00
Piles	1	LS	$ 180,000.00	$ 180,000.00
Concrete	520	CY	$ 1,872.00	$ 973,440.00
Metals:				
Channel Cover Modification at New Gates	1	LS	$ 30,000.00	$ 30,000.00
Support Beam for Roof	2	EA	$ 28,800.00	$ 57,600.00
Access Hatches:				
Main Level Access Hatch 48" x 36" - Forklift Rated	6	EA	$ 7,800.00	$ 46,800.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Coarse Screen - Alternative 4

Updated By: L. Musselman
Date: 8/18/2022
Checked By: TY
Date: 8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
Lower Level Channel Access Hatches (21" x 24")	11	SF	$ 468.00	$ 4,914.00
Lower Level Channel Access Hatches (52" x 48")	159	SF	$ 312.00	$ 49,608.00
Lower Level Channel Access Hatches (24" x 48")	24	SF	$ 468.00	$ 11,232.00
Mechanical/Process				
Equipment:				
Existing Screens Demolition	2	EA	$ 50,000.00	$ 100,000.00
Mechanical Screens (3/4" Flex-Rake)	3	EA	$ 699,440.00	$ 2,098,320.00
Washer/Compactors	3	EA	$ 171,600.00	$ 514,800.00
Slide Gates with Electrical Motors (3' W x 3' H)	1	EA	$ 23,400.00	$ 23,400.00
Slide Gates with Electrical Motors (6' W x 9' H)	6	EA	$ 90,994.80	$ 545,968.80
HVAC				
Reconnection of Odor Control System	1	LS	$ 30,000.00	$ 30,000.00
Extend Odor Control Piping to New Screen	1	LS	$ 12,000.00	$ 12,000.00
Coarse Screen Room HVAC System Upgrade	1	LS	$ 60,000.00	$ 60,000.00
Coarse Screen Basement HVAC Upgrade	1	LS	$ 60,000.00	$ 60,000.00
Plumbing				
Plant Water System Connection to Washer/Compactors	3	EA	$ 24,000.00	$ 72,000.00
Connect Floor Drains to Process Drain	1	LS	$ 10,000.00	$ 10,000.00
Replacement of Sump Pump and Valves	1	LS	$ 10,000.00	$ 10,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 1,671,422.05	$ 1,671,422.05
Subtotal (rounded to nearest $1,000):				$ 11,441,000.00
Contingency (rounded to nearest $1,000):				$ 3,432,000.00
Total (rounded to nearest $1,000):				$ 14,873,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 25% of the subtotal project cost.
6 Estimated costs were rounded to the nearest thousand dollars.
7 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
8 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Coarse Screen - Alternative 5

Updated By: L. Musselman
Date: 8/18/2022
Checked By: TY
Date: 8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 1,365,290.10	$ 1,365,290.10
Mobilization/Demobilization	1	LS	$ 332,497.21	$ 332,497.21
Temporary Facilities				
Bypass Pumping:				
Bypass Pump and Pipe Rental (3 x 30 mgd for 6 months)	1	LS	$ 1,080,000.00	$ 1,080,000.00
Delivery/Installation	1	LS	$ 150,000.00	$ 150,000.00
Removal	1	LS	$ 100,000.00	$ 100,000.00
Operation & Maintenance	1	LS	$ 100,000.00	$ 100,000.00
Bypass Pumping for 30" Sewer (10 mgd for 1 month)	1	LS	$ 50,000.00	$ 50,000.00
Temporary Bulkheads in Infl and Eff Channel	2	EA	$ 25,000.00	$ 50,000.00
Temporary Access Road	1	LS	$ 15,000.00	$ 15,000.00
Civil/Site				
Sidewalk Demolition	80	SY	$ 50.00	$ 4,000.00
Curb Demolition	50	LF	$ 20.00	$ 1,000.00
Pavement Demolition	500	SY	$ 10.00	$ 5,000.00
Existing Ductbank Relocation	1	LS	$ 350,000.00	$ 350,000.00
Sidewalk Replacement	80	SY	$ 70.00	$ 5,600.00
Curb Replacement	50	LF	$ 25.00	$ 1,250.00
Paving Replacement	500	SY	$ 50.00	$ 25,000.00
30" Sewer Demolition	20	LF	$ 100.00	$ 2,000.00
30" Sewer Manhole Demolition	1	LS	$ 5,000.00	$ 5,000.00
30" Sewer Replacement	15	LF	$ 641.59	$ 9,623.89
New Manhole for 30" Sewer	1	EA	$ 10,000.00	$ 10,000.00
Pipe Reconnection	1	EA	$ 5,000.00	$ 5,000.00
Existing Stormwater Pipe Demolition	1	LS	$ 10,000.00	$ 10,000.00
Architectural				
Coarse Screen Room:				
Exterior South Wall Demo and Rebuild for Roll-Up Doors	600	SF	$ 54.00	$ 32,400.00
New Roll-Up Doors	6	EA	$ 26,776.13	$ 160,656.79
Partial Roof Demolition to Receive New	1	LS	$ 24,000.00	$ 24,000.00
New Base Building with Foundation, Exterior Walls, Roof with M	680	SF	$ 360.00	$ 244,800.00
New Windows	108	SF	$ 130.87	$ 14,133.88
New Door	1	EA	$ 4,860.86	$ 4,860.86
Structural				
Existing Wall Demolition	1	LS	$ 20,000.00	$ 20,000.00
Concrete Cut in Existing Channel (Confined Space)	4	EA	$ 60,000.00	$ 240,000.00
Concrete Fill Existing Infl. Channel	1	LS	$ 12,000.00	$ 12,000.00
Excavation and Backfill	2,000	CY	$ 68.40	$ 136,800.00
Excavation Shoring	5,400	SF	$ 91.20	$ 492,480.00
Piles	1	LS	$ 180,000.00	$ 180,000.00
Concrete	520	CY	$ 1,872.00	$ 973,440.00
Metals:				
Channel Cover Modification at New Gates	1	LS	$ 30,000.00	$ 30,000.00
Support Beam for Roof	2	EA	$ 28,800.00	$ 57,600.00
Access Hatches:				
Main Level Access Hatch 48" x 36" - Forklift Rated	6	EA	$ 7,800.00	$ 46,800.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Coarse Screen - Alternative 5

Updated By: L. Musselman
Date: 8/18/2022
Checked By: TY
Date: 8/18/2022

Item	Qty	Unit	Unit Cost	Total Cost
Lower Level Channel Access Hatches (21" x 24")	11	SF	$ 468.00	$ 4,914.00
Lower Level Channel Access Hatches (52" x 48")	159	SF	$ 312.00	$ 49,608.00
Lower Level Channel Access Hatches (24" x 48")	24	SF	$ 468.00	$ 11,232.00
Solid Metal Wheel Plates	200	SF	$ 156.00	$ 31,200.00
Guide Rails	55	SF	$ 156.00	$ 8,580.00
Mechanical/Process				
Equipment:				
Existing Screens Demolition	2	EA	$ 50,000.00	$ 100,000.00
Mechanical Screens (3/4" Flex-Rake)	3	EA	$ 699,440.00	$ 2,098,320.00
Washer/Compactors	3	EA	$ 171,600.00	$ 514,800.00
Conveyors	3	EA	$ 71,760.00	$ 215,280.00
Self-Leveling Roll-Off Containers	3	EA	$ 214,396.00	$ 643,188.00
Slide Gates with Electrical Motors (3' W x 3' H)	1	EA	$ 23,400.00	$ 23,400.00
Slide Gates with Electrical Motors (6' W x 9' H)	6	EA	$ 90,994.80	$ 545,968.80
HVAC				
Reconnection of Odor Control System	1	LS	$ 30,000.00	$ 30,000.00
Extend Odor Control Piping to New Screen	1	LS	$ 12,000.00	$ 12,000.00
Coarse Screen Room HVAC System Upgrade	1	LS	$ 60,000.00	$ 60,000.00
Coarse Screen Basement HVAC Upgrade	1	LS	$ 60,000.00	$ 60,000.00
Plumbing				
Plant Water System Connection to Washer/Compactors	3	EA	$ 24,000.00	$ 72,000.00
Connect Floor Drains to Process Drain	1	LS	$ 10,000.00	$ 10,000.00
Replacement of Sump Pump and Valves	1	LS	$ 10,000.00	$ 10,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 1,895,984.05	$ 1,895,984.05
			Subtotal (rounded to nearest $1,000):	$ 12,743,000.00
			Contingency (rounded to nearest $1,000):	$ 3,823,000.00
			Total (rounded to nearest $1,000):	$ 16,566,000.00

The following assumptions were made in the development of the construction cost estimate:
1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 25% of the subtotal project cost.
6 Estimated costs were rounded to the nearest thousand dollars.
7 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
8 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises	Updated By: Nate Hovorka
Preliminary/Primary System Upgrades	Date: 12/6/2021
Preliminary Opinion of Probable Construction Costs	Checked By: J. Cannon
RSPS Alternative 1: Renovate Existing Pumps and Rebuild/Replace Selective Components	Date: 12/6/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 445,000	$ 445,000
Mobilization/Demobilization	1	LS	$ 125,000	$ 125,000
Mechanical/Process				
Equipment:				
Rebuild Pumps	3	EA	$ 50,000	$ 150,000
New Motors and Impellers	6	EA	$ 390,000	$ 2,340,000
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 623,000	$ 623,000
VFDs	6	EA	$ 78,000	$ 468,000
Subtotal (rounded to nearest $1,000):				$ 4,150,000
Contingency (rounded to nearest $1,000):				$ 1,250,000
Total (rounded to nearest $1,000):				$ 5,400,000

The following assumptions were made in the development of the construction cost estimate:

1. Contractor General Conditions costs are set at 12% of the subtotal project cost.
2. Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3. Installation of major equipment was estimated at 30% of the equipment cost.
4. Contractor overhead and profit is estimated as 20% of the equipment cost.
5. Electrical cost is estimated at 25% of the subtotal project cost.
6. Estimated costs were rounded to the nearest thousand dollars.
7. Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
8. Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
RSPS Alternative 2: Replace Pumps with Similar Units

Updated By: Nate Hovorka
Date: 12/6/2021
Checked By: J. Cannon
Date: 12/6/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 546,000	$ 546,000
Mobilization/Demobilization	1	LS	$ 146,000	$ 146,000
Civil/Site				
Bypass Pumping:				
Pump Rental (6 pumps)	1	MONTHS	$ 108,000	$ 108,000
Pump Rental (6 pumps)		WEEKS	$ 36,000	
Pump Rental (6 pumps)		DAYS	$ 12,000	
Delivery/Installation	1	LS	$ 72,000	$ 72,000
Removal	1	LS	$ 42,000	$ 42,000
Fuel Cost	72	HR	$ 350	$ 25,000
Structural				
Demo pump floor slab	40	CY	$ 360	$ 14,000
Install new pump floor slab	40	CY	$ 1,200	$ 48,000
Motor Platform modification	1	LS	$ 20,000	$ 20,000
Mechanical/Process				
Equipment:				
Vertical End-Suction Close-Coupled Pump	6	EA	$ 468,000	$ 2,810,000
Piping:				
Pump discharge pipe allowance	6	LS	$ 10,000	$ 60,000
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 738,000	$ 738,000
VFDs	6	LS	$ 78,000	$ 468,000
Subtotal (rounded to nearest $1,000):				$ 5,100,000
Contingency (rounded to nearest $1,000):				$ 1,530,000
Total (rounded to nearest $1,000):				$ 6,630,000

The following assumptions were made in the development of the construction cost estimate:

1. Contractor General Conditions costs are set at 12% of the subtotal project cost.
2. Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3. Installation of major equipment was estimated at 30% of the equipment cost.
4. Contractor overhead and profit is estimated as 20% of the equipment cost.
5. Electrical cost is estimated at 25% of the subtotal project cost.
6. Estimated costs were rounded to the nearest thousand dollars.
7. Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
8. Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
RSPS Alternative 3: Replace Pumps with Alternative Pump Design

Updated By: N. Hovorka
Date: 12/6/2021
Checked By: J. Cannon
Date: 12/6/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 517,000	$ 517,000
Mobilization/Demobilization	1	LS	$ 137,000	$ 137,000
Civil/Site				
Bypass Pumping:				
Pump Rental (6 pumps)	1	MONTHS	$ 108,000	$ 108,000
Pump Rental (6 pumps)	0	WEEKS	$ 36,000	$ -
Pump Rental (6 pumps)	0	DAYS	$ 12,000	$ -
Delivery/Installation	1	LS	$ 72,000	$ 72,000
Removal	1	LS	$ 42,000	$ 42,000
Fuel Cost	72	HR	$ 350	$ 25,000
Structural				
Demo pump floor slab	40	CY	$ 360	$ 14,000
Install new pump floor slab	40	CY	$ 1,200	$ 48,000
Demo motor platform	1	LS	$ 25,000	$ 25,000
Mechanical/Process				
Equipment:				
Dry-Pit Submersible Pumps	6	EA	$ 427,700	$ 2,570,000
Piping:				
Pump discharge pipe allowance	6	LS	$ 10,000	$ 60,000
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 741,000	$ 741,000
VFDs	6	EA	$ 78,000	$ 468,000
			Subtotal (rounded to nearest $1,000):	$ 4,830,000
			Contingency (rounded to nearest $1,000):	$ 1,450,000
			Total (rounded to nearest $1,000):	$ 6,280,000

The following assumptions were made in the development of the construction cost estimate:

1. Contractor General Conditions costs are set at 12% of the subtotal project cost.
2. Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3. Installation of major equipment was estimated at 30% of the equipment cost.
4. Contractor overhead and profit is estimated as 20% of the equipment cost.
5. Electrical cost is estimated at 25% of the subtotal project cost.
6. Estimated costs were rounded to the nearest thousand dollars.
7. Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
8. Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
RSPS Optional Improvements

Updated By: Nate Hovorka
Date: 12/6/2021
Checked By: J. Cannon
Date: 12/6/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	$ 1	LS	$ 136,000	$ 136,000
Mobilization/Demobilization	$ 1	LS	$ 38,000	$ 38,000
Structural				
Sump Pit	$ 1	LS	$ 28,000	$ 28,000
Influent Channel Demo	$ 6	CY	$ 360	$ 2,000
Mechanical/Process				
Equipment:				
6" Slide Gates	$ 4	EA	$ 9,360	$ 37,000
Pump Isolation Gate Valve Electric Actuator	$ 6	EA	$ 23,398	$ 140,000
Check Valve Alternative	$ 6	EA	$ 60,060	$ 360,000
Wet Well Stop Log Groove with Stop Logs	$ 2	EA	$ 37,050	$ 74,000
Suction Conduit Slide Gates	$ 2	EA	$ 91,260	$ 183,000
30" Knife Gate	$ -	EA	$ 54,600	$ -
Piping:				
Discharge Conduit Drainpipes	2	LS	$ 15,600	$ 31,000
Discharge Conduit Drain Valves	2	LS	$ 15,600	$ 31,000
Electrical/Instrumentation				
Electrical Allowance	$ 1	LS	$ 206,000	$ 206,000
			Subtotal (rounded to nearest $1,000):	$ 1,270,000
			Contingency (rounded to nearest $1,000):	$ 381,000
			Total (rounded to nearest $1,000):	$ 1,650,000

The following assumptions were made in the development of the construction cost estimate:

1. Contractor General Conditions costs are set at 12% of the subtotal project cost.
2. Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3. Installation of major equipment was estimated at 30% of the equipment cost.
4. Contractor overhead and profit is estimated as 20% of the equipment cost.
5. Electrical cost is estimated at 25% of the subtotal project cost.
6. Estimated costs were rounded to the nearest thousand dollars.
7. Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
8. Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises	Updated By: T. Junker
Preliminary/Primary System Upgrades	Date: 12/5/2021
Preliminary Opinion of Probable Construction Costs	Checked By: J. Sturdevant
Conduits - Alternative 1	Date: 12/6/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 124,000	$ 124,000
Mobilization/Demobilization	1	LS	$ 35,000	$ 35,000
Civil/Site				
Bypass Pumping:				
Pump Rental (6 pumps)	1	MONTHS	$ 108,000	$ 108,000
Pump Rental (6 pumps)	2	WEEKS	$ 36,000	$ 72,000
Delivery/Installation	1	LS	$ 72,000	$ 72,000
Removal	1	LS	$ 42,000	$ 42,000
Fuel Cost	105.6	HR	$ 350	$ 37,000
Inspection				
Mobilization/Demobilization	8	EA	$ 9,600	$ 77,000
Deployment and Data Collection Combination CCTV	4	DAYS	$ 9,000	$ 36,000
Architectural				
Structural				
Geopolymer:				
Wet Wells	888	SF	$ 71	$ 63,000
Suction Conduits	1,360	SF	$ 71	$ 96,000
Discharge Conduits	1,680	SF	$ 71	$ 119,000
Structural Concrete Repairs:				
Type #1 Repair	3,928	SF	$ 70	$ 275,000
Type #2 Repair	0	SF	$ 140	$ -
Type #3 Repair	0	SF	$ 705	$ -
Concrete Joint Sealant	0	LF	$ 50	$ -
Mechanical/Process				
HVAC				
Plumbing				
Electrical/Instrumentation				
Subtotal (rounded to nearest $1,000):				$ 1,156,000
Contingency (rounded to nearest $1,000):				$ 347,000
Total (rounded to nearest $1,000):				$ 1,503,000

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Estimated costs were rounded to the nearest thousand dollars.
6 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
7 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Conduits - Alternative 2

Updated By: T. Junker
Date: 12/5/2021
Checked By: J. Sturdevant
Date: 12/6/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 118,000	$ 118,000
Mobilization/Demobilization	1	LS	$ 33,000	$ 33,000
Civil/Site				
Bypass Pumping:				
Pump Rental (6 pumps)	1	MONTHS	$ 108,000	$ 108,000
Pump Rental (6 pumps)	2	WEEKS	$ 36,000	$ 72,000
Delivery/Installation	1	LS	$ 72,000	$ 72,000
Removal	1	LS	$ 42,000	$ 42,000
Fuel Cost	105.6	HR	$ 350	$ 37,000
Inspection				
Mobilization/Demobilization	8	EA	$ 9,600	$ 77,000
Deployment and Data Collection Combination CCTV	4	DAYS	$ 8,970	$ 36,000
Architectural				
Structural				
Epoxy				
Wet Wells	888	SF	$ 59	$ 52,000
Suction Conduits	1,360	SF	$ 59	$ 80,000
Discharge Conduits	1,680	SF	$ 59	$ 99,000
Structural Concrete Repairs:				
Type #1 Repair	3,928	SF	$ 70	$ 275,000
Type #2 Repair	0	SF	$ 140	$ -
Type #3 Repair	0	SF	$ 705	$ -
Concrete Joint Sealant	0	LF	$ 50	$ -
Mechanical/Process				
HVAC				
Plumbing				
Electrical/Instrumentation				
Subtotal (rounded to nearest $1,000):				$ 1,101,000
Contingency (rounded to nearest $1,000):				$ 330,000
Total (rounded to nearest $1,000):				$ 1,431,000

The following assumptions were made in the development of the construction cost estimate:
1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Estimated costs were rounded to the nearest thousand dollars.
6 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
7 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Conduits - Alternative 3

Updated By: T. Junker
Date: 12/5/2021
Checked By: J. Sturdevant
Date: 12/6/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 160,000	$ 160,000
Mobilization/Demobilization	1	LS	$ 45,000	$ 45,000
Civil/Site				
Bypass Pumping:				
Pump Rental (6 pumps)	1	MONTHS	$ 108,000	$ 108,000
Pump Rental (6 pumps)	2	WEEKS	$ 36,000	$ 72,000
Delivery/Installation	1	LS	$ 72,000	$ 72,000
Removal	1	LS	$ 42,000	$ 42,000
Fuel Cost	105.6	HR	$ 350	$ 37,000
Bulkhead installation	2	EA	$ -	$ -
Cleaning				
High Pressure Jetting	4	DAYS	$ 24,057	$ 96,000
Inspection				
Mobilization/Demobilization	8	EA	$ 9,600	$ 77,000
Deployment and Data Collection Combination CCTV	4	DAYS	$ 8,970	$ 36,000
Architectural				
Structural				
Glass Fiber				
Wet Wells	1	LS	$ 202,200	$ 202,000
Suction Conduits	1	LS	$ 249,480	$ 249,000
Discharge Conduits	1	LS	$ 297,000	$ 297,000
Structural Concrete Repairs:				
Type #1 Repair	0	SF	$ 130	$ -
Type #2 Repair	0	SF	$ 200	$ -
Type #3 Repair	0	SF	$ 765	$ -
Concrete Joint Sealant	0	LF	$ 50	$ -
Mechanical/Process				
HVAC				
Plumbing				
Electrical/Instrumentation				
Subtotal (rounded to nearest $1,000):				$ 1,493,000
Contingency (rounded to nearest $1,000):				$ 448,000
Total (rounded to nearest $1,000):				$ 1,941,000

The following assumptions were made in the development of the construction cost estimate:
1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Estimated costs were rounded to the nearest thousand dollars.
6 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
7 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Fine Screens - Alternative 1

Updated By: PC
Date: 3/15/2021
Checked By: TAY
Date: 3/17/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 498,800.00	$ 498,800.00
Mobilization/Demobilization	1	LS	$ 140,600.00	$ 140,600.00
Civil/Site				
Channel Cleaning and Grit Removal	4	EA	$ 10,000.00	$ 40,000.00
Architectural				
Channel Re-Coating	4	EA	$ 25,000.00	$ 100,000.00
Structural				
Metals:				
Replacement of Gratings	1	LS	$ 40,000.00	$ 40,000.00
Wall Modification for Conveyors Re-Arrangement	1	LS	$ 10,000.00	$ 10,000.00
Mechanical/Process				
Equipment:				
Existing Washer/Compactors/Conveyors Demolition	1	LS	$ 20,000.00	$ 20,000.00
Existing Screens Removal, Shipping and Handling for Retrofit	4	EA	$ 50,000.00	$ 200,000.00
Retrofit with New Screen Media and Existing Frame	4	EA	$ 500,800.00	$ 2,003,200.00
New Washer/Compactors (5.0 Hp)	4	EA	$ 124,800.00	$ 499,200.00
New Transfer Conveyors (long)	110	LF	$ 2,730.00	$ 300,300.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 803,200.00	$ 803,200.00
			Subtotal (rounded to nearest $1,000):	$ 4,655,000.00
			Contingency (rounded to nearest $1,000):	$ 1,397,000.00
			Total (rounded to nearest $1,000):	$ 6,052,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Fine Screens - Alternative 2

Updated By: PC
Date: 3/15/2021
Checked By: TAY
Date: 3/17/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 475,300.00	$ 475,300.00
Mobilization/Demobilization	1	LS	$ 133,900.00	$ 133,900.00
Civil/Site				
Channel Cleaning and Grit Removal	4	EA	$ 10,000.00	$ 40,000.00
Architectural				
Channel Re-Coating	4	EA	$ 25,000.00	$ 100,000.00
Structural				
Metals:				
Replacement of Gratings	1	LS	$ 40,000.00	$ 40,000.00
Wall Modification for Conveyors Re-Arrangement	1	LS	$ 10,000.00	$ 10,000.00
Mechanical/Process				
Equipment:				
Existing Equipment Demolition	4	EA	$ 50,000.00	$ 200,000.00
New Perforated Plate Screens	4	EA	$ 436,800.00	$ 1,747,200.00
New Washer/Compactors (5.0 Hp) with Grinder	4	EA	$ 156,000.00	$ 624,000.00
New Transfer Conveyors (long)	110	LF	$ 2,730.00	$ 300,300.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 765,400.00	$ 765,400.00
			Subtotal (rounded to nearest $1,000):	$ 4,436,000.00
			Contingency (rounded to nearest $1,000):	$ 1,331,000.00
			Total (rounded to nearest $1,000):	$ 5,767,000.00

Alexandria Renew Enterprises	Updated By:	PC
Preliminary/Primary System Upgrades	Date:	3/15/2021
Preliminary Opinion of Probable Construction Costs	Checked By:	TAY
Fine Screens - Alternative 3	Date:	3/17/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 450,200.00	$ 450,200.00
Mobilization/Demobilization	1	LS	$ 126,900.00	$ 126,900.00
Civil/Site				
Channel Cleaning and Grit Removal	4	EA	$ 10,000.00	$ 40,000.00
Architectural				
Channel Re-Coating	4	EA	$ 25,000.00	$ 100,000.00
Structural				
Metals:				
Replacement of Gratings	1	LS	$ 40,000.00	$ 40,000.00
Mechanical/Process				
Equipment:				
Existing Equipment Demolition	4	EA	$ 50,000.00	$ 200,000.00
New Perforated Plate Screens	4	EA	$ 436,800.00	$ 1,747,200.00
New Washer/Compactors (7.5 Hp) with Grinder	2	EA	$ 226,200.00	$ 452,400.00
New Transfer Conveyors (short)	50	LF	$ 2,730.00	$ 136,500.00
New Sluice (Long)	60	LF	$ 1,950.00	$ 117,000.00
Motorized Sluice Gates	4	EA	$ 11,700.00	$ 46,800.00
Piping:				
Plant Water Piping	1	LS	$ 20,000.00	$ 20,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 725,000.00	$ 725,000.00
Subtotal (rounded to nearest $1,000):				$ 4,202,000.00
Contingency (rounded to nearest $1,000):				$ 1,261,000.00
Total (rounded to nearest $1,000):				$ 5,463,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Fine Screens - Alternative 4

Updated By: PC
Date: 3/15/2021
Checked By: TAY
Date: 3/17/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 475,600.00	$ 475,600.00
Mobilization/Demobilization	1	LS	$ 134,000.00	$ 134,000.00
Civil/Site				
Channel Cleaning and Grit Removal	4	EA	$ 10,000.00	$ 40,000.00
Architectural				
Channel Re-Coating	4	EA	$ 25,000.00	$ 100,000.00
Structural				
Metals:				
Replacement of Gratings	1	LS	$ 40,000.00	$ 40,000.00
Mechanical/Process				
Equipment:				
Existing Equipment Demolition	4	EA	$ 50,000.00	$ 200,000.00
New Center Flow Band Screens	4	EA	$ 421,200.00	$ 1,684,800.00
New Washer/Compactors (5.0 Hp) with Grinder	4	EA	$ 156,000.00	$ 624,000.00
New Transfer Conveyors (short)	50	LF	$ 2,730.00	$ 136,500.00
New Transfer Conveyors (long)	80	LF	$ 2,730.00	$ 218,400.00
Piping:				
Plant Water Piping	1	LS	$ 20,000.00	$ 20,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 765,900.00	$ 765,900.00
			Subtotal (rounded to nearest $1,000):	$ 4,439,000.00
			Contingency (rounded to nearest $1,000):	$ 1,332,000.00
			Total (rounded to nearest $1,000):	$ 5,771,000.00

Alexandria Renew Enterprises		Updated By:	PC
Preliminary/Primary System Upgrades		Date:	3/15/2021
Preliminary Opinion of Probable Construction Costs		Checked By:	TAY
Fine Screens - Alternative 5		Date:	3/17/2021

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 447,200.00	$ 447,200.00
Mobilization/Demobilization	1	LS	$ 126,000.00	$ 126,000.00
Civil/Site				
Channel Cleaning and Grit Removal	4	EA	$ 10,000.00	$ 40,000.00
Architectural				
Channel Re-Coating	4	EA	$ 25,000.00	$ 100,000.00
Structural				
Metals:				
Replacement of Gratings	1	LS	$ 40,000.00	$ 40,000.00
Mechanical/Process				
Equipment:				
Existing Equipment Demolition	4	EA	$ 50,000.00	$ 200,000.00
New Center Flow Band Screens	4	EA	$ 421,200.00	$ 1,684,800.00
New Washer/Compactors (7.5 Hp) with Grinder	2	EA	$ 226,200.00	$ 452,400.00
New Transfer Conveyors (short)	50	LF	$ 2,730.00	$ 136,500.00
New Sluice (long)	80	LF	$ 1,950.00	$ 156,000.00
Motorized Sluice Gates	4	EA	$ 11,700.00	$ 46,800.00
Piping:				
Plant Water Piping	1	LS	$ 24,000.00	$ 24,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 720,100.00	$ 720,100.00
Subtotal (rounded to nearest $1,000):				$ 4,174,000.00
Contingency (rounded to nearest $1,000):				$ 1,252,000.00
Total (rounded to nearest $1,000):				$ 5,426,000.00

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	3/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	0
Alternative 1 - Grit Separator Units		Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 260,174.78	$ 260,174.78
Mobilization/Demobilization	1	LS	$ 73,318.18	$ 73,318.18
Temporary Facilities				
No Scope				$ -
Civil/Site				
No Scope				$ -
Architectural				
No Scope				$ -
Structural				
No Scope				$ -
Mechanical/Process				
Equipment:				
Demolition (PISTA and Pumps)	1	LS	$ 50,000.00	$ 50,000.00
PISTA 360 Model 50.0	4	EA	$ 102,749.40	$ 410,997.60
V-FORCE Baffle	4	EA	$ 43,481.88	$ 173,927.52
Influent Gates	4	EA	$ 31,200.00	$ 124,800.00
Effluent Gates	4	EA	$ 31,200.00	$ 124,800.00
Piping:				
Demolition (Pump Piping)	1	LS	$ 50,000.00	$ 50,000.00
6" Grit Pipe	500	LF	$ 705.12	$ 352,560.00
Fittings:				
6" Tee	26	EA	$ 4,065.36	$ 105,699.36
6" 90o Bend	12	EA	$ 3,191.76	$ 38,301.12
6"x4" Reducer	8	EA	$ 2,848.56	$ 22,788.48
6" 45o Bend	4	EA	$ 2,967.12	$ 11,868.48
Valves:				
6" Check Valve	4	EA	$ 3,812.64	$ 15,250.56
6" Plug Valve	12	EA	$ 9,350.64	$ 112,207.68
HVAC				
No Scope				$ -
Plumbing				
Install New Drains and Sediment Bucket	12	EA	$ 3,603.60	$ 43,243.20
Demolish Existing Floor Drains	12	EA	$ 1,200.00	$ 14,400.00
Small Diameter Piping Allowance	1	LS	$ 25,000.00	$ 25,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 251,376.60	$ 251,376.60
Instrumentation Allowance	1	LS	$ 167,584.40	$ 167,584.40
			Subtotal (rounded to nearest $1,000):	$ 2,428,000.00
			Contingency (rounded to nearest $1,000):	$ 728,000.00
			Total (rounded to nearest $1,000):	$ 3,156,000.00

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	3/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	0
Alternative 1 - Grit Pumps		Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 48,341.85	$ 48,341.85
Mobilization/Demobilization	1	LS	$ 13,622.90	$ 13,622.90
Temporary Facilities				
No Scope				$ -
Civil/Site				
No Scope				$ -
Architectural				
No Scope				$ -
Structural				
Concrete:				
Grit Pump Equipment Pad	15	CY	$ 1,872.00	$ 28,080.00
Mechanical/Process				
Equipment:				
Wemco Model C	4	EA	$ 65,128.05	$ 260,512.20
Fittings:				
6"x4" Reducer	8	EA	$ 2,848.56	$ 22,788.48
HVAC				
No Scope				$ -
Plumbing				
No Scope				$ -
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 46,707.10	$ 46,707.10
Instrumentation Allowance	1	LS	$ 31,138.07	$ 31,138.07
			Subtotal (rounded to nearest $1,000):	$ 451,000.00
			Contingency (rounded to nearest $1,000):	$ 135,000.00
			Total (rounded to nearest $1,000):	$ 586,000.00

Alexandria Renew Enterprises			Updated By:	L. Musselman
Preliminary/Primary System Upgrades			Date:	3/18/2022
Preliminary Opinion of Probable Construction Costs			Checked By:	0
Alternative 1 - Grit Dewatering Units			Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 256,447.60	$ 256,447.60
Mobilization/Demobilization	1	LS	$ 72,267.84	$ 72,267.84
Temporary Facilities				
Grit Dewatering Equipment Rental and On-Site Operators (6 mont	6	EA	$ 78,000.00	$ 468,000.00
Civil/Site				
No Scope				$ -
Architectural				
New Removeable Translucent Panel	700	SF	$ 126.00	$ 88,200.00
Structural				
Existing Platform Demolition	1	LS	$ 25,000.00	$ 25,000.00
Metals:				
Aluminum Grated Access Platform	610	SF	$ 114.00	$ 69,540.00
Stairs	10	RISER	$ 360.00	$ 3,600.00
Mechanical/Process				
Demolition	1	LS	$ 25,000.00	$ 25,000.00
Equipment:				
Wemco Hydrogritter with Wemclone	4	EA	$ 119,538.12	$ 478,152.48
Piping:				
6" Grit Pipe	260	LF	$ 705.12	$ 183,331.20
8" PVC Drain Pipe	150	LF	$ 18.66	$ 2,798.64
10" PVC Drain Pipe	110	LF	$ 27.74	$ 3,051.05
Fittings:				
6" Tee	4	EA	$ 4,065.36	$ 16,261.44
6" 90o Bend	12	EA	$ 3,191.76	$ 38,301.12
6" 45o Bend	8	EA	$ 2,967.12	$ 23,736.96
8" Tee	7	EA	$ 3,177.72	$ 22,244.04
8" 90o Bend	13	EA	$ 2,416.44	$ 31,413.72
8" 45o Bend	4	EA	$ 2,146.56	$ 8,586.24
8" to 10" Wye	4	EA	$ 3,900.00	$ 15,600.00
Valves:				
6" Plug Valve	8	EA	$ 9,350.64	$ 74,805.12
HVAC				
Reconnection of Odor Control System	1	LS	$ 30,000.00	$ 30,000.00
Plumbing				
Install New Drains and Sediment Bucket	4	EA	$ 3,603.60	$ 14,414.40
Demolish Existing Floor Drains	4	EA	$ 1,200.00	$ 4,800.00
Small Diameter Piping Allowance	1	LS	$ 25,000.00	$ 25,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 247,775.46	$ 247,775.46
Instrumentation Allowance	1	LS	$ 165,183.64	$ 165,183.64

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	3/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	0
Alternative 1 - Grit Dewatering Units		Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
			Subtotal (rounded to nearest $1,000):	$ 2,394,000.00
			Contingency (rounded to nearest $1,000):	$ 718,000.00
			Total (rounded to nearest $1,000):	$ 3,112,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 15% of the subtotal project cost.
6 Instrumentation cost is estimated at 10% of the subtotal project cost.
7 Estimated costs were rounded to the nearest thousand dollars.
8 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
9 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Alternative 2 - Grit Separator Units

Updated By: L. Musselman
Date: 3/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 276,874.27	$ 276,874.27
Mobilization/Demobilization	1	LS	$ 78,024.15	$ 78,024.15
Temporary Facilities				
No Scope				$ -
Civil/Site				
No Scope				$ -
Architectural				
No Scope				$ -
Structural				
No Scope				$ -
Mechanical/Process				
Equipment:				
Demolition (PISTA and Pumps)	1	LS	$ 50,000.00	$ 50,000.00
PISTA 360 Model 50.0	4	EA	$ 102,749.40	$ 410,997.60
V-FORCE Baffle	4	EA	$ 43,481.88	$ 173,927.52
Influent Gates	4	EA	$ 31,200.00	$ 124,800.00
Effluent Gates	4	EA	$ 31,200.00	$ 124,800.00
Piping:				
Demolition (Pump Piping)	1	LS	$ 50,000.00	$ 50,000.00
6" Grit Pipe	550	LF	$ 705.12	$ 387,816.00
Fittings:				
6" Tee	28	EA	$ 4,065.36	$ 113,830.08
6" 90o Bend	18	EA	$ 3,191.76	$ 57,451.68
6"x4" Reducer	8	EA	$ 2,848.56	$ 22,788.48
6" 45o Bend	4	EA	$ 2,967.12	$ 11,868.48
Valves:				
6" Check Valve	6	EA	$ 3,812.64	$ 22,875.84
6" Plug Valve	16	EA	$ 9,350.64	$ 149,610.24
HVAC				
No Scope				$ -
Plumbing				
Install New Drains and Sediment Bucket	12	EA	$ 3,603.60	$ 43,243.20
Demolish Existing Floor Drains	12	EA	$ 1,200.00	$ 14,400.00
Small Diameter Piping Allowance	1	LS	$ 25,000.00	$ 25,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 267,511.37	$ 267,511.37
Instrumentation Allowance	1	LS	$ 178,340.91	$ 178,340.91
			Subtotal (rounded to nearest $1,000):	$ 2,584,000.00
			Contingency (rounded to nearest $1,000):	$ 775,000.00
			Total (rounded to nearest $1,000):	$ 3,359,000.00

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	3/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	0
Alternative 2 - Grit Pumps		Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 73,109.65	$ 73,109.65
Mobilization/Demobilization	1	LS	$ 20,602.56	$ 20,602.56
Temporary Facilities				
No Scope				$ -
Civil/Site				
No Scope				$ -
Architectural				
No Scope				$ -
Structural				
Concrete:				
Grit Pump Equipment Pad	25	CY	$ 1,872.00	$ 46,800.00
Mechanical/Process				
Equipment:				
Wemco Model C	6	EA	$ 64,988.82	$ 389,932.92
Fittings:				
6"x4" Reducer	12	EA	$ 2,848.56	$ 34,182.72
HVAC				
No Scope				$ -
Plumbing				
No Scope				$ -
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 70,637.35	$ 70,637.35
Instrumentation Allowance	1	LS	$ 47,091.56	$ 47,091.56
Subtotal (rounded to nearest $1,000):				$ 682,000.00
Contingency (rounded to nearest $1,000):				$ 205,000.00
Total (rounded to nearest $1,000):				$ 887,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Alternative 2 - Grit Dewatering Units

Updated By: L. Musselman
Date: 3/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 291,620.78	$ 291,620.78
Mobilization/Demobilization	1	LS	$ 66,353.68	$ 66,353.68
Temporary Facilities				
Grit Dewatering Equipment Rental and On-Site Operators (6 mont	6	EA	$ 78,000.00	$ 468,000.00
Civil/Site				
No Scope				$ -
Architectural				
New Removeable Translucent Panel	700	SF	$ 126.00	$ 88,200.00
Structural				
Existing Platform Demolition	1	LS	$ 25,000.00	$ 25,000.00
Metals:				
Aluminum Grated Access Platform	220	SF	$ 114.00	$ 25,080.00
Stairs	16	RISER	$ 360.00	$ 5,760.00
Mechanical/Process				
Demolition	1	LS	$ 25,000.00	$ 25,000.00
Equipment:				
Coanda Grit Washer RoSF4.1 and Hydrocyclone	4	EA	$ 193,440.00	$ 773,760.00
Piping:				
6" Grit Pipe	305	LF	$ 705.12	$ 215,061.60
8" PVC Drain Pipe	125	LF	$ 18.66	$ 2,332.20
10" PVC Drain Pipe	110	LF	$ 27.74	$ 3,051.05
Fittings:				
6" Tee	4	EA	$ 4,065.36	$ 16,261.44
6" 90o Bend	12	EA	$ 3,191.76	$ 38,301.12
8" Tee	4	EA	$ 3,177.72	$ 12,710.88
8" 90o Bend	8	EA	$ 2,416.44	$ 19,331.52
8" 45o Bend	4	EA	$ 2,146.56	$ 8,586.24
8" to 10" Wye	4	EA	$ 3,900.00	$ 15,600.00
Valves:				
6" Plug Valve	8	EA	$ 9,350.64	$ 74,805.12
HVAC				
Reconnection of Odor Control System	1	LS	$ 30,000.00	$ 30,000.00
Plumbing				
Install New Drains and Sediment Bucket	4	EA	$ 3,603.60	$ 14,414.40
Demolish Existing Floor Drains	4	EA	$ 1,200.00	$ 4,800.00
Small Diameter Piping Allowance	1	LS	$ 25,000.00	$ 25,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 283,658.34	$ 283,658.34
Instrumentation Allowance	1	LS	$ 189,105.56	$ 189,105.56
Subtotal (rounded to nearest $1,000):				$ 2,722,000.00
Contingency (rounded to nearest $1,000):				$ 817,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Alternative 2 - Grit Dewatering Units

Updated By: L. Musselman
Date: 3/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
			Total (rounded to nearest $1,000):	$ 3,539,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 15% of the subtotal project cost.
6 Instrumentation cost is estimated at 10% of the subtotal project cost.
7 Estimated costs were rounded to the nearest thousand dollars.
8 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
9 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Alternative 3 - Grit Separator Units

Updated By: L. Musselman
Date: 3/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 1,344,703.89	$ 1,344,703.89
Mobilization/Demobilization	1	LS	$ 369,768.93	$ 369,768.93
Temporary Facilities				
72" PE Bypass Pipe	150	LF	$ 608.40	$ 91,260.00
72" Motorized Valve	1	EA	$ 105,034.18	$ 105,034.18
Civil/Site				
Erosion and Sediment Control	1	LS	$ 93,720.00	$ 74,976.00
Sheeting and Shoring	1	LS	$ 645,600.00	$ 516,480.00
Excavation and Backfill	1	LS	$ 1,800,000.00	$ 1,440,000.00
Architectural				
Architectural Allowance	1	LS	$ 50,000.00	$ 50,000.00
Structural				
Demolition	840	CY	$ 600.00	$ 504,000.00
Concrete:				
HeadCell Tanks	210	CY	$ 1,872.00	$ 393,120.00
Channels on Grit Deck	120	CY	$ 1,872.00	$ 224,640.00
Channels in Basement	65	CY	$ 1,872.00	$ 121,680.00
Elevated Top Slab	550	CY	$ 1,872.00	$ 1,029,600.00
Grout:				
HeadCell Tanks	270	CY	$ 720.00	$ 194,400.00
Metals:				
Metal Channel Covers	410	SF	$ 117.00	$ 47,970.00
Metal HeadCell Covers	850	SF	$ 117.00	$ 99,450.00
Gantry Crane for Stop Logs	1	LS	$ 12,480.00	$ 12,480.00
Aluminum Grated Access Platform	0	SF	$ 114.00	$ -
Stairs	0	RISER	$ 360.00	$ -
Mechanical/Process				
Equipment:				
Demolition (PISTA and Pumps)	1	LS	$ 50,000.00	$ 50,000.00
HeadCell Units	3	EA	$ 306,279.99	$ 918,839.98
HeadCell Influent Channel Gate	1	EA	$ 24,960.00	$ 24,960.00
HeadCell Influent Gates	3	EA	$ 70,200.00	$ 210,600.00
Vortex Influent Channel Gates	2	EA	$ 31,200.00	$ 62,400.00
Vortex Effluent Channel Gates	2	EA	$ 31,200.00	$ 62,400.00
Stop Log Frames	2	EA	$ 23,400.00	$ 46,800.00
Stop Log Set	1	EA	$ 19,500.00	$ 19,500.00
PISTA 360 Model 50.0	2	EA	$ 102,749.40	$ 205,498.80
V-FORCE Baffle	2	EA	$ 43,481.88	$ 86,963.76
Piping:				
Demolition (Pump Piping and Grit Effluent)	1	LS	$ 60,000.00	$ 60,000.00
30" DI Primary Influent Pipe	120	LF	$ 2,496.00	$ 299,520.00
48" DI Primary Influent Pipe	50	LF	$ 5,460.00	$ 273,000.00
6" Grit Pipe	690	LF	$ 705.12	$ 486,532.80
Fittings:				
48"x30" Reducer	1	EA	$ 61,857.12	$ 61,857.12

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Alternative 3 - Grit Separator Units

Updated By: L. Musselman
Date: 3/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
30" 90o Bend	1	EA	$ 26,647.92	$ 26,647.92
48"x30" Reducing Bend	1	EA	$ 82,920.24	$ 82,920.24
48" 90o Bend	0	EA	$ 93,478.32	$ -
6" Tee	12	EA	$ 4,065.36	$ 48,784.32
6" 90o Bend	28	EA	$ 3,191.76	$ 89,369.28
6" 45o Bend	8	EA	$ 2,967.12	$ 23,736.96
6"x4" Reducer	6	EA	$ 2,848.56	$ 17,091.36
8" Tee	2	EA	$ 3,177.72	$ 6,355.44
Valves:				
30" Manual Butterfly Valve	4	EA	$ 23,306.40	$ 93,225.60
30" Electrically Actuated Butterfly Valve	4	EA	$ 43,764.24	$ 175,056.96
6" Check Valve	6	EA	$ 3,812.64	$ 22,875.84
6" Plug Valve	12	EA	$ 9,350.64	$ 112,207.68
HVAC				
HVAC Allowance	1	LS	$ 100,000.00	$ 100,000.00
Plumbing				
Install New Drains and Sediment Bucket	12	EA	$ 3,603.60	$ 43,243.20
Demolish Existing Floor Drains	12	EA	$ 1,200.00	$ 14,400.00
Small Diameter Piping	1	LS	$ 39,000.00	$ 39,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 1,300,331.62	$ 1,300,331.62
Instrumentation Allowance	1	LS	$ 866,887.74	$ 866,887.74
			Subtotal (rounded to nearest $1,000):	$ 12,551,000.00
			Contingency (rounded to nearest $1,000):	$ 3,765,000.00
			Total (rounded to nearest $1,000):	$ 16,316,000.00

Alexandria Renew Enterprises	Updated By: L. Musselman
Preliminary/Primary System Upgrades	Date: 3/18/2022
Preliminary Opinion of Probable Construction Costs	Checked By: 0
Alternative 3 - Grit Pumps	Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 62,135.66	$ 62,135.66
Mobilization/Demobilization	1	LS	$ 17,510.05	$ 17,510.05
Temporary Facilities				
No Scope				$ -
Civil/Site				
No Scope				$ -
Architectural				
No Scope				$ -
Structural				
Concrete:				
Grit Pump Equipment Pad	25	CY	$ 1,872.00	$ 46,800.00
Mechanical/Process				
Equipment:				
Wemco Model C	5	EA	$ 64,988.82	$ 324,944.10
Fittings:				
6"x4" Reducer	10	EA	$ 2,848.56	$ 28,485.60
HVAC				
No Scope				$ -
Plumbing				
No Scope				$ -
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 60,034.46	$ 60,034.46
Instrumentation Allowance	1	LS	$ 40,022.97	$ 40,022.97
			Subtotal (rounded to nearest $1,000):	$ 580,000.00
			Contingency (rounded to nearest $1,000):	$ 174,000.00
			Total (rounded to nearest $1,000):	$ 754,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Alternative 3 - Grit Dewatering Units

Updated By: L. Musselman
Date: 3/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 388,755.29	$ 388,755.29
Mobilization/Demobilization	1	LS	$ 93,726.53	$ 93,726.53
Temporary Facilities				
Grit Dewatering Equipment Rental and On-Site Operators (6 mont	6	EA	$ 78,000.00	$ 468,000.00
Civil/Site				
No Scope				$ -
Architectural				
New Removeable Translucent Panel	700	SF	$ 126.00	$ 88,200.00
Structural				
Existing Platform Demolition	1	LS	$ 25,000.00	$ 25,000.00
Metals:				
Aluminum Grated Access Platform	700	SF	$ 114.00	$ 79,800.00
Stairs	4	RISER	$ 360.00	$ 1,440.00
Mechanical/Process				
Demolition	1	LS	$ 25,000.00	$ 25,000.00
Equipment:				
Coanda Grit Washer RoSF4.2 and Hydrocyclone	3	EA	$ 256,620.00	$ 769,860.00
Coanda Grit Washer RoSF4.1 and Hydrocyclone	2	EA	$ 193,440.00	$ 386,880.00
Piping:				
6" Grit Pipe	510	LF	$ 705.12	$ 359,611.20
8" PVC Drain Pipe	100	LF	$ 18.66	$ 1,865.76
10" PVC Drain Pipe	175	LF	$ 27.74	$ 4,853.94
Fittings:				
6" Tee	5	EA	$ 4,065.36	$ 20,326.80
6" 90o Bend	15	EA	$ 3,191.76	$ 47,876.40
8" Tee	5	EA	$ 3,177.72	$ 15,888.60
8" 90o Bend	10	EA	$ 2,416.44	$ 24,164.40
8" 45o Bend	5	EA	$ 2,146.56	$ 10,732.80
8" to 10" Wye	5	EA	$ 3,900.00	$ 19,500.00
Valves:				
6" Plug Valve	10	EA	$ 9,350.64	$ 93,506.40
HVAC				
Reconnection of Odor Control System	1	LS	$ 30,000.00	$ 30,000.00
Plumbing				
Install New Drains and Sediment Bucket	4	EA	$ 3,603.60	$ 14,414.40
Demolish Existing Floor Drains	4	EA	$ 1,200.00	$ 4,800.00
Small Diameter Piping Allowance	1	LS	$ 25,000.00	$ 25,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 377,508.11	$ 377,508.11
Instrumentation Allowance	1	LS	$ 251,672.07	$ 251,672.07
			Subtotal (rounded to nearest $1,000):	$ 3,628,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Alternative 3 - Grit Dewatering Units

Updated By: L. Musselman
Date: 3/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
			Contingency (rounded to nearest $1,000):	$ 1,088,000.00
			Total (rounded to nearest $1,000):	$ 4,716,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 15% of the subtotal project cost.
6 Instrumentation cost is estimated at 10% of the subtotal project cost.
7 Estimated costs were rounded to the nearest thousand dollars.
8 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
9 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Alternative 4 - Grit Separator Units

Updated By: L. Musselman
Date: 3/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 2,502,094.03	$ 2,502,094.03
Mobilization/Demobilization	1	LS	$ 598,366.21	$ 598,366.21
Temporary Facilities				
72" PE Bypass Pipe	300	LF	$ 608.40	$ 182,520.00
Grit Removal Equipment Rental	24	EA	$ 120,000.00	$ 2,880,000.00
Civil/Site				
Erosion and Sediment Control	1	LS	$ 93,720.00	$ 93,720.00
Sheeting and Shoring	1	LS	$ 645,600.00	$ 645,600.00
Excavation and Backfill	1	LS	$ 1,800,000.00	$ 1,800,000.00
Architectural				
Architectural Allowance	1	LS	$ 50,000.00	$ 50,000.00
Structural				
Demolition	1,400	CY	$ 600.00	$ 840,000.00
Concrete:				
HeadCell Tanks	420	CY	$ 1,872.00	$ 786,240.00
Channels on Grit Deck	240	CY	$ 1,872.00	$ 449,280.00
Channels in Basement	130	CY	$ 1,872.00	$ 243,360.00
Elevated Top Slab	1,100	CY	$ 1,872.00	$ 2,059,200.00
Grout:				
HeadCell Tanks	540	CY	$ 720.00	$ 388,800.00
Metals:				
Metal Channel Covers	820	SF	$ 117.00	$ 95,940.00
Metal HeadCell Covers	1,700	SF	$ 117.00	$ 198,900.00
Gantry Crane for Stop Logs	1	LS	$ 12,480.00	$ 12,480.00
Aluminum Grated Access Platform	20	SF	$ 114.00	$ 2,280.00
Stairs	10	RISER	$ 360.00	$ 3,600.00
Mechanical/Process				
Equipment:				
Demolition (PISTA and Pumps)	1	LS	$ 50,000.00	$ 50,000.00
HeadCell Units	6	EA	$ 306,279.99	$ 1,837,679.97
Channel Influent Gates	2	EA	$ 24,960.00	$ 49,920.00
HeadCell Influent Gates	6	EA	$ 70,200.00	$ 421,200.00
Stop Log Frames	2	EA	$ 23,400.00	$ 46,800.00
Stop Log Set	1	EA	$ 19,500.00	$ 19,500.00
Piping:				
Demolition (Pump Piping and Grit Effluent)	1	LS	$ 100,000.00	$ 100,000.00
30" DI Primary Influent Pipe	240	LF	$ 2,496.00	$ 599,040.00
48" DI Primary Influent Pipe	100	LF	$ 5,460.00	$ 546,000.00
6" Grit Pipe	820	LF	$ 705.12	$ 578,198.40
Fittings:				
48"x30" Reducer	2	EA	$ 61,857.12	$ 123,714.24
30" 90o Bend	2	EA	$ 26,647.92	$ 53,295.84
48"x30" Reducing Bend	2	EA	$ 82,920.24	$ 165,840.48
48" 90o Bend	1	EA	$ 93,478.32	$ 93,478.32
6" Tee	12	EA	$ 4,065.36	$ 48,784.32

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	3/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	0
Alternative 4 - Grit Separator Units		Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
6" 90o Bend	28	EA	$ 3,191.76	$ 89,369.28
6" 45o Bend	8	EA	$ 2,967.12	$ 23,736.96
6"x4" Reducer	6	EA	$ 2,848.56	$ 17,091.36
8" Tee	2	EA	$ 3,177.72	$ 6,355.44
Valves:				
30" Manual Butterfly Valve	4	EA	$ 23,306.40	$ 93,225.60
30" Electrically Actuated Butterfly Valve	4	EA	$ 43,764.24	$ 175,056.96
6" Check Valve	6	EA	$ 3,812.64	$ 22,875.84
6" Plug Valve	12	EA	$ 9,350.64	$ 112,207.68
HVAC				
HVAC Allowance	1	LS	$ 100,000.00	$ 100,000.00
Plumbing				
Install New Drains and Sediment Bucket	12	EA	$ 3,603.60	$ 43,243.20
Demolish Existing Floor Drains	12	EA	$ 1,200.00	$ 14,400.00
Small Diameter Piping	1	LS	$ 39,000.00	$ 39,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 2,430,290.08	$ 2,430,290.08
Instrumentation Allowance	1	LS	$ 1,620,193.39	$ 1,620,193.39
			Subtotal (rounded to nearest $1,000):	$ 23,353,000.00
			Contingency (rounded to nearest $1,000):	$ 7,006,000.00
			Total (rounded to nearest $1,000):	$ 30,359,000.00

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	3/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	0
Alternative 4 - Grit Pumps		Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 195,149.44	$ 195,149.44
Mobilization/Demobilization	1	LS	$ 54,993.80	$ 54,993.80
Temporary Facilities				
No Scope				$ -
Civil/Site				
No Scope				$ -
Architectural				
No Scope				$ -
Structural				
Concrete:				
Grit Pump Equipment Pad	25	CY	$ 2,433.60	$ 60,840.00
Mechanical/Process				
Equipment:				
Hazleton HNR Grit Pumps	6	EA	$ 193,663.08	$ 1,161,978.48
Fittings:				
6"x4" Reducer	12	EA	$ 2,848.56	$ 34,182.72
HVAC				
No Scope				$ -
Plumbing				
No Scope				$ -
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 188,550.18	$ 188,550.18
Instrumentation Allowance	1	LS	$ 125,700.12	$ 125,700.12
			Subtotal (rounded to nearest $1,000):	$ 1,821,000.00
			Contingency (rounded to nearest $1,000):	$ 546,000.00
			Total (rounded to nearest $1,000):	$ 2,367,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Alternative 4 - Grit Dewatering Units

Updated By: L. Musselman
Date: 3/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 623,477.52	$ 623,477.52
Mobilization/Demobilization	1	LS	$ 159,872.09	$ 159,872.09
Temporary Facilities				
Grit Dewatering Equipment Rental and On-Site Operators (6 mont	6	EA	$ 78,000.00	$ 468,000.00
Civil/Site				
No Scope				
Architectural				
Cyclone Classifier Room Expansion	1,400	SF	$ 360.00	$ 504,000.00
New Removeable Translucent Panel	700	SF	$ 126.00	$ 88,200.00
Structural				
Cyclone Classifier Room Expansion	2,500	SF	$ 100.00	$ 250,000.00
Existing Platform Demolition	1	LS	$ 25,000.00	$ 25,000.00
Metals:				
Aluminum Grated Access Platform	1,000	SF	$ 114.00	$ 114,000.00
Stairs	8	RISER	$ 360.00	$ 2,880.00
Mechanical/Process				
Demolition	1	LS	$ 25,000.00	$ 25,000.00
Equipment:				
Coanda Grit Washer RoSF4.2 and Hydrocyclone	6	EA	$ 256,620.00	$ 1,539,720.00
Piping:				
6" Grit Pipe	510	LF	$ 705.12	$ 359,611.20
8" PVC Drain Pipe	100	LF	$ 18.66	$ 1,865.76
10" PVC Drain Pipe	175	LF	$ 27.74	$ 4,853.94
Fittings:				
6" Tee	6	EA	$ 4,065.36	$ 24,392.16
6" 90o Bend	18	EA	$ 3,191.76	$ 57,451.68
8" Tee	6	EA	$ 3,177.72	$ 19,066.32
8" 90o Bend	12	EA	$ 2,416.44	$ 28,997.28
8" 45o Bend	12	EA	$ 2,146.56	$ 25,758.72
8" to 10" Wye	6	EA	$ 3,900.00	$ 23,400.00
Valves:				
6" Plug Valve	12	EA	$ 9,350.64	$ 112,207.68
HVAC				
Cyclone Classifier Room Expansion	1,400	SF	$ 200.00	$ 280,000.00
Reconnection of Odor Control System	1	LS	$ 30,000.00	$ 30,000.00
Plumbing				
Install New Drains and Sediment Bucket	4	EA	$ 3,603.60	$ 14,414.40
Demolish Existing Floor Drains	4	EA	$ 1,200.00	$ 4,800.00
Small Diameter Piping Allowance	1	LS	$ 25,000.00	$ 25,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 604,292.87	$ 604,292.87
Instrumentation Allowance	1	LS	$ 402,861.91	$ 402,861.91

Alexandria Renew Enterprises	Updated By: L. Musselman
Preliminary/Primary System Upgrades	Date: 3/18/2022
Preliminary Opinion of Probable Construction Costs	Checked By: 0
Alternative 4 - Grit Dewatering Units	Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
			Subtotal (rounded to nearest $1,000):	$ 5,819,000.00
			Contingency (rounded to nearest $1,000):	$ 1,746,000.00
			Total (rounded to nearest $1,000):	$ 7,565,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 15% of the subtotal project cost.
6 Instrumentation cost is estimated at 10% of the subtotal project cost.
7 Estimated costs were rounded to the nearest thousand dollars.
8 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
9 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises		Updated By:	L. Musselman
Preliminary/Primary System Upgrades		Date:	8/18/2022
Preliminary Opinion of Probable Construction Costs		Checked By:	0
Screenings and Grit Loading: Alternative 1		Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 194,635.04	$ 194,635.04
Mobilization/Demobilization	1	LS	$ 54,848.84	$ 54,848.84
Temporary Facilities				
Screenings Handling	1	LS	$ 10,000.00	$ 10,000.00
Civil/Site				
No Scope				
Architectural				
No Scope				
Structural				
Concrete:				
Dock Bumper	2	EA	$ 1,560.00	$ 3,120.00
Fill Existing Discharge Chutes	30	CY	$ 482.04	$ 14,461.20
Core Drill New Discharge Chutes	8	EA	$ 7,800.00	$ 62,400.00
Metals:				
Guide Rails	186	SF	$ 156.00	$ 29,016.00
Aluminum Grated Access Platform	280	SF	$ 114.00	$ 31,920.00
Stairs	12	RISER	$ 360.00	$ 4,320.00
Mechanical/Process				
Equipment:				
Existing Conveyors Demolition	1	LS	$ 40,000.00	$ 40,000.00
Screenings Screw Conveyors	2	EA	$ 85,824.96	$ 171,649.92
Grit Screw Conveyors	2	EA	$ 111,557.16	$ 223,114.32
Transfer Screw Conveyors	2	EA	$ 95,472.00	$ 190,944.00
Truck Loading Screw Conveyors	2	EA	$ 167,076.00	$ 334,152.00
CCTV Monitoring Technology	4	EA	$ 29,484.00	$ 117,936.00
HVAC				
No Scope				
Plumbing				
Install New Drains and Sediment Bucket	4	EA	$ 3,603.60	$ 14,414.40
Demolish Existing Floor Drains	4	EA	$ 1,560.00	$ 6,240.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 188,053.18	$ 188,053.18
Instrumentation Allowance	1	LS	$ 125,368.78	$ 125,368.78
			Subtotal (rounded to nearest $1,000):	$ 1,817,000.00
			Contingency (rounded to nearest $1,000):	$ 545,000.00
			Total (rounded to nearest $1,000):	$ 2,362,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.

Alexandria Renew Enterprises	Updated By:	L. Musselman
Preliminary/Primary System Upgrades	Date:	8/18/2022
Preliminary Opinion of Probable Construction Costs	Checked By:	0
Screenings and Grit Loading: Alternative 1	Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost

4 Contractor overhead and profit is estimated as 20% of the equipment cost.

5 Electrical cost is estimated at 15% of the subtotal project cost.

6 Instrumentation cost is estimated at 10% of the subtotal project cost.

7 Estimated costs were rounded to the nearest thousand dollars.

8 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.

9 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises	Updated By: L. Musselman
Preliminary/Primary System Upgrades	Date: 8/18/2022
Preliminary Opinion of Probable Construction Costs	Checked By: 0
Screenings and Grit Loading: Alternative 2	Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 188,527.68	$ 188,527.68
Mobilization/Demobilization	1	LS	$ 53,127.77	$ 53,127.77
Temporary Facilities				
Screenings Handling	1	LS	$ 10,000.00	$ 10,000.00
Civil/Site				
No Scope				
Architectural				
No Scope				
Structural				
Concrete:				
Dock Bumper	2	EA	$ 1,560.00	$ 3,120.00
Truck Bay Concrete Floor Modification	1	LS	$ 60,000.00	$ 60,000.00
Fill Existing Discharge Chutes	30	CY	$ 482.04	$ 14,461.20
Core Drill New Discharge Chutes	2	EA	$ 7,800.00	$ 15,600.00
Mechanical/Process				
Equipment:				
Existing Conveyors Demolition	1	LS	$ 40,000.00	$ 40,000.00
Roll-Off Containers	2	EA	$ 11,856.00	$ 23,712.00
Automated Rail System	2	EA	$ 293,280.00	$ 586,560.00
Screenings Screw Conveyors	2	EA	$ 85,824.96	$ 171,649.92
Screenings Transfer Conveyors	2	EA	$ 33,009.60	$ 66,019.20
Screenings Loading Conveyors	2	EA	$ 40,436.76	$ 80,873.52
Grit Screw Conveyors	2	EA	$ 60,849.36	$ 121,698.72
HVAC				
No Scope				
Plumbing				
Install New Drains and Sediment Bucket	4	EA	$ 3,603.60	$ 14,414.40
Demolish Existing Floor Drains	4	EA	$ 1,560.00	$ 6,240.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 182,152.34	$ 182,152.34
Instrumentation Allowance	1	LS	$ 121,434.90	$ 121,434.90
Subtotal (rounded to nearest $1,000):				$ 1,760,000.00
Contingency (rounded to nearest $1,000):				$ 528,000.00
Total (rounded to nearest $1,000):				$ 2,288,000.00

The following assumptions were made in the development of the construction cost estimate:

1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 15% of the subtotal project cost.

Alexandria Renew Enterprises	Updated By: L. Musselman
Preliminary/Primary System Upgrades	Date: 8/18/2022
Preliminary Opinion of Probable Construction Costs	Checked By: 0
Screenings and Grit Loading: Alternative 2	Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost

6 Instrumentation cost is estimated at 10% of the subtotal project cost.

7 Estimated costs were rounded to the nearest thousand dollars.

8 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.

9 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Screenings and Grit Loading: Alternative 3

Updated By: L. Musselman
Date: 8/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 223,403.52	$ 223,403.52
Mobilization/Demobilization	1	LS	$ 62,955.90	$ 62,955.90
Temporary Facilities				
Screenings Handling	1	LS	$ 10,000.00	$ 10,000.00
Civil/Site				
No Scope				
Architectural				
No Scope				
Structural				
Concrete:				
Dock Bumper	2	EA	$ 1,560.00	$ 3,120.00
Truck Bay Concrete Floor Modification	1	LS	$ 60,000.00	$ 60,000.00
Fill Existing Discharge Chutes	30	CY	$ 482.04	$ 14,461.20
Core Drill New Discharge Chutes	4	EA	$ 7,800.00	$ 31,200.00
Metals:				
Solid Metal Wheel Plates	200	SF	$ 156.00	$ 31,200.00
Guide Rails	55	SF	$ 156.00	$ 8,580.00
Mechanical/Process				
Equipment:				
Existing Conveyors Demolition	1	LS	$ 40,000.00	$ 40,000.00
Self-Leveling Roll-Off Containers	4	EA	$ 192,075.00	$ 768,300.00
Screenings Screw Conveyors	2	EA	$ 85,824.96	$ 171,649.92
Screenings Transfer Conveyors	2	EA	$ 29,708.64	$ 59,417.28
Screenings Loading Conveyors	2	EA	$ 56,116.32	$ 112,232.64
Grit Screw Conveyors	2	EA	$ 54,088.32	$ 108,176.64
HVAC				
No Scope				
Plumbing				
Install New Drains and Sediment Bucket	4	EA	$ 3,603.60	$ 14,414.40
Demolish Existing Floor Drains	4	EA	$ 1,560.00	$ 6,240.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 215,848.81	$ 215,848.81
Instrumentation Allowance	1	LS	$ 143,899.21	$ 143,899.21
			Subtotal (rounded to nearest $1,000):	$ 2,085,000.00
			Contingency (rounded to nearest $1,000):	$ 626,000.00
			Total (rounded to nearest $1,000):	$ 2,711,000.00

The following assumptions were made in the development of the construction cost estimate:
1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.

Alexandria Renew Enterprises	Updated By: L. Musselman
Preliminary/Primary System Upgrades	Date: 8/18/2022
Preliminary Opinion of Probable Construction Costs	Checked By: 0
Screenings and Grit Loading: Alternative 3	Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost

4 Contractor overhead and profit is estimated as 20% of the equipment cost.
5 Electrical cost is estimated at 15% of the subtotal project cost.
6 Instrumentation cost is estimated at 10% of the subtotal project cost.
7 Estimated costs were rounded to the nearest thousand dollars.
8 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.
9 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Screenings and Grit Loading Alternative 4

Updated By: L. Musselman
Date: 8/18/2022
Checked By: 0
Date: 1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 100,289.62	$ 100,289.62
Mobilization/Demobilization	1	LS	$ 28,261.97	$ 28,261.97
Temporary Facilities				
Screenings Handling	1	LS	$ 10,000.00	$ 10,000.00
Civil/Site				
No Scope				
Architectural				
No Scope				
Structural				
Concrete:				
Dock Bumper	2	EA	$ 1,560.00	$ 3,120.00
Truck Bay Concrete Floor Modification	1	LS	$ 60,000.00	$ 60,000.00
Fill Existing Discharge Chutes	30	CY	$ 482.04	$ 14,461.20
Core Drill New Discharge Chutes	4	EA	$ 7,800.00	$ 31,200.00
Metals:				
Solid Metal Wheel Plates	200	SF	$ 156.00	$ 31,200.00
Guide Rails	55	SF	$ 156.00	$ 8,580.00
Mechanical/Process				
Equipment:				
Existing Conveyors Demolition	1	LS	$ 40,000.00	$ 40,000.00
Roll-Off Containers	4	EA	$ 10,140.00	$ 40,560.00
Screenings Screw Conveyors	2	EA	$ 85,824.96	$ 171,649.92
Screenings Transfer Conveyors	2	EA	$ 29,708.64	$ 59,417.28
Screenings Loading Conveyors	2	EA	$ 77,572.56	$ 155,145.12
HVAC				
No Scope				
Plumbing				
Install New Drains and Sediment Bucket	4	EA	$ 3,603.60	$ 14,414.40
Demolish Existing Floor Drains	4	EA	$ 1,560.00	$ 6,240.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 96,898.19	$ 96,898.19
Instrumentation Allowance	1	LS	$ 64,598.79	$ 64,598.79
			Subtotal (rounded to nearest $1,000):	$ 936,000.00
			Contingency (rounded to nearest $1,000):	$ 281,000.00
			Total (rounded to nearest $1,000):	$ 1,217,000.00

The following assumptions were made in the development of the construction cost estimate:
1 Contractor General Conditions costs are set at 12% of the subtotal project cost.
2 Mobilization/demobilization cost are set a 3.5% of the subtotal project cost, excluding general conditions cost.
3 Installation of major equipment was estimated at 30% of the equipment cost.
4 Contractor overhead and profit is estimated as 20% of the equipment cost.

Updated By:	L. Musselman
Date:	8/18/2022
Checked By:	0
Date:	1/0/1900

Item	Qty	Unit	Unit Cost	Total Cost

5 Electrical cost is estimated at 15% of the subtotal project cost.

6 Instrumentation cost is estimated at 10% of the subtotal project cost.

7 Estimated costs were rounded to the nearest thousand dollars.

8 Estimated cost estimate accuracy is -20% to +30%. For comparative purposes, a 30% contingency was applied to all cost estimates to reflect the high end cost based on the estimated range of accuracy.

9 Construction costs are presented in current dollars at the time of this TM development.

Alexandria Renew Enterprises	Prepared By: CE
Preliminary/Primary System Upgrades	Date: 10/7/2021
Preliminary Opinion of Probable Construction Costs	Checked By: NH
Primary Weir Observation House - Alternative 1 (Renovate)	Date: 6/23/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 265,000.00	$ 265,000
Mobilization/Demobilization	1	LS	$ 75,000.00	$ 75,000
Civil/Site				
Site Prep/Staging (Allowance)	1	LS	$ 25,000.00	$ 25,000
Architectural				
Temporary Protection	10,815	SF	$ 11.00	$ 119,000
Demolition	10,815	SF	$ 27.00	$ 292,000
Steel Roof Decking	10,815	SF	$ 4.00	$ 43,000
EPDM Roof	10,815	SF	$ 38.00	$ 411,000
Painting/Refurbishment of Steel Members	10815	SF	$ 12.00	$ 130,000
Final Cleaning	10,815	SF	$ 2.00	$ 22,000
Structural				
Demolish Existing Cross Walk Sections	310	LF	$ 360.00	$ 112,000
Construct New Cross Walkway (aluminum construction)	400.00	LF	$ 444.00	$ 178,000
Modify Handrail (aluminum railing, allowance)	1	LS	$ 15,000.00	$ 15,000
Mechanical/Process				
Odor Control Piping (Allowance)	1	LS	$ 70,000.00	$ 70,000
HVAC				
HVAC Allowance	10,815	SF	$ 18.50	$ 200,000
Plumbing				
Plumbing Allowance	1	LS	$ 10,000.00	$ 10,000
Electrical/Instrumentation				
Electrical Allowance (Replacement of Deteriorated Components)	1	LS	$ 500,000.00	$ 500,000
2021 Construction Cost (rounded to nearest $1,000):				$ 2,467,000
Contingency (rounded to nearest $1,000):				$ 740,000
2021 Total Project Cost (rounded to nearest $1,000):				$ 3,207,000

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Primary Weir Observation House - Alternative 2 (Aluminum Covers)

Prepared By: CE
Date: 10/7/2021
Checked By: NH
Date: 6/3/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 343,000.00	$ 343,000.00
Mobilization/Demobilization	1	LS	$ 97,000.00	$ 97,000.00
Civil/Site				
Site Prep/Staging (Allowance)	1	LS	$ 25,000.00	$ 25,000.00
Architectural				
Note: all costs associated with demolition carried in Structural				
Structural				
Demolish Building (Complete Demolition and Removal)	1	LS	$ 1,185,000.00	$ 1,185,000.00
Demolish Existing Cross Walk Sections	310	LF	$ 360.00	$ 112,000.00
Furnish and Install Flat Plate Aluminum Covers	1	LS	$ 338,400.00	$ 338,000.00
Construct New Cross Walkway (aluminum construction)	400	LF	$ 444.00	$ 178,000.00
Modify Handrail (aluminum railing, allowance)	1.00	LS	$ 15,000.00	$ 15,000.00
Aluminum Panel Lifting Equipment (Allowance)	1	LS	$ 50,000.00	$ 50,000.00
Coating of Existing Concrete Effluent Launders	9,000	SF	$ 40.00	$ 360,000.00
Mechanical/Process				
Odor control piping				
6" SST, SCH 10, OA Piping w Supports	240	LF	$ 240.00	$ 58,000.00
14" SST, SCH 10, OA Piping w Supports	60	LF	$ 540.00	$ 32,000.00
24" SST, SCH 10, OA Piping w Supports	100	LF	$ 870.00	$ 87,000.00
42" SST, SCH 10, OA Piping w Supports	100	LF	$ 1,560.00	$ 156,000.00
Allowance for Fittings (20%) and Pipe Supports	1	LS	$ 66,600.00	$ 67,000.00
HVAC				
HVAC Allowance	1	LS	$ -	$ -
Plumbing				
Plumbing Allowance	1	LS	$ -	$ -
Electrical/Instrumentation				
Exterior Lighting Allowance	1	LS	$ 100,000.00	$ 100,000.00
2021 Construction Cost (rounded to nearest $1,000):				$ 3,203,000.00
Contingency (rounded to nearest $1,000):				$ 961,000.00
2021 Total Project Cost (rounded to nearest $1,000):				$ 4,164,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Primary Weir Observation House - Alternative 3 (Geomembrane Covers)

Prepared By: CE
Date: 10/7/2021
Checked By: NH
Date: 6/3/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 418,000.00	$ 418,000.00
Mobilization/Demobilization	1	LS	$ 118,000.00	$ 118,000.00
Civil/Site				
Site Prep/Staging (Allowance)	1	LS	$ 25,000.00	$ 25,000.00
Architectural				
Note: all costs associated with demolition carried in Structural				
Structural				
Demolish Building (Complete Demolition and Removal)	1	LS	$ 1,185,000.00	$ 1,185,000.00
Demolish Existing Cross Walk Sections	310	LF	$ 360.00	$ 112,000.00
Furnish and Install Structurally Supported Geomembrane Covers	1	LS	$ 1,003,080.00	$ 1,003,000.00
Construct New Cross Walkway (aluminum construction)	400	LF	$ 444.00	$ 178,000.00
Coating of Existing Concrete Effluent Launders	9,000.00	SF	$ 40.00	$ 360,000.00
Mechanical/Process				
Odor control piping				
6" SST, SCH 10, OA Piping w Supports	240	LF	$ 240.00	$ 58,000.00
14" SST, SCH 10, OA Piping w Supports	60	LF	$ 540.00	$ 32,000.00
24" SST, SCH 10, OA Piping w Supports	100	LF	$ 870.00	$ 87,000.00
42" SST, SCH 10, OA Piping w Supports	100	LF	$ 1,560.00	$ 156,000.00
	1	LS	$ 66,600.00	$ 67,000.00
HVAC				
HVAC Allowance	1	LS	$ -	$ -
Plumbing				
Plumbing Allowance	1	LS	$ -	$ -
Electrical/Instrumentation				
Exterior Lighting Allowance	1	LS	$ 100,000.00	$ 100,000.00
2021 Construction Cost (rounded to nearest $1,000):				$ 3,899,000.00
Contingency (rounded to nearest $1,000):				$ 1,170,000.00
2021 Total Project Cost (rounded to nearest $1,000):				$ 5,069,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
General Improvements

Prepared By: CE
Date: 10/7/2021
Checked By: NH
Date: 6/23/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 323,000.00	$ 323,000.00
Mobilization/Demobilization	1	LS	$ 91,000.00	$ 91,000.00
Civil/Site				
N/A				
Architectural				
F Replace PST handrailing	2,435	LF	$ 200.00	$ 487,000.00
Handrail post removal/repair	812	EA	$ 100.00	$ 81,000.00
Structural				
Saw cut concrete at slide gate locations	3	LS	$ 5,000.00	$ 15,000.00
Provide aluminum grating at slide gate locations	72	SF	$ 150.00	$ 11,000.00
Provide influent baffle plate at PST #8	1	LS	$ 5,000.00	$ 5,000.00
PST concrete renovations	1	LS	$ 150,000.00	$ 150,000.00
Replace PST influent baffles	1,360	SF	$ 100.00	$ 136,000.00
Replace PST scum baffles	576	SF	$ 100.00	$ 58,000.00
Mechanical/Process				
Demolish plunger pumps, eqpt pads, and associated piping	3	EA	$ 10,000.00	$ 30,000.00
Demolish scum skimmers and actuators	8	LS	$ 7,500.00	$ 60,000.00
Furnish/Install scum skimmers and actuators	8	EA	$ 78,000.00	$ 624,000.00
Furnish/install submersible recirculating chopper pumps and contr	1	LS	$ 156,000.00	$ 156,000.00
Furnish/install slide gates with electric actuators	1	LS	$ 82,680.00	$ 83,000.00
Extend odor control connection to PST effluent box	1	LS	$ 20,000.00	$ 20,000.00
Provide piping for spray water to scum skimmers	1	LS	$ 50,000.00	$ 50,000.00
Replace sludge and drain valves is PST gallery	1	LS	$ 200,000.00	$ 200,000.00
Replace odor control fan	1	LS	$ 100,000.00	$ 100,000.00
HVAC				
HVAC Allowance		LS	$ -	
Plumbing				
Plumbing Allowance		LS	$ -	
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 331,000.00	$ 331,000.00
2021 Construction Cost (rounded to nearest $1,000):				$ 3,011,000.00
Contingency (rounded to nearest $1,000):				$ 903,000.00
2021 Total Project Cost (rounded to nearest $1,000):				$ 3,914,000.00

Alexandria Renew Enterprises
Preliminary/Primary System Upgrades
Preliminary Opinion of Probable Construction Costs
Primary Scum Processing - Alternative 1 (In Kind Replacement; Truck Bay)

Prepared By: CE
Date: 10/7/2021
Checked By: NH
Date: 6/23/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 156,000.00	$ 156,000.00
Mobilization/Demobilization	1	LS	$ 44,000.00	$ 44,000.00
Civil/Site				
Site Prep/Staging (Allowance)	1	LS	$ 25,000.00	$ 25,000.00
Architectural				
N/A				
Structural				
Removal of Existing Scum Concentrator Access Platform	30	LF	$ 36.00	$ 1,000.00
Structural Modification of Scum Room Floor (Allowance)	1	LS	$ 25,000.00	$ 25,000.00
Temporary Modification of Scum Room Access (Allowance)	1	LS	$ 25,000.00	$ 25,000.00
Mechanical/Process				
Demolish Existing Scum Processing Equipment and Piping	1	LS	$ 25,000.00	$ 25,000.00
Furnish and Install New Scum Concentrator System	1	EA	$ 786,240.00	$ 786,000.00
Dilute Scum/Drainage Piping Modifications	1	LS	$ 20,000.00	$ 20,000.00
Concentrated Scum Piping, 3" DI (glass-lined)	100	LF	$ 639.60	$ 64,000.00
Allowance for Fittings (20%)	1	LS	$ 12,800.00	$ 13,000.00
Insulation/Jacket for Scum Piping	100	LF	$ 72.00	$ 7,000.00
HVAC				
HVAC Allowance	1	LS	$ 5,000.00	$ 5,000.00
Plumbing				
Plumbing Allowance	1	LS	$ 25,000.00	$ 25,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 236,000.00	$ 236,000.00
Heat Tracing	100	LF	$ 24.00	$ 2,000.00
2021 Construction Cost (rounded to nearest $1,000):				$ 1,459,000.00
Contingency (rounded to nearest $1,000):				$ 438,000.00
2021 Total Project Cost (rounded to nearest $1,000):				$ 1,897,000.00

Alexandria Renew Enterprises		Prepared By:	CE
Preliminary/Primary System Upgrades		Date:	10/7/2021
Preliminary Opinion of Probable Construction Costs		Checked By:	NH
Primary Scum Processing - Alternative 2 (Scum Screen)		Date:	6/23/2022

Item	Qty	Unit	Unit Cost	Total Cost
General				
General Conditions	1	LS	$ 88,000.00	$ 88,000.00
Mobilization/Demobilization	1	LS	$ 25,000.00	$ 25,000.00
Civil/Site				
Site Prep/Staging (Allowance)	1	LS	$ 25,000.00	$ 25,000.00
Architectural				
N/A				
Structural				
Removal of Existing Scum Concentrator Access Platform	30	LF	$ 36.00	$ 1,000.00
Structural Modification of Scum Room Floor	1	LS	$ 25,000.00	$ 25,000.00
Mechanical/Process				
Demolish Existing Scum Processing Equipment and Piping	1	LS	$ 25,000.00	$ 25,000.00
Furnish and Install New Scum Screen System	1	EA	$ 452,400.00	$ 452,000.00
Dilute Scum/Drainage Piping Modifications	1	LS	$ 20,000.00	$ 20,000.00
HVAC				
HVAC Allowance	1	LS	$ 5,000.00	$ 5,000.00
Plumbing				
Plumbing Allowance	1	LS	$ 25,000.00	$ 25,000.00
Electrical/Instrumentation				
Electrical Allowance	1	LS	$ 132,000.00	$ 132,000.00
2021 Construction Cost (rounded to nearest $1,000):				$ 823,000.00
Contingency (rounded to nearest $1,000):				$ 247,000.00
2021 Total Project Cost (rounded to nearest $1,000):				$ 1,070,000.00

Appendix I

Lifecycle Costs

AlexRenew PPSU	8/18/22	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 1 Coarse Screens Upgrade	L. Musselman	TAY
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 25,830	$ 23,024	$ -	$ 235	$ -	$ 29,885	$ 78,974	102%	$ 80,940	$ 78,583
2	41.22	$ 26,220	$ 23,372	$ -	$ 239	$ -	$ 30,337	$ 80,168	105%	$ 84,210	$ 79,376
3	41.84	$ 26,617	$ 23,726	$ -	$ 242	$ -	$ 30,796	$ 81,380	108%	$ 87,612	$ 80,177
4	42.47	$ 27,019	$ 24,084	$ -	$ 246	$ -	$ 31,261	$ 82,610	110%	$ 91,151	$ 80,986
5	43.12	$ 27,427	$ 24,448	$ -	$ 250	$ -	$ 31,734	$ 83,859	113%	$ 94,833	$ 81,804
6	43.77	$ 27,842	$ 24,818	$ -	$ 254	$ -	$ 32,214	$ 85,127	116%	$ 98,664	$ 82,629
7	44.43	$ 28,263	$ 25,193	$ -	$ 257	$ -	$ 32,701	$ 86,414	119%	$ 102,649	$ 83,463
8	45.10	$ 28,690	$ 25,574	$ -	$ 261	$ -	$ 33,195	$ 87,721	122%	$ 106,796	$ 84,305
9	45.78	$ 29,124	$ 25,961	$ -	$ 265	$ -	$ 33,697	$ 89,047	125%	$ 111,110	$ 85,156
10	46.48	$ 29,564	$ 26,353	$ -	$ 269	$ -	$ 34,206	$ 90,393	128%	$ 115,598	$ 86,016
11	47.18	$ 30,011	$ 26,752	$ -	$ 273	$ -	$ 34,723	$ 91,760	131%	$ 120,267	$ 86,884
12	47.89	$ 30,465	$ 27,156	$ -	$ 277	$ -	$ 35,248	$ 93,147	134%	$ 125,125	$ 87,760
13	48.62	$ 30,926	$ 27,567	$ -	$ 282	$ -	$ 35,781	$ 94,555	138%	$ 130,180	$ 88,646
14	49.35	$ 31,393	$ 27,983	$ -	$ 286	$ -	$ 36,322	$ 95,985	141%	$ 135,439	$ 89,541
15	50.10	$ 31,868	$ 28,406	$ -	$ 290	$ -	$ 36,871	$ 97,436	145%	$ 140,910	$ 90,444
16	50.85	$ 32,350	$ 28,836	$ -	$ 295	$ -	$ 37,429	$ 98,909	148%	$ 146,602	$ 91,357
17	51.62	$ 32,839	$ 29,272	$ -	$ 299	$ -	$ 37,995	$ 100,404	152%	$ 152,523	$ 92,279
18	52.40	$ 33,335	$ 29,714	$ -	$ 304	$ -	$ 38,569	$ 101,922	156%	$ 158,685	$ 93,210
19	53.20	$ 33,839	$ 30,164	$ -	$ 308	$ -	$ 39,152	$ 103,463	160%	$ 165,095	$ 94,151
20	54.00	$ 34,351	$ 30,620	$ -	$ 313	$ -	$ 39,744	$ 105,027	164%	$ 171,764	$ 95,101
t Present Worth		**$ 566,434**	**$ 504,910**	**$ -**	**$ 5,158**	**$ -**	**$ 655,369**				**$ 1,732,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 1 hour per day for operations staff to do routine inspection and monitoring of equipment and 1 hour per day to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the coarse screening system.
5. Coarse screening removal and disposal cost is $64/wet ton per AlexRenew. Coarse screening removal costs would be the same for Alternatives 1 and 2.
6. Hauling of self-leveling roll-off containers cost is approximately $812.50/container. Coarse screenings disposal costs are assumed to be $64/wet ton for Alternatives 3 and 4.
7. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
8. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
9. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
10. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU		8/18/22	11217618
Project		Date	Job No.
Lifecycle Cost Analysis - Alternative 2 Coarse Screens Upgrade		L. Musselman	TAY
Subject		Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 25,830	$ 31,850	$ 628	$ 5,528	$ -	$ 19,029	$ 82,864	102%	$ 84,928	$ 82,454
2	41.22	$ 26,220	$ 32,331	$ 637	$ 5,611	$ -	$ 19,317	$ 84,117	105%	$ 88,358	$ 83,286
3	41.84	$ 26,617	$ 32,820	$ 647	$ 5,696	$ -	$ 19,609	$ 85,389	108%	$ 91,928	$ 84,127
4	42.47	$ 27,019	$ 33,316	$ 657	$ 5,782	$ -	$ 19,906	$ 86,680	110%	$ 95,641	$ 84,976
5	43.12	$ 27,427	$ 33,820	$ 667	$ 5,870	$ -	$ 20,206	$ 87,990	113%	$ 99,504	$ 85,833
6	43.77	$ 27,842	$ 34,331	$ 677	$ 5,958	$ -	$ 20,512	$ 89,321	116%	$ 103,524	$ 86,700
7	44.43	$ 28,263	$ 34,850	$ 687	$ 6,048	$ -	$ 20,822	$ 90,671	119%	$ 107,706	$ 87,575
8	45.10	$ 28,690	$ 35,377	$ 697	$ 6,140	$ -	$ 21,137	$ 92,042	122%	$ 112,056	$ 88,458
9	45.78	$ 29,124	$ 35,912	$ 708	$ 6,233	$ -	$ 21,456	$ 93,433	125%	$ 116,583	$ 89,351
10	46.48	$ 29,564	$ 36,455	$ 719	$ 6,327	$ -	$ 21,781	$ 94,846	128%	$ 121,292	$ 90,253
11	47.18	$ 30,011	$ 37,006	$ 730	$ 6,423	$ -	$ 22,110	$ 96,280	131%	$ 126,192	$ 91,164
12	47.89	$ 30,465	$ 37,566	$ 741	$ 6,520	$ -	$ 22,444	$ 97,735	134%	$ 131,289	$ 92,084
13	48.62	$ 30,926	$ 38,134	$ 752	$ 6,618	$ -	$ 22,784	$ 99,213	138%	$ 136,593	$ 93,013
14	49.35	$ 31,393	$ 38,710	$ 763	$ 6,718	$ -	$ 23,128	$ 100,713	141%	$ 142,110	$ 93,952
15	50.10	$ 31,868	$ 39,295	$ 775	$ 6,820	$ -	$ 23,478	$ 102,235	145%	$ 147,851	$ 94,900
16	50.85	$ 32,350	$ 39,889	$ 786	$ 6,923	$ -	$ 23,833	$ 103,781	148%	$ 153,823	$ 95,858
17	51.62	$ 32,839	$ 40,492	$ 798	$ 7,028	$ -	$ 24,193	$ 105,350	152%	$ 160,037	$ 96,825
18	52.40	$ 33,335	$ 41,105	$ 810	$ 7,134	$ -	$ 24,559	$ 106,943	156%	$ 166,502	$ 97,802
19	53.20	$ 33,839	$ 41,726	$ 823	$ 7,242	$ -	$ 24,930	$ 108,560	160%	$ 173,227	$ 98,789
20	54.00	$ 34,351	$ 42,357	$ 835	$ 7,351	$ -	$ 25,307	$ 110,201	164%	$ 180,225	$ 99,786
t Present Worth		**$ 566,434**	**$ 698,455**	**$ 13,769**	**$ 121,220**	**$ -**	**$ 417,306**				**$ 1,817,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 1 hour per day for operations staff to do routine inspection and monitoring of equipment and 1 hour per day to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the coarse screening system.
5. Coarse screening removal and disposal cost is $64/wet ton per AlexRenew. Coarse screening removal costs would be the same for Alternatives 1 and 2.
6. Hauling of self-leveling roll-off containers cost is approximately $812.50/container. Coarse screenings disposal costs are assumed to be $64/wet ton for Alternatives 3 and 4.
7. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
8. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
9. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
10. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU		8/18/22	11217618
Project		Date	Job No.
Lifecycle Cost Analysis - Alternative 3 Coarse Screens Upgrade		L. Musselman	TAY
Subject		Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 24,979	$ -	$ 470	$ -	$ 29,870	$ 68,234	102%	$ 69,933	$ 67,896
2	41.22	$ 13,110	$ 25,357	$ -	$ 478	$ -	$ 30,321	$ 69,266	105%	$ 72,758	$ 68,582
3	41.84	$ 13,308	$ 25,740	$ -	$ 485	$ -	$ 30,780	$ 70,313	108%	$ 75,697	$ 69,274
4	42.47	$ 13,509	$ 26,129	$ -	$ 492	$ -	$ 31,245	$ 71,376	110%	$ 78,755	$ 69,973
5	43.12	$ 13,714	$ 26,524	$ -	$ 500	$ -	$ 31,718	$ 72,455	113%	$ 81,936	$ 70,679
6	43.77	$ 13,921	$ 26,925	$ -	$ 507	$ -	$ 32,197	$ 73,550	116%	$ 85,246	$ 71,392
7	44.43	$ 14,132	$ 27,332	$ -	$ 515	$ -	$ 32,684	$ 74,662	119%	$ 88,690	$ 72,113
8	45.10	$ 14,345	$ 27,746	$ -	$ 523	$ -	$ 33,178	$ 75,791	122%	$ 92,272	$ 72,841
9	45.78	$ 14,562	$ 28,165	$ -	$ 530	$ -	$ 33,680	$ 76,937	125%	$ 96,000	$ 73,576
10	46.48	$ 14,782	$ 28,591	$ -	$ 538	$ -	$ 34,189	$ 78,100	128%	$ 99,877	$ 74,318
11	47.18	$ 15,006	$ 29,023	$ -	$ 547	$ -	$ 34,706	$ 79,281	131%	$ 103,912	$ 75,068
12	47.89	$ 15,233	$ 29,462	$ -	$ 555	$ -	$ 35,230	$ 80,480	134%	$ 108,109	$ 75,826
13	48.62	$ 15,463	$ 29,907	$ -	$ 563	$ -	$ 35,763	$ 81,696	138%	$ 112,476	$ 76,591
14	49.35	$ 15,697	$ 30,359	$ -	$ 572	$ -	$ 36,304	$ 82,931	141%	$ 117,020	$ 77,364
15	50.10	$ 15,934	$ 30,818	$ -	$ 580	$ -	$ 36,852	$ 84,185	145%	$ 121,747	$ 78,145
16	50.85	$ 16,175	$ 31,284	$ -	$ 589	$ -	$ 37,410	$ 85,458	148%	$ 126,665	$ 78,933
17	51.62	$ 16,419	$ 31,757	$ -	$ 598	$ -	$ 37,975	$ 86,750	152%	$ 131,782	$ 79,730
18	52.40	$ 16,668	$ 32,237	$ -	$ 607	$ -	$ 38,549	$ 88,061	156%	$ 137,105	$ 80,535
19	53.20	$ 16,920	$ 32,725	$ -	$ 616	$ -	$ 39,132	$ 89,393	160%	$ 142,643	$ 81,347
20	54.00	$ 17,175	$ 33,220	$ -	$ 626	$ -	$ 39,724	$ 90,744	164%	$ 148,405	$ 82,168
t Present Worth		**$ 283,217**	**$ 547,783**	**$ -**	**$ 10,317**	**$ -**	**$ 655,034**				**$ 1,496,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 1 hour per day for operations staff to do routine inspection and monitoring of equipment and 1 hour per day to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the coarse screening system.
5. Coarse screening removal and disposal cost is $64/wet ton per AlexRenew. Coarse screening removal costs would be the same for Alternatives 1 and 2.
6. Hauling of self-leveling roll-off containers cost is approximately $812.50/container. Coarse screenings disposal costs are assumed to be $64/wet ton for Alternatives 3 and 4.
7. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
8. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
9. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
10. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	8/18/22	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 4 Coarse Screens Upgrade	L. Musselman	TAY
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 29,761	$ -	$ 2,823	$ -	$ 17,873	$ 63,372	102%	$ 64,950	$ 63,058
2	41.22	$ 13,110	$ 30,211	$ -	$ 2,865	$ -	$ 18,143	$ 64,330	105%	$ 67,573	$ 63,694
3	41.84	$ 13,308	$ 30,668	$ -	$ 2,909	$ -	$ 18,417	$ 65,302	108%	$ 70,303	$ 64,337
4	42.47	$ 13,509	$ 31,132	$ -	$ 2,953	$ -	$ 18,696	$ 66,290	110%	$ 73,143	$ 64,986
5	43.12	$ 13,714	$ 31,602	$ -	$ 2,997	$ -	$ 18,978	$ 67,292	113%	$ 76,097	$ 65,642
6	43.77	$ 13,921	$ 32,080	$ -	$ 3,043	$ -	$ 19,265	$ 68,309	116%	$ 79,171	$ 66,305
7	44.43	$ 14,132	$ 32,565	$ -	$ 3,089	$ -	$ 19,556	$ 69,342	119%	$ 82,369	$ 66,974
8	45.10	$ 14,345	$ 33,058	$ -	$ 3,135	$ -	$ 19,852	$ 70,390	122%	$ 85,697	$ 67,650
9	45.78	$ 14,562	$ 33,557	$ -	$ 3,183	$ -	$ 20,152	$ 71,454	125%	$ 89,158	$ 68,332
10	46.48	$ 14,782	$ 34,065	$ -	$ 3,231	$ -	$ 20,457	$ 72,535	128%	$ 92,760	$ 69,022
11	47.18	$ 15,006	$ 34,580	$ -	$ 3,280	$ -	$ 20,766	$ 73,631	131%	$ 96,507	$ 69,719
12	47.89	$ 15,233	$ 35,102	$ -	$ 3,329	$ -	$ 21,080	$ 74,744	134%	$ 100,405	$ 70,422
13	48.62	$ 15,463	$ 35,633	$ -	$ 3,380	$ -	$ 21,399	$ 75,874	138%	$ 104,461	$ 71,133
14	49.35	$ 15,697	$ 36,172	$ -	$ 3,431	$ -	$ 21,722	$ 77,021	141%	$ 108,681	$ 71,851
15	50.10	$ 15,934	$ 36,719	$ -	$ 3,482	$ -	$ 22,051	$ 78,186	145%	$ 113,071	$ 72,576
16	50.85	$ 16,175	$ 37,274	$ -	$ 3,535	$ -	$ 22,384	$ 79,368	148%	$ 117,638	$ 73,308
17	51.62	$ 16,419	$ 37,837	$ -	$ 3,589	$ -	$ 22,723	$ 80,568	152%	$ 122,390	$ 74,048
18	52.40	$ 16,668	$ 38,409	$ -	$ 3,643	$ -	$ 23,066	$ 81,786	156%	$ 127,334	$ 74,795
19	53.20	$ 16,920	$ 38,990	$ -	$ 3,698	$ -	$ 23,415	$ 83,022	160%	$ 132,478	$ 75,550
20	54.00	$ 17,175	$ 39,580	$ -	$ 3,754	$ -	$ 23,769	$ 84,278	164%	$ 137,829	$ 76,313
t Present Worth		**$ 283,217**	**$ 652,658**	**$ -**	**$ 61,900**	**$ -**	**$ 391,942**				**$ 1,390,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 1 hour per day for operations staff to do routine inspection and monitoring of equipment and 1 hour per day to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the coarse screening system.
5. Coarse screening removal and disposal cost is $64/wet ton per AlexRenew. Coarse screening removal costs would be the same for Alternatives 1 and 2.
6. Hauling of self-leveling roll-off containers cost is approximately $812.50/container. Coarse screenings disposal costs are assumed to be $64/wet ton for Alternatives 3 and 4.
7. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
8. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
9. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
10. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU		8/18/22	11217618
Project		Date	Job No.
Lifecycle Cost Analysis - Alternative 5 Coarse Screens Upgrade		L. Musselman	TAY
Subject		Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 38,037	$ 942	$ 11,055	$ -	$ 32,623	$ 95,573	102%	$ 97,952	$ 95,099
2	41.22	$ 13,110	$ 38,612	$ 956	$ 11,223	$ -	$ 33,116	$ 97,017	105%	$ 101,909	$ 96,059
3	41.84	$ 13,308	$ 39,196	$ 970	$ 11,392	$ -	$ 33,617	$ 98,484	108%	$ 106,026	$ 97,029
4	42.47	$ 13,509	$ 39,789	$ 985	$ 11,564	$ -	$ 34,125	$ 99,973	110%	$ 110,309	$ 98,008
5	43.12	$ 13,714	$ 40,390	$ 1,000	$ 11,739	$ -	$ 34,641	$ 101,485	113%	$ 114,764	$ 98,997
6	43.77	$ 13,921	$ 41,001	$ 1,015	$ 11,917	$ -	$ 35,165	$ 103,019	116%	$ 119,400	$ 99,996
7	44.43	$ 14,132	$ 41,621	$ 1,031	$ 12,097	$ -	$ 35,697	$ 104,576	119%	$ 124,224	$ 101,005
8	45.10	$ 14,345	$ 42,250	$ 1,046	$ 12,280	$ -	$ 36,236	$ 106,157	122%	$ 129,242	$ 102,024
9	45.78	$ 14,562	$ 42,889	$ 1,062	$ 12,465	$ -	$ 36,784	$ 107,762	125%	$ 134,462	$ 103,054
10	46.48	$ 14,782	$ 43,537	$ 1,078	$ 12,654	$ -	$ 37,340	$ 109,391	128%	$ 139,894	$ 104,094
11	47.18	$ 15,006	$ 44,195	$ 1,094	$ 12,845	$ -	$ 37,905	$ 111,045	131%	$ 145,545	$ 105,145
12	47.89	$ 15,233	$ 44,864	$ 1,111	$ 13,039	$ -	$ 38,478	$ 112,724	134%	$ 151,424	$ 106,206
13	48.62	$ 15,463	$ 45,542	$ 1,128	$ 13,237	$ -	$ 39,060	$ 114,428	138%	$ 157,541	$ 107,278
14	49.35	$ 15,697	$ 46,230	$ 1,145	$ 13,437	$ -	$ 39,650	$ 116,158	141%	$ 163,905	$ 108,360
15	50.10	$ 15,934	$ 46,929	$ 1,162	$ 13,640	$ -	$ 40,250	$ 117,914	145%	$ 170,525	$ 109,454
16	50.85	$ 16,175	$ 47,639	$ 1,180	$ 13,846	$ -	$ 40,858	$ 119,697	148%	$ 177,414	$ 110,558
17	51.62	$ 16,419	$ 48,359	$ 1,197	$ 14,055	$ -	$ 41,476	$ 121,507	152%	$ 184,580	$ 111,674
18	52.40	$ 16,668	$ 49,090	$ 1,215	$ 14,268	$ -	$ 42,103	$ 123,344	156%	$ 192,037	$ 112,801
19	53.20	$ 16,920	$ 49,832	$ 1,234	$ 14,484	$ -	$ 42,739	$ 125,208	160%	$ 199,794	$ 113,940
20	54.00	$ 17,175	$ 50,586	$ 1,253	$ 14,702	$ -	$ 43,385	$ 127,101	164%	$ 207,864	$ 115,090
t Present Worth		**$ 283,217**	**$ 834,144**	**$ 20,653**	**$ 242,440**	**$ -**	**$ 715,416**				**$ 2,096,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 1 hour per day for operations staff to do routine inspection and monitoring of equipment and 1 hour per day to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the coarse screening system.
5. Coarse screening removal and disposal cost is $64/wet ton per AlexRenew. Coarse screening removal costs would be the same for Alternatives 1 and 2.
6. Hauling of self-leveling roll-off containers cost is approximately $812.50/container. Coarse screenings disposal costs are assumed to be $64/wet ton for Alternatives 3 and 4.
7. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
8. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
9. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
10. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 16,605	$ 35,191	$ 59,253	$ 265,847	$ -	$ -	$ 376,896	102%	$ 386,280	$ 375,029
2	41.22	$ 16,856	$ 35,723	$ 60,149	$ 265,847	$ -	$ -	$ 378,575	105%	$ 397,662	$ 374,835
3	41.84	$ 17,111	$ 36,263	$ 61,058	$ 265,847	$ -	$ -	$ 380,279	108%	$ 409,399	$ 374,658
4	42.47	$ 17,369	$ 36,811	$ 61,981	$ 265,847	$ -	$ -	$ 382,009	110%	$ 421,502	$ 374,499
5	43.12	$ 17,632	$ 37,368	$ 62,918	$ 265,847	$ -	$ -	$ 383,765	113%	$ 433,983	$ 374,358
6	43.77	$ 17,898	$ 37,933	$ 63,869	$ 265,847	$ -	$ -	$ 385,548	116%	$ 446,855	$ 374,234
7	44.43	$ 18,169	$ 38,506	$ 64,835	$ 265,847	$ -	$ -	$ 387,357	119%	$ 460,132	$ 374,129
8	45.10	$ 18,444	$ 39,088	$ 65,815	$ 265,847	$ -	$ -	$ 389,194	122%	$ 473,826	$ 374,042
9	45.78	$ 18,723	$ 39,679	$ 66,810	$ 265,847	$ -	$ -	$ 391,059	125%	$ 487,951	$ 373,974
10	46.48	$ 19,006	$ 40,279	$ 67,820	$ 265,847	$ -	$ -	$ 392,952	128%	$ 502,522	$ 373,923
11	47.18	$ 19,293	$ 40,888	$ 68,846	$ 265,847	$ -	$ -	$ 394,874	131%	$ 517,553	$ 373,891
12	47.89	$ 19,585	$ 41,506	$ 69,886	$ 265,847	$ -	$ -	$ 396,824	134%	$ 533,060	$ 373,878
13	48.62	$ 19,881	$ 42,134	$ 70,943	$ 265,847	$ -	$ -	$ 398,805	138%	$ 549,060	$ 373,883
14	49.35	$ 20,181	$ 42,771	$ 72,016	$ 265,847	$ -	$ -	$ 400,815	141%	$ 565,568	$ 373,907
15	50.10	$ 20,486	$ 43,417	$ 73,104	$ 265,847	$ -	$ -	$ 402,855	145%	$ 582,601	$ 373,950
16	50.85	$ 20,796	$ 44,074	$ 74,209	$ 265,847	$ -	$ -	$ 404,927	148%	$ 600,178	$ 374,011
17	51.62	$ 21,111	$ 44,740	$ 75,331	$ 265,847	$ -	$ -	$ 407,029	152%	$ 618,317	$ 374,092
18	52.40	$ 21,430	$ 45,416	$ 76,470	$ 265,847	$ -	$ -	$ 409,164	156%	$ 637,036	$ 374,191
19	53.20	$ 21,754	$ 46,103	$ 77,626	$ 265,847	$ -	$ -	$ 411,330	160%	$ 656,356	$ 374,310
20	54.00	$ 22,083	$ 46,800	$ 78,800	$ 265,847	$ -	$ -	$ 413,530	164%	$ 676,296	$ 374,449
Net Present Worth		**$ 364,136**	**$ 771,720**	**$ 1,299,392**	**$ 5,048,995**	**$ -**	**$ -**				**$ 7,484,243**

The following assumptions were used to estimate annual operation and maintenance costs:
1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives were assumed to require 1 hour per day for operations staff to do routine inspection and monitoring of equipment, 1 day per month for monthly PM, and 1 day per year for pump removal for repairs.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Pumps are to be rebuild every 6 years and and VFDs replaced every 10 years.
4. Energy unit cost is $0.08/kW/hr. Three pumps run under design average flow.
5. Chemical cost is system specific and is not applicable to the raw sweage pumps.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 16,605	$ 49,267	$ 64,968	$ 281,454	$ -	$ -	$ 412,293	102%	$ 422,559	$ 410,251
2	41.22	$ 16,856	$ 50,012	$ 65,950	$ 281,454	$ -	$ -	$ 414,271	105%	$ 435,159	$ 410,179
3	41.84	$ 17,111	$ 50,768	$ 66,947	$ 281,454	$ -	$ -	$ 416,279	108%	$ 448,156	$ 410,126
4	42.47	$ 17,369	$ 51,536	$ 67,959	$ 281,454	$ -	$ -	$ 418,317	110%	$ 461,564	$ 410,094
5	43.12	$ 17,632	$ 52,315	$ 68,986	$ 281,454	$ -	$ -	$ 420,386	113%	$ 475,397	$ 410,081
6	43.77	$ 17,898	$ 53,106	$ 70,029	$ 281,454	$ -	$ -	$ 422,487	116%	$ 489,669	$ 410,090
7	44.43	$ 18,169	$ 53,908	$ 71,088	$ 281,454	$ -	$ -	$ 424,619	119%	$ 504,394	$ 410,119
8	45.10	$ 18,444	$ 54,723	$ 72,163	$ 281,454	$ -	$ -	$ 426,784	122%	$ 519,589	$ 410,168
9	45.78	$ 18,723	$ 55,551	$ 73,254	$ 281,454	$ -	$ -	$ 428,981	125%	$ 535,268	$ 410,238
10	46.48	$ 19,006	$ 56,391	$ 74,361	$ 281,454	$ -	$ -	$ 431,211	128%	$ 551,448	$ 410,329
11	47.18	$ 19,293	$ 57,243	$ 75,486	$ 281,454	$ -	$ -	$ 433,475	131%	$ 568,147	$ 410,441
12	47.89	$ 19,585	$ 58,109	$ 76,627	$ 281,454	$ -	$ -	$ 435,773	134%	$ 585,381	$ 410,575
13	48.62	$ 19,881	$ 58,987	$ 77,785	$ 281,454	$ -	$ -	$ 438,107	138%	$ 603,169	$ 410,729
14	49.35	$ 20,181	$ 59,879	$ 78,961	$ 281,454	$ -	$ -	$ 440,475	141%	$ 621,530	$ 410,905
15	50.10	$ 20,486	$ 60,784	$ 80,155	$ 281,454	$ -	$ -	$ 442,879	145%	$ 640,483	$ 411,102
16	50.85	$ 20,796	$ 61,703	$ 81,367	$ 281,454	$ -	$ -	$ 445,320	148%	$ 660,048	$ 411,320
17	51.62	$ 21,111	$ 62,636	$ 82,597	$ 281,454	$ -	$ -	$ 447,797	152%	$ 680,247	$ 411,560
18	52.40	$ 21,430	$ 63,583	$ 83,846	$ 281,454	$ -	$ -	$ 450,312	156%	$ 701,100	$ 411,823
19	53.20	$ 21,754	$ 64,544	$ 85,113	$ 281,454	$ -	$ -	$ 452,865	160%	$ 722,631	$ 412,107
20	54.00	$ 22,083	$ 65,520	$ 86,400	$ 281,454	$ -	$ -	$ 455,456	164%	$ 744,863	$ 412,413
Net Present Worth		**$ 364,136**	**$ 1,080,408**	**$ 1,424,714**	**$ 5,345,390**	**$ -**	**$ -**				**$ 8,214,648**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives were assumed to require 1 hour per day for operations staff to do routine inspection and monitoring of equipment, 1 day per month for monthly PM, and 1 day per year for pump removal for repairs.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Pumps are to be rebuild every 6 years and and VFDs replaced every 10 years.
4. Energy unit cost is $0.08/kW/hr. Two pumps run under design average flow.
5. Chemical cost is system specific and is not applicable to the raw sweage pumps.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	12/6/21	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 3 - Flygt Dry-pit Submersible Pump	N. Hovorka	J. Cannon
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacmenet	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 16,605	$ 45,631	$ 53,989	$ 282,460	$ -	$ -	$ 398,684	102%	$ 408,611	$ 396,710
2	41.22	$ 16,856	$ 46,321	$ 54,805	$ 282,460	$ -	$ -	$ 400,441	105%	$ 420,631	$ 396,485
3	41.84	$ 17,111	$ 47,021	$ 55,633	$ 282,460	$ -	$ -	$ 402,225	108%	$ 433,025	$ 396,279
4	42.47	$ 17,369	$ 47,732	$ 56,474	$ 282,460	$ -	$ -	$ 404,035	110%	$ 445,805	$ 396,092
5	43.12	$ 17,632	$ 48,453	$ 57,328	$ 282,460	$ -	$ -	$ 405,873	113%	$ 458,984	$ 395,924
6	43.77	$ 17,898	$ 49,186	$ 58,195	$ 282,460	$ -	$ -	$ 407,739	116%	$ 472,576	$ 395,775
7	44.43	$ 18,169	$ 49,930	$ 59,075	$ 282,460	$ -	$ -	$ 409,633	119%	$ 486,593	$ 395,644
8	45.10	$ 18,444	$ 50,684	$ 59,968	$ 282,460	$ -	$ -	$ 411,556	122%	$ 501,050	$ 395,533
9	45.78	$ 18,723	$ 51,451	$ 60,874	$ 282,460	$ -	$ -	$ 413,508	125%	$ 515,961	$ 395,441
10	46.48	$ 19,006	$ 52,228	$ 61,795	$ 282,460	$ -	$ -	$ 415,489	128%	$ 531,342	$ 395,368
11	47.18	$ 19,293	$ 53,018	$ 62,729	$ 282,460	$ -	$ -	$ 417,500	131%	$ 547,209	$ 395,315
12	47.89	$ 19,585	$ 53,820	$ 63,677	$ 282,460	$ -	$ -	$ 419,542	134%	$ 563,577	$ 395,281
13	48.62	$ 19,881	$ 54,633	$ 64,640	$ 282,460	$ -	$ -	$ 421,614	138%	$ 580,463	$ 395,267
14	49.35	$ 20,181	$ 55,459	$ 65,617	$ 282,460	$ -	$ -	$ 423,718	141%	$ 597,885	$ 395,272
15	50.10	$ 20,486	$ 56,298	$ 66,609	$ 282,460	$ -	$ -	$ 425,853	145%	$ 615,861	$ 395,298
16	50.85	$ 20,796	$ 57,149	$ 67,616	$ 282,460	$ -	$ -	$ 428,021	148%	$ 634,409	$ 395,343
17	51.62	$ 21,111	$ 58,013	$ 68,639	$ 282,460	$ -	$ -	$ 430,222	152%	$ 653,549	$ 395,408
18	52.40	$ 21,430	$ 58,890	$ 69,676	$ 282,460	$ -	$ -	$ 432,456	156%	$ 673,300	$ 395,493
19	53.20	$ 21,754	$ 59,780	$ 70,730	$ 282,460	$ -	$ -	$ 434,724	160%	$ 693,684	$ 395,598
20	54.00	$ 22,083	$ 60,684	$ 71,799	$ 282,460	$ -	$ -	$ 437,025	164%	$ 714,721	$ 395,724
Net Present Worth		**$ 364,136**	**$ 1,000,664**	**$ 1,183,947**	**$ 5,364,503**	**$ -**	**$ -**				**$ 7,913,251**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives were assumed to require 1 hour per day for operations staff to do routine inspection and monitoring of equipment, 1 day per month for monthly PM, and 1 day per year for pump removal for repairs.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Pumps are to be rebuild every 6 years and and VFDs replaced every 10 years.
4. Energy unit cost is $0.08/kW/hr. Two pumps run under design average flow.
5. Chemical cost is system specific and is not applicable to the raw sweage pumps.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU		12/5/21	11217618
Project		Date	Job No.
Lifecycle Cost Analysis - Alternative 1 Conduits Upgrade		T. Junker	
Subject		Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	General Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ -	$ 13,142	$ -	$ -	$ -	$ -	$ 13,142	102%	$ 13,469	$ 13,077
2	41.22	$ -	$ 13,340	$ -	$ -	$ -	$ -	$ 13,340	105%	$ 14,013	$ 13,209
3	41.84	$ -	$ 13,542	$ -	$ -	$ -	$ -	$ 13,542	108%	$ 14,579	$ 13,342
4	42.47	$ -	$ 13,747	$ -	$ -	$ -	$ -	$ 13,747	110%	$ 15,168	$ 13,476
5	43.12	$ -	$ 13,955	$ -	$ -	$ -	$ -	$ 13,955	113%	$ 15,781	$ 13,613
6	43.77	$ -	$ 14,166	$ -	$ -	$ -	$ -	$ 14,166	116%	$ 16,418	$ 13,750
7	44.43	$ -	$ 14,380	$ -	$ -	$ -	$ -	$ 14,380	119%	$ 17,081	$ 13,889
8	45.10	$ -	$ 14,597	$ -	$ -	$ -	$ -	$ 14,597	122%	$ 17,771	$ 14,029
9	45.78	$ -	$ 14,818	$ -	$ -	$ -	$ -	$ 14,818	125%	$ 18,489	$ 14,170
10	46.48	$ -	$ 15,042	$ -	$ -	$ -	$ -	$ 15,042	128%	$ 19,236	$ 14,313
11	47.18	$ -	$ 15,269	$ -	$ -	$ -	$ -	$ 15,269	131%	$ 20,013	$ 14,458
12	47.89	$ -	$ 15,500	$ -	$ -	$ -	$ -	$ 15,500	134%	$ 20,821	$ 14,604
13	48.62	$ -	$ 15,734	$ -	$ -	$ -	$ -	$ 15,734	138%	$ 21,663	$ 14,751
14	49.35	$ -	$ 15,972	$ -	$ -	$ -	$ -	$ 15,972	141%	$ 22,538	$ 14,900
15	50.10	$ -	$ 16,214	$ -	$ -	$ -	$ -	$ 16,214	145%	$ 23,448	$ 15,050
16	50.85	$ -	$ 16,459	$ -	$ -	$ -	$ -	$ 16,459	148%	$ 24,395	$ 15,202
17	51.62	$ -	$ 16,708	$ -	$ -	$ -	$ -	$ 16,708	152%	$ 25,381	$ 15,356
18	52.40	$ -	$ 16,960	$ -	$ -	$ -	$ -	$ 16,960	156%	$ 26,406	$ 15,511
19	53.20	$ -	$ 17,217	$ -	$ -	$ -	$ -	$ 17,217	160%	$ 27,473	$ 15,667
20	54.00	$ -	$ 17,477	$ -	$ -	$ -	$ -	$ 17,477	164%	$ 28,582	$ 15,825
Net Present Worth		**$ -**	**$ 288,191**	**$ -**	**$ -**	**$ -**	**$ -**				**$ 288,000**

The following assumptions were used to estimate annual operation and maintenance costs:
1. General maintenance for cleaning based on Magnolia quote provided for conduits inspection.
2. General maintenance for inspection based on RedZone Robotics quote provided for conduits inspection.
3. General maintenance assumes inspections every 10-years.
4. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
5. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
6. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
7. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

	AlexRenew PPSU	12/5/21	11217618
	Project	Date	Job No.
	Lifecycle Cost Analysis - Alternative 2 Conduits Upgrade	T. Junker	
	Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	General Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ -	$ 13,142	$ -	$ -	$ -	$ -	$ 13,142	102%	$ 13,469	$ 13,077
2	41.22	$ -	$ 13,340	$ -	$ -	$ -	$ -	$ 13,340	105%	$ 14,013	$ 13,209
3	41.84	$ -	$ 13,542	$ -	$ -	$ -	$ -	$ 13,542	108%	$ 14,579	$ 13,342
4	42.47	$ -	$ 13,747	$ -	$ -	$ -	$ -	$ 13,747	110%	$ 15,168	$ 13,476
5	43.12	$ -	$ 13,955	$ -	$ -	$ -	$ -	$ 13,955	113%	$ 15,781	$ 13,613
6	43.77	$ -	$ 14,166	$ -	$ -	$ -	$ -	$ 14,166	116%	$ 16,418	$ 13,750
7	44.43	$ -	$ 14,380	$ -	$ -	$ -	$ -	$ 14,380	119%	$ 17,081	$ 13,889
8	45.10	$ -	$ 14,597	$ -	$ -	$ -	$ -	$ 14,597	122%	$ 17,771	$ 14,029
9	45.78	$ -	$ 14,818	$ -	$ -	$ -	$ -	$ 14,818	125%	$ 18,489	$ 14,170
10	46.48	$ -	$ 15,042	$ -	$ -	$ -	$ -	$ 15,042	128%	$ 19,236	$ 14,313
11	47.18	$ -	$ 15,269	$ -	$ -	$ -	$ -	$ 15,269	131%	$ 20,013	$ 14,458
12	47.89	$ -	$ 15,500	$ -	$ -	$ -	$ -	$ 15,500	134%	$ 20,821	$ 14,604
13	48.62	$ -	$ 15,734	$ -	$ -	$ -	$ -	$ 15,734	138%	$ 21,663	$ 14,751
14	49.35	$ -	$ 15,972	$ -	$ -	$ -	$ -	$ 15,972	141%	$ 22,538	$ 14,900
15	50.10	$ -	$ 16,214	$ -	$ -	$ -	$ -	$ 16,214	145%	$ 23,448	$ 15,050
16	50.85	$ -	$ 16,459	$ -	$ -	$ -	$ -	$ 16,459	148%	$ 24,395	$ 15,202
17	51.62	$ -	$ 16,708	$ -	$ -	$ -	$ -	$ 16,708	152%	$ 25,381	$ 15,356
18	52.40	$ -	$ 16,960	$ -	$ -	$ -	$ -	$ 16,960	156%	$ 26,406	$ 15,511
19	53.20	$ -	$ 17,217	$ -	$ -	$ -	$ -	$ 17,217	160%	$ 27,473	$ 15,667
20	54.00	$ -	$ 17,477	$ -	$ -	$ -	$ -	$ 17,477	164%	$ 28,582	$ 15,825
Net Present Worth		**$ -**	**$ 288,191**	**$ -**	**$ -**	**$ -**	**$ -**				**$ 288,000**

The following assumptions were used to estimate annual operation and maintenance costs:
1. General maintenance for cleaning based on Magnolia quote provided for conduits inspection.
2. General maintenance for inspection based on RedZone Robotics quote provided for conduits inspection.
3. General maintenance assumes inspections every 10-years.
4. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
5. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
6. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
7. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU | 12/5/21 | 11217618
Project | Date | Job No.

Lifecycle Cost Analysis - Alternative 3 Conduits Upgrade | T. Junker
Subject | Comp. By | Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	General Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ -	$ 13,142	$ -	$ -	$ -	$ -	$ 13,142	102%	$ 13,469	$ 13,077
2	41.22	$ -	$ 13,340	$ -	$ -	$ -	$ -	$ 13,340	105%	$ 14,013	$ 13,209
3	41.84	$ -	$ 13,542	$ -	$ -	$ -	$ -	$ 13,542	108%	$ 14,579	$ 13,342
4	42.47	$ -	$ 13,747	$ -	$ -	$ -	$ -	$ 13,747	110%	$ 15,168	$ 13,476
5	43.12	$ -	$ 13,955	$ -	$ -	$ -	$ -	$ 13,955	113%	$ 15,781	$ 13,613
6	43.77	$ -	$ 14,166	$ -	$ -	$ -	$ -	$ 14,166	116%	$ 16,418	$ 13,750
7	44.43	$ -	$ 14,380	$ -	$ -	$ -	$ -	$ 14,380	119%	$ 17,081	$ 13,889
8	45.10	$ -	$ 14,597	$ -	$ -	$ -	$ -	$ 14,597	122%	$ 17,771	$ 14,029
9	45.78	$ -	$ 14,818	$ -	$ -	$ -	$ -	$ 14,818	125%	$ 18,489	$ 14,170
10	46.48	$ -	$ 15,042	$ -	$ -	$ -	$ -	$ 15,042	128%	$ 19,236	$ 14,313
11	47.18	$ -	$ 15,269	$ -	$ -	$ -	$ -	$ 15,269	131%	$ 20,013	$ 14,458
12	47.89	$ -	$ 15,500	$ -	$ -	$ -	$ -	$ 15,500	134%	$ 20,821	$ 14,604
13	48.62	$ -	$ 15,734	$ -	$ -	$ -	$ -	$ 15,734	138%	$ 21,663	$ 14,751
14	49.35	$ -	$ 15,972	$ -	$ -	$ -	$ -	$ 15,972	141%	$ 22,538	$ 14,900
15	50.10	$ -	$ 16,214	$ -	$ -	$ -	$ -	$ 16,214	145%	$ 23,448	$ 15,050
16	50.85	$ -	$ 16,459	$ -	$ -	$ -	$ -	$ 16,459	148%	$ 24,395	$ 15,202
17	51.62	$ -	$ 16,708	$ -	$ -	$ -	$ -	$ 16,708	152%	$ 25,381	$ 15,356
18	52.40	$ -	$ 16,960	$ -	$ -	$ -	$ -	$ 16,960	156%	$ 26,406	$ 15,511
19	53.20	$ -	$ 17,217	$ -	$ -	$ -	$ -	$ 17,217	160%	$ 27,473	$ 15,667
20	54.00	$ -	$ 17,477	$ -	$ -	$ -	$ -	$ 17,477	164%	$ 28,582	$ 15,825
Net Present Worth		**$ -**	**$ 288,191**	**$ -**	**$ -**	**$ -**	**$ -**				**$ 288,000**

The following assumptions were used to estimate annual operation and maintenance costs:
1. General maintenance for cleaning based on Magnolia quote provided for conduits inspection.
2. General maintenance for inspection based on RedZone Robotics quote provided for conduits inspection.
3. General maintenance assumes inspections every 10-years.
4. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
5. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
6. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
7. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	4/6/21	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 1 Fine Screens Upgrade	PC	TAY
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 25,830	$ 24,047	$ -	$ 2,082	$ -	$ 75,074	$ 127,032	102%	$ 130,195	$ 126,403
2	41.22	$ 26,220	$ 24,411	$ -	$ 2,113	$ -	$ 76,209	$ 128,953	105%	$ 135,454	$ 127,679
3	41.84	$ 26,617	$ 24,780	$ -	$ 2,145	$ -	$ 77,361	$ 130,902	108%	$ 140,926	$ 128,967
4	42.47	$ 27,019	$ 25,154	$ -	$ 2,178	$ -	$ 78,530	$ 132,881	110%	$ 146,619	$ 130,269
5	43.12	$ 27,427	$ 25,535	$ -	$ 2,210	$ -	$ 79,718	$ 134,890	113%	$ 152,541	$ 131,583
6	43.77	$ 27,842	$ 25,921	$ -	$ 2,244	$ -	$ 80,923	$ 136,929	116%	$ 158,703	$ 132,911
7	44.43	$ 28,263	$ 26,312	$ -	$ 2,278	$ -	$ 82,146	$ 139,000	119%	$ 165,114	$ 134,253
8	45.10	$ 28,690	$ 26,710	$ -	$ 2,312	$ -	$ 83,388	$ 141,101	122%	$ 171,784	$ 135,608
9	45.78	$ 29,124	$ 27,114	$ -	$ 2,347	$ -	$ 84,649	$ 143,234	125%	$ 178,723	$ 136,976
10	46.48	$ 29,564	$ 27,524	$ -	$ 2,383	$ -	$ 85,929	$ 145,400	128%	$ 185,942	$ 138,359
11	47.18	$ 30,011	$ 27,940	$ -	$ 2,419	$ -	$ 87,228	$ 147,598	131%	$ 193,453	$ 139,755
12	47.89	$ 30,465	$ 28,363	$ -	$ 2,455	$ -	$ 88,546	$ 149,829	134%	$ 201,268	$ 141,165
13	48.62	$ 30,926	$ 28,791	$ -	$ 2,492	$ -	$ 89,885	$ 152,094	138%	$ 209,398	$ 142,590
14	49.35	$ 31,393	$ 29,227	$ -	$ 2,530	$ -	$ 91,244	$ 154,394	141%	$ 217,857	$ 144,029
15	50.10	$ 31,868	$ 29,668	$ -	$ 2,568	$ -	$ 92,623	$ 156,728	145%	$ 226,657	$ 145,483
16	50.85	$ 32,350	$ 30,117	$ -	$ 2,607	$ -	$ 94,024	$ 159,098	148%	$ 235,813	$ 146,951
17	51.62	$ 32,839	$ 30,572	$ -	$ 2,647	$ -	$ 95,445	$ 161,503	152%	$ 245,338	$ 148,434
18	52.40	$ 33,335	$ 31,035	$ -	$ 2,687	$ -	$ 96,888	$ 163,945	156%	$ 255,249	$ 149,932
19	53.20	$ 33,839	$ 31,504	$ -	$ 2,727	$ -	$ 98,353	$ 166,423	160%	$ 265,560	$ 151,445
20	54.00	$ 34,351	$ 31,980	$ -	$ 2,768	$ -	$ 99,840	$ 168,939	164%	$ 276,287	$ 152,973
Present Worth		**$ 566,434**	**$ 527,342**	**$ -**	**$ 45,651**	**$ -**	**$ 1,646,337**				**$ 2,786,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 2 hours per day for operations staff to do routine inspection and monitoring of equipment and to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the fine screening system.
5. Fine screening removal and disposal cost is $64/wet ton per AlexRenew. Fine screening removal costs would be the same for all Alternatives.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	4/6/21	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 2 Fine Screens Upgrade	PC	TAY
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 25,830	$ 25,491	$ -	$ 2,082	$ -	$ 75,074	$ 128,476	102%	$ 131,675	$ 127,840
2	41.22	$ 26,220	$ 25,876	$ -	$ 2,113	$ -	$ 76,209	$ 130,418	105%	$ 136,994	$ 129,130
3	41.84	$ 26,617	$ 26,267	$ -	$ 2,145	$ -	$ 77,361	$ 132,390	108%	$ 142,528	$ 130,433
4	42.47	$ 27,019	$ 26,664	$ -	$ 2,178	$ -	$ 78,530	$ 134,391	110%	$ 148,285	$ 131,749
5	43.12	$ 27,427	$ 27,068	$ -	$ 2,210	$ -	$ 79,718	$ 136,423	113%	$ 154,275	$ 133,079
6	43.77	$ 27,842	$ 27,477	$ -	$ 2,244	$ -	$ 80,923	$ 138,486	116%	$ 160,507	$ 134,422
7	44.43	$ 28,263	$ 27,892	$ -	$ 2,278	$ -	$ 82,146	$ 140,579	119%	$ 166,990	$ 135,779
8	45.10	$ 28,690	$ 28,314	$ -	$ 2,312	$ -	$ 83,388	$ 142,705	122%	$ 173,736	$ 137,149
9	45.78	$ 29,124	$ 28,742	$ -	$ 2,347	$ -	$ 84,649	$ 144,862	125%	$ 180,754	$ 138,533
10	46.48	$ 29,564	$ 29,176	$ -	$ 2,383	$ -	$ 85,929	$ 147,052	128%	$ 188,056	$ 139,931
11	47.18	$ 30,011	$ 29,618	$ -	$ 2,419	$ -	$ 87,228	$ 149,275	131%	$ 195,652	$ 141,343
12	47.89	$ 30,465	$ 30,065	$ -	$ 2,455	$ -	$ 88,546	$ 151,532	134%	$ 203,555	$ 142,770
13	48.62	$ 30,926	$ 30,520	$ -	$ 2,492	$ -	$ 89,885	$ 153,823	138%	$ 211,778	$ 144,210
14	49.35	$ 31,393	$ 30,981	$ -	$ 2,530	$ -	$ 91,244	$ 156,149	141%	$ 220,333	$ 145,666
15	50.10	$ 31,868	$ 31,450	$ -	$ 2,568	$ -	$ 92,623	$ 158,509	145%	$ 229,233	$ 147,136
16	50.85	$ 32,350	$ 31,925	$ -	$ 2,607	$ -	$ 94,024	$ 160,906	148%	$ 238,493	$ 148,621
17	51.62	$ 32,839	$ 32,408	$ -	$ 2,647	$ -	$ 95,445	$ 163,338	152%	$ 248,127	$ 150,121
18	52.40	$ 33,335	$ 32,898	$ -	$ 2,687	$ -	$ 96,888	$ 165,808	156%	$ 258,150	$ 151,636
19	53.20	$ 33,839	$ 33,395	$ -	$ 2,727	$ -	$ 98,353	$ 168,314	160%	$ 268,578	$ 153,166
20	54.00	$ 34,351	$ 33,900	$ -	$ 2,768	$ -	$ 99,840	$ 170,859	164%	$ 279,427	$ 154,712
Present Worth		**$ 566,434**	**$ 559,002**	**$ -**	**$ 45,651**	**$ -**	**$ 1,646,337**				**$ 2,817,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 2 hours per day for operations staff to do routine inspection and monitoring of equipment and to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the fine screening system.
5. Fine screening removal and disposal cost is $64/wet ton per AlexRenew. Fine screening removal costs would be the same for all Alternatives.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	4/6/21	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 3 Fine Screens Upgrade	PC	TAY
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 25,830	$ 23,912	$ -	$ 2,999	$ -	$ 75,074	$ 127,814	102%	$ 130,997	$ 127,181
2	41.22	$ 26,220	$ 24,273	$ -	$ 3,044	$ -	$ 76,209	$ 129,746	105%	$ 136,288	$ 128,465
3	41.84	$ 26,617	$ 24,640	$ -	$ 3,090	$ -	$ 77,361	$ 131,708	108%	$ 141,794	$ 129,761
4	42.47	$ 27,019	$ 25,013	$ -	$ 3,137	$ -	$ 78,530	$ 133,699	110%	$ 147,521	$ 131,071
5	43.12	$ 27,427	$ 25,391	$ -	$ 3,185	$ -	$ 79,718	$ 135,720	113%	$ 153,480	$ 132,393
6	43.77	$ 27,842	$ 25,775	$ -	$ 3,233	$ -	$ 80,923	$ 137,772	116%	$ 159,680	$ 133,730
7	44.43	$ 28,263	$ 26,164	$ -	$ 3,282	$ -	$ 82,146	$ 139,855	119%	$ 166,130	$ 135,079
8	45.10	$ 28,690	$ 26,560	$ -	$ 3,331	$ -	$ 83,388	$ 141,970	122%	$ 172,841	$ 136,442
9	45.78	$ 29,124	$ 26,961	$ -	$ 3,382	$ -	$ 84,649	$ 144,116	125%	$ 179,823	$ 137,819
10	46.48	$ 29,564	$ 27,369	$ -	$ 3,433	$ -	$ 85,929	$ 146,295	128%	$ 187,087	$ 139,210
11	47.18	$ 30,011	$ 27,783	$ -	$ 3,485	$ -	$ 87,228	$ 148,506	131%	$ 194,644	$ 140,615
12	47.89	$ 30,465	$ 28,203	$ -	$ 3,537	$ -	$ 88,546	$ 150,752	134%	$ 202,507	$ 142,034
13	48.62	$ 30,926	$ 28,629	$ -	$ 3,591	$ -	$ 89,885	$ 153,031	138%	$ 210,687	$ 143,468
14	49.35	$ 31,393	$ 29,062	$ -	$ 3,645	$ -	$ 91,244	$ 155,344	141%	$ 219,198	$ 144,916
15	50.10	$ 31,868	$ 29,501	$ -	$ 3,700	$ -	$ 92,623	$ 157,693	145%	$ 228,052	$ 146,378
16	50.85	$ 32,350	$ 29,947	$ -	$ 3,756	$ -	$ 94,024	$ 160,077	148%	$ 237,264	$ 147,855
17	51.62	$ 32,839	$ 30,400	$ -	$ 3,813	$ -	$ 95,445	$ 162,497	152%	$ 246,849	$ 149,348
18	52.40	$ 33,335	$ 30,860	$ -	$ 3,871	$ -	$ 96,888	$ 164,954	156%	$ 256,820	$ 150,855
19	53.20	$ 33,839	$ 31,326	$ -	$ 3,929	$ -	$ 98,353	$ 167,448	160%	$ 267,194	$ 152,377
20	54.00	$ 34,351	$ 31,800	$ -	$ 3,988	$ -	$ 99,840	$ 169,979	164%	$ 277,988	$ 153,915
Present Worth		**$ 566,434**	**$ 524,374**	**$ -**	**$ 65,768**	**$ -**	**$ 1,646,337**				**$ 2,803,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 2 hours per day for operations staff to do routine inspection and monitoring of equipment and to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the fine screening system.
5. Fine screening removal and disposal cost is $64/wet ton per AlexRenew. Fine screening removal costs would be the same for all Alternatives.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	4/6/21	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 4 Fine Screens Upgrade	PC	TAY
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 25,830	$ 24,137	$ -	$ 2,329	$ -	$ 75,074	$ 127,369	102%	$ 130,541	$ 126,739
2	41.22	$ 26,220	$ 24,502	$ -	$ 2,364	$ -	$ 76,209	$ 129,295	105%	$ 135,814	$ 128,018
3	41.84	$ 26,617	$ 24,873	$ -	$ 2,400	$ -	$ 77,361	$ 131,250	108%	$ 141,300	$ 129,310
4	42.47	$ 27,019	$ 25,249	$ -	$ 2,436	$ -	$ 78,530	$ 133,234	110%	$ 147,008	$ 130,615
5	43.12	$ 27,427	$ 25,630	$ -	$ 2,473	$ -	$ 79,718	$ 135,248	113%	$ 152,946	$ 131,933
6	43.77	$ 27,842	$ 26,018	$ -	$ 2,510	$ -	$ 80,923	$ 137,293	116%	$ 159,124	$ 133,264
7	44.43	$ 28,263	$ 26,411	$ -	$ 2,548	$ -	$ 82,146	$ 139,369	119%	$ 165,552	$ 134,609
8	45.10	$ 28,690	$ 26,810	$ -	$ 2,587	$ -	$ 83,388	$ 141,476	122%	$ 172,240	$ 135,968
9	45.78	$ 29,124	$ 27,216	$ -	$ 2,626	$ -	$ 84,649	$ 143,614	125%	$ 179,197	$ 137,340
10	46.48	$ 29,564	$ 27,627	$ -	$ 2,665	$ -	$ 85,929	$ 145,786	128%	$ 186,436	$ 138,726
11	47.18	$ 30,011	$ 28,045	$ -	$ 2,706	$ -	$ 87,228	$ 147,990	131%	$ 193,967	$ 140,126
12	47.89	$ 30,465	$ 28,469	$ -	$ 2,747	$ -	$ 88,546	$ 150,227	134%	$ 201,802	$ 141,540
13	48.62	$ 30,926	$ 28,899	$ -	$ 2,788	$ -	$ 89,885	$ 152,498	138%	$ 209,954	$ 142,968
14	49.35	$ 31,393	$ 29,336	$ -	$ 2,830	$ -	$ 91,244	$ 154,804	141%	$ 218,435	$ 144,411
15	50.10	$ 31,868	$ 29,780	$ -	$ 2,873	$ -	$ 92,623	$ 157,144	145%	$ 227,259	$ 145,869
16	50.85	$ 32,350	$ 30,230	$ -	$ 2,916	$ -	$ 94,024	$ 159,520	148%	$ 236,439	$ 147,341
17	51.62	$ 32,839	$ 30,687	$ -	$ 2,961	$ -	$ 95,445	$ 161,932	152%	$ 245,990	$ 148,828
18	52.40	$ 33,335	$ 31,151	$ -	$ 3,005	$ -	$ 96,888	$ 164,380	156%	$ 255,926	$ 150,330
19	53.20	$ 33,839	$ 31,622	$ -	$ 3,051	$ -	$ 98,353	$ 166,865	160%	$ 266,264	$ 151,847
20	54.00	$ 34,351	$ 32,100	$ -	$ 3,097	$ -	$ 99,840	$ 169,388	164%	$ 277,020	$ 153,379
Present Worth		**$ 566,434**	**$ 529,321**	**$ -**	**$ 51,067**	**$ -**	**$ 1,646,337**				**$ 2,793,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 2 hours per day for operations staff to do routine inspection and monitoring of equipment and to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the fine screening system.
5. Fine screening removal and disposal cost is $64/wet ton per AlexRenew. Fine screening removal costs would be the same for all Alternatives.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 25,830	$ 23,423	$ -	$ 2,717	$ -	$ 75,074	$ 127,043	102%	$ 130,206	$ 126,414
2	41.22	$ 26,220	$ 23,777	$ -	$ 2,758	$ -	$ 76,209	$ 128,964	105%	$ 135,466	$ 127,690
3	41.84	$ 26,617	$ 24,137	$ -	$ 2,800	$ -	$ 77,361	$ 130,913	108%	$ 140,938	$ 128,978
4	42.47	$ 27,019	$ 24,501	$ -	$ 2,842	$ -	$ 78,530	$ 132,893	110%	$ 146,631	$ 130,280
5	43.12	$ 27,427	$ 24,872	$ -	$ 2,885	$ -	$ 79,718	$ 134,902	113%	$ 152,554	$ 131,595
6	43.77	$ 27,842	$ 25,248	$ -	$ 2,928	$ -	$ 80,923	$ 136,941	116%	$ 158,717	$ 132,923
7	44.43	$ 28,263	$ 25,630	$ -	$ 2,973	$ -	$ 82,146	$ 139,012	119%	$ 165,128	$ 134,264
8	45.10	$ 28,690	$ 26,017	$ -	$ 3,018	$ -	$ 83,388	$ 141,113	122%	$ 171,799	$ 135,619
9	45.78	$ 29,124	$ 26,410	$ -	$ 3,063	$ -	$ 84,649	$ 143,247	125%	$ 178,738	$ 136,988
10	46.48	$ 29,564	$ 26,810	$ -	$ 3,110	$ -	$ 85,929	$ 145,412	128%	$ 185,958	$ 138,371
11	47.18	$ 30,011	$ 27,215	$ -	$ 3,157	$ -	$ 87,228	$ 147,611	131%	$ 193,470	$ 139,767
12	47.89	$ 30,465	$ 27,626	$ -	$ 3,204	$ -	$ 88,546	$ 149,842	134%	$ 201,285	$ 141,178
13	48.62	$ 30,926	$ 28,044	$ -	$ 3,253	$ -	$ 89,885	$ 152,108	138%	$ 209,416	$ 142,602
14	49.35	$ 31,393	$ 28,468	$ -	$ 3,302	$ -	$ 91,244	$ 154,407	141%	$ 217,876	$ 144,041
15	50.10	$ 31,868	$ 28,898	$ -	$ 3,352	$ -	$ 92,623	$ 156,742	145%	$ 226,677	$ 145,495
16	50.85	$ 32,350	$ 29,335	$ -	$ 3,403	$ -	$ 94,024	$ 159,111	148%	$ 235,833	$ 146,963
17	51.62	$ 32,839	$ 29,779	$ -	$ 3,454	$ -	$ 95,445	$ 161,517	152%	$ 245,360	$ 148,447
18	52.40	$ 33,335	$ 30,229	$ -	$ 3,506	$ -	$ 96,888	$ 163,959	156%	$ 255,271	$ 149,945
19	53.20	$ 33,839	$ 30,686	$ -	$ 3,559	$ -	$ 98,353	$ 166,437	160%	$ 265,583	$ 151,458
20	54.00	$ 34,351	$ 31,150	$ -	$ 3,613	$ -	$ 99,840	$ 168,954	164%	$ 276,311	$ 152,987
Present Worth		**$ 566,434**	**$ 513,656**	**$ -**	**$ 59,578**	**$ -**	**$ 1,646,337**				**$ 2,786,000**

The following assumptions were used to estimate annual operation and maintenance costs:
1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 2 hours per day for operations staff to do routine inspection and monitoring of equipment and to handle screenings, which may require periodic raking to even out the load in the dumpster.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the fine screening system.
5. Fine screening removal and disposal cost is $64/wet ton per AlexRenew. Fine screening removal costs would be the same for all Alternatives.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU		3/18/22	11217618
Project		Date	Job No.
Lifecycle Cost Analysis - Alternative 1: Four Enhanced Vortex Grit Separators with Four Standard Grit Pumps with Four Hydrocyclone/Grit Classifier Units		L. Musselman	
Subject		Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 240,792	$ -	$ 36,548	$ -	$ 286,392	$ 576,647	102%	$ 591,005	$ 573,791
2	41.22	$ 13,110	$ 244,432	$ -	$ 37,100	$ -	$ 290,722	$ 585,365	105%	$ 614,879	$ 579,582
3	41.84	$ 13,308	$ 248,128	$ -	$ 37,661	$ -	$ 295,117	$ 594,214	108%	$ 639,717	$ 585,431
4	42.47	$ 13,509	$ 251,879	$ -	$ 38,231	$ -	$ 299,579	$ 603,198	110%	$ 665,558	$ 591,339
5	43.12	$ 13,714	$ 255,687	$ -	$ 38,809	$ -	$ 304,108	$ 612,317	113%	$ 692,443	$ 597,307
6	43.77	$ 13,921	$ 259,553	$ -	$ 39,395	$ -	$ 308,706	$ 621,574	116%	$ 720,414	$ 603,335
7	44.43	$ 14,132	$ 263,477	$ -	$ 39,991	$ -	$ 313,373	$ 630,972	119%	$ 749,515	$ 609,424
8	45.10	$ 14,345	$ 267,460	$ -	$ 40,595	$ -	$ 318,110	$ 640,511	122%	$ 779,792	$ 615,575
9	45.78	$ 14,562	$ 271,503	$ -	$ 41,209	$ -	$ 322,920	$ 650,194	125%	$ 811,291	$ 621,787
10	46.48	$ 14,782	$ 275,608	$ -	$ 41,832	$ -	$ 327,802	$ 660,024	128%	$ 844,063	$ 628,062
11	47.18	$ 15,006	$ 279,775	$ -	$ 42,465	$ -	$ 332,758	$ 670,003	131%	$ 878,159	$ 634,401
12	47.89	$ 15,233	$ 284,005	$ -	$ 43,107	$ -	$ 337,788	$ 680,132	134%	$ 913,632	$ 640,803
13	48.62	$ 15,463	$ 288,298	$ -	$ 43,758	$ -	$ 342,895	$ 690,415	138%	$ 950,538	$ 647,270
14	49.35	$ 15,697	$ 292,657	$ -	$ 44,420	$ -	$ 348,079	$ 700,853	141%	$ 988,935	$ 653,802
15	50.10	$ 15,934	$ 297,081	$ -	$ 45,091	$ -	$ 353,342	$ 711,448	145%	$ 1,028,882	$ 660,401
16	50.85	$ 16,175	$ 301,573	$ -	$ 45,773	$ -	$ 358,684	$ 722,204	148%	$ 1,070,444	$ 667,065
17	51.62	$ 16,419	$ 306,132	$ -	$ 46,465	$ -	$ 364,106	$ 733,123	152%	$ 1,113,684	$ 673,797
18	52.40	$ 16,668	$ 310,760	$ -	$ 47,168	$ -	$ 369,611	$ 744,206	156%	$ 1,158,671	$ 680,597
19	53.20	$ 16,920	$ 315,459	$ -	$ 47,881	$ -	$ 375,199	$ 755,458	160%	$ 1,205,476	$ 687,466
20	54.00	$ 17,175	$ 320,228	$ -	$ 48,605	$ -	$ 380,871	$ 766,879	164%	$ 1,254,171	$ 694,404
Present Worth		**$ 283,217**	**$ 5,280,476**	**$ -**	**$ 801,477**	**$ -**	**$ 6,280,471**				**$ 12,645,642**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 1 hours per day for operations staff to do routine inspection and monitoring of equipment
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the grit removal system.
5. Grit removal and disposal cost is $49/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

GHD

AlexRenew PPSU	3/18/22	11217618	
Project	Date	Job No.	
Lifecycle Cost Analysis - Alternative 2: Four Enhanced Vortex Grit Separators with Six Standard Grit Pumps with Four Hydrocyclone/Grit Washer Units	L. Musselman		
Subject	Comp. By	Checked By	

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 244,919	$ -	$ 41,022	$ -	$ 262,738	$ 561,594	102%	$ 575,577	$ 558,813
2	41.22	$ 13,110	$ 248,622	$ -	$ 41,642	$ -	$ 266,710	$ 570,084	105%	$ 598,828	$ 564,452
3	41.84	$ 13,308	$ 252,381	$ -	$ 42,271	$ -	$ 270,742	$ 578,703	108%	$ 623,017	$ 570,149
4	42.47	$ 13,509	$ 256,197	$ -	$ 42,911	$ -	$ 274,835	$ 587,452	110%	$ 648,184	$ 575,903
5	43.12	$ 13,714	$ 260,070	$ -	$ 43,559	$ -	$ 278,990	$ 596,333	113%	$ 674,367	$ 581,715
6	43.77	$ 13,921	$ 264,002	$ -	$ 44,218	$ -	$ 283,208	$ 605,349	116%	$ 701,608	$ 587,586
7	44.43	$ 14,132	$ 267,993	$ -	$ 44,886	$ -	$ 287,490	$ 614,501	119%	$ 729,949	$ 593,516
8	45.10	$ 14,345	$ 272,045	$ -	$ 45,565	$ -	$ 291,836	$ 623,791	122%	$ 759,436	$ 599,505
9	45.78	$ 14,562	$ 276,157	$ -	$ 46,254	$ -	$ 296,248	$ 633,222	125%	$ 790,113	$ 605,556
10	46.48	$ 14,782	$ 280,332	$ -	$ 46,953	$ -	$ 300,727	$ 642,795	128%	$ 822,029	$ 611,667
11	47.18	$ 15,006	$ 284,571	$ -	$ 47,663	$ -	$ 305,274	$ 652,513	131%	$ 855,235	$ 617,840
12	47.89	$ 15,233	$ 288,873	$ -	$ 48,384	$ -	$ 309,889	$ 662,378	134%	$ 889,782	$ 624,075
13	48.62	$ 15,463	$ 293,240	$ -	$ 49,115	$ -	$ 314,574	$ 672,392	138%	$ 925,725	$ 630,373
14	49.35	$ 15,697	$ 297,674	$ -	$ 49,858	$ -	$ 319,330	$ 682,557	141%	$ 963,119	$ 636,735
15	50.10	$ 15,934	$ 302,174	$ -	$ 50,611	$ -	$ 324,157	$ 692,876	145%	$ 1,002,024	$ 643,161
16	50.85	$ 16,175	$ 306,742	$ -	$ 51,376	$ -	$ 329,058	$ 703,352	148%	$ 1,042,501	$ 649,652
17	51.62	$ 16,419	$ 311,380	$ -	$ 52,153	$ -	$ 334,033	$ 713,985	152%	$ 1,084,612	$ 656,208
18	52.40	$ 16,668	$ 316,087	$ -	$ 52,942	$ -	$ 339,083	$ 724,779	156%	$ 1,128,425	$ 662,831
19	53.20	$ 16,920	$ 320,866	$ -	$ 53,742	$ -	$ 344,209	$ 735,737	160%	$ 1,174,008	$ 669,520
20	54.00	$ 17,175	$ 325,717	$ -	$ 54,555	$ -	$ 349,413	$ 746,860	164%	$ 1,221,431	$ 676,277
Present Worth		**$ 283,217**	**$ 5,370,990**	**$ -**	**$ 899,591**	**$ -**	**$ 5,761,737**				**$ 12,315,535**

The following assumptions were used to estimate annual operation and maintenance costs:
1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 1 hours per day for operations staff to do routine inspection and monitoring of equipment
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the grit removal system.
5. Grit removal and disposal cost is $49/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU | 3/18/22 | 11217618
Project | Date | Job No.

Lifecycle Cost Analysis - Alternative 3: Three Stacked Tray Grit Removal Units Two Enhanced Vortex Grit Separators with Five Standard Grit Pumps with Four Hydrocyclone/Grit Washer | L. Musselman
Subject | Comp. By | Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 93,025	$ -	$ 34,187	$ -	$ 142,487	$ 282,614	102%	$ 289,651	$ 281,214
2	41.22	$ 13,110	$ 94,431	$ -	$ 34,704	$ -	$ 144,641	$ 286,886	105%	$ 301,351	$ 284,052
3	41.84	$ 13,308	$ 95,859	$ -	$ 35,228	$ -	$ 146,828	$ 291,224	108%	$ 313,524	$ 286,919
4	42.47	$ 13,509	$ 97,308	$ -	$ 35,761	$ -	$ 149,048	$ 295,626	110%	$ 326,189	$ 289,815
5	43.12	$ 13,714	$ 98,779	$ -	$ 36,302	$ -	$ 151,301	$ 300,096	113%	$ 339,365	$ 292,739
6	43.77	$ 13,921	$ 100,273	$ -	$ 36,850	$ -	$ 153,588	$ 304,633	116%	$ 353,074	$ 295,694
7	44.43	$ 14,132	$ 101,789	$ -	$ 37,408	$ -	$ 155,910	$ 309,238	119%	$ 367,336	$ 298,678
8	45.10	$ 14,345	$ 103,328	$ -	$ 37,973	$ -	$ 158,268	$ 313,913	122%	$ 382,175	$ 301,692
9	45.78	$ 14,562	$ 104,890	$ -	$ 38,547	$ -	$ 160,660	$ 318,659	125%	$ 397,613	$ 304,737
10	46.48	$ 14,782	$ 106,476	$ -	$ 39,130	$ -	$ 163,089	$ 323,477	128%	$ 413,674	$ 307,812
11	47.18	$ 15,006	$ 108,085	$ -	$ 39,722	$ -	$ 165,555	$ 328,367	131%	$ 430,384	$ 310,919
12	47.89	$ 15,233	$ 109,719	$ -	$ 40,322	$ -	$ 168,058	$ 333,332	134%	$ 447,770	$ 314,057
13	48.62	$ 15,463	$ 111,378	$ -	$ 40,932	$ -	$ 170,599	$ 338,371	138%	$ 465,857	$ 317,226
14	49.35	$ 15,697	$ 113,062	$ -	$ 41,550	$ -	$ 173,178	$ 343,487	141%	$ 484,675	$ 320,428
15	50.10	$ 15,934	$ 114,771	$ -	$ 42,179	$ -	$ 175,796	$ 348,680	145%	$ 504,254	$ 323,661
16	50.85	$ 16,175	$ 116,507	$ -	$ 42,816	$ -	$ 178,454	$ 353,951	148%	$ 524,623	$ 326,928
17	51.62	$ 16,419	$ 118,268	$ -	$ 43,464	$ -	$ 181,152	$ 359,302	152%	$ 545,815	$ 330,227
18	52.40	$ 16,668	$ 120,056	$ -	$ 44,121	$ -	$ 183,890	$ 364,734	156%	$ 567,863	$ 333,560
19	53.20	$ 16,920	$ 121,871	$ -	$ 44,788	$ -	$ 186,670	$ 370,249	160%	$ 590,802	$ 336,926
20	54.00	$ 17,175	$ 123,713	$ -	$ 45,465	$ -	$ 189,493	$ 375,846	164%	$ 614,667	$ 340,326
Present Worth		**$ 283,217**	**$ 2,040,004**	**$ -**	**$ 749,704**	**$ -**	**$ 3,124,685**				**$ 6,197,610**

The following assumptions were used to estimate annual operation and maintenance costs:
1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 1 hours per day for operations staff to do routine inspection and monitoring of equipment
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the grit removal system.
5. Grit removal and disposal cost is $49/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	3/18/22	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 4: Six Stacked Tray Grit Removal Units with Six Severe-Duty Grit Pumps with Six Hydrocyclone/Grit Washer Units	L. Musselman	
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 107,552	$ -	$ 53,245	$ -	$ 142,487	$ 316,199	102%	$ 324,072	$ 314,633
2	41.22	$ 13,110	$ 109,178	$ -	$ 53,245	$ -	$ 144,641	$ 320,174	105%	$ 336,318	$ 317,012
3	41.84	$ 13,308	$ 110,829	$ -	$ 53,245	$ -	$ 146,828	$ 324,210	108%	$ 349,037	$ 319,418
4	42.47	$ 13,509	$ 112,504	$ -	$ 53,245	$ -	$ 149,048	$ 328,307	110%	$ 362,248	$ 321,852
5	43.12	$ 13,714	$ 114,205	$ -	$ 53,245	$ -	$ 151,301	$ 332,465	113%	$ 375,970	$ 324,315
6	43.77	$ 13,921	$ 115,932	$ -	$ 53,245	$ -	$ 153,588	$ 336,686	116%	$ 390,224	$ 326,807
7	44.43	$ 14,132	$ 117,685	$ -	$ 53,245	$ -	$ 155,910	$ 340,972	119%	$ 405,031	$ 329,328
8	45.10	$ 14,345	$ 119,464	$ -	$ 53,245	$ -	$ 158,268	$ 345,322	122%	$ 420,412	$ 331,877
9	45.78	$ 14,562	$ 121,270	$ -	$ 53,245	$ -	$ 160,660	$ 349,737	125%	$ 436,391	$ 334,457
10	46.48	$ 14,782	$ 123,103	$ -	$ 53,245	$ -	$ 163,089	$ 354,220	128%	$ 452,989	$ 337,066
11	47.18	$ 15,006	$ 124,964	$ -	$ 53,245	$ -	$ 165,555	$ 358,770	131%	$ 470,232	$ 339,706
12	47.89	$ 15,233	$ 126,854	$ -	$ 53,245	$ -	$ 168,058	$ 363,389	134%	$ 488,146	$ 342,376
13	48.62	$ 15,463	$ 128,772	$ -	$ 53,245	$ -	$ 170,599	$ 368,078	138%	$ 506,756	$ 345,076
14	49.35	$ 15,697	$ 130,718	$ -	$ 53,245	$ -	$ 173,178	$ 372,838	141%	$ 526,091	$ 347,808
15	50.10	$ 15,934	$ 132,695	$ -	$ 53,245	$ -	$ 175,796	$ 377,669	145%	$ 546,178	$ 350,571
16	50.85	$ 16,175	$ 134,701	$ -	$ 53,245	$ -	$ 178,454	$ 382,574	148%	$ 567,048	$ 353,365
17	51.62	$ 16,419	$ 136,737	$ -	$ 53,245	$ -	$ 181,152	$ 387,553	152%	$ 588,731	$ 356,192
18	52.40	$ 16,668	$ 138,804	$ -	$ 53,245	$ -	$ 183,890	$ 392,607	156%	$ 611,259	$ 359,050
19	53.20	$ 16,920	$ 140,903	$ -	$ 53,245	$ -	$ 186,670	$ 397,738	160%	$ 634,666	$ 361,941
20	54.00	$ 17,175	$ 143,033	$ -	$ 53,245	$ -	$ 189,493	$ 402,946	164%	$ 658,987	$ 364,865
Present Worth		**$ 283,217**	**$ 2,358,581**	**$ -**	**$ 1,011,233**	**$ -**	**$ 3,124,685**				**$ 6,777,716**

The following assumptions were used to estimate annual operation and maintenance costs:
1. Typical labor cost is $47/hr per AlexRenew. Each of the Alternatives was assumed to require 1 hours per day for operations staff to do routine inspection and monitoring of equipment
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the grit removal system.
5. Grit removal and disposal cost is $49/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	8/18/22	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 1: Redundant Screw Conveyor Layout with Trailers and Additional Monitoring	L. Musselman	
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 38,744	$ 17,916	$ 2,177	$26,992	$ -	$ 123,251	$ 209,079	102%	$ 214,285	$ 208,044
2	41.22	$ 39,330	$ 18,187	$ 2,210	$27,400	$ -	$ 125,114	$ 212,240	105%	$ 222,941	$ 210,144
3	41.84	$ 39,925	$ 18,462	$ 2,243	$27,814	$ -	$ 127,006	$ 215,449	108%	$ 231,947	$ 212,264
4	42.47	$ 40,528	$ 18,741	$ 2,277	$28,234	$ -	$ 128,926	$ 218,706	110%	$ 241,317	$ 214,407
5	43.12	$ 41,141	$ 19,024	$ 2,311	$28,661	$ -	$ 130,875	$ 222,013	113%	$ 251,065	$ 216,570
6	43.77	$ 41,763	$ 19,312	$ 2,346	$29,095	$ -	$ 132,853	$ 225,369	116%	$ 261,206	$ 218,756
7	44.43	$ 42,395	$ 19,604	$ 2,382	$29,534	$ -	$ 134,862	$ 228,776	119%	$ 271,758	$ 220,964
8	45.10	$ 43,035	$ 19,900	$ 2,418	$29,981	$ -	$ 136,901	$ 232,235	122%	$ 282,735	$ 223,194
9	45.78	$ 43,686	$ 20,201	$ 2,454	$30,434	$ -	$ 138,971	$ 235,746	125%	$ 294,156	$ 225,446
10	46.48	$ 44,347	$ 20,507	$ 2,491	$30,894	$ -	$ 141,072	$ 239,310	128%	$ 306,039	$ 227,722
11	47.18	$ 45,017	$ 20,817	$ 2,529	$31,361	$ -	$ 143,204	$ 242,928	131%	$ 318,401	$ 230,020
12	47.89	$ 45,698	$ 21,131	$ 2,567	$31,836	$ -	$ 145,369	$ 246,601	134%	$ 331,263	$ 232,341
13	48.62	$ 46,388	$ 21,451	$ 2,606	$32,317	$ -	$ 147,567	$ 250,329	138%	$ 344,644	$ 234,686
14	49.35	$ 47,090	$ 21,775	$ 2,645	$32,805	$ -	$ 149,798	$ 254,114	141%	$ 358,566	$ 237,054
15	50.10	$ 47,802	$ 22,104	$ 2,685	$33,301	$ -	$ 152,063	$ 257,956	145%	$ 373,050	$ 239,447
16	50.85	$ 48,524	$ 22,438	$ 2,726	$33,805	$ -	$ 154,362	$ 261,855	148%	$ 388,119	$ 241,863
17	51.62	$ 49,258	$ 22,778	$ 2,767	$34,316	$ -	$ 156,695	$ 265,814	152%	$ 403,797	$ 244,304
18	52.40	$ 50,003	$ 23,122	$ 2,809	$34,835	$ -	$ 159,064	$ 269,833	156%	$ 420,109	$ 246,770
19	53.20	$ 50,759	$ 23,472	$ 2,852	$35,361	$ -	$ 161,469	$ 273,912	160%	$ 437,079	$ 249,260
20	54.00	$ 51,526	$ 23,826	$ 2,895	$35,896	$ -	$ 163,910	$ 278,053	164%	$ 454,735	$ 251,776
Net Present Worth		**$849,651**	**$392,891**	**$47,732**	**$591,915**	**$0**	**$2,702,841**				**$ 4,585,031**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. This Alternative was assumed to require 2 hours per day for operations staff to do routine inspection and monitoring of equipment.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the grit removal system.
5. Grit removal and disposal cost is $49/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	8/18/22	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 2: Separated Screenings and Grit Screw Conveyor Layout with Roll-Off Containers on an Automated	L. Musselman	
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacmenet	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 7,687	$ 3,997	$16,533	$ -	$ 117,914	$ 159,045	102%	$ 163,006	$ 158,258
2	41.22	$ 13,110	$ 7,803	$ 4,058	$16,783	$ -	$ 119,696	$ 161,450	105%	$ 169,590	$ 159,855
3	41.84	$ 13,308	$ 7,921	$ 4,119	$17,036	$ -	$ 121,506	$ 163,891	108%	$ 176,441	$ 161,468
4	42.47	$ 13,509	$ 8,041	$ 4,181	$17,294	$ -	$ 123,343	$ 166,369	110%	$ 183,568	$ 163,098
5	43.12	$ 13,714	$ 8,163	$ 4,245	$17,555	$ -	$ 125,208	$ 168,884	113%	$ 190,983	$ 164,744
6	43.77	$ 13,921	$ 8,286	$ 4,309	$17,821	$ -	$ 127,100	$ 171,437	116%	$ 198,698	$ 166,407
7	44.43	$ 14,132	$ 8,411	$ 4,374	$18,090	$ -	$ 129,022	$ 174,029	119%	$ 206,724	$ 168,086
8	45.10	$ 14,345	$ 8,538	$ 4,440	$18,364	$ -	$ 130,973	$ 176,660	122%	$ 215,075	$ 169,782
9	45.78	$ 14,562	$ 8,667	$ 4,507	$18,641	$ -	$ 132,953	$ 179,331	125%	$ 223,763	$ 171,496
10	46.48	$ 14,782	$ 8,799	$ 4,575	$18,923	$ -	$ 134,963	$ 182,042	128%	$ 232,802	$ 173,226
11	47.18	$ 15,006	$ 8,932	$ 4,645	$19,209	$ -	$ 137,003	$ 184,794	131%	$ 242,206	$ 174,975
12	47.89	$ 15,233	$ 9,067	$ 4,715	$19,500	$ -	$ 139,074	$ 187,588	134%	$ 251,990	$ 176,741
13	48.62	$ 15,463	$ 9,204	$ 4,786	$19,794	$ -	$ 141,177	$ 190,424	138%	$ 262,169	$ 178,524
14	49.35	$ 15,697	$ 9,343	$ 4,858	$20,094	$ -	$ 143,311	$ 193,303	141%	$ 272,759	$ 180,326
15	50.10	$ 15,934	$ 9,484	$ 4,932	$20,397	$ -	$ 145,478	$ 196,225	145%	$ 283,777	$ 182,146
16	50.85	$ 16,175	$ 9,627	$ 5,006	$20,706	$ -	$ 147,677	$ 199,192	148%	$ 295,240	$ 183,984
17	51.62	$ 16,419	$ 9,773	$ 5,082	$21,019	$ -	$ 149,910	$ 202,203	152%	$ 307,166	$ 185,841
18	52.40	$ 16,668	$ 9,921	$ 5,159	$21,337	$ -	$ 152,176	$ 205,260	156%	$ 319,574	$ 187,716
19	53.20	$ 16,920	$ 10,071	$ 5,237	$21,659	$ -	$ 154,477	$ 208,364	160%	$ 332,483	$ 189,611
20	54.00	$ 17,175	$ 10,223	$ 5,316	$21,987	$ -	$ 156,813	$ 211,514	164%	$ 345,914	$ 191,524
Net Present Worth		**$ 283,217**	**$ 168,574**	**$ 87,662**	**$ 362,555**	**$ -**	**$ 2,585,799**				**$ 3,487,807**

The following assumptions were used to estimate annual operation and maintenance costs:
1. Typical labor cost is $47/hr per AlexRenew. This Alternative was assumed to require 1 hours per day for operations staff to do routine inspection and monitoring of equipment.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the grit removal system.
5. Grit removal and disposal cost is $49/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	8/18/22	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 3: Separated Screenings and Grit Screw Conveyor Layout with Self-Leveling Roll-Off Containers	L. Musselman	
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacmenet	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 10,716	$ 4,353	$ 17,474	$ -	$ 124,634	$ 170,092	102%	$ 174,327	$ 169,249
2	41.22	$ 13,110	$ 10,878	$ 4,419	$ 17,738	$ -	$ 126,518	$ 172,663	105%	$ 181,369	$ 170,958
3	41.84	$ 13,308	$ 11,043	$ 4,486	$ 18,006	$ -	$ 128,431	$ 175,274	108%	$ 188,695	$ 172,683
4	42.47	$ 13,509	$ 11,210	$ 4,554	$ 18,278	$ -	$ 130,373	$ 177,923	110%	$ 196,318	$ 174,426
5	43.12	$ 13,714	$ 11,379	$ 4,623	$ 18,554	$ -	$ 132,344	$ 180,613	113%	$ 204,248	$ 176,186
6	43.77	$ 13,921	$ 11,551	$ 4,692	$ 18,835	$ -	$ 134,345	$ 183,344	116%	$ 212,498	$ 177,964
7	44.43	$ 14,132	$ 11,726	$ 4,763	$ 19,120	$ -	$ 136,376	$ 186,116	119%	$ 221,082	$ 179,760
8	45.10	$ 14,345	$ 11,903	$ 4,835	$ 19,409	$ -	$ 138,437	$ 188,930	122%	$ 230,013	$ 181,574
9	45.78	$ 14,562	$ 12,083	$ 4,908	$ 19,702	$ -	$ 140,530	$ 191,786	125%	$ 239,304	$ 183,407
10	46.48	$ 14,782	$ 12,266	$ 4,983	$ 20,000	$ -	$ 142,655	$ 194,685	128%	$ 248,971	$ 185,258
11	47.18	$ 15,006	$ 12,451	$ 5,058	$ 20,302	$ -	$ 144,812	$ 197,629	131%	$ 259,028	$ 187,127
12	47.89	$ 15,233	$ 12,639	$ 5,134	$ 20,609	$ -	$ 147,001	$ 200,616	134%	$ 269,491	$ 189,016
13	48.62	$ 15,463	$ 12,830	$ 5,212	$ 20,921	$ -	$ 149,223	$ 203,649	138%	$ 280,377	$ 190,923
14	49.35	$ 15,697	$ 13,024	$ 5,291	$ 21,237	$ -	$ 151,479	$ 206,728	141%	$ 291,703	$ 192,850
15	50.10	$ 15,934	$ 13,221	$ 5,371	$ 21,558	$ -	$ 153,769	$ 209,854	145%	$ 303,486	$ 194,796
16	50.85	$ 16,175	$ 13,421	$ 5,452	$ 21,884	$ -	$ 156,094	$ 213,026	148%	$ 315,746	$ 196,762
17	51.62	$ 16,419	$ 13,624	$ 5,535	$ 22,215	$ -	$ 158,454	$ 216,247	152%	$ 328,500	$ 198,748
18	52.40	$ 16,668	$ 13,830	$ 5,618	$ 22,551	$ -	$ 160,850	$ 219,516	156%	$ 341,770	$ 200,754
19	53.20	$ 16,920	$ 14,039	$ 5,703	$ 22,892	$ -	$ 163,281	$ 222,835	160%	$ 355,575	$ 202,780
20	54.00	$ 17,175	$ 14,251	$ 5,789	$ 23,238	$ -	$ 165,750	$ 226,204	164%	$ 369,939	$ 204,826
Net Present Worth		**$ 283,217**	**$ 235,000**	**$ 95,465**	**$ 383,188**	**$ -**	**$ 2,733,176**				**$ 3,730,046**

The following assumptions were used to estimate annual operation and maintenance costs:
1. Typical labor cost is $47/hr per AlexRenew. This Alternative was assumed to require 1 hours per day for operations staff to do routine inspection and monitoring of equipment.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the grit removal system.
5. Grit removal and disposal cost is $49/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	8/18/22	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 4: Simplified Screenings Screw Conveyor Layout with Direct Washer Discharge to Roll-Off Containers	L. Musselman	
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacmenet	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 38,744	$ 3,707	$ 4,897	$ 1,323	$ -	$ 123,809	$ 172,481	102%	$ 176,776	$ 171,627
2	41.22	$ 39,330	$ 3,763	$ 4,971	$ 1,343	$ -	$ 125,681	$ 175,089	105%	$ 183,917	$ 173,359
3	41.84	$ 39,925	$ 3,820	$ 5,047	$ 1,363	$ -	$ 127,581	$ 177,736	108%	$ 191,346	$ 175,109
4	42.47	$ 40,528	$ 3,878	$ 5,123	$ 1,384	$ -	$ 129,510	$ 180,423	110%	$ 199,076	$ 176,876
5	43.12	$ 41,141	$ 3,937	$ 5,200	$ 1,405	$ -	$ 131,468	$ 183,151	113%	$ 207,117	$ 178,661
6	43.77	$ 41,763	$ 3,996	$ 5,279	$ 1,426	$ -	$ 133,455	$ 185,920	116%	$ 215,484	$ 180,464
7	44.43	$ 42,395	$ 4,057	$ 5,359	$ 1,448	$ -	$ 135,473	$ 188,731	119%	$ 224,188	$ 182,286
8	45.10	$ 43,035	$ 4,118	$ 5,440	$ 1,470	$ -	$ 137,521	$ 191,584	122%	$ 233,244	$ 184,125
9	45.78	$ 43,686	$ 4,180	$ 5,522	$ 1,492	$ -	$ 139,600	$ 194,480	125%	$ 242,666	$ 185,983
10	46.48	$ 44,347	$ 4,243	$ 5,605	$ 1,514	$ -	$ 141,711	$ 197,421	128%	$ 252,469	$ 187,860
11	47.18	$ 45,017	$ 4,307	$ 5,690	$ 1,537	$ -	$ 143,853	$ 200,405	131%	$ 262,667	$ 189,756
12	47.89	$ 45,698	$ 4,373	$ 5,776	$ 1,561	$ -	$ 146,028	$ 203,435	134%	$ 273,277	$ 191,671
13	48.62	$ 46,388	$ 4,439	$ 5,864	$ 1,584	$ -	$ 148,236	$ 206,511	138%	$ 284,316	$ 193,606
14	49.35	$ 47,090	$ 4,506	$ 5,952	$ 1,608	$ -	$ 150,477	$ 209,633	141%	$ 295,801	$ 195,560
15	50.10	$ 47,802	$ 4,574	$ 6,042	$ 1,632	$ -	$ 152,752	$ 212,802	145%	$ 307,750	$ 197,533
16	50.85	$ 48,524	$ 4,643	$ 6,134	$ 1,657	$ -	$ 155,061	$ 216,019	148%	$ 320,182	$ 199,527
17	51.62	$ 49,258	$ 4,713	$ 6,226	$ 1,682	$ -	$ 157,406	$ 219,285	152%	$ 333,115	$ 201,540
18	52.40	$ 50,003	$ 4,785	$ 6,320	$ 1,708	$ -	$ 159,785	$ 222,600	156%	$ 346,572	$ 203,574
19	53.20	$ 50,759	$ 4,857	$ 6,416	$ 1,733	$ -	$ 162,201	$ 225,966	160%	$ 360,571	$ 205,629
20	54.00	$ 51,526	$ 4,930	$ 6,513	$ 1,760	$ -	$ 164,653	$ 229,382	164%	$ 375,136	$ 207,704
Net Present Worth		**$ 849,651**	**$ 81,299**	**$ 107,398**	**$ 29,015**	**$ -**	**$ 2,715,089**				**$ 3,782,452**

The following assumptions were used to estimate annual operation and maintenance costs:
1. Typical labor cost is $47/hr per AlexRenew. This Alternative was assumed to require 2 hours per day for operations staff to do routine inspection and monitoring of equipment.
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Energy unit cost is $0.08/kW/hr. Only one screen and one compactor will run under average flow conditions.
4. Chemical cost is system specific and is not applicable to the grit removal system.
5. Grit removal and disposal cost is $49/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% and was then used to calculate the annual O&M cost of each year in the future.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively, and they are used for annual NPV calculation.
8. The sum of annual NPVs for the next 20 years is the 20-yr O&M NPV.
9. The initial construction cost estimate is combined with the 20-yr O&M NPV to calculate life cycle cost.

AlexRenew PPSU	10/8/21	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 1 PWOH Upgrade (Building Refurbishment)	CE	NH
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 11,070	$ 21,145	$ -	$ 48,691	$ -	$ -	$ 80,905	102%	$ 82,920	$ 80,504
2	41.22	$ 11,237	$ 21,464	$ -	$ 49,427	$ -	$ -	$ 82,128	105%	$ 86,269	$ 81,317
3	41.84	$ 11,407	$ 21,789	$ -	$ 50,174	$ -	$ -	$ 83,370	108%	$ 89,754	$ 82,138
4	42.47	$ 11,580	$ 22,118	$ -	$ 50,933	$ -	$ -	$ 84,630	110%	$ 93,380	$ 82,967
5	43.12	$ 11,755	$ 22,453	$ -	$ 51,703	$ -	$ -	$ 85,910	113%	$ 97,152	$ 83,804
6	43.77	$ 11,932	$ 22,792	$ -	$ 52,484	$ -	$ -	$ 87,209	116%	$ 101,076	$ 84,650
7	44.43	$ 12,113	$ 23,137	$ -	$ 53,278	$ -	$ -	$ 88,527	119%	$ 105,159	$ 85,504
8	45.10	$ 12,296	$ 23,486	$ -	$ 54,083	$ -	$ -	$ 89,865	122%	$ 109,407	$ 86,367
9	45.78	$ 12,482	$ 23,841	$ -	$ 54,901	$ -	$ -	$ 91,224	125%	$ 113,826	$ 87,238
10	46.48	$ 12,670	$ 24,202	$ -	$ 55,731	$ -	$ -	$ 92,603	128%	$ 118,424	$ 88,119
11	47.18	$ 12,862	$ 24,568	$ -	$ 56,573	$ -	$ -	$ 94,003	131%	$ 123,208	$ 89,008
12	47.89	$ 13,056	$ 24,939	$ -	$ 57,429	$ -	$ -	$ 95,424	134%	$ 128,185	$ 89,906
13	48.62	$ 13,254	$ 25,316	$ -	$ 58,297	$ -	$ -	$ 96,867	138%	$ 133,363	$ 90,814
14	49.35	$ 13,454	$ 25,699	$ -	$ 59,178	$ -	$ -	$ 98,332	141%	$ 138,750	$ 91,730
15	50.10	$ 13,658	$ 26,087	$ -	$ 60,073	$ -	$ -	$ 99,818	145%	$ 144,355	$ 92,656
16	50.85	$ 13,864	$ 26,482	$ -	$ 60,981	$ -	$ -	$ 101,327	148%	$ 150,186	$ 93,591
17	51.62	$ 14,074	$ 26,882	$ -	$ 61,903	$ -	$ -	$ 102,859	152%	$ 156,253	$ 94,536
18	52.40	$ 14,286	$ 27,289	$ -	$ 62,839	$ -	$ -	$ 104,414	156%	$ 162,565	$ 95,490
19	53.20	$ 14,502	$ 27,701	$ -	$ 63,789	$ -	$ -	$ 105,993	160%	$ 169,132	$ 96,453
20	54.00	$ 14,722	$ 28,120	$ -	$ 64,753	$ -	$ -	$ 107,595	164%	$ 175,964	$ 97,427
Net Present Worth		**$ 242,757**	**$ 463,692**	**$ -**	**$ 1,067,768**	**$ -**	**$ -**				**$ 1,774,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. This alternatives was assumed to require 6 hours per week for daily inspection, routine maintenance and cleaning associated with the PWOH
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Annual energy cost is estimated based on a unit cost of $0.08/kW/hr.
4. Chemical cost is system specific and is not applicable to the PWOH alternatives
5. Disposal cost is not applicable for the PWOH alternatives
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd over the next 20 years. This equates to an annual growth of 1.51% year and was used to estimate the annual O&M cost of each future year
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively. These values were used to calculate the present worth of annual cost for each year
8. Net present worth cost is calculated by totalizing the present worth values of annual O&M costs over the 20-year life cycle selected for analysis.

AlexRenew PPSU		10/8/21	11217618
Project		Date	Job No.
Lifecycle Cost Analysis - Alternative 2 PWOH Upgrade (Aluminum Covers)		CE	NH
Subject		Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 7,380	$ 15,273	$ -	$ 6,704	$ -	$ -	$ 29,357	102%	$ 30,088	$ 29,212
2	41.22	$ 7,491	$ 15,504	$ -	$ 6,805	$ -	$ -	$ 29,801	105%	$ 31,303	$ 29,507
3	41.84	$ 7,605	$ 15,739	$ -	$ 6,908	$ -	$ -	$ 30,251	108%	$ 32,568	$ 29,804
4	42.47	$ 7,720	$ 15,977	$ -	$ 7,012	$ -	$ -	$ 30,709	110%	$ 33,884	$ 30,105
5	43.12	$ 7,836	$ 16,218	$ -	$ 7,118	$ -	$ -	$ 31,173	113%	$ 35,252	$ 30,409
6	43.77	$ 7,955	$ 16,463	$ -	$ 7,226	$ -	$ -	$ 31,644	116%	$ 36,676	$ 30,716
7	44.43	$ 8,075	$ 16,712	$ -	$ 7,335	$ -	$ -	$ 32,123	119%	$ 38,158	$ 31,026
8	45.10	$ 8,197	$ 16,965	$ -	$ 7,446	$ -	$ -	$ 32,608	122%	$ 39,699	$ 31,339
9	45.78	$ 8,321	$ 17,221	$ -	$ 7,559	$ -	$ -	$ 33,101	125%	$ 41,303	$ 31,655
10	46.48	$ 8,447	$ 17,482	$ -	$ 7,673	$ -	$ -	$ 33,602	128%	$ 42,971	$ 31,975
11	47.18	$ 8,575	$ 17,746	$ -	$ 7,789	$ -	$ -	$ 34,110	131%	$ 44,707	$ 32,297
12	47.89	$ 8,704	$ 18,014	$ -	$ 7,907	$ -	$ -	$ 34,626	134%	$ 46,513	$ 32,623
13	48.62	$ 8,836	$ 18,287	$ -	$ 8,026	$ -	$ -	$ 35,149	138%	$ 48,392	$ 32,953
14	49.35	$ 8,969	$ 18,563	$ -	$ 8,148	$ -	$ -	$ 35,680	141%	$ 50,347	$ 33,285
15	50.10	$ 9,105	$ 18,844	$ -	$ 8,271	$ -	$ -	$ 36,220	145%	$ 52,380	$ 33,621
16	50.85	$ 9,243	$ 19,129	$ -	$ 8,396	$ -	$ -	$ 36,767	148%	$ 54,496	$ 33,960
17	51.62	$ 9,382	$ 19,418	$ -	$ 8,523	$ -	$ -	$ 37,323	152%	$ 56,698	$ 34,303
18	52.40	$ 9,524	$ 19,711	$ -	$ 8,652	$ -	$ -	$ 37,888	156%	$ 58,988	$ 34,649
19	53.20	$ 9,668	$ 20,009	$ -	$ 8,783	$ -	$ -	$ 38,460	160%	$ 61,371	$ 34,999
20	54.00	$ 9,814	$ 20,312	$ -	$ 8,915	$ -	$ -	$ 39,042	164%	$ 63,850	$ 35,352
Net Present Worth		**$ 161,838**	**$ 334,940**	**$ -**	**$ 147,012**	**$ -**	**$ -**				**$ 644,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. This alternatives was assumed to require 4 hours per week for daily inspection, routine maintenance and cleaning associated with the PWOH
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Annual energy cost is estimated based on a unit cost of $0.08/kW/hr.
4. Chemical cost is system specific and is not applicable to the PWOH alternatives
5. Disposal cost is not applicable for the PWOH alternatives
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd over the next 20 years. This equates to an annual growth of 1.51% year and was used to estimate the annual O&M cost of each future yea
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively. These values were used to calculate the present worth of annual cost for each year
8. Net present worth cost is calculated by totalizing the present worth values of annual O&M costs over the 20-year life cycle selected for analysis.

AlexRenew PPSU	10/8/21	11217618
Project	Date	Job No.
Lifecycle Cost Analysis - Alternative 3 PWOH Upgrade (Geomembrane Covers)	CE	NH
Subject	Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 7,380	$ 25,269	$ -	$ 6,704	$ -	$ -	$ 39,353	102%	$ 40,333	$ 39,158
2	41.22	$ 7,491	$ 25,651	$ -	$ 6,805	$ -	$ -	$ 39,948	105%	$ 41,962	$ 39,553
3	41.84	$ 7,605	$ 26,039	$ -	$ 6,908	$ -	$ -	$ 40,552	108%	$ 43,657	$ 39,953
4	42.47	$ 7,720	$ 26,433	$ -	$ 7,012	$ -	$ -	$ 41,165	110%	$ 45,421	$ 40,356
5	43.12	$ 7,836	$ 26,833	$ -	$ 7,118	$ -	$ -	$ 41,787	113%	$ 47,256	$ 40,763
6	43.77	$ 7,955	$ 27,238	$ -	$ 7,226	$ -	$ -	$ 42,419	116%	$ 49,164	$ 41,174
7	44.43	$ 8,075	$ 27,650	$ -	$ 7,335	$ -	$ -	$ 43,060	119%	$ 51,150	$ 41,590
8	45.10	$ 8,197	$ 28,068	$ -	$ 7,446	$ -	$ -	$ 43,711	122%	$ 53,217	$ 42,010
9	45.78	$ 8,321	$ 28,492	$ -	$ 7,559	$ -	$ -	$ 44,372	125%	$ 55,366	$ 42,434
10	46.48	$ 8,447	$ 28,923	$ -	$ 7,673	$ -	$ -	$ 45,043	128%	$ 57,603	$ 42,862
11	47.18	$ 8,575	$ 29,360	$ -	$ 7,789	$ -	$ -	$ 45,724	131%	$ 59,930	$ 43,294
12	47.89	$ 8,704	$ 29,804	$ -	$ 7,907	$ -	$ -	$ 46,415	134%	$ 62,351	$ 43,731
13	48.62	$ 8,836	$ 30,255	$ -	$ 8,026	$ -	$ -	$ 47,117	138%	$ 64,869	$ 44,173
14	49.35	$ 8,969	$ 30,712	$ -	$ 8,148	$ -	$ -	$ 47,829	141%	$ 67,490	$ 44,619
15	50.10	$ 9,105	$ 31,177	$ -	$ 8,271	$ -	$ -	$ 48,553	145%	$ 70,216	$ 45,069
16	50.85	$ 9,243	$ 31,648	$ -	$ 8,396	$ -	$ -	$ 49,287	148%	$ 73,052	$ 45,524
17	51.62	$ 9,382	$ 32,126	$ -	$ 8,523	$ -	$ -	$ 50,032	152%	$ 76,003	$ 45,983
18	52.40	$ 9,524	$ 32,612	$ -	$ 8,652	$ -	$ -	$ 50,788	156%	$ 79,073	$ 46,447
19	53.20	$ 9,668	$ 33,105	$ -	$ 8,783	$ -	$ -	$ 51,556	160%	$ 82,267	$ 46,916
20	54.00	$ 9,814	$ 33,606	$ -	$ 8,915	$ -	$ -	$ 52,335	164%	$ 85,590	$ 47,389
Net Present Worth		**$ 161,838**	**$ 554,148**	**$ -**	**$ 147,012**	**$ -**	**$ -**				**$ 863,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. This alternatives was assumed to require 4 hours per week for daily inspection, routine maintenance and cleaning associated with the PWOH
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Annual energy cost is estimated based on a unit cost of $0.08/kW/hr.
4. Chemical cost is system specific and is not applicable to the PWOH alternatives
5. Disposal cost is not applicable for the PWOH alternatives
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd over the next 20 years. This equates to an annual growth of 1.51% year and was used to estimate the annual O&M cost of each future yea
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively. These values were used to calculate the present worth of annual cost for each year
8. Net present worth cost is calculated by totalizing the present worth values of annual O&M costs over the 20-year life cycle selected for analysis.

AlexRenew PPSU Project	10/8/21 Date	11217618 Job No.
Lifecycle Cost Analysis - Alternative 1 Scum Upgrade (In Kind Replacement; Truck Bay) Subject	CE Comp. By	NH Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 12,915	$ 13,415	$ -	$ 3,130	$ -	$ 13,138	$ 42,597	102%	$ 43,658	$ 42,386
2	41.22	$ 13,110	$ 13,617	$ -	$ 3,177	$ -	$ 13,337	$ 43,241	105%	$ 45,421	$ 42,814
3	41.84	$ 13,308	$ 13,823	$ -	$ 3,225	$ -	$ 13,538	$ 43,895	108%	$ 47,256	$ 43,246
4	42.47	$ 13,509	$ 14,032	$ -	$ 3,274	$ -	$ 13,743	$ 44,558	110%	$ 49,165	$ 43,682
5	43.12	$ 13,714	$ 14,244	$ -	$ 3,323	$ -	$ 13,951	$ 45,232	113%	$ 51,151	$ 44,123
6	43.77	$ 13,921	$ 14,460	$ -	$ 3,374	$ -	$ 14,161	$ 45,916	116%	$ 53,217	$ 44,569
7	44.43	$ 14,132	$ 14,678	$ -	$ 3,425	$ -	$ 14,376	$ 46,610	119%	$ 55,367	$ 45,018
8	45.10	$ 14,345	$ 14,900	$ -	$ 3,476	$ -	$ 14,593	$ 47,315	122%	$ 57,603	$ 45,473
9	45.78	$ 14,562	$ 15,126	$ -	$ 3,529	$ -	$ 14,814	$ 48,030	125%	$ 59,930	$ 45,932
10	46.48	$ 14,782	$ 15,354	$ -	$ 3,582	$ -	$ 15,038	$ 48,756	128%	$ 62,351	$ 46,395
11	47.18	$ 15,006	$ 15,586	$ -	$ 3,636	$ -	$ 15,265	$ 49,493	131%	$ 64,870	$ 46,863
12	47.89	$ 15,233	$ 15,822	$ -	$ 3,691	$ -	$ 15,496	$ 50,242	134%	$ 67,490	$ 47,336
13	48.62	$ 15,463	$ 16,061	$ -	$ 3,747	$ -	$ 15,730	$ 51,001	138%	$ 70,217	$ 47,814
14	49.35	$ 15,697	$ 16,304	$ -	$ 3,804	$ -	$ 15,968	$ 51,772	141%	$ 73,053	$ 48,297
15	50.10	$ 15,934	$ 16,551	$ -	$ 3,861	$ -	$ 16,209	$ 52,555	145%	$ 76,004	$ 48,784
16	50.85	$ 16,175	$ 16,801	$ -	$ 3,920	$ -	$ 16,454	$ 53,349	148%	$ 79,074	$ 49,276
17	51.62	$ 16,419	$ 17,055	$ -	$ 3,979	$ -	$ 16,703	$ 54,156	152%	$ 82,268	$ 49,774
18	52.40	$ 16,668	$ 17,313	$ -	$ 4,039	$ -	$ 16,955	$ 54,975	156%	$ 85,591	$ 50,276
19	53.20	$ 16,920	$ 17,574	$ -	$ 4,100	$ -	$ 17,212	$ 55,806	160%	$ 89,049	$ 50,783
20	54.00	$ 17,175	$ 17,840	$ -	$ 4,162	$ -	$ 17,472	$ 56,650	164%	$ 92,646	$ 51,296
Net Present Worth		**$ 283,217**	**$ 294,177**	**$ -**	**$ 68,634**	**$ -**	**$ 288,109**				**$ 934,000**

The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. This alternative was assumed to require 7 hours per week for operations staff to perform daily inspection, routine maintenance and cleaning of scum concentration equipment
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Annual energy cost is estimated based on a unit cost of $0.08/kW/hr.
4. Chemical cost is system specific and is not applicable to the scum handling system.
5. Concentrated scum removal and disposal cost is $64/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% which was used to calculate the annual O&M cost for future years.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively. These values are used to calculate net present worth of O&M cost for each year over 20 years.
8. Net present worth cost is calculated by totalizing the present worth values of annual O&M costs over the 20-year life cycle selected for analysis.

AlexRenew PPSU		10/8/21	11217618
Project		Date	Job No.
Lifecycle Cost Analysis - Alternative 2 Scum Upgrade (Scum Screen)		CE	NH
Subject		Comp. By	Checked By

Present Worth Calculations

Year	Flow, MGD	Labor	Equipment Maintenance	Equipment Replacement	Energy Use	Chemical Use	Disposal	Net Annual Cost, $/Year	Inflation Factor	Net Annual Costs (with inflation)	Present Worth (2021 USD)
1	40.60	$ 7,380	$ 6,798	$ -	$ 1,294	$ -	$ 1,501	$ 16,973	102%	$ 17,395	$ 16,889
2	41.22	$ 7,491	$ 6,900	$ -	$ 1,313	$ -	$ 1,524	$ 17,229	105%	$ 18,098	$ 17,059
3	41.84	$ 7,605	$ 7,005	$ -	$ 1,333	$ -	$ 1,547	$ 17,490	108%	$ 18,829	$ 17,231
4	42.47	$ 7,720	$ 7,111	$ -	$ 1,353	$ -	$ 1,571	$ 17,754	110%	$ 19,590	$ 17,405
5	43.12	$ 7,836	$ 7,218	$ -	$ 1,374	$ -	$ 1,594	$ 18,023	113%	$ 20,381	$ 17,581
6	43.77	$ 7,955	$ 7,327	$ -	$ 1,395	$ -	$ 1,618	$ 18,295	116%	$ 21,204	$ 17,758
7	44.43	$ 8,075	$ 7,438	$ -	$ 1,416	$ -	$ 1,643	$ 18,572	119%	$ 22,061	$ 17,937
8	45.10	$ 8,197	$ 7,550	$ -	$ 1,437	$ -	$ 1,668	$ 18,852	122%	$ 22,952	$ 18,118
9	45.78	$ 8,321	$ 7,665	$ -	$ 1,459	$ -	$ 1,693	$ 19,137	125%	$ 23,879	$ 18,301
10	46.48	$ 8,447	$ 7,780	$ -	$ 1,481	$ -	$ 1,719	$ 19,427	128%	$ 24,844	$ 18,486
11	47.18	$ 8,575	$ 7,898	$ -	$ 1,503	$ -	$ 1,745	$ 19,720	131%	$ 25,847	$ 18,673
12	47.89	$ 8,704	$ 8,017	$ -	$ 1,526	$ -	$ 1,771	$ 20,019	134%	$ 26,891	$ 18,861
13	48.62	$ 8,836	$ 8,139	$ -	$ 1,549	$ -	$ 1,798	$ 20,321	138%	$ 27,977	$ 19,051
14	49.35	$ 8,969	$ 8,262	$ -	$ 1,572	$ -	$ 1,825	$ 20,628	141%	$ 29,108	$ 19,244
15	50.10	$ 9,105	$ 8,387	$ -	$ 1,596	$ -	$ 1,852	$ 20,940	145%	$ 30,283	$ 19,438
16	50.85	$ 9,243	$ 8,513	$ -	$ 1,620	$ -	$ 1,880	$ 21,257	148%	$ 31,507	$ 19,634
17	51.62	$ 9,382	$ 8,642	$ -	$ 1,645	$ -	$ 1,909	$ 21,578	152%	$ 32,779	$ 19,832
18	52.40	$ 9,524	$ 8,773	$ -	$ 1,670	$ -	$ 1,938	$ 21,904	156%	$ 34,104	$ 20,032
19	53.20	$ 9,668	$ 8,905	$ -	$ 1,695	$ -	$ 1,967	$ 22,236	160%	$ 35,481	$ 20,234
20	54.00	$ 9,814	$ 9,040	$ -	$ 1,721	$ -	$ 1,997	$ 22,572	164%	$ 36,914	$ 20,439
Net Present Worth		**$ 161,838**	**$ 149,067**	**$ -**	**$ 28,371**	**$ -**	**$ 32,927**				**$ 372,000**

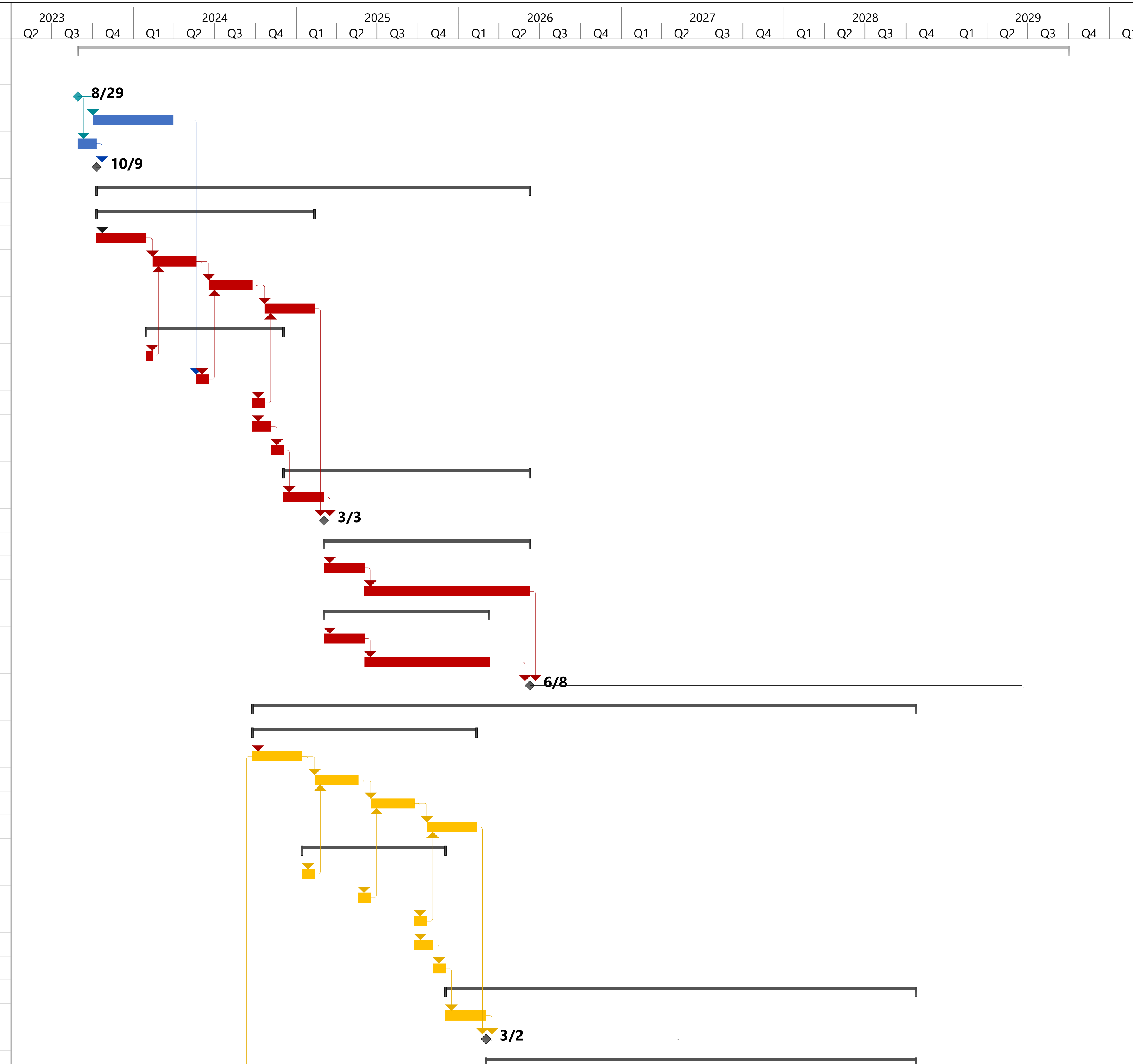
The following assumptions were used to estimate annual operation and maintenance costs:

1. Typical labor cost is $47/hr per AlexRenew. This alternative was assumed to require 4 hours per week for operations staff to perform daily inspection, routine maintenance and cleaning of scum concentration equipment
2. Annual equipment maintenance cost is projected at 2% of initial installed equipment capital costs.
3. Annual energy cost is estimated based on a unit cost of $0.08/kW/hr.
4. Chemical cost is system specific and is not applicable to the scum handling system.
5. Concentrated scum removal and disposal cost is $64/wet ton per AlexRenew.
6. The average daily flow at the facility is assumed to increase from 40 mgd to 54 mgd in the next 20 years at an annual growth of 1.51% which was used to calculate the annual O&M cost for future years.
7. The inflation rate and normal discount rate are assumed to be 2.48% and 3.00%, respectively. These values are used to calculate net present worth of O&M cost for each year over 20 years.
8. Net present worth cost is calculated by totalizing the present worth values of annual O&M costs over the 20-year life cycle selected for analysis.

Appendix J

Project Schedule

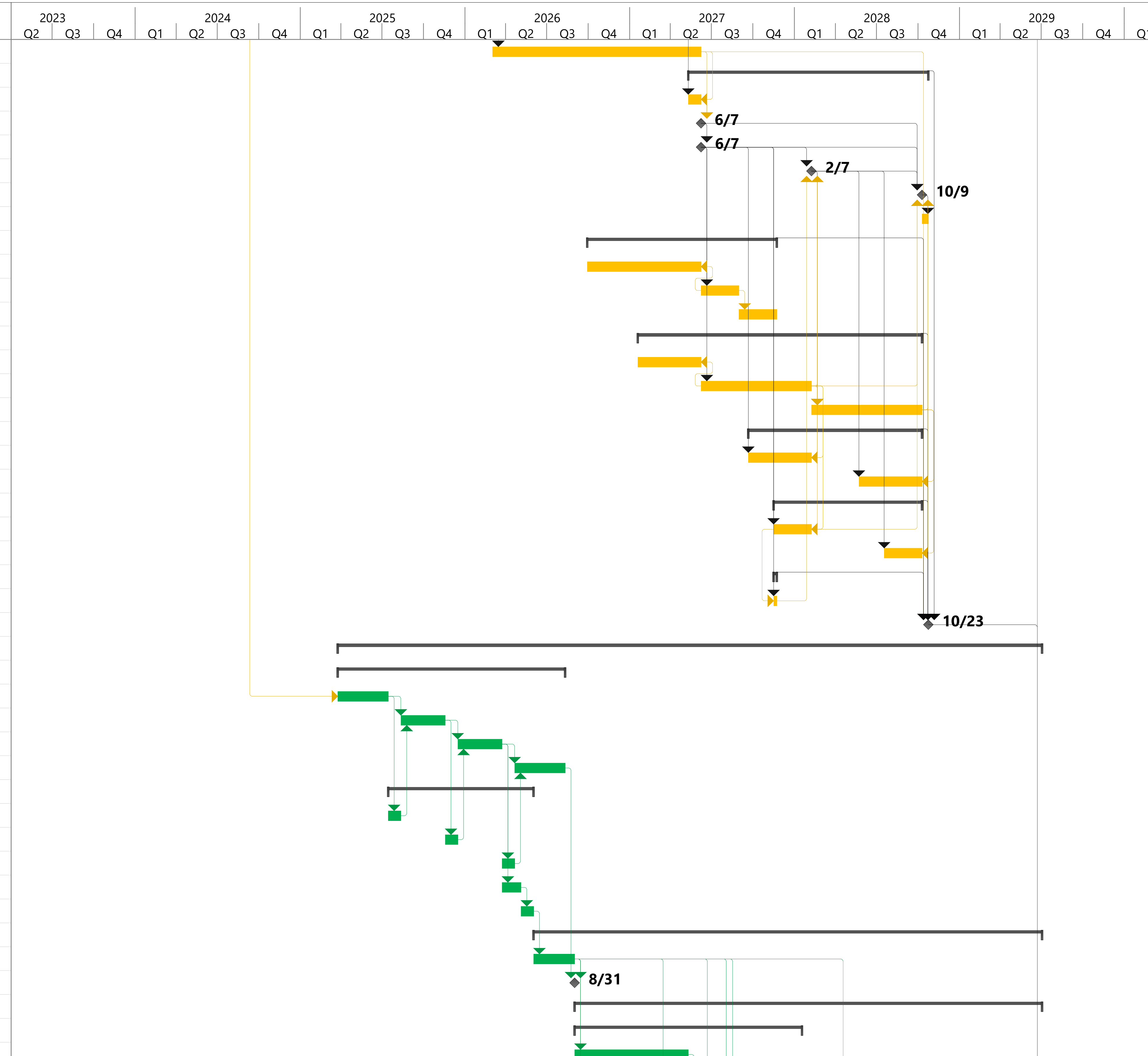
ID	Task Name	Duration	Start	Finish
0	**Alternative 5: Phase 1 CMAR, Phase 2 CMAR, Phase 3 CMAR (3-phase CMAR)**	**1590 days**	**Tue 8/29/23**	**Mon 10/1/29**
1	Current Date	0 days	Tue 8/29/23	Tue 8/29/23
2	CMAR Procurement	26 wks	Mon 10/2/23	Fri 3/29/24
3	Revise Phase 1 SOW for CMAR	6 wks	Tue 8/29/23	Mon 10/9/23
4	Design NTP	0 days	Mon 10/9/23	Mon 10/9/23
5	**Phase 1 - CMAR**	**695 days**	**Tue 10/10/23**	**Mon 6/8/26**
6	**Phase 1 Design**	**350 days**	**Tue 10/10/23**	**Mon 2/10/25**
7	30% Design	16 wks	Tue 10/10/23	Mon 1/29/24
8	60% Design	14 wks	Tue 2/13/24	Mon 5/20/24
9	95% Design	14 wks	Tue 6/18/24	Mon 9/23/24
10	100% Design	16 wks	Tue 10/22/24	Mon 2/10/25
11	**Phase 1 CMAR Pre-Construction**	**220 days**	**Tue 1/30/24**	**Mon 12/2/24**
12	30% Design Review	2 wks	Tue 1/30/24	Mon 2/12/24
13	60% Design Review	4 wks	Tue 5/21/24	Mon 6/17/24
14	95% Design Review	4 wks	Tue 9/24/24	Mon 10/21/24
15	GMP #1	6 wks	Tue 9/24/24	Mon 11/4/24
16	GMP #1 Approval	4 wks	Tue 11/5/24	Mon 12/2/24
17	**Phase 1 Construction**	**395 days**	**Tue 12/3/24**	**Mon 6/8/26**
18	Preliminary Shop Drawings	13 wks	Tue 12/3/24	Mon 3/3/25
19	Construction Mobilization	0 days	Mon 3/3/25	Mon 3/3/25
20	**P-1 POWH**	**330 days**	**Tue 3/4/25**	**Mon 6/8/26**
21	Fabrication and Delivery	13 wks	Tue 3/4/25	Mon 6/2/25
22	Installation	53 wks	Tue 6/3/25	Mon 6/8/26
23	**P-3 Misc. PST**	**265 days**	**Tue 3/4/25**	**Mon 3/9/26**
24	Fabrication and Delivery	13 wks	Tue 3/4/25	Mon 6/2/25
25	Installation	40 wks	Tue 6/3/25	Mon 3/9/26
26	Phase 1 Substantial Completion	0 days	Mon 6/8/26	Mon 6/8/26
27	**Phase 2 - CMAR**	**1065 days**	**Tue 9/24/24**	**Mon 10/23/28**
28	**Phase 2 Design**	**360 days**	**Tue 9/24/24**	**Mon 2/9/26**
29	30% Design	16 wks	Tue 9/24/24	Mon 1/13/25
30	60% Design	14 wks	Tue 2/11/25	Mon 5/19/25
31	95% Design	14 wks	Tue 6/17/25	Mon 9/22/25
32	100% Design	16 wks	Tue 10/21/25	Mon 2/9/26
33	**Phase 2 CMAR Pre-Construction**	**230 days**	**Tue 1/14/25**	**Mon 12/1/25**
34	30% Design Review	4 wks	Tue 1/14/25	Mon 2/10/25
35	60% Design Review	4 wks	Tue 5/20/25	Mon 6/16/25
36	95% Design Review	4 wks	Tue 9/23/25	Mon 10/20/25
37	GMP #2	6 wks	Tue 9/23/25	Mon 11/3/25
38	GMP #2 Approval	4 wks	Tue 11/4/25	Mon 12/1/25
39	**Phase 2 Construction**	**755 days**	**Tue 12/2/25**	**Mon 10/23/28**
40	Preliminary Shop Drawings	13 wks	Tue 12/2/25	Mon 3/2/26
41	Construction Mobilization	0 days	Mon 3/2/26	Mon 3/2/26
42	**Building A**	**690 days**	**Tue 3/3/26**	**Mon 10/23/28**



Project: Alternative 5: Phase 1 CMAR, Phase 2 CMAR, Phase 3 CMAR (3-phase CMAR)
Date: Mon 8/28/23

Milestone ◆	Task - Phase 1	Task - Phase 3	Task - Burn Building
Summary	Task - Phase 2	Task - General	Manual Milestone ◆

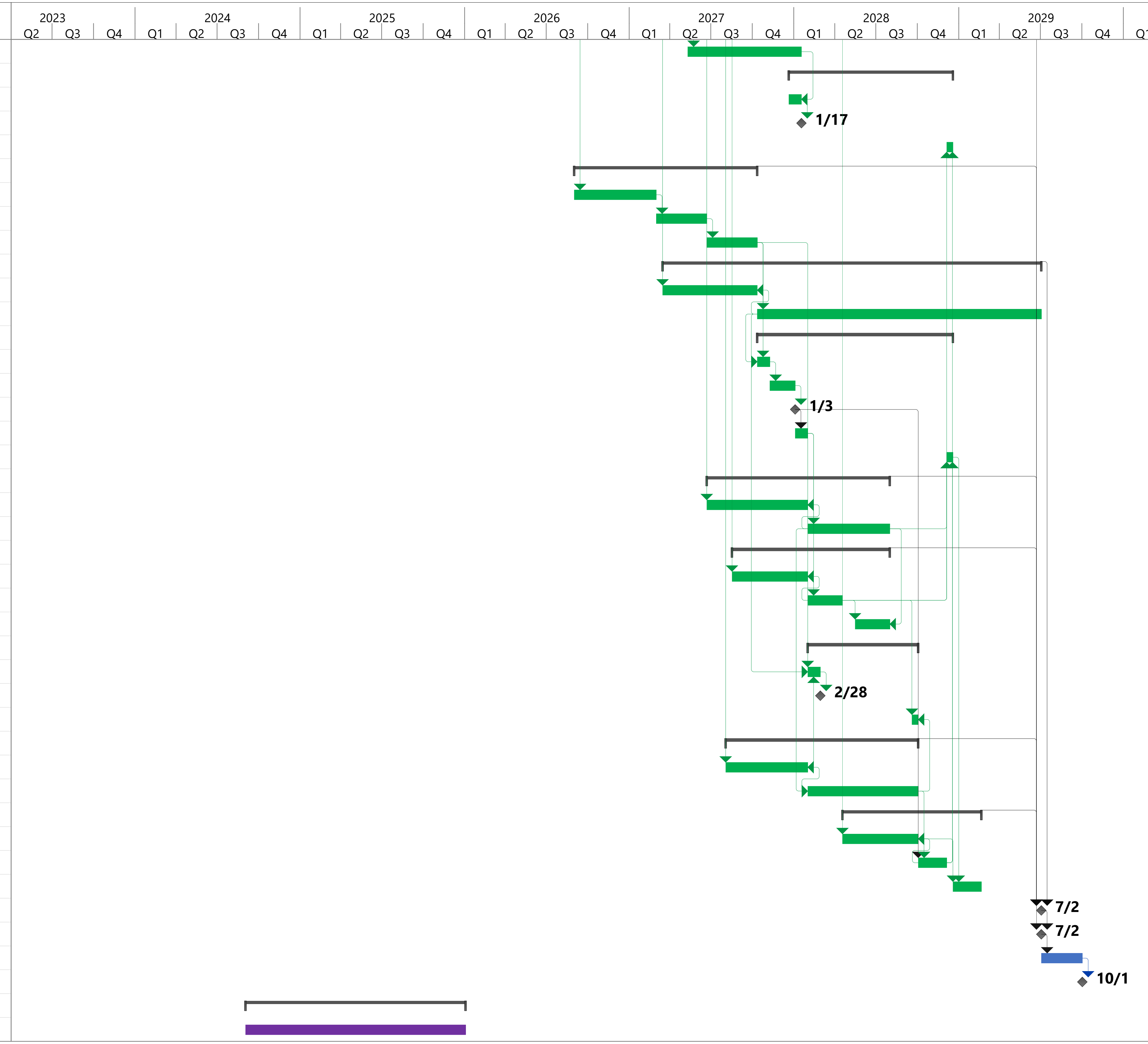
ID	Task Name	Duration	Start	Finish
43	**CS-1 Channel**	**66 wks**	**Tue 3/3/26**	**Mon 6/7/27**
44	**Bypass Pumping**	**380 days**	**Tue 5/11/27**	**Mon 10/23/28**
45	Mobilize/Test Pumps	4 wks	Tue 5/11/27	Mon 6/7/27
46	Initiate Bypass Pumping	0 days	Mon 6/7/27	Mon 6/7/27
47	Isolate RSPS North Side	0 days	Mon 6/7/27	Mon 6/7/27
48	Isolate RSPS South Side	0 days	Mon 2/7/28	Mon 2/7/28
49	Cease Bypass Pumping	0 days	Mon 10/9/28	Mon 10/9/28
50	Demobilize Bypass Pumping	2 wks	Tue 10/10/28	Mon 10/23/28
51	**CS-2 Screen Replace**	**300 days**	**Tue 9/29/26**	**Mon 11/22/27**
52	Fab/Deliver Screens	36 wks	Tue 9/29/26	Tue 6/8/27
53	Replace CS1	12 wks	Tue 6/8/27	Mon 8/30/27
54	Replace CS2	12 wks	Tue 8/31/27	Mon 11/22/27
55	**R-1 Pump Replace**	**450 days**	**Tue 1/19/27**	**Mon 10/9/28**
56	Fab/Deliver Pumps	20 wks	Tue 1/19/27	Tue 6/8/27
57	North Side RSPS	35 wks	Tue 6/8/27	Mon 2/7/28
58	South Side RSPS	35 wks	Tue 2/8/28	Mon 10/9/28
59	**R-2 Misc. RSPS**	**275 days**	**Tue 9/21/27**	**Mon 10/9/28**
60	North Side Wet Well	20 wks	Tue 9/21/27	Mon 2/7/28
61	South Side Wet Well	20 wks	Tue 5/23/28	Mon 10/9/28
62	**C-1 Conduit Repair**	**235 days**	**Tue 11/16/27**	**Mon 10/9/28**
63	North Side	12 wks	Tue 11/16/27	Mon 2/7/28
64	South Side	12 wks	Tue 7/18/28	Mon 10/9/28
65	**C-2 Inspection**	**5 days**	**Tue 11/16/27**	**Mon 11/22/27**
66	North Side	1 wk	Tue 11/16/27	Mon 11/22/27
67	Phase 2 Substantial Completion	0 days	Mon 10/23/28	Mon 10/23/28
68	**Phase 3 - CMAR**	**1115 days**	**Tue 3/25/25**	**Mon 7/2/29**
69	**Phase 3 Design**	**360 days**	**Tue 3/25/25**	**Mon 8/10/26**
70	30% Design	16 wks	Tue 3/25/25	Mon 7/14/25
71	60% Design	14 wks	Tue 8/12/25	Mon 11/17/25
72	95% Design	14 wks	Tue 12/16/25	Mon 3/23/26
73	100% Design	16 wks	Tue 4/21/26	Mon 8/10/26
74	**Phase 3 CMAR Pre-Construction**	**230 days**	**Tue 7/15/25**	**Mon 6/1/26**
75	30% Design Review	4 wks	Tue 7/15/25	Mon 8/11/25
76	60% Design Review	4 wks	Tue 11/18/25	Mon 12/15/25
77	95% Design Review	4 wks	Tue 3/24/26	Mon 4/20/26
78	GMP #3	6 wks	Tue 3/24/26	Mon 5/4/26
79	GMP #3 Approval	4 wks	Tue 5/5/26	Mon 6/1/26
80	**Phase 3 Construction**	**805 days**	**Tue 6/2/26**	**Mon 7/2/29**
81	Preliminary Shop Drawings	13 wks	Tue 6/2/26	Mon 8/31/26
82	Construction Mobilization	0 days	Mon 8/31/26	Mon 8/31/26
83	**Building K**	**740 days**	**Tue 9/1/26**	**Mon 7/2/29**
84	**FS-1 Fine Screens**	**360 days**	**Tue 9/1/26**	**Mon 1/17/28**
85	Fab/Deliver Screens	36 wks	Tue 9/1/26	Mon 5/10/27



Project: Alternative 5: Phase 1 CMAR, Phase 2 CMAR, Phase 3 CMAR (3-phase CMAR)
Date: Mon 8/28/23

Milestone ◆	Task - Phase 1	Task - Phase 3	Task - Burn Building
Summary	Task - Phase 2	Task - General	Manual Milestone ◆

ID	Task Name	Duration	Start	Finish
86	Installation	36 wks	Tue 5/11/27	Mon 1/17/28
87	**Temporary Screenings Handling**	**260 days**	**Tue 12/21/27**	**Mon 12/18/28**
88	Install Temp Screenings Handling	4 wks	Tue 12/21/27	Mon 1/17/28
89	Initiate Temporary Screenings	0 days	Mon 1/17/28	Mon 1/17/28
90	Demobilize Temporary Screenings	2 wks	Tue 12/5/28	Mon 12/18/28
91	**G-1 Replace Vortex**	**290 days**	**Tue 9/1/26**	**Mon 10/11/27**
92	Fab/Deliver Vortex	26 wks	Tue 9/1/26	Mon 3/1/27
93	Replace GS2	16 wks	Tue 3/2/27	Mon 6/21/27
94	Replace GS1	16 wks	Tue 6/22/27	Mon 10/11/27
95	**G-2 Install Stacked Tray**	**600 days**	**Tue 3/16/27**	**Mon 7/2/29**
96	Fab/Deliver Stacked Tray	30 wks	Tue 3/16/27	Tue 10/12/27
97	Installation	90 wks	Tue 10/12/27	Mon 7/2/29
98	**Loading Demolition**	**310 days**	**Tue 10/12/27**	**Mon 12/18/28**
99	Demo West Classifiers	4 wks	Tue 10/12/27	Mon 11/8/27
100	Install Temp Grit Dewatering	8 wks	Tue 11/9/27	Mon 1/3/28
101	Initiate Temporary Dewatering	0 days	Mon 1/3/28	Mon 1/3/28
102	Demo East Classifiers/Platform	4 wks	Tue 1/4/28	Mon 1/31/28
103	Demobilize Temp Dewatering	2 wks	Tue 12/5/28	Mon 12/18/28
104	**G-3 Install Washers**	**290 days**	**Tue 6/22/27**	**Mon 7/31/28**
105	Fab/Deliver Washers	32 wks	Tue 6/22/27	Tue 2/1/28
106	Installation	26 wks	Tue 2/1/28	Mon 7/31/28
107	**L-2 Conveyors**	**250 days**	**Tue 8/17/27**	**Mon 7/31/28**
108	Fab/Deliver Conveyors	24 wks	Tue 8/17/27	Tue 2/1/28
109	Install East Conveyors	11 wks	Tue 2/1/28	Mon 4/17/28
110	Install West Conveyors	11 wks	Tue 5/16/28	Mon 7/31/28
111	**Temporary Scum Handling**	**175 days**	**Tue 2/1/28**	**Mon 10/2/28**
112	Install Temp Scum Handling	4 wks	Tue 2/1/28	Mon 2/28/28
113	Initiate Temporary Scum	0 days	Mon 2/28/28	Mon 2/28/28
114	Demobilize Temporary Scum	2 wks	Tue 9/19/28	Mon 10/2/28
115	**P-2 Primary Scum**	**305 days**	**Tue 8/3/27**	**Mon 10/2/28**
116	Fab/Deliver Scum	26 wks	Tue 8/3/27	Tue 2/1/28
117	Installation	35 wks	Tue 2/1/28	Mon 10/2/28
118	**L-1 Trolley System**	**220 days**	**Tue 4/18/28**	**Mon 2/19/29**
119	Fab/Deliver Trolley	24 wks	Tue 4/18/28	Tue 10/3/28
120	Install East Truck Bay	9 wks	Tue 10/3/28	Mon 12/4/28
121	Install West Truck Bay	9 wks	Tue 12/19/28	Mon 2/19/29
122	Phase 3 Substantial Completion	0 days	Mon 7/2/29	Mon 7/2/29
123	**Construction Substantial Completion**	**0 days**	**Mon 7/2/29**	**Mon 7/2/29**
124	**Punchlist**	**13 wks**	**Tue 7/3/29**	**Mon 10/1/29**
125	**Construction Final Completion**	**0 days**	**Mon 10/1/29**	**Mon 10/1/29**
126	**City of Alexandria Burn Building**	**350 days**	**Mon 9/2/24**	**Fri 1/2/26**
127	Construction - Late Start	70 wks	Mon 9/2/24	Fri 1/2/26



Project: Alternative 5: Phase 1 CMAR, Phase 2 CMAR, Phase 3 CMAR (3-phase CMAR)
Date: Mon 8/28/23

Milestone ◆	Task - Phase 1	Task - Phase 3	Task - Burn Building
Summary	Task - Phase 2	Task - General	Manual Milestone ◆

ghd.com The Power of Commitment

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Attachment B
Sample Professional Services Agreement

To be provided as an addendum.

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<u>Attachment C</u>
RFP 24-020 Cover Sheet

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RFP 24-020 Cover Sheet

Issue Date:

RFP #: 24-020

Proposals submitted to AlexRenew: No later than 2:00 PM ET, December 19, 2023

Location of Submission: Electronically via e-mail

Contract Administrator: Igor Scherbakov
Procurement Manager
igor.scherbakov@alexrenew.com

Proposal Submitted by:

Name:____

Address:____

Telephone: ____

Email: ____

TIN or SSN: ____

Alexandria Professional & Occupational License Tax #: ____________________

License # and Specialty: __________________________________

Business Classification (check all that apply):

☐ Minority Owned	☐ Woman Owned	☐ Veteran Owned	☐ Disability
☐ Individual	☐ Partnership	☐ Corporation	☐ State Incorporated
☐ Small	☐ Large		

Attestation:

The undersigned offers and agrees that the terms, conditions and detailed information provided herein, including all appendices attached hereto, will serve as the basis for a professional services contract, if awarded thereto.

____
Name and Title (Respondent's authorized representative)

______________________________ ______________________________
Authorized Signature Date

SUBMIT THIS FORM WITH YOUR PROPOSAL

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Attachment D

RFP 24-020 Checklist

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RFP 24-020 Checklist

RESPONDENT NAME: Click or tap here to enter text.

The purpose of the RRP Checklist is to aid the Respondent to ensure all submittal requirements have been included in the Respondent's Proposal and to provide a page reference indicating the location of each submittal requirement in the Proposal.

Contents	Checklist	Proposal Page Reference
Cover Page	☐	
Cover Sheet	☐	
This Checklist	☐	
Table of Contents	☐	
Submittal Letter	☐	
Team Organization and Commitment	☐	
Related Project Experience	☐	
Supporting CMAR Process Management	☐	
Resumes	☐	
SCC Registration Form	☐	

ADDENDA ACKNOWLEDGEMENT. Your signature below serves as your acknowledgment that all addenda have been received and incorporated into the Proposal submission. Check all that apply.

☐ Addendum No. 1 ☐ Addendum No. 2 ☐ Addendum No. 3 ☐ Addendum No. 4

☐ Addendum No. 5 ☐ Addendum No. 6 ☐ Addendum No. 7 ☐ Addendum No. 8

____

Name and Title (Respondent's authorized representative)

____________________ ____________________

Authorized Signature Date

RETURN THIS FORM WITH YOUR PROPOSAL.

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Attachment E
SCC Registration Form

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Compliance with Virginia Law for Transacting Business in Virginia

The undersigned hereby agrees that, if AlexRenew accepts your Proposal for services in conjunction with this RFP, you meet the requirements of Virginia Code § 2.2-4311.2.

Please complete the following by checking the appropriate line that applies and providing the requested information:

A. ☐ Respondent is a Virginia business entity organized and authorized to transact business in Virginia by the SCC and such Respondent's Identification Number issued to it by the SCC is Click or tap here to enter text. (The SCC number is NOT your federal ID number).

B. ☐ Respondent is an out-of-state (foreign) business entity that is authorized to transact business in Virginia by the SCC and such Respondent's Identification Number issued to it by the SCC is Click or tap here to enter text.

C. ☐ Respondent does not have an Identification Number issued to it by the SCC and such Respondent does not require authorization to transact business in Virginia by the SCC for the following reason or reasons. (Please add additional pages if necessary).

____

Legal Name of Company (as listed on W-9)

____

Name and Title (Respondent's authorized representative)

__________________________	__________________________
Authorized Signature	Date

RETURN THIS FORM WITH YOUR PROPOSAL.

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