EXETER, NEW HAMPSHIRE WASTEWATER TREATMENT FACILITY UPGRADE

30% DESIGN VALUE ENGINEERING WORKSHOP DECEMBER 7-11, 2015

FINAL REPORT
January 13, 2016

PROCESSANALYSTS

HAZEN AND SAWYER
Environmental Engineers & Scientists

OAK POINT ASSOCIATES

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SECTION 1 - INTRODUCTION

1.1 INTRODUCTION

On December 7 – 11, 2015 a five-day Value Engineering Workshop was held in Exeter, NH on the design of the proposed Exeter Wastewater Treatment Facility Upgrade under design by Wright-Pierce. The design was approximately 30-35% complete at the time the Workshop was held.

Participants from Exeter attending the Introductory Session on Day 1 and the afternoon of Day 5 are listed below. A list of all participants is contained on the attached sign-in sheets.

Town of Exeter		**Session Attended**
Jennifer Perry	Director of Public Works	Mon AM & Fri PM
Michael Jeffers	Water and Sewer Manager/Engineer	Mon AM & Fri PM
Steve Dalton	Senior Wastewater Operator	Mon AM & Fri PM
Scott Butler	Operator	Mon AM
Ed Bugbee	Water and Sewer Technician	Mon AM
Larry Pond	Water and Sewer Technician	Mon AM & Fri PM
Matt Berube	Water and Sewer Engineering Tech.	Mon AM
Russell Dean	Exeter Town Manager	Fri PM
Julie Gilman	Chair - Board of Selectmen	Fri PM
Don Clement	Vice-chair – Board of Selectmen	Mon AM & Fri PM
Paul Vlasich	Exeter Town Engineer	Fri PM
Bob Kelly	Chair- Water and Sewer Advisory Committee	Mon AM & Fri PM

NH Department of Environmental Services		
Sharon Rivard	Design Review Engineer	Mon AM & Fri PM
Dennis Greene	Design Review Engineer	Mon AM & Fri PM
VE Workshop Team	*(Attended full workshop except For Brian Como)*	
Edward Rushbrook	Value Engineering Workshop Facilitator	Process Analysts
Scott Donovan	Architect	Oak Point Associates
Sarah Glast	Process Engineer	Hazen & Sawyer
Stephen Cluff	Mechanical Engineer	Hazen & Sawyer
Will Leadbitter	Structural Engineer	Hazen and Sawyer
Brian Como	Cost Estimator (Day 3 and 4 only)	Hazen and Sawyer
Jennifer Cass	Civil/Site Engineer	Hazen and Sawyer
Original Designer		
Ed Leonard	Project Manager – Wright-Pierce	Mon AM & Fri PM
Andy Morrill	Lead Project Engineer – Wright-Pierce	Mon AM & Fri PM

The attached PowerPoint handout and time-block schedule that describe the workshop schedule and the six (6) phases of the VE process to be followed were provided to key participants prior to the Workshop.

1.2 BACKGROUND

The Town of Exeter operates a secondary wastewater treatment facility consisting of aerated lagoons. The discharge from the lagoons is disinfected prior to discharge to the Squamscott River and subsequently to Great Bay. The facility is operated under a National Pollutant Discharge Elimination System (NPDES) permit issued by the Environmental Protection Agency (EPA).

In 2012, a permit was issued to Exeter requiring a 3 mg/L Total Nitrogen as a rolling average from April 1 to October 31. In 2013, those permit limits were changed to require an 8 mg/L Total Nitrogen limit to the Year 2023, at which time an evaluation would be made of the performance of an upgrade to the treatment facility along with non-point source actions to be undertaken by the Town.

At that time, EPA will evaluate the performance to date and make a determination as to whether the Nitrogen limit of 3 mg/L will be enforced as mandatory.

As part of this project, the main pump station will be upgraded to reduce CSOs. The treatment facility will be upgraded to achieve a Total Nitrogen concentration of 5 mg/L or less. It should be noted that the current permit held by Exeter is for a 3 MGD discharge. Exeter has petitioned for this upgrade to be designed to add a 2.65 MGD capacity to minimize the cost of construction. In addition, it is anticipated that flows in the system will be reduced over time as infiltration/inflow (I/I) improvements are made in the collection system. At the time of the Workshop, it appeared that this approach will be acceptable to EPA and NHDES.

To meet the 5 mg/L or less Total Nitrogen limit, a 4-Stage Bardenpho process is proposed up to a capacity of 2.2 MGD, at which time the process will be operated as a modified Ludgack-Ettinger process up to 2.65 MGD. Supplemental alkalinity and carbon systems are proposed to be provided.

To reach a capacity of 3 MGD, it is anticipated that primary clarifiers would be added to the process or a third activated sludge train utilizing the 4-Stage Bardenpho process would be constructed.

Given a projected project cost of $50M, a Value Engineering Study was required by the NHDES.

Additional details on the proposed design are contained in **Section 3**, the Information Phase of the Workshop.

Exeter Wastewater Treatment Facility Upgrade
VE Workshop

Dec 7-11, 2015

SIGN-IN SHEET

12/7/2015

NAME / ORGANIZATION / TITLE	E-MAIL	PHONE/FAX
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Exeter Wastewater Treatment Facility Upgrade
VE Workshop

Dec 7-11, 2015

SIGN-IN SHEET

12/7/2015

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Exeter Wastewater Treatment Facility Upgrade **Dec 7-11, 2015**
VE Workshop

SIGN-IN SHEET

12/11/2015

Page 1

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Exeter Wastewater Treatment Facility Upgrade
VE Workshop

Dec 7-11, 2015

SIGN-IN SHEET

12/11/2015

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WELCOME TO THE

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN

VALUE ENGINEERING WORKSHOP

Process Analysts
Hazen and Sawyer
Wright-Pierce Associates

THE PURPOSE OF THIS WORKSHOP

- The purpose of this workshop is to apply Value Engineering to the Exeter Wastewater Treatment Facility Upgrade Design .
- The design is approximately 30-35% complete.
- The goal of the VE is to:
  - a) Determine if the cost can be reduced
  - b) Possibly improve the "function" of the project
  - c) Help validate the projected construction cost of the project in preparation for the 2016 Town Meeting.
  - d) Provide an independent evaluation of the design

VALUE ENGINEERING AND HOW WILL IT BE APPLIED

- Value Engineering is a compressed review process used since 1945 to improve the value of a project, by focusing on **function**.
- The VE process as described in EPA Publication 430/9-84-009 and SAVE Value Standard will be followed.
- A VE team consisting of an experienced Architect, Civil, Process, Structural, and Mechanical engineers will evaluate the proposed design and projected costs in their disciplines to investigate whether the function or cost of the project can be improved.
- A report on the results of the VE will be issued after the VE and Exeter and Wright-Pierce will review the VE findings to determine which recommendations are worthy of implementation.

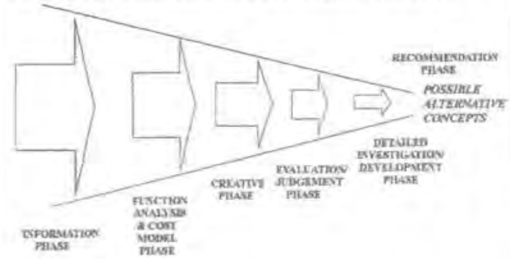
WHAT VALUE ENGINEERING IS ***NOT***

- It's not an indication that there is a problem with the proposed design.
- **IT'S NOT AN ARBITRARY REDESIGN OF THE PROJECT.**
- It's not a complete design review of the project.
- It's not an exercise to arbitrarily eliminate elements of a project
- **It's not a "mandate"** – VE recommendations must be credible and acceptable to Exeter and Wright-Pierce to be adopted.

BENEFITS OF VALUE ENGINEERING

- It provides an owner with an independent project review
- It provides an owner with an opportunity to understand their project in more detail than normally available
- Potential reductions in construction and life-cycle costs are identified.
- If necessary, project elements can be prioritized by function to control the cost at bid by focusing on the function of those elements.

The six-phase VE Job Plan is a process that progressively evaluates alternatives to improve function and value.



STEP 1: THE INFORMATION PHASE

- GOAL: Obtain an understanding of the proposed design.
- Wright-Pierce will present the proposed design concepts and costs to the VE team and other participants.
- Exeter participants will give the team information on local conditions
- The VE team should ask questions to help them understand the design concepts in their discipline.
- Constraints and "off-the-table" items will be identified such as the 4-Stage Bardenpho treatment process which will not change.
- Following the design presentation Wright-Pierce will leave the workshop but will remain available for questions from the VE team.

STEP 2 - THE FUNCTION ANALYSIS

- **GOAL: To identify the intended function of the project which is called the Basic Function.**
- The Function Analysis will be used to develop a list of "active" verbs and "measurable" nouns and agreeing on one that best describes it .
- The simple verb/noun approach minimizes subjectivity and once defined.
- The Basic Function guides the VE team in assessing the impact of project elements on the cost of the project. A change that would negatively impact the Basic Function cannot proposed by the VE.

WHY IS "FUNCTION" THE FOCUS OF VALUE ENGINEERING ?

- The goal of Value Engineering is to improve "value".
- To assess the value of a project it's "intended function" must be identified.
- The defined "intended function" should be measurable to allow the VE to be most effective.
- By focusing on "function" Value Engineering provides a non-subjective assessment of "value". ***Function is key to VE.***

THE FUNCTION OF INDIVIDUAL PROJECT ELEMENTS CAN ALSO HELP GUIDE THE VE EFFORT

- **"Basic" Function:** The element is necessary for the Basic Function of the project to be achieved.
- **"Secondary" Function:** The element is not necessary for the Basic Function of the project to be achieved.
- **"Secondary/Essential Function":** The element doesn't directly provide the Basic Function but is necessary to support the Basic Function.

SAMPLE FUNCTIONAL ANALYSIS AND COST/WORTH RATIO

PROJECT ELEMENT: EMERGENCY POWER GENERATOR BUILDING
BASIC FUNCTION: SUPPLY POWER

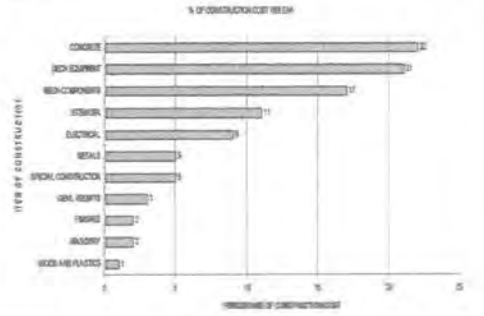
FUNCTION
B = BASIC
S = SECONDARY
S/E = SECONDARY ESSENTIAL

RATING
7 = [illegible] POTENTIAL FOR EVALUATION
3-6 = [illegible] POTENTIAL FOR EVALUATION
1-2 = [illegible] POTENTIAL FOR EVALUATION

ITEM	FUNCTION						
	VERB	NOUN	KIND	COST	WORTH	C/W RATIO	RATING
FOUNDATION	SUPPORT	STRUCTURE	S				
GENERATOR UNIT	SUPPLY	POWER	B				
ATS	SWITCH	POWER SOURCE	SE				
DRIVEWAY /PARKING	PROVIDE	VEHICLE ACCESS	S				
BUILDING ENCLOSURE	ENCLOSE	EQUIPMENT	S				
LANDSCAPING	PROVIDE	AESTHETICS	S				

COST MODELS

- Cost models are used to show which elements of the project make up the largest portions of the overall cost .
- Elements making up a large portion of the project cost offer the greatest potential for value improvement.
- Elements with a very small contribution to the project cost can be eliminated from consideration in the VE as they offer little potential for value improvement.
- The team can identify a cutoff to eliminate elements that are small and unlikely to produce a significant savings to make best use of the time available for evaluation efforts.



V.E. CAN USE THREE INDICATORS IN EVALUATING A PROJECT DURING THE INFORMATION PHASE

- A **"Function Analysis"** is used to define the intended function of the project to identify necessary project elements and elements that have a secondary function.
- **"Cost Models"** are used to show the relative cost of various elements of the project. Large cost elements may offer the greatest opportunity for value improvement.
- **"Cost/Worth"** ratios can sometimes be useful to identify project elements offering the most potential for an improvement in project value of several being considered.

COST/WORTH RATIOS

- VE can use the "Cost/Worth" ratios to roughly compare alternative project elements to identify the "best few" for detailed investigation.
- The VE team can assign what they consider to be an approximate "worth" of alternative elements based on their experience. High accuracy isn't needed as costs will be explored in detail later.
- A high C/W indicates that the cost of a project element could possibly be reduced and may be worth evaluating.
- *VE considers elements that have a Secondary function as having low worth since they don't support the Basic Function.*

SAMPLE FUNCTIONAL ANALYSIS AND C/W RATIO

PROJECT ELEMENT EMERGENCY POWER GENERATOR BUILDING
BASIC FUNCTION: SUPPLY POWER

FUNCTION
[illegible]

RATING
[illegible]

ITEM	FUNCTION						
	VERB	NOUN	KIND	COST	WORTH	C/W RATIO	RATING
FOUNDATION	SUPPORT	STRUCTURE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
GENERATOR UNIT	SUPPLY	POWER	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ATS	SWITCH	POWER SOURCE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	PROVIDE	VEHICLE ACCESS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ENCLOSE	EQUIPMENT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LANDSCAPING	PROVIDE	AESTHETICS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

FOR A CHANGE TO BE CONSIDERED FOR POSSIBLE ADOPTION

- It must not reduce the intended function of the project.
  - *Secondary elements offer the greatest potential*
- The change must produce a cost reduction

THE VE INDICATORS ARE USED TO IDENTIFY ELEMENTS WITH THE GREATEST VALUE IMPROVEMENT POTENTIAL

- The **"Function Analysis"** to identify elements that are critical to the project so their function can't be changed, and elements that are not and can be changed.
- **"Cost Models"** to identify the largest cost elements that could offer the greatest opportunity for value improvement.
- **"Cost/Worth"** ratios if used to help identify and rank the "best few" project elements offering the most potential for value improvement.

STEP 3 : THE CREATIVE PHASE

- GOAL: To quickly list alternative design concepts to elements identified as offering the potential for value improvement.
- The technical expertise of the VE team in their disciplines is valuable in this phase.
- Discussion is kept to a minimum in this phase since the ideas will be evaluated in the next step.

PROJECT ANYTOWN USA ITEM Aeration Tanks

DATE ______ 5 = High rating

CREATIVE	EVALUATION		
IDEA	ADVANTAGES	DISADVANTAGES	RATING
Delete one interior wall			
Reduce size of tank			
Simplify ventilating			
Reduce number of influent gates			

Process Analysis

STEP 4: THE EVALUATION PHASE

- GOAL: To compare and rank alternatives to elements of the project listed in the Creative Phase to identify the "best few" worth evaluating in the Detailed Investigation Phase.

IMPORTANT: *The time available in the workshop must be taken into account in prioritizing the alternatives to be investigated in detail. It's not possible to evaluate all elements of a project in a VE, so "time management" is required by the VE team, with only the elements offering the most potential being selected for detailed investigation.*

Ask yourself, "what's the best use of my time in evaluating alternative design concepts in time available in this workshop that will result in value improvement "?

STEP 4 : THE EVALUATION PHASE

- Considerations in the Evaluation Phase may include:

  Basis of Design
  Performance Requirements
  Reliability
  Capital Cost and Operational Costs
  Maintenance
  Safety
  Schedule and Cost Impact of Changes

PROJECT ANYTOWN USA ITEM Aeration Tanks

DATE ______ 5 = High rating

CREATIVE	EVALUATION		
IDEA	ADVANTAGES	DISADVANTAGES	RATING
Delete one interior wall	Reduce interior wall cost	Need to increase outer wall thickness	[illegible]
Reduce size of tank	Reduce cost of construction	Could affect process efficiency / capacity	4
Simplify ventilating	Reduce cost of construction	Requires revision of drawings	[illegible]
Reduce number of influent gates	Reduce construction cost	Possibly reduce process flexibility	[illegible]

Process Analysis

STEP 5: DETAILED INVESTIGATIONS

- GOAL: To develop detailed comparisons of alternative designs to the original design to show potential cost savings .
- Detailed comparisons of the "Best Few" alternatives are developed to determine if changes can improve the cost effectiveness of the project in the individual disciplines.
- Some team members may have more work than others as a result of the creative and evaluation phases.
- Documentation of the Detailed Investigations must be thorough to be considered further for implementation .

Process Analysis 25

Process Analysis 26

COST ESTIMATING

- Cost comparisons made in the Detailed Investigation Phase are intended to be relative comparisons.
- Cost estimates for unit price items are the quickest to estimate, equipment and systems the most time consuming.
- Cost comparisons developed in the workshop must be reasonable and represent credible comparisons, and contingencies and allowances should be used to represent unknowns.
- Cost comparisons will be evaluated by the designer as part of the report review process to determine if they are reasonable.

Process Analysis 27

Process Analysis 28

STEP 6: PRESENTATION PHASE

- GOAL: To report the findings of the workshop verbally.
- Identify the item evaluated
- Briefly describe the "proposed design concept" and "alternative" evaluated
- Briefly describe the pros and cons
- Identify the cost differences found

Process Analysis 29

STEP 6: VE REPORT PREPARATION AND REVIEW

- The results of the VE workshop will be formalized in a written report and presented to Exeter within 10 days which will include:
  - Executive Summary of Findings and Recommendations
  - Copies of Detailed Investigation Phase worksheets with detailed calculations, design criteria, sketches, costs, etc., clearly comparing alternative design approaches
  - Appendices: Key drawings, figures and support data
- Wright-Pierce and Exeter will review the report and decide on whether recommendations are worthy of adoption.

Process Analysis 30

Exeter Wastewater Treatment Facility Design - Dec. 7-11
5-Day Value Engineering Workshop
Tentative Schedule
GRAY BLOCKS INDICATE TIME FOR DETAILED INVESTIGATIONS

NOTE: Times for Creative and Evaluation Phases approximate depending on number of alternatives identified for evaluation.

TIME	DAY ONE ACTIVITY	DAY TWO ACTIVITY	DAY THREE ACTIVITY	DAY FOUR ACTIVITY	DAY FIVE ACTIVITY
8:30	INTRODUCTION TO VE PROCESS	REVIEW DAY TWO ACTIVITIES	REVIEW STATUS OF EVALUATIONS	REVIEW STATUS OF EVALUATIONS	REVIEW STATUS OF EVALUATIONS
9:00					
9:30	PRESENTATION OF PROPOSED DESIGN BY DESIGNER	INITIATE EVALUATION PHASE			
10:00	AND TEAM DISCUSSION	EVALUATE AND RANK ALTERNATIVES	CONTUNUE DETAILED INVESTIGATIONS	CONTINUE DETAILED INVESTIGATIONS	START TO FINALIZE DETAILED INVESTIGATIONS
10:30		BY DISCIPLINE			
11:00	SITE VISIT & IDENTIFY ADDITIONAL DATA NEEDED				
11:30		IDENTIFY ADDITIONAL DATA NEEDED	PROGRESS CHECK	PROGRESS CHECK	CHECK STATUS ON EVALUATIONS
12:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
12:30					
1:00 PM	PERFORM FUNCTIONAL ANALYSIS AND REVIEW COST MODELS BY DISCIPLINE				
1:30 PM					FINALIZE DETAILED INVESTIGATIONS FOR PRESENTATION
2:00 PM		INITIATE DETAILED INVESTIGATIONS	CONTINUE DETAILED INVESTIGATIONS	CONTINUE DETAILED INVESTIGATIONS	
2:30 PM					
3:00 PM	INITIATE CREATIVE PHASE BY DISCIPLINE				ORAL PRESENTATION OF FINDINGS TO OWNER AND DESIGNER
3:30 PM		IDENTIFY ADDITIONAL INFORMATION NEEDED			
4:00 PM	SUMMARIZE DAY ONE PROGRESS	SUMMARIZE DAY TWO PROGRESS	SUMMARIZE DAY THREE PROGRESS	SUMMARIZE DAY THREE PROGRESS	CLOSE WORKSHOP

EXETER, NH

WATEWATER TREATMENT FACILITY UPGRADE

VALUE ENGINEERING WORKSHOP

NOVEMBER 5, 2015 PRE-WORKSHOP MEETING NOTES

**November 6, 2015 Revisions*

***November 11 Revisions*

- ❑ Participants and roles
  - Jennifer, Paul Vlasich, Steve Dalton, **Mike Jeffers*
  - Sharon Rivard . and possibly Gloria from DES
  - EPA – someone from permits, possibly Dave Pinkham or Dan Arsenault
  - Ed Leonard of Wright-Pierce and design team members
- ❑ Discussion of Exeter's goals and specific expectations for the workshop
  - Fresh set of technical eyes
  - Obtain/ensure "cost-effective" project
  - Meet DES requirement to hold a VE
  - Help confirm **realistic* project cost for warrant article
  - Obtain energy efficient design
- ❑ Unique project aspects
  - **Meet AO of* 8mg/L N initially, but provide flexibility to go to *Permit Limit of 3mg/L if needed in future
  - Right-sizing to less than 3MGD permit (so far acceptable to EPA and DES)
  - Compartmentalize process units to give 4-stage Bardenpho with < 3MGD initial capacity but allow for possible future expansion (Option 6)
  - Sludge lagoon decommissioning (major cost and possible *"*special*" waste material and possible wildlife and Phragmites considerations) **more geotech needed*
  - Existing Pubic Works campus operations and treatment process continuity
  - Construction phasing/switchover *(*contained in section 3 of PDR)*
  - Buried high pressure gas line in lagoon area
  - Pump station and force main to be included in VE
  - <u>May</u> include decommissioning of existing lagoons #2 and #3
  - **Alternative site plan was developed – VE to evaluate and compare*
- ❑ Design completion status of project by design discipline

- "Pencils down" * *pending Exeter decisions on 15 cost savings items suggested by W-P, VE recommendations, and additional geotech evaluations in lagoon*
- Tight completion schedule –AO calls for construction start June 2016
- Possibly second VE at 70%+/- completion but not decided yet

❑ Status of project cost estimate and budget

- Possibly $60 Million with lagoon "decommissioning/cleanup"
- Need reliable cost in January for March Town Meeting article

❑ Identify special design considerations and/or constraints if applicable

- *See Unique Project Aspects above*

❑ Discuss pre-workshop material available including drawings, specifications and cost estimate.

- Need electronic and hard copies of PER, drawings, specs, and cost estimate by CSI Division for various project elements , i.e,.buildings, process units, etc.

❑ Discuss pre-workshop handout material to be used

- *<u>**Pre-workshop Meeting Notes</u>*
- V.E. Team memo - sample given to Jennifer
- V.E. methodology - sample given to Jennifer
- Workshop agenda - sample given to Jennifer
- PowerPoint handout - sample given to Jennifer
- Preliminary Cost Models – **electronic estimate will be provided by W-P*
- Preliminary Design Report – Received from Jennifer – ***<u>To be replaced with October Report per W-P</u>*
- Site layout, floor plans, elevations, etc.- Drawings received from Jennifer : **electronic drawings to be provided to PA by W-P, with 2 hard copies provided for VE workshop, FTP site to be set up for VE team use.*

❑ Workshop participants contact information (*to be provided – see item 1 on pg. 1*)

❑ Set schedule and duration of workshop : December 7-11

❑ Confirm location of workshop : Public Works garage conference room

❑ OTHER: additional details to be developed as we progress

SECTION 2 - SUMMARY OF FINDINGS

2.1 RECOMMENDATIONS

The following is a Summary of Findings and Recommendations resulting from the Exeter, NH Wastewater Treatment Facility (WWTF) Upgrade 30% Design Value Engineering Workshop held during the week of December 7-11, 2015.

Section 6 of this report contains detailed backup assumptions, calculations, capital and life-cycle cost estimates, and sketches that were developed during the Detailed Investigation Phase of the VE workshop which support the Findings summarized in this section. The VE Recommendation status noted on each of the elements evaluated in detail is a result of the VE team's opinion on the anticipated impact on the project in terms of both capital and life-cycle costs, and redesign and schedule impacts. Recommendations also take process performance into account for process-related elements.

It should be noted that costs shown in this section and in the VE Recommendation Summary sheets are raw construction costs which do not include contingencies, contractor overhead and profit, or project development costs such as legal, interim financing, or technical services and that the projected savings are not necessarily cumulative. To obtain the full project cost impact requires the raw construction costs figures to be multiplied by a factor of 2.0 to 2.34 as described in the Cost Estimating section of **Section 6** of this report.

Stand Alone Recommendations which resulted from items observed by the VE Team during their evaluations and noted as worthy of consideration but not developed in detail during the Detailed Investigation Phase due to lack of sufficient time or insufficient technical detail at the point in the design process at which the VE was performed, are included in **Section 2.2** of this report.

1. WASTEWATER TREATMENT PROCESS:

As a result of the Random Function Analysis performed following the Information Phase of the workshop it was agreed by the VE team that the Basic Function of the proposed Exeter WWTF upgrade is to "Remove Nitrogen". As a result, a significant effort was expended in the Workshop to evaluate the effectiveness of the treatment process to evaluate the adequacy of the proposed process configuration while taking care to avoid negatively impacting the nitrogen removal performance capability of the process.

A. Treatment Process Validation:

A review of the overall treatment process was performed to validate the proposed treatment process configuration and sizing utilizing a BioWin computer model to evaluate the parameters used by Wright-Pierce in the design of the biological treatment process. Overall it was concluded that the biological treatment process design is appropriate for the conditions anticipated.

As result of the modeling it was suggested that consideration should be given to making Zones A and B swing zones in the event that additional aerobic volume became needed in the treatment process, but it was noted that they would probably not be operated in that mode under normal conditions, however a detailed investigation was not performed on that change.

Based on the modeling performed, it was recommended that additional wastewater analyses be performed to determine the available carbon in the wastewater more accurately. It was also noted that based on the wastewater characteristics provided to date it may be possible to eliminate the need for supplemental alkalinity in the treatment process. To address these points a recommendation was made that one additional week of wastewater analysis be performed to include an analysis on the effluent soluble COD to determine the readily biodegradable carbon available in the influent to the process at a probable cost noted below.

Potential Capital Cost Increase Identified $19,647.00

Potential Life Cycle O&M Cost Savings Identified $0.00

RECOMMENDATION STATUS: Recommended for Consideration

B. Supplemental Alkalinity:

An evaluation was performed to determine the need for supplemental alkalinity which is currently proposed. Based on those evaluations it was concluded that it may be possible to eliminate supplemental alkalinity from the project, possibly reducing the cost of the equipment and building associated with the alkalinity system. The details of the evaluations are contained in **Section 6** and the projected potential capital and life cycle cost savings for elimination of alkalinity and the associated building enclosure were significant and it is recommended that the need for supplemental alkalinity be thoroughly evaluated as the design process continues.

Potential Capital Cost Savings Identified $381,500.00

Potential Life Cycle O&M Cost Savings Identified $2,010,530.00

RECOMMENDATION STATUS: Recommended for Consideration

C. Ammonia-Based DO Control Strategy:

An evaluation was performed to determine the potential impact of implementing an ammonia-based DO control strategy to control oxygen provided to the treatment process. By incorporating Ammonia and DO probes and controllers in each aeration tank, optimal control of DO in the aeration process would be provided and supplemental carbon needs would possibly be reduced. Since providing DO is a major operational cost, potentially reducing both aeration and supplemental carbon requirements to achieve the effluent quality required would result in substantial life-cycle savings as shown below even though a capital cost increase would occur. The detailed results of this evaluation are provided in detail in **Section 6** of this report.

Potential Capital Cost Increase Identified $61,600.00

Potential Life Cycle O&M Cost Savings Identified $606,300.00

RECOMMENDATION STATUS: Recommended for Consideration

D. Primary Treatment:

The design of the activated sludge process as currently proposed does not include primary treatment for the reduction of suspended solids and BOD ahead of the biological process. As a result of a recent oil spill into the collection system Exeter representatives requested that the VE include an evaluation on the impact of incorporating primary treatment into the treatment process. To accomplish that the VE team compared the impact of conventional primary clarification and a proprietary Salsnes filter process on the overall treatment process.

1. Primary Treatment:

The following is a summary of the evaluation of the two primary treatment options noted above.

Conventional Primary Clarifiers:

An evaluation of conventional primary clarification was performed that was based on the addition of two circular primary clarifiers to the treatment process. To reflect the overall impact of the addition of primary treatment, an evaluation of the biological process was also performed to determine the aeration tanks and aeration blower size reductions , and the cost impacts that would occur in that portion of the treatment process. In addition to the primary clarifiers, for this option it was proposed that one gravity thickener be added to the treatment process for primary solids thickening as part of the solids handling train.

Based on the evaluations performed, an increase in capital costs was projected which was the net result of the addition of two primary clarifiers and the reduction of the aeration tank sizing taking the associated reduction of concrete for construction into account. An increase in both capital cost and life-cycle costs was projected. Detailed backup calculations and costing for this option are contained in Section 6.

Potential Capital Cost Increase Identified................. $1,484,990.00

Potential Life Cycle Cost Increase Identified. $1,935,689.00

RECOMMENDATION STATUS: It is the Team understands that the subject of primary clarifiers had been discussed during the project development which resulted in an initial decision to not include primary clarification. Given that the addition of primary clarifiers would result in an increase in the capital costs on the project, and an increase in life-cycle costs, the VE recommendation is that the decision to include primary treatment be made through discussions between the Town of Exeter and Wright-Pierce as to whether the addition of primary treatment should be made.

It should be noted that if primary clarifiers are added to the treatment process that significant redesign efforts will be required for the both the biological treatment process and the primary clarifiers and solids handling processes, along with the associated design schedule delay.

2. Primary Treatment with Proprietary Salsnes Filters:

As an alternative to conventional primary clarifiers, an evaluation was made on the addition of the proprietary Salsnes filter technology, with associated dewatering attachment for dewatering primary solids removed by the filter. An increase in capital cost was projected for this option, and a life-cycle cost increase was also projected with this technology.

It should be noted that the Salsnes filters are proprietary and would require piloting to develop acceptable design parameters. Since arranging for and performing piloting would result in a significant delay in the project schedule the Salsnes filter technology is not recommended.

Potential Capital Cost Increase Identified $1,197,090.00

Potential Life Cycle Cost Increase Identified $1,213,380.00

RECOMMENDATION STATUS: Not recommended

3. Primary Sludge Fermentation:

If primary treatment were to be added to the treatment process, primary sludge would be available to recover carbon for use in the denitrification process. As a result, a brief evaluation was performed to determine the potential supplemental carbon value. Given that primary sludge fermentation would require construction of an additional primary sludge fermenter structure and support system including equipment and piping and therefore provide savings to offset the cost of supplemental carbon, this alternative is not recommended.

Potential Capital Cost Increase Identified ....Not Calculated

Potential Life Cycle Cost Savings Identified ....Not Calculated

RECOMMENDATION STATUS: Not recommended

E. Construction Re-Sequencing:

As currently proposed, the construction of the WWTF Upgrade would be performed in four steps to allow the three cells of the aerated lagoon process to remain in service at all times during construction. To evaluate the potential to reduce construction time, and significant cost savings in General Conditions associated with the overall construction period, it was recommended that consideration be given to requesting a waiver from NHDES to allow only two cells to be operated during the summer construction period since an evaluation showed that given that the lagoon BOD removal kinetics two cells are adequate to provide the treatment process performance required during the summer months. It would be expected that significant savings in General Conditions would be obtained if a waiver was obtained.

Potential Capital Cost Savings Identified .... $ Not calculated

Potential Life Cycle Cost Savings Identified...... $ Not calculated

RECOMMENDATION STATUS: Recommended for Consideration

F. Aeration Tank Diffusers and Mixers:

A request was made to the VE Team to provide an opinion on the aeration tank diffusers materials and mixer technology proposed for the project. As this was not identified as a high priority for Detailed Investigation in the Evaluation Phase of the workshop a detailed comparison of alternative aeration diffuser types or mixers and their associated costs was not performed. However, in comparing EPDM diffusers to Teflon Membrane diffusers, it was concluded that there was no apparent need to utilize Teflon for diffusers since there were no unique wastewater characteristics identified that would justify the additional cost of using that material. It was therefore recommended that the industry standard diffuser material, EPDM, be utilized and a cost savings would be expected for that material compared to Teflon.

In considering the possible use of "big bubble" mixing systems rather than Hyperboloid mixers as currently proposed, an opinion was offered that although "big bubble" diffusers would potentially be more cost-effective in large square aeration tanks, that the Hyperboloid mixers proposed are considered more appropriate for the extended rectangular geometry of the proposed treatment process and no cost comparison was performed.

G. UV Disinfection:

The proposed project is designed to replace the current chlorine disinfection system with a high output UV disinfection system. The new UV system would be installed in the existing chlorine contact chamber and provided with standby power and an uninterruptable power source (UPS). Discussion with Exeter representatives during the workshop indicated that there is a strong preference to change the disinfection system to the UV system to avoid potential overdosing of chemicals possible with the chlorination/dechlorination system.

An evaluation of the elimination of UV disinfection and retaining the existing chlorination/dechlorination system resulted in significant capital cost savings and a significant life-cycle cost savings.

Potential Capital Cost Savings Identified $867,226.00

Potential Life Cycle Cost Savings Identified $1,421,096.00

RECOMMENDATION STATUS: Recommended for Consideration

H. Sludge Dewatering:

As currently designed, two high-speed centrifuges are proposed for sludge dewatering, one serving strictly as standby. The standby centrifuge was provided to allow sludge to be dewatered in the event that routine centrifuge maintenance or repairs require a unit be taken off line. An evaluation was performed to determine the impact of eliminating one centrifuge to reduce capital costs, with either intermittent liquid sludge hauling or an increase in sludge storage capacity in lieu of sludge dewatering in the event that centrifuge maintenance or repair were required.

Based on the evaluation performed it was determined that increasing the sludge storage volume would increase the life-cycle costs as a result of the need for additional sludge storage aeration. In addition there would be a slight increase in odor generation potential. Based on those two factors it was concluded that the option of increasing the sludge storage capacity was less desirable than the option of hauling sludge offsite during a centrifuge shutdown.

However, the elimination of one centrifuge combined with hauling sludge off-site during an assumed two week period annually to account for repairs or maintenance was calculated to provide a significant capital cost savings. Even with an increase in operational costs assumed for sludge hauling, a life-cycle cost savings was projected. It should be noted that the evaluation performed assumed that hauling would be budgeted for two weeks annually for centrifuge maintenance and repairs. This is a very conservative assumption and is not likely to occur; therefore increasing the probable life cycle cost savings projected.

Potential Capital Cost Increase Identified $874,335.00

Potential Life Cycle Cost Increase Identified $2,389,334.00

RECOMMENDATION STATUS: Not Recommended

Note: As part of the solids handling evaluations a preliminary assessment was made on the probable cost of eliminating centrifuge dewatering and hauling 6% liquid sludge to another facility for disposal. Based on a preliminary projection of much higher costs for hauling thickened sludge this alternative was eliminated from consideration.

2. CIVIL/SITE WORK:

A. Site Layout Review:

During the Information Phase of the workshop the VE Team was informed that two site layouts had been developed to date by Wright-Pierce, and the VE Team was asked to provide an opinion on which of the two appeared more desirable. It was also noted that a third site layout was going to be evaluated as the design progressed. During discussions on site layout Exeter Public Works representatives emphasized that the need that adequate space for a "snow dump" needed to be taken into account and provided in any potential site layout revisions.

Based on a review of the cost models which showed very high site work costs for rock and soil excavation, an evaluation was performed to determine if a revision of the site layout could reduce site excavation costs by focusing on the available subsurface information from borings performed to date which showed that the ledge elevations varied widely across the site. The site layout was evaluated with the specific intent of reducing excavation costs, based on an interpolation of boring information available at the time of the VE. All structures were assumed to remain at the elevation shown in the proposed design. A significant effort was made to interpret the ledge profiles and arranging structures to then be located to minimize rock excavation which resulted in a significant capital cost savings.

The VE Team was advised that additional borings will be performed as the design process continues and it should be noted that the additional information obtained could affect the site layout proposed by the VE Team. In any case, it is recommended that a detailed review of ledge profiles which are highly variable across the site be performed a part of the upcoming site layout evaluations as additional boring information is obtained as the design process proceeds.

Potential Capital Cost Savings Identified $558,000.00

Potential Life Cycle O&M Cost Savings Identified $0.00

RECOMMENDATION STATUS: It is strongly recommended that a revised site layout be developed, with site layout developed by the VE serving as a start point.

NOTE: Based on the request made prior to the VE that the two site layouts developed to date be reviewed and that an opinion for a preference be provided by the VE Team the "original" site layout was identified as the preferable option based on traffic flow and process unit location.

3. STRUCTURAL:

A. Aeration Tank Concrete - Member Thickness:

As part of the evaluations performed, the walls and base slab thicknesses for the aeration tanks were reviewed and appeared to be reasonably sized for this point in the design process. Based on that review, it was determined that it may be possible to reduce the thickness of the base slab and walls slightly to produce a capital cost savings.

It was noted that with the proposed reductions, a slightly reduction in the factor of safety and buoyancy prevention would occur.

Potential Capital Cost Savings..$65,000.00

Potential O&M Cost Savings Identified....................................$0.00

RECOMMENDATION STATUS: It is recommended that the wall thicknesses and base slab thicknesses be reviewed as part of the design process to determine if the potential savings identified could actually be achieved.

B. Secondary Clarifier Concrete - Member Thickness:

A review of concrete member thicknesses for the secondary clarifiers indicated that as proposed, the wall and base slab thicknesses appear appropriate for the current level of design. As part of the evaluation, it was noted that buoyancy should be checked, taking the slope bottom of the clarifier into account to be sure that the actual deep point of the clarifiers is accounted for in the buoyancy calculations.

RECOMMENDATION STATUS: Recommended for Review

4. ARCHITECTURAL:

A. Solids Handling Building/Lower Level – Automatic Sprinkler System Requirements:

The proposed Solids Handling Building houses process equipment in the lower level which has no windows and only a single egress and therefore by code falls into the category of "stories without openings" which requires the installation of an automatic sprinkler system. The use of an automatic sprinkler system will require the installation of a 12" ductile iron water main extension to the pump station at a cost of approximately $706,500 to satisfy the required fire flow rate.

An evaluation was performed that considered a possible reconfiguration of the building to eliminate the need for the sprinkler system. Even though additional capital costs would be incurred to provide a second egress from the basement level, the projected capital cost savings by eliminating the need for the water main was $789,850. It was confirmed that the lower level of this building is the only building area in the proposed upgrade project that would require an automatic sprinkler system. Based on discussions with the Town, it was determined that a need for a water main extension other than for fire protection does not exist and it is not a high priority.

Potential Capital Cost Savings Identified $789,850.00

Potential O&M Cost Savings Identified..................................$0.00

RECOMMENDATION STATUS: It is recommended that a strong effort be made to reconfigure the Solids Handling Building to avoid the need for sprinkler system and therefore eliminate the need for the water main extension.

B. Headworks Building:

The proposed Headworks Building will be a new enclosed building housing grit removal and screening equipment. An evaluation was performed in the workshop to determine the impact of eliminating a fully-enclosed structure and providing a roof structure or "canopy" type roof over the de-gritting equipment and classifier and the screening equipment. It was noted in discussions with Town representatives that this approach would be acceptable.

Potential Capital Cost Savings Identified $566,185.00

Potential O&M Cost Savings Identified..................................$0.00

RECOMMENDATION STATUS: Recommended for consideration

C. Maintenance Building:

The design as proposed includes the construction of a new building with one vehicular bay for the Vactor truck, one bay for a pickup truck and plow, and additional space for a workshop area. Since the Maintenance Building does not have a direct effect on Nitrogen removal, which was the basic function of the overall project, deletion of the building was evaluated. Discussion with Town representatives indicates that there is a strong desire to have such a building to separate water and sewer equipment.

With a projected cost savings of approximately $338,600, the VE recommendation was made to eliminate the building, and retain the current vehicular storage setup, or preferably defer construction of such a facility until the development of the Public Works Master Plan being developed by Turner Group so that it ties in more efficiently with the long-term Master Plan layout and use.

Potential Capital Cost Savings Identified $338,600.00

Potential O&M Cost Savings Identified..................................$0.00

RECOMMENDATION STATUS: It is recommended that consideration be given to eliminating this building from this project to be included in the Master Plan.

5. MAIN PUMP STATION:

The proposed design calls for the installation of a 16" ductile iron force main using open cut excavation. A brief evaluation was performed to determine if trenchless technology such as horizontal directional drilling or pipe bursting could offer a construction cost advantage. Based on a preliminary indication that trenchless technology would offer little cost benefit at the current design flow this alternative was not evaluated in detail.

6. CONSTRUCTION COSTS/PROJECT COSTS VALIDATION:

At the request of the Town of Exeter, a cost estimator participated in the VE Workshop for two days. The purpose of involving a cost estimator was to provide an opinion as to the adequacy of the current cost estimate given the fact that it will be necessary for Exeter to have a cost included in a warrant article for construction to be presented at the 2016 Town Meeting. A review of a number of unit price item quantities and unit costs was performed as well as a review and recommendations for project factors applied to construction costs such as overhead and profit, contingency, etc., to obtain an "all-in" project cost estimate.

A review of the cost estimates resulted in the conclusion that for this point in the design process, that the quantities estimated and unit prices being projected are for the most part, acceptable and reasonable at this point in the design process. A review of project factors such as overhead and profit, design and construction contingencies, legal fees, interim financing, resulted in a recommendation that higher values be used at this point in the design process/included. The values included in the original project cost projection and values recommended by the VE Team are contained in **Section 6**.

It should be noted, that although it is recommended that more conservative factors be considered at this point in the design process that as the project approaches bidding there is a potential for a reduction in the projected overall project cost based on the fact that quantities and equipment costs would be more clearly defined at that time, which could possibly offset the more conservative factors recommended in the early stages of design.

2.2 STAND-ALONE RECOMMENDATIONS:

In addition to the recommendations made as a result of Detailed Investigations that were performed observations made by the VE team that resulted in "Stand-Alone Recommendations".

Stand-Alone Recommendations are intended to identify aspects of the project for which insufficient technical or cost information existed at the time of the workshop to allow a Detailed Investigation to be performed. In addition they include aspects of the design for which a need for consideration appeared to exist but had not yet been addressed, and items which appeared to not require a Detailed Investigation to allow the Team to make a recommendation. The Stand-Alone Recommendations listed below were made with the understanding that there may be some that are planned to be addressed as the design progresses.

1. Reuse salvaged lagoon rip-rap for new construction
2. Reduce pavement binder thickness to 2" at a potential savings of $56,000.
3. Continue the removal of I/I in the collection system
4. Eliminate demolition of the bathroom in the main pump station
5. Eliminate the skylight and new doors in the pump station
6. Optimize the odor control systems by analyzing odors, and consider ozone at the pump station
7. Reuse existing aggregate base in the pipe trenches
8. Defer sludge removal in lagoons 1,2,&3 as suggested by Wright-Pierce if acceptable to NHDES (potential savings $3.8 Million)
9. Defer or delete wetlands recreation as suggested by Wright-Pierce (Potential savings $4.3 Million)
10. Consider metal roofing which would increase the capital cost but reduce life-cycle costs.

SECTION 3 – INFORMATIONAL PHASE

3.1 DESIGN PRESENTATION

The purpose of the Informational Phase of the VE process is to provide a presentation by the project designer to VE team with detailed information on the proposed design including design concepts, constraints, and design rationale so that the design intent of a proposed project is clearly understood.

Although preliminary information including the Preliminary Design Report, drawings, and the cost estimate was made available on an FTP site by Wright-Pierce prior to the workshop to familiarize the VE Team with the project including selected drawings, a PowerPoint presentation was made by Wright Pierce during which questions were asked by the team on the proposed design. A copy of that presentation is included at the end of this section.

During the informational presentation it was explained that the proposed upgrade is a result of NPDES discharge permit limits being given to Exeter that cannot be met with the existing aerated/facultative lagoon process. Exeter has been issued an NPDES permit under an Administrative Order by Consent (AOC) agreed to by the town and EPA requiring a Total Nitrogen limit of 8mg/L as an interim limit, with the understanding that a more stringent limit of 3 mg/L could possibly be issued in 2023 depending on how well the upgraded facility performs and non-point source nitrogen control actions Exeter adopts between now and then.

In addition, although Exeter currently holds a discharge permit with a flow limit of 3.0 MGD, the town has petitioned EPA and NHDES to allow the proposed upgrade to be designed to a capacity of 2.65MGD while holding the possibility open that the permit could be expanded to 3.0 MGD in the future, depending on how effective current I/I reduction measures being taken in the collection system are at reducing existing infiltration and inflow into the system. It appears that this will be allowed with the condition that the facility be designed to easily be expanded to 3.0MGD if necessary in the future.

The cost of the upgraded facility is projected to be over $50 million and as a result Exeter was required to perform Value Engineering on the project to meet NHDES funding program requirements. Given the projected impact on user costs Exeter was also interested in applying VE to validate the proposed treatment process design and determine if the construction cost of the upgrade could possibly be reduced.

Alternative wastewater treatment processes capable of achieving the casual permit limits was evaluated in a preliminary design report prepared in October 2015. In that report an activated sludge process configured to allow operation in either the Modified Ludzack-Ettinger (MLE) process or the 4-Stage Bardenpho process was identified as the most cost-effective treatment process for the proposed upgrade . Given the extent of preliminary evaluations performed it was determined that the VE would not evaluate alternative treatment processes but rather validate the design of the proposed treatment process in terms of configuration and "sizing" as well as investigate any potential modifications of the proposed process as currently configured that could improve the performance or reliability of the process .

In order for the project to proceed it will be necessary for Exeter to present a warrant article to fund construction of the project at the March 2016 town meeting for voter approval. As a result, Exeter asked that the VE focus on the accuracy of the projected construction cost given the current status of the project as part of the VE evaluations.

In the informational presentation it was noted that the project is behind schedule in the AOC which currently requires construction to start in June of 2016. Although the status of the schedule has been conveyed to EPA and NHDES is, no responses have been received from those agencies on the potential impacts of not meeting that scheduled date

Wright-Pierce reviewed the project using the PowerPoint presentation that follows this section, and provided full size and reduced scale drawings for use by the VE team during the workshop. During that presentation the team asked questions of Wright-Pierce within their discipline to provide them with a clear understanding of the proposed design and considerations that were given during a design development .

Selected drawings, information on the basis of design, and the 30% cost estimate are contained in the Appendices. Additional information and details can be obtained in the October 2015 Preliminary Design Report which is not included in this report.

Following the presentation by Wright-Pierce, a tour of the facility and the main pump station was made by the VE Team to familiarize them the existing site and structures.

Town of Exeter, New Hampshire
WWTF & Main Pump Station Upgrade
30% Value Engineering Session

Presenters
Ed Leonard, PE
Andy Morrill, PE

WRIGHT-PIERCE
Engineering a Better Environment

December 7, 2015

Exeter Background

- Population
  - 14,306 (census)
- Collection
  - 9 pump stations
  - 51 miles of piping
  - 3,600 accounts
- Project Focus
  - Main Pump Station
  - WWTF

Presentation Overview

- ✓ Project Team
- ✓ Project - Drivers, Needs & Goals
- ✓ Project Scope
- ✓ Schedule/Implementation
- ✓ Preliminary Cost Estimate
- ✓ Cost Savings

Project Drivers

- 2012 Exeter WWTF NPDES Permit
  - Total Nitrogen limit of 3 mg/l
  - Rolling Seasonal Average (April 1st thru October 31st)
- 2013 EPA Administrative Order on Consent
  - Interim Total Nitrogen limit of 8 mg/l
  - Requires WWTF Upgrade and NPS measures
  - After 2023 Engineering Evaluation, EPA will decide if Total Nitrogen limit of 3 mg/L will be mandatory

Wastewater Facilities Plan

- Upgrade Main PS to reduce/eliminate CSOs (AO)
- Upgrade WWTF to achieve <5-mg/l eff TN (AOC)
- Utilize 4-stage Bardenpho based on life cycle cost
- Provide space for future primary/tertiary treatment
- Decommission the aerated lagoons
- Continue to address AOC requirements (T/A, NCP)
- Fund river monitoring program
- Updated ordinances to address current/future TN
- Encourage State to foster watershed cooperation

Main Pump Station Background

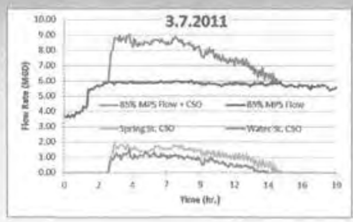
- Constructed in 1964, upgraded in 1985 and 1995
- Flows
  - Average Daily Flow: 1.7-mgd
  - Existing Design Peak Flow: 7.9-mgd (5500-gpm)
- CSO Locations

Additional Project Needs and Goals

- Want to house all WWTF staff plus 4 DPW Staff in the WWTF Control Building
- Want to eliminate hazardous chemicals
- Want to minimize O&M costs
- Want to maximize TN Removal w/o Tertiary
- Want to construct capacity in phases

Main Pump Station Background

Main Pump Station
Background



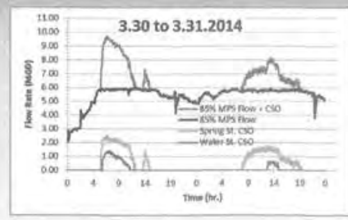
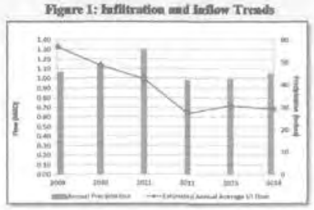


Table 1: CSO Event – April 2007 ("Patriot's Day Storm" – 100+ Year Storm)

Date	Total CSO (MG)	Influent WWTF (MG)	Combined Flow (MG)
4/15/2007	0.35	3.60	3.95
4/16/2007	1.87	4.30	6.17
4/17/2007	8.34	4.40	12.74
4/18/2007	6.51	4.40	10.91
4/19/2007	0.04	4.00	4.04
4/20/2007	0.01	3.60	3.61

Figure 1: Infiltration and Inflow Trends



Main Pump Station
Design Basis

- Pump Station Flows
  - Average Daily Flow: 1.7-mgd
  - Design Minimum Flow: 1.0-mgd
  - Four dry-pit submersible pumps with VFDs
  - Design Peak Flow: 9-mgd (with 3 pumps), 10-mgd (with standby pump) due to decreasing I/I trends over past 10 years.
- Forcemains
  - New 16-inch diameter DI forcemain (6,300-lf), duty main
  - Existing 16-inch CI forcemain, peak flow main
    - Estimated to be used 5 to 10 days per year

Main Pump Station
Design Basis

- Upgrade capacity to <u>minimize</u> CSOs
- Sewer Flows
  - Set design peak sewer flow to PS at 9-mgd (to minimize CSOs)
- Influent Channel/ Wet Well Modifications
  - Influent channel grinder with 11.0-mgd capacity
  - Two wet wells separated by isolation gate
  - Influent slide gate for each wet well
  - Sewer upgrade needed to increase flows to MPS

Main PS Improvements

- Electrical
  - 350 kW Emergency Generator
  - New Electric Room
- Architectural
  - Door replacement
  - Repair damaged building components
- Mechanical
  - Upgrade the heating system
  - Increase ventilation rates to declassify Pump Room

Main Pump Station Design Basis

- In order to <u>eliminate</u> CSOs, need to:
  - Continue removing I/I
  - Increase capacity of sewers between Spring Street Diversion and PS
  - Increase pump capacity and add a fifth pump
  - Expand footprint of pump station and wetwell
  - Increase the generator size

WWTF Background

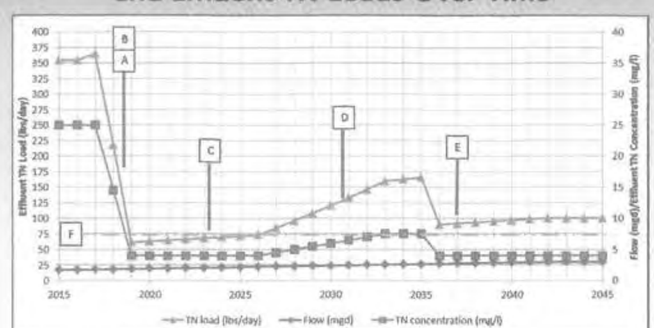
- Constructed in 1964 (lagoons)
- Upgraded in 1988 (lagoons) and 2002 (outfall)
- Existing Flows
  - Average Daily Flow: 1.7-mgd
  - Design Daily Flow: 3.0-mgd
  - Design Peak Flow: 7.9-mgd
- Effluent Disposal
  - Squamscott River to Great Bay
  - 25:1 dilution factor

Main PS Improvements

- DPW Water Main
  - 12-inch ductile iron
- Other Considerations
  - Contaminated soils & groundwater
  - Swazey Parkway
  - Newfields Road
    - Pavement Overlay
    - FM & WM < 10-feet separation

Phased Construction

Conceptual Wastewater Flow, Effluent TN Concentration and Effluent TN Loads Over Time



A - Complete Initial WWTF Upgrade (2018)
B - Complete Nitrogen Control Plan (2018)
C - Complete Engineering Evaluation (2023)
D - Hit "Trigger Flow", beginning planning for Phase 2 Upgrade (2030)
E - Complete Phase 2 Upgrade (2036)
F - NPDES Permit Limit (75 lbs/day) based on 3.0-mgd at 3-mg/l effluent TN. Superseded by AOC (8-mg/l, no mass limit).

WWTF Upgrades

- Influent Flow Measurement and Sampling
  - Magnetic flow meters on both MPS forcemains
  - Provide stubs for future connections from Stratham and Newfields
  - Reuse influent sampler (relocated to Headworks)
- Septage
  - Mechanical Septage Receiving Unit
  - Convert existing Grit Tank to Septage Tank
  - Convert Grit Building to Septage Building

WWTF Upgrades

- Primary Treatment
  - Future - site plan and hydraulic allowance
- Biological Nitrogen Removal
  - Phase 1 - Two AS trains
    - 2.2-mgd (4-S Bardenpho) and 2.65-mgd (MLE)
    - Supplemental Alkalinity system
    - Supplemental Carbon system
  - Future Phase(s)
    - Add primary OR add third train; 3.0-mgd (4-S Bardenpho)

WWTF Upgrades

- Screening and Grit Removal
  - 12.5 MGD capacity
  - Multi-rake bar screen (1/4-inch)
  - Vortex grit removal unit w/ grit washer
  - New Headworks Building

- Influent Equalization (IEQ) Basin
  - Two off-line basins within Lagoon No. 1
  - IEQ Pump Station w/ forcemain to Headworks

WWTF Upgrades

- Tertiary Treatment
  - Future - site plan and hydraulic allowance (if req'd)
- UV Disinfection
  - Low pressure, high output system
  - Enclose in a building per DES regs.
- Effluent Flow, Sampling & Outfall
  - New Parshall Flume and instruments
  - Reuse existing sampler
  - Outfall – no modifications

WWTF Upgrades

- Sludge Processing Systems
  - Two sludge storage tanks
    - 300,000 gallons total
  - Two dewatering centrifuges
  - Two emulsion polymer units w/ aging
  - Future potassium permanganate system
  - Future dry polymer
  - New Sludge Handling Building
    - Drive thru sludge truck bay
    - Main electrical room and new service entrance

Lagoon Decommissioning

- All Aerated Lagoons
  - Lagoon Closure Plan req'd
  - Dredge, dewater and dispose of all sludge
  - Anticipate disposal as "unclassified waste"
- Sludge Storage Lagoon
  - Majority of WWTF buildings and structures
- Aerated Lagoon No. 1
  - New Influent Equalization Basins
- Aerated Lagoons No. 2 & No. 3
  - Restore to flood plain and tidal wetlands

WWTF Upgrades

- Support Systems
  - Plant Water System
    - Triplex w/ VFDs and hydropneumatic tank
  - Sodium Hypochlorite System for RSL
  - GAC Odor Control Systems
    - Dewatering
    - Headworks
    - Septage
  - Yard Waste Pump Station

WWTF Upgrades

- Site
  - New access drive from Route 85
  - On-site drives and sidewalks
  - Stormwater management to meet MS4 req'ts
  - Reserve space for snow dump
  - Significant ledge removal
    - 10,800 CY for WWTF
  - Significant earthwork
    - 75,000 CY of cut/fill for WWTF
    - 380,000 CY of cut/fill for wetlands restoration

WWTF Upgrades

- Architectural
  - New buildings
    - Headworks, Solids Handling, Disinfection, SuppChemical
    - Maintenance Garage
  - Comprehensive renovations
    - Control
  - Minor renovations
    - Grit, Chlorination
  - Upgrades to meet 2009 IBC, as amended
  - Currently NH is evaluating 2015 IBC and design may need to meet that code.

WWTF Upgrades

- Geotechnical
  - Assessed subsurface conditions in June
    - Ledge, till, clay, fill, sludge
    - Geotechnical Data Report available
    - Geotechnical Design Memorandum available
  - Currently starting supplemental investigations
    - Additional characterization of ledge & groundwater flow
    - Additional characterization of sludge (quantity/quality)
    - Will revise GDR and GDM

WWTF Upgrades

- Structural
  - New structures
    - Aeration Tanks, Secondary Clarifiers, Sludge Storage Tanks
    - Foundations for new buildings
  - Comprehensive renovations
    - Chlorine Contact Tank
  - Upgrades to meet IBC and ASCE 7

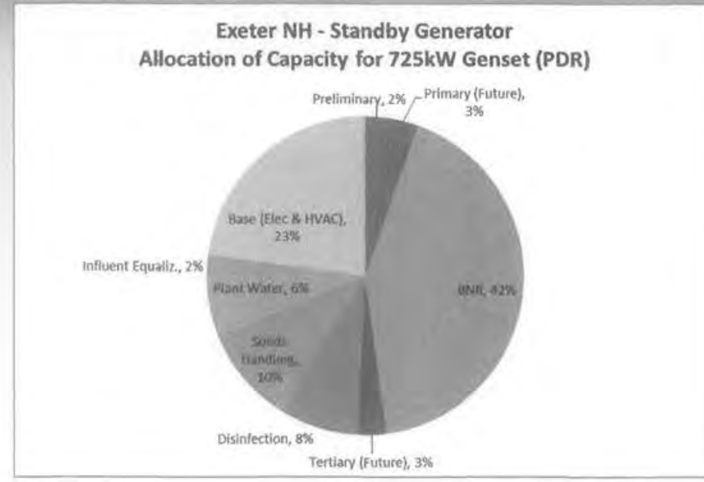
WWTF Upgrades

- Mechanical/Plumbing
  - Comprehensive upgrade to include renovations and new buildings
  - Will use energy efficient heating plants and energy recovery provisions allowed by codes
    - Effluent heat recovery
    - Air-to-air heat recovery
    - Air recirculation approaches
  - Utility service upgrades for gas and water
  - Upgrades to meet 2009 International Energy Conservation Code and International Plumbing Code

WWTF Upgrades

- SCADA & Instrumentation
  - Comprehensive upgrade to include:
    - New SCADA system with four workstations and one tablet
    - Integrate existing radio telemetry system
    - New instrumentation for control, trending and safety
    - Fiber optic communication network
    - Alarming and reporting software

WWTF Upgrades



WWTF Upgrades

- Electrical
  - Comprehensive upgrade to include:
    - New utility service
    - New standby generator and ATS in walk-in, SA enclosure
    - Duct bank network for power, control and signal wiring
    - Exterior site lighting
    - Interior lighting, data and telephone systems
    - Addressable fire alarm system
  - Upgrades to meet 2014 NEC and NFPA 820 (2012)

Site Permitting

F-NPDES Construction General Permit	S-Environmental Review
F-NPDES General Permit for Dewatering	S-Design Review (DES, DOT)
F-ACOE Programmatic General Permit **	S-Lagoon Closure Plan/ SQC **
F-FEMA Letter of Map Revision **	S-Pesticide Application Permit ***
S-Shoreland Zone Permit	L-Site Plan Review
S-Alteration of Terrain	L-Shoreland Zone Conditional Use
S-Wetlands Permit **	L-Wetlands Conservation Conditional Use
S-Dept of Historic Resources Review	L-Burn Permit ***

F = federal; S = State; L = Local
** permits associated with lagoon decommissioning
*** permits associated with invasive species

Anticipated Construction Contracts

- 1 - WWTF Upgrade
- 2 - Main Pump Station Upgrade
- 3 - Forcemain and Water Main
- 4 - Lagoon Decommissioning

Funding Sources

- All project components:
  - NHDES SRF w/ Principal Forgiveness
  - NHDES SAG and SAG Plus
  - US Economic Development Administration
  - Congressional STAG
- Energy efficiency items:
  - Unitil
- Wetlands restoration
  - NHDES Aquatic Resources Mitigation Fund
  - Wetlands Compensation Bank (create)
  - NGOs (e.g., Duck's Unlimited, Nature Conservancy)

Project Cost Estimate

Design contingency - 15%

Inflation to midpoint - 5%

(to October 2017)

TABLE 4-1
ESTIMATED CAPITAL COSTS FOR CONTRACTS 1, 2, 3 AND 4
BEFORE VALUE ENGINEERING

Project Component		CONTRACT 1 WWTF TN 4 mg/l	CONTRACT 2/3 Main Pump Station FM & WM	CONTRACT 4 Lagoon Decommissioning	Notes
Construction		$34,400,000	$5,050,000	$8,720,000	1
Construction Contingency	[illegible]	$1,720,000	$250,000	$440,000	2
Technical Services		$6,880,000	$1,010,000	$870,000	3
Value Engineering		$60,000	$0	$0	4
Materials Testing	[illegible]	$90,000	$10,000	$20,000	5
Asbestos and Lead Paint Abatement		$0	[illegible]	$0	6
Activated Sludge Seeding		[illegible]	$0	$0	
Direct Equipment Purchase		$0	$0	$0	7
Land Acquisition/Easements		$0	$0	$0	7
Legal/Administrative		[illegible]	[illegible]	[illegible]	8
Interim Financing	[illegible]	$220,000	$30,000	$50,000	9
ENGINEER'S ESTIMATE		$43,500,000	$6,370,000	$10,110,000	10,11
[illegible]		[illegible]	[illegible]	[illegible]	
Differential from Facilities Plan		$5,560,000	$1,200,000	$5,140,000	
% differential from Facilities Plan		9%	20%	63%	
TOTAL - CONTRACTS 1 TO 4		$59,870,000	<< Note 12		
Total from Facilities Plan		[illegible]			
Differential from Facilities Plan		$8,000,000			
% differential from Facilities Plan		15%			
TOTAL - CONTRACTS 1/2/3		$49,750,000	<< for Town Meeting 2016		

Notes
1.) Construction cost estimate details provided in Appendices. Costs based on ENR CCI 10337
2.) Construction contingency is an allowance at 5% of construction cost.
3.) Technical services is an allowance at 20% of construction cost for Contracts 1/2/3 and 10% for Contract 4
4.) Value engineering is an allowance assuming two sessions.
5.) Materials testing is an allowance based on similar sized projects.
6.) Asbestos and lead paint is not anticipated at the WWTF site, but should be evaluated at the Main Pump Station site
7.) None anticipated
8.) Legal/administrative costs are for bond counsel and project advertisements.
9.) Financing is an allowance based on assumed interim financing costs at 0.5%
10.) DES estimate for 5 mg/l effluent TN for Exeter was $44M ("Analysis of Nitrogen Loading Reductions for WWTF and NPS in the Great Bay Estuary Watershed", Dec 2010, ENR 8660).
11.) Contract 4 represents the cost for Option 3 "coastal wetlands creation" (Section 2.5.16), which is more than identified in the Wastewater Facilities Plan. The total cost for Option 2 "upland wetlands restoration" (Section 2.5.16) is $6.9M, which is the same as was identified in the Wastewater Facilities Plan. Under either scenario, approximately $3.8M is related to sludge removal and disposal.
12.) Total cost of $59.8M includes Contract 4/Option 3 ("coastal wetlands creation")
Total cost is $56.7M with Contract 4/Option 2 ("upland wetlands restoration")
Total costs is $53.5 with Contract 4/Option 1 ("keep lagoons for storage").

Energy Efficiency Items

- DES/EPA asked for several items to be considered. WP will adopt additional items:
  - Daylighting via solar tubes
  - LEED items on a case-by-case basis
  - Refine standby generator sizing
  - SCADA trending of power metering
  - SCADA warnings based on demand charge threshold

Energy Efficiency Items (continued)

- WP will review:
  - Jockey pump for Main Pump Station
  - Jockey blower for Aeration Tanks
  - Large bubble mixing for Sludge Storage Tanks
  - High efficiency diffusers for Aeration Tanks
  - Ammonia probes for Aeration Tanks

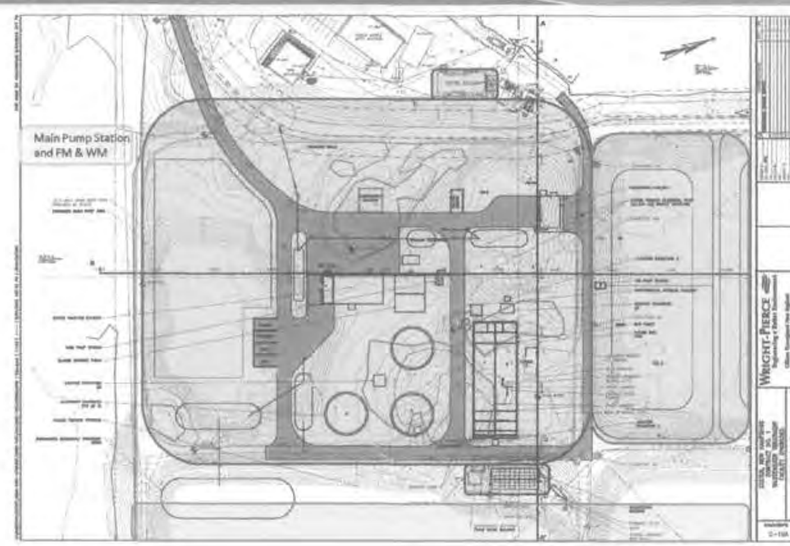
Cost Saving Opportunities (continued)

- Numerous items are under consideration
  - Simplify septage receiving, eliminate odor control
  - Eliminate Headworks odor control
  - Use diesel vs natural gas generators
  - Defer IEQ basin upgrades except IEQ PS
  - Seek DES waiver on SST volume
  - Reconfigure site plan to minimize ledge removal
  - Reconfigure Solids Handling Bldg to eliminate YPS
  - Reconfigure Headworks Bldg to incorporate SuppAlk
  - Defer sludge removal/disposal in Lagoons 1/2/3
  - Defer wetlands restoration in Lagoons 2/3

Cost Saving Opportunities

- Cost estimate was higher than that included in the WW Facilities Study
  - Identified 15 cost saving opportunities in Figure 1-2
  - Reviewed these with DPW on Nov 16.
  - Decisions documented in Nov 18 memo.
- Several items were rejected
  - Eliminate future tertiary system from hydraulic profile
  - Eliminate Main PS channels, grinder, odor control
  - Reduce Headworks peak flow from 12.5 to 6.6-mgd
  - Eliminate UV disinfection and UV Building

Sequencing



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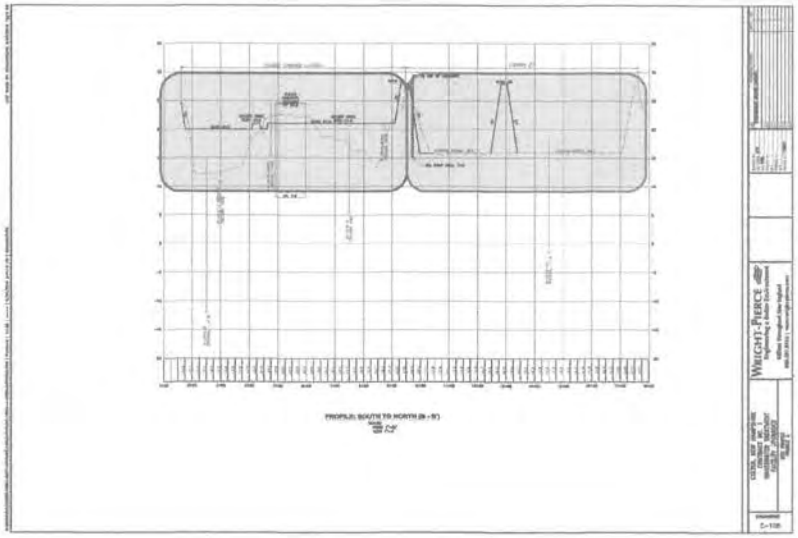
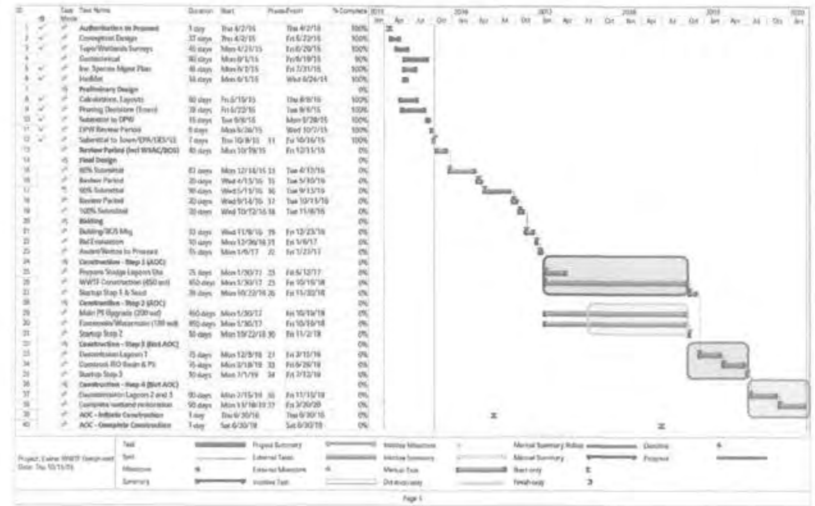


Schedule



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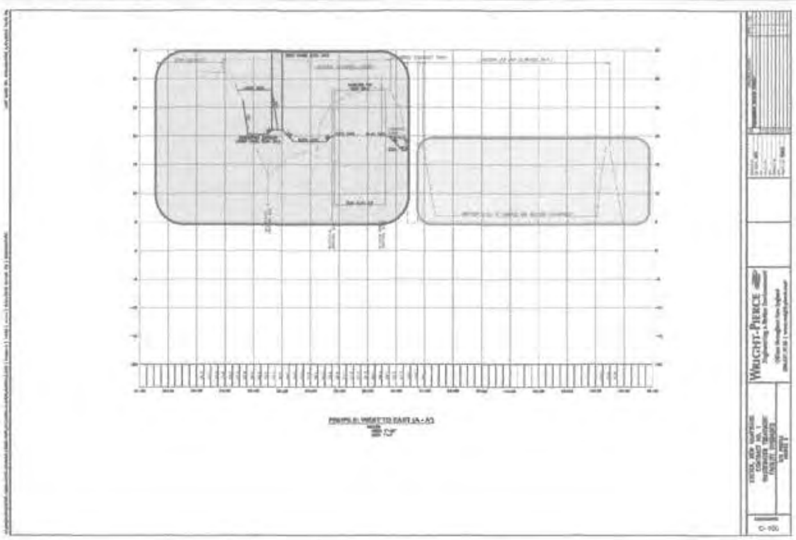
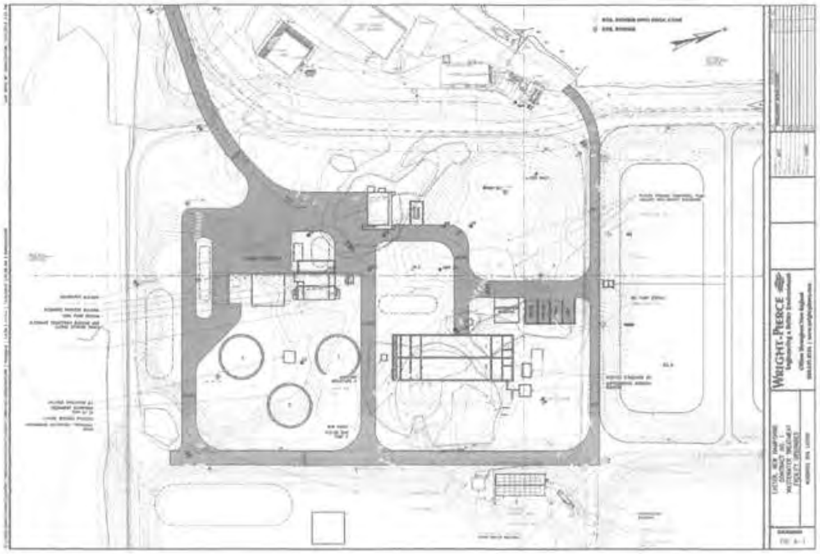


Questions & Discussion

WRIGHT-PIERCE

Engineering a Better Environment

Alternate Site Plan



SECTION 4 - FUNCTION ANALYSIS AND COST MODELS

4.1 FUNCTION ANALYSIS

A key step in the Value Engineering process is the Function Analysis. The Function Analysis identifies the intended function of a project which is referred to as the Basic Function. A key principle of the Value Engineering process is that any proposed changes to the project must not diminish that Basic Function.

Given the fact that the proposed project is a wastewater treatment facility a Random Function Analysis was determined adequate to identify the Basic Function for the upgrade. A Random Function Analysis is performed by having the VE team develop a list of functions that the proposed upgrade will perform and selecting the one considered to most accurately describe the primary function of the proposed upgrade which becomes the Basic Function. The list of functions developed by the VE Team and the Basic Function follows this section.

It was agreed by the team that the Basic Function of the project was to "Remove/Nitrogen".

A brief Function Analysis was also performed on select elements of the project to identify elements that were considered Basic (B), or Secondary/Essential (SE) to keep the team aware of those elements which were essential in meeting the basic Function. Elements with a Basic Function are elements that are necessary for the intended function of the project to be met. Secondary Essential elements are elements that do not contribute directly to the Basis Function but are necessary for it to be met, such as standby power to operate essential equipment in the event of a power failure. Elements not classified as basic or secondary essential were considered secondary, meaning that they are not necessary for the upgrade to Remove Nitrogen .

4.2 COST MODELS

following the Function Analysis cost models produced from the current level cost estimate were reviewed by the team. The function of Cost Models in the VE process is to show the how costs values of the project are distributed over various elements of the project and where the highest cost elements of the process exist. The highest cost elements of the project are considered to offer the greatest opportunity for value improvement by changes in the project. The high cost elements therefore serve as an indicator to the team as to where their efforts are most likely to lead to value or function improvement.

An overall cost model and cost models for various elements of the project were prepared in preparation for the workshop from cost data provided by Wright-Pierce and distributed to the VE Team prior to the workshop to show the distribution of costs across various elements of the project. The cost models are included at the end of this section.

From the cost models they could be seen that the structural elements, treatment process elements, and civil/site work made up a majority of the cost of the project. Those elements therefore became a major focus for the workshop effort. In addition, given that changes in some of those elements would affect architectural elements of the project, architecture was also a focus of the VE effort. It was noted that although a significant element of the project, insufficient detail existed at this stage of a project for electrical complements to be evaluated in detail.

Exeter, NH
Wastewater Treatment Facilty Upgrade Design
V.E. Workshop

RANDOM FUNCTION ANALYSIS

December 7-11, 2015

"BASIC FUNCTION" OF THE PROPOSED UPGRADE

VERB	NOUN	KIND
REMOVE	**NITROGEN**	**BASIC**
ELIMINATE	HAZ CHEMS	SECONDARY
REDUCE	CSO	SECONDARY
INCREASE	CAPACITY	SECONDARY
MEET	**ACO SCHEDULE**	**BASIC**
IMPROVE	ENVIRONMENT	SECONDARY
IMPROVE	STORM WATER QUALITY	SECONDARY
OPTIMIZE	SPACE ON SITE	SECONDARY
MEET	DISINFECTION PERMIT	SECONDARY
MINIMIZE	COMMUNITY DISTURBANCE	SECONDARY
SAVE	ENERGY	SECONDARY
CONSIDER	OPERABILITY	SECONDARY
SIMPLIFY	OPERABILITY	SECONDARY
AVOID	FILTRATION	SECONDARY
MAINTAIN	OPERATIONS DURING CONSTR	SECONDARY
ACCOMMODATE	FUTURE EXPANSION	SECONDARY
MAXIMIZE	SOLIDS CAKE	SECONDARY
ACCOMMODATE	CLIMATE CHANGE	SECONDARY

FUNCTION **B = Basic**
S = Secondary
SE = Secondary Essential

EXETER, NH WASTEWATER TREATMENT FACILITY UPGRADE

Dec. 7-11, 2015

V.E. WORKSHOP

FUNCTION ANALYSIS

PROJECT ELEMENT: TREATMENT PROCESS - $6,109,000

FUNCTION
B = Basic
S = Secondary
SE = Secondary Essential

	FUNCTION			($1000)			C/W
ELEMENT	VERB	NOUN	KIND	COST	%	WORTH	
SOLIDS PROCESSING SYSTEMS			S	$1,236,000	20.2%		
AERATION TANKS / BNR	**Remove**	**Nitrogen**	B	$1,124,000	18.4%		
SECONDARY CLARIFICATION	Remove	Solids	B	$870,000	14.2%		
SCREENINGS AND GRIT REMOVAL			S	$658,000	10.8%		
UV DISINFECTION			S	$629,000	10.3%		
ODOR CONTROL SYSTEMS			S	$263,000	4.3%		
PLANT WATER SYSTEM			S	$227,000	3.7%		
YARD WASTE PUMP STATION			S	$220,000	3.6%		
SEPTAGE RECEIVING			S	$212,000	3%		
SLUDGE STORAGE TANKS			S	$189,000	3%		
INFLUENT EQUALIZATION BASINS	Improve	Treatment	B	$164,000	3%		
POLYMER SYSTEM			S	$107,000	2%		
SUPPLEMENTAL ALKALINITY SYSTEM	Improve	Treatment	B	$97,000	2%		
SUPPLEMENTAL CARBON SYSTEM	Improve	Treatment	B	$74,000	1%		
WWTF PROCESS DEMOLITION			S	$39,000	1%		

EXETER, NH WASTEWATER TREATMENT FACILITY UPGRADE Dec. 7-11, 2015

V.E. WORKSHOP

FUNCTION ANALYSIS

FUNCTION
B = Basic
S = Secondary
SE = Secondary Essential

PROJECT ELEMENT: CIVIL - $3,754,000

	FUNCTION			($1000)			C/W
ELEMENT	VERB	NOUN	KIND	COST	%	WORTH	
WWTF SITE PIPING	convey	wastewater	B	$1,540,000	41%		
WWTF SITE WORK	allow	construction	B	$1,150,000	31%		
WWTF INVASIVE SPECIES MGMT			S	$450,000	12%		
WWTF SITE DRAINAGE			SE	$264,000	7%		
WWTF DEMOLITION			S	$225,000	6%		
WWTF ELECT. DUCTBANKS AND PADS			S	$125,000	3%		

EXETER, NH WASTEWATER TREATMENT FACILITY UPGRADE

Dec. 7-11, 2015

V.E. WORKSHOP

FUNCTION ANALYSIS

FUNCTION
B = Basic
S = Secondary
SE = Secondary Essential

PROJECT ELEMENT: CIVIL /SITE- $1,150,000

	FUNCTION			($1000)			C/W
ELEMENT	VERB	NOUN	KIND	COST	%	WORTH	
Bituminous Binder			S	$286,000	25.0%		
Chain Link Fence			S	$175,000	15.0%		
Site Grading- Cuts and Fills	allow	construction	SE	$166,000	14.0%		
Bituminous Surface Paving			S	$110,000	10.0%		
Aggregate Sub-base			S	$70,200	6.0%		
Guard Rail			S	$60,000	5.0%		

EXETER, NH WASTEWATER TREATMENT FACILITY UPGRADE — Dec. 7-11, 2015

V.E. WORKSHOP

FUNCTION ANALYSIS

FUNCTION
B = Basic
S = Secondary
SE = Secondary Essential

PROJECT ELEMENT: STRUCTURAL -$7,193,000

	FUNCTION			($1000)			C/W
ELEMENT	VERB	NOUN	KIND	COST	%	WORTH	
AERATION TANKS / BNR (NEW)	remove	nitrogen	B	$2,500,000	34.8%		
SECONDARY CLAR. & SCUM SYSTEM (NEW)	remove	solids	B	$1,900,000	26.4%		
SOLIDS HANDLING BUILDING (NEW)			S	$875,000	12.2%		
SLUDGE STORAGE TANKS (NEW)			S	$780,000	10.8%		
HEADWORKS BUILDING (NEW)			S	$442,000	6.1%		
JUNCTION STRUCTURES (NEW)	distribute	wastewater	B	$200,000	2.8%		
DISINFECTION MODIFICATIONS			S	$110,000	1.5%		
MAINTENANCE GARAGE (NEW)			S	$84,000	1.2%		
SUPPLEMENTAL CHEMICAL BUILDING (NEW)			S	$55,000	1%		
CONCRETE CRACK/SPALL REPAIR			S	$55,000	1%		
INFLUENT EQUALIZATION	improve	process	B	$50,000	1%		
YARD WASTE PUMP STATION			S	$50,000	1%		
GRIT BUILDING MODS -(SEPTAGE REC'G)			S	$43,000	1%		
PARSHALL FLUME	measure	flow	S/E	$20,000	0%		
CONTROL BUILDING MODIFICATIONS			S	$19,000	0%		
CHEMICAL BLDG MODIFICATIONS (PW BLDG)			S	$10,000	0%		

V.E. WORKSHOP

FUNCTION ANALYSIS

FUNCTION
B = Basic
S = Secondary
SE = Secondary Essential

PROJECT ELEMENT: ARCHITECTURAL - $2,293,000

	FUNCTION			($1000)			C/W
ELEMENT	VERB	NOUN	KIND	COST	%	WORTH	
SOLIDS HANDLING BUILDING (NEW)			S	$921,000	40.2%		
HEADWORKS BUILDING (NEW)			S	$416,000	18.1%		
CONTROL BUILDING MODIFICATIONS			S	$302,000	13.2%		
SUPPLEMENTAL CHEMICAL BUILDING (NEW)	assist	nitrogen removal	B	$187,000	8.2%		
MAINTENANCE GARAGE (NEW)			S	$149,000	6.5%		
PROCESS EQUIPMENT & PIPING FINISHES			S	$100,000	4.4%		
GRIT BUILDING MODS (SEPTAGE RECEIVING)			S	$78,000	3.4%		
DISINFECTION BUILDING (NEW)			S	$78,000	3.4%		
CHEMICAL BUILDING MODS (PW BLDG)			S	$62,000	3%		

EXETER, NH WASTEWATER TREATMENT FACILITY UPGRADE

Dec. 7-11, 2015

V.E. WORKSHOP

FUNCTION ANALYSIS

FUNCTION

B = Basic

S = Secondary

SE = Secondary Essential

PROJECT ELEMENT: MAIN PUMP STA. TOTAL - $3,595,000

	FUNCTION			($1000)			C/W
ELEMENT	VERB	NOUN	KIND	COST	%	WORTH	
CIVIL	convey	wastewater	B	$1,750,000	49.0%		
ELEC	power	pumps	B	$650,000	18.0%		
PROCESS	convey	wastewater	B	$525,000	15.0%		
SPECIALS			S	$305,000	8.0%		
STRUCTURAL			S	$150,000	4.0%		
ARCHITECTURAL			S	$92,000	3.0%		
HVAC/PLUMBING			S	$71,000	2.0%		
INSTRUMENTATION	control	pumps	S/E	$52,000	1.0%		

EXETER, NH WASTEWATER TREATMENT FACILITY UPGRADE

Dec. 7-11, 2015

V.E. WORKSHOP

FUNCTION ANALYSIS

FUNCTION

B = Basic

S = Secondary

SE = Secondary Essential

PROJECT ELEMENT: MAIN PUMP STA. - CIVIL- $1,750,000

	FUNCTION			($1000)			C/W
ELEMENT	VERB	NOUN	KIND	COST	%	WORTH	
16" DI Force Main	convey	wastewater	B	$657,400	38.0%		
12" DI Water line			S	$506,400	29.0%		
Initial Pavement binder			S	$151,000	9.0%		
Site Piping and Site Work			S	$100,000	6.0%		
Aggregate Base			S	$80,700	5.0%		
Final Pavement			S	$53,600	3.0%		
Fire Hydrant			S	$40,000	2.0%		
Loam and Seeding			S	$25,000	1.0%		
1" Corp Stop			S	$22,000	1.0%		
Traffic Control			S	$20,000	1.0%		

EXETER, NH WASTEWATER TREATMENT FACILITY UPGRADE

Dec. 7-11, 2015

V.E. WORKSHOP

FUNCTION ANALYSIS

FUNCTION
B = Basic
S = Secondary
SE = Secondary Essential

PROJECT ELEMENT: LAGOON DECOMM. - $6,850,000

	FUNCTION			($1000)			C/W
ELEMENT	VERB	NOUN	KIND	COST	%	WORTH	
LAGOON-EMBANK. REM/ WETLAND CREATION			S	$4,300,000	62.8%		
LAGOON - SLUDGE REMOVAL & DISPOSAL	allow	construction	S/E	$2,500,000	36.5%		
MOBILIZATION/DEMOBILIZATION			S	$50,000	0.7%		

EXETER, NH WASTEWATER TREATMENT FACILITY UPGRADE

Dec. 7-11, 2015

V.E. WORKSHOP

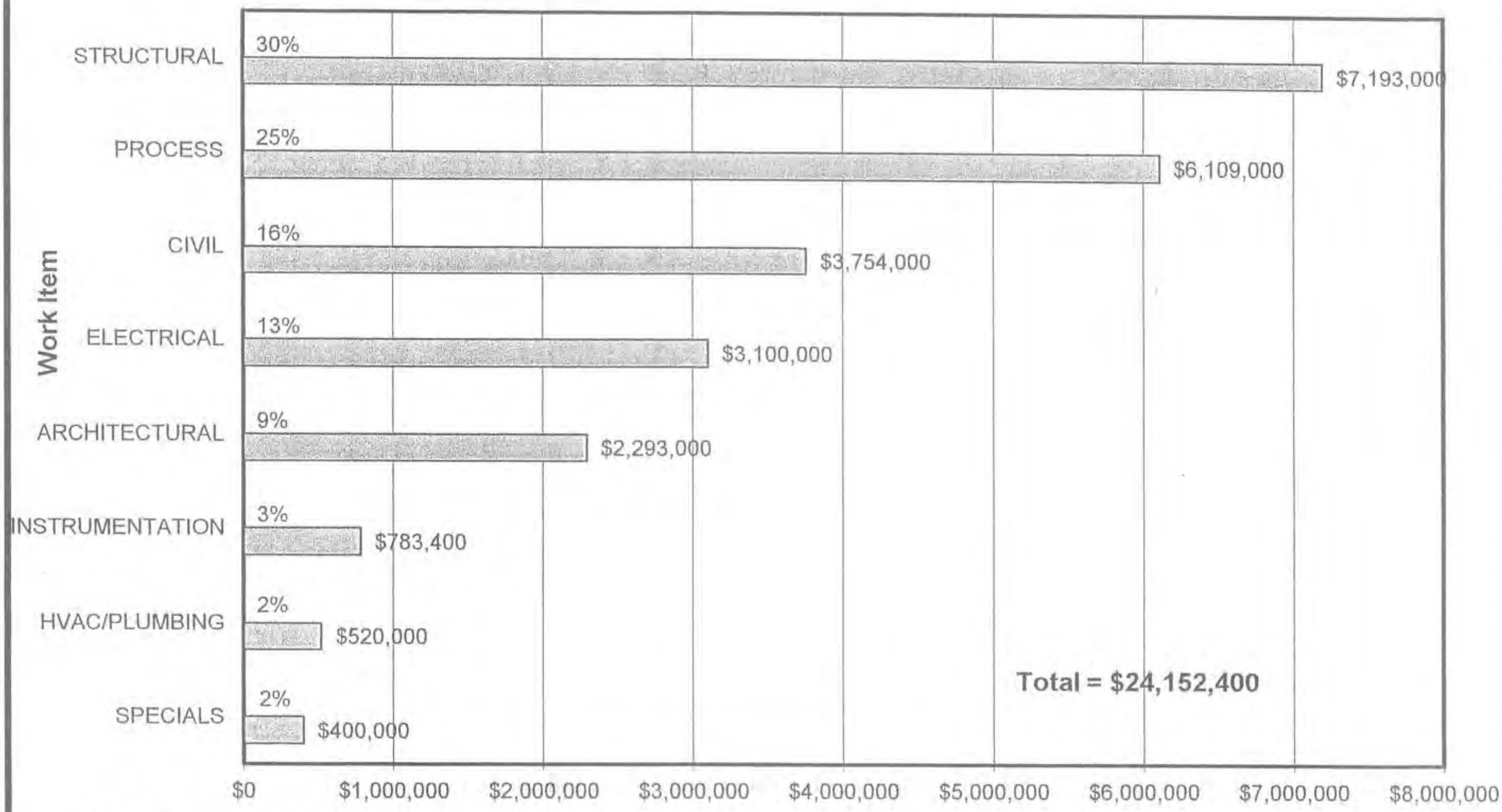
FUNCTION ANALYSIS

PROJECT ELEMENT: LAGOON DECOMM. - $4,300,000

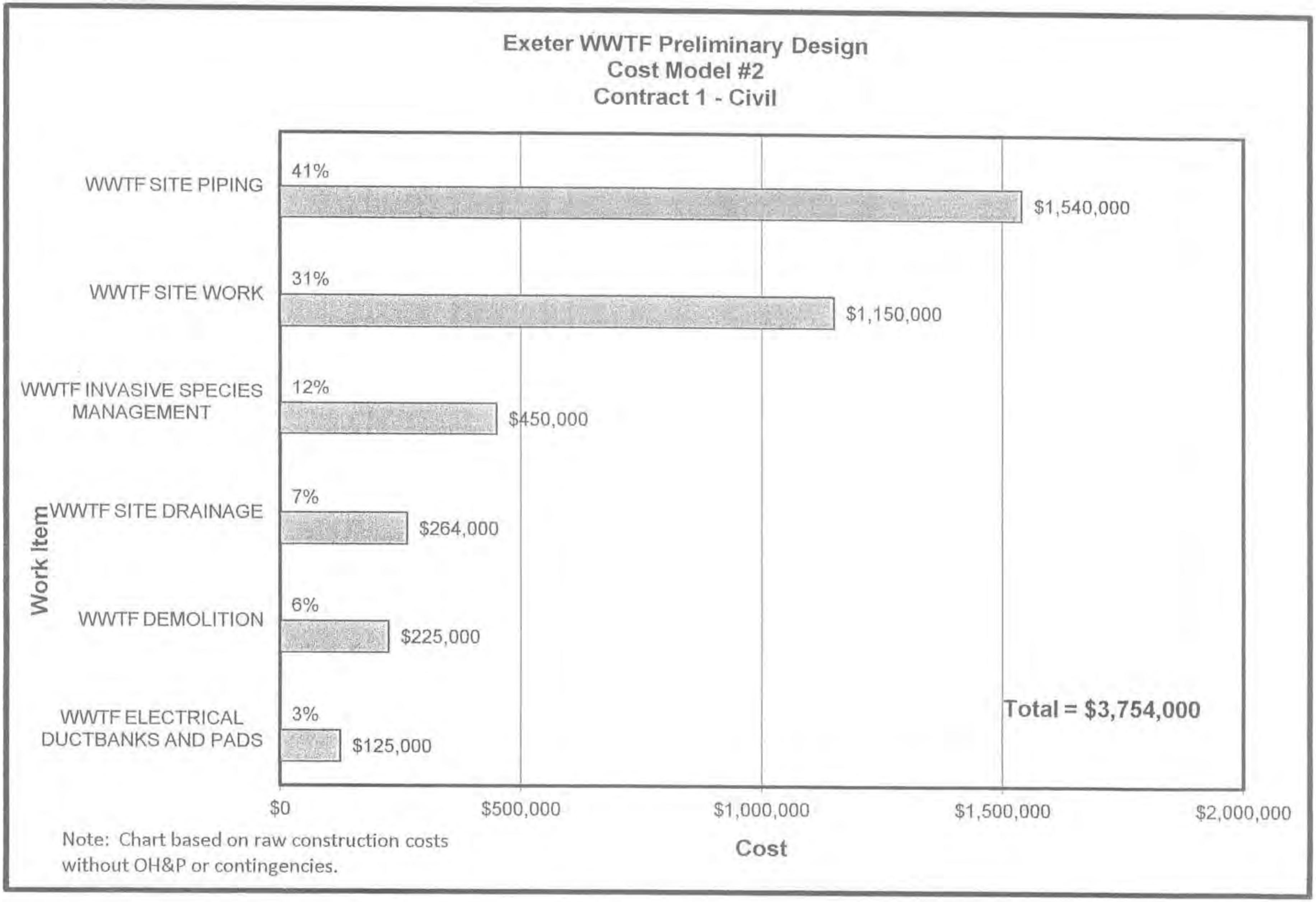
FUNCTION
B = Basic
S = Secondary
SE = Secondary Essential

	FUNCTION			($1000)			C/W
ELEMENT	VERB	NOUN	KIND	COST	%	WORTH	
Low Marsh Exc. and Rem. of Unsuitables			S	$2,502,000	58.3%		
Excavation of Outer Embankment			S	$1,142,000	26.6%		
Low Marsh Restoration Plantings			S	$273,750	6.4%		
Fill to Maintain 6-ft of Cover Over Outfall			S	$134,000	3.1%		
Embankment Restoration Plantings			S	$68,000	1.6%		

Exeter WWTF Preliminary Design
Cost Model #1
Contract 1 - WWTF - Totals



Note: Chart based on raw construction costs without OH&P or contingencies.



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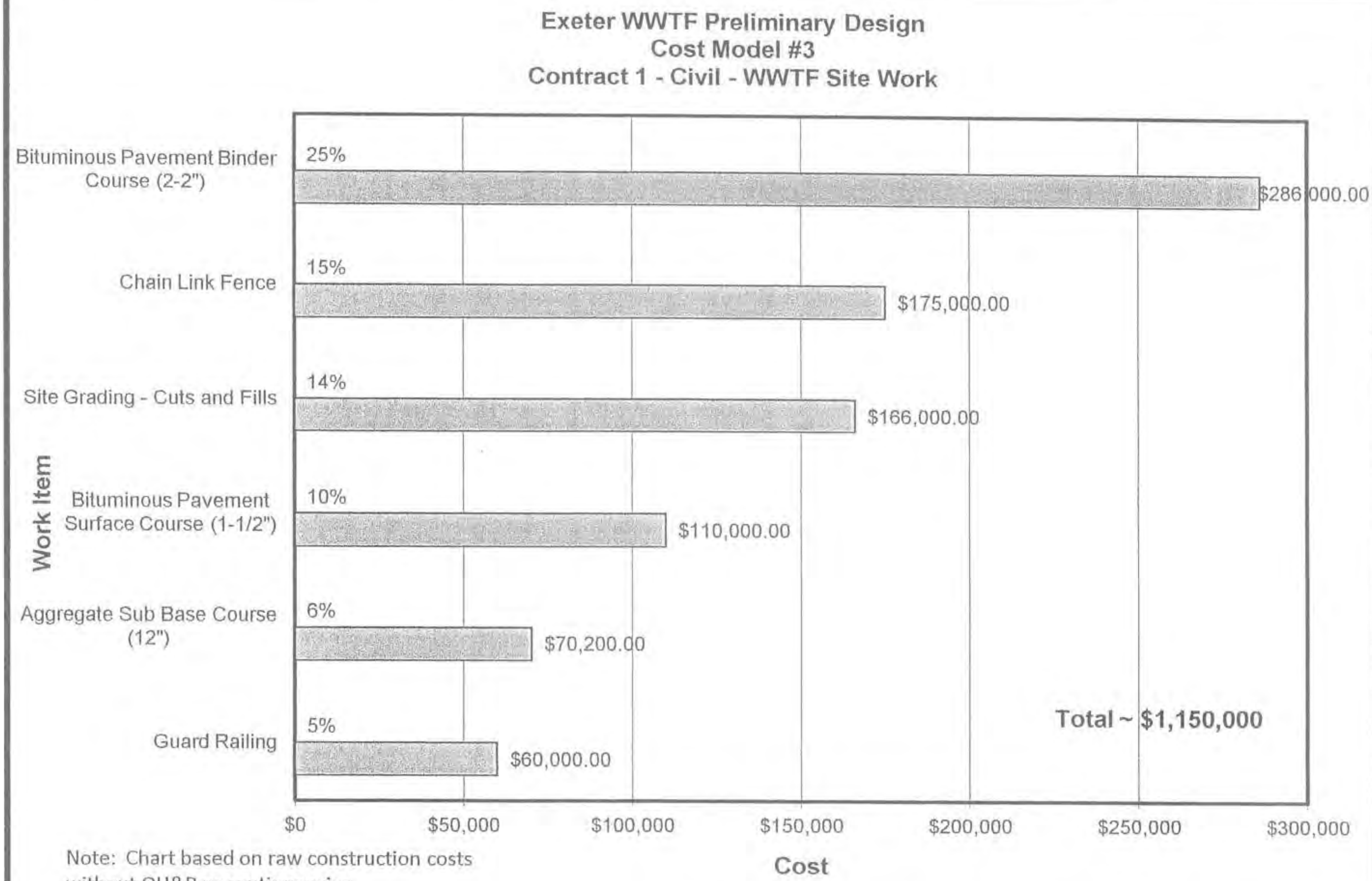
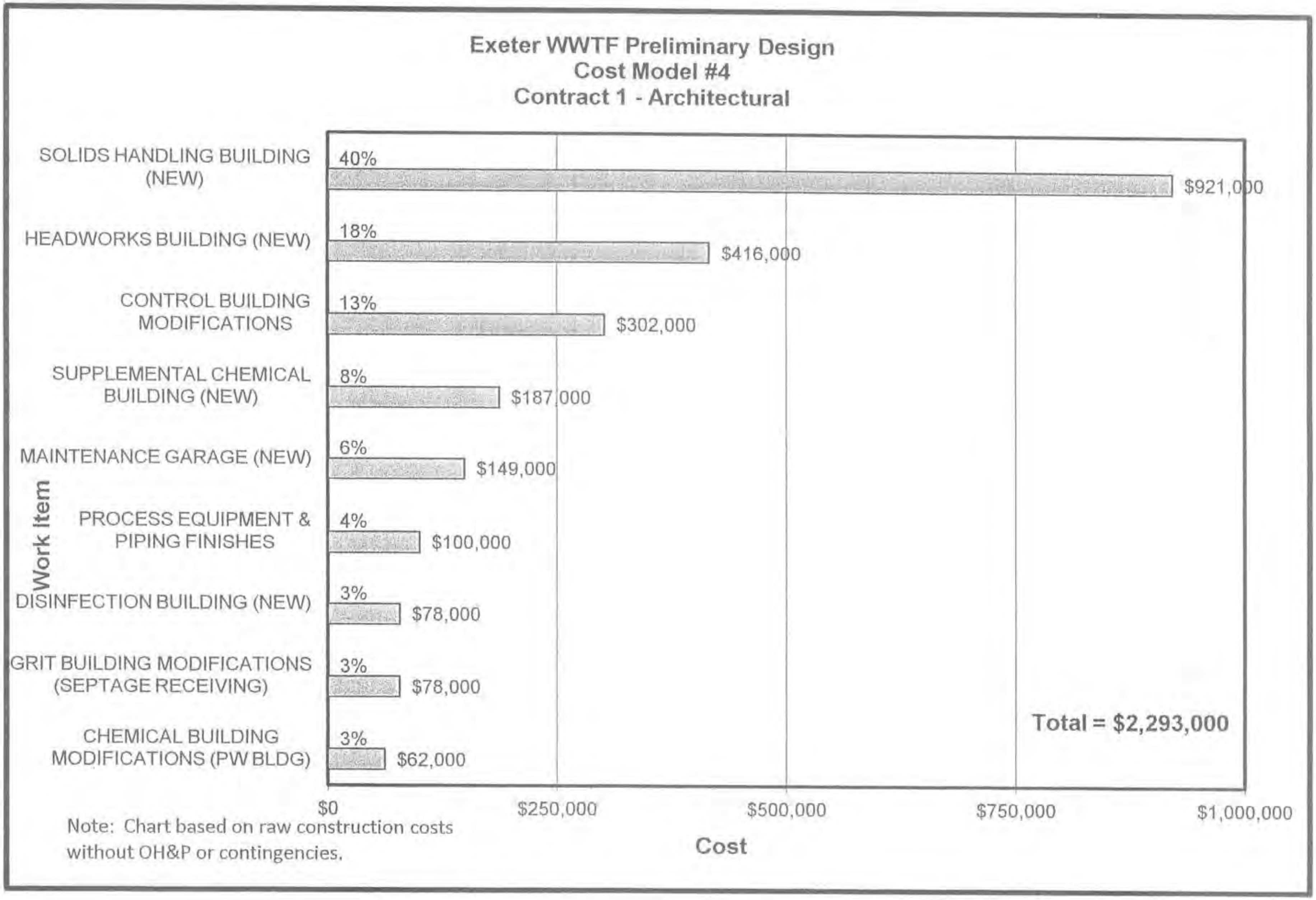
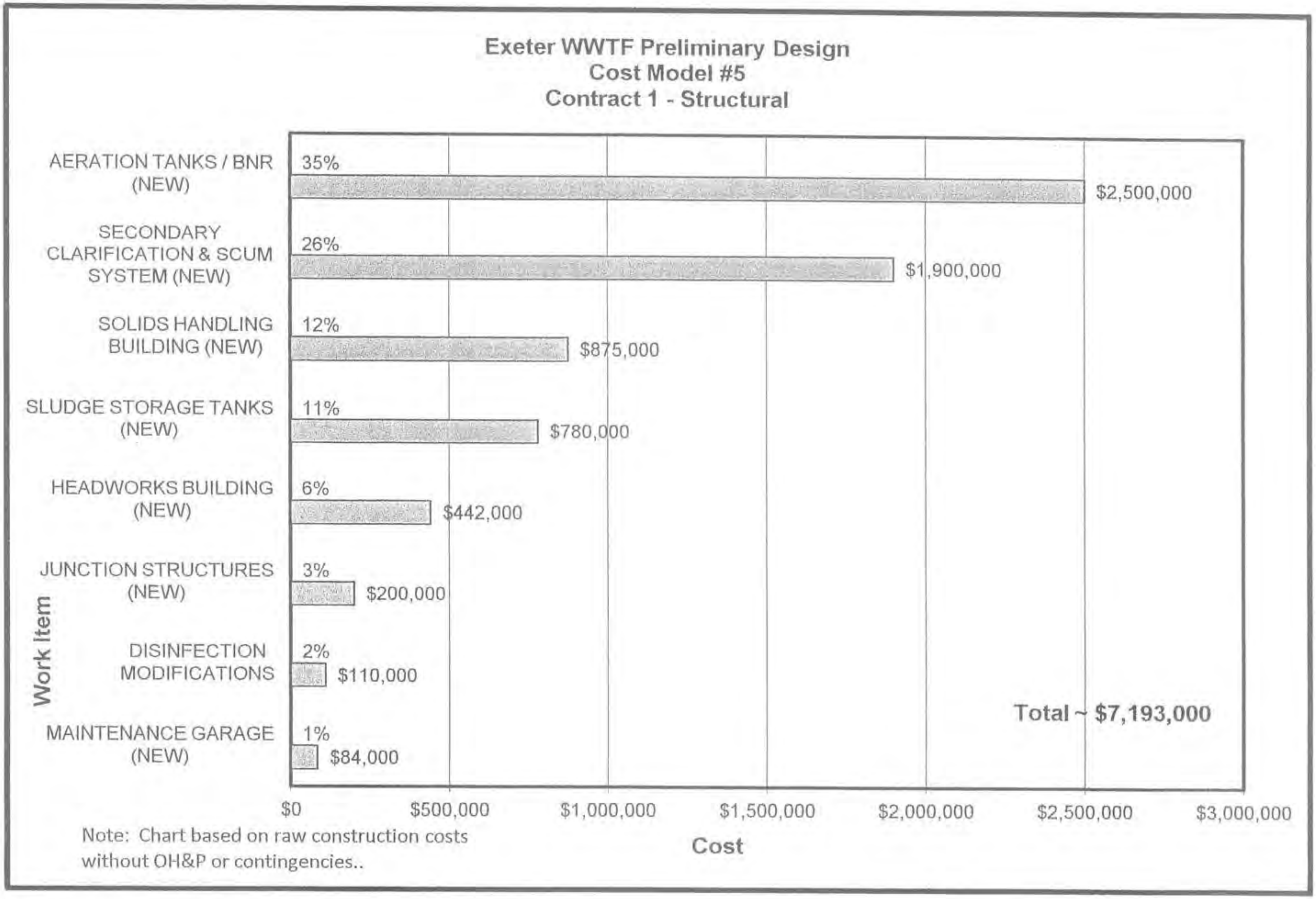
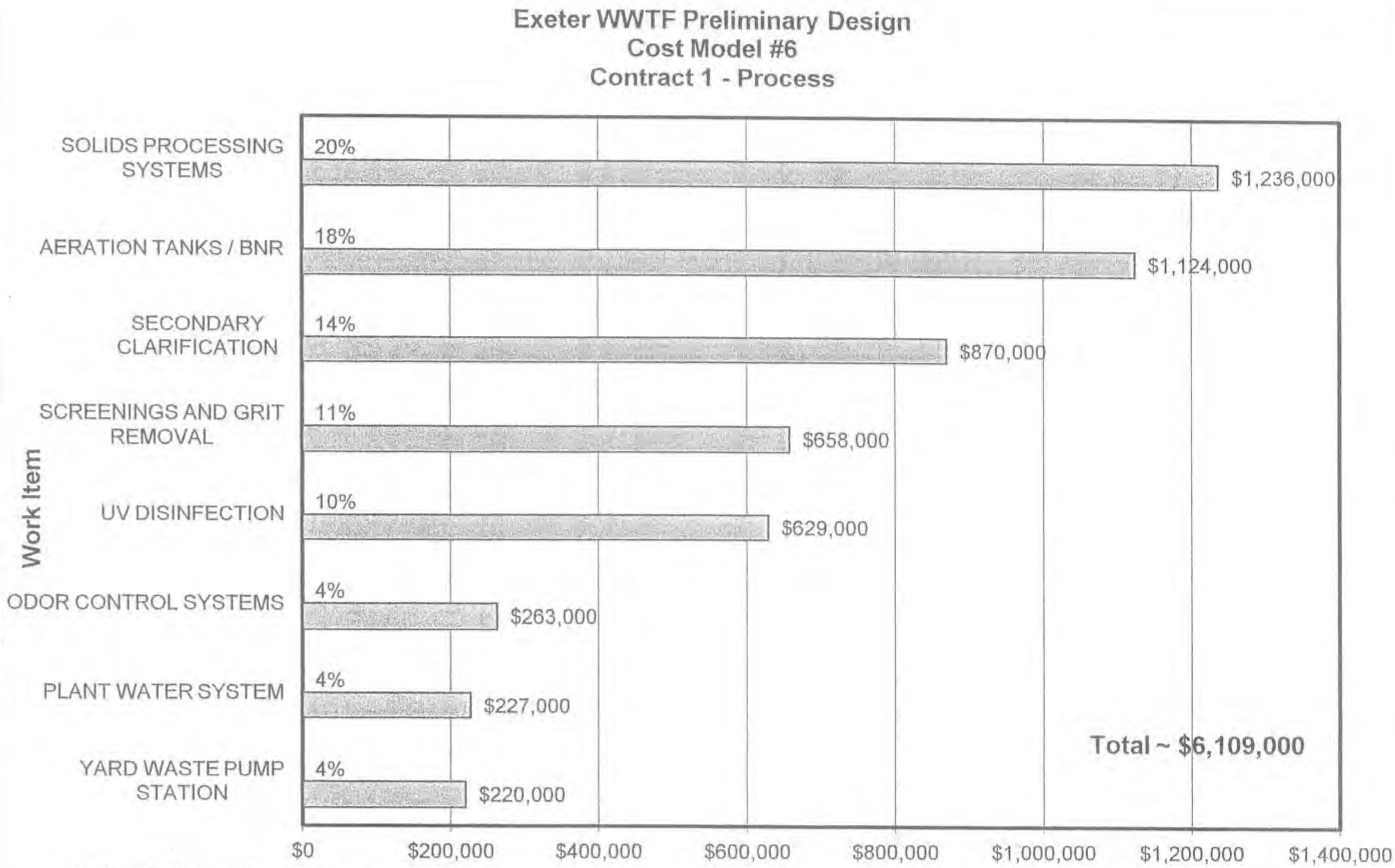


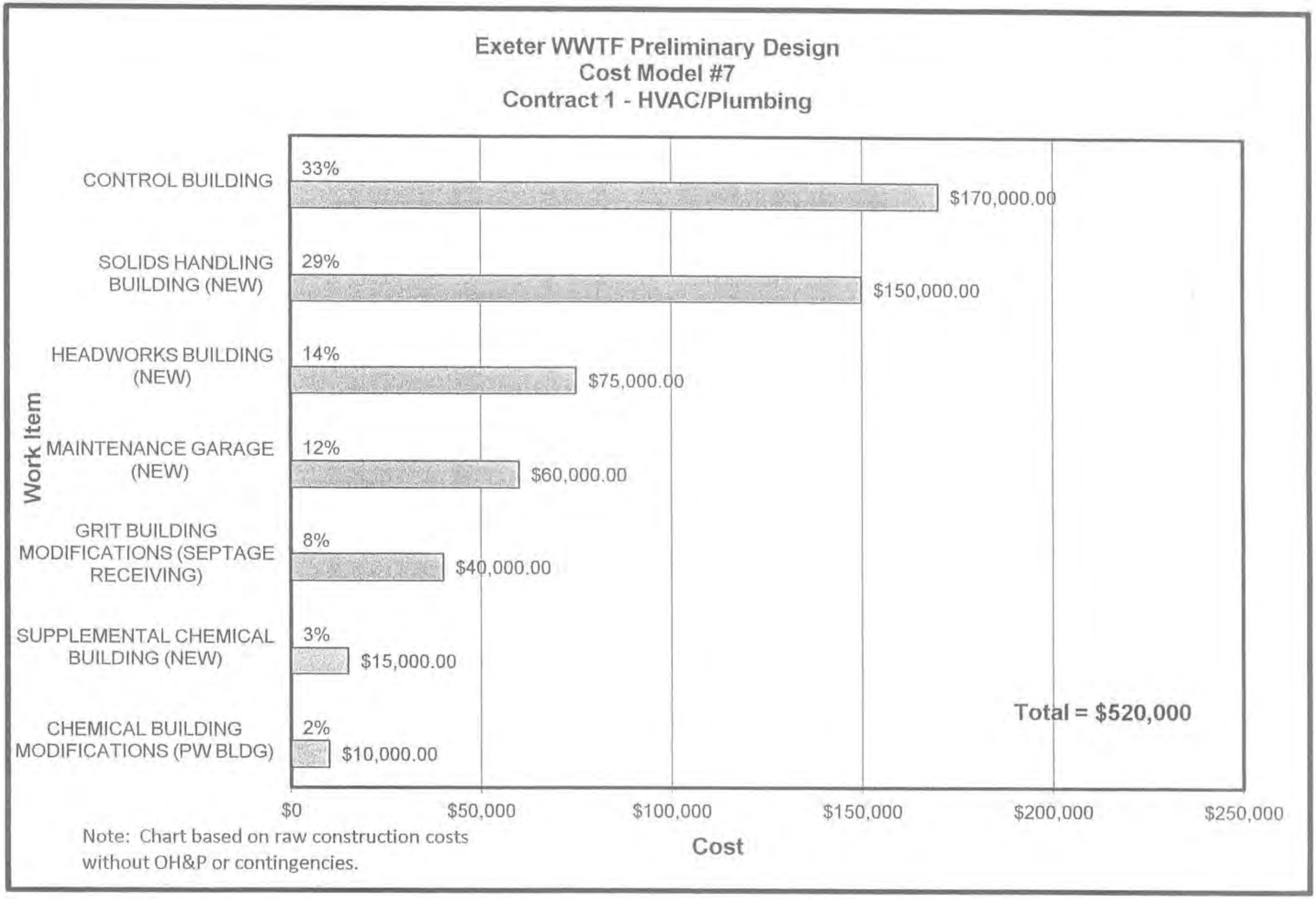
Note: Chart based on raw construction costs without OH&P or contingencies.


Exeter WWTF Preliminary Design
Cost Model #4
Contract 1 - Architectural
SOLIDS HANDLING BUILDING (NEW)
40%
$921,000
HEADWORKS BUILDING (NEW)
18%
$416,000
CONTROL BUILDING MODIFICATIONS
13%
$302,000
SUPPLEMENTAL CHEMICAL BUILDING (NEW)
8%
$187,000
MAINTENANCE GARAGE (NEW)
6%
$149,000
PROCESS EQUIPMENT & PIPING FINISHES
4%
$100,000
DISINFECTION BUILDING (NEW)
3%
$78,000
GRIT BUILDING MODIFICATIONS (SEPTAGE RECEIVING)
3%
$78,000
CHEMICAL BUILDING MODIFICATIONS (PW BLDG)
3%
$62,000
Work Item
$0
$250,000
$500,000
$750,000
$1,000,000
Cost
Total = $2,293,000
Note: Chart based on raw construction costs without OH&P or contingencies.


Exeter WWTF Preliminary Design
Cost Model #5
Contract 1 - Structural
AERATION TANKS / BNR (NEW)
35%
$2,500,000
SECONDARY CLARIFICATION & SCUM SYSTEM (NEW)
26%
$1,900,000
SOLIDS HANDLING BUILDING (NEW)
12%
$875,000
SLUDGE STORAGE TANKS (NEW)
11%
$780,000
HEADWORKS BUILDING (NEW)
6%
$442,000
JUNCTION STRUCTURES (NEW)
3%
$200,000
DISINFECTION MODIFICATIONS
2%
$110,000
MAINTENANCE GARAGE (NEW)
1%
$84,000
Total ~ $7,193,000
Work Item
$0
$500,000
$1,000,000
$1,500,000
$2,000,000
$2,500,000
$3,000,000
Cost
Note: Chart based on raw construction costs without OH&P or contingencies..



Note: Chart based on raw construction costs without OH&P or cotingencies.



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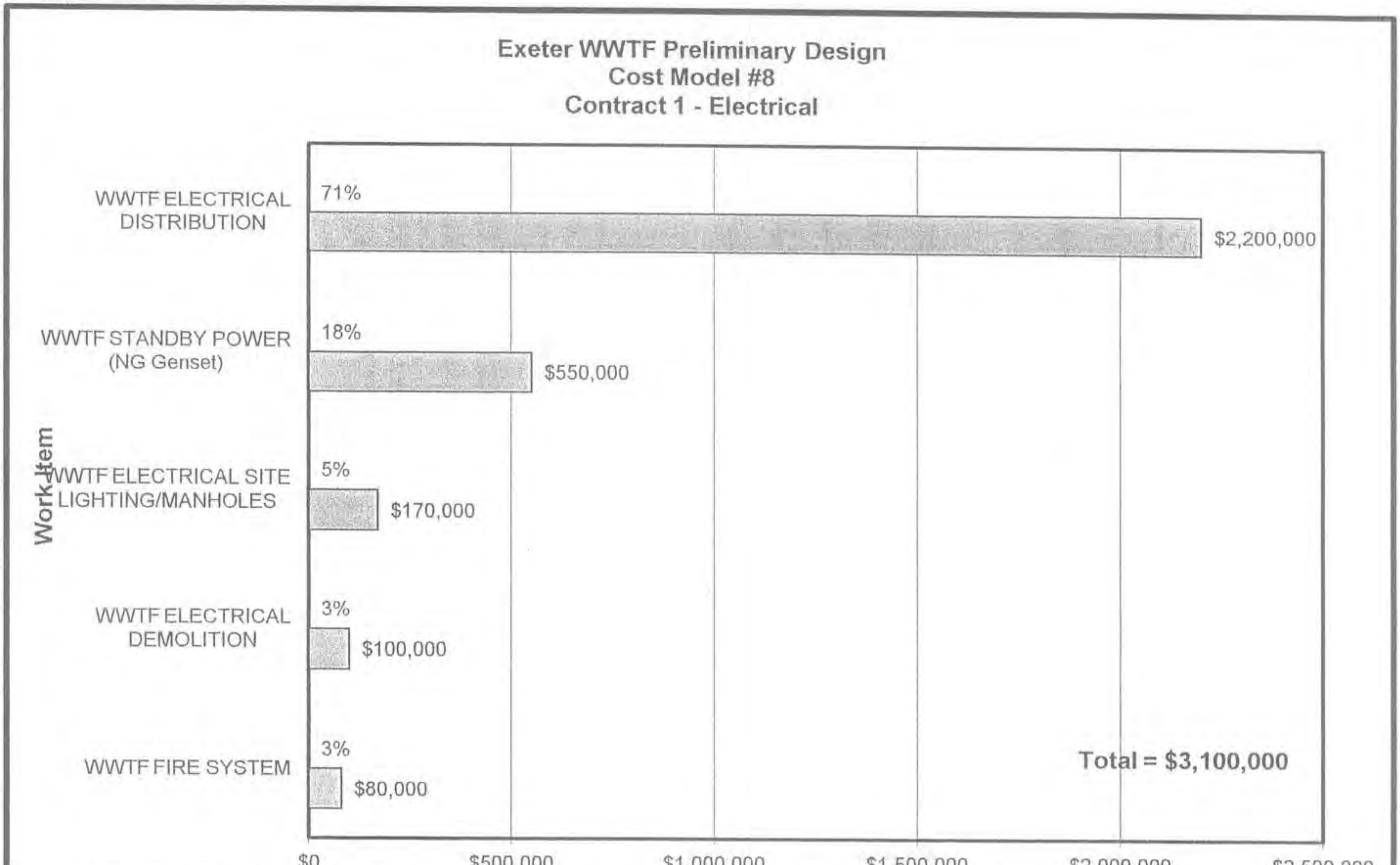
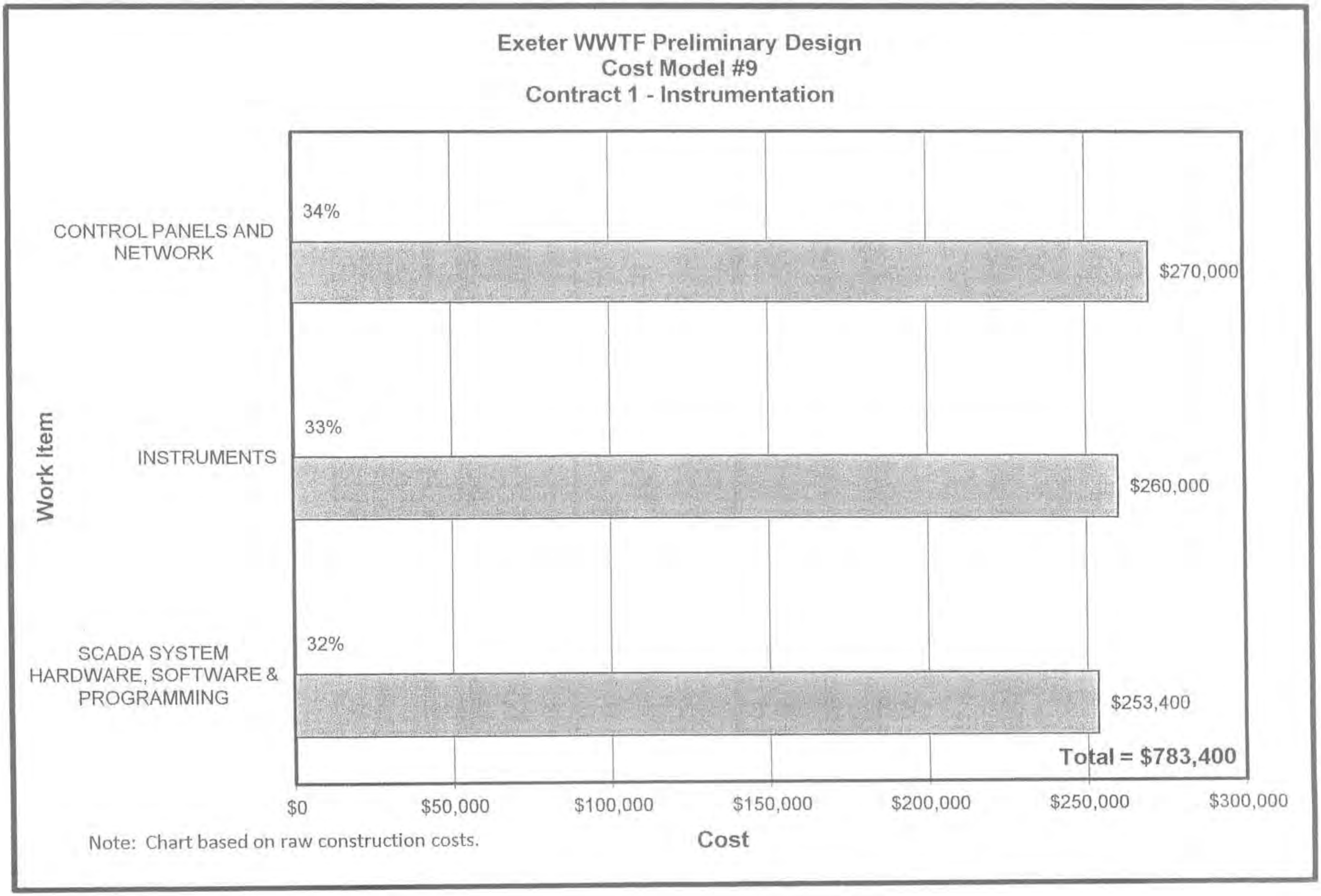
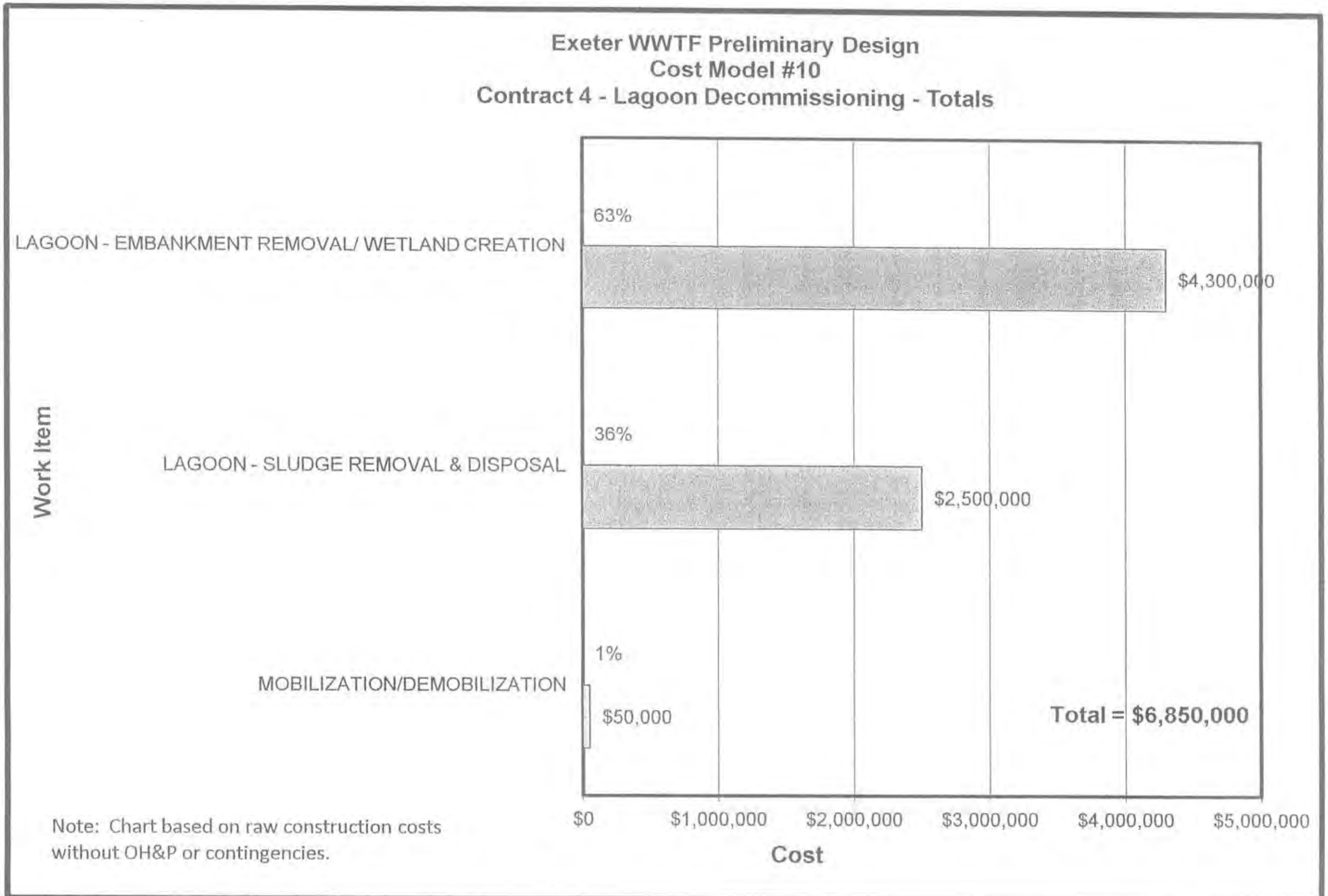


Note: Chart based on raw construction costs without OH&P or contingencies.


Exeter WWTF Preliminary Design
Cost Model #9
Contract 1 - Instrumentation
Work Item
CONTROL PANELS AND NETWORK
INSTRUMENTS
SCADA SYSTEM HARDWARE, SOFTWARE & PROGRAMMING
34%
33%
32%
$270,000
$260,000
$253,400
Total = $783,400
$0
$50,000
$100,000
$150,000
$200,000
$250,000
$300,000
Cost
Note: Chart based on raw construction costs.



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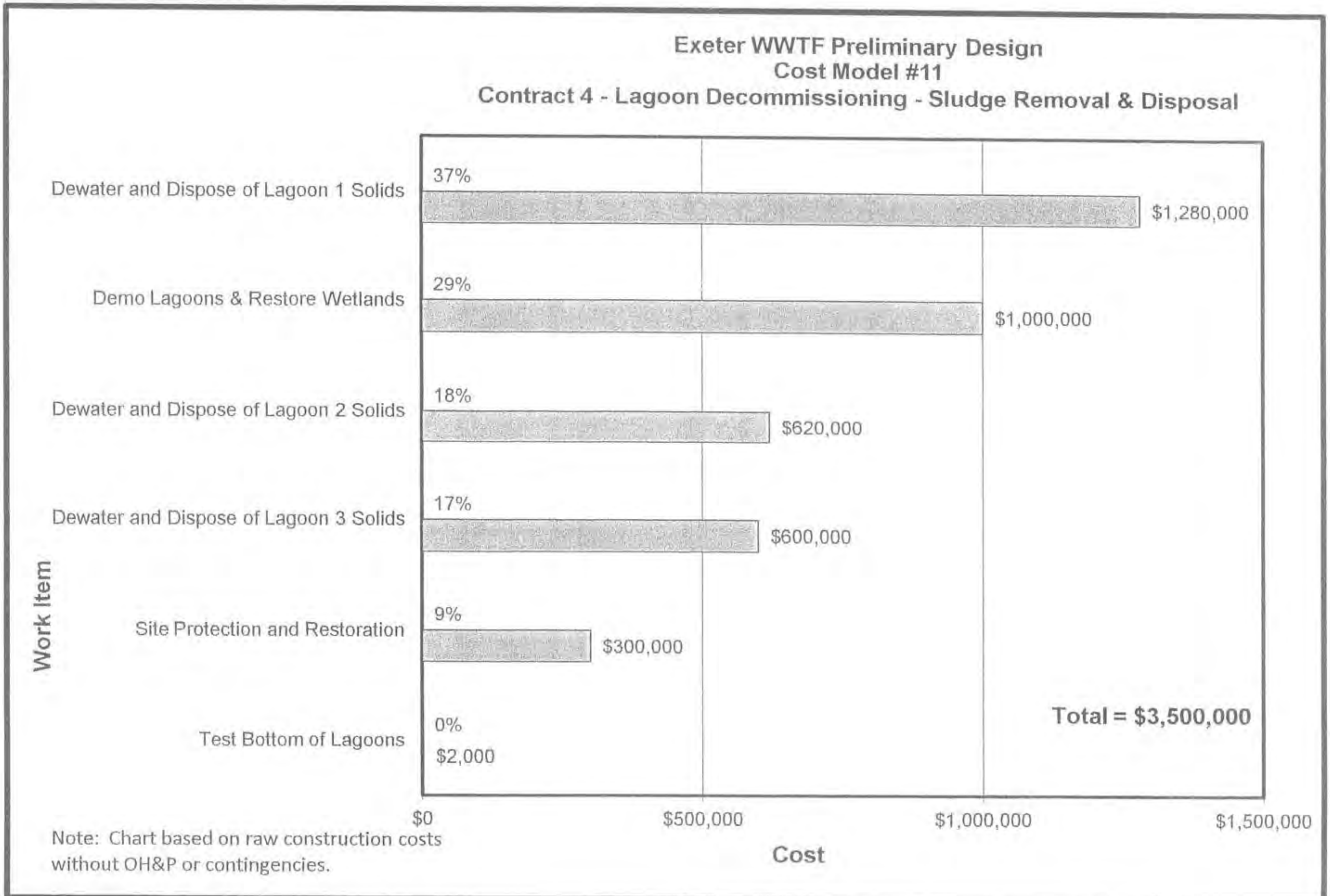
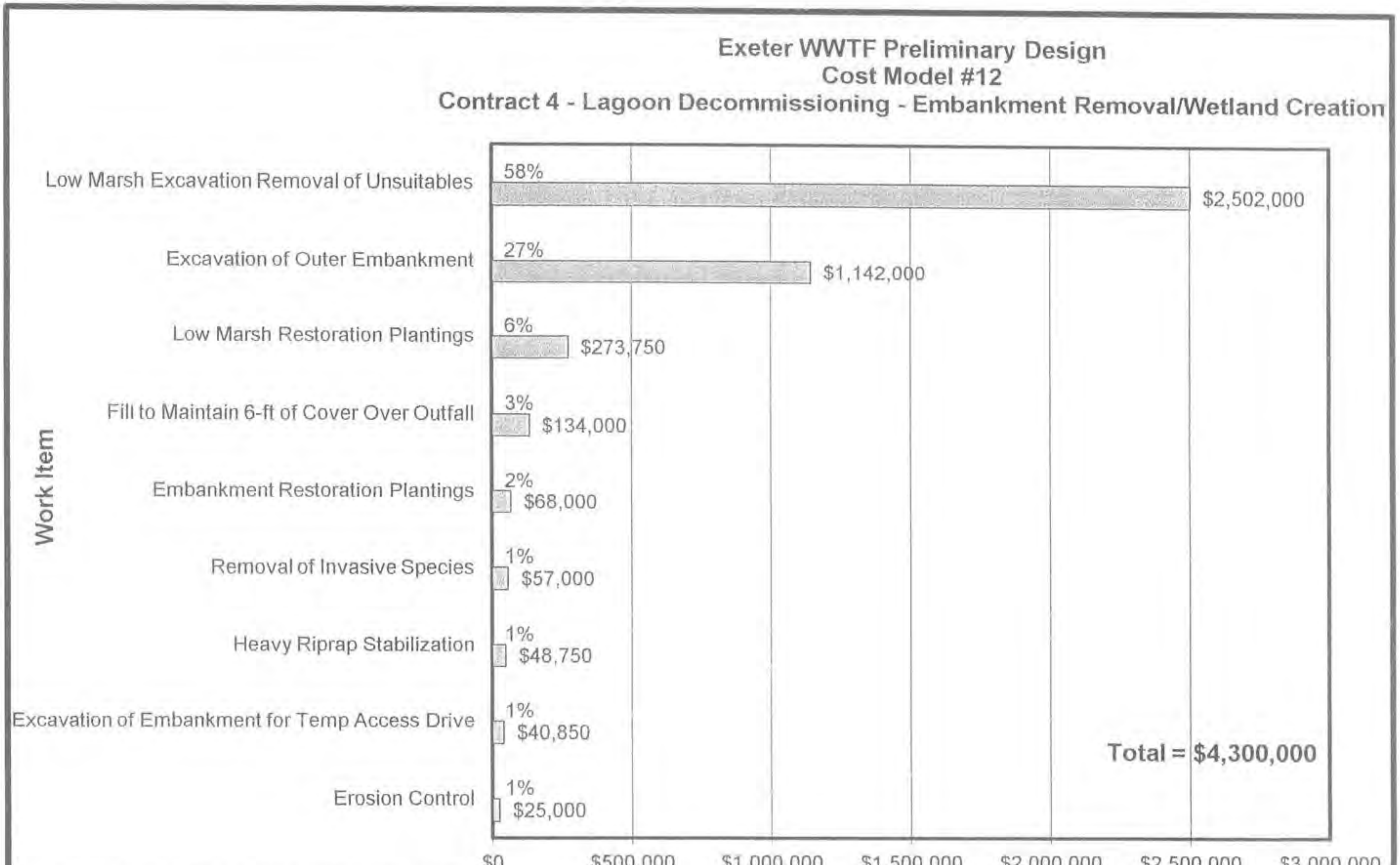
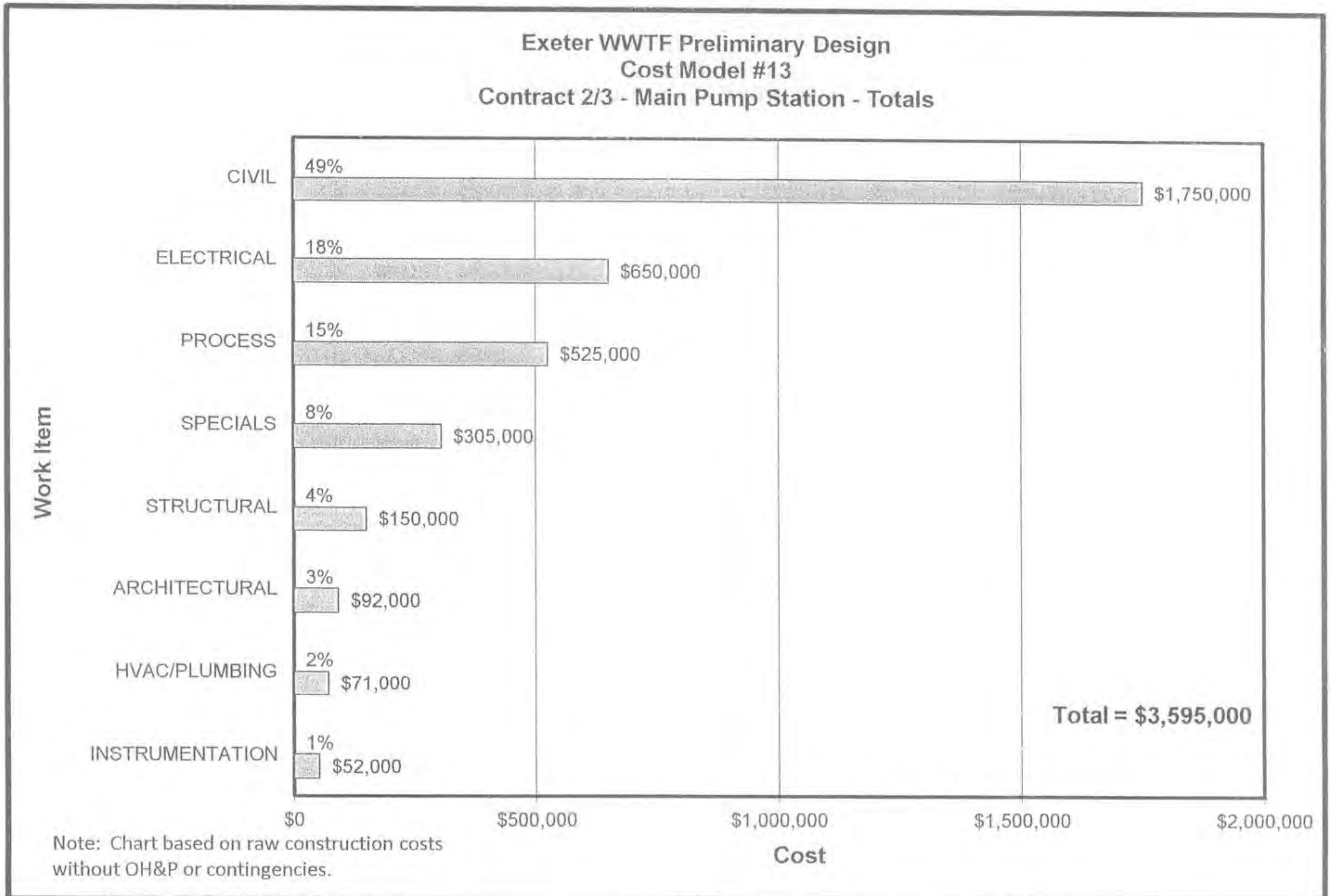
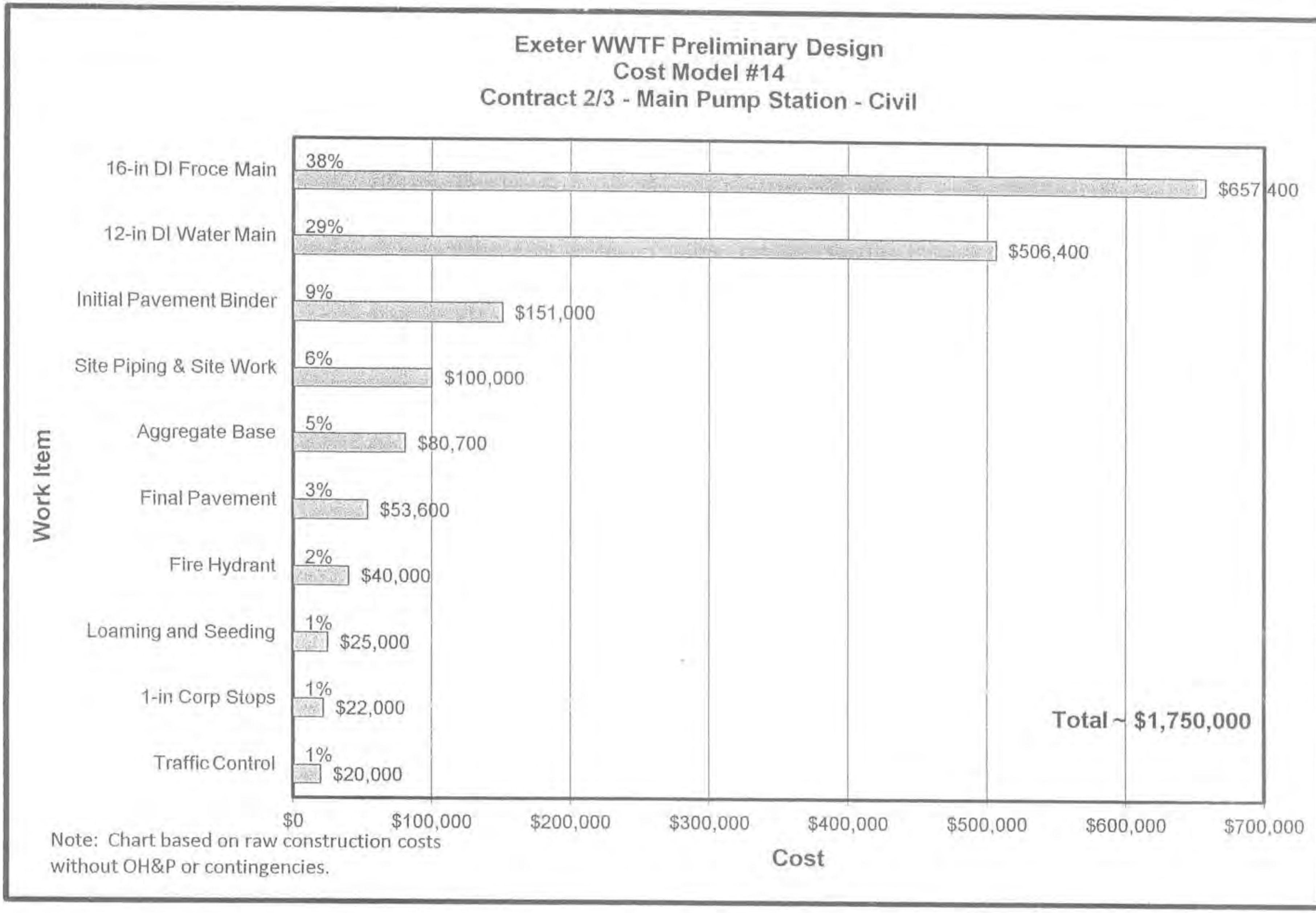

Exeter WWTF Preliminary Design
Cost Model #11
Contract 4 - Lagoon Decommissioning - Sludge Removal & Disposal
Dewater and Dispose of Lagoon 1 Solids
37%
$1,280,000
Demo Lagoons & Restore Wetlands
29%
$1,000,000
Dewater and Dispose of Lagoon 2 Solids
18%
$620,000
Dewater and Dispose of Lagoon 3 Solids
17%
$600,000
Site Protection and Restoration
9%
$300,000
Test Bottom of Lagoons
0%
$2,000
Total = $3,500,000
Work Item
$0
$500,000
$1,000,000
$1,500,000
Cost
Note: Chart based on raw construction costs
without OH&P or contingencies.



Note: Chart based on raw construction costs without OH&P or contingencies.



C:\Users\ed rushbrook\Documents\A - MY NEWER DOCUMENTS FEB 26 2014\My Newer Documents\EXETER VE - Sept 2015\Exeter WWTF - Cost Models 1 - 14 - ELR - Nov 30


Exeter WWTF Preliminary Design
Cost Model #14
Contract 2/3 - Main Pump Station - Civil
Work Item
16-in DI Froce Main
12-in DI Water Main
Initial Pavement Binder
Site Piping & Site Work
Aggregate Base
Final Pavement
Fire Hydrant
Loaming and Seeding
1-in Corp Stops
Traffic Control
38%
$657,400
29%
$506,400
9%
$151,000
6%
$100,000
5%
$80,700
3%
$53,600
2%
$40,000
1%
$25,000
1%
$22,000
1%
$20,000
Total ~ $1,750,000
$0
$100,000
$200,000
$300,000
$400,000
$500,000
$600,000
$700,000
Cost
Note: Chart based on raw construction costs
without OH&P or contingencies.

SECTION 5 – CREATIVE AND EVALUATION PHASES

5.1 CREATIVE PHASE

The goal of the Creative Phase of the Workshop was to generate a list of alternative approaches to elements of the design identified as constituting a high percentage of the construction cost that offered the potential to improve the "value" of the project as well as elements having a "Secondary Function" and considered to contribute little value to achieving the Basic Function and therefore also offering the potential for value improvement. Little discussion occurred during this phase of the workshop in keeping with standard VE procedures. The results of the Creative Phase are shown on the following worksheets.

5.2 EVALUATION PHASE

Following the Creative Phase the Evaluation Phase of the Workshop was initiated to discuss advantages and disadvantages of alternative approaches listed in the Creative Phase with the goal of identifying the "best few" that would offer the greatest potential for value improvement and therefore be worthy of detailed investigations. Considerations included in discussions and evaluations are shown in the PowerPoint Handout in Section 1.1.

Alternative approaches were ranked to indicate those considered most worthy of detailed investigation in the workshop based on potential capital cost savings, operational reliability or improvement, ease of maintenance, and energy usage.

Elements of the project evaluated were based on the Function Analysis and Cost/Worth Model review, as well as individual rankings and discussed are summarized on the following worksheets.

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CREATIVE IDEA LISTING / EVALUATION

PROJECT ELEMENT: TREATMENT PROCESS

ITEM	IDEA	PROS	CONS	RATING
1	Perform process QA/QC evaluation, including projected flows and loads	Validate process design/sizing Possibly change process sizing ? Possibly reduce blower size ? Change alkalinity requirements ?	None apparent at this time	10
2	Review aeration tank flexibilty and consider full floor diffusers	Increase process stability	Increase construction cost	10
3	Add ammonia based DO control **(include as Standalone)**	Energy savings	Minor cost and maintenance added	
4	Evaluate primary sludge fermentation (only if primary clarifiers are added) (PROVIDE NARRATIVE STAND-ALONE)	Free supplemental carbon source Reduce carbon chemical cost Potential to avoid 3rd aeration tank in future	Would require addition of primary clarifiers	
5	Review supplemental alkalinity needs	Possibly reduce suppemental alkalinity costs	Could negatively impact nitrogen removal if supplemental alkalinity is needed	8
6	Eliminate UV Disinfection, keep Chlor/ Dechlor	Reduced construction cost	"Haz" chems on site Requires dechlorination	10
7	Eliminate one centrifuge	Reduced construction cost	Need backup dewatering plan	10
8	Evaluate different mixing technologies (large bubble, mixer/aerator) **(evaluation asked for in PDR)**	Reduced construction cost	May not reduce cost significantly	10
9	Evaluate alternative "sludge handling" technologies (GBT, RDT, hold and haul, etc.) **(Provide as narrative)**	Possible equipment cost savings	Possibly lower solids and greater sludge hauling costs	7
10	Schedule Phase 3 to be concurrent with Phase 1 & 2	Accelerate construction schedule Complete earlier	Potential reduction of treatment in lagoons	10
11	Review capacity of pump station pumps	Optimize pumps Validate sizing	**Not sufficient time to evaluate**	
12	Provide opinion on addition of primary clarifiers as requested			10

1 - 5 = Low Development Potential
6 - 7 = Moderate Development Potential
8 -10 High Development Potential

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CREATIVE IDEA LISTING / EVALUATION

PROJECT ELEMENT: CIVIL - SITE

ITEM	IDEA	PROS	CONS	RATING
1	Modify layout, centralize stormwater to lagoon area, reduce rock exc. , closer clarifier spacing,reduce pavement, reuse site road b/w lagoon 4 and control bldg	reduced ledge excavation reduced constructioncost reduce impacted area more flexibility	redesign required but planned anyway	10
2	Provide opinion on preferebIe alternate W-P site layout plans as requested			10
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

1 - 5 = Low Development Potential
6 - 7 = Moderate Development Potential
8 -10 High Development Potential

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CREATIVE IDEA LISTING / EVALUATION

PROJECT ELEMENT: STRUCTURAL

ITEM	IDEA	PROS	CONS	RATING
1	Reduce rock removal quantity by modifying site layout and possibly the hydraulic grade line	Reduced rock exc. cost Possibly better accessibility	None apparent	10
2	Eliminate or reduce the scope of the headworks	Reduced construction cost	Less "elbow room"	
3	Eliminate or reduce the scope of the sludge handling building (ties in with second egress under arch.)	Reduced construction cost Eliminate water main cost ?	Could impact blower layout and equipment accessibility	
4				
5				
6				
7				
8				
9				
10				
11				
12				

1 - 5 = Low Development Potential
6 - 7 = Moderate Development Potential
8 -10 High Development Potential

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CREATIVE IDEA LISTING / EVALUATION

PROJECT ELEMENT: ARCHITECTURAL

ITEM	IDEA	PROS	CONS	RATING
1	Eliminate the headworks building Review exterior wall system $416,000 raw construction cost	Construction cost savings	More difficult winter maintenance Potential freezing problems Possible impacts on life cycle cost	10
2	Review overall control building modifications	Short term cost savings	Long term impacts	
3	Eliminate Maintenance building $302,000 raw construction cost	Construction cost savings	Town considers it important Eliminates tool storage and machine shop	4
4	Eliminate/modify solids handling bld'g. (Elim. if liquid sludge hauled off site) $921,000 raw construction cost	Construction cost savings Possibly elim. Need for water line	Impacts treatment process Higher life-cycle hauling costs if liquid sludge.	10
5	Eliminate supplemental chemical building **(assume covered in "process" evals)**	Construction cost savings (W-P recommends housing only alkalinity, carbon to be outside)	Potential freezing of chemicals ? More difficult winter maintenance	
6				
7				
8				
9				
10				
11				
12				

1 - 5 = Low Development Potential
6 - 7 = Moderate Development Potential
8 -10 High Development Potential

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CREATIVE IDEA LISTING / EVALUATION

PROJECT ELEMENT: MAIN PUMP STATION

ITEM	IDEA	PROS	CONS	RATING
1	Consider trenchless technology	Reduce cost Avoid open cuts Less public inconvenience	Unknown buried utilities ? Higher cost ?	10
2	Eliminate 12" water main $506,000 raw construction cost	Major cost reduction Town agrees in concept Appears not needed for fire protection	No increase in water flow at public works	10
3	Consider bidding water main as bid alternate if possible interest $657,000 raw construction cost	Not needed for nitrogen removal so won't impact Basic Function	Can't do if sprinklers are needed needed for fire protection	
4	Eliminate demo of bathroom	Minor cost savings Not a key functional item	Remains "as-is"	
5	Reuse excavate aggregate in pipe trench is if suitable **(Include as Stand-alone item)**	Reduce cost	Acceptibility not known May be difficult to determine quality	
6	Reduce water main size $506,000 raw construction cost	Possible cost savings	Need hydraulic analysis **Not sufficient time to for detailed evaluation**	5
7	Consider bidding alternate materials	Reduce cost	Acceptibilty of alternates to town ?	6-7
8	Reconfigure existing entrance	Possibly reduce cost	Redesign required Savings probably minor	
9	Change location of water main feed point connection to shorten length of main required	Reduce cost	**No alternate location to tie into**	5
10				
11				
12				

1 - 5 = Low Development Potential
6 - 7 = Moderate Development Potential
8 -10 High Development Potential

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CREATIVE IDEA LISTING / EVALUATION

PROJECT ELEMENT: COST ESTIMATE REVIEW

ITEM	IDEA	PROS	CONS	RATING
1	Review cost estimate to check unit prices used	Provide partial validation of cost estimate	None	10
2	Review "project cost " factors , i.e, OH&P, design and construction contingencies, escalation factors, etc.	Provides validation of "project cost" factors	None	10
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

1 - 5 = Low Development Potential
6 - 7 = Moderate Development Potential
8 -10 High Development Potential

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CREATIVE IDEA LISTING / EVALUATION

PROJECT ELEMENT: LAGOON - DECOMMISSIONING AND SLUDGE REMOVAL

ITEM	IDEA	PROS	CONS	RATING
1	Eliminate wetland creation $4,300,000 raw construction cost	Major cost reduction potential Not strongly supported by town Wright-Pierce recommends as 1 of 15 cost saving measures	None could be shown as no apparent need was identified	10
2	Make all Invasive Species removal "cut and herbicide " approach	Reduce cost	Could repopulate May be short term fix	7
3	Defer sludge removal $3,800,000 raw construction cost	Major cost savings potential Wright-Pierce recommends as 1 of 15 cost saving measures	Possible NHDES requirement	
4				
5				
6				
7				
8				
9				
10				
11				
12				

1 - 5 = Low Development Potential
6 - 7 = Moderate Development Potential
8 -10 High Development Potential

SECTION 6
DETAILED INVESTIGATIONS

TREATMENT PROCESS

Exeter, NH
Wastewater Treatment Facility Upgrade Design
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VE RECOMMENDATION

PROJECT ELEMENT: Process Validation and Comments

PREPARED BY: Sarah Galst

Original Design Description: (Attach sketch if applicable)
Two Aeration Tanks (ATs) configured as 4-stage Bardenpho with capability to convert to MLE at higher flows.
Future expansion by adding one additional AT.
Three 70-ft FSTs
Limited 2014-2015 data set used to set Flows and Loads
BioWin process model used for analysis
Flows and loads as shown in Table 7, memo: Updates to Design Loads, August 26, 2015

Proposed Design Description: (Attach sketch if applicable)
See attached review and comments
Proposals:
1. Run one addition week of analyses for the following parameters to refine ww fract and better understand the carbon that is inherent to the wastewater. Modify model kinetics to capture heterotrophic popultion using glycerol.

2. Eliminate Alkalinity
3. Consider zones A1 and A2 becoming swing zones in the event that additional aerobic volume is needed (would not be operated as aerated under normal conditions)

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:	Disadvantages:
1. More accurately model carbon usage	1. Potential to increase carbon costs if demand increases based on sampling
2. Reduce costs associated with alkalinity (detailed in separate analysis)	2. See separate analysis
3. Increase flexibility to nitrify under low solids/temperature conditions	3. Potential to increase capital costs

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$ -	$ -	$ -
VE PROPOSAL	$ 19,647.00	$ -	$ 19,647.00
SAVINGS	$ (19,647.00)	$ -	$ (19,647.00)

Process Validation Notes

Overall, the process design will achieve the nitrogen removal targets.

Comments are as follows:

- Influent Loading conditions were developed based on a limited data set. Recommend continuing the sampling through design to gain confidence in the future loading conditions
- WW fractions were held at default with the exception of the Fac and the Fxsp. Recommend running one addition week of analyses for the following parameters to refine ww fract and better understand the carbon that is inherent to the wastewater (will help refine supplemental carbon needs):
    - Inf COD, sCOD, floc filter COD, BOD, sBOD, NH3, TKN, PO4, TP, TSS, VSS
    - Eff sCOD
- No supplemental alkalinity was observed as needed; an influent alkalinity of 160 mgCaCO3/L (3.2 mmol/L) was sufficient (this is further addressed in another comment)
- Carbon was added in the model as a methanol input. The model structure associated with the methanol degrading subpopulation in the *BioWin* model was used, but would need modifications to its kinetic and stoichiometric coefficients to better simulate heterotropohic biomass and more accurately predict supplemental carbon needs:
    - ***Methylotrophs Kinetic Parameters***: Max Specific Growth Rate (1/d) (default 1.3): Adjust to 1.65, with Arrhenius of 1.029
    - ***Methylotrophs Stoichiometric Parameters:*** Yield (anoxic) (default 0.4): Adjust to 0.54
    - Glycerol should be added to the anoxic zone so that 60-100% of the glycerol is utilized through the zone, minimizing bleed-over into the aerobic zone.
    - Specific Denitrification Rates (sDNRs) should be limited to 6-7 mgN/gVSS/hr (0.16 mgN/mgVSS/d) based on the upper range of average sDNRs found for crude glycerin.
    - The Aerobic Methylotrophic growth module should be used as the methylotrophic population is being used to mimic a glycerol-consuming heterotrophic population that is capable of aerobic growth.
- Final Settling Tanks: Given there is no historical database, and no ability to determine site specific settling coefficients, the Daigger 1995 theoretical correlation and an average SVI of 105 mL/g were used to determine the Vo and k; our experience indicates that the Daigger k value is low and the SVI of 150 mL/g is conservative.
    - Other theoretical correlations show that, at an SVI of 150 mL/g, settling problems may occur. However, at an SVI of 120mL/g, sufficient clarifier capacity exists for the max flow/solids concentration occur.
    - We would expect that an SVI of 120mL/g would be more typical of a bardenpho process.
- Recommend that Zones A1 and A2 become swing zones to provide maximum flexibility to maintain nitrification in the event of stressed operational conditions (loss of solids inventory, cold temperatures).

Exeter, NH
Wastewater Treatment Facility Upgrade Design
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Cost Estimates

ITEM: Process Validation and Comments (Increased Diffuser Coverage)							
Prepared by: Sarah Galst							
DATE:		ORIGINAL EST.			PROPOSED EST.		
ITEM	UNIT	QUANTITY	COST / UNIT	TOTAL COST	QUANTITY	COST / UNIT	TOTAL COST
Diffusers and piping	ft2	0	$14.75	$0	1332	$14.75	$19,647
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
TOTAL				**$0**			**$19,647**

Exeter, NH
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VE RECOMMENDATION

PROJECT ELEMENT: Supplemental Alkalinity Building/System

PREPARED BY: Sarah Galst, Scott Donovan

Original Design Description: (Attach sketch if applicable)
Supplemental alkalinity is called for support the BNR process
~90 gpd are reccommended for current average conditions

System at time of VE review includes:

- Architectural components for Supplemental Chemical Building ($187,000)
- Structural components for Supplemental Chemical Building ($55,000)
- Process components (Tanks, mixers, pumps, pipes) ($97,000)
- HVAC/Plumbing components for Supplemental Chemical Building ($15,000)
- Supplemental Alkalinity Remote (I/O) ($12,500)
- Electrical, estimated at $15,000

Proposed Design Description: (Attach sketch if applicable)
See attached review and comments
Remove supplemental alkalinity and all associated equipment, buildings (see attached calculations)

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:
Reduced costs (capital and O&M)
Reduction in process operational complexity

Disadvantages:
If wastewater characteristics are different than indicated in limited database, supplemental alkalinity may be required.

If only 40% of nitrate is denitrified, alkalinity could drop to levels that may inhibit nitrification.

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$ 381,500.00	$ 109,500.00	$ 2,010,531.50
VE PROPOSAL	$ -	$ -	$ -
SAVINGS	$ 381,500.00	$ 109,500.00	$ 2,010,531.50

Present Worth Factor (P/A, 3%, 20) = 14.877

CALCULATION

PROJECT ELEMENT: Supplemental Alkalinity Building/System

PREPARED BY: Sarah Galst

SUPPLEMENTAL ALKALINITY CALCULATION

	Full nit/denit		Assume only 40% denit			Source
Flow	3	4.5	3	4.5	mgd	
Inf Alkalinity	160	160	160	160	mgCaCO3/L	*Design Ann Avg and Max Month concentrations Table in Nitrogen chapter of PDR*
Inf TKN	33	28	33	28	mgN/L	
Inf Ammonia	26	22	26	22	mgN/L	
Assumed effluent TN						
NH3	1	1	1	1	mgN/L	*PDR, Tertiary Treatment appendix, pg 3*
NOx	0.5	0.5	14.5	12.1	mgN/L	
Organic N	2	2	2	2	mgN/L	
Assimilation of TKN	20%	20%	20%	20%		*assumption, assimilation*
Ammonia to be nitrified	23.4	19.4	23.4	19.4	mgN/L	*80% of TKN minus 1 mg/L of NH3 and 2 mg/L organic N in effluent*
Alkalinity demand	7.14	7.14	7.14	7.14	mgCaCO3/mgNH3-N	
Alkalinity req'd for nitrification	167	139	167	139	mgCaCO3/L	
Alkalinity recovery	3.57	3.57	3.57	3.57	mgCaCO3/mgNH3-N	*Alkalinity is recovered via denitrification*
Nitrate to be denitrified	22.9	18.9	8.9	7.3	mgN/L	*Ammonia nitrified minus NOx in the effluent*
Alkalinity recovered	82	67	32	26	mgCaCO3/L	
Alkalinity Demand	85	71	135	113	mgCaCO3/L	
Target eff Alkalinity	50	50	25	25	mgCaCO3/L	*Target of 50mg/L average, and 25mg/L stressed conditions*
Supplemental Alkalinity req'd	-25	-39	0	-22	mgCaCO3/L	

Exeter, NH
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December 7-11, 2015

Cost Estimates

ITEM: Supplemental Alkalinity Building/System							
Prepared by: Sarah Galst, Scott Donovan							
DATE:		ORIGINAL EST.			PROPOSED EST.		
ITEM	UNIT	QUANTITY	COST / UNIT	TOTAL COST	QUANTITY	COST / UNIT	TOTAL COST
Mg(OH)2	gpd	150	$2.00	$300	0	$2.00	$0
				$0			$0
				$0			$0
				$0			$0
TOTAL O&M (per day)				**$300**			**$0**
Architectural for Supp Chem Bldg	unit	1	$187,000	$187,000	0	$187,000	$0
Structural for Supp Chem Bldg	unit	1	$55,000	$55,000	0	$55,000	$0
Process components (Tanks, mixers, pumps,	unit	1	$97,000	$97,000	0	$97,000	$0
HVAC/Plumbing for Supp Chem Bldg	unit	1	$15,000	$15,000	0	$15,000	$0
Supp Alk Remote (I/O)	unit	1	$12,500	$12,500	0	$12,500	$0
Electrical	unit	1	$15,000	$15,000	0	$10,000	$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
TOTAL CAPITAL				**$381,500**			**$0**

Exeter, NH
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V.E. Workshop

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VE RECOMMENDATION

PROJECT ELEMENT: Ammonia-based DO control strategy

PREPARED BY: Sarah Galst

Original Design Description: (Attach sketch if applicable)
At time of VE, aeration strategy had not yet been determined

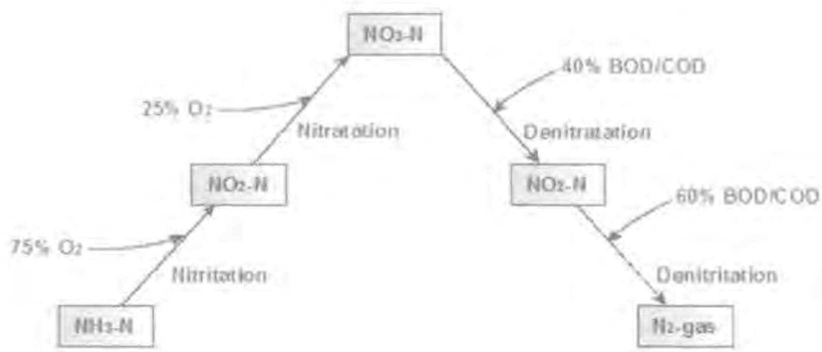
Proposed Design Description: (Attach sketch if applicable)
Incorporate NH3 ($18,000/controller+probe) and DO ($4000/controller+probe) in each aeration basin, as shown
Establish an operational strategy with DO concentrations tied to ammonia concentrations, for example:

If NH3 is less than 1.5 mg/L, reduce DO concentration to 0.5 mg/L by decreasing aeration

If NH3 is above 1.5 mg/L, increase target DO concentration to 2.0 mg/L by increasing aeration

Process modeling should be used to refine these suggested starting points.

Simultaneous Nitrification/Denitrification (SND) can provide aeration and carbon benefits by halting the nitrification process at NO2, and denitrifying from NO2. This saves approximately 25% aeration and 40% carbon requirements over traditional Nitrification/Denitrification (shown below).
High level process modeling was conducted to quantify the aeration and carbon savings - modeling demonstrated a 17% savings in aeration and a 100% savings on supplemental carbon at Average Design conditions (3.0 mgd)



DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:
Reduced operating costs (aeration energy and supplemental carbon) while achieving effluent TN goals

Disadvantages:
Reliance on instrumentation and maintenance of instrumentation is required

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$ -	$ 110,230.00	$ 1,639,891.71
VE PROPOSAL	$ 61,600.00	$ 65,335.00	$ 1,033,588.80
SAVINGS	$ (61,600.00)	$ 44,895.00	$ 606,302.92

Present Worth Factor (P/A, 3%, 20) = 14.877

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: Dec 7-11, 2015

CALCULATION SHEET

PREPARED BY:
Sarah Galst

ELEMENT:
Ammonia-based DO Control Strategy

Exeter, NH
Wastewater Treatment Facility Upgrade Design
V.E. Workshop

December 7-11, 2015

Cost Estimates

ITEM: Ammonia-based DO control strategy							
Prepared by: Sarah Galst							
DATE:		ORIGINAL EST.			PROPOSED EST.		
ITEM	UNIT	QUANTITY	COST / UNIT	TOTAL COST	QUANTITY	COST / UNIT	TOTAL COST
Aeration energy	kwh	1657	$0.13	$215	1375.31	$0.13	$179
Supplemental Carbon	gpd	50	$1.73	$87	0	$1.73	$0
				$0			$0
				$0			$0
TOTAL O&M (per day)				**$302**			**$179**
Ammonia Controller	unit	0	$15,000	$0	2	$15,000	$30,000
Ammonia Probe	unit	0	$3,000	$0	2	$3,000	$6,000
DO Controller	unit	0	$2,000	$0	2	$2,000	$4,000
DO Probe	unit	0	$2,000	$0	2	$2,000	$4,000
Subtotal				$0			$44,000
Installation	40%			$0			$17,600
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
TOTAL CAPITAL				**$0**			**$61,600**

Exeter, NH
Wastewater Treatment Facility Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: Primary Treatment (conventional)

PREPARED BY: VE Team

Original Design Description: (Attach sketch if applicable)
At time of VE, no primary treatment is planned

Proposed Design Description: (Attach sketch if applicable)
As requested, VE examined the cost associated with installing primary treatment.
A comparison of the conventional primary treatment alternative was conducted estimating the cost of two 45ft diameter PSTs, one gravity thickener, and one splitter structure

Initial process modeling analysis indicates the potential to save 18% AT volume, 21% aeration and increase supplemental carbon by 13% (at annual average, design conditions - 3.0 mgd), while maintaining effluent quality, with primary treatment online (modeling assumed a 30% reduction in TSS and CBOD, and a 10% reduction in TKN)

Effluent		Current Design	Primary Treatment	% decrease
NH3	mgN/L	0.3	0.3	
NO3	mgN/L	0.8	0.9	
NO2	mgN/L	0.1	0.0	
TN	mgN/L	2.9	2.9	
Alk	mgCaCO3/L	66.5	82.0	
TSS	mg/L	5.6	5.5	
CBOD	mg/L	2.1	2.2	
Glycerol	gpd	40	45	-13%
Aeration	SCFM	1,867	1,467	21%
WAS	lb/d	3,566	2,163	39%
Tank Volume	MG	0.90	0.74	18%

Costs estimated on the attached calculation sheet for PSTs, GTs, and Splittler structure, and energy.

Cost reduction for reduced length of AT aerobic zone (118' to 83'):

Base slab	242 CY @ $600/CY = $145,200
Walls	142 CY @ $1,000/CY = $142,000
Rock excavation	435 CY @ $80/CY = $34,800
Soil excavation	1,570 CY @ $13/CY = $20,410

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:
Lower loading on secondary treatment process
Reduced aeration tank size, and associated structural/civil work (reduced costs)
Protection for secondary treatment from FOG in the influent
Reduced aeration demand (reduced costs)

Disadvantages:
Additional primary treatment process offers more operational complexity
Increased supplemental carbon demand (and costs)

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$ -	$ 110,230	$ 1,639,892
VE PROPOSAL	$ 1,484,990	$ 140,525	$ 3,575,580
SAVINGS	$ (1,484,990)	$ (30,295)	$ (1,935,689)

Present Worth Factor (P/A, 3%, 20) = 14.877

Exeter, NH
Wastewater Treatment Facility Upgrade Design
V.E. Workshop

December 7-11, 2015

Cost Estimates

ITEM: Primary Treatment (conventional)							
Prepared by: VE Team							
DATE:		ORIGINAL EST.			PROPOSED EST.		
ITEM	UNIT	QUANTITY	COST / UNIT	TOTAL COST	QUANTITY	COST / UNIT	TOTAL COST
Aeration energy	kwh/d	1657	$0.13	$215	1309.03	$0.13	$170
Supplemental Carbon	gpd	50	$1.73	$87	56.5	$1.73	$98
PST energy (drive, sludge pump)	kwh/d	0	$0.13	$0	895.2	$0.13	$116
				$0			$0
TOTAL O&M (per day)				**$302**			**$384**
Prrimary Settling Tanks (2 @ 45 ft diameter)							
Slab	CY			$0	320	$600	$192,000
Walls	CY			$0	270	$1,000	$270,000
Excavation				$0	3400	$13	$44,200
Topping				$0	1	$20,000	$20,000
Backfill				$0	1	$20,000	$20,000
PST Equipment, install (assumed at 75% of FST costs [$870,000] from WP)				$0	2	$217,500	$435,000
Electrical				$0	2	$150,000	$300,000
yard piping 24" DIP	LF			$0	200	$255	$51,000
yard piping 6"DIP	LF			$0	300	$80	$24,000
Misc metals (Bridge/Railings/Supt)	unit			$0	1	$25,000	$25,000
						subtotal	***$1,381,200***
Gravity Thickener (1 @ 25" diameter)							
Slab	CY			$0	40	$600	$24,000
Walls	CY			$0	55	$1,000	$55,000
Excavation				$0	1	$12,000	$12,000
Backfill				$0	1	$4,000	$4,000
GT Equipment, install (assumed at 40% of FST costs [$870,000] from WP)				$0	1	$116,000	$116,000
Electrical				$0	1	$85,000	$85,000
						subtotal	***$296,000***

Cost Estimates

ITEM: Primary Treatment (conventional)							
Prepared by: VE Team							
DATE:		ORIGINAL EST.			PROPOSED EST.		
ITEM	UNIT	QUANTITY	COST / UNIT	TOTAL COST	QUANTITY	COST / UNIT	TOTAL COST
Splitter Structure							
Slab	CY			$0	33	$600	$19,800
Walls	CY			$0	90	$1,000	$90,000
Excavation				$0	1	$10,000	$10,000
Backfill				$0	1	$5,000	$5,000
Access Stairs				$0	1	$15,000	$15,000
Gates				$0	2	$5,200	$10,400
						subtotal	***$150,200***
Aeration Tank concrete (presented as cost saved)							
Base slab	CY			$0	-242	$600	-$145,200
Walls	CY			$0	-142	$1,000	-$142,000
Rock excavation	CY			$0	-435	$80	-$34,800
Soil excavation	CY			$0	-1570	$13	-$20,410
						subtotal	***-$342,410***
TOTAL CAPITAL				**$0**			**$1,484,990**

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12-11-15

CALCULATION SHEET

PREPARED BY: SDG

ELEMENT: PST

Primary Settling Reqmts

Avg SOR < 1,200 gpd/ft²

Peak hour SOR < 3000 gpd/ft²

Flows	mgd	ft² req'd	diameter (ft)
Current Avg	1.7	708	30
Design Avg	3.0	1250	40
Future Peak hour	6.6	1100	37

45 ft diameter

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/11/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: PRIMARY CLARIFIERS

PRIMARY CLARIFIERS

2 TOTAL

45.0' DIAMETER

TOW EL 30.00

INVERT EL 15.00

GRADE EL 25.00

ASSUME 16" WALLS

ASSUME 24" BASE SLAB W/ PRVs

SLAB $\left(\frac{45}{2}+1.33+1.0\right)^2 \pi (2.0)/27 = 145$ CY (1.33 = 2AD WALL, 1.0 = LIP)

CENTER WELL $(5)^2 \pi (5)/27 = 15$ CY

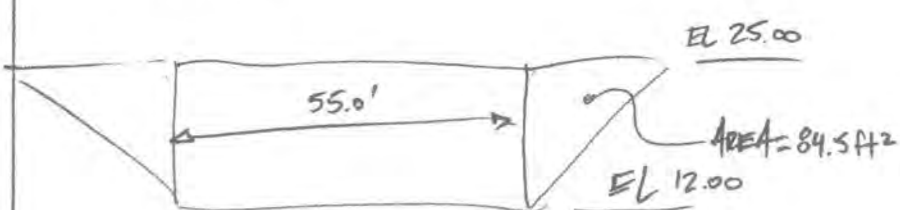
} 160 CY SLAB ON GRADE

WALL $(15.0)(1.33)(2\pi)(22.5)/27 = 105$ CY

TROUGH $(6.0\,ft^2)(2\pi)(22.5)/27 = 30$ CY

} 135 CY WALL

ROCK @ 11.0 PER BORING L-2, ∴ ASSUME NO ROCK EXCAVATION



SOIL EXCAVATION $\frac{\left(\frac{55}{2}\right)^2 \pi (13)}{27} + \frac{2\pi\left(\frac{55}{2}\right)(84.5)}{27} = 1{,}700$ CY

Date: 12/11/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: PRIMARY CLARIFIERS

PC TOTALS (STRUCTURE, EXCAVATION & BACKFILL)
2 TANKS

SLAB: (160)(2)(600) = $192,000
WALLS: (135)(2)(1,000) = $270,000
EXC: (1,700)(2)(13) = $44,200
2" GROUT TOPPING = $20,000
BACKFILL = $20,000

$550,000

OTHER COSTS:
- EQUIPMENT
- ELECTRICAL
- INSTRUMENTATION
- YARD PIPING
- BRIDGE ACCESS STAIRS

GRAVITY THICKENER

- ASSUME 25' DIAMETER
- 14" WALLS
- 15' DEPTH
- 18" BASE SLAB

SLAB: $(14.67)^2\pi(1.5)/27$ = 40 CY x $600 = $24,000

WALLS: $(15)(1.12)(2\pi)(12.5)/27$ = 55 CY x $1,000 = $55,000

EXCAVATION = $12,000
BACKFILL = $4,000

$95,000

OTHER COSTS
- EQUIP
- ELECTRICAL
- INST
- YARD PIPING

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/11/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: PRIMARY CLARIFIERS

SPLITTER STRUCTURE

ASSUME 20'x20'

SLAB: $(22)^2(1.5)/27 \times 600 =$ \$20,000

WALLS: $6(15')(1.33')(20)/27 \times 1{,}000 =$ \$90,000

(6 = 4 EXT/2 INT WALLS)

EXCAVATION = \$10,000

BACKFILL = \$5,000

\$125,000

OTHER COSTS

- GATES
- ACCESS STAIRS & HANDRAIL (\$15,000)
- ELEC/INST

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: DEC 1' 2015

CALCULATION SHEET

PREPARED BY: STEPHEN CLIFF

ELEMENT: PRIMARY TANK PIPING

• FUTURE SPLITTER STRUCTURE #1 => FUTURE PRIMARY CLARIFIERS

-> 50 LF 24" DIP * $255/LF = $12,750

• FUTURE PRIMARY CLARIFIER #1/#2 CONNECTED PIPING

-> 70 LF 24" DIP * $255/LF = $17,850

• FUTURE PRIMARY CLARIFIER #1/#2 => JUNCTION STRUCTURE #_

-> 80 LF 24" DIP * $255/LF = $20,400

• FUTURE PRIMARY CLARIFIER #1/2 => SLUDGE STORAGE TANK

-> 300 LF 6" DIP * $80/LF = $24,000

TOTAL PIPING ESTIMATE = $75,000

(2) 4FT SLUICE GATE @ SPLITTER BOX $4000/EA = $8000

⇓

30% INSTALL $2400 = $10,400

PRIMARY SETTLING TANK
ASSUME (2) 5 HP DRIVES (2 DUTY) = 10 HP
ASSUME (2) 20 HP SLUDGE PUMPS (1 DUTY/1 STANDBY) = 20 HP

GRAVITY THICKENER
ASSUME (1) 5 HP DRIVE = 5 HP
ASSUME (2) 20 HP SLUDGE PUMPS (1 DUTY/1 STANDBY) = 20 HP

Exeter, NH
Wastewater Treatment Facility Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: Primary Treatment (filter)

PREPARED BY: VE Team

Original Design Description: (Attach sketch if applicable)
At time of VE, no primary treatment is planned

Proposed Design Description: (Attach sketch if applicable)
As requested, VE examined the cost associated with installing primary treatment.
Consider the Salsnes filter technology, with the dewatering attachment, either in the preliminary treatment building or outside, to provide primary removal. Sludge would be dewatered with the incorporated dewatering device, thereby reducing the sludge stored in the SSTs. Note, this is a newer technology and pilot testing may be required.
Initial process modeling analysis indicates the potential to save 18% AT volume, 21% aeration and increase supplemental carbon by 13% (at annual average, design conditions - 3.0 mgd), while maintaining effluent quality, with primary treatment online (modeling assumed a 30% reduction in TSS and CBOD, and a 10% reduction in TKN)

Effluent		Current Design	Primary Treatment	% decrease
NH3	mgN/L	0.3	0.3	
NO3	mgN/L	0.8	0.9	
NO2	mgN/L	0.1	0.0	
TN	mgN/L	2.9	2.9	
Alk	mgCaCO3/L	66.5	82.0	
TSS	mg/L	5.6	5.5	
CBOD	mg/L	2.1	2.2	
Glycerol	gpd	40	45	-13%
Aeration	SCFM	1,867	1,467	21%
WAS	lb/d	3,566	2,163	39%
Tank Volume	MG	0.90	0.74	18%

Sludge storage capacity would be increased to ~8.5 days (from 6 days), assuming the concentration of WAS remains consistent, which has implications to the analysis conducted looking at eliminating one of the two centrifuges.

Cost reduction for reduced length of AT aerobic zone (118' to 83'):

Base slab	242 CY @ $600/CY = $145,200
Walls	142 CY @ $1,000/CY = $142,000
Rock excavation	435 CY @ $80/CY = $34,800
Soil excavation	1,570 CY @ $13/CY = $20,410

New equipment could be placed in the preliminary treatment building by expanding the building approximately 500ft2 to accommodate the extra 300ft2 of equipment.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:
Lower loading on secondary treatment process
Reduced aeration tank size, and associated structural/civil work (reduced costs)
Protection for secondary treatment from FOG in the influent
Reduced aeration demand (reduced costs)

Disadvantages:
Additional primary treatment process offers more operational complexity
Increased supplemental carbon demand (and costs)
Piloting would require a delay to project schedule

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$ -	$ 110,230	$ 1,639,892
VE PROPOSAL	$ 1,197,090	$ 111,325	$ 2,853,272
SAVINGS	$ (1,197,090)	$ (1,095)	$ (1,213,380)

Present Worth Factor (P/A, 3%, 20) = 14.877

Cost Estimates

ITEM: Primary Treatment (filter)							
Prepared by: VE Team							
DATE:		ORIGINAL EST.			PROPOSED EST.		
ITEM	UNIT	QUANTITY	COST / UNIT	TOTAL COST	QUANTITY	COST / UNIT	TOTAL COST
Aeration energy	kwh/d	1657	$0.13	$215	1309.03	$0.13	$170
Supplemental Carbon	gpd	50	$1.73	$87	56.5	$1.73	$98
Unit enerrgy (assume 8hp, 2 filters online)	kwh/d	0	$0.13	$0	286.464	$0.13	$37
				$0			$0
TOTAL O&M (per day)				**$302**			**$305**
Salsnes Filter	unit			$0	3	$375,000	$1,125,000
Installation (of filter)				$0	3	$80,000	$240,000
Concrete (for filter pad)	yd			$0	12	$375	$4,500
						subtotal	***$1,369,500***
Aeration Tank concrete (presented as cost saved)							
Base slab	CY			$0	-242	$600	-$145,200
Walls	CY			$0	-142	$1,000	-$142,000
Rock excavation	CY			$0	-435	$80	-$34,800
Soil excavation	CY			$0	-1570	$13	-$20,410
				$0		***subtotal***	***-$342,410***
Headworks building expansion	ft2			$0	500	$340.00	$170,000
TOTAL CAPITAL				**$0**			**$1,197,090**

salsnes filter

Eco-Efficient Solids Separation

Benchmarking **water solutions**

THREE CRITICAL PROCESSES

In a Salsnes Filter system **SOLIDS SEPARATION, SLUDGE THICKENING and DEWATERING** are performed in one compact unit, removing, on average, **50% TSS, 20% BOD and producing drier sludge (20–30% DM).** A Salsnes Filter system provides primary treatment in a fraction of the footprint, at 30 – 60% lower capital cost and with significantly lower total lifecycle costs when compared to conventional primary treatment. **What's more, sludge handling, transportation and disposal costs are drastically reduced.** Today, Salsnes Filter systems are installed around the world in a variety of applications within municipal wastewater treatment plants and in challenging industrial solids separation applications.

Cost-effective, compact, high-performing, chemical-free and sustainable – the Salsnes Filter system defines eco-efficient.

Seemingly Endless **Applications**

Municipal Wastewater Treatment

- Enhance primary treatment performance – without adding chemicals
- Solids separation upstream of secondary processes such as:
  - – Oxidation Ditches
  - – Sequencing Batch Reactors
  - – Biological Aerated Filters
  - – Dissolved Air Flotation
  - – Moving Bed Bio Reactors
  - – Membrane Bio Reactors
- Primary treatment for new plants
- Grit removal after a coarse screen
- Increase primary or secondary process capacity
- Plant expansion where land is expensive or unavailable
- Dig-free, concrete-free solution for mountainous or earthquake-prone areas
- Combined sewer overflow (CSO) treatment
- Stormwater treatment

Industrial Wastewater Treatment

- Aquaculture
- Tanneries
- Pulp & paper
- Slaughterhouses
- Food processing
- Breweries and wineries

All The **Flexibility** You Need

With both Enclosed and Open modular systems, unlimited design flow capacity and the option to install indoors or outdoors, a Salsnes Filter system provides all the flexibility you need.

SF systems are free-standing and enclosed

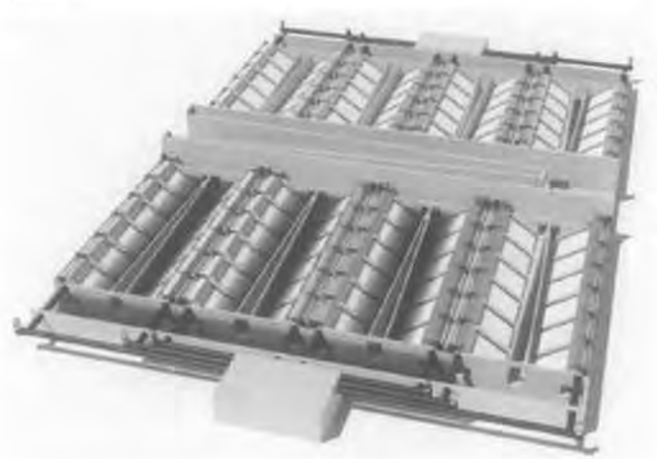

SFK systems are open for concrete channel installation

Filtermesh & Cogwheel Design

The filtermesh is made of polyethylene and is very durable. The way it's mounted and tensioned to the cogwheel is patented - it improves performance and allows the filter to handle higher flow rates and solids loadings, increasing treatment capacity in a smaller footprint.

Unlimited Design Flow Capacity

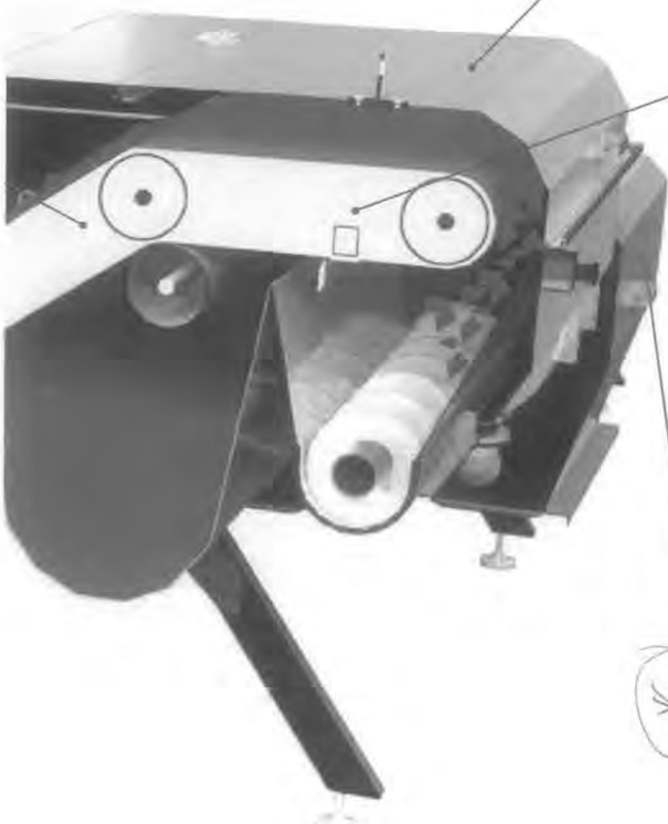
The modular design of the Salsnes Filter system allows for installation configurations to serve any capacity requirement. Filters can perform together as one, sharing components such as the blower for the Air Knife filtermesh cleaning system.



The Agua Prieta WWTP in Guadalajara, Mexico arranged filters (as shown above) to treat 350 MGD (55,200 m^3/h) of wastewater using only 10,550 ft^2 (980 m^2) of land. Primary settling tanks would have needed 215,000 ft^2 (20,000 m^2) of land.

Control Power Panel (CPP)

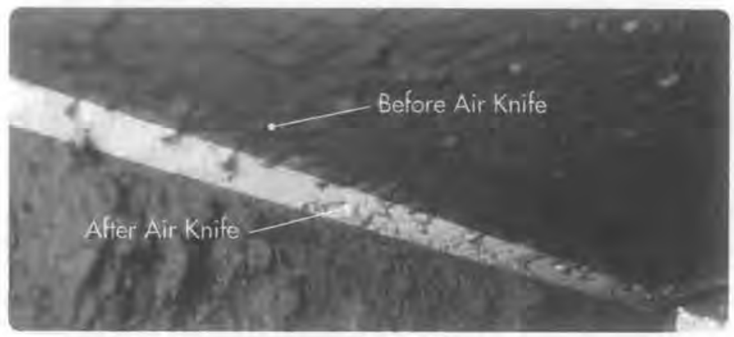
The CPP houses a Programmable Logic Controller (PLC) that makes this a completely automated system, ideal for remote or unstaffed facilities. A water pressure sensor tells the unit when to rotate the filtermesh (and at what speed), while the PLC simultaneously starts the Air Knife and sludge screw press.



Quick Connects
Allow for fast and easy maintenance.

Access Hatch
Enables quick visual inspections of performance and internal components.

Air Knife
The Air Knife filtermesh cleaning system starts automatically when the mesh begins to rotate. It uses compressed air to clean, which has many benefits compared to scrapers, brushes or water-based cleaning systems. Air is gentler on the mesh (to elongate its life) and on particles (so they don't break into smaller pieces). Air cleaning also keeps sludge drier for more effective dewatering.



Integrated or Stand-alone Dewatering Unit
To save space and money, the enclosed SF system contains an optional integrated dewatering process. Sludge drops into the collection area from the thickening process at 3–8 % DM and is conveyed across the unit by an auger. It can then be fed to a sludge stabilization process (e.g. direct digester feed);

Or processed further through the dewatering unit to produce sludge that is 20–30% DM (without the need for any additional dewatering equipment).

For larger installations, a stand-alone dewatering unit is available to dewater sludge from multiple filters. It can apply a higher pressure to produce even drier sludge (20–40% DM typical).

Separation, Thickening and Dewatering - All in one compact unit.

① Wastewater enters the inlet chamber.

② The solids above the filtermesh create a "filter mat." The mat enhances separation performance as particles build-up on the mesh, creating progressively smaller holes that retain increasingly smaller particles.

③ Water that is filtered past the mesh exits through the outlet.

④ Wastewater influent rises to a certain level (measured by a sensor) and the filtermesh starts to rotate like a conveyor belt, transporting sludge and enabling the thickening process.

⑤ Gravity thickens the sludge to 3–8% DM.

⑥ Sludge drops into the collection area.

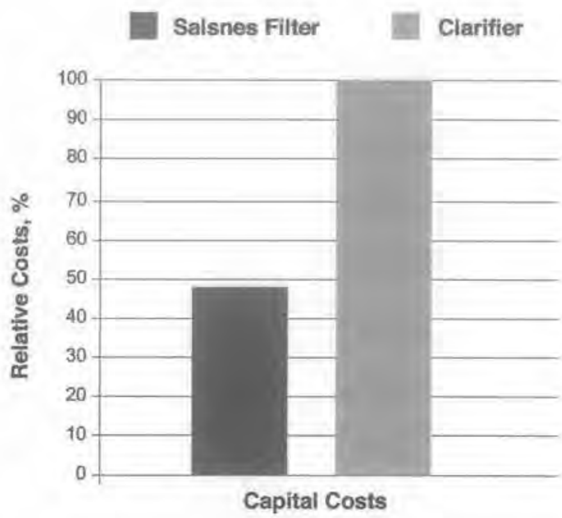
⑦ Using air (not water), the Air Knife automatic cleaning system removes any remaining sludge from the filtermesh into the collection area.

⑧ A screw press further dewaters the sludge to 20–30% DM before it exits the unit.

What Are The Overall **Cost** Benefits?

Compared To Conventional Primary Treatment, a Salsnes Filter System Can Offer:

- 30 – 60% lower investment cost. See **Figure 1**.
- 1/10th the land requirements. See **Figure 2**.
- Integrated thickening and dewatering
- The additional benefit of grit removal in the separation stage
- Significantly lower lifecycle costs
- Smaller volume of drier sludge that reduces disposal costs. See **Figure 3**.
- Less civil works (no concrete basins required)
- Equal to, or greater removal of TSS & BOD (on average 50% and 20% respectively)
- Smaller secondary/biological treatment processes (less aeration and/or space needed)
- Primary sludge with higher energy value
- Fully-automated equipment
- Fast and easy maintenance
- Lower operating costs (no chemicals to purchase)

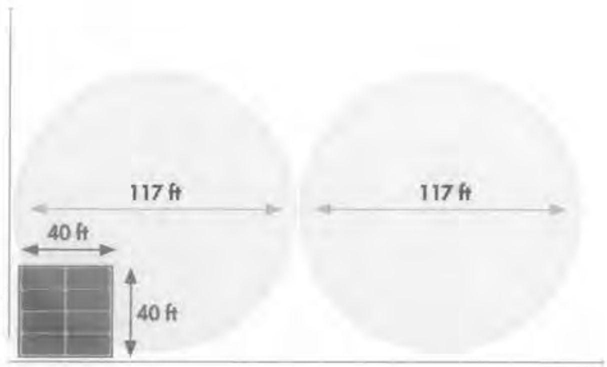


* Design load of 1.3 MGD (200 m^3/h) at 250 mg/l TSS

* Designed for average TSS removal of 65% for Salsnes Filter and 50% for primary clarifiers

Figure 1. Cost Comparison

The above evaluation was completed by the Norwegian State Pollution Control Agency to discover cost efficient technology that could fulfill the European Union's stringent criteria for primary treatment. As you can see, the savings are substantial. A Salsnes Filter system costs half that of conventional primary sedimentation and clarification.



Two clarifiers **vs** Eight SF:6000 Salsnes Filters

Figure 2. Land Requirements Comparison
Tomasjord WWTP, Norway - 10.5 MGD (1,650 m^3/h)

For those expanding primary or secondary capacity where land is expensive or unavailable, a Salsnes Filter system is ideal. It will typically use 1/10th the land of conventional treatment systems. The Tomasjord WWTP in Norway would have needed 21,530 ft^2 (2,000 m^2) of land to install clarifiers. Instead they installed a Salsnes Filter system and only used 1,600 ft^2 (150 m^2) of land.

Figure 3. Sludge Volume Comparison

The integrated thickening and dewatering processes of the Salsnes Filter system can drastically reduce sludge handling, transportation and disposal costs. The dry sludge exiting a Salsnes Filter system is 20–30% DM, while primary clarifier sludge can be 2% DM.

There Are Even **Environmental** Benefits

- Less CO_2 produced during construction and operation. See **Figure 4**.
- Less concrete for installation due to small footprint

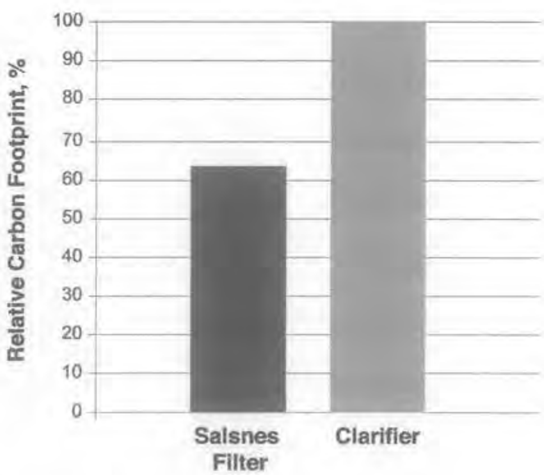


Figure 4. Carbon Footprint Analysis

This carbon footprint analysis compares the Salsnes Filter SF:6000 to a clarifier in a 2 MGD (315 m^3/h) municipal wastewater treatment plant in North America. It reveals that the Salsnes Filter system has a substantially lower environmental impact mainly because less concrete is required for installation.

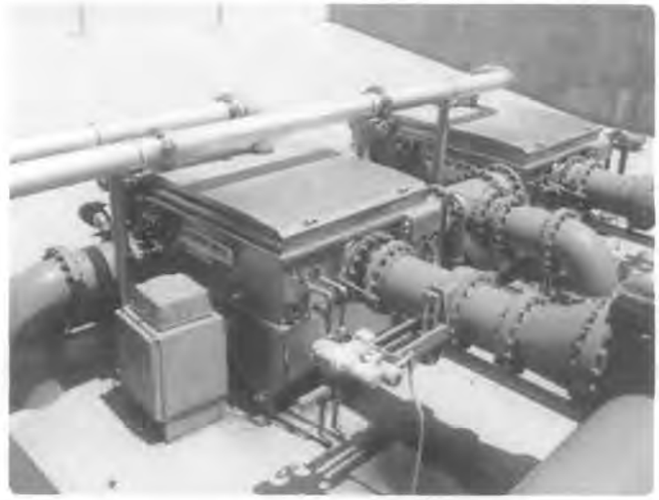
Clarifier	Carbon Footprint (kg CO_2e)
Making rebar, scrapers and concrete for tanks	195,033
Scraper replacement	98,495
Energy requirement (for scrapers, pumps and dewatering)	428,560
Total (20 years)	**722,088**

Salsnes Filter	Carbon Footprint (kg CO_2e)
Making chamber, filtermesh and building surrounding infrastructure	4,418
Filtermesh replacements	2,920
Energy requirement (for filtermesh, Air Knife and screw press)	452,720
Total (20 years)	**460,058**

Customer **Testimonials**

"Our real driver was to reduce the loading on the downstream processes, which was successfully accomplished."

– Ralph Martini, Plant Operator
Heyburn WWTP, Idaho, USA



"We are extremely pleased with the performance of our Salsnes Filter system. It has been reliable, easy to maintain and it has significantly reduced TSS and BOD loadings. This has enabled us to recover lost treatment capacity at our facility in a cost effective manner. Another plus is the small footprint of the system which allowed it to easily fit into a very limited space within our plant."

– Danny Lyndall, General Manager
Daphne Utilities, Daphne, AL

Our **Company**

Operating from Norway since 1991, we have focused on perfecting our solids separation filter technology through research, product development, testing, and quality initiatives. This focus and dedication has produced a highly efficient and reliable filter that maximizes solids separation, while dramatically decreasing costs including capital, operating, maintenance and land. With installations around the world and in a variety of municipal and industrial applications, the Salsnes Filter system is synonymous with eco-efficient solids separation technology.

Salsnes Filter is a brand in the Trojan Technologies group of businesses. www.salsnes-filter.com

About Trojan Technologies

The Trojan Technologies group of businesses offers products under the brands Aquafine, OpenCEL, Salsnes Filter, Trojan Marinex, TrojanUV, US Peroxide and VIQUA. Applications and markets served include municipal wastewater, drinking water, environmental contaminant treatment; ballast water treatment; residential water treatment; ultrapurification of water used in food and beverage manufacturing, pharmaceutical processing and semiconductor applications; filtration and solids separation.

Trojan Technologies has offices in the U.K., Canada, Germany, China, France, Australia, Italy, Spain, United Arab Emirates and the U.S. www.trojantechnologies.com

System Specifications

Model	SF:1000	SF:2000	SF:4000	SF:6000
Style	Enclosed, free-standing			
Material of Construction	316L Stainless Steel			
Weight (Dry)	914 lbs (415 kg)	1,521 lbs (690 kg)	2,248 lbs (1,020 kg)	2,469 lbs (1,120 kg)
Standard Electrical Voltages	480/277V 3 ph, 3 wire + gnd, 60 Hz 400/230V 3 ph, 3 wire + gnd, 50 Hz			
Operating Power Consumption (Design Dependent)	3.1 KW	4.3 KW	5.1 KW	6.1 KW
Accreditations (Electrical)	CE, UL, UL approved for Class 1 Div1			
Performance				
Maximum Hydraulic Flow	0.3 MGD (54 m^3/hr)	0.9 MGD (144 m^3/hr)	1.8 MGD (288 m^3/hr)	3.7 MGD (576 m^3/hr)
Treated Flow (Municipal Wastewater)	0.2 MGD (31 m^3/hr)	0.5 MGD (79 m^3/hr)	1.0 MGD (158 m^3/hr)	2.5 MGD (394 m^3/hr)
Maximum Head Loss	17" (440 mm)	12" (300 mm)	13" (330 mm)	14" (350 mm)
TSS Removal Efficiency	30 - 80% (design dependent)			
BOD Removal Efficiency	15 - 40% (design dependent)			
Sludge Dry Matter After Thickening	3 – 8%			
Sludge Dry Matter After Integrated Dewatering Unit	20 – 30%			
Sludge Dry Matter After Stand-alone Dewatering Unit	20 – 40%			
Dimensions				
Length x Width x Height (complete unit)	5 x 4.5 x 4.7' (1.4 x 1.3 x 1.4 m)	7 x 5.4 x 4.5' (2.1 x 1.6 x 1.3 m)	8 x 6.5 x 5' (2.5 x 2.0 x 1.5 m)	9.1 x 8.1 x 6' (2.8 x 2.5 x 1.8 m)
Inlet Diameter (pumped/gravity)	4" ANSI (100 mm DIN)	6" / 8" ANSI (150/200 mm DIN)	8" / 14" ANSI (200/350 mm DIN)	10" / 16" ANSI (250/400 mm DIN)
Outlet Diameter	6" ANSI (150 mm DIN)	10" ANSI (250 mm DIN)	14" ANSI (350 mm DIN)	16" ANSI (400 mm DIN)
Overflow Diameter	Combined with outlet			
Bottom Drain Diameter	N/A	4" ANSI (100 mm DIN)		
Water Connection	½" NPT (13 mm BSP)			¾" NPT (19 mm BSP) 1/2" NPT for UL Div1

Model	SFK:200	SFK:400	SFK:600
Style	Concrete open channel (by others)		
Material of Frame	316L Stainless Steel		
Weight	661 lbs (300 kg)	816 lbs (370 kg)	1,543 lbs (700 kg)
Standard Electrical Voltages	480/277V 3 ph, 3 wire + gnd, 60 Hz 400/230V 3 ph, 3 wire + gnd, 50 Hz		
Operating Power Consumption (Design Dependent)	4.3 KW	5.1 KW	6.1 KW
Accreditations (Electrical)	CE, UL, UL approved for Class 1 Div1		
Performance			
Maximum Hydraulic Flow	0.9 MGD (144 m^3/hr)	1.8 MGD (288 m3/hr)	3.7 MGD (576 m3/hr)
Treated Flow (Municipal Wastewater)	0.5 MGD (79 m^3/hr)	1.0 MGD (158 m^3/hr)	2.5 MGD (394 m^3/hr)
Head Loss	16" (400 mm)		
TSS Removal Efficiency	30 - 80% (design dependent)		
BOD Removal Efficiency	15 - 40% (design dependent)		
Sludge Dry Matter after Thickening	3 – 8%		
Sludge Dry Matter After Integrated Dewatering Unit	20 – 30%		
Sludge Dry Matter After Stand-alone Dewatering Unit	20 – 40%		
Dimensions			
Length x Width x Height (frame)	6.6 x 3.3 x 5' (2 x 1 x 1.5 m)	8 x 3.3 x 4.2' (2.4 x 1 x 1.3 m)	8 x 5.9 x 5.9' (2.4 x 1.8 x 1.8 m)
Overflow	Arranged in channel wall		
Water Connection	½" NPT (13 mm BSP)		¾" NPT (19 mm BSP) 1/2" NPT for UL Div1

salsnes Filter

Salsnes Filter AS, Verftsgt. 11
7800 Namsos, Norway

North America: T. 519.457.3400 F. 519.457.3030
Europe: T. +47 74 27 48 60 F. +47 74 27 48 59

www.salsnes-filter.com

VE RECOMMENDATION

PROJECT ELEMENT: Primary Sludge Fermentation

PREPARED BY: Sarah Galst

Original Design Description: (Attach sketch if applicable)
At time of VE, no primary tanks are planned

Proposed Design Description: (Attach sketch if applicable)
If primary treatment process is constructed (see separate analysis), consider primary sludge fermentation to recover carbon for use with denitrification. This may offset the need for supplemental carbon.

PRIMARY SLUDGE FERMENTATION CALCULATION				*Source*
	COD content of PS ferm	0.125	lb rbCOD/lb PS VSS	*Assumed*
Inf VSS Load	Existing ann avg	2156	lbVSS/d	*Tables 2 and 7, memo: Updates to Design Loads, August 26, 2015*
	Ann Avg (design)	5000	lbVSS/d	
	Max Mo (design)	6525	lbVSS/d	
	Assumed PST Removal	30%		*Assumed*
Carbon from primary sludge fermentation	Existing ann avg	81	lb rbCOD	
	Ann Avg (design)	188	lb rbCOD	
	Max Mo (design)	245	lb rbCOD	
	Micro C 2000 Carbon content	1,040,000	mgCOD/L	*from MicroC website*
Carbon demand (from WP estimates)	Existing ann avg	50	gpd	*from supplemental alk and C systems memo, pg 9**
	Ann Avg (design)	130	gpd	
	Max Mo (design)	230	gpd	
COD demand	Existing ann avg	434	lbCOD/d	
	Ann Avg (design)	1128	lbCOD/d	
	Max Mo (design)	1996	lbCOD/d	
Supplemental carbon still required	Existing ann avg	353	lbCOD/d	
	Ann Avg (design)	941	lbCOD/d	
	Max Mo (design)	1752	lbCOD/d	

**Can be updated if modeling results change based on client input, further refinement, or incorporation of VE comments*

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:
Reduce supplemental carbon needs

Disadvantages:
New system required, including odor control. Calculations do not indicate that primary sludge can offset all supplemental carbon - **NOT RECOMMENDED.**

Present Worth Factor (P/A, 3%, 20) = 14.877

Exeter, NH
Wastewater Treatment Facility Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: Construction re-Sequencing

PREPARED BY: Sarah Galst

Original Design Description: (Attach sketch if applicable)
Construction to be phased as follows:

- Step 1: Construction of WWTP
- Step 2: Main pump station upgrade, Forcemain/Watermain (concurrent with Step 1)
- Step 3: Decomission Lagoon 1, construct EQ basin (subsequent to Steps 1/2)
- Step 4: Decommission Lagoon 2 and 3 (subsequent to Step 3)

The current schedule is behind by ~6 months according to the VE informational presentation.

Proposed Design Description: (Attach sketch if applicable)
Utilize existing piping to decommission Lagoon 1, construct EQ basin concurrent with Steps 1 & 2
Sufficient detention time exists ***in summer only*** to send flow to Lagoons 2 and 3, under current average flows.

			Detention time per Lagoon (d)			
			Flow (mgd)			
	Volume		*1.7*	*3*	*4.5*	*6.6*
Lagoon 1	26	MG	*15.3*	*8.7*	*5.8*	*3.9*
Lagoon 2	27	MG	15.9	9.0	6.0	4.1
Lagoon 3	23.4	MG	13.8	7.8	5.2	3.5

Lagoon 2+3 detention time **29.6**

Influent BOD	200
Effluent BOD	30
Removal (E, as percent)	85
K1 (winter)	0.06 1/d
K1 (summer)	0.12 1/d
Detention time*	t = E/2.3k1(100-E)
Detention time (winter)*	41.1 d
Detention time (summer)*	20.5 d

*detention time calculated consistent with NEW HAMPSHIRE CODE OF ADMINISTRATIVE RULES, Env-Wq 713.08

Note, NEW HAMPSHIRE CODE OF ADMINISTRATIVE RULES states "There shall be a minimum of 3 separate cells. Baffles may be used to create up to 2 cells in one lagoon" in Env-Wq 713.08 Aerated Lagoon Design: General Requirements. If this proposed construction sequence is desired, Exeter must request a variance from New Hampshire DES to allow for 2-Lagoon operation in the summer months. Construction of Step 3 would then occur in the summer of 2018 (at the end of Steps 1 and 2).

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:
Schedule is recovered to bring project back on track

Disadvantages:
Variance must be requested
Step 3 must be constructed in summer months

NOTE: No cost estimate was performed, as this recommendation would only recover time. There is the potential to avoid fees for missed deadlines if the regulatory body assigns fees to late/missed milestones.

Present Worth Factor (P/A, 3%, 20) = 14.877

Exeter, NH
Wastewater Treatment Facility Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: Aeration Tank Diffusers and Mixers (Narrative)

PREPARED BY: Sarah Galst

Original Design Description: (Attach sketch if applicable)
9-inch EPDM membrane disks used for diffused aeration
Hyperboloid mixers used for mixing in anoxic and swing zones

Proposed Design Description: (Attach sketch if applicable)
VE was requested to provide input on diffuser and mixer selection. Given the priority of items selected for more detailed evaluation, a narrative opinion is provided here.

Diffusers:
VE was requested to provide input on diffuser selection as it compares to SSI Teflon-membrane diffusers. There is no apparent reason for Teflon unless there is a unique wastewater quality (i.e. petroleum discharge). Recommend maintaining current design and using the industry standard for the anticipated municipal wastewater.

Mixers:
VE was requested to provide input on mixer selection as it compares to big bubble mixing systems. Big bubble will be more cost effective in a larger, more square tanks, however the geometry of the anoxic/swing cells in this application are not idea for big bubble mixing. Big bubble is not recommended.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:

Disadvantages:

NOTE: See attached calculations for details

Present Worth Factor (P/A, 3%, 20) = 14.877

Exeter, NH
Wastewater Treatment Facility Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: UV disinfection system

PREPARED BY: Sarah Galst, Stephen Cluff

Original Design Description: (Attach sketch if applicable)
A low pressure, high output UV disinfection system will be constructed in half of the existing Chlorine Contact Tank. A ventilated building will be constructed around the UV disinfection system for year-round operation. The UV system will be connected to the WWTP's standby power source and the control panel will be equipped with an uninterruptible power supply. Instrumentation (level, flow, turbidity), controls and SCADA connectivity for the UV disinfection system will be provided. This system was assigned a cost of $1,056,506 in the original WP design.

Proposed Design Description: (Attach sketch if applicable)
Eliminate UV System, retain CCT and current disinfection facilities

Replace instrumentation to assist with potential over-dosing of chemicals

Existing chlor/dechlor pumps appeared to be in good working order at site inspection (VE was told that they were recently replaced), so it is recommended that the double walled piping be replaced between the existing storage facility and the CCT (assumed 700 ft run). Total pipe calculated as:
700 ft *2 runs*2 systems = 2800 ft

Chemical use assumed to remain consistent with current use of 336 gall/wk of 12.5% hypo and 42 gall/wk of 38% bisulphite

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:
Significant cost savings
Increased reliability with new instrumentation

Disadvantages:
Chemicals remain on-site
Operationally intensive
Potential for chemical over/under-dose

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$ 1,056,506.00	$ 64,240.00	$ 2,012,204.48
VE PROPOSAL	$ 189,280.00	$ 27,010.00	$ 591,107.77
SAVINGS	$ 867,226.00	$ 37,230.00	$ 1,421,096.71

Present Worth Factor (P/A, 3%, 20) = 14.877

Cost Estimates

ITEM: UV disinfection system							
Prepared by: Sarah Galst, Stephen Cluff							
DATE:		ORIGINAL EST.			PROPOSED EST.		
ITEM	UNIT	QUANTITY	COST / UNIT	TOTAL COST	QUANTITY	COST / UNIT	TOTAL COST
Energy (Power Consumption at Average Flow, 17.16 kW)	kwh/d	411.84	$0.13	$54	0	$0.13	$0
Sodium Hypochlorite	gpd	0	$1.36	$0	14.3	$1.36	$19
Sodium Bisulphite	gpd	0	$1.50	$0	6.0	$1.50	$9
UV lamps **($333/lamp every 13000 hrs) - see trojan quote**	lamp	200	$0.61	$123	0	$0.05	$0
TOTAL O&M				**$176**			**$28**
UV associated Process	unit	1	$629,000	$629,000	0		$0
UV associated Arch	unit	1	$78,000	$78,000	0		$0
UV associated Structural	unit	1	$110,000	$110,000	0		$0
UV associated Electrical	unit	1	$152,000	$152,000	0		$0
UV associated Instrumentation	unit	1	$87,506	$87,506	0		$0
				$0	0		$0
TRC probe and analyzer + 40% installation	unit	0	$6,440	$0	2	$6,440	$12,880
double-walled piping	ft	0	$63.00	$0	2800	$63.00	$176,400
				$0			$0
				$0			$0
				$0			$0
				$0			$0
				$0			$0
TOTAL CAPITAL				**$1,056,506**			**$189,280**

TROJAN UV3000PLUS™

COMMERCIAL INFORMATION

Total Capital Cost: $439,500 (US$)

This price excludes any taxes that may be applicable and is valid for 90 days from the date of this letter.

OPERATING COST ESTIMATE

Operating Conditions

Average Flow: **1.7 US_MGD**
Yearly Usage: **8750 hours - assumed**
UV Transmittance: **65% - assumed**

compare to Ozonia quote of $25

Power Requirements		Lamp Replacement	
Average Power Draw:	**11.9 kW**	Number lamps per year:	**41**
Cost per kW hour:	**$0.05**	Price per lamp:	**$333**
Annual Power Cost:	**$5,206**	**Annual Lamp Replacement Cost:**	**$13,653**
Total Annual O&M Cost: $18,859			

This cost estimate is based on the average flow and UV transmittance listed above. Actual operating costs may be lower due to the TrojanUV3000Plus™ automatic dose pacing control system. As UV demand decreases, by a change in operating conditions, the power level of the lamps decreases accordingly. The dose pacing system minimizes equipment power levels while the target UV dose is maintained to ensure disinfection at all times.

EQUIPMENT WARRANTEES

1. Trojan Technologies warrants all components of the system (excluding UV lamps) against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, which ever comes first.
2. UV lamps purchased are warranted for 12,000 hours of operation or 3 years from shipment, whichever comes first. The warranty is pro-rated after 9,000 hours of operation. This means that if a lamp fails prior to 9,000 hours of use, a new lamp is provided at no charge.
3. Electronic ballasts are warranted for 5 years, pro-rated after 1 year.

Exeter, NH
Wastewater Treatment Facility Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: Eliminate one dewatering centrifuge

PREPARED BY: Sarah Galst, Stephen Cluff

Original Design Description: (Attach sketch if applicable)
Dewatering of sludge will be by two centrifuges, two sludge feed pumps feeding sludge to the centrifuges, and two polymer make-down systems.

Proposed Design Description: (Attach sketch if applicable)
NH regulations require "where undigested or partially digested sludge is to be centrifuged, duplicate centrifuges should be provided unless **nuisance-free storage** of sludge is provided". If 6-8.5 days (8.5 days of storage could be realized by incorporating a primary treatment with separate primary sludge dewatering - see separate analysis for "Primary Treatment (filter)") of sludge storage can be considered "nuisance-free", then there is an opportunity to postpone/cancel installation of the second, backup, centrifuge. For this evaluation, dewatering of sludge will be by one centrifuge, one sludge feed pump feeding sludge to the centrifuge, and one polymer make-down system. Piping was reduced by one-third.

Option 1: If this option is implemented, non-dewatered sludge can be hauled off site at a cost of ~$100/1000 gall as an emergency option for disposal.
Option 2: A second option could be to increase the storage volume in the sludge storage tanks. This analysis looked at doubling the volume of the sludge storage tanks.

A cost evaluation was done considering a need to haul sludge offsite 2 weeks each year to accommodate extended periods of offline equipment *(Option 1)*.

Calculation	sludge lb/d	WAS mg/L	Sludge to be hauled gall/d	Total for 1 week gall
Avg (design, 3.0 mgd)	3600	10000	43100	301700
			Total for gall 2 weeks:	603400
			Total 1000gall for 2 weeks:	603.4

Alternatively , the sludge storage tanks can be doubled in volume to eliminate/minimize the sludge hauling fee *(Option 2)*. This alternative was also costed out, but was determined to cost more than the current design. **NOT RECOMMENDED FOR FURTHUR CONSIDERATION**

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:	Disadvantages:
Cost	No redundancy for dewatering 1. Repairs must be made within the sludge storage HRT (6-8.5 days, depending on primary treatment) to avoid paying higher hauling costs OR 2. the SST volume must be increased to provide longer storage time

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY		INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
	ORIGINAL DESIGN	$ 1,175,000.00	$ -	$ 1,175,000.00
Increased hauling $	VE PROPOSAL	$ 593,335.00	$ 60,000.00	$ 1,485,955.00
	SAVINGS	$ 581,665.00	$ (60,000.00)	$ (310,955.00)
Increased SST vol.	VE PROPOSAL	$ 2,049,335.00	$ 101,835.00	$ 3,564,334.30
	SAVINGS	$ (874,335.00)	$ (101,835.00)	$ (2,389,334.30)

Present Worth Factor (P/A, 3%, 20) = 14.877

HAZEN AND SAWYER
Environmental Engineers & Scientists

Aeration for Increased SST Volume

Date ______ of ______
By ______ Chkd. ______
Job ______

Current SST Volume 300,000 gall
Proposed SST Volume 600,000 gall
Assumed air demand 40 SCFM/1000 ft^3
= 0.00535 SCFM/gall

600,000 gall × 0.00535 SCFM/gall = 3200 SCFM
Use 4 800 SCFM blowers (consistent with current design)

Each specified blower is 60 hp
Add'l energy req'd:

= 2 blowers × 60 hp × 0.746 kw/hp × 24 hr/d
= 2150 kWh

Exeter, NH
Wastewater Treatment Facility Upgrade Design
V.E. Workshop

December 7-11, 2015

Cost Estimates

ITEM: Eliminate one dewatering centrifuge							
Prepared by: Sarah Galst and Stephen Cluff							
DATE:		ORIGINAL EST.			PROPOSED EST.		
ITEM	UNIT	QUANTITY	COST / UNIT	TOTAL COST	QUANTITY	COST / UNIT	TOTAL COST
OPTION 1: INCREASED HAULING							
Hauling cost	$/1000gall	0	$100.00	$0	600	$100.00	$60,000
TOTAL O&M per year				**$0**			**$60,000**
OPTION 2: INCREASED SST VOLUME							
Aeration Energy	kwh	0	$0.13	$0	2148.48	$0.13	$279
TOTAL O&M per day				**$0**			**$279**
CENTRIFUGE COSTS							
SLUDGE FEED PUMPS	unit	2	$23,400	$46,800	1	$23,400	$23,400
SLUDGE GRINDERS	unit	2	$15,600	$31,200	1	$15,600	$15,600
CENTRIFUGE & CONTROLS	unit	2	$480,000	$960,000	1	$480,000	$480,000
PIPING	LS	1	$30,000	$30,000	0.6667	$30,000	$20,001
POLYMER MAKEUP SYSTEM	unit	2	$51,000	$102,000	1	$51,000	$51,000
PIPING	LS	1	$5,000.00	$5,000	0.6667	$5,000	$3,334
TOTAL CAPITAL				**$1,175,000**			**$593,335**
OPTION 2: INCREASED SST VOLUME							
CENTRIFUGE COSTS (from above)				$1,175,000			$593,335
Increased SST (cost shown is the addition $ for doubled volume, see attached for details)					1	$886,000	$886,000
TOTAL CAPITAL				**$1,175,000**			**$1,479,335**

Sludge Storage Tanks (Double Size)

Civil	N/A	
Structural	$ 780,000	Includes "Civil" as soil excavation and rock ledge excavation are included
Ledge	$ 103,085	
Process	$ 189,000	
	$1,072,000	

	W	L	H		Volume	Gallons	Total Gallons (2 Tanks)	
Current	25.5	50	20		25500	190,740		
	25.5	50	18	Useable	22950	171,666	343,332	PDR Notes 300,000
								Target Factor (2.0)
Revised	38	70	18		47880	358,142	716,285	2.086

Structural	Quantity (PDR Costs)	Unit	Unit Cost	Total Cost	1 Tank Basis				
Base Slab	275	cy	$ 600	$165,000	$ [illegible]	$ 172,118			
Tank Wall	320	cy	$ 1,000	$320,000	$ 1,060	$ 228,874			
Structural Slab	130	cy	$ 1,200	$156,000	$ 61	$ 162,729			
Beam	15	cy	$ 1,500	$ 22,500	$ 75	$ 16,093			
Concrete Fill	60	cy	$ 300	$ 18,000	$ 7	$ 18,776			
PVC Waterstop	270	lf	$ 15	$ 4,050	$ 13	$ 2,897			
Aluminum Guard	220	lf	$ 100	$ 22,000	$ 73	$ 15,735			
Aluminum Stairs	8	lf	$ 1,000	$ 8,000		$ 16,000			
Excavation	772.6	cy	$ 13	$ 10,044	$ [illegible]	$ 10,477			
Ledge	1289	cy	$ 80	$103,120	$ 40	$ 107,568			
Structural Fill	500	cy	$ 25	$ 12,500	$ 41	$ 8,940			
General Fill	3200	cy	$ 13	$ 41,600	$ 138	$ 29,754	*For 2 Tanks*		
						$ 789,962	*$*	***1,579,923***	Structural
					Area Based Factor		**$**	**378,000**	Process (assume doubles)
					Perimeter Based Factor		$	1,958,000	Total Cost to Double SSTs

Cost Estimates

ITEM: Eliminate one dewatering centrifuge							
Prepared by: Sarah Galst and Stephen Cluff							
DATE:		ORIGINAL EST.			PROPOSED EST.		
ITEM	UNIT	QUANTITY	COST / UNIT	TOTAL COST	QUANTITY	COST / UNIT	TOTAL COST
OPTION 1: INCREASED HAULING							
Hauling cost	$/1000gall	0	$100.00	$0	600	$100.00	$60,000
TOTAL O&M per year				**$0**			**$60,000**
OPTION 2: INCREASED SST VOLUME							
Aeration Energy	kwh	0	$0.13	$0	2148.48	$0.13	$279
TOTAL O&M per day				**$0**			**$279**
CENTRIFUGE COSTS							
SLUDGE FEED PUMPS	unit	2	$23,400	$46,800	1	$23,400	$23,400
SLUDGE GRINDERS	unit	2	$15,600	$31,200	1	$15,600	$15,600
CENTRIFUGE & CONTROLS	unit	2	$480,000	$960,000	1	$480,000	$480,000
PIPING	LS	1	$30,000	$30,000	0.6667	$30,000	$20,001
POLYMER MAKEUP SYSTEM	unit	2	$51,000	$102,000	1	$51,000	$51,000
PIPING	LS	1	$5,000.00	$5,000	0.6667	$5,000	$3,334
TOTAL CAPITAL				**$1,175,000**			**$593,335**
OPTION 2: INCREASED SST VOLUME							
CENTRIFUGE COSTS (from above)				$1,175,000			$593,335
Increased SST (cost shown is the addition $ for doubled volume, see attached for details)					1	$886,000	$886,000
TOTAL CAPITAL				**$1,175,000**			**$1,479,335**

Sludge Storage Tanks (Double Size)

Civil	N/A	
Structural	$ 780,000	Includes "Civil" as soil excavation and rock ledge excavation are included
Ledge	$ 103,085	
Process	$ 189,000	
	$1,072,000	

	W	L	H		Volume	Gallons	Total Gallons (2 Tanks)	
Current								
	25.5	50	20		25500	190,740		
	25.5	50	18	Useable	22950	171,666	343,332	PDR Notes 300,000 Target Factor (2.0)
Revised	38	70	18		47880	358,142	716,285	2.086

	PDR Costs							
Structural	Quantity	Unit	Unit Cost	Total Cost	1 Tank Basis			
Base Slab	275	cy	$ 600	$165,000	$ 65	$ 172,118		
Tank Wall	320	cy	$ 1,000	$320,000	$ 1,060	$ 228,874		
Structural Slab	130	cy	$ 1,200	$156,000	$ 61	$ 162,729		
Beam	15	cy	$ 1,500	$ 22,500	$ 75	$ 16,093		
Concrete Fill	60	cy	$ 300	$ 18,000	$ 7	$ 18,776		
PVC Waterstop	270	lf	$ 15	$ 4,050	$ 13	$ 2,897		
Aluminum Guard	220	lf	$ 100	$ 22,000	$ 73	$ 15,735		
Aluminum Stairs	8	lf	$ 1,000	$ 8,000		$ 16,000		
Excavation	772.6	cy	$ 13	$ 10,044	$ 4	$ 10,477		
Ledge	1289	cy	$ 80	$103,120	$ 40	$ 107,568		
Structural Fill	500	cy	$ 25	$ 12,500	$ 41	$ 8,940		
General Fill	3200	cy	$ 13	$ 41,600	$ 138	$ 29,754	***For 2 Tanks***	
						$ 789,962	***$ 1,579,923***	Structural
				Area Based Factor			**$ 378,000**	Process (assume doubles)
				Perimeter Based Factor			**$ 1,958,000**	**Total Cost to Double SSTs**

Exeter, NH
Wastewater Treatment Facilty Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: Evaluate Alternative Solids Handling and Disposal

PREPARED BY: Stephen Cluff

Original Design Description: (Attach sketch if applicable)

Original design provides for equipment and facilities to dewater sludge using centrifuge technology.

Proposed Design Description: (Attach sketch if applicable)
Evaluated alternative life cycle cost benefit of hauling average 6% gravity belt thickened sludge.
Gravity belt thickeners have shown to have lower life cycle costs due to the less energy demand in some instances.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:	Disadvantages:
Potential Cost Savings	Lower % Solids

Annual Comparison

Cost of hauling average 6% thickened sludge: $\frac{739 \text{ Dry Ton} \times 100}{6.00\%} =$ 12,316 Wet Tons

12,316 Wet Tons X $100/Wet Ton = $1.23 Million/Yr

Centrifuge Annual Energy and Solids Disposal from October 2015 PDR

Annual O&M Costs	
1) Annual Energy Cost	
Total Connected Operating Horsepower (HP)	**200**
% of Connected HP as Operating HP	75%
Operating HP	150
KW/HP	0.746
Total capacity (lb/hr) - @ 0.75% solids	1,816
Hours of Operation/year (Design Avg)	814
Total KWH/Yr	161,889
Electricity Cost ($/KWH)	$0.14
Annual Energy Cost	**$23,000**
2) Disposal and Transportation Cost (Design Avg)	
Total Dry Solids (ton/year)	739
Expected Cake Solids	19%
Sludge Qty (Wet Tons/yr)	3,890
$/Wet Ton	$100
Annual Disposal Cost	**$390,000**

Cost savings proposal was withdrawn from further consideration due to high cost of hauling 6% thickened sludge and insignificant energy cost savings compared to 19% centrifuge dewatered sludge.

CIVIL / SITE

Exeter, NH
Wastewater Treatment Facilty Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: Site Layout Redesign

PREPARED BY: J. Cass (Hazen and Sawyer)

Original Design Description: (Attach sketch if applicable)
Two site layout alternatives were provided in the Wright-Pierce PDR, herein referred to as Original Layout and Alternative A Layout. All Alternatives place the new WWTP in the Sludge Thickening Lagoon (Lagoon 4), and use Lagoon 1 as Equalization Basins.

The Orignal Layout places the Headworks building, future Primary Clarifiers, and BNR tanks on the north side of Lagoon 4. The Sludge Handling Building, Sludge Storage Tanks, Generator, and (three) Secondary Clarifers are in the middle section of Lagoon 4. Space is accomodated for one additional future Secondary Clarifier. The Snow Dump is placed to the south side of Lagoon 4, overlapping the existing Snow Dump Location.This configuration uses a perimeter road and one West-East road between the Headworks-BNR Tank area and the Sludge Handling-Secondary Clarifiers area, Stormwater features, possibly biorention cells, are placed throughout the facilities, with one larger pond placed in Lagoon 3. The Maintenance Building is placed on the west side of the site, and Materials Storage areas are placed on the south side of the site.
Issues encountered with this site layout include high rock (ledge) and soil excavation.

Alternative "A" layout places the Headworks building on the west side. Future Primary Clarifiers are placed north of the Headworks building in the norhwest area; the BNR tanks are placed in a north-south configuration on the northeast area; (three) Secondary Clarifiers are placed in a triangular arrangement in the southeast area; and the Sludge Handling Building, Sludge Storage Tanks and Generator are located in the southwest area. No space is accomodated for an additional Secondary Clarifier. This configuration uses a road teeing in one direction dead ending to the BNR tanks and in the other direction looping to the south around the Sludge Facilities and east around the Secondary Clarifiers and BNR tanks. Stormwater features, possibly biorention cells, are placed throughout the facilities, with one larger pond placed in Lagoon 3. The Maintenance Building and Materials Storage areas are provided adjacent to each other on the north side of the site. It is not clear where the Snow Dump area is provided in this layout.
According to the PDR, this site layout saves approximately $500,000, which is assumed to be from less rock and soil excavation. However, it does not leave room for future expansion of the Secondary Clarifers and impedes efficient traffic flow.

Proposed Design Description: (Attach sketch if applicable)
The layout proposed herein is referred to as Alternative B.
For the most part, this layout is similar to the Original Layout but all facilities are shifted to the south side of the site and the Snow Dump area is pushed to the north side of Lagoon 4.. All stormwater treatment facilities are proposed to be placed in Lagoon 4 in the form of a constructed wetland. The Maintenance Building, Materials Storage area, and Vactor Debris are placed in the southeast part of Lagoon 4.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN (Alternative B):

Advantages:	Disadvantages:
Reduces rock excavation	Requires relocation of Snow Dump area
Maintains original building arrangement (in different location)	Places Headworks further away from Equalization Basin
Increases area for Snow Dump	
Reduces excavation needed for stormwater treatment	Places Secondary Clarifiers further away from disinfection and outfall facilities
Reuses Lagoon 1 and existing outfall facilities	

Cost savings includes earth and rock cut and fill associated with building layout - impacts to piping and roadway costs are not included.

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$ 1,617,303	-	$ 1,617,303
VE PROPOSAL	$ 1,058,949	-	$ 1,058,949
SAVINGS	$ 558,354	$ -	$ 558,354

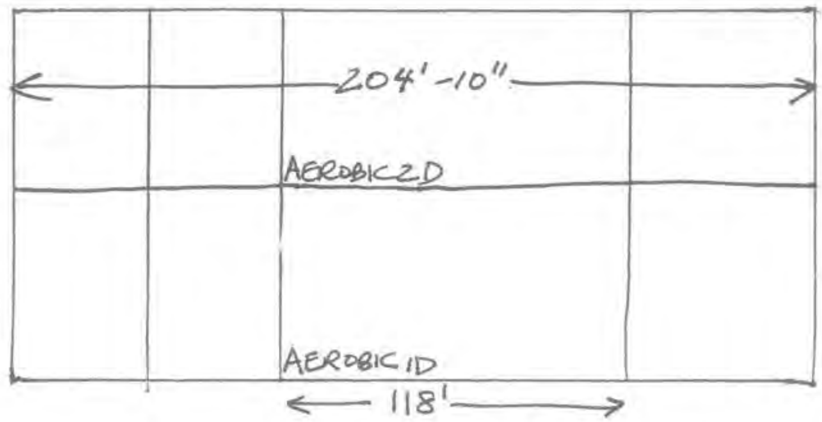
EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/10/15

CALCULATION SHEET

PREPARED BY: J. Cass

ELEMENT: BNR Tank Sizing



AEROBIC "D" LENGTHS TO BE REDUCED BY 30%

∴ 118' * (.30) = 35.4' ≈ 35'-4"

118 - 35.4' = 82.6' say 83'

TOTAL BNR TANK SIZE REDUCED

204'-10" - 35'-4" = 169'-6"

Date: 12/9/15

CALCULATION SHEET

PREPARED BY: W.G.L. ELEMENT: EXCAVATION

p. 6 of 115 (PDR COST ESTIMATE)

W-P UNIT PRICE "LEDGE" EXCAVATION

SHB = 2,340 CY × \$80/CY = \$187,200
AT1#2 = 5,100 CY × " = \$408,000
SC (3) = 2,160 CY × " = \$172,800
SST = 1,000 CY × " = \$80,000
SITE PIPING = 200 CY (NEGLECT FOR ANALYSIS PURPOSES)

p. 18 of 115

SHB: 1,332 CY @ \$13 (EXCAVATION)
2,925 CY @ \$80 (LEDGE)

AT1#2: 5,923 CY @ \$13 (EXCAVATION)
6,355 CY @ \$80 (LEDGE)

p. 19 of 115

SC (3 TOTAL): 4,252 CY @ \$13 (EXCAVATION), 12,750 CY TOTAL
890 CY @ \$80 (LEDGE), 2,670 CY TOTAL

SST: 775 CY @ \$13 (EXCAVATION)
1,290 CY @ \$80 (LEDGE)

SITE PLAN ALT. B (VE TEAM DEVELOPED)

SST: BORING W-D (1980 EEI)
GRADE @ 17.0
ROCK @ 14.5 (2.5' BELOW GRADE, CONFIRMED PER EEI DRAWING SP-1B) FROM PDR

W-P DRAWINGS PR-33 & PR-34

INVERT @ 10.00 (18" SLAB)
BOT OF SLAB @ 8.50
6" STONE LAYER, BOT OF EXCATION @ 8.00

AVG EXIST GRADE @ SST
17.5 (VARIES 15 TO 20)

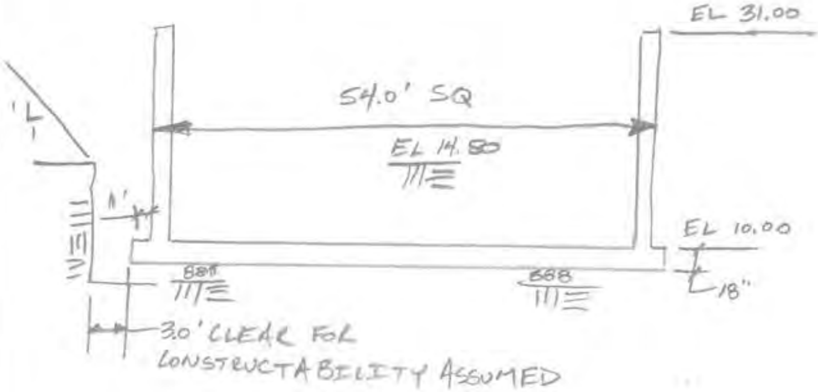
EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/9/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: EXCAVATION



ASSUME ROCK @ 14.5 OVER ENTIRE FOOTPRINT. CONSERVATIVE ASSUMPTION BASED ON ADJACENT BORINGS HA 15-6 (ROCK @ -12.0) W-4 (EEI 1980, ROCK @ 7.5)

AREA OF ROCK EXCAVATION = $(3'+1'+54'+1'+3')^2 = 3{,}844\ ft^2$

VOLUME " " " $= (3{,}844)(4.5'+1.5'+0.5')/27 = \underline{925\ CY}$ ROCK

← APPROX. EQUAL TO W-P QNTY OF 1,000 CY

SOIL EXCAVATION

VOLUME = $\frac{3(62')^2}{27} + \frac{4(62')(4.5ft^2)}{27}$ = 470 CY, SAY $\underline{\underline{500\ CY}}$ SOIL

IMPACT OF LOCATION ALT. B FOR SST:

- STRUCTURE APPEARS TO BEAR IN BEDROCK, SOUTH SIDE BEARING WOULD NEED CONFIRMATION BY ONE ADDITIONAL BORING
- ANTICIPATED BEARING PRESSURE = 1,500 TO 2,000 KSF
- ALLOWABLE FOR GLACIAL TILL = 16,000 KSF, OK
- " " BEDROCK = 20,000 KSF, OK

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/9/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: EXCAVATION

SOLIDS HANDLING BUILDING (SHB):

BORING HA15-6 - GRADE @ 23.5, ROCK @ -12.0 ✓
W-D (1980) - GRADE @ 17.0, ROCK @ 14.5 ✓
W-4 (1980) - GRADE @ 18.0, ROCK @ 7.5 ✓
W-4B (1980) - GRADE @ 18.0, ROCK @ ~~12.0~~ @ 11.0

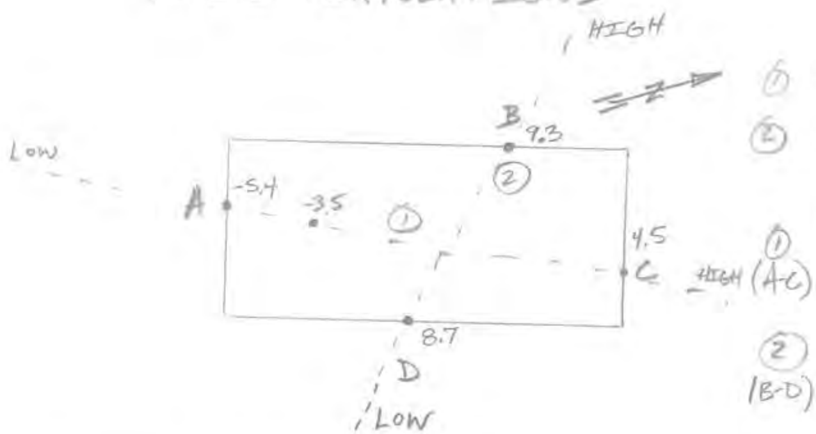
CONFIRMED PER EEI DRAWING SP-18 FROM PDR

EXISTING GRADE @ ±13.0 UNDER PROPOSED SHB FOOTPRINT

W-P DRAWINGS PR-29, 30 & 31

INVERT @ 8.00 (18" SLAB)
BOT OF SLAB @ 6.50
6" STONE LAYER, BOT OF EXCAVATION @ 6.00

ROCK INTERPOLATIONS



(1) HA15-6 TO W-D = 285'
(2) W-4 TO W-4B = 290'

(1) HIGH (A-C) $\frac{12.0 + 14.5}{285} = 0.093'/FT$ ROCK SLOPE

(2) (B-D) $\frac{11 - 7.5}{285} = 0.012'/FT$ ROCK SLOPE

POINT A: 71.0' FROM HA15-6

$-12.0 + (71)(0.093) = -5.4$ ESTIMATED ROCK @ PT. A

POINT B: 139' FROM W-4B

$11.0 + 139(-0.012) = 9.3$ ESTIMATED ROCK @ PT. B

POINT C: 108' FROM W-D

$14.5 - 108(0.093) = 4.5$ ESTIMATED ROCK @ PT. C

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/9/15

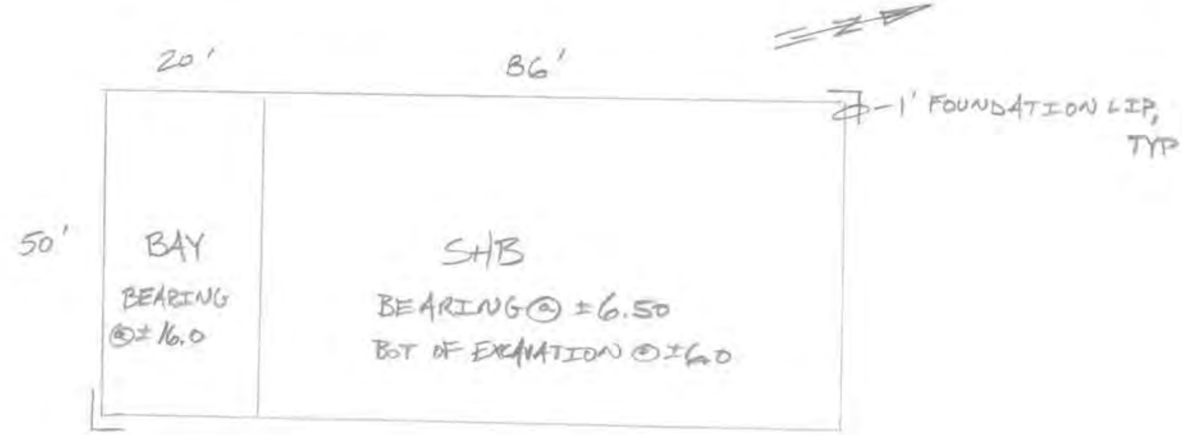
CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: EXCAVATION

POINT D: 102' FROM W-4

$7.5 + 102(0.012) = 8.7$ ESTIMATED ROCK @ PT. D



$\frac{9.3+8.7+4.5}{3} = 7.5$ AVERAGE ROCK ELEVATION NEGLECTING -3.5 @ SOUTH EDGE

VOLUME OF ROCK EXCAVATION $= (94')(58')(7.5-6.0)/27 = \underline{300}$ CY

(MUCH LESS THAN W-P QNTY OF 2,340 CY)

NO ROCK EXCAVATION @ CONTAINER BAY SINCE BEARING @ ±16.0

SOIL EXCAVATION

(13.0 / 7.5 — AREA = 15.1 ft²)

$VOLUME = (5.5')(94')(58')/27 + [2(94)+2(58)]\,15.1/27 = \underline{\underline{1,280}}$ CY

IMPACT OF LOCATION ALT. B FOR SHB

- NORTHERN ½ OF STRUCTURE LIKELY TO BEAR ON OR NEAR BEDROCK, OK
- ROCK APPEARS TO BE DROPPING BELOW BEARING OVER SOUTHERN ½, STRUCTURAL FILL MAY BE REQUIRED
- NEED TWO ADDITIONAL BORINGS IN PROPOSED SHB FOOTPRINT

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

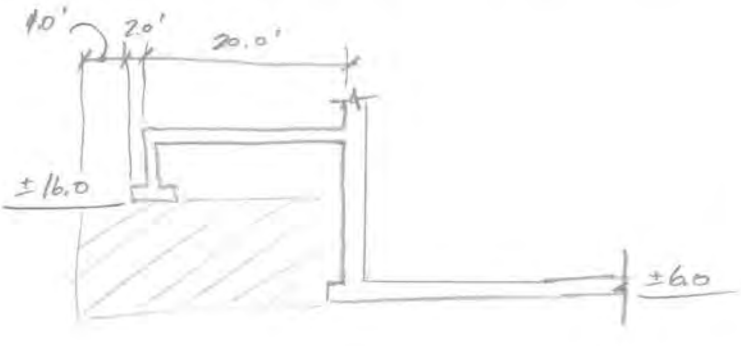
Date: 12/9/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: EXCAVATION

ESTIMATE SHB STRUCTURAL FILL FOR ALT. B SITE PLAN



** ASSUME MATERIAL BELOW 9.5 CAN SUPPORT SHB BASED ON BORING HA15-6

STRUCTURAL FILL

$$(26.0')(62.0')(10.0')/27 = 600 \text{ CY} @ \$25/\text{CY} = \$15{,}000$$

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V.E. WORKSHOP

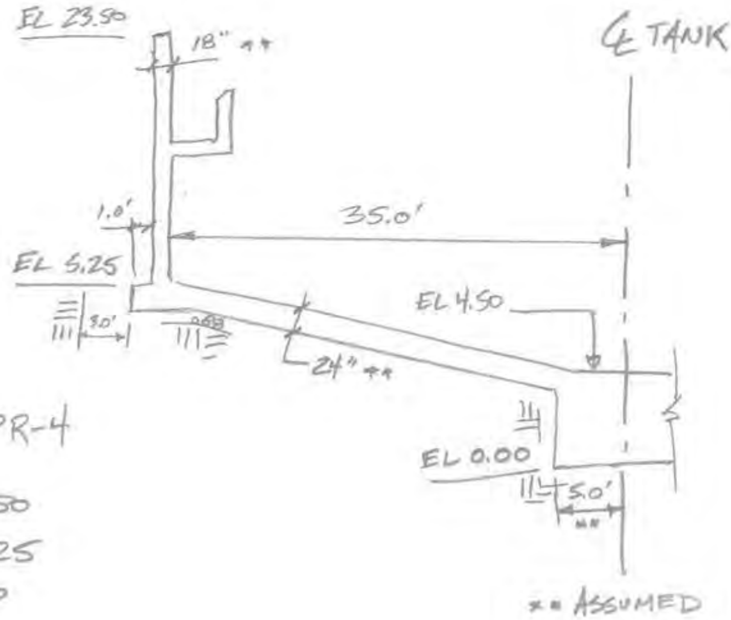
Date: 12/9/15

CALCULATION SHEET

PREPARED BY: W.G.L

ELEMENT: EXCAVATION

SECONDARY CLARIFIERS



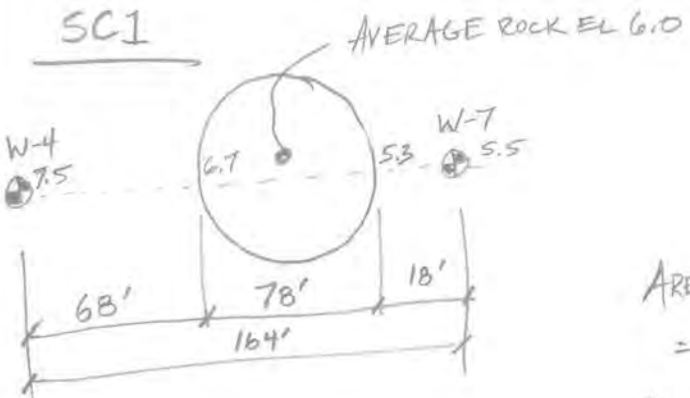
ADJACENT BORINGS:

W-D ROCK @ 14.5
W-4 ROCK @ 7.5
W-7 ROCK @ 5.5
W-5 ROCK @ 2.8
HA15-7 ROCK @ 1.0

W-P DRAWING PR-21 & PR-4

PERIMETER T.O.W. 23.50
PERIMETER INVERT 5.25
CENTER INVERT 4.50
DIAMETER = 70.0'

SC1



AVG BOT OF EXCAVATION

$$\frac{(5.25-2.0-0.5)+(4.50-2.0-0.5)}{2} = 2.375$$

AREA OF EXCAVATION

$$= (35.0+1.5+1.0+3.0)^2\pi = 5{,}150\ ft^2$$

AREA CENTER WELL

$$= (5.0+2.0)^2\pi = 150\ ft^2$$

ROCK VOLUME OF CENTER WELL

$$(150\ ft^2)(5.0\ ft)/27 = 28\ CY$$

ROCK VOLUME OF TANK

$$(6.0'-2.4')(5{,}150\ ft^2)/27 = 687\ CY$$

TOTAL = 715 CY

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

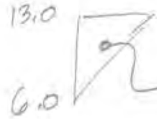
Date: 12/9/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: EXCAVATION

SOIL EXCAVATION



$$\frac{(2\pi)(40.5')(24.5\ ft^2)}{27} + \frac{7.0(\pi)(40.5)^2}{27}$$

= 1,565 CY

SC2

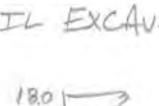
SC2 APPROXIMATELY CENTERED BETWEEN HA15-7 & W-7

AVG ROCK = $\frac{1.0 + 5.5}{2}$ = 3.25

ROCK VOLUME OF CENTER WELL = 28 CY
ROCK VOLUME OF TANK $(3.25' - 2.4')(5,150\ ft^2)/27$ = 162 CY } TOTAL = 190 CY

GRADE VARIES EL 14.0 TO EL 22.0, OR AVG EL 18.0

SOIL EXCAVATION



$$\frac{(2\pi)(40.5')(109\ ft^2)}{27} + \frac{14.75(\pi)(40.5)^2}{27}$$

= 3,850 CY

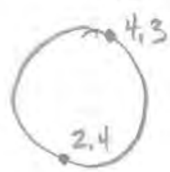
SC3

DISTANCE FROM HA15-7 TO W-4 = 165'

$\frac{7.5 + 1.0}{165}$ = 0.0515'/FT

TOTAL ROCK = 190 CY

TOTAL SOIL = 3,850 CY



AVG ROCK = 3.3
(IDENTICAL TO SC2)

Date: 12/9/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: EXCAVATION

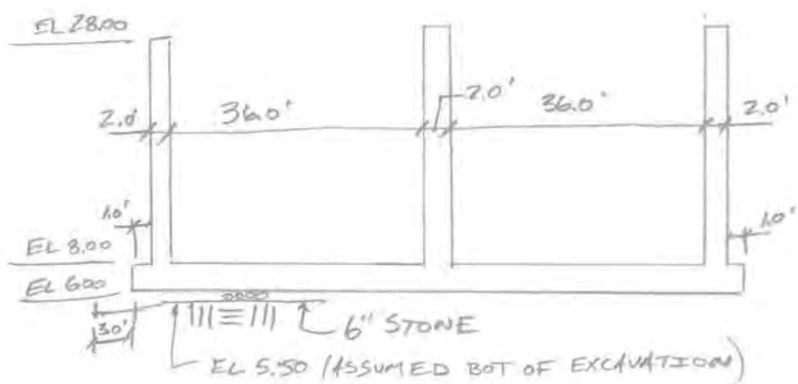
IMPACT OF LOCATION ALT. B FOR SC:

- ALL CLARIFIERS WILL BEAR IN BEDROCK, OK
- NEED AT LEAST ONE ADDITIONAL BORING PER CLARIFIER

TOTAL CLARIFIER ROCK = 715+190+190 = 1,095 CY < 2,160 CY

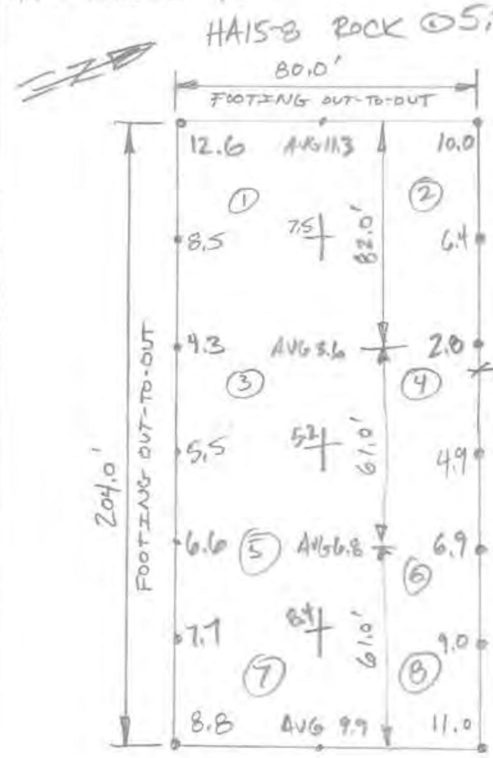
TOTAL CLARIFIER SOIL = 1,565+2(3,850) = 9,265 CY

AERATION TANKS 1&2



ADJACENT BORINGS

HA15-9 ROCK @ 20.0 W-D ROCK @ 14.5
W-14 ROCK @ 20.0 W-7 ROCK @ 5.5
HA15-7 ROCK @ 1.0 W-5 ROCK @ 2.8
HA15-8 ROCK @ 5.5



W-D TO HA15-8 = 265'

$$\frac{14.5-5.5}{265} = 0.034'/FT$$

W-7 TO W-5 = 137'

$$\frac{5.5-2.8}{137} = 0.0197'/FT$$

HA15-7 TO HA15-9 = 610'

$$\frac{20.0-1.0}{610} = 0.0311'/FT$$

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/9/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: EXCAVATION

DIVIDE STRUCTURE INTO 8 AREAS FOR ROCK CALCULATION

① $\frac{12.6+11.3+8.5+7.5}{4} = 10.0$ $(40+3)(41+3)(10.0-5.5)/27 = 315$ CY

② $\frac{11.3+10.0+7.5+6.4}{4} = 8.8$ $(40+3)(41+3)(8.8-5.5)/27 = 231$ CY

③ $\frac{8.5+7.5+5.5+5.2}{4} = 6.7$ $(40+3)(71.5)(6.7-5.5)/27 = 137$ CY

④ $\frac{7.5+6.4+5.2+2.8}{4} = 5.5$ $= 0$ CY

⑤ $\frac{5.5+5.2+7.7+8.4}{4} = 6.7$ $(40+3)(61.0)(6.7-5.5)/27 = 117$ CY

⑥ $\frac{5.2+4.9+8.4+9.0}{4} = 6.9$ $(40+3)(61)(6.9-5.5)/27 = 136$ CY

⑦ $\frac{7.7+8.4+8.8+9.9}{4} = 8.7$ $(40+3)(33.5)(8.7-5.5)/27 = 171$ CY

⑧ $\frac{8.4+9.0+9.9+11.0}{4} = 9.6$ $(40+3)(33.5)(9.6-5.5)/27 = 219$ CY

ROCK EXCAVATION 1,326 CY

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WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/10/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: EXCAVATION

AT SOIL EXCAVATION

- ASSUME AVERAGE GRADE OVER FOOTPRINT @ 22.0
- ROCK AVERAGE = $\frac{10.0+8.8+6.7+5.5+6.7+6.9+8.7+9.6}{8} = 7.9$

$$\frac{(86.0')(210')(22.0-7.9)+2(210)(99.4)+2(86)(99.4)}{27}$$

$$= \underline{\underline{11610\ CY}}$$

IMPACT OF LOCATION ALT. B FOR AT/#2:

- STRUCTURE APPEARS TO BEAR IN BEDROCK OF NEAR BEDROCK ∴ BEARING CAPACITY IS ADEQUATE
- ANTICIPATED BEARING PRESSURE ≅ 2,000 PSF, OK
- NEED ADDITIONAL BORINGS, 3 TO 4 MINIMUM

SUMMARY OF ROCK QUANTITIES

	PDR (SEPT 2015 DESIGN QUANTITIES)	ALT. B SITE PLAN	
SHB	2,340 CY	300 CY	
AT/#2	5,100 CY	1,325 CY	NET REDUCTION
SC (3 TOT)	2,160 CY	1,095 CY	= 6,955
SST	1,000 CY	925 CY	× \$80/CY = \$556,400
	10,600 CY	3,645 CY	


N
HA15-3
MAINT
W-4B(1980)
HW
GT
PS
W-2(1980)
PC1
HA
15-4
PC2
L-2(1980)
HA15-6
SHB
SST
13
W-D(1980)
HA15-8
W-5A
(1980)
SC1
W-4
(1980)
W-7(1980)
AT1 AT2
W-5(1980)
SC3
SC2
HA15-9
W-14
HA15-7
HA15-6 TO W-D (1980) = 284'
W-4 TO W-4B = 290'

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/10/15

CALCULATION SHEET

PREPARED BY: J. Cass

ELEMENT: Headworks Bldg. Excavation

Process Segment of Bldg	Invert Elev	Bottom Elev – 6" Stone (18" thick slab)
Influent Channel	~28.0	25.5
Vortex Grit Removal	20.96	18.46
Effluent Channel	29.50	27.0

Note Elevations for portions of bldg are unknown ⇒ Use average of known elevations for rock removal estimation. Refinement of calc will be needed when building is further designed.

$$\text{Avg. Elev.} = \frac{25.5 + 18.46 + 27.0}{3}$$

= El. 23.65 ~~??~~

Say El. 23.5

Cut/Fill Report

Generated: 2015-12-11 13:01:06

By user: JCass

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Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
ROCK CUT (1)	full	1.000	1.000	74794.70	5345.46	854.72	4490.74<Cut>
Snow Dump Volume	full	1.000	1.000	51894.86	30.18	32741.03	32710.85<Fill>
CUT-FILL	full	1.000	1.000	203667.33	9731.50	19691.93	9960.43<Fill>

Totals

	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	330356.89	15107.14	53287.68	38180.55<Fill>

* Value adjusted by cut or fill factor other than 1.0

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/10/15

CALCULATION SHEET

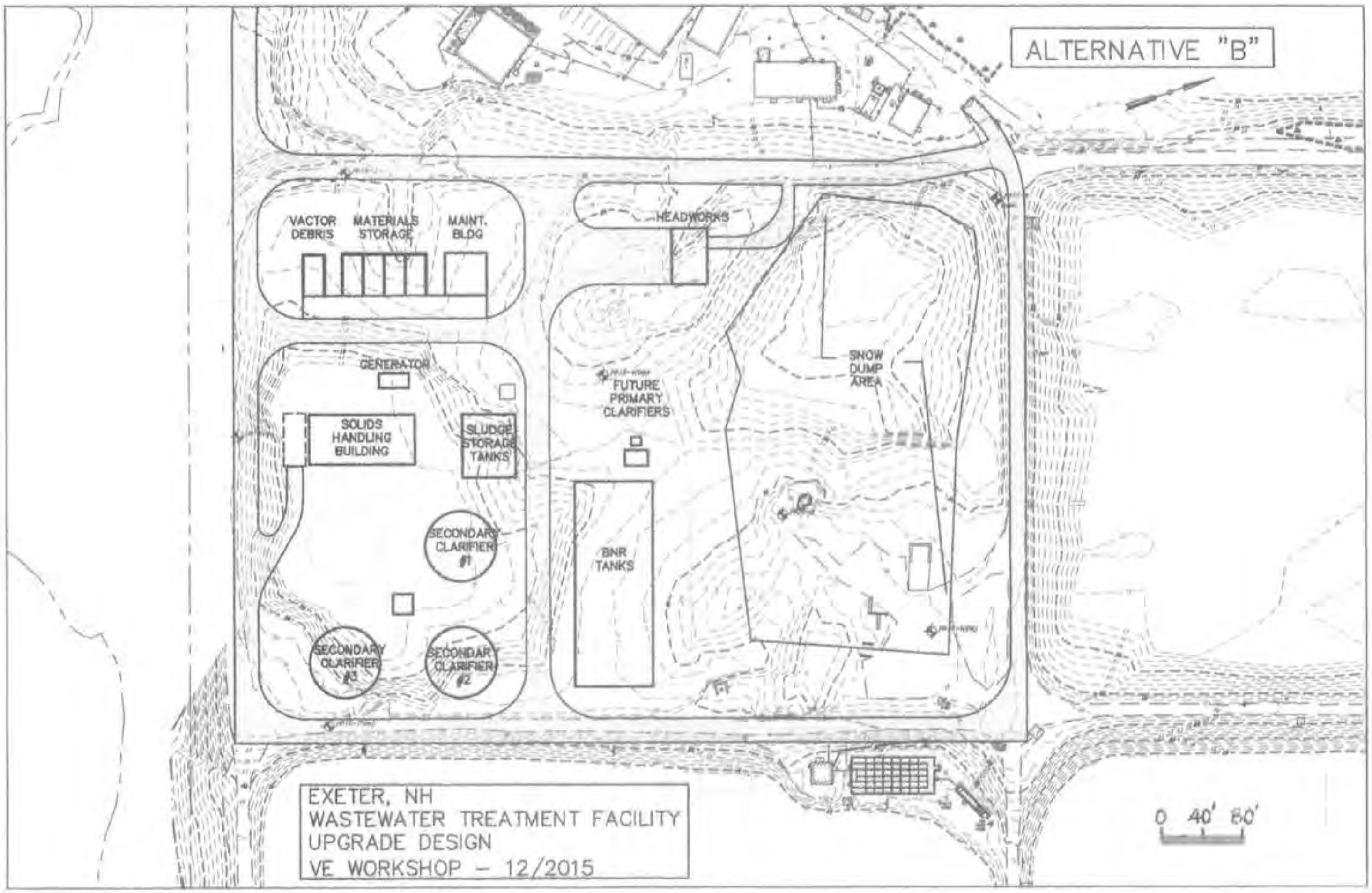
PREPARED BY: J. Cass

ELEMENT: Snow Dump Capacity

- Existing Snow Dump Area: approximately 67,600 SF.

- Proposed Snow Dump Area: approximately 95,200 S.F. (Alternative B)

Therefore, sufficient area for snow dump should be provided in new configuration (Alternative B).


ALTERNATIVE "B"
VACTOR DEBRIS
MATERIALS STORAGE
MAINT. BLDG
HEADWORKS
SNOW DUMP AREA
GENERATOR
FUTURE PRIMARY CLARIFIERS
SOLIDS HANDLING BUILDING
SLUDGE STORAGE TANKS
BNR TANKS
SECONDARY CLARIFIER #1
SECONDARY CLARIFIER #3
SECONDARY CLARIFIER #2
EXETER, NH
WASTEWATER TREATMENT FACILITY
UPGRADE DESIGN
VE WORKSHOP – 12/2015
0 40' 80'

STRUCTURAL

Exeter, NH
Wastewater Treatment Facilty Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: Aeration Tank concrete member thicknesses

PREPARED BY: W.G.L.

Original Design Description: (Attach sketch if applicable)
202'x78' Aeration Tank, tank invert elevation 8.00, top of wall elevation 28.00, max fluid elevation 26.00, grade elevation 20.00.
From W-P PDR cost estimate, base slab = 1,400 CY, walls = 1,300 CY (concrete quantities)
Wall and slab thicknesses were backed out from these yardages. The following approximate member thicknesses were determined:
Base slab = 28", Exterior walls = 22", Interior walls = 18"
$2.14M concrete cost.

Proposed Design Description: (Attach sketch if applicable)
Structural calculations were performed assuming the cantilever wall condition in the aerobic zone would control wall thickness and that all exterior walls would be the same thickness for constructability purposes. It was confirmed that 22" walls are adequate for the Aeration Tank exterior. In order to transfer the base moment from the cantilever wall to the base slab, the slab must have the same capacity as the wall (assume same reinforcing and thickness).

Based on structural requirements, the base can be reduced from 28" to 22" in thickness. Local buoyancy of the base slab also needs to be considered. With a 1.25 safety factor, the base slab must remain 28" thick. With a 1.1 safety factor, the base slab can be reduced to 22". Cost savings for 22" base slab are approximately $65,000.

W-P to consider using a 22" base slab for Aeration Tanks.
PDR cost estimate quantities are confirmed to be accurate based on calculated member thicknesses.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:
-Reduced concrete volume for base slab.
-Reduced rock excavation to maintain 8.00 invert

Disadvantages:
-Lower safety factor for slab buoyancy

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN			
VE PROPOSAL			
SAVINGS	$65,000		

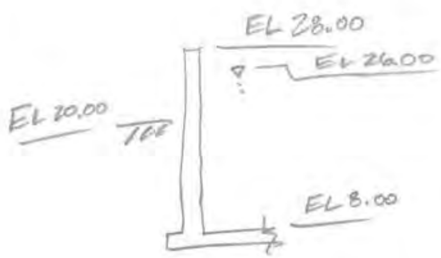
RESIZE AT/#2 BASED ON THE ADDITION OF PRIMARY TREATMENT

118' AEROBIC ZONE REDUCED IN LENGTH BY 30%

118(0.7) = 83.0' (35.0' REDUCTION)

DETERMINE WALL THICKNESS OVER AEROBIC ZONE

- CANTILEVER WALL CONDITION, SIZE WALL FOR BASE MOMENT & SHEAR
- FULL SATURATED SOIL CONDITION, GRADE AT EL 20.00
- TOP OF WALL EL 28.00
- TANK INVERT EL 8.00
- MAX FLUID EL 26.00
- U = 1.4F, U = 1.6H
- EMPTY TANK - FULL SOIL & FULL TANK - NO SOIL
- $S_d \cong 1.4$ - SATURATED SOIL EQUIV. LATERAL = 85 PCF



$M_{u_{SOIL}} = (1.6)(1.4)(0.085)(20.0-8.0)^3/6 = 54.9 \text{ k-ft/ft}$

$M_{u\,fluid} = (1.4)(1.4)(0.0624)(26.0-8.0)^3/6 = 118.9 \text{ k-ft/ft}$ ⇐ CONTROLS

$V_{u\,fluid} = (1.4)(0.0624)(18)^2/2 = 14.2 \text{ k/ft}$

$\phi V_c = \dfrac{0.75(2)\sqrt{4{,}500}(12)(19.5)}{1{,}000} = 23.5 \text{ k/ft}$, OK

Date: 12/10/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: AT/ #2

20" WALL

$a = \frac{60^2}{(1.7)(4.5)(12)} = 39.216$

$b = (-17.5)(60) = -1,050$ $A_{s_{req}} = 1.61 \text{ in}^2/\text{ft}$

$c = \frac{12(119)}{0.7} = 1,587$

22" WALL

$a = 39.216$

$b = -1,170$ $A_{s_{req}} = 1.42 \text{ in}^2/\text{ft}$, OK, USE AS BASIS OF ANALYSIS

$c = 1,587$ #9 DWLS @8", $A_s = 1.50 \text{ in}^2/\text{ft}$

24" WALL

$a = 39.216$

$b = -1,290$

$c = 1,587$ $A_{s_{req}} = 1.28 \text{ in}^2/\text{ft}$

AERATION TANK QUANTITIES (PDR COST 10/115)

BASE SLAB 1,400 CY
WALLS 1,300 CY

$(80')(204')(x)/27 = 1,400$ CY

$X = 2.32' \Rightarrow 28"$ ASSUMED THICKNESS FOR BASE SLAB IN PDR COST

EXTERIOR WALL LENGTH $= (202')(2) + 3(78') = 638'$

INTERIOR " " $= 5(78') = 390'$

WALL THICKNESS
22" EXT
18" INT

$(638')(1.83')(20')/27 = 865$ CY
$(390')(1.5')(20')/27 = 435$ CY

TOTAL = 1,300 CY ✓

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/10/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: AT/#2

STRUCTURE REDUCTION FOR PRIMARY TREATMENT

SLAB: $(35')(80')(2.33')/27 = 242$ CY × \$600/CY = \$145,200

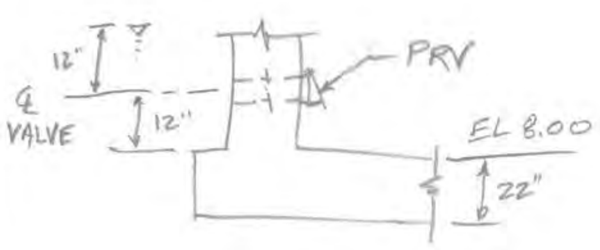
WALLS: $3(35')(20')(1.83')/27 = 142$ CY × \$1,000/CY = \$142,000

ROCK: $\frac{35}{44}(315 + 231) = 435$ CY × \$80 /CY = \$34,800

SOIL: $\frac{35}{210}(9,430) = 1,570$ CY × \$13/CY = \$20,410

\$342,410 COST REDUCTION IF AEROBIC ZONE REDUCED TO 83'

CHECK 22" SLAB SINCE 22" EXTERIOR WALLS ARE ADEQUATE



- KEEP 22" SLAB THICKNESS TO MATCH WALL THICKNESS, MAINTAIN MOMENT CAPACITY
- CHECK BUOYANCY, ASSUME GROUNDWATER TO 1' ABOVE PRV

$DL = \frac{22}{12}(0.145) = 0.266$ ksf ↓

$BL = \left(\frac{22}{12} + 1' + 1'\right)(0.0624) = 0.239$ ksf ↑

$F.S. = \frac{0.266}{0.239} = 1.11$ (22" SLAB)

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/10/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: AT/#2

IF 28" SLAB

$DL = \frac{28}{12}(0.145) = 0.338 \text{ ksf} \downarrow$

$BL = \left(\frac{28}{12} + 1' + 1'\right)(0.0624) = 0.27 \text{ ksf} \uparrow$

$F.S. = \frac{0.338}{0.27} = 1.25$ (28" SLAB)

ACI 350.4R-04, SECTION 3.1.2

- S.F. = 1.1 FOR WORST-CASE CONDITIONS
- S.F. = 1.25 FOR WELL-DEFINED FLOOD & GROUNDWATER
- ASSUME GROUNDWATER TO 1.0' ABOVE VALVE, PRESSURE REQUIRED TO OPEN VALVE

CONCRETE REDUCTION

$\left(\frac{6}{12}\right)(80')(204')/27 = 302 \text{ CY} \times \$600/\text{CY} = \$181,200$ ← CONCRETE, REBAR, FORMWORK, FINISHING, ETC

$\times \$125/\text{CY} = \$37,750$ ← RAW CONCRETE

ROCK EXCAVATION REDUCTION

$\left(\frac{6}{12}\right)(86')(210')/27 = 335 \text{ CY} \times \$80/\text{CY} = \$26,750$

TOTAL = \$64,500

SUMMARY: W-P CAN CONSIDER USING F.S. = 1.1 ON THE A.T. BASE SLAB BUOYANCY RESISTANCE. \$65,000 COST SAVINGS.

Exeter, NH
Wastewater Treatment Facilty Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: Secondary Clarifier concrete member thicknesses

PREPARED BY: W.G.L.

Original Design Description: (Attach sketch if applicable)
70' diameter secondary clarifiers (3 total), tank invert elevation 5.25, center well invert elevation 4.50, top of wall elevation 23.50, grade elevation 20.00.
From W-P PDR cost estimate, base slab = 350 CY each, walls = 275 CY each (concrete quantities)
Wall and slab thicknesses were backed out from these yardages. The following approximate member thicknesses were determined:
Base slab = 24", Exterior walls = 18"
$1.46M concrete cost.

Proposed Design Description: (Attach sketch if applicable)
The W-P PDR secondary clarifier design was compared to recent Hazen and Sawyer tank designs of similar footprint and function. The assumed wall thickness and base slab thickness are confirmed to be accurate for the current level of design.

A basic local buoyancy check was performed on the clarifier base slab. It was aasumed that pressure relief valves allowing groundwater to flow into an empty tank will be placed at elevation 6.25. The high portion of the base slab at elevation 5.25 was found to have adeqaute safety factors (1.16). As the slab slopes downward, the buoyany load increases and local upfilt may be an issue. Design engineer will need to be aware of this issue.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:
Design was confirmed to be reasonable and accurate for a PDR level design.

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN			
VE PROPOSAL			
SAVINGS	$0		

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

CALCULATION SHEET SECONDARY   Date: 12/11/15

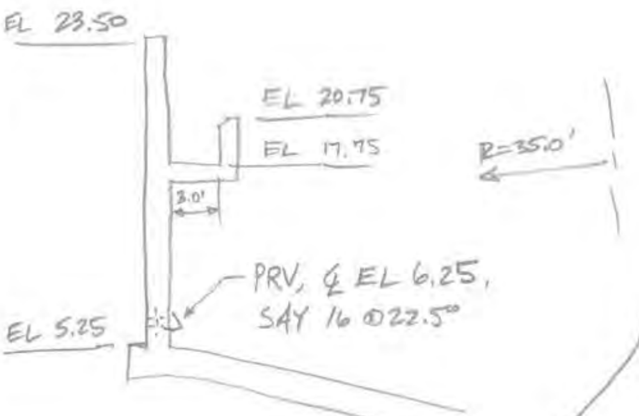
PREPARED BY: W.G.L.   ELEMENT: CLARIFIER MEMBER THICKNESS CHECK

DIAMETER = 70'

TOW EL 23.50

WALL INVERT EL 5.25

CENTER INVERT EL 4.50



BASED ON RECENT SIMILAR HAZEN&SAWYER CLARIFIER DESIGNS, 18" ADEQUATE FOR THIS CONFIGURATION

WALL & TROUGH

ESTIMATED AREA OF TROUGH WALL AND SLAB

$(3.0')(1.0') + (3.0')(1.0) = 6.0\ ft^2$

ASSUME 18" EXTERIOR WALL

AREA WALL $= (18.25)(1.5) = 27.4\ ft^2$

VOLUME WALL & TROUGH =

$$\frac{(6.0 + 27.4)(2\pi)(35.0)}{27} = 272\ CY$$

PDR COST ESTIMATE TOTALS

260 CY (WALL) + 15 CY (ELEVATED TROUGH SLAB) = 275 CY

275 CY ≅ 272 CY ∴ ASSUMED PDR WALL & TROUGH THICKNESSES

BASE SLAB AND CENTER WELL

VOLUME CENTER WELL $= (2.5)(15)(10)/27 = 15\ CY$

VOLUME OF BASE SLAB $= \frac{(\pi)(35+1.5+1.0)^2(2.0)}{27} = 330\ CY$

15 CY + 330 CY = 345 CY = 350 CY (PDR COST ESTIMATE TOTAL)

** WALL & SLAB THICKNESSES ARE CONFIRMED TO BE ACCURATE FOR PDR STAGE

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/11/15

CALCULATION SHEET

PREPARED BY: W.G.L.

ELEMENT: SECONDARY CLARIFIER MEMBER THICKNESS CHECK

BUOYANCY CHECK (LOCAL)

$DL = 2(0.145) = 0.29\ ksf \downarrow$

$BL = (1+1+2)(0.0624) = 0.25ksf \uparrow$

$F.S. = \frac{0.29}{0.25} = 1.16$, OK, BETWEEN 1.1 & 1.25

NOTE BUOYANT LOAD WILL INCREASE AS THE SLAB SLOPES DOWN TOWARDS CENTER WELL. ENGINEER CAN CONSIDER USING CENTER MASS AS AN "ANCHOR". ADDITIONAL VALVES MAY BE CONSIDERED AT SLAB LOW POINTS, ALTHOUGH NOT DESIRED AS THEY WOULD BE PRONE TO CLOGGING.

ARCHITECTURAL

VE RECOMMENDATION

PROJECT ELEMENT: **Solids Handling Building (Lower Level - Automatic Sprinkler System)**

PREPARED BY: SCD

Original Design Description: (Attach sketch if applicable)

The solids handling building houses process equipment in the lower level which falls into the category of "Stories without openings" according to 2009 IBC section 903.2.11.1.

Because of this lower level, it is undestood that a 12" ductile iron water main is being proposed for installation on site to service the automatic sprinkler system for this building's lower level.

Other buildings on site do not require fire supression from an automatic sprinkler system

The cost of installing the 12" DI water main: $706,500

Proposed Design Description: (Attach sketch if applicable)

Reconfigure Solids Handling Building in order to eliminate need for 12" water main.

If alternate "Process Building" is to be pursued, design such as to avoid same issues.

Refer to attached "calculation sheet".
Refer to attached concept sketch.
Refer to attached 2015 IBC Commentary excerpts.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:

Cost savings.

Potential positive schedule impacts.

Discussions indicate that the water main is not a high priority to the town.

Disadvantages:

Process equipment not in a conditioned space.

Some maintenance will take place outside.

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$4,951,500		
VE PROPOSAL	$4,161,650		
SAVINGS	$789,850		

EXETER, NH
WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP

Date: 12/11/15

CALCULATION SHEET

PREPARED BY: SCD

ELEMENT **Solids Handling Building**
(Lower Level - Automatic Sprinkler System)

"As a large windowless story, the lower floor is required to have an automatic sprinkler system. With an automatic sprinkler system, this level is allowed to have one centrally located exit."

This appears to be the only building needing an automatice sprinkler system. As a result, the 12" DI water main is apparently required with the associated costs as follows:

12" DI Water Main	$506,400	
12" Gate Valve	$8,000	
Fire Hydrant Assembly	$40,000	
Aggregate Base	$40,350	(value is prorated at 50% of contracts 2&3 costs.)
Initital Pavement Binder	$75,500	(value is prorated at 50% of contracts 2&3 costs.)
Final Pavement (Wearing Course)	$26,800	(value is prorated at 50% of contracts 2&3 costs.)
Driveway Pavement	$4,600	(value is prorated at 50% of contracts 2&3 costs.)
Pavment Stripping	$4,850	(value is prorated at 50% of contracts 2&3 costs.)
Total:	$706,500	

Soilds Handling Building Construction Total:	$4,245,000
Soilds Handling Building Construction Total (w/water main):	$4,951,500

Footprint below grade: 86'-0" x 50'-0" = 4,300 SF
Floor to Floor Height = 16'-8"

2009 IBC, Chapter 9, Section 903.2.11.1 Stories Without Openings
". . .all stories, including basements, of all buildings where the floor area exceeds 1,500 square feet and where there is not provided not fewer than one of the following types of exterior wall openings. . ."

903.2.11.1.1 Extrerior Stairways - Exterior stairways in each lineal 50' of exterior wall are considered acceptable.

903.2.11.1.3 Basements - "Where any portion of a basement is located more than 75' from openings or where walls or other obstructions. . ."

Consider the following: (Verify with AHJ)

Option 1: Provide exterior stairs (with overhead canopies) to avoid basement with lack of exterior access.
Relocate Mechanical Room S001 to upper floor (enlarge upper floor if necessary)
Delete interior stair and/or walls to avoid issues with interior partitions. Basement access would be from the exterior.

Option 2: Enlarge first floor plan (delete majority of lower level and relocate mechanical room to grade level).
Provide a separate structure for the blower equipment.
Provide a lower level room for pumps that does not exceed 1,500 SF.
(See estimated costs/savings for Option 2 on page 3.)

Option 3: Alternate "Process Building" Plans
Avoid same issues with Solids Handling Building by providing as much area as possbile in the upper story.

References:
2009 International Building Code
2015 International Building Code Commentary

WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP
Date: 12/11/15

CALCULATION SHEET

PREPARED BY: SCD

ELEMENT **Solids Handling Building**
(Lower Level - Automatic Sprinkler System)

Remove blowers from the basement level of Solids Handling Building and provide "lean-to" structure:
Floor area assumed: 60'-0" x 20'-0" = 1,200 SF
Wall height: 14'
Roof Pitch: 3/12

Concrete					
	4" Concrete slab:	53	CY	$600	$31,800
	4' Concrete frost wall:	36	CY	$700	$25,200
Exterior Walls					
	8" CMU, split face:	1400	SF	$15	$21,000
Roof					
	Plywood decking on wood trusses:	1200	SF	$14	$16,800
Roofing					
	Architectural asphalt shingles:	1260	SF	$5	$6,300
	Edge trim:	162	LF	$25	$4,050
	Metal siding at gable end:	50	SF	$10	$500
Subtotal (Lean-to Building for Blowers):					$105,650

Revise basement level of Solids Handling Building to house pumps only with total area to be no greater than 1,500 SF.

Concrete					
	Deduct concrete slab:	-100	CY	$1,200	-$120,000
	Deduct concrete basement wall:	-92	CY	$1,000	-$92,000
	Deduct concrete column:	-5	CY	$2,000	-$10,000
	Deduct concrete beam:	-30	CY	$1,500	-$45,000
	Concrete slab on grade:	100	CY	$500	$50,000
	Concrete frost Wall:	40	CY	$700	$28,000
Subtotal (reconfiguration of Solids Handling Building's lower level):					-$189,000
Solids Handling Building Construction Total:					$4,951,500
Revised Solids Handling Building Construction Total:					$4,762,500
Add for Blower Lean-to (above):					$105,650
Deduct for 12" DI water main:					-$706,500
Total Estimated Cost:					$4,161,650

EXETER WWTF VE WORKSHOP

REVIEW OF SOLIDS HANDLING BUILDING - LOWER LEVEL

[F] 903.2.9 Group S-1. An *automatic sprinkler system* shall be provided throughout all buildings containing a Group S-1 occupancy where one of the following conditions exists:

1. A Group S-1 *fire area* exceeds 12,000 square feet (1115 m²).
2. A Group S-1 *fire area* is located more than three stories above *grade plane*.
3. The combined area of all Group S-1 *fire areas* on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m²).
4. A Group S-1 *fire area* used for the storage of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m²).
5. A Group S-1 occupancy used for the storage of upholstered furniture or mattresses exceeds 2,500 square feet (232 m²).

❖ An automatic sprinkler system must be provided throughout all buildings containing a Group S-1 occupancy fire area where the fire area exceeds 12,000 square feet (1115 m²); is more than three stories above grade plane; combined, on all floors including mezzanines, exceeds 24,000 square feet (2230 m²); or is used for the storage of commercial motor vehicles and exceeds 5,000 square feet (464 m²). See the commentary to the definition of "Commercial motor vehicle" in Chapter 2.

The first three sprinkler threshold requirements for Group S-1 occupancies are identical to those of Groups F-1 and M (see commentary, Sections 903.2.4 and 903.2.7). Group S-1 occupancies, such as warehouses and self-storage buildings, are assumed to be used for the storage of combustible materials. While high-piled storage does not change the Group S-1 occupancy classification, sprinkler protection, if required, may have to comply with the additional requirements of Chapter 32 of the IFC. High-piled stock or rack storage in any occupancy must comply with the code and the IFC. The fifth sprinkler threshold is the same as for Group F-1 except that, in this case, upholstered furniture and mattresses are being stored and not manufactured. Group M has a similar threshold, but is required for larger occupancies containing such items with an area of 5,000 square feet (464 m²) versus what is required for Groups S-1 and F-1 occupancies of 2,500 square feet (232 m²). See the commentary for Group M and Group F-1 definitions for more discussion on this issue. Again, it is important to note that the threshold is based upon the square footage of the occupancy and not upon the size of the fire area. A formal interpretation (IFC Interpretation 20-14) has been issued on this section. The formal interpretation addresses self storage warehouses specifically and whether such a facility between 2500 and 12000 square feet would require an automatic sprinkler system. This is based upon the fact that upholstered furniture may be stored in such units. The response provided noted that a sprinkler system would be required based on the fact the requirements are focused on the square footage of the occupancy and are not based on fire area or the amount of upholstered furniture or mattresses present.

[F] 903.2.9.1 Repair garages. An *automatic sprinkler system* shall be provided throughout all buildings used as repair garages in accordance with Section 406, as shown:

1. Buildings having two or more *stories* above *grade plane*, including basements, with a *fire area* containing a repair garage exceeding 10,000 square feet (929 m²).
2. Buildings not more than one *story above grade plane*, with a *fire area* containing a repair garage exceeding 12,000 square feet (1115 m²).
3. Buildings with repair garages servicing vehicles parked in basements.
4. A Group S-1 *fire area* used for the repair of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m²).

❖ Automatic sprinklers may be required in repair garages, depending on the quantity of combustibles present, their location and floor area. In addition, any Group S-1 fire area intended for the repair of commercial motor vehicles that exceeds 5,000 square feet (464 m²) would require sprinklers. This is the same criteria as Group S-1 occupancies and Group S-2 enclosed parking garages storing commercial motor vehicles. Repair garages may contain significant quantities of flammable liquids and other combustible materials. These occupancies are typically considered Ordinary Hazard Group 2 occupancies as defined in NFPA 13. Portions of repair garages used for parts cleaning using flammable or combustible liquids may require automatic sprinkler protection. If quantities of hazardous materials exceed the limitations in Section 307 for maximum allowable quantities per control area, the repair garage would be reclassified as a Group H occupancy. Note that the term "commercial motor vehicles" is specially defined in Chapter 2.

[F] 903.2.9.2 Bulk storage of tires. Buildings and structures where the area for the storage of tires exceeds 20,000 cubic feet (566 m³) shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

❖ This section specifies when an automatic sprinkler system is required for the bulk storage of tires based on the volume of the storage area as opposed to a specific number of tires. Even in fully sprinklered buildings, tire fires pose significant problems to fire departments. Tire fires produce thick smoke and are difficult to extinguish by sprinklers alone. NFPA 13 contains specific fire protection requirements for the storage of rubber tires.

Whether the volume of tires is divided into different fire areas or not is irrelevant to the application of this section. If the total for all areas where tires are stored is great enough that the resultant storage volume exceeds 20,000 cubic feet (566 m³), the building must be sprinklered throughout. See the commentary to the Section 202 definition of "Tires, bulk storage of" for further information.

[F] 903.2.10 Group S-2 enclosed parking garages. An *automatic sprinkler system* shall be provided throughout buildings classified as enclosed parking garages in accordance with Section 406.6 where either of the following conditions exists:

1. Where the *fire area* of the enclosed parking garage exceeds 12,000 square feet (1115 m²).
2. Where the enclosed parking garage is located beneath other groups.

Exception: Enclosed parking garages located beneath Group R-3 occupancies.

❖ Fire records have shown that fires in parking structures typically fully involve only a single automobile with minor damage to adjacent vehicles. An enclosed parking garage, however, does not allow the dissipation of smoke and hot gases as readily as an open parking structure, which is also considered a Group S-2 occupancy. If the enclosed parking garage has a fire area greater than 12,000 square feet (1115 m²) or is located beneath another occupancy group, the enclosed parking garage must be protected with an automatic sprinkler system. This requirement that the enclosed parking garage located beneath other occupancy groups is required to be sprinklered is based on the potential for a fire to develop undetected, which would endanger the occupants of the other occupancy. The 12,000-square-foot (1115 m²) threshold is similar to other occupancies such as Groups M and S-1.

It should be noted that while open parking garages are considered a Group S-2 occupancy, they are not required by the provisions of this section to be equipped with an automatic sprinkler system.

The exception exempts enclosed garages in buildings where the garages are located below a Group R-3 occupancy. The exception is essentially moot since the code requires all buildings with a Group R occupancy to be sprinklered throughout. Because the entire building with the residential occupancy is required to be sprinklered according to Section 903.2.8, the garage would be sprinklered as well. It should be noted that if the Group R-3 occupancy was protected with an NFPA 13D system, the enclosed parking garage would not require sprinklers.

[F] 903.2.10.1 Commercial parking garages. An *automatic sprinkler system* shall be provided throughout buildings used for storage of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m²).

❖ Because of the larger-sized vehicles involved in commercial parking structures, such as those housing commercial motor vehicles as defined in Section 202, a more stringent sprinkler threshold is required. Bus garages may also be located adjacent to passenger terminals (Group A-3) that have a substantial occupant load. Commercial parking requires only a single vehicle in order to be classified as commercial parking.

The criterion for sprinkler protection is based on the size of the fire area and not the size of the commercial parking. If the commercial parking involves only 1,000 square feet (93 m²) but the fire area exceeds 5,000 square feet (464 m²), sprinkler protection is required.

[F] 903.2.11 Specific building areas and hazards. In all occupancies other than Group U, an *automatic sprinkler system* shall be installed for building design or hazards in the locations set forth in Sections 903.2.11.1 through 903.2.11.6.

❖ Sections 903.2.11.1 through 903.2.11.2 specify certain conditions under which an automatic sprinkler system is required, even in otherwise nonsprinklered buildings. As indicated, the listed conditions in the noted sections are applicable to all occupancies except Group U. Most structures that qualify as Group U do not typically have the type of conditions stipulated in Sections 903.2.11.1 through 903.2.11.3.

[F] 903.2.11.1 Stories without openings. An *automatic sprinkler system* shall be installed throughout all *stories*, including basements, of all buildings where the floor area exceeds 1,500 square feet (139.4 m²) and where there is not provided not fewer than one of the following types of *exterior wall* openings:

1. Openings below grade that lead directly to ground level by an exterior *stairway* complying with Section 1009 or an outside ramp complying with Section 1010. Openings shall be located in each 50 linear feet (15 240 mm), or fraction thereof, of *exterior wall* in the *story* on at least one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm).
2. Openings entirely above the adjoining ground level totaling not less than 20 square feet (1.86 m²) in each 50 lineal feet (15 240 mm), or fraction thereof, of *exterior wall* in the story on at least one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm). The height of the bottom of the clear opening shall not exceed 44 inches (1118 mm) measured from the floor.

❖ Because of both the lack of openings in exterior walls for access by the fire department for fire fighting and rescue and the problems associated with venting the products of combustion during fire suppression operations, all stories, including any basements of buildings that do not have adequate openings as defined in this section, must be equipped with an automatic sprinkler system. This section applies to stories without sufficient exterior openings where the floor area exceeds 1,500 square feet (139 m²) and where the building is not otherwise required to be fully sprinklered. The requirement for an automatic sprinkler system in this section applies only to the affected area and does not mandate sprinkler protection throughout the entire building.

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Stories without openings, as defined in this section, are stories that do not have at least 20 square feet ($1.9 m^2$) of opening leading directly to ground level in each 50 lineal feet (15 240 mm) or fraction thereof on at least one side. Since exterior doors will provide openings of 20 square feet ($1.9 m^2$), or slightly less in some occupancies, exterior stairways and ramps in each 50 lineal feet (15 240 mm) are considered acceptable.

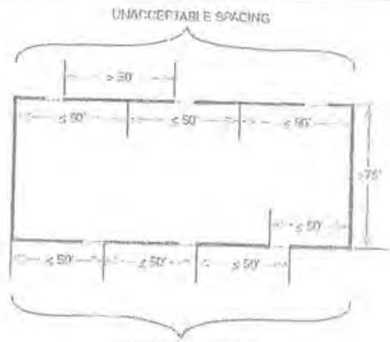
This section specifically states that the required openings be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm). If the openings in the exterior wall are located without regard to the location of the adjacent openings, it is possible that segments of the exterior wall will not have the required access to the interior of the building for fire-fighting purposes. Any arrangement of required stairways, ramps or openings that results in a portion of the wall 50 feet (15 240 mm) or more in length with no openings to the exterior does not meet the intent of the code that access be provided in each 50 lineal feet (15 240 mm) (see Commentary Figure 903.2.11.1).

There is a further restriction on openings that are entirely above grade. More specifically, to support fire-fighting operations the openings need to be accessible and usable. Therefore, Item 2 specifies that the maximum sill height be 44 inches (1118 mm) above the floor. This height is consistent with the height provided for emergency escape and rescue windows in Section 1030.3.

One application of this section has been addressed in the 2009 edition of the *International Code Interpretations* book and deals with automotive service shops that have below-grade service areas where employees perform oil changes and other minor maintenance services. The below-grade areas are typically open to the grade-level service bays via openings providing access to the underside of the vehicle without requiring the vehicle to be lifted into the air. Inasmuch as the below-grade space has no openings directly to the exterior, the question was asked if it would be regulated as a windowless story and thus be required to be equipped with an automatic sprinkler suppression system in accordance with Section 903.2.11.1.

The answer to that question is no. Because of the openness between the adjacent service levels, the below-grade area would be more appropriately regulated similar to a mezzanine rather than a story. A mezzanine is not regulated as a separate story but rather as part of the same story that it serves. Therefore, if the below-grade service level is in compliance with the applicable provisions of Section 505, the windowless story provisions of Section 903.2.11.1 would be evaluated based on the exterior wall openings of the main level and not the service mezzanine below. The direct interconnections between the two adjacent floor levels by multiple service openings provide access to the lower service area for fire-fighting and rescue operations. As such, it would not be regulated as a windowless story.

The requirement to sprinkler the basement is independent of mixed-use conditions. Whether the basement is separated or nonseparated is irrelevant to the need for sprinkler protection, nor does the requirement to provide sprinklers in the basement imply that sprinklers must be provided elsewhere. This requirement is applicable to the basement or any story without openings irrespective of other code provisions.



For SI: 1 foot = 304.8 mm

Figure 903.2.11.1
SPACING OF OPENINGS IN STORIES OR BASEMENTS

These provisions are not based on the size of fire areas but rather on the size of the basement. Thus, subdividing the basement into multiple fire areas would have no effect on the requirement. However, one benefit of the multiple fire areas could be that each fire area could have a separate limited area sprinkler system with less than 20 sprinklers.

903.2.11.1.1 Opening dimensions and access. Openings shall have a minimum dimension of not less than 30 inches (762 mm). Such openings shall be accessible to the fire department from the exterior and shall not be obstructed in a manner such that fire fighting or rescue cannot be accomplished from the exterior.

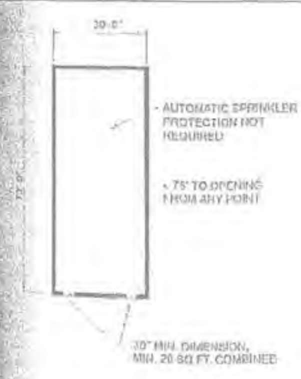
To qualify, an opening must not be less than 30 inches (762 mm) in least dimension and must be accessible to the fire department from the exterior. The minimum opening dimension gives fire department personnel access to the interior of the story or basement for fire-fighting and rescue operations and provides openings that are large enough to vent the products of combustion.

903.2.11.1.2 Openings on one side only. Where openings in a *story* are provided on only one side and the opposite wall of such *story* is more than 75 feet (22 860 mm) from such openings, the *story* shall be equipped throughout with an approved *automatic sprinkler system*, or openings as specified above shall be provided on not fewer than two sides of the *story*.

If openings are provided on only one side, an automatic sprinkler system would still be required if the opposite wall of the story is more than 75 feet (22 860 mm) from existing openings. An alternative to providing the automatic sprinkler system would be to design openings on at least two sides of the exterior of the building. As long as the story being considered is not a basement, the openings on two sides can be greater than 75 feet (22 860 mm) from any portion of the floor. In basements, if any portion is more than 75 feet (22 860 mm) from the openings, the entire basement must be equipped with an automatic sprinkler system, as indicated in Section 903.2.11.1.3. Providing openings on more than one wall allows cross ventilation to vent the products of combustion [see Commentary Figures 903.2.11.1.2(1–4)].

[F] 903.2.11.1.3 Basements. Where any portion of a *basement* is located more than 75 feet (22 860 mm) from openings required by Section 903.2.11.1, or where walls, partitions or other obstructions are installed that restrict the application of water from hose streams, the *basement* shall be equipped throughout with an *approved automatic sprinkler system*.

❖ The 75-foot (22 860 mm) distance is intended to be measured in the line of travel—not in a straight line perpendicular to the wall. Where obstructions, such as walls or other partitions, are present in a basement, the walls and partitions enclosing any room or space must have openings that provide an equivalent degree of fire department access to that provided by the openings prescribed in Section 903.2.11.1 for exterior walls. When obstructions such as walls or partitions are installed in the basement, the ability to apply hose streams through these openings and



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = $0.0929 m^2$

Figure 903.2.11.1.2(1)
OPENINGS IN STORIES OR BASEMENTS—LESS THAN 75 FEET FROM ANY POINT TO AN OPENING

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = $0.0929 m^2$

Figure 903.2.11.1.2(2)
OPENINGS IN STORIES OR BASEMENTS—MORE THAN 75 FEET FROM ANY POINT TO AN OPENING

reach the basement area is reduced or eliminated. The configuration and clear-opening requirements become useless when an interior wall or other obstruction is placed inside the basement. In that case, it is reasonable to require automatic fire sprinklers to provide adequate protection in the basement. If an equivalent degree of fire department access to all portions of the floor area is not provided, the basement would require an automatic sprinkler system.

[F] 903.2.11.2 Rubbish and linen chutes. An *automatic sprinkler system* shall be installed at the top of rubbish and linen chutes and in their terminal rooms. Chutes shall have additional sprinkler heads installed at alternate floors and at the lowest intake. Where a rubbish chute extends through a building more than one floor below the lowest intake, the extension shall have sprinklers installed that are recessed from the drop area of the chute and protected from freezing in accordance with Section 903.3.1.1. Such sprinklers shall be installed at alternate floors, beginning with the second level below the last intake and ending with the floor above the discharge. Chute sprinklers shall be accessible for servicing.

❖ Gravity rubbish (waste) and linen chutes can pose a significant hazard to building occupants if they are not properly installed and protected. Generally, these systems are installed in high-occupancy buildings where the occupants will be sleeping or are incapable of self-rescue, such as in Group I, R-1 and R-2 occupancies. For occupant convenience, openings to the chutes are commonly provided in areas accessible to the public and, in older buildings, the chute openings may be located in an exit access corridor. In comparison to other building shafts, gravity rubbish and linen chutes always contain fuel. As bags of waste debris or linen fall through the chute, they can deposit fuels such as waste cooking oil, which adheres to the shaft surface. This waste material and other debris provide fuel that can support and accelerate vertical fire spread. The greatest accumulation of fuel will be in the termination room; however, a significant amount of fuel that covers the interior surface area of the chute will be found in the sections of chutes closest to the collection or termination room. Therefore, it is important that the automatic sprinklers be properly placed and protected so they are available in the event of a fire in the termination room and to protect waste compaction equipment where such equipment is installed.

Installation of gravity chutes for rubbish or linen requires compliance with the code, the IFC and Chapter 6 of NFPA 82. Under the code, permanent rubbish and linen chutes are constructed inside of a fire-resistance-rated shaft assembly with a minimum 1-hour fire-resistance rating in buildings less than four stories in height; in buildings four or more stories in height, the fire-resistance rating is increased to 2 hours by Section 713.4. The design of the shaft system and its openings must also comply with the requirements in Sections 713.11 and 713.13, which require the termination room receiving the discharged material to be separated from the building by a fire barrier or horizontal assembly having a fire-resistance rating equivalent to that of the shaft that it serves.

Section 713.13.6 requires the installation of an automatic sprinkler system in rubbish and linen chutes to comply with the requirements of Section 903.2.11.2. Section 903.2.11.2 correlates with the requirements in Chapter 22 of NFPA 13. Chapter 22 of NFPA 13 contains the special occupancy requirements for all buildings, including gravity waste and linen chutes. The provisions align the code and IFC requirements with those in NFPA 82 and NFPA 13.

A critical term in this section is "extension." The term was selected to address chutes installed in buildings of pedestal construction or other designs in which the fire-resistant construction shaft and chute pass through a less hazardous occupancy, such as a Group S-2 parking garage, or other floors that do not have access to the shaft. In these areas, chute openings are generally not provided. As a result, this section now contains a specific provision that may impose a requirement for sprinklers in the portion of the chute that serves as an extension beyond the last intake and the termination room or discharge area.

Because objects will be falling through the chute, the code requires the chute sprinklers to be recessed and protected from impact. Sprinklers are not required at every story housing a chute. The code requires automatic sprinklers at the top of the chute and at its termination. In addition, sprinkler heads are required at alternate floors within the chute, with a head being installed at the floor level with the lowest intake point into the chute. Previously, these additional sprinkler heads were only required where the chute extended through three or more floors. These provisions, plus the previously discussed requirements for extensions, may result in additional sprinkler heads within some shafts as compared to the previous requirements.

Sprinklers in chutes that are in locations subject to freezing require freeze protection in accordance with the requirements of Section 903.3.1.1 and, therefore, the NFPA 13 standard. This can be accomplished using a dry-pendant sprinkler or constructing a dry-pipe sprinkler system.

[F] 903.2.11.3 Buildings 55 feet or more in height. An *automatic sprinkler system* shall be installed throughout buildings that have one or more stories with an *occupant load* of 30 or more located 55 feet (16 764 mm) or more above the lowest level of fire department vehicle access, measured to the finished floor.

Exceptions:

1. Open parking structures.
2. Occupancies in Group F-2.

❖ Because of the difficulties associated with manual suppression of a fire in mid-rise buildings in excess of 55 feet (16 764 mm) above the lowest level of fire department vehicle access, an automatic sprinkler system is required throughout the building regardless of occupancy. Buildings that qualify for a sprinkler system under this section are not necessarily high-rise buildings as defined in Section 202 and are focused also on those with occupants located on the upper floors. These provisions apply only to buildings with occupied floors having an occupant load of 30 or more located on stories 55 feet or greater from fire department vehicle access. The 55 feet is measured to the finished floor (see Commentary Figure 903.2.11.3).

The listed exceptions are occupancies that, based on height only, do not require an automatic sprinkler system. Open parking structures are also exempt from the high-rise provisions of Section 403. Although an automatic sprinkler system is not required in open parking structures, a sprinkler system may still be needed, depending on the building construction type and the area and number of parking tiers (see Table 406.3.5).

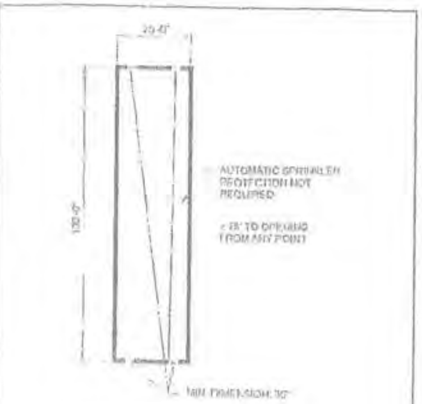
[F] 903.2.11.4 Ducts conveying hazardous exhausts. Where required by the *International Mechanical Code*, automatic sprinklers shall be provided in ducts conveying hazardous exhaust or flammable or combustible materials.

Exception: Ducts where the largest cross-sectional diameter of the duct is less than 10 inches (254 mm).

❖ Section 510 of the IMC addresses the requirements for hazardous exhaust systems. To protect against the spread of fire within a hazardous exhaust system and to prevent a duct fire from involving the building, an automatic sprinkler system must be installed to protect the exhaust duct system. Where materials conveyed in the ducts are not compatible with water, alternative extinguishing agents should be used. The fire suppression requirement is intended to apply to exhaust systems having an actual fire hazard. An automatic sprinkler system in the duct would be of little value for an exhaust system that conveys only nonflammable or noncombustible materials, fumes, vapors or gases.

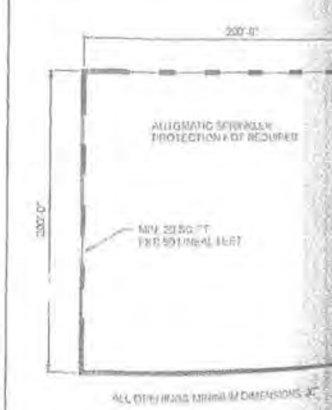
The exception recognizes the reduced hazard associated with smaller ducts and the impracticality of installing sprinkler protection. Another exception in the IMC indicates that laboratory hoods that meet specific provisions of the IMC are not required to be suppressed. Because the IMC is more specific in this regard, it should be consulted for the proper application of the exception.

[F] 903.2.11.5 Commercial cooking operations. An *automatic sprinkler system* shall be installed in commercial



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m².

Figure 903.2.11.1.2(3)
OPENINGS IN STORIES OR BASEMENTS—LESS THAN 75 FEET FROM ANY POINT TO AN OPENING



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m².

Figure 903.2.11.1.2(4)
OPENINGS IN STORIES OR BASEMENTS

kitchen exhaust hood and duct systems where an *automatic sprinkler system* is used to comply with Section 904.

❖ An automatic suppression system is required for commercial kitchen exhaust hood and duct systems where required by Section 609 of the IFC or by the IMC to have a Type I hood. Type I hoods are required for commercial cooking equipment that produces grease-laden vapors or smoke. Section 904.12 recognizes that alternative extinguishing systems other than an automatic sprinkler system may be used. Where an automatic sprinkler system is used for commercial cooking operations, it must comply with the requirements identified in Section 904.11.4.

[F] 903.2.11.6 Other required suppression systems. In addition to the requirements of Section 903.2, the provisions indicated in Table 903.2.11.6 require the installation of a fire suppression system for certain buildings and areas.

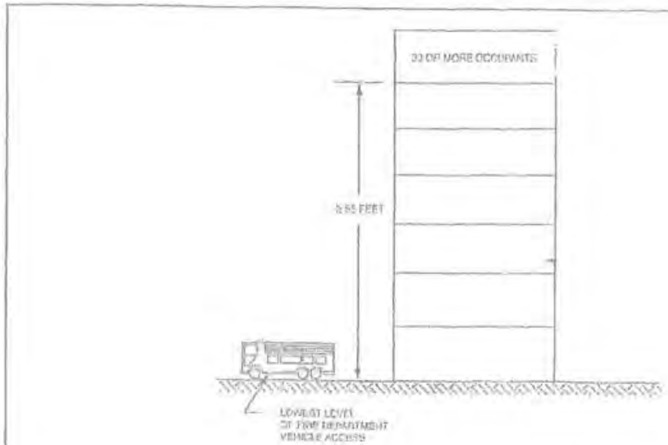
❖ In addition to Section 903.2, requirements for automatic fire suppression systems are also found elsewhere in the code as indicated in Table 903.2.11.6.

TABLE 903.2.11.6. See next column.

❖ Table 903.2.11.6 identifies other sections of the code that require an automatic fire suppression system based on the specific occupancy or use because of the unique hazards of such use or occupancy. The table does not identify the various sections of the code that contain design alternatives based on the use of an automatic fire suppression system, typically an automatic sprinkler system.

[F] TABLE 903.2.11.6
ADDITIONAL REQUIRED SUPPRESSION SYSTEMS

SECTION	SUBJECT
402.5, 402.6.2	Covered and open mall buildings
403.3	High-rise buildings
404.3	Atriums
405.3	Underground structures
407.6	Group I-2
410.7	Stages
411.4	Special amusement buildings
412.3.6	Airport traffic control towers
412.4.6, 412.4.6.1, 412.6.5	Aircraft hangars
415.11.11	Group H-5 HPM exhaust ducts
416.5	Flammable finishes
417.4	Drying rooms
419.5	*Live/work units*
424.3	Children's play structures
507	Unlimited area buildings
509.4	Incidental uses
1029.6.2.3	Smoke-protected assembly seating
IFC	Sprinkler system requirements as set forth in Section 903.2.11.6 of the *International Fire Code*



For SI: 1 foot = 304.8 mm.

Figure 903.2.11.3
SPRINKLER REQUIREMENTS: OCCUPANTS 55 FEET OR GREATER FROM FIRE DEPARTMENT VEHICLE ACCESS

903.2.12 During construction. *Automatic sprinkler systems* required during construction, *alteration* and demolition operations shall be provided in accordance with Chapter 33 of the *International Fire Code*.

❖ Chapter 33 of the code and Chapter 14 of the IFC address fire safety requirements during construction, alteration or demolition work. Working sprinkler systems should remain operative at all times unless it is absolutely necessary to shut down the system because of the proposed work. All sprinkler system impairments should be rectified as quickly as possible unless specific prior approval has been obtained from the fire code official. Buildings with a required sprinkler system should not be occupied unless the sprinkler system has been installed and tested consistent with Section 901.5. If the system must be placed out of service, the requirements of Section 901.7 of the IFC are necessary to address the temporary impairment to the fire protection system.

[F] 903.3 Installation requirements. *Automatic sprinkler systems* shall be designed and installed in accordance with Sections 903.3.1 through 903.3.8.

❖ Specific design, installation and testing criteria are given for automatic sprinkler systems in the sections and subsections that follow, as well as an indication of the applicability of a nationally recognized standard in the area. The information required to complete a thorough review of an automatic sprinkler system is listed in Commentary Figure 903.3.

[F] 903.3.1 Standards. Sprinkler systems shall be designed and installed in accordance with Section 903.3.1.1 unless otherwise permitted by Sections 903.3.1.2 and 903.3.1.3 and other chapters of this code, as applicable.

❖ Automatic sprinkler systems are to be installed to comply with the code and NFPA 13, 13R or 13D. As provided for in Section 102.4, where differences occur between the code and NFPA 13, 13R or 13D, the code applies. The fire code official also has the authority to approve the type of sprinkler system to be installed. See Commentary Figure 903.3.1 for typical design parameters for each type of sprinkler system.

This section also provides a pointer to other sections of the code that might provide more specific or related sprinkler requirements such as those found in Chapter 4 of the code.

[F] 903.3.1.1 NFPA 13 sprinkler systems. Where the provisions of this code require that a building or portion thereof be equipped throughout with an *automatic sprinkler system* in accordance with this section, sprinklers shall be installed throughout in accordance with NFPA 13 except as provided in Sections 903.3.1.1.1 and 903.3.1.1.2.

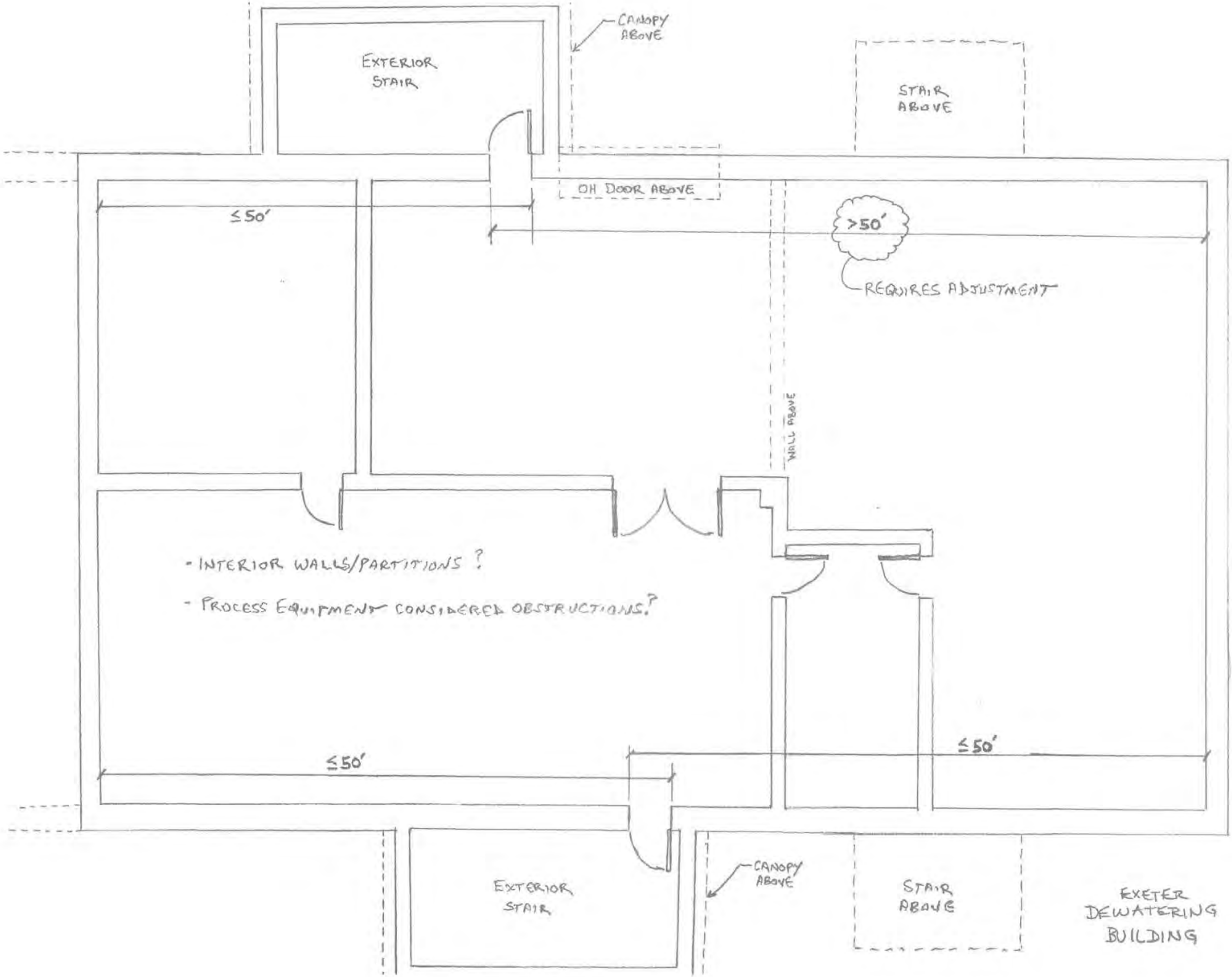
❖ NFPA 13 contains the minimum requirements for the design and installation of automatic water sprinkler systems and exposure protection sprinkler systems. The requirements contained in the standard include the character and adequacy of the water supply and the selection of sprinklers, piping, valves and all of the materials and accessories. The standard does not include requirements for installation of private fire service mains and their appurtenances; installation of fire pumps or construction and installation of gravity and pressure tanks and towers.

NFPA 13 defines seven classifications or types of water sprinkler systems: wet pipe [see Commentary Figure 903.3.1.1], dry pipe, preaction or deluge; combined dry pipe and preaction; antifreeze systems; sprinkler systems that are designed for a special purpose and outside sprinklers for exposure protection. While numerous variables must be considered in selecting the proper type of sprinkler system, the wet-pipe sprinkler system is recognized as the most effective and efficient. The wet-pipe system is also the most reliable type of sprinkler system, because water under pressure is available at the sprinkler. Therefore, wet-pipe sprinkler systems are recommended wherever possible.

The extent of coverage and distribution of sprinklers is based on the NFPA 13 standard. Numerous conditions exist in the standard where sprinklers are specifically required and also where they may or may not be located. Once it is determined that the sprinkler system is to be in accordance with NFPA 13, that standard must be reviewed for installation details. For example, exterior spaces such as combustible canopies are required to be equipped with sprinklers according to Section 8.15.7 of NFPA 13 where the canopy extends for a distance of 4 feet (1219 mm) or more. A 3-foot (914 mm) combustible canopy would not require sprinklers nor would a 6-foot (1829 mm) canopy constructed of noncombustible materials, provided there is no combustible storage under the canopy.

Because installation is required to be in accordance with NFPA 13, if the standard allows for the omission of sprinklers in any location, then the building is still considered as sprinklered throughout. For example, Section 8.15.8.1.1 of NFPA 13 allows sprinklers to be omitted from bathrooms in dwelling units in motels and hotels. If sprinklers are not provided in the bathrooms because of the conditions stipulated in NFPA 13, the building would still be considered as sprinklered throughout in accordance with the code, NFPA 13 and the IFC.

Exceptions for the use of NFPA 13R and 13D systems are addressed throughout the code when exceptions based on the use of sprinklers are provided. More specifically, if the use of these other standards is appropriate it will be noted within the exception. For a building to be considered "equipped throughout" with an NFPA 13 sprinkler system, complete protection must be provided in accordance with the referenced standard, subject to the exempt locations indicated in Section 903.3.1.1.1. See Commentary Figure 904.2.1 for examples of requirements modified through the use of sprinkler systems.



EXTERIOR STAIR
CANOPY ABOVE
STAIR ABOVE
OH DOOR ABOVE
≤50'
>50'
REQUIRES ADJUSTMENT
WALL ABOVE
- INTERIOR WALLS/PARTITIONS ?
- PROCESS EQUIPMENT CONSIDERED OBSTRUCTIONS?
≤50'
≤50'
EXTERIOR STAIR
CANOPY ABOVE
STAIR ABOVE
EXETER DEWATERING BUILDING

VE RECOMMENDATION

PROJECT ELEMENT: **Headworks Building**

PREPARED BY: SCD

Original Design Description: (Attach sketch if applicable)

The Headworks Building will be a new building to receive the influent and remove grit and screenings. It will be approximately 41 feet wide by 56 feet long and 2 stories high. Half of the length of the lower floor will be wastewater channels and grit removal units and the other half storage, pump and container rooms. The entire upper level will be an electrical room and a grit/screenings room.

Proposed Design Description: (Attach sketch if applicable)

Remove "upper level" of headworks building and provide canopy over the influent headworks screening equipment and the grit clasifier.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:

Cost savings.

Potential positive schedule impacts.

Disadvantages:

Process equipment not in a conditioned space.

Some maintenance will take place outside.

Winter conditions may cause freezing.

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$1,064,284		
VE PROPOSAL	$498,100		
SAVINGS	$566,184		

Date: 12/11/15

CALCULATION SHEET

PREPARED BY: SCD

ELEMENT **Headworks Building**

Original Building Costs:

Architectural	$415,284
Structural	$442,000
HVAC/Plumbing	$71,000
Electrical	$136,000
Total:	$1,064,284

Process Costs (to remain):

Screenings and Grit Removal:	$658,000	
Instrumentation:	$35,136	
	$34,518	← $276,147 / 8
	$17,851	← $142,809 / 8
Total:	$745,505	

Revised Headworks Building Costs:

Remove Upper Level of Headworks Building:			
Estimated at 65% of overall building costs:			-$691,784
Subtotal Revised Headworks Building Costs:			$372,500
Add Canopy and Freeze Protection:			
Add pipe heat trace:	100 LF	$40	$4,000
Add chute jacket:	20 LF	$80	$1,600
Canopy structure:	1 EA	$105,000	$105,000
Miscellaneous	1 LS	$15,000	$15,000
Subtotal add Canopy and Freeze Protection:			$125,600
Total Estimated Cost:			$498,100

Exeter, NH
Wastewater Treatment Facilty Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: **Maintenance Building**

PREPARED BY: SCD

Original Design Description: (Attach sketch if applicable)

The Maintenance Building will be a new building with one vehicular bay for the vac truck, one bay for the plow and service trucks and additional space to the side for maintenance, an electrical room and a single user bathroom. The building will be a pre-engineered metal framed building. It will be approximately 46 feet wide by 46 feet long and 1 story high.

Proposed Design Description: (Attach sketch if applicable)

Because the Maintenance Building is not directly related to the WWTF process, the deletion of this building could be a potential cost savings measure.

OR

Defer construction of this building to the Public Works "master plan" being developed by the Turner Group so that it ties in more efficiently with the long term master plan.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:

Cost savings.

Potential positive schedule impacts.

Disadvantages:

Appears to be an important item for the Town.

Equipment remains unprotected.

Current situation would remain.

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$338,599		
VE PROPOSAL	$0		
SAVINGS	$338,599		

WASTEWATER TREATMENT FACILITY UPGRADE DESIGN
V.E. WORKSHOP
Date: 12/11/15

CALCULATION SHEET

PREPARED BY: SCD

ELEMENT **Maintenance Building**

Maintenance Building:

Architectural	$148,139
Structural	$84,000
HVAC/Plumbing	$56,460
Electrical	$50,000
Total:	$338,599

MAIN PUMP STATION

Exeter, NH
Wastewater Treatment Facilty Upgrade Design
V.E. Workshop

December 7-11, 2015

VE RECOMMENDATION

PROJECT ELEMENT: New 16" Force Main Installation

PREPARED BY: Stephen Cluff

Original Design Description: (Attach sketch if applicable)

Original design of the 16" ductile iron forcemain includes installation using open excavation.

Proposed Design Description: (Attach sketch if applicable)
Evaluated the applicability of other trenchless technology including horizontal directional drilling (HDD) and pipe bursting. Recommend further reevaluate pipe bursting existing force main to either current size or higher to eliminate new force main dependent upon any design flow modification.

Withdrawn from further consideration due to low expected benefit at current design flow.

DISCUSSION OF PROPOSED ALTERNATIVE DESIGN:

Advantages:	Disadvantages:
Potential Cost Savings	Temporary Bypass Pumping Required
	One force main leads to less operational flexibility
	Minimal cost savings expected

NOTE: See attached calculations for details

LIFE CYCLE COST SUMMARY	INITIAL CAP. COST	O&M COST	LIFE CYCLE COST
ORIGINAL DESIGN	$657,400	N/A	N/A
VE PROPOSAL	N/A	N/A	N/A
SAVINGS	N/A	N/A	N/A

SECTION 7– APPENDICES

7.1
DESIGN WASTEWATER FLOWS AND LOADS AND DESIGN DATA SUMMARY

TABLE 2-12
FUTURE WASTEWATER FLOW PROJECTIONS

Category	Current 2014 (gpd)	Future Planning Horizon 2014 to 2040 (gpd)	Future Theoretical Build-out 2040+ (gpd)
Existing Flows			
Residential	490,000	-	-
Institutional	100,000	-	-
Commercial/Industrial	330,000	-	-
Sewer Only	80,000	-	-
Inflow/Infiltration	700,000	-	-
Septage	0	-	-
Total – Existing Flows	**1,700,000**	**1,700,000**	**1,700,000**
Sewered Area - Redevelopment	-	200,000	200,000
Sewered Area – Developable Parcels	-	247,300	494,400
Sewer Extension – Existing Parcels	-	34,200	34,200
Sewer Extension – Developable Parcels	-	116,400	232,900
Sewer Extension – Developed/ TN Mgmt	-	2,200	2,200
Septage	-	3,000	3,000
Total – Exeter	1,700,000	**2,303,100**	**2,666,700**
New Flows – Other Towns	-	300,000	777,000
Future I/I to be Removed	-	-	(443,700)
Total – with Regional	1,700,000	**2,603,100**	**3,000,000**
% of Total Flow from Other Towns	-	*12%*	*26%*

TABLE 2-13
EXISTING AND PROJECTED WASTEWATER FLOWS AND LOADS

	Existing No Septage (Current)	Projected Without Septage (2040)	Projected With Septage (2040)
Flows (MGD)			
Annual Average (Note 3)	1.71*	3.00	3.00
Minimum Month	1.18*	1.60	1.60
Maximum Month	2.88*	5.10	5.10
Maximum Two-Week	3.09*	5.40	5.40
Maximum Day (99.5th Percentile)	3.75*	6.60	6.60
Instantaneous Peak Flow (100th Percentile)	5.65*	9.75	9.75
Biochemical Oxygen Demand (lbs/day)			
Annual Average	2,138*	5,400	5,600
Maximum Month	3,484*	6,800	7,100
Maximum Day	4,210*	7,900	8,200
Total Suspended Solids (lbs/day)			
Annual Average	2,544*	6,000	6,400
Maximum Month	3,632*	10,500	11,200
Maximum Day	4,376*	12,600	13,400
Ammonia-Nitrogen (lbs/day)			
Annual Average	265**	550	570
Maximum Month	320**	660	680
Maximum Day	360**	750	780
Total Kjeldahl Nitrogen (lbs/day)			
Annual Average	306**	690	710
Maximum Month	320**	910	940
Maximum Day	480**	1090	1120
Total Phosphorus (lbs/day)			
Annual Average	45**	110	120
Maximum Month	57**	140	150
Maximum Day	77**	190	210

Notes:
1) "*" denotes measured data for 2011 to 2013.
2) "**" denotes measured data for 2010 and 2014 only, limited data set.
3) Existing and projected conditions exclude on-site recycle flows & loads
4) Existing permitted flow and design flow is 3.0-mgd.
5) Future peak flows to WWTF will be increased in order to reduce or eliminate CSO activity in the collection system.

TABLE 5
4-STAGE BARDENPHO PROCESS MODELING RESULTS – FUTURE DESIGN CONDITIONS

	Annual Average (2 Trains)	Annual Average (3 Trains)	Max Month (3 Trains)
Plant Influent			
Flow rate, mgd	3.00	3.00	5.00
Peak Day Flow Rate, mgd	6.60	6.60	6.60
Peak Inst. Flow Rate, mgd	9.50	9.50	9.50
Peak Inst. Flow Rate to Secondary Process, mgd	6.60	6.60	6.60
BOD5, mg/L	200	200	187
TSS, mg/L	216	216	187
VSS, mg/L	194	194	168
TKN, mg/L	44.0	44.0	38.0
NH3, mg/L	33.0	33.0	28.5
NOx, mg/l	0.0	0.0	0.0
P, mg/L	6.0	6.0	5.0
Ortho P, mg/l	3.4	3.4	2.8
Temp, C	10	10	10
Aeration Tanks			
No. of Tanks per Train	4	4	4
Total No. of Tanks	8	12	12
Total Volume, Mgal	1.86	2.78	2.78
Volume, Pre-Anoxic, Mgal	0.37	0.55	0.55
Volume, Post-Anoxic, Mgal	0.37	0.56	0.56
HRT, Total Anoxic, hr	5.92	8.88	5.30
Volume, Pre-Aerobic Mgal	1.10	1.65	1.65
Volume, Re-Aeration, Mgal	0.02	0.02	0.02
HRT, Pre-Aerobic, hr	8.80	13.20	7.92
HRT, Total Aerobic, hr	8.92	13.38	8.03
SRT, Aerobic, days	8.00	8.00	12.00
MLVSS, Oxic Zone, mg/L	2667	1631	3286
MLSS, Oxic Zone, mg/L	3310	2018	4109
HRT, Total, hr	14.84	22.26	13.33
Actual Oxygen Requirement, lb/d	8,136	8,004	11,820
Standard Oxygen Requirement, lb/d	23,743	23,358	34,310
Total estimated airflow, scfm	3,097	3,046	4,475
Internal Recyle, mgd	12.00	12.00	20.00
Supplemental Alkalinity Addition, lb/d $CaCO_3$	1,750	1,750	2,550
Supplemental Carbon Addition,	100	100	25

	Annual Average (2 Trains)	Annual Average (3 Trains)	Max Month (3 Trains)
methanol gpd			
Supplemental Carbon Addition, lbsCOD/day	991	991	248
Secondary Clarifier			
No. of Tanks Online	2	3	3
Diameter, ft	75	75	75
Depth, ft	16	16	16
SOR, average day, gal/sf/d	445	296	495
SLR, peak day, lb/sf/d	33.4	13.6	31.1
Effluent Quality			
Effluent BOD5, mg/l	3.4	2.4	3.0
Effluent COD, mg/l	32.4	28.4	32.3
Effluent TKN, mg/l	1.5	1.5	3.1
Effluent NH3, mg/l	1.0	1.0	1.0
Effluent NOx, mg/l	1.0	1.0	1.2
Effluent TN, mg/l	3.5	3.5	3.8
Effluent TN, lbs/day	74	74	155
Effluent P, mg/l	3.3	2.9	2.6
Effluent TSS, mg/l	8.1	4.5	9.4
Waste Activated Sludge			
Flow rate, mgd	0.0332	0.07	0.0459
TSS, mg/L	9,892	6,028	12,274
VSS, mg/L	7,967	4,868	9,807
WAS, lb/d	3,380	3,538	4,699

As shown in Table 3, expanding the MLE process presented in Section 4.1.1 to a 4-stage Bardenpho process with carbon addition will allow treatment to 3.5 mg/L TN. The model shows the Bardenpho process achieving TN concentrations 3.8 mg/L at maximum month conditions. As discussed previously, it is assumed that a tertiary denitrification filter will be used to achieve treatment to below 3 mg/L TN.

As shown in the Table 3, in order to provide sufficient aerobic solids retention time of 12 days at maximum month conditions to ensure nitrification at the low temperature of 10°C, a mixed liquor suspended solids (MLSS) concentration in the secondary system of 4,109 mg/L was

SECTION 7.2
COST ESTIMATE
AND
CONSTRUCTION COST VALIDATION

PRELIMINARY DESIGN REPORT
Cost Estimate Backup
for the
TOWN OF EXETER, NH
WWTF & MAIN PUMP STATION UPGRADE

October 2015

WRIGHT-PIERCE
Engineering a Better Environment

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE
PRELIMINARY DESIGN REPORT
COST ESTIMATE BACKUP

OCTOBER 2015

Prepared By:

Wright-Pierce
230 Commerce Way, Suite 302
Portsmouth, NH 03801

TOWN OF EXETER, NEW HAMPSHIRE
WWTF PRELIMINARY DESIGN
W-P PROJECT NO. 12883B
ENR INDEX 10037 (September 2015)

TABLE 4-1
ESTIMATED CAPITAL COSTS FOR CONTRACTS 1, 2, 3 AND 4
BEFORE VALUE ENGINEERING

Project Component		**CONTRACT 1** WWTF TN 4 mg/l	**CONTRACT 2/3** Main Pump Station FM & WM	**CONTRACT 4** Lagoon Decommissioning	**Notes**
Construction		$34,400,000	$5,050,000	$8,720,000	1
Construction Contingency	5%	$1,720,000	$250,000	$440,000	2
Technical Services		$6,880,000	$1,010,000	$870,000	3
Value Engineering		$60,000	$0	$0	4
Materials Testing	0.25%	$90,000	$10,000	$20,000	5
Asbestos and Lead Paint Abatement		$0	$10,000	$0	6
Activated Sludge Seeding		$10,000	$0	$0	
Direct Equipment Purchase		$0	$0	$0	7
Land Acquisition/Easements		$0	$0	$0	7
Legal/Administrative		$10,000	$10,000	$10,000	8
Interim Financing	0.5%	$220,000	$30,000	$50,000	9
ENGINEER'S ESTIMATE		$43,390,000	$6,370,000	$10,110,000	10,11
Toplist Amounts from Facilities Plan		*$39,830,000*	*$5,070,000*	*$6,970,000*	
Differential from Facilities Plan		*$3,560,000*	*$1,300,000*	*$3,140,000*	
% differential from Facilities Plan		*9%*	*26%*	*45%*	
TOTAL - CONTRACTS 1 TO 4		$59,870,000	<< Note 12		
Total from Facilities Plan		*$51,870,000*			
Differential from Facilities Plan		*$8,000,000*			
% differential from Facilities Plan		*15%*			
TOTAL - CONTRACTS 1/2/3		$49,760,000	<< For Town Meeting 2016		

Notes

1.) Construction cost estimate details provided in Appendices. Costs based on ENR CCI 10037.
2.) Construction contingency is an allowance at 5% of construction cost.
3.) Technical services is an allowance at 20% of construction cost for Contracts 1/2/3 and 10% for Contract 4.
4.) Value engineering is an allowance assuming two sessions.
5.) Materials testing is an allowance based on similar sized projects.
6.) Asbestos and lead paint is not anticipated at the WWTF site, but should be evaluated at the Main Pump Station site.
7.) None anticipated
8.) Legal/administrative costs are for bond counsel and project advertisements.
9.) Financing is an allowance based on assumed interim financing costs at 0.5%.
10.) DES estimate for 5 mg/l effluent TN for Exeter was $44M ("Analysis of Nitrogen Loading Reductions for WWTF and NPS in the Great Bay Estuary Watershed", Dec 2010, ENR 8660).
11.) Contract 4 represents the cost for Option 3 "coastal wetlands creation" (Section 2.5.16), which is more than identified in the Wastewater Facilities Plan. The total cost for Option 2 "upland wetlands restoration" (Section 2.5.16) is $6.9M, which is the same as was identified in the Wastewater Facilities Plan. Under either scenario, approximately $3.8M is related to sludge removal and disposal.
12.) Total cost of $59.8M includes Contract 4/Option 3 ("coastal wetlands creation").
Total cost is $56.7M with Contract 4/Option 2 ("upland wetlands restoration").
Total costs is $53.5 with Contract 4/Option 1 ("keep lagoons for storage").

TOWN OF EXETER, NEW HAMPSHIRE
WWTF PRELIMINARY DESIGN
W-P PROJECT NO. 12883B
ENR INDEX 10037 (September 2015)

TABLE 4-2
CONSTRUCTION COST ESTIMATE FOR CONTRACTS 1, 2, 3, AND 4
BEFORE VALUE ENGINEERING

DESCRIPTION	CONTRACT 1 WWTF TN 4 mg/l	CONTRACT 2/3 Main Pump Station FM & WM	CONTRACT 4 Lagoon Decommissioning
CIVIL			
MPS FORCEMAIN & WATERMAIN		$1,650,000	
MPS SITE PIPING AND SITE WORK		$100,000	
WWTF DEMOLITION	$222,000		
WWTF SITE WORK	$1,150,000		
WWTF SITE DRAINAGE	$264,000		
WWTF INVASIVE SPECIES MANAGEMENT	$450,000		
WWTF ELECTRICAL DUCTBANKS AND PADS	$125,000		
WWTF SITE PIPING	$1,540,000		
ARCHITECTURAL			
MAIN PUMP STATION MODIFICATIONS		$93,000	
CONTROL BUILDING MODIFICATIONS	$302,000		
GRIT BUILDING MODIFICATIONS (SEPTAGE RECEIVING)	$78,000		
HEADWORKS BUILDING (NEW)	$416,000		
CHEMICAL BUILDING MODIFICATIONS (PW BLDG)	$67,000		
DISINFECTION BUILDING (NEW)	$78,000		
SOLIDS HANDLING BUILDING (NEW)	$921,000		
SUPPLEMENTAL CHEMICAL BUILDING (NEW)	$187,000		
MAINTENANCE GARAGE (NEW)	$149,000		
PROCESS EQUIPMENT & PIPING FINISHES	$100,000		
STRUCTURAL			
MAIN PUMP STATION CHANNELS & VAULT		$150,000	
CONTROL BUILDING MODIFICATIONS	$19,000		
GRIT BUILDING MODIFICATIONS (SEPTAGE RECEIVING)	$47,000		
HEADWORKS BUILDING (NEW)	$442,000		
CHEMICAL BUILDING MODIFICATIONS (PW BLDG)	$10,000		
DISINFECTION MODIFICATIONS	$110,000		
INFLUENT EQUALIZATION	$50,000		
AERATION TANKS / BNR (NEW)	$2,500,000		
SECONDARY CLARIFICATION & SCUM SYSTEM (NEW)	$1,900,000		
SOLIDS HANDLING BUILDING (NEW)	$875,000		
SUPPLEMENTAL CHEMICAL BUILDING (NEW)	$55,000		
MAINTENANCE GARAGE (NEW)	$84,000		
YARD WASTE PUMP STATION	$50,000		
PARSHALL FLUME	$20,000		
SLUDGE STORAGE TANKS (NEW)	$780,000		
JUNCTION STRUCTURES (NEW)	$200,000		
CONCRETE CRACK/SPALL REPAIR	$55,000		
PROCESS			
MAIN PUMP STATION UPGRADE		$525,000	
WWTF PROCESS DEMOLITION	$39,000		
SEPTAGE RECEIVING	$212,000		
SCREENINGS AND GRIT REMOVAL	$658,000		
INFLUENT EQUALIZATION BASINS	$164,000		
PRIMARY TREATMENT	Future phase		
AERATION TANKS / BNR	$1,124,000		
SECONDARY CLARIFICATION	$870,000		
SUPPLEMENTAL ALKALINITY SYSTEM	$97,000		
SUPPLEMENTAL CARBON SYSTEM	$74,000		
TERTIARY TREATMENT (including excavation, piping, building)	Future phase		
UV DISINFECTION	$629,000		
OUTFALL	$0		
SLUDGE STORAGE TANKS	$189,000		
SOLIDS PROCESSING SYSTEMS	$1,236,000		
POLYMER SYSTEM	$107,000		
PERMANGANATE SYSTEM	$0		
PLANT WATER SYSTEM	$227,000		
YARD WASTE PUMP STATION	$220,000		
ODOR CONTROL SYSTEMS	$263,000		
JUNCTION STRUCTURES/GATES	$0		
HVAC/PLUMBING		$71,000	
CONTROL BUILDING	$170,000		
GRIT BUILDING MODIFICATIONS (SEPTAGE RECEIVING)	$40,000		

TOWN OF EXETER, NEW HAMPSHIRE
WWTF PRELIMINARY DESIGN
W-P PROJECT NO. 12883B
ENR INDEX 10037 (September 2015)

TABLE 4-2
CONSTRUCTION COST ESTIMATE FOR CONTRACTS 1, 2, 3, AND 4
BEFORE VALUE ENGINEERING

DESCRIPTION		CONTRACT 1 WWTF TN 4 mg/l	CONTRACT 2/3 Main Pump Station FM & WM	CONTRACT 4 Lagoon Decommissioning
CHEMICAL BUILDING MODIFICATIONS (PW BLDG)		$10,000		
SUPPLEMENTAL CHEMICAL BUILDING (NEW)		$15,000		
HEADWORKS BUILDING (NEW)		$75,000		
SOLIDS HANDLING BUILDING (NEW)		$150,000		
MAINTENANCE GARAGE (NEW)		$60,000		
INSTRUMENTATION				
INSTRUMENTS		$260,000	$15,000	
CONTROL PANELS AND NETWORK		$270,000	$20,000	
SCADA SYSTEM HARDWARE, SOFTWARE & PROGRAMMING		$253,400	$17,000	
ELECTRICAL				
MAIN PUMP STATION (w/NG Genset)			$650,000	
WWTF STANDBY POWER (NG Genset)		$550,000		
WWTF ELECTRICAL DISTRIBUTION		$2,200,000		
WWTF ELECTRICAL SITE LIGHTING/MANHOLES		$170,000		
WWTF FIRE SYSTEM		$80,000		
WWTF PAGING SYSTEM		$0		
WWTF SECURITY SYSTEM		$0		
WWTF ELECTRICAL DEMOLITION		$100,000		
SPECIALS				
MOBILIZATION/DEMOBILIZATION		$100,000	$50,000	$50,000
SHEETING		$0	$0	
PILES		$0	$0	
BYPASS PUMPING		$0	$155,000	
GROUNDWATER DEWATERING		$100,000	$50,000	
CONTAMINATED SOILS & GROUNDWATER		none	$50,000	none
LAGOON - SLUDGE REMOVAL & DISPOSAL		$200,000	none	$2,500,000
LAGOON - EMBANKMENT REMOVAL/ WETLAND CREATION		none	none	$4,300,000
SUBTOTAL, CONSTRUCTION		$19,749,000	$2,822,000	$6,850,000
GENERAL CONTRACTOR OH&P, GENERAL CONDITIONS	15.0%	$2,962,000	$423,000	$0
SUBTOTAL, SUBCONTRACTORS		$4,403,400	$848,000	$0
GENERAL CONTRACTOR MARKUP	5.0%	$220,000	$42,000	$342,500
ELECTRICAL/ TELEPHONE/ GAS ALLOWANCES		$90,000	$20,000	$0
BONDS AND INSURANCE	1.5%	$360,000	$60,000	$100,000
UNIT PRICE ITEMS		$974,000	$0	$0
SUBTOTAL, CONSTRUCTION COSTS		$28,760,000	$4,220,000	$7,290,000
PROJECT MULTIPLIER, DESIGN CONTINGENCY	1.15			
PROJECT MULTIPLIER, INFLATION TO MIDPT CONST.	1.04			
ENGINEERS ESTIMATE OF CONSTRUCTION COST		**$34,400,000**	**$5,050,000**	**$8,720,000**

Hazen

TOWN OF EXETER, NEW HAMPSHIRE

WWTF

CONTRACT 1

PRELIMINARY DESIGN REPORT BASE ESTIMATE RECREATED

Estimator:		*Date:*	
Reviewer:	*Brian Como*	*Date:*	*12/9/2015*

CSI #	Description		Total
	General Conditions/Indirect Costs – Included Below	*0.0%*	$ -
	Civil		$ 3,754,000
	Architectrual		$ 2,293,000
	Structural		$ 7,193,000
	Process		$ 6,109,000
	HVAC/Plumbing (sub OH&P backed-out)		$ 452,174
	Instrumentation (sub OH&P backed-out)		$ 681,217
	Electrical (sub OH&P backed-out)		$ 2,695,652
Special Conditions	*Specials*		$ 400,000
		Subtotal:	**$ 23,578,043**
	Value of Subcontracted Work	$ 3,829,043	
	Subcontractor Overhead, Profit & Fee	*15.0%*	$ 574,357
		Subtotal:	**$ 24,152,400**
	Prime Contractor Overhead, Profit and General Conditions (Not on subcontract)	*15.0%*	$ 2,962,350
		Subtotal:	**$ 27,114,750**
	Prime Contractor Profit (Not on subcontract)	*0.0%*	$ -
		Subtotal:	**$ 27,114,750**
	Prime Contractor Profit (On subcontract only)	*5.0%*	$ 220,170
		Subtotal:	**$ 27,334,920**
	Bond and Insurance taken on $ 24,152,400	*1.5%*	$ 362,286
		Subtotal:	**$ 27,697,206**
	Contract Allowances (Electrical / Telephone / Gas)		$ 90,000
	Unit Price Items		$ 974,000
		Subtotal:	**$ 28,761,206**
	Design Contingency	*15.0%*	$ 4,314,181
		Subtotal:	**$ 33,075,387**
	Escalation	*4.0%*	$ 1,323,015
		Subtotal:	**$ 34,398,402**
		Total (Rounded):	**$ 34,400,000**

Note: Project Assumptions NTP: 1/30/17, 627 CCD (21 months)

Hazen

TOWN OF EXETER, NEW HAMPSHIRE

MAIN PUMP STATION

CONTRACT 2/3

PRELIMINARY DESIGN REPORT BASE ESTIMATE RECREATED

Estimator:		Date:	
Reviewer:	Brian Como	Date:	12/9/2015

CSI #	Description				Total
	General Conditions/Indirect Costs - Included Below		0.0%	$	-
	Civil			$	1,750,000
	Architectrual			$	92,000
	Structural			$	150,000
	Process			$	525,000
	HVAC/Plumbing (sub OH&P backed-out)			$	61,739
	Instrumentation (sub OH&P backed-out)			$	45,217
	Electrical (sub OH&P backed-out)			$	565,217
Special Conditions	Specials			$	305,000
			Subtotal:	**$**	**3,494,174**
	Value of Subcontracted Work		$ 672,174		
	Subcontractor Overhead, Profit & Fee		15.0%	$	100,826
			Subtotal:	**$**	**3,595,000**
	Prime Contractor Overhead, Profit and General Conditions (Not on subcontract)		15.0%	$	423,300
			Subtotal:	**$**	**4,018,300**
	Prime Contractor Profit (Not on subcontract)		0.0%	$	-
			Subtotal:	**$**	**4,018,300**
	Prime Contractor Profit (On subcontract only)		5.0%	$	38,650
			Subtotal:	**$**	**4,056,950**
	Bond and Insurance taken on $	3,595,000	1.5%	$	53,925
			Subtotal:	**$**	**4,110,875**
	Contract Allowances (Electrical / Telephone / Gas)			$	20,000
	Unit Price Items			$	-
			Subtotal:	**$**	**4,130,875**
	Design Contingency		15.0%	$	619,631
			Subtotal:	**$**	**4,750,506**
	Escalation		4.0%	$	190,020
			Subtotal:	**$**	**4,940,527**
			Total (Rounded):	**$**	**4,900,000**

Note: Project Assumptions NTP: 1/30/17, 627 CCD (21 months)

Hazen

TOWN OF EXETER, NEW HAMPSHIRE

LAGOON

CONTRACT 4

PRELIMINARY DESIGN REPORT BASE ESTIMATE RECREATED

Estimator:		Date:	
Reviewer:	Brian Como	Date:	12/9/2015

CSI #	Description				Total
	General Conditions/Indirect Costs - Included Below		0.0%	$	-
	Civil				
	Architectrual				
	Structural				
	Process				
	HVAC/Plumbing				
	Instrumentation				
	Electrical				
Special Conditions	Specials			$	6,850,000
			Subtotal:	**$**	**6,850,000**
	Value of Subcontracted Work	$ -			
	Subcontractor Overhead, Profit & Fee		15.0%	$	-
			Subtotal:	**$**	**6,850,000**
	Prime Contractor Overhead, Profit and General Conditions (Not on subcontract)		0.0%	$	-
			Subtotal:	**$**	**6,850,000**
	Prime Contractor Profit (Not on subcontract)		5.0%	$	342,500
			Subtotal:	**$**	**7,192,500**
	Prime Contractor Profit (On subcontract only)		5.0%	$	-
			Subtotal:	**$**	**7,192,500**
	Bond and Insurance taken on $	6,850,000	1.5%	$	102,750
			Subtotal:	**$**	**7,295,250**
	Contract Allowances (Electrical / Telephone / Gas)			$	-
	Unit Price Items			$	-
			Subtotal:	**$**	**7,295,250**
	Design Contingency		15.0%	$	1,094,288
			Subtotal:	**$**	**8,389,538**
	Escalation		4.0%	$	335,582
			Subtotal:	**$**	**8,725,119**
			Total (Rounded):	**$**	**8,700,000**

Note: Project Assumptions NTP: 1/30/17, 627 CCD (21 months)

Hazen

TOWN OF EXETER, NEW HAMPSHIRE

WWTF

CONTRACT 1

PRELIMINARY DESIGN REPORT BASE ESTIMATE BY HAZEN

Estimator:		*Date:*	
Reviewer:	*Brian Como*	*Date:*	*12/9/2015*

CSI #	Description		Total	
	General Conditions/Indirect Costs (allow percentage)	*8.0%*	*$*	*1,886,243*
	Civil		*$*	*3,754,000*
	Architectrual		*$*	*2,293,000*
	Structural		*$*	*7,193,000*
	Process		*$*	*6,109,000*
	HVAC/Plumbing (sub OH&P backed-out)		*$*	*452,174*
	Instrumentation (sub OH&P backed-out)		*$*	*681,217*
	Electrical (sub OH&P backed-out)		*$*	*2,695,652*
Special Conditions	*Specials*		*$*	*400,000*
		Subtotal:	**$**	**25,464,287**
	Value of Subcontracted Work	*$ 3,829,043*		
	Subcontractor Overhead, Profit & Fee	*21.0%*	*$*	*804,099*
		Subtotal:	**$**	**26,268,386**
	Prime Contractor Overhead (Not on subcontract)	*10.0%*	*$*	*2,163,524*
		Subtotal:	**$**	**28,431,910**
	Prime Contractor Profit (Not on subcontract)	*5.0%*	*$*	*1,189,938*
		Subtotal:	**$**	**29,621,849**
	Prime Contractor Profit (On subcontract only)	*5.0%*	*$*	*231,657*
		Subtotal:	**$**	**29,853,506**
	Bond and Insurance taken on $ 29,853,506	*1.5%*	*$*	*447,803*
		Subtotal:	**$**	**30,301,309**
	Contract Allowances (Electrical / Telephone / Gas)		*$*	*90,000*
	Unit Price Items		*$*	*974,000*
		Subtotal:	**$**	**31,365,309**
	Design Contingency	*20.0%*	*$*	*6,273,062*
		Subtotal:	**$**	**37,638,370**
	Escalation	*5.5%*	*$*	*2,068,518*
		Subtotal:	**$**	**39,706,888**
		Total (Rounded):	**$**	**39,700,000**

Note: Project Assumptions NTP: 1/30/17, 627 CCD (21 months)

Hazen

TOWN OF EXETER, NEW HAMPSHIRE

MAIN PUMP STATION

CONTRACT 2/3

PRELIMINARY DESIGN REPORT BASE ESTIMATE BY HAZEN

Estimator:		Date:	
Reviewer:	Brian Como	Date:	12/9/2015

CSI #	Description			Total
	General Conditions/Indirect Costs (allow percentage)	8.0%	$	279,534
	Civil		$	1,750,000
	Architectrual		$	92,000
	Structural		$	150,000
	Process		$	525,000
	HVAC/Plumbing (sub OH&P backed-out)		$	61,739
	Instrumentation (sub OH&P backed-out)		$	45,217
	Electrical (sub OH&P backed-out)		$	565,217
Special Conditions	Specials		$	305,000
		Subtotal:	$	3,773,708
	Value of Subcontracted Work	$ 672,174		
	Subcontractor Overhead, Profit & Fee	21.0%	$	141,157
		Subtotal:	$	3,914,864
	Prime Contractor Overhead (Not on subcontract)	10.0%	$	310,153
		Subtotal:	$	4,225,018
	Prime Contractor Profit (Not on subcontract)	5.0%	$	170,584
		Subtotal:	$	4,395,602
	Prime Contractor Profit (On subcontract only)	5.0%	$	40,667
		Subtotal:	$	4,436,269
	Bond and Insurance taken on $ 4,436,269	1.5%	$	66,544
		Subtotal:	$	4,502,813
	Contract Allowances (Electrical / Telephone / Gas)		$	20,000
	Unit Price Items		$	-
		Subtotal:	$	4,522,813
	Design Contingency	20.0%	$	904,563
		Subtotal:	$	5,427,375
	Escalation	4.6%	$	251,342
		Subtotal:	$	5,678,718
		Total (Rounded):	$	5,700,000

Note: Project Assumptions NTP: 1/30/17, 365 CCD (12 months)

Hazen

TOWN OF EXETER, NEW HAMPSHIRE

LAGOON

CONTRACT 4

PRELIMINARY DESIGN REPORT BASE ESTIMATE BY HAZEN

Estimator:		*Date:*	
Reviewer:	*Brian Como*	*Date:*	*12/9/2015*

CSI #	Description				Total
	General Conditions/Indirect Costs - Included Below		*8.0%*	*$*	*548,000*
	Civil				
	Architectrual				
	Structural				
	Process				
	HVAC/Plumbing				
	Instrumentation				
	Electrical				
Special Conditions	*Specials*			*$*	*6,850,000*
			Subtotal:	**$**	**7,398,000**
	Value of Subcontracted Work	*$*	*-*		
	Subcontractor Overhead, Profit & Fee		*15.0%*	*$*	*-*
			Subtotal:	**$**	**7,398,000**
	Prime Contractor Overhead, Profit and General Conditions (Not on subcontract)		*0.0%*	*$*	*-*
			Subtotal:	**$**	**7,398,000**
	Prime Contractor Profit (Not on subcontract)		*0.0%*	*$*	*-*
			Subtotal:	**$**	**7,398,000**
	Prime Contractor Profit (On subcontract only)		*5.0%*	*$*	*-*
			Subtotal:	**$**	**7,398,000**
	Bond and Insurance taken on $	*7,398,000*	*1.5%*	*$*	*110,970*
			Subtotal:	**$**	**7,508,970**
	Contract Allowances			*$*	*-*
	Unit Price Items			*$*	*-*
			Subtotal:	**$**	**7,508,970**
	Design Contingency		*15.0%*	*$*	*1,126,346*
			Subtotal:	**$**	**8,635,316**
	Escalation		*10.2%*	*$*	*876,864*
			Subtotal:	**$**	**9,512,179**
			Total (Rounded):	**$**	**9,500,000**

Note: Project Assumptions NTP: 12/3/18, 473 CCD (16 months)

Escalation Calculation

	Example	Contract 1 Escalation Check 1	Escalation Check 2	Escalation Used
Date of Estimate Pricing	08/14/08	10/1/2015	10/1/2015	10/1/2015
Expected Start of Construction	06/01/12	1/30/2017	1/30/2017	1/30/2017
(a) Construction Duration (months)	36	20.90	20.90	20.90
(b) Annual Rate of Escalation	8.50%	3.00%	2.00%	2.50%
(c) # Months from Estimate to Start of Construction	46	16	16	16
(d) # Months to Midpoint of Construction	18	10	10	10
(c) + (d) Total # Months	64	26.0	26.0	26.0
(e) /12 months X (b) Escalation	54.511%	6.614%	4.384%	5.496%

	Example	Contract 2/3 Escalation Check 1	Escalation Check 2	Escalation Used
Date of Estimate Pricing	08/14/08	10/1/2015	10/1/2015	10/1/2015
Expected Start of Construction	06/01/12	1/30/2017	1/30/2017	1/30/2017
(a) Construction Duration (months)	36	20.90	20.90	12.17
(b) Annual Rate of Escalation	8.50%	3.00%	2.00%	2.50%
(c) # Months from Estimate to Start of Construction	46	16	16	16
(d) # Months to Midpoint of Construction	18	10	10	6
(c) + (d) Total # Months	64	26.0	26.0	22.0
(e) /12 months X (b) Escalation	54.511%	6.614%	4.384%	4.631%

	Example	Contract 4 Escalation Check 1	Escalation Check 2	Escalation Used
Date of Estimate Pricing	08/14/08	10/1/2015	10/1/2015	10/1/2015
Expected Start of Construction	06/01/12	1/30/2017	1/30/2017	12/3/2018
(a) Construction Duration (months)	36	20.90	20.90	15.77
(b) Annual Rate of Escalation	8.50%	3.00%	2.00%	2.50%
(c) # Months from Estimate to Start of Construction	46	16	16	39
(d) # Months to Midpoint of Construction	18	10	10	8
(c) + (d) Total # Months	64	26.0	26.0	47.0
(e) /12 months X (b) Escalation	54.511%	6.614%	4.384%	10.154%

7.3
SELECTED DRAWINGS

SECTION 7.4
SUPPLEMENTAL INFORMATION
ON ODOR CONTROL SYSTEM RECOMMENDATION

From: Cluff, Stephen <scluff@hazenandsawyer.com>
To: erushbrook <erushbrook@aol.com>
Cc: Mahoney, Deborah S <DMahoney@hazenandsawyer.com>
Subject: Ozone Type Odor Control
Date: Wed, Jan 6, 2016 1:56 pm
Attachments: Parkson-OHxyPhogg-Brochure.pdf (653K)

Ed,

This is the summary for an more appropriately named Oxidant Fogger Odor Control. I generally call it Ozone odor control which resulted in some confusion. ***For clarification, ozone is not directly injected into the wet well but is combined with compressed air and water*** to produce hydroxyl radicals that are sprayed into the wet well headspace in an atomized form. These hydroxyl radicals are in a very high oxidative state, and will oxidize the odors present. And because of the extended detention time, no active ventilation, they have more time needed to achieve the odor reduction. When the hydroxyl radicals have taken care of the odors, and are still active they will also work to reduce the buildup of FOG material in the wet well. Ozone is produced and mixed with water and compressed air to make the hydroxyl radicals. There may be some minimal residual ozone present, although the manufacturer may say that the design precludes this. Therefore, the designer/owner should be aware that certain materials of construction (like rubber) and ozone are not compatible and therefore, material selection such as electrical cables and other wet well components need to be ozone resistant.

Due to reports of limited odors at the Exeter main pump influent wet well and occasional fats, oils and grease (FOG) build-up, we recommend design and installation of this type of odor control system at this location. Vendors supplying this technology are Vapex and Parkson, but they actually sell the same product (see attached brochure). They have entered into a partnering agreement to sell this technology across America.

Stephen F. Cluff, PE

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scluff@hazenandsawyer.com | hazenandsawyer.com

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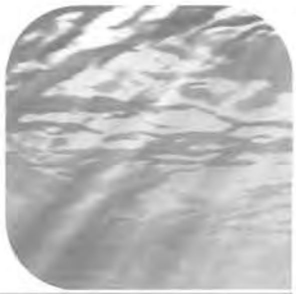


Parkson
Treating Water Right

OHxyPhogg
ENERGIZED BY VAPEX

Odor Control Technology

Low Energy, In-Situ Oxidant Fogger
Effective in Enclosed or Partially-Enclosed Odorous Areas up to 60,000 cubic feet

- No chemicals required
- Eliminates scrubbers or significantly reduces scrubber load
- Minimal startup cost and easy installation
- Low maintenance

OHxyPhogg™ systems have been successfully installed in over 200 applications

The Parkson OHxyPhogg™ odor control system uses patented air atomizing three-fluid nozzles for incredibly efficient fogging results.

The OHxyPhogg™ combines ozone, water and air to create a oxidant fog that is efficiently dispersed throughout confined spaces, such as lift stations, wet wells, holding tanks and headwork areas. This fog creates a chemical reaction that reduces or eliminates H^2S bacteria and other odorous compounds.

Unlike competitive offerings, the OHxyPhogg™ does not require the extraction of foul air, but treats the offensive odors in place, thus drastically reducing energy costs.

Ft. Collins, Colorado
Before: 4" grease

Ft. Collins, Colorado
After: < 1" grease

Grease Removal

OHxyPhogg™ kills biofilm and breaks down grease. While odor control is often the primary area of interest, the oxidant fog is an effective method of reducing grease in most applications.

Significant H_2S removal

OHxyPhogg™ can serve as a replacement to costly and environmentally unfriendly chemical scrubbers by removing the odors before they reach the treatment plant. OHxyPhogg™ treats air in-situ and is capable of 90% to 100% removal of H_2S. The technology is customizable to meet varying installation requirements and can be installed indoors or outdoors; five different unit sizes are available and multiple nozzles can be introduced, based on the application requirements and chamber size.

The delivered oxidant fog results in almost instantaneous odor reduction. Additionally, the system is extremely easy to maintain, with simple cartridge filter replacements and nozzle cleaning.

Features

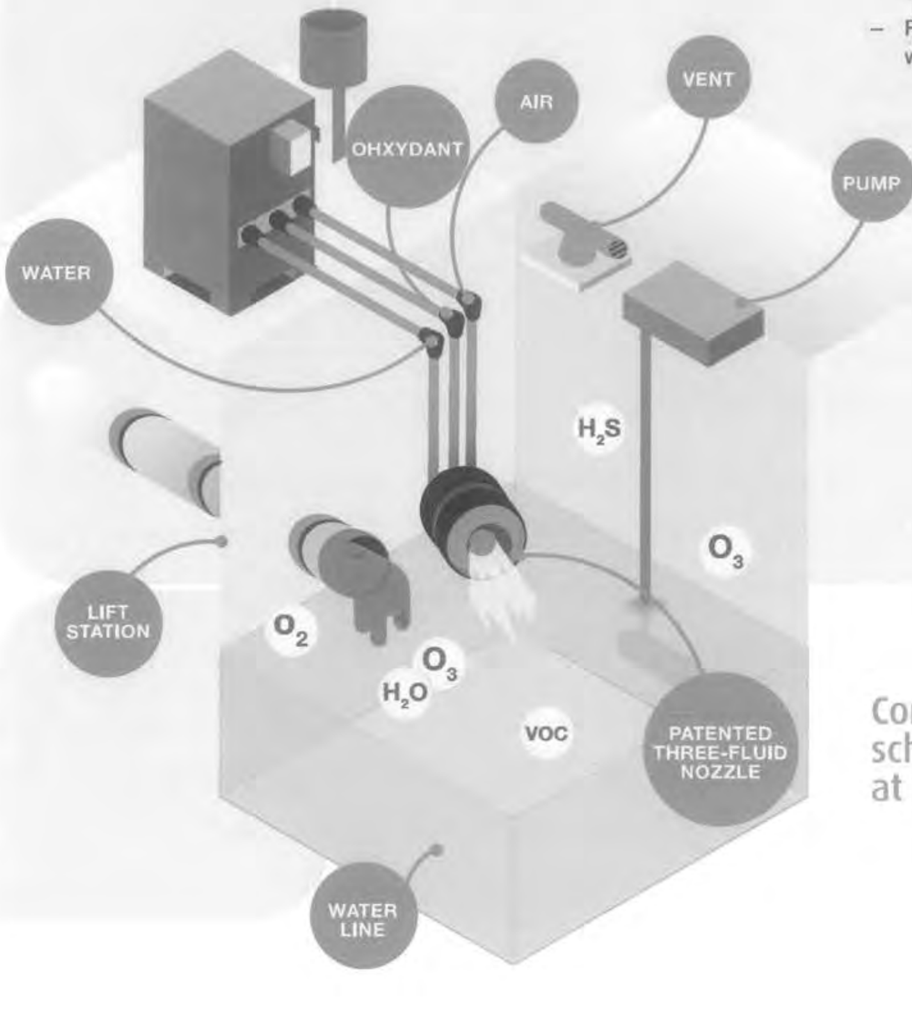
- Easy installation
- Environmentally friendly
- Online and additional offsite fault monitoring on the V350
- Startup within hours
- Straight forward maintenance
- Packaged and modular design for easy upgrades
- Numerous safety measures to automatically turn off system, if necessary
- Rapid reaction with odorous gases
- Corrosion-resistant coated stainless steel enclosure for indoor or outdoor installation
- Newest oxidant generation technology

Benefits

- Destroys H_2S and associated odors
- Eliminates odor complaints
- Reduces H_2S corrosion in the wet well
- Breaks down most greases
- No chemical storage or handling required for improved safety
- Oxidant reacts faster than competitive Cl_2
- Reacted chemistry condenses safely back into water stream with positive downstream effects
- Extensive degree of built-in safety features with ETL certification

Patented, Highly Efficient Atomizing Nozzle

- Generates an average five-micron sized oxidant fog
- Results in highly effective mist containing water, air and oxidant



Contact Parkson to schedule a demonstration at your facility

OHxyPhogg™'s technology includes a powerful combination of oxidants, while also maintaining a balanced pH

Oxidant	Oxidation (oxidant potential voltage)	Relative Oxidation (potential power)
Fluorine	3.06	2.25
Hydroxyl radical OH-	2.80	2.05
Atomic oxygen O	2.42	1.78
Ozone O_3	2.07	1.52
Hydrogen peroxide H_2O_2	1.77	1.30
Permanganate	1.67	1.23
Chlorine dioxide	1.50	1.10
Chlorine gas	1.36	1.00
Oxygen O_2	1.23	0.90
Hypochlorite	0.94	0.96

OHxyPhogg™ offers a very competitive lifecycle cost versus more traditional options

Category	OHxyPhogg™	Carbon Scrubber	Biological Scrubber	Chemical Scrubber
Chemical or Carbon Costs	None	High cost of carbon replacement	Medium cost for media replacement	High cost for chemical usage
Capital Cost	Low	High	High	High
Energy Cost	Low	High	High	High
Footprint Size	Low	Medium	Medium	Large

Specifications

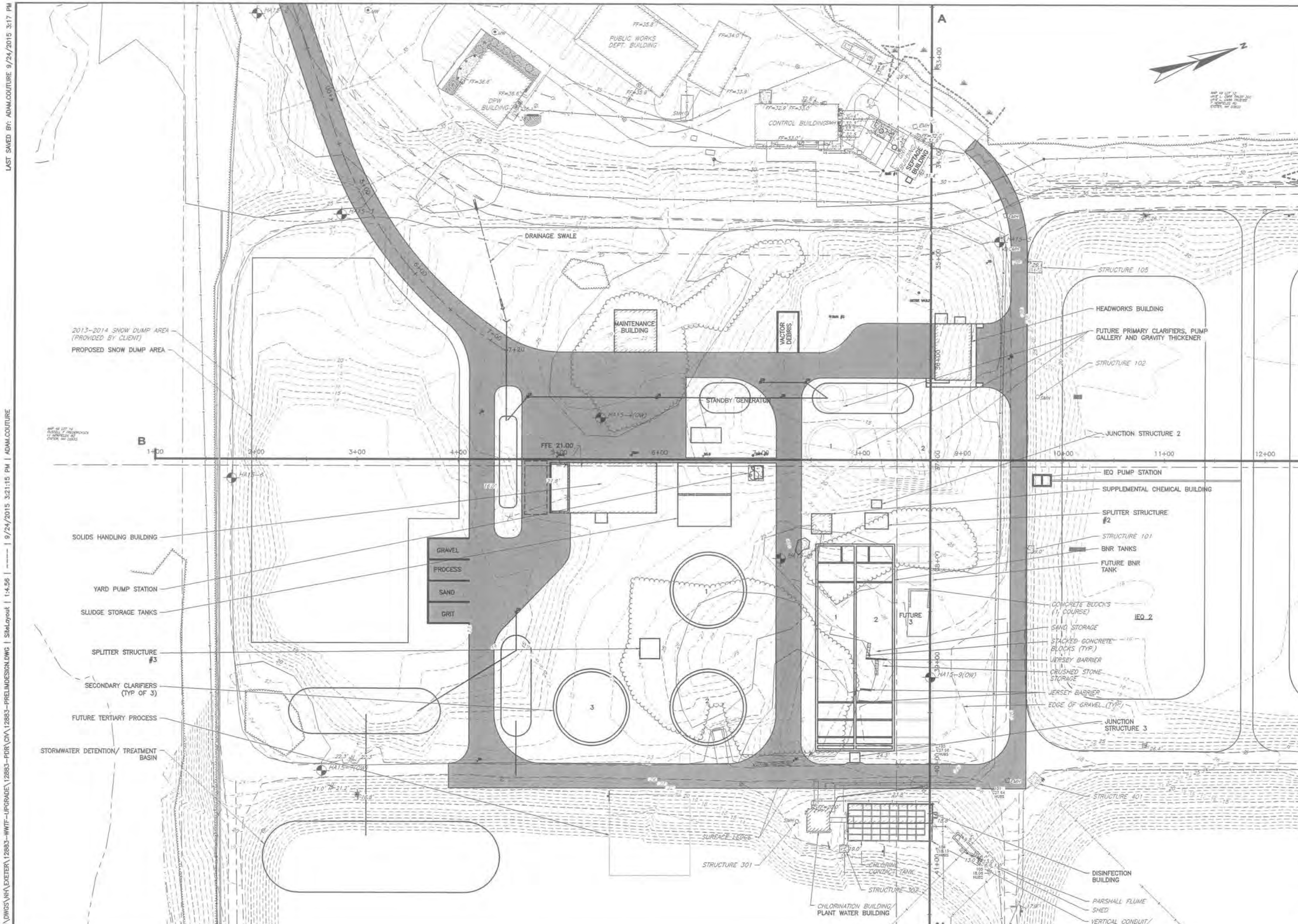
Specifications	V40	V80	V150	V250	V350
Oxidant Output	0 – 0.4lbs/ day	0 – 0.8lbs/ day	0 – 1.5lbs/ day	0 – 2.5lbs/ day	0 – 3.5 lbs/day
Nozzle H20 Consumption	1 – 6 gph @~20 psi	4 – 10 gph @20 psi/nozzle	4 – 10 gph @20 psi/nozzle	4 – 10 gph @20 psi/nozzle	4 – 10 gph @20 psi/nozzle
Nozzle Air Output	15 cfm @2 psi	40 cfm @2 psi/nozzle	40 cfm @2 psi/ nozzle	40 cfm @2 psi/nozzle	40 cfm @2 psi/nozzle
System Dimensions	43"L x 35"W x 45"H	43"L x 35"W x 45"H	43"L x 35"W x 45"H	43"L x 35"W x 45"H	43"L x 35"W x 45"H
Power Requirements	110VAC, 60Hz, 18 Amp	110VAC, 60Hz, 18 Amp	110VAC, 60Hz, 18 Amp	220VAC, 60Hz, 20 Amp	220VAC, 60Hz, 20 Amp

Parkson
Treating Water Right

CELEBRATING 50 YEARS 2010

Fort Lauderdale
Chicago
Montreal
Dubai

1.888-PARKSON
odor@parkson.com
www.parkson.com



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NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY:
CAD COORD.: APC
CAD:
CHECKED BY:
APPROVED BY:
DATE:
PROJECT NO. 12883

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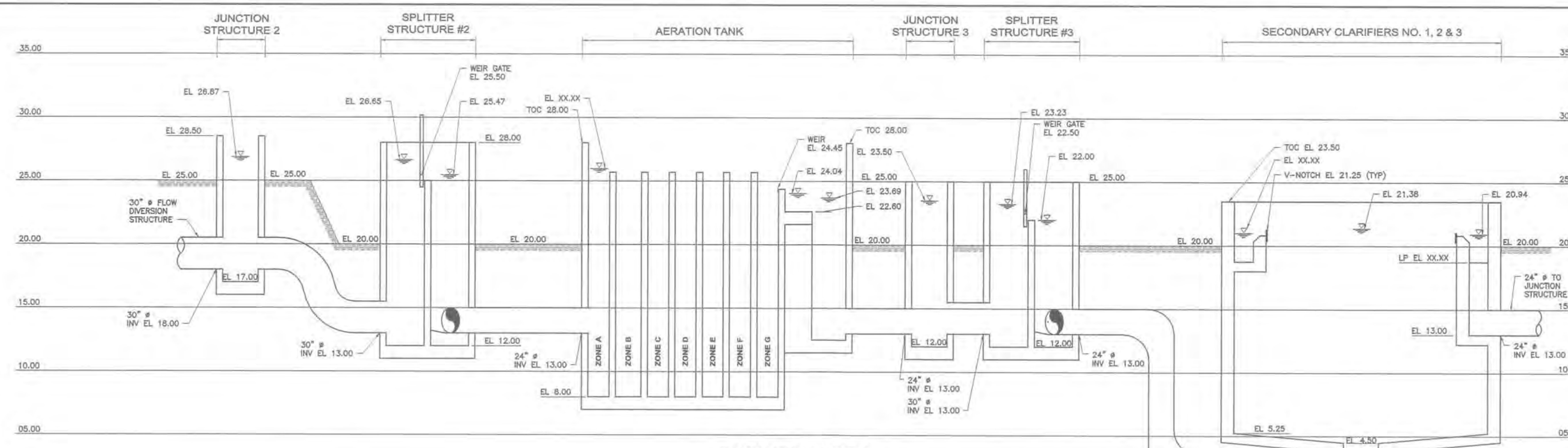
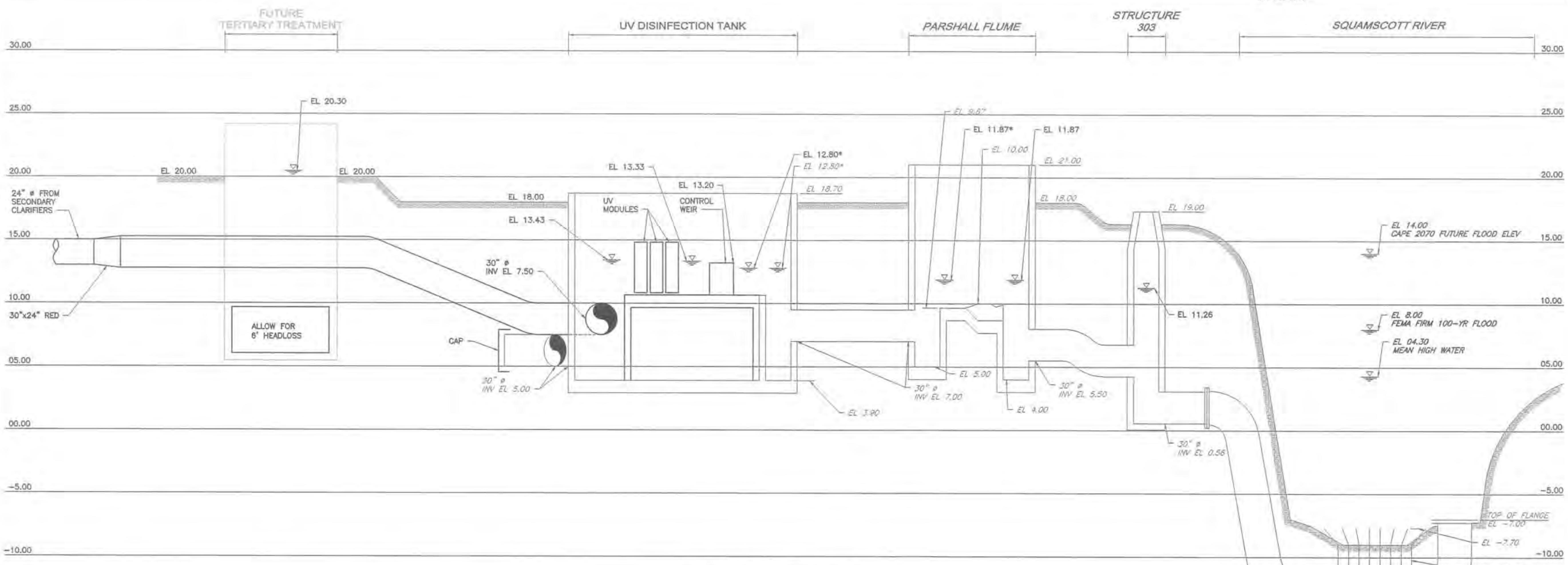
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

FOCUS SITE PLAN

DRAWING
C-10A



HYDRAULIC PROFILE
SCALE: HORIZONTAL: NTS – VERTICAL: 1/4"=1'-0"



HYDRAULIC PROFILE
SCALE: HORIZONTAL: NTS – VERTICAL: 1/4"=1'-0"

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1, PR-2, AND PR-3.

NO. | SUBMISSIONS/REVISIONS | APP'D | DATE
PRELIMINARY DESIGN REPORT

DESIGNED BY:
CAD COORD: APC
CAD:
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO. 12883

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

HYDRAULIC PROFILE II

DRAWING
PR-4

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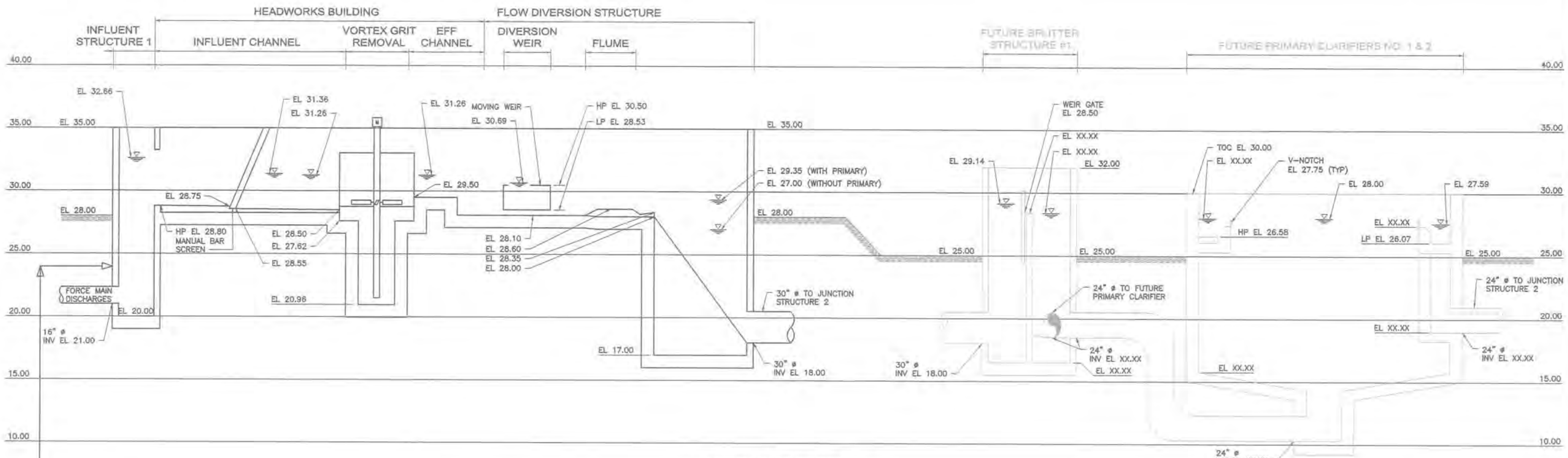
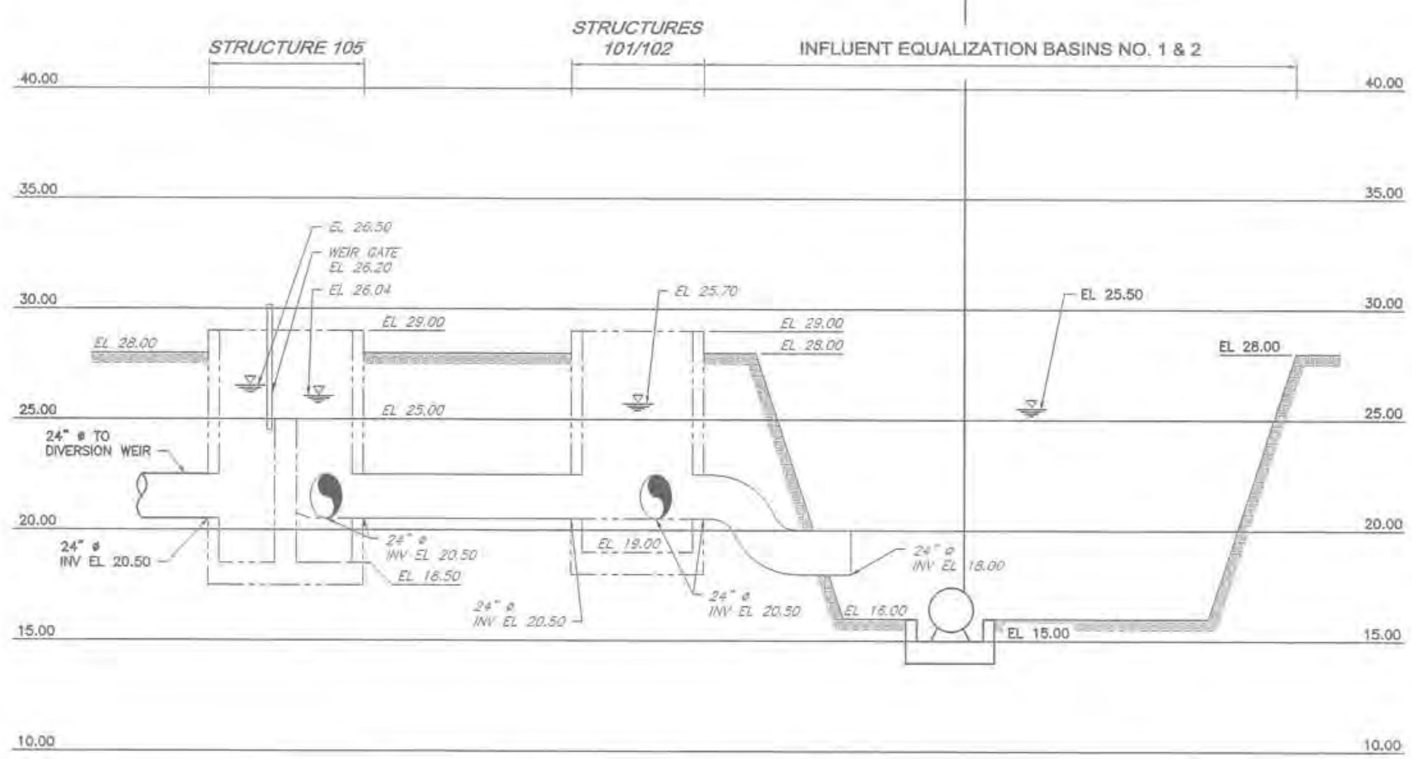


HYDRAULIC PROFILE
SCALE: HORIZONTAL: NTS – VERTICAL: 1/4"=1'-0"



HYDRAULIC PROFILE
SCALE: HORIZONTAL: NTS – VERTICAL: 1/4"=1'-0"

BASIS OF HYDRAULIC PROFILE

HYDRAULIC GRADE LINE ELEVATIONS:	I	II	III	IV	IV	IV
DESIGN FLOW PHASE	MINIMUM DAY MHW	ANNUAL AVERAGE MHW	MAXIMUM MONTH MHW	PEAK DAY 100–YR	PEAK HOUR 25–YR	PEAK HOUR 100–YR
FLOW - MGD						
INFLUENT PRE–EQ	1.68	3.08	5.18	6.68	12.58	12.58
INFLUENT POST–EQ	1.68	3.08	5.18	6.68	6.68	6.68
RETURN SLUDGE RATE	1.08	1.97	3.00	3.00	3.00	3.00
INFLUENT + RETURN SLUDGE	2.76	5.06	8.18	9.68	9.68	9.68
INTERNAL RECYCLE	5.05	9.25	10.00	10.00	10.00	10.00
INF+RS+IR	7.81	14.31	18.18	19.68	19.68	19.68
SECONDARY EFF/TERTIARY INF–EFF	1.68	3.08	5.18	6.68	6.68	6.68
UNIT PROCESSES			**NUMBER OF UNITS IN SERVICE**			
INFLUENT SCREENING	1	1	1	1	1	1
GRIT REMOVAL	1	1	1	1	1	1
PRIMARY SETTLING TANKS (FUTURE)	1	2	2	2	2	1
AERATION TANK TRAINS	1	2	2	2	2	1
SECONDARY SETTLING TANKS	2	2	3	3	3	2
TERTIARY FILTRATION (FUTURE)	1	2	3	3	3	2
UV CHANNELS	1	1	1	1	1	1

NOTES:

1. SHADING IS REPRESENTATIVE OF SCENARIO VI PEAK HOUR HYDRAULIC GRADE LINE. AN ASTERISK (*) HAS BEEN PLACED BY THE HGL ELEVATION CORRESPONDING TO THE SHADING.
2. SCENARIO VI HYDRAULICS BASED ON A 100-YEAR FLOOD EVENT IN SQUAMSCOTT RIVER AND NUMBER OF UNIT PROCESSES IN SERVICE AS NOTED ABOVE.
3. ALL ELEVATIONS ARE SHOWN IN NAVD 1929.

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

PRELIMINARY DESIGN REPORT

DESIGNED BY: APC
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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

HYDRAULIC PROFILE I

DRAWING
PR-3

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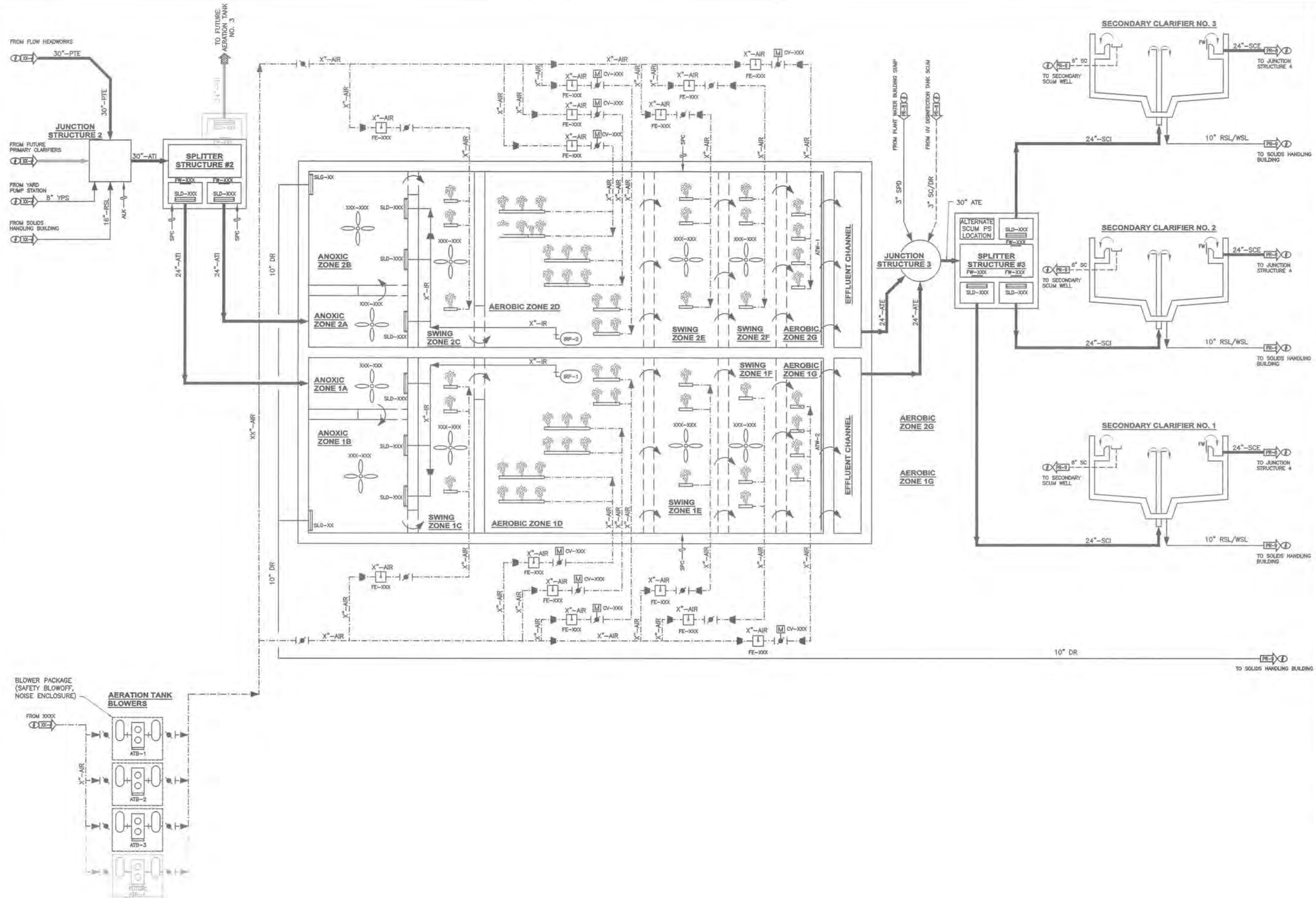

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY:
CAD COORD: APC
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

PROCESS FLOW SCHEMATIC
BNR/SECONDARY TREATMENT

DRAWING
PR-7

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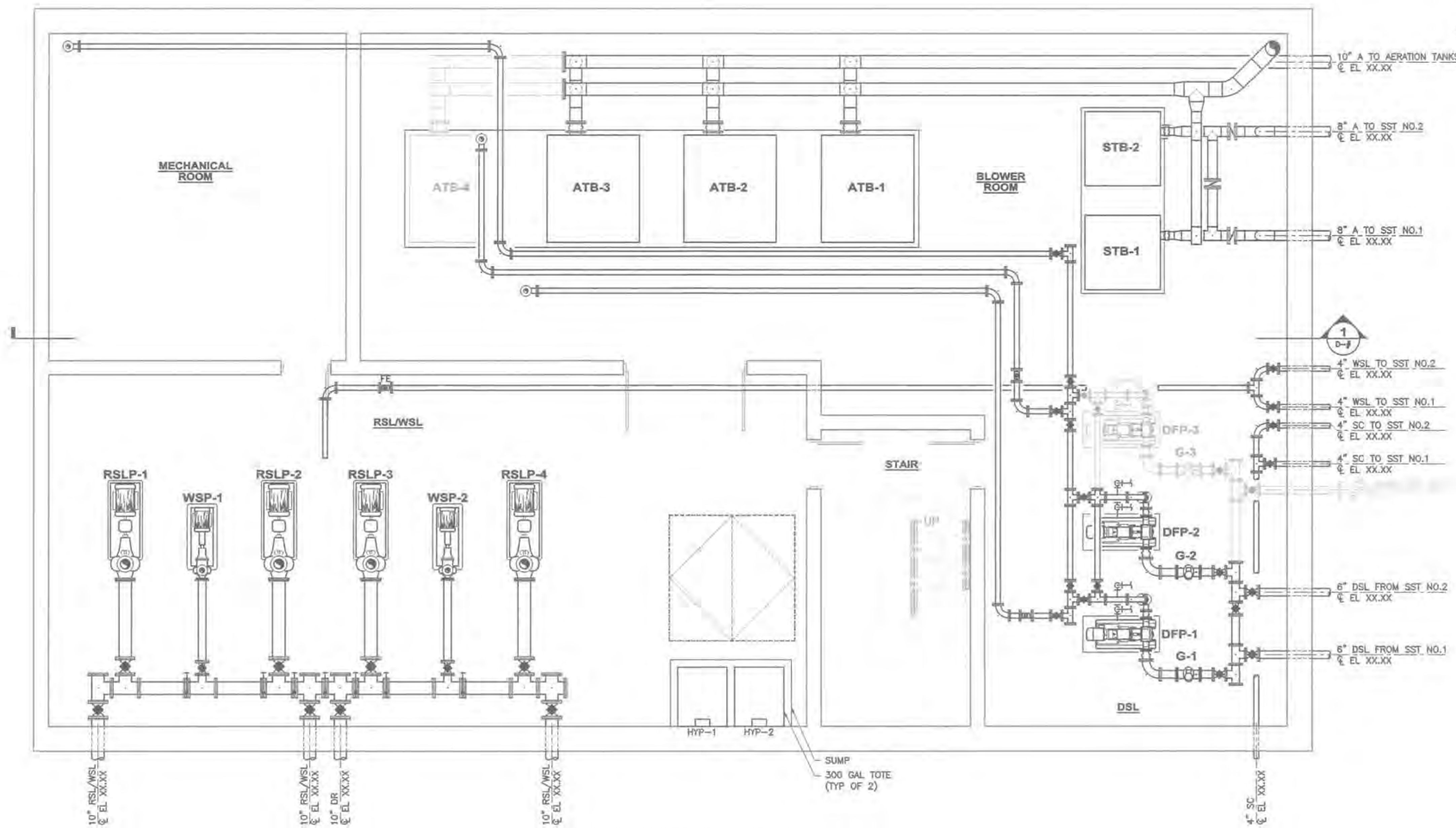
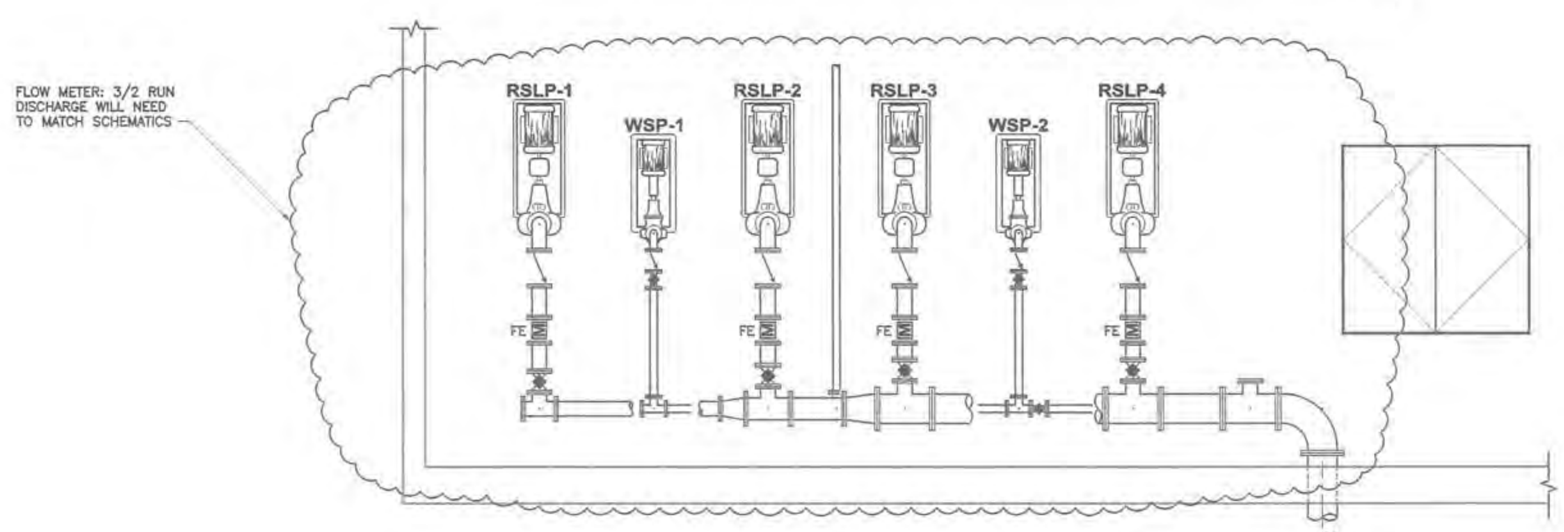


LOWER FLOOR PLAN

SCALE: 1/4"=1'-0"



RSL/WSL DISCHARGE PIPING PLAN

SCALE: 1/4"=1'-0"

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY:
CAD COORD: APC
CAD:
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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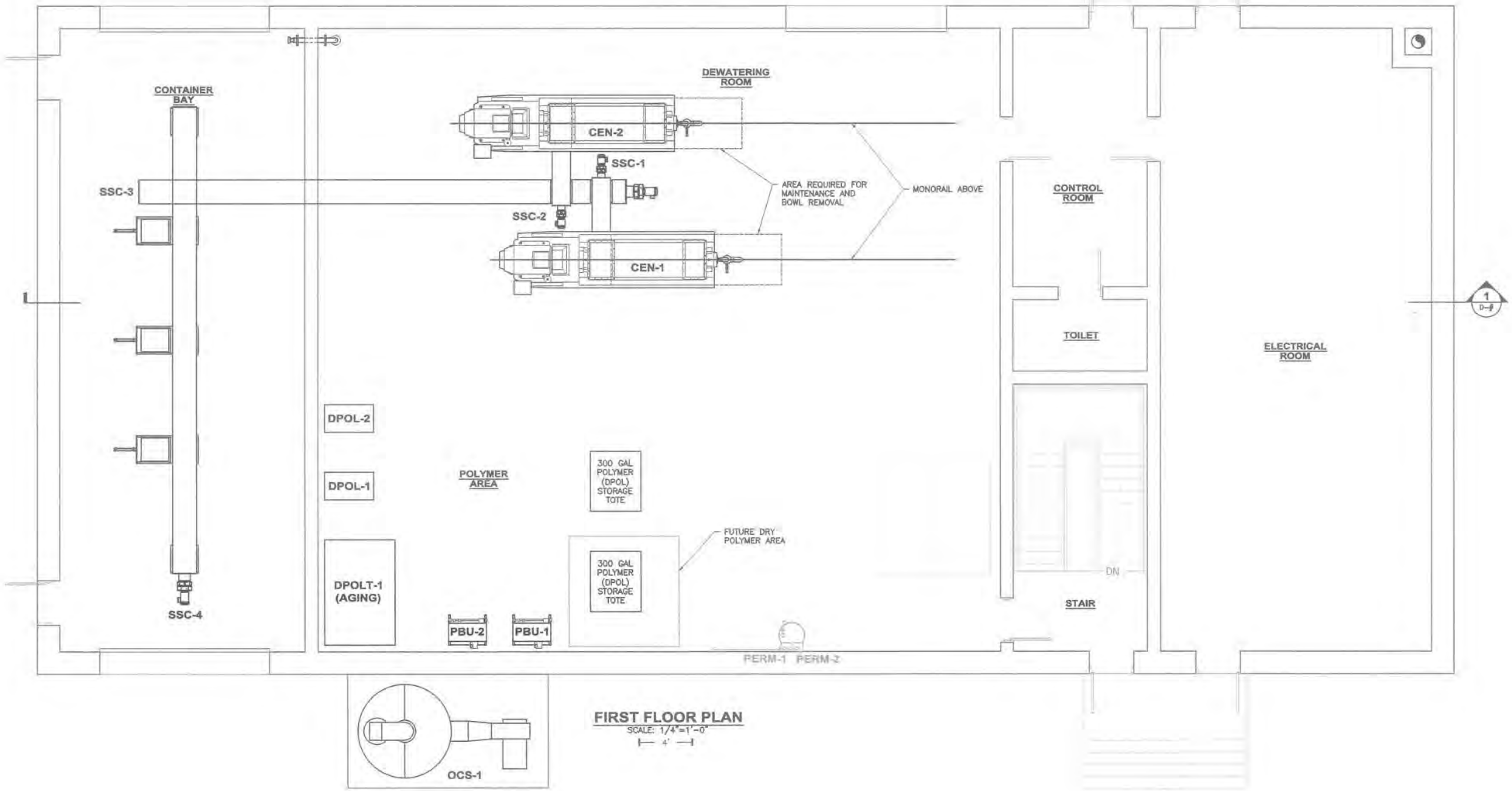
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

SOLIDS HANDLING BUILDING
LOWER FLOOR PLAN

DRAWING
PR-29



FIRST FLOOR PLAN

SCALE: 1/4"=1'-0"

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY:
CAD COORD: APC
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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SOLIDS HANDLING BUILDING
FIRST FLOOR PLAN

DRAWING
PR-30