Ainley & Associates Limited
195 County Court Boulevard, Suite 300, Brampton, ON L6W 4P7
Tel: (905) 452-5172 Fax: (705) 445-0968
E-mail: brampton@ainleygroup.com

December 29, 2017 File No. 115157

Triton Engineering Services Limited
105 Queen Street West Unit 14
Fergus, ON N1M 1S6

Attn: **Christine Furlong, P.Eng.**
Project Manager

Ref: **Town of Erin, Urban Centre Wastewater Servicing Class EA**
Treatment Technology Alternatives, Technical Memorandum

Dear Ms. Furlong:

We are pleased to present the Technical Memorandum for the "Treatment Technology Alternatives" for the Urban Centre Wastewater Servicing Schedule 'C' Municipal Class Environmental Assessment (EA).

This Technical Memorandum provides a review of the Treatment Technology Alternatives and includes those alternatives identified in the Servicing and Settlement Master Plan (SSMP). The Technical Memorandum establishes and evaluates alternative for the wastewater treatment system as a component of Phase 3 of the Municipal Class EA process. The recommended preferred Alternative is presented in the Technical Memorandum which will remain in draft until completion of the public review process.

Yours truly,

AINLEY & ASSOCIATES LIMITED

Draft

Joe Mullan, P.Eng.
Project Manager

Town of Erin
Urban Centre Wastewater Servicing
Class Environmental Assessment

Technical Memorandum
Treatment Technology Alternatives

Draft

December 2017

Urban Centre Wastewater Servicing Class Environmental Assessment

Technical Memorandum Treatment Technology Alternatives

Project No. 115157

Prepared for:
The Town of Erin

Prepared By:

Draft

____
Preya Balgobin, P.Eng.

Reviewed By:

Draft

____
Gary Scott, P.Eng.

Ainley Group
195 County Court Blvd., Suite 300
Brampton, ON L6W 4P7

Phone: (905) 452 – 5172
www.ainleygroup.com

Table of Contents

1.0 Introduction 1

1.1 Assimilative Capacity Study (ACS) 1
1.2 Service Area 1
1.3 Plant Capacity/Service Population 1

2.0 Objectives 1

3.0 Design Basis 2

3.1 Population and Flows 2
3.2 Peaking Factor and Peak Flows 3
3.3 WWTP Influent Characteristics 3
3.4 WWTP Effluent Limits and Objectives 4

4.0 Evaluation Methodology 5

4.1 Approach to Life-Cycle Cost Analysis 6

5.0 Liquid Treatment 7

5.1 Overview of Liquid Treatment Train Processes 7
5.2 Liquid Train Evaluation Criteria 8
5.3 Screening of Long List of Liquid Train Treatment Technologies 12
5.4 Detailed Description of Liquid Train Short Listed Technologies 16
5.5 Development of Alternatives for Liquid Treatment Train 26
5.6 Evaluation of Liquid Treatment Train Alternatives 29
5.7 Re-Oxygenation of Treated Effluent 33
5.8 Preliminary Preferred Alternative for the Liquid Treatment Train 34

6.0 Sludge/Biosolids Treatment and Management 35

6.1 Objectives and Overview 35
6.2 Sludge/Biosolids Train Evaluation Methodology 36
6.3 Evaluation of On-Site Sludge Stabilization Technologies 37
6.4 Options for Revenue Generation 46

7.0 Septage Management 49

7.1 *Objectives and Overview* 49
7.2 *Septage Flows* 50
7.3 *Septage Characteristics* 50
7.4 *Overview of Septage Management Approaches* 51
7.5 *Septage Management Evaluation Criteria* 52
7.6 *Evaluation of Septage Management Alternatives* 53

8.0 Preliminary WWTP Preferred Design Concept 60

8.1 *WWTP Site Plan* 61
8.2 *Capital Costs of WWTP Construction* 63

9.0 Conclusions and Recommendations 64

Appendices

Appendix A: Life Cycle Cost Evaluation of Primary/Secondary Treatment Alternatives
Appendix B: Life Cycle Cost Evaluation of Tertiary Treatment Alternatives
Appendix C: Life Cycle Cost Evaluation of Disinfection System Alternatives
Appendix D: Life Cycle Cost Evaluation of Effluent Re-Oxygenation Alternatives
Appendix E: Life Cycle Cost Evaluation of Sludge Stabilization Alternatives
Appendix F: Life Cycle Cost Evaluation of Septage Management Alternatives

List of Tables

Table 1 – Wastewater Treatment Plant Construction Phasing 2
Table 2 – WWTP Phases of Construction and Population Served 3
Table 3 – Peaking Factors and Design Flows 3
Table 4 – WWTP Influent Characteristics and Loading Rates 3
Table 5 – Erin WWTP Effluent Limits 4
Table 6 – Proposed WWTP Effluent / Operational Objectives 5
Table 7 – Liquid Train Long-List Screening Criteria 9
Table 8 – Liquid Train Short-List Screening Criteria 10
Table 9 – Evaluation of Long List of Liquid Train Treatment Technologies 13
Table 10 – Advantages and Disadvantages of Modified CAS Process 18
Table 11 – Advantages and Disadvantages of the SBR Process 20
Table 12 – Advantages and Disadvantages of the MBR Process 22
Table 13 – Cost Estimates for Primary/Secondary Treatment Alternatives 23
Table 14 – Cost Estimates for Tertiary Treatment Alternatives 24
Table 15 – Advantages and Disadvantages of Chlorination/De-Chlorination 25
Table 16 – Advantages and Disadvantages of UV Disinfection 25
Table 17 – Cost Estimate for Disinfection Alternatives 26
Table 18 – Tertiary Treatment Short-List Screening Criteria 27
Table 19 – Detailed Evaluation of Tertiary Treatment Alternatives 28
Table 20 – Cost Comparison of Liquid Treatment Train Alternatives 29
Table 21 – Detailed Evaluation of Liquid Treatment Train Alternatives 30
Table 22 - Detailed Evaluation of Disinfection System Alternatives 32
Table 23 – Life-Cycle Costs of Effluent Re-Oxygenation 34
Table 24 - Sludge Stabilization Short-List Screening Criteria 38
Table 25 – Evaluation of Long List of Sludge Stabilization Technology Alternatives 40
Table 26 – Advantages and Disadvantages of the Aerobic Digestion Alternative 43
Table 27 – Advantages and Disadvantages of the ATAD Alternative 44
Table 28– Cost Estimates for Sludge Stabilization Alternatives 44
Table 29 – Detailed Evaluation of Sludge Stabilization Alternatives 45
Table 30 – Advantages and Disadvantages of Thermal Drying 47
Table 31 – Advantages and Disadvantages of Solar Drying 47
Table 32 – Advantages and Disadvantages of On-Site Composting 48
Table 33 – Advantages and Disadvantages of Biosolids Management Contractor 49
Table 34 – Estimated Septage Flow to Erin WWTP 50
Table 35 – Raw Septage Characteristics 51
Table 36 – Septage Management Long-List Screening Criteria 52
Table 37 – Septage Management Short-List Screening Criteria 53
Table 38 – Evaluation of Long List of Septage Management Technologies 54
Table 39 – Advantages and Disadvantages of Direct Co-Treatment 55
Table 40 – Advantages and Disadvantages of Increasing the Capacity of the Main Plant 56
Table 41 - Advantages and Disadvantages of Pre-Treatment with Geotubes® 57
Table 42 – Cost Estimates of Septage Management Alternatives 57
Table 43 – Septage Management Short-List Screening Criteria 58
Table 44 – Detailed Evaluation of Septage Management Alternatives 59
Table 45 – Estimated Capital Construction of Erin WWTP 63

List of Figures

Figure 1 –Modified CAS Process Flow Schematic 17
Figure 2 – Modified CAS Reactor Layout 18
Figure 3 – Sequencing Batch Reactor Process Flow Schematic 19
Figure 4 – Sequencing Batch Reactor Layout 20
Figure 5 – Membrane Bioreactor Process Flow Schematic 21
Figure 6 –Membrane Bioreactor Layout 22
Figure 7 – Preferred Liquid Treatment Train Process Flow Schematic 35
Figure 8 – Conventional Aerobic Digester Process Flow Schematic 42
Figure 9 – ATAD Process Flow Schematic 43
Figure 10 – Preferred Liquid Treatment Train Process Flow Schematic 60
Figure 11 – Preferred Solids Treatment Train Process Flow Schematic 61
Figure 12 – Conceptual Site Layout of Preliminary Preferred Alternatives 62

Glossary of Terms

ACS	Assimilative Capacity Study
ADF	Average Daily Flow
ATAD	Autothermal Thermophilic Aerobic Digester
BAF	Biological Aerated Filters
BOD	Biological Oxygen Demand.
CAS	Conventional Activated Sludge.
BOD_5	Biochemical oxygen demand
CVC	Credit Valley Conservation Authority
DO	Dissolved Oxygen
ECA	Environmental Compliance Approval
HESL	Hutchinson Environmental Sciences Limited:
IFAS	Integrated Fixed-Film Activated Sludge:
MBBR	Moving Bed Bioreactors
MBR	Membrane Bioreactors
MLSS	Mixed Liquor Suspended Solids
MOECC	Ministry of the Environment and Climate Change
NPV	Net Present Value
O&M	Operation and maintenance:
PHF	Peak Hourly Flow
PWQO	Provincial Water Quality Objectives (PWQO).
RAS	Return Activated Sludge
RBC	Rotating Biological Contractor:
SBR	Sequencing Batch Reactor
SSMP	Servicing and Settlement Master Plan
TAN	Total Ammonia Nitrate:
TM	Technical Memorandum
TP	Total Phosphorous
TSS	Total Suspended Solids
UCWS Class EA	Urban Centre Wastewater Servicing Class Environmental Assessment
UV	Ultra-Violet
WAS	Waste Activated Sludge
WWTP	Waste Water Treatment Plant

1.0 Introduction

This Technical Memorandum has been prepared in support of the Town of Erin Urban Centre Wastewater Servicing Class Environmental Assessment (UCWS EA) to identify and evaluate alternative solutions for the treatment of wastewater generated by the existing population and projected growth within the urban areas of Erin Village and Hillsburgh. The UCWS EA follows a 2014 Servicing and Settlement Master Plan (SSMP), completed by B.M. Ross. The SSMP completed part of Phase 1 and Phase 2 of the Class EA process and recommended construction of a new municipal wastewater collection system and wastewater treatment plant (WWTP) to service both urban communities. The SSMP also recommended discharge of the treated effluent to the West Credit River between 10th Line and Winston Churchill Boulevard.

The UCWS EA commenced in 2016 and Phases 1 and 2 were completed during the fall of 2017 with the following results:

1.1 Assimilative Capacity Study (ACS)

In 2014, B.M Ross performed an assimilative capacity study (ACS) as part of the SSMP. During 2016, the ACS was updated by Hutchinson Environmental Sciences Ltd. (HESL) to include hydrodynamic modelling and additional data collected since the 2014 ACS was completed. The 2014 ACS determined that phosphorous loading to the West Credit River was the limiting factor to the amount of treated wastewater that could be discharged to the West Credit River. The updated, 2016 ACS confirmed this and also established WWTP effluent limits for the discharge to the West Credit River. The effluent limits and discharge flow rates recommended in the 2016 ACS have been accepted by the Ministry of the Environment and Climate Change (MOECC) and Credit Valley Conservation (CVC).

1.2 Service Area

The SSMP examined the existing septic systems throughout the urban areas of Erin Village and Hillsburgh. As part of the UCWS EA, during 2016, a more detailed assessment of these systems was undertaken and a service area covering the existing developed portions of the communities was defined.

1.3 Plant Capacity/Service Population

Based on the results of the ACS, the septic system survey, and discussions with Wellington County on potential new growth areas, it was established that a WWTP with an average capacity of 7,172 m^3/d at an effluent phosphorus concentration of 0.046 mg/L could service all of the existing urban areas, including an allowance for infill and intensification, as well as all of the areas zoned for development within the study area, as defined by Wellington County. This flow will allow a residential population of approximately 14,559 people. When industrial, commercial, and industrial growth is included, the equivalent population is 18,873.

2.0 Objectives

This technical memorandum (TM) presents the evaluation of treatment technology alternatives available for Erin's proposed wastewater treatment plant. The information presented in this TM constitutes a component of Phase 3 of the Class EA process, which involves examination of alternative methods of implementing the preferred solution(s) as determined in the previous phases of the Class EA. The new WWTP will be designed to service the existing community plus projected residential, commercial, and industrial growth in the study area. Additional technical memoranda will address other components of Phase 3 activities, including locations of the wastewater treatment plant and wastewater discharge to the West Credit River as well as collection system alternatives.

3.0 Design Basis

The basis of design for Erin's WWTP was developed using information from the following documents:

- The Assimilative Capacity Studies (2014 and 2016)
- Ainley technical memorandum entitled "System Capacity and Sewage Flows"
- Ainley technical memorandum entitled "Septic System Overview".

The projected sewage flow from the existing communities represents 40% of the full build out flow for the WWTP. To achieve full build out, it is envisaged that the wastewater treatment plant would be constructed in phases. For the purpose of this technology alternatives evaluation, it is assumed that the wastewater treatment plant will be constructed in two phases. It has also been assumed that the plant would be designed to have three process trains, each with a capacity equal to one third of the full build out capacity. The table below illustrates the capacity, timing, and allocation of flows between existing development and growth. The years selected as the "Forecasted Year of Construction" were selected to establish a life-cycle in order to perform the life-cycle cost analyses. It does not imply that the project will necessarily be constructed in those years.

Table 1 – Wastewater Treatment Plant Construction Phasing

Phase	Capacity (m^3/d)	Allocation to Existing Population	Allocation to Growth Population	Forecasted Year of Construction
Phase 1	4,780	60%	40%	2020 – 2022
Phase 2	2,390	0%	100%	2028 – 2030

Phase 1 would provide two thirds of the full build out flow and allowable discharge to the river. Phase 1 would also provide for 100% of the required capacity to service the existing community (2,844 m^3/d) as well as 45% of the total growth identified for full build out. Phase 1 allocation would be 60% to existing community and 40% to growth. Phase 2 (Full Buildout) would involve construction of one additional process train onto the Phase 1 plant to treat the maximum allowable flow that was established by the 2016 ACS. This would service all remaining growth.

For the purposes of this evaluation, it is assumed that Phase 1 will be designed to meet the effluent limits prescribed for the Full Buildout.

3.1 Population and Flows

Contributing wastewater flows were calculated as outlined in the "System Capacity and Sewage Flows" technical memorandum. Plant capacity is based on per capita residential flows for the existing urban areas with allowance for institutional, commercial, and industrial flows as well as allowances for infill and intensification in existing areas. Growth areas were established by Wellington County and flow was calculated for these areas as outlined in the "System Capacity and Sewage Flows" technical memorandum. Based on the above, a capacity of 7,172 m^3/d was established to service all of the existing and growth areas. To be able to discharge this volume of treated effluent to the West Credit River, the ACS established that the effluent concentration for total phosphorus would need to be 0.046 mg/L.

Based on the maximum allowable WWTP discharge flow of 7,172 m^3/d and the assumed per capita flow contributions, the number of residents that could be served is 14,559. The table below shows WWTP flow rates, population served, and percentage of the Full Buildout flow that each phase.

Table 2 – WWTP Phases of Construction and Population Served

	Phase 1	Phase 2 / Full Buildout
Total WWTP Capacity (Average Day Flow)	4,780 m^3/d	7, 172 m^3/d
Residential Population Served	8,864	14,559
Equivalent Population* Served	12,893	18,873

*Equivalent population captures contributions from commercial, institutional, and industrial sources.

3.2 Peaking Factor and Peak Flows

The Harmon Formula, as detailed in the Ministry of the Environment and Climate Change's "Design Guidelines for Sewage Works (2008)", was used to determine peaking factors and peak hourly flows for Phase 1 and Phase 2.

The table below presents the peaking factors and peak hourly flows used for Phase 1 and Phase 2. It should be noted that the peak flows below include contributions from inflow and infiltration.

Table 3 – Peaking Factors and Design Flows

	Phase 1	Phase 2 / Full Buildout
Average Day Flow	4,780 m^3/d	7, 172 m^3/d
Harmon Peaking Factor	2.84	2.67
Peak Hourly Flow	11,779 m^3/d	19,148 m^3/d

Sewage Pumping Stations as well as specific unit processes will need to be designed for the peak instantaneous flows.

3.3 WWTP Influent Characteristics

The existing urban areas within the study area use private, on-site wastewater systems to manage wastewater. As such, there is no data available for the raw sewage/wastewater to be received at the new WWTP. Raw sewage characteristics used for the technology alternatives evaluation were derived from the Ministry of the Environment and Climate Change "Design Guidelines for Sewage Works (2008)", Page 8-9 and are listed in the table below.

Table 4 – WWTP Influent Characteristics and Loading Rates

Influent Parameter	Typical Raw Sewage Concentrations (mg/L)	Loading (kg/d)	
		Phase 1	Phase 2 (Full Buildout)
Biological Oxygen Demand (BOD)	175	837	1,255
Total Suspended Solids (TSS)	175	837	1,255
Total Ammonia Nitrogen (TAN)	35	110	165
Total Kjeldhal Nitrogen	35	167	251

Influent Parameter	Typical Raw Sewage Concentrations (mg/L)	Loading (kg/d)	
		Phase 1	Phase 2 (Full Buildout)
Total Phosphorous (TP)	7	33	50

Loadings are calculated based on average day flows for both Phase 1 and Phase 2.

There are a number of rural residents who will be outside the recommended service area of the proposed wastewater collection system and will remain on septic systems. Hauled septage from these residents will be received and treated at the new WWTP.

Evaluation of the alternatives for management and treatment of septage is presented in Section 8 of this technical memorandum. The influent characteristics listed in Table 4 do not include contributions from septage. Influent characteristics that incorporate septage addition to the wastewater treatment system are presented in Section 8.3.

3.4 WWTP Effluent Limits and Objectives

In addition to phosphorous limits, the ACS established effluent limits for other regulated parameters under Full Buildout flow. For the purposes of this technical memorandum, is has been assumed that the same treatment technology will be used for Phase 1 and Full Buildout. For this reason, the effluent limits associated with the Full Buildout flow were also used as the limits for Phase 1 flow and evaluation of treatment alternatives.

The ACS also found that dissolved oxygen (DO) levels in the West Credit River are well above the Provincial Water Quality Objective (PWQO) of 6 mg/L. HESL determined that an effluent DO concentration of 4 mg/L would maintain the oxygen levels in the river.

The table below presents the WWTP effluent limits for the regulated parameters for Erin's WWTP.

Table 5 – Erin WWTP Effluent Limits

Parameter	Effluent Concentration Limit (mg/L)
Carbonaceous Biological Oxygen Demand (cBOD5)	5 mg/L
Total Suspended Solids (TSS)	5 mg/L
Total Phosphorous (TP)	0.045 mg/L
Total Ammonia Nitrate (TAN)	0.6 mg/L (summer: May 15 to October 15) 2 mg/L (winter: October 16 to May 14)
Nitrate Nitrogen	5 mg/L
Minimum Dissolved Oxygen	4 mg/L
E. Coli.	100 cfu/100mL
pH	6.5 - 8.5

These effluent limits are stringent when compared against other wastewater treatment facilities in Ontario. This is due to the West Credit River's classification as a Policy 1 receiver. To achieve the required level of treatment, the Erin WWTP will need to be an Advanced Wastewater Treatment Facility, incorporating both secondary and tertiary treatment and include an add-on technology for re-oxygenation of the treated effluent.

Typically, the Environmental Compliance Approval (ECA) for municipal wastewater treatment facilities includes effluent or operational objectives in addition to the effluent limits. Effluent objectives are set as treatment goals for the WWTP as a guarantee that the limits will not be exceeded. The operational objectives proposed for Erin's WWTP are presented in the table below

Table 6 – Proposed WWTP Effluent / Operational Objectives

Parameter	Effluent Concentration Objective
Biological Oxygen Demand (BOD)	3 mg/L
Total Suspended Solids (TSS)	3 mg/L
Total Phosphorous (TP)	0.03 mg/L
Total Ammonia	0.3 mg/L (summer: May 15 to October 15) 1 mg/L (winter: October 16 to May 14)
Nitrate Nitrogen	4 mg/L
Minimum Dissolved Oxygen	5 mg/L
E. Coli.	100 cfu / 100mL

4.0 Evaluation Methodology

An evaluation methodology to identify a recommended treatment technology alternative for Erin's WWTP has been developed based on methodologies and guidelines outlined in the Municipal Class Environmental Assessment. This evaluation was performed on four distinct wastewater treatment processes, which are outlined below:

- Liquid Treatment
- Aeration of the Treated Effluent
- Sludge/Biosolids Treatment
- Septage Treatment/Management

Liquid Treatment refers to the process (treatment train) that treats the raw sewage to produce the liquid effluent that can be released to the West Credit River.

Aeration of the Treated Effluent refers to the process to be used to maintain dissolved oxygen levels in the treated effluent above 4 mg/L. This is included as a separate component, since, depending on what technologies are recommended for the liquid treatment train, a separate aeration step may not be required. For example, if the preferred liquid train treatment is a membrane bioreactor (MBR), the MBR's blowers could be sized to continuously maintain a minimum DO level of 4 mg/L in the aerobic stage and since there are no processes downstream of the MBR that remove oxygen or are hindered by elevated DO levels in the wastewater stream, the DO level would remain at 4 mg/L until discharge to the river. No additional aeration step would be required prior to discharge into the West Credit River.

Sludge/Biosolids Treatment refers to the system that will treat the residual solids component of the wastewater. Treatment can be to a level where the final product can be used or disposed of off-site, i.e. to agricultural land, or treatment can be to the minimum level required to allow trucking the sludge/biosolids to an off-site, privately owned, facility for final treatment and use and/or disposal.

Septage Treatment/Management refers to the alternatives available for receiving and treating septage such that it will meet the quality requirements for discharge to the environment. Septage requires both liquid and sludge/biosolids treatment.

Evaluation of each of the four (4) treatment processes involved two main steps:

- Identification of a long list of potential alternative solutions and the screening of this list down to a short list of viable alternatives.
- A detailed evaluation of the short-listed alternatives to identify a recommended preferred alternative.

To achieve this goal, the following steps were undertaken:

- Develop a set of long-list screening criteria to screen the long list of alternatives to a short list. This set of criteria is meant to capture features that are considered essential to the success of the WWTP servicing Erin and to establish viability of the alternative.
- Develop a set of short-list evaluation criteria to evaluate the short-listed alternatives. This set of criteria consists of primary and secondary criteria and weightings. These criteria provide a more in-depth analysis of the technologies, sufficient to identify the recommended technology.
- Generate a long list of technologies that could be used for the process being evaluated.
- Use the long-list screening criteria to reduce the long list to a short list.
- Develop design concepts (treatment trains) using the short-listed technologies.
- Perform detailed evaluations of each design concept, including a life-cycle cost analysis, using the short-list evaluation criteria.
- Identify the recommended alternative, based on the results of the detailed evaluation.

Separate sets of screening/evaluation criteria were used for each of the four (4) processes, since the objectives for each process are different.

4.1 Approach to Life-Cycle Cost Analysis

A life-cycle cost analysis was carried out on each short-listed alternative as part of the detailed evaluation. The analyses incorporated factors such as equipment costs, construction costs, annual operating and maintenance costs, and the Net Present Value (NPV) over the expected life of the facility.

Equipment and operating costs for each alternative were obtained from budgetary quotes, solicited from relevant equipment suppliers. Construction costs for common systems were estimated from data in Ainley's possession from projects of a similar nature and scope. Estimates for general contracting, site works, and yard piping were based on a percentage of equipment and building/tankage construction costs.

Actual costs associated with each alternative may be significantly affected by inflation and market conditions, however, changes in the conditions that affect these cost estimates would affect all alternatives proportionately, since the same assumptions and rationale were used to evaluate all alternatives. In this regard, the results of the comparative cost evaluation should remain the same.

The parameters and assumptions used in the life-cycle cost analyses are listed below.

- All costs are presented in 2017 Canadian dollars.
- Phase 1 construction projected to begin in 2020 and finish in 2022.

- Phase 2 construction is projected to begin in 2028 and finish in 2030.
- NPV costs are based on a 50-year life cycle for the facility.
- Major equipment replacements were incorporated at 30-year intervals.
- Electrical and I&C costs were factored into equipment installation costs.
- An estimated inflation rate of 2% was used
- An estimated interest rate of 5% was used.
- Electricity costs of 0.11/kWh was used.
- Land costs were included in the WWTP Site Evaluation Technical Memorandum
- The estimates related to site works, assume that there is no contaminated soil on the property.
- Cost estimates are net of taxes which apply to all alternatives.

5.0 Liquid Treatment

5.1 Overview of Liquid Treatment Train Processes

Treatment of the liquid component of wastewater involves several stages, typically starting with removal of grit and larger particles and ending with disinfection of the treated effluent just prior to release to the environment. The stages traditionally associated with treating the liquid train are described below.

Preliminary Treatment

Raw sewage arriving at the treatment plant by gravity or from a pumping station is first subjected to preliminary treatment which involves removal of larger objects and grit from the wastewater. Technologies used for preliminary treatment include various types of screens and grit removal systems. This process results in screenings and grit waste which is typically sent to a landfill.

Primary Treatment

Primary treatment is geared towards removal of particles that can be easily removed without the addition of chemicals or biological means. Typically, gravity settling technologies, such as clarification, are used for primary treatment. However, other technologies, such as filters, can be used. Some secondary treatment technologies do not require primary treatment. Primary treatment produces primary sludge, which is sent to the sludge treatment system.

Secondary Treatment

Once solids, grit, and settlables are removed from the wastewater, secondary treatment is implemented to reduce organics and other contaminants such as phosphorous, nitrogen, and ammonia. Technologies used for secondary treatment are usually biological in nature, such as aeration tanks, biological filters, and moving bed bioreactors. The biological sludge resulting from biological treatment is commonly referred to as “activated sludge” and is separated from the liquid via secondary clarification. Depending on the treatment technology used for in the secondary treatment stage, secondary sludge can either be recycled to the biological treatment step as return activated sludge (RAS) and/or sent to the sludge treatment system as waste activated sludge (WAS).

Tertiary Treatment

Where secondary treatment alone cannot meet a facility's required effluent limits/objectives for particular parameters, it may be necessary to add a further treatment stage referred to as tertiary treatment. Tertiary treatment typically focuses on removal of parameters with low effluent limits, including phosphorous, nitrogen, and suspended solids.

Disinfection

Disinfection is performed to deactivate and/or kill pathogenic micro-organisms found in the liquid stream. Typically, E. coli is used as the indicator organism to measure the effectiveness of the disinfection process. Traditionally, chlorination has been used for disinfection, however, ultra-violet radiation and ozonation are becoming more common.

The effluent limit on nitrogen species for the Town of Erin is lower than most wastewater treatment facilities in Ontario. Typically, the MOE enforces a limit on total ammonia nitrogen (TAN). However, the West Credit River ACS, through the suggestion by the CVC, also recommends a limit on nitrate-nitrogen in to ensure that the nitrate-nitrogen loading to the river will be at a level that will not negatively impact the brook trout fishery in the river. Achieving the nitrate-nitrogen effluent limit requires a treatment process that can remove both ammonia and nitrate nitrogen.

In domestic wastewater, nitrogen generally exists as ammonia (NH_4). In order to remove nitrogen from the wastewater, a two-step process called nitrification/denitrification must take place. Nitrification is the conversion of ammonia to nitrite (NO_2) and then to nitrate (NO_3). Denitrification is the conversion of nitrate to nitrogen gas, which is released to the atmosphere.

The nitrification process requires the presence of oxygen (aerobic conditions) to convert ammonia to nitrite (NO_2) and nitrate (NO_3). The denitrification process, on the other hand, can only take place where the oxygen concentration is less than 0.5 mg/L (anoxic conditions). In the absence of free oxygen, denitrifying bacteria will use the oxygen in the nitrate molecules as they assimilate BOD. This process releases nitrogen in gaseous form.

The treatment alternative chosen for Erin will need to incorporate steps that will nitrify and denitrify the wastewater in order to achieve the treatment objectives for TAN and nitrate-nitrogen.

For the purposes of this evaluation process, preliminary treatment was not evaluated since the alternatives available will not be appreciably different in terms of environmental impact or cost.

5.2 Liquid Train Evaluation Criteria

5.2.1 Long-List Screening Criteria

The criteria selected for long-list screening of the liquid train alternatives are presented in the table below.

Table 7 – Liquid Train Long-List Screening Criteria

Criteria	Description
Proven Reliability	Demonstrated track record of consistently meeting and/or exceeding the treatment objectives set forth for the UCWS EA.
Ease of Expansion to Buildout	Ability of the system to easily to expand to meet UCWS EA WWTP Full Buildout capacity.
Operation and Maintenance Complexity	Simplicity of operation and maintenance and level of staffing required.
Cost	Have value in terms of performance and/or operation and maintenance that are reflective of the capital costs.

Proven Reliability

In order to gain acceptance and approval by the Ministry of Environment and Climate Change (MOECC) in Ontario through the issuance of an Environmental Compliance Certificate (ECA), proponents must be able to demonstrate that a treatment process can achieve the required objectives on a consistent basis. In order for a technology to be carried forward for detailed analysis, the technology must therefore have a demonstrated history of being reliable and able to meet the performance requirements set out for the UCWS EA.

For primary and secondary treatment, MOECC typically prefers a minimum of three successfully operating plants of similar size and capacity, located in a similar climate and with comparable effluent criteria in order to be considered for implementation in Erin.

The effluent limit set for phosphorous will require best available technology to achieve the desired contaminant removal. There are several advanced treatment processes that have been proven successful at the proposed limits for phosphorus, however, operating plants under similar conditions as those proposed for Erin is limited. Tertiary treatment technologies that have been successfully proven in both operating plants and pilot studies to achieve the required phosphorous removal levels were considered in the long list.

Other factors taken into consideration include the technology's ability to adjust to changing influent conditions, such as high/low flows or fluctuations in sewage characteristics.

Ease of Expansion to Buildout

This criterion reviews how easily a technology can be expanded to match the facility's planned expansion from initial construction to Phase 2 / Full Buildout. Alternatives that require minimal component upgrades and financial investment were rated more favourably.

Operation / Maintenance Complexity

This criterion reviews how complex the technology/system is to operate and maintain. It also reviews the required operator skill level and staffing requirements. Technologies that were deemed very complex to operate or to have intensive maintenance schedules were excluded from the short list of alternatives, as are technologies that require highly skilled operators.

Cost

The cost criterion looks at capital cost, operation and maintenance costs, and the net present value of the alternative. Capital costs include purchase of equipment and its installation as well as the construction costs of tanks and buildings. Operation and maintenance aspects include costs related to utilities (electricity, gas, potable water), chemicals, etc. It should be noted that labour costs associated with the number of operators required were considered equivalent for all alternatives.

5.2.2 Short-List Evaluation Criteria

The criteria and weightings selected for the liquid train short-list evaluation are presented in the table below and descriptions of each follow.

Where warranted, weightings for some criteria were adjusted, to more accurately reflect the differing objectives in the process being evaluated. Where weightings were revised from those shown below, the revised weightings are listed in the report before the results of the analysis are presented.

Table 8 – Liquid Train Short-List Screening Criteria

Primary Criteria	Weight	Secondary Criteria	Weight
Social / Culture	15%	Aesthetic Impacts (plant appearance)	10%
		Traffic Impacts (during construction and operation)	10%
		Noise Impacts (during operation)	40%
		Odours Impacts (during operation)	40%
Technical	35%	Ability to Meet Regulatory Objectives	30%
		Technology / Process Robustness	30%
		Ease of Expansion and Phasing to Buildout	20%
		Energy Requirements	5%
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10%
		Site Requirements (plant footprint)	5%
Environmental	20%	Public Health and Safety	30%
		Sustainability	20%
		Climate Change Impacts / Greenhouse Gas Generation	20%
		Natural Environment Impacts	10%
		Waste Generation	20%
Economic	30%	Capital Cost	30%
		Operation and Maintenance Costs	40%
		Net Present Value	30%

Social/Culture

Aesthetic Impacts: Aesthetic impacts relate to the technology's or facility's physical appearance and how aesthetically pleasing it might be. Alternatives that are more likely to blend in with the rural agricultural setting scored higher in the evaluation.

Traffic Disruption/Truck Traffic: This criterion captures the level of traffic disruption that could exist during the facility's construction and day-to-day operation. Factors considered would be delivery of large amounts of concrete during construction, which would result in numerous concrete trucks travelling to the site. Pre-fabricated units have a lesser impact on the local traffic during construction. Traffic impacts during operation would include increased traffic due to such activities as frequent chemical deliveries. A higher score was given to technologies/systems that would minimize traffic disruptions.

Noise Impacts: This criterion relates to the amount of noise that would be generated during normal operation of the facility. Systems with numerous pieces of motorized equipment or that require continuous blower operation rather than intermittent blower operation would have higher noise emissions. Technologies with lower noise generation were scored higher.

Odours: The odours criterion relates to the likelihood for a technology to emit/generate odours during normal operation. For example, odours from systems housed in an enclosed space/building may be more easily controlled than odours from open tanks. Technologies that minimize odours were scored higher than those prone to emitting odours.

Technical

Ability to Meet Regulatory Objectives: The ability to meet regulatory objectives relates to a technology's ability to consistently achieve the effluent limits and objectives. The required phosphorous effluent limit for Erin is very low. Technologies with a demonstrated ability to consistently meet Erin's phosphorous effluent limits, in addition to the other regulated parameters, were scored higher.

Process Robustness: The robustness of a technology refers to its ability to cope with or adjust to changing operational demands and adverse events. Examples include the system's ability to cope with unexpected high flow events, variations in sewage strength, temperature variations, weather events, or utility interruptions. A higher score was applied to technologies/systems that are more flexible to operational fluctuations.

Ease of Expansion and Phasing to Buildout: The technology chosen for Erin must be able to expand relatively easily to grow with Erin's population. The technology will also need to be able to facilitate expansion under a phased development plan to meet the full buildout population. Processes or technologies which require minimal component upgrades as the system expands were rated more favourably.

Energy Requirements: The energy requirements for some technologies can be higher than others and would have a higher environmental and cost impact. Alternatives with lower energy requirements were scored higher in the evaluation.

Operation and Maintenance Requirements: This criterion captures the level of effort required by operations staff to operate and maintain the system as well as staffing requirements and operator skill level. Systems that require minimal operational intervention, standard operator skill level, and fewer staff were rated more favorably.

Site Requirements: Site requirements relate to the space that will be needed for the technology / system as compared to the space available for the treatment facility.

Environmental

Public Health and Safety: This criterion looks at the level of risks posed to the public, such as accidents, spills, fires, etc. Examples of these risks include high temperature/pressure operations or increased handling of hazardous chemicals.

Sustainability: This criterion captures a technology's ability to meet current needs for performance and protection of the environment in a way that will not negatively impact the environment in the future. It also includes the ability of the alternative to maintain its performance over the life of the facility.

Climate Change Impacts/Greenhouse Gas Generation: The criterion relates to how the technology might contribute to climate change. Factors such as greenhouse gas emissions are considered. Processes with lower impacts on climate change triggers were scored higher in the evaluation.

Impacts to the Natural Environment: This criterion captures impacts on the local flora and fauna during construction and operation. If construction associated with an alternative would require removal of a large number of trees or significant disturbances to local wildlife, it scored lower in the evaluation.

Waste Generation: This criterion reflects the amount of waste that an alternative would produce. Waste can be in the form of waste chemicals, filter media, replacement parts, etc.

Economic

Capital Cost: This criterion relates to the financial investment required to purchase and install the alternative. Factors such as equipment cost, installation costs, construction of ancillary infrastructure, and land costs were evaluated. Alternatives with lower capital costs were rated more favourably.

Operation and Maintenance Costs: This criterion captures the estimated cost to operate and maintain the system. Aspects considered include cost of utilities (electricity, gas, water), cost of chemicals, such as coagulants, and frequency of major equipment replacements.

Net Present Value: The Net Present Value analysis captures the present value of all costs associated with initial construction and operation and maintenance of the technology / system for the expected life span of the technology / system. The net present value analysis in this report uses a 50-year life cycle.

5.3 Screening of Long List of Liquid Train Treatment Technologies

The long list of technologies considered for the primary, secondary, tertiary, and disinfection treatment process of the liquid treatment train are listed, described, and evaluated in the table below.

Table 9 – Evaluation of Long List of Liquid Train Treatment Technologies

No.	Technology	Description	Screening Criteria					Rationale
			Track Record	Ease of Expansion	O&M	Cost	Carry Forward	
Primary Treatment								
P1	Conventional Primary Clarifier	Conventional clarifier that employs gravity settling to remove settleable particles. A sludge collection system scrapes the settled solids from the bottom of the clarifier into sludge hoppers. A scum collection system scrapes scum from the top of the clarifier into a scum hopper.	✓	✓	✓	✓	**Yes**	▪ Well established technology ▪ Easily expanded ▪ Well established and understood O&M requirements ▪ Capital costs are comparable with other technologies
P2	Enhanced Primary Treatment	Technologies that would have higher solids removal compared to a conventional clarifier and needed to facilitate or enhance secondary treatment technologies. For example, use of filtration for high solids removal to pair with membranes in the secondary treatment or use of a clarification technology that also includes some nutrient removal in order to reduce loading on secondary treatment.	✓	✓	✓	✓	**Yes**	▪ These types of technologies are carried forward as they are needed to facilitate some of the secondary treatment technologies considered, such as membrane bioreactors.
Primary / Secondary Treatment								
S1	Modified Conventional Activated Sludge System (CAS)	The traditional CAS process involves primary settling via a standard clarifier, followed by aeration, and completed by secondary clarification. The CAS process is a flexible process that can be modified to denitrify by adding one or more anoxic tanks and/or perform phosphorous removal by dosing with coagulant at one or multiple locations in the process.	✓	✓	✓	✓	**Yes**	▪ The CAS is a well-established and extensively used technology ▪ Easily expandable ▪ Well established and understood O&M requirements ▪ Costs are comparable with other technologies
S2	Extended Aeration	The extended aeration process is similar to the CAS process, except the primary clarification step is removed. Preliminary treated sewage is fed directly to the aeration tank. The residence time is between a minimum of 15 hours compared to 6 hours in the CAS process. Aeration tank effluent flows to a secondary clarifier for solids separation.	X	✓	✓	✓	No	▪ Well- established technology, but not suitable for denitrification ▪ Easily expandable ▪ O&M requirements comparable with other technologies ▪ Costs are comparable with other technologies
S3	Sequencing Batch Reactor (SBR) for Biological Nutrient Removal	The SBR process performs BOD and nitrogen removal and settling in the same tank. The phases in the SBR process are fill, react, settle, decant, and idle. During the react stage, air is introduced into the reactor to facilitate biological growth. Primary treatment and secondary clarification are not required in an SBR system. SBRs can accommodate fluctuations in flows by either adjusting cycle times or via an equalization tank upstream of the SBR or a combination of both. SBRs can also achieve the advanced nutrient removal required for Erin.	✓	✓	✓	✓	**Yes**	▪ SBR is a well-established technology, especially for smaller plants ▪ Easily expandable due to the minimal number of tanks/reactors in the process ▪ O&M requirements comparable with other technologies ▪ Costs are low due to fewer reactors/tanks in the process
S4	Rotating Biological Contactors (RBC)	An RBC consists of a cylinder of plastic discs that are mounted on a rotating shaft. The cylinder is partially submerged in the wastewater and continuously rotated. Micro-organisms attach to and grow on the discs. Exposure to air when portions of the discs are out of the wastewater provides oxygen to the organisms and submergence	X	✓	X	✓	No	▪ Lack of operational flexibility to achieve advanced nutrient removal ▪ Easily expandable ▪ O&M difficulties in high flow periods where biomass tends to get washed off the discs

No.	Technology	Description	Screening Criteria					Rationale
			Track Record	Ease of Expansion	O&M	Cost	Carry Forward	
		causes the organisms to take up the nutrients in the wastewater. Nitrification and denitrification both occur on the RBC.						▪ Costs are comparable with other technologies
S5	Membrane Bioreactors (MBR)	An MBR is a modified CAS process with membranes submerged in the aeration tank or installed downstream of the aeration tank. The membranes combine microfiltration or ultrafiltration with a suspended growth process. The combination provides high nutrient and suspended solids removal. Secondary clarifiers and filtration are not required with an MBR system. Sewage temperature will affect an MBR's treatment capacity. MBRs also remove particulate phosphorous, so a tertiary stage may not be needed. Treatment capacity is affected at lower wastewater temperatures.	✓	✓	✓	✓	**Yes**	▪ MBR is a relatively newer technology, but now has a proven track record for advanced nutrient removal ▪ Relatively easy to expand by adding membrane cartridges and no secondary clarifier or tertiary system to expand ▪ O&M requirements higher than CAS system but offset by removal of clarifier and tertiary treatment in system ▪ Membranes require regular replacement at five to twelve year intervals, depending on the effectiveness of preliminary treatment. ▪ Costs are comparable with other technologies
S6	Moving Bed Bioreators (MBBR)	An MBBR uses plastic media, suspended in an aerated tank. Micro-organisms attach to and grow on the media. Nitrification takes place in an aerated tank and denitrification is achieved in a second, anoxic tank.	X	✓	✓	✓	No	▪ MBBR is a newer technology, but insufficient experience in achieving advanced nutrient removal ▪ Easily expanded by adding media to void space ▪ O&M requirements comparable with other technologies ▪ Costs are comparable with other technologies
S7	Integrated Fixed Film Activated Sludge (IFAS) Process with Chemical Addition for Phosphorous Removal	The IFAS process is a variation of an MBBR. IFAS combines the CAS system (suspended growth) with a biofilm on media system (attached growth). Plastic media is added to the aeration stage to provide surface area for micro-organisms to attach to and grow. The IFAS system achieves BOD removal and nitrification via the mix liquor suspended growth (MLSS) and denitrification via the biofilm on the media. Effluent from the IFAS goes to a clarifier to separate solids.	X	✓	X	✓	No	▪ Only one successful installation in Ontario. Insufficient experience in achieving advanced nutrient removal ▪ Easily expanded by adding more media to void space ▪ Operational difficulties associated with retaining media in tank without affecting hydraulics and foaming issues reported ▪ Costs are comparable with other technologies
S8	Two-Staged Biological Aerated Filters (BAF)	BAFs are usually up-flow filters that use granular or plastic media. BOD removal and nitrification would take place in an aerated BAF and denitrification would occur in a subsequent anoxic BAF. An external carbon source would be needed in the anoxic tank to feed the biomass. A clarifier is not needed downstream of a BAF.	X	✓	X	✓	No	▪ Lack of history in advanced nutrient removal ▪ Ease of expansion is comparable with other technologies ▪ O&M requirements are high ▪ Costs are comparable with other technologies
Tertiary Treatment								
T1	Tertiary Membrane Filters	Use of ultrafiltration membranes to remove phosphorous. Commonly used in drinking water systems. Membranes can remove phosphorous down to 0.02 mg/L. Sewage temperature will impact treatment capacity of tertiary membranes.	✓	✓	✓	✓	**Yes**	▪ Newer technology. Well applied for drinking water installations in Ontario ▪ Can be expanded by adding membrane cartridges ▪ Relatively complex O&M requirements, but acceptable due to its high performance ▪ Membranes require regular replacement at ten-year intervals. ▪ Expensive relative to other technologies, but acceptable due to its high performance and ability to meet effluent criteria with minimal chemical addition.

No.	Technology	Description	Screening Criteria					Rationale
			Track Record	Ease of Expansion	O&M	Cost	Carry Forward	
T2	Two-Stage Continuous Backwash Up-Flow Sand Filters (e.g. DynaSand)	Two stage filtration refers to up-flow filters that use sand as the filter media. Chemical addition is used to facilitate phosphorous removal. The majority of removal occurs in the first stage. The second stage is a polishing step.	✓	✓	✓	✓	**Yes**	▪ Shown effective in pilot test studies, with one full-scale installation in Ontario ▪ High chemical usage
T3	Cloth Disc Filters	Cloth disc filters consist of a cartridge of circular filters that are made of a specialized cloth material. Solids accumulate on both sides of the filters. When solids accumulation reaches the upper limit, a backwash cycle is initiated to clean the filters	X	✓	✓	✓	No	▪ No history of achieving the advanced level of phosphorous removal required.
T4	High Rate Clarification (e.g. ActiFlo)	High rate clarifiers employ flocculation then use of micro-sand and a polymer. Coagulant is added to the secondary treatment effluent after which polymer and micro-sand are introduced into the wastewater stream. The flocs are then settled out of the water using a lamella clarifier.	X	✓	✓	✓	No	▪ No history of achieving the advanced level of phosphorous removal required.
T5	Adsorptive Deep Bed Filtration (e.g. BluePro)	A deep bed filtration process where a hydrous ferric coating is continuously applied to the sand media. Phosphorous in the wastewater chemically binds with the coating on the sand particles. The sand is continuously washed to remove adsorbed phosphorous and then recycled to the filter, where it is recoated with the ferric coating and reused.	✓	✓	✓	✓	**Yes**	▪ A few full-scale Canadian installations and several US installations. Some systems achieve phosphorous removal as low as 0.02 mg/L.
Disinfection								
D1	Chlorination / De-chlorination	A chlorination / dichlorination system uses sodium hypochlorite to disinfect the wastewater. The chlorinated wastewater is sent through a contact chamber to provide the required contact time. Sodium bisulphite is added to the contact tank effluent to remove residual chlorine, which can be harmful to the environment if over dosing occurs.	✓	✓	✓	✓	**Yes**	▪ Well established technology ▪ Easily expanded ▪ Extensive experience with dosing systems needed. ▪ Costs are comparable with other technologies
D2	Ultra-Violet Radiation	Ultra-violet lamps are used to irradiate the wastewater with ultraviolet radiation which inactivates pathogens. No by-products are left in the wastewater.	✓	✓	✓	✓	**Yes**	▪ Newer but, now a well-proven technology ▪ Easily expandable ▪ Relatively simple operation and maintenance requirements ▪ Costs are comparable with other technologies
D3	Ozonation	An on-site ozone generator is used to generate ozone, which is then dosed into the wastewater. Ozone inactivates pathogens and quickly degrades, leaving no by-products in the wastewater.	✓	X	X	✓	No	▪ Newer but, a proven technology ▪ Not very easily expandable ▪ Ozone is very reactive and more hazardous than chlorination/dichlorination chemicals. ▪ Costs are higher than other technologies

5.3.1 Summary of Short-List Technologies

The technologies that were short-listed for detailed evaluation for the liquid train treatment are listed below.

Primary Treatment

- Conventional Primary Clarifier
- Advanced Primary Treatment

Secondary Treatment

- Modified Conventional Activated Sludge Process
- Sequencing Batch Reactor
- Membrane Bioreactor

Tertiary Treatment

- Tertiary Membrane Filtration (Ultrafiltration)
- Two-Stage Up-Flow Sand Filters
- Adsorptive Deep Bed Filtration

Disinfection Treatment

- Chlorination/De-Chlorination
- Ultraviolet Radiation

5.4 Detailed Description of Liquid Train Short Listed Technologies

5.4.1 Technology Alternatives for Primary Treatment

The short listed primary treatment technologies are not all applicable to all of the short listed secondary treatment technologies. As such, the detailed evaluation of the primary treatment technologies has been coupled together with the detailed evaluation of the secondary treatment alternatives in order to identify the best combination of primary-secondary treatment.

5.4.2 Technology Alternatives for Primary/Secondary Treatment

Alternative 1: Modified Conventional Activated Sludge Process (CAS)

Figure 1 shows a flow schematic of the modified CAS process. The primary treatment alternative that couples with the CAS process is a traditional primary clarifier. For advanced nutrient removal, the CAS system is modified to include an anoxic zone upstream of the aeration tank. The anoxic zone is used to facilitate denitrification.

Wastewater flows from the preliminary treatment system into the primary clarifier, where settleable solids are removed. Sludge and scum from the primary clarifier are directed to the sludge/solids treatment system.

From the primary clarifier, wastewater flows into the anoxic zone, where denitrification takes place. The denitrification step is positioned upstream of the nitrification step (aeration) because denitrifying bacteria require sufficient BOD (carbon source) in the wastewater to support their metabolic activity and the aeration step reduces BOD levels. Denitrifying bacteria are introduced into the anoxic zone via a recycled activated sludge (RAS) stream from the secondary clarifier and nitrates are introduced into the anoxic zone through a nitrified mixed liquor recycle stream from the aeration tank.

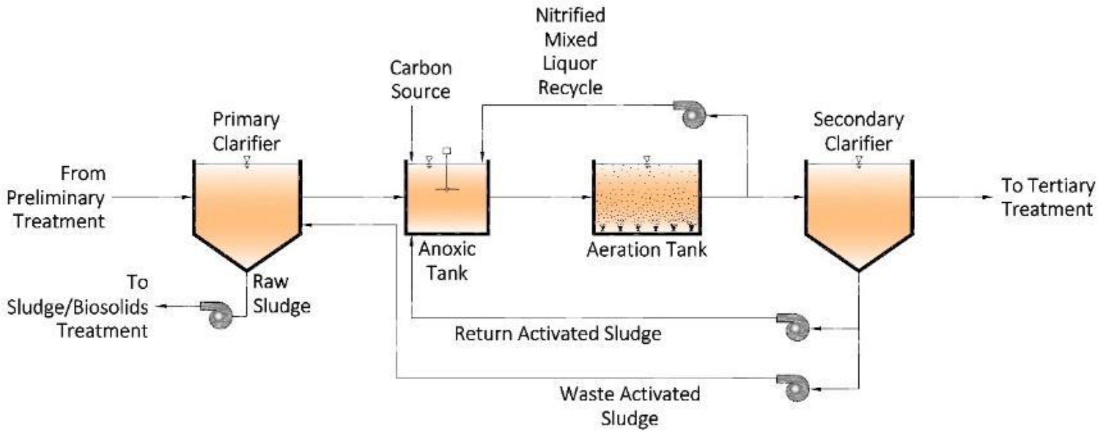

Figure 1 –Modified CAS Process Flow Schematic

In the anoxic zone, the denitrifying bacteria use the component of the nitrate molecule as an oxygen source for respiration and release nitrogen gas as a product.

The wastewater serves as a carbon source to the denitrifying bacteria. However, if BOD levels in the wastewater are not high enough, an external carbon source, such as methanol, would be required.

From the anoxic zone, wastewater flows to the aeration tank where BOD levels are reduced and ammonia and ammonium are converted to nitrate. Alternatives for aeration as applicable to all secondary treatment processes involve installation of high efficiency fine bubble diffusers systems and high efficiency blowers. If chemical phosphorous removal is included in this system, the coagulant can be added in the aeration tank and/or the anoxic tank.

The final step in the modified CAS process is removal of solids, which is typically done by a secondary/final clarifier. Sludge that is not recycled as RAS to the anoxic zone, is classified as waste activated sludge(WAS) and can be pumped directly to the sludge/biosolids treatment system or sent to the primary clarifier sludge hoppers for co-thickening before being sent to the sludge/biosolids treatment system.

Figure 2 shows a schematic of the biological stage of the modified CAS process. The anoxic zone and aeration tank could be constructed as a pair of independent channels for Phase 1, where one channel could serve as a by-pass to the other in the event that maintenance is required in one of the channels and it needs to be taken out of service.

A third channel would be constructed to accommodate Phase 2 flows. The plant layout shows the use of rectangular clarifiers, which were chosen based on the east of construction and expansion compared with circular clarifiers. However, circular clarifiers have equivalent benefits and are also viable. Selection of rectangular or circular clarifiers can be made during the design phase. Sufficient space has been identified for the WWTP site to support either alternative.

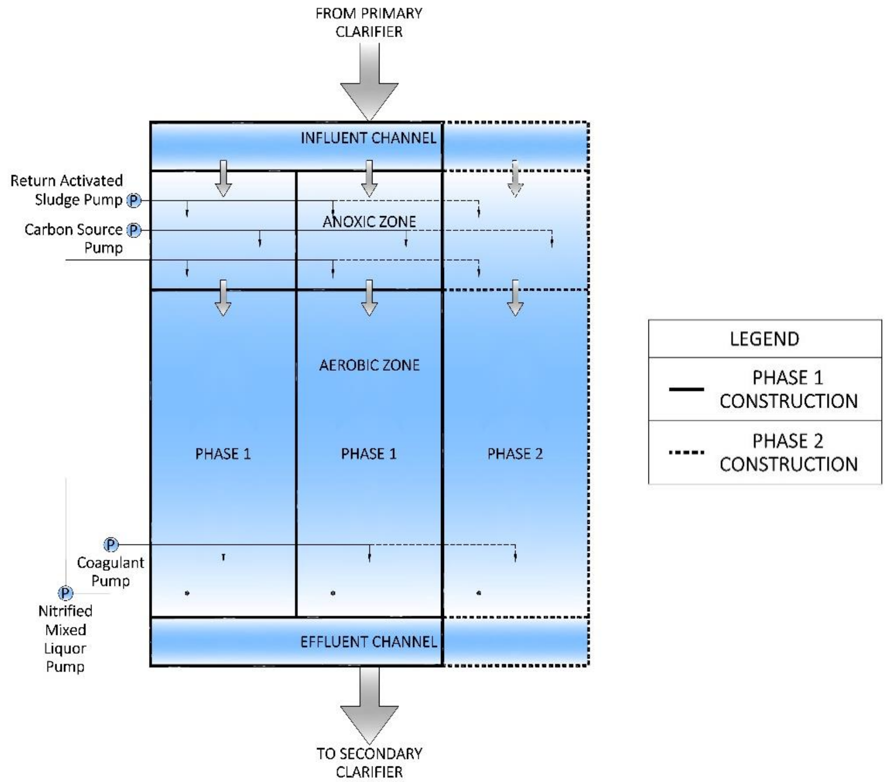

Figure 2 – Modified CAS Reactor Layout

Advantages and disadvantages of the modified CAS process are listed in the table below.

Table 10 – Advantages and Disadvantages of Modified CAS Process

Advantages	Disadvantages
▪ Well understood process and easy to operate ▪ Construction is straightforward. ▪ Lower aeration demand/costs when coupled with primary treatment. ▪ Relatively easy to expand if clarifiers and biological system constructed as rectangular tanks.	▪ System not very flexible for high flow events ▪ Tertiary treatment stage would be needed for the required advanced phosphorous removal. ▪ Requires large amount of chemical if phosphorous removal is required in the secondary treatment stage to facilitate advanced removal in the tertiary treatment stage.

Alternative 2: Sequencing Batch Reactor (SBR)

The SBR system uses a single tank/reactor as the anoxic tank, the aerobic tank, and the settling tank required for biological removal of nutrients from the wastewater. Primary clarification is not required in an SBR system. Wastewater flows from the preliminary treatment system directly to the SBR reactor. Figure 3 shows a flow schematic of a SBR system. All phases of the of treatment by the SBR occur in the reactor.

The SBR reactor is divided into two sections, a “pre-react” zone, where no aeration is provided and a main zone, which includes an aeration system. In general, there are four stages in the operation of an SBR, all of which occur in a single reactor. The typical stages are: fill, react, settle, decant, which are shown in Figure 3. There are several variations to the sequence and duration of each cycle, depending on the vendor.

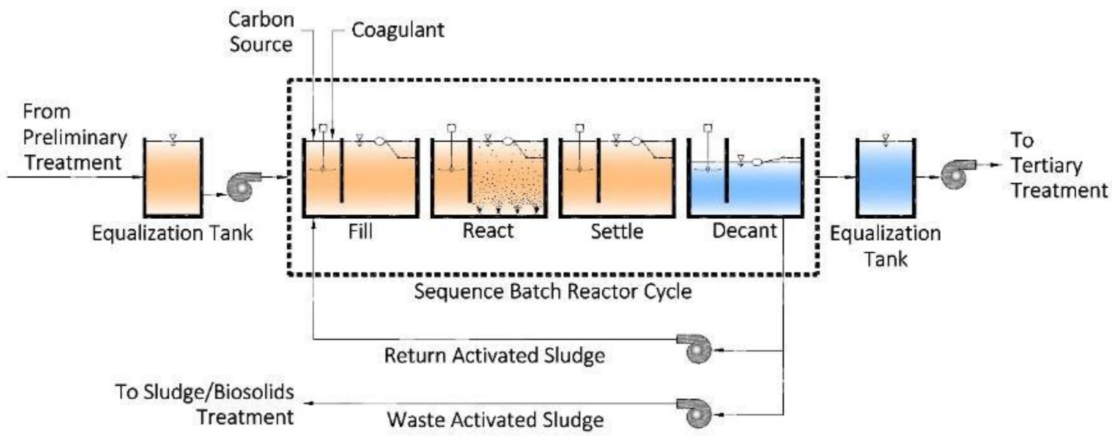

Figure 3 – Sequencing Batch Reactor Process Flow Schematic

During the fill stage, wastewater is introduced into the reactor into the pre-react zone along with a coagulant to precipitate phosphorous and a carbon source for the denitrifying bacteria, if needed.

The react phase occurs next where wastewater flows to the main zone and air is introduced into the reactor to support the micro- organisms that convert ammonia to nitrite and nitrate. Once the react phase is complete, the settle phase takes place, where the aeration system is de-activated and denitrification takes place. The settle phase also is a quiescent period that allows solids to settle to the bottom of the reactor. The final step is the decant phase in which the treated wastewater is decanted out of the SBR, via a decanter at the effluent end of the reactor.

Effluent from the SBR flows to an equalization tank designed to allow secondary effluent to be pumped to the tertiary treatment stage at an even flow rate.

The SBR includes two sets of pumps in the main zone. The pumps and their functions are described below:

- RAS Pumps: Pumps activated sludge from the main zone to the pre-react zone to keep the micro-organisms required to convert nitrates to nitrogen gas in the reactor.
- WAS Pumps: Pumps waste activated sludge from the main zone in the settle phase to the sludge/biosolids treatment system

In systems where the BOD levels in the SBR influent wastewater is not high enough to sustain the denitrifying micro-organisms, an external carbon, such as methanol, would be needed as supplemental carbon source.

To achieve the high level of phosphorous removal required for Erin, a coagulant is added in to the reactor to precipitate phosphorous and reduce loading to the tertiary treatment system.

Figure 4 shows the general layout of an SBR unit. As with Alternative 1 above, the SBR system would be constructed as three treatment trains. Phase 1 flow would be treated using two SBRs and a third would be added to treat Phase 2 flows.

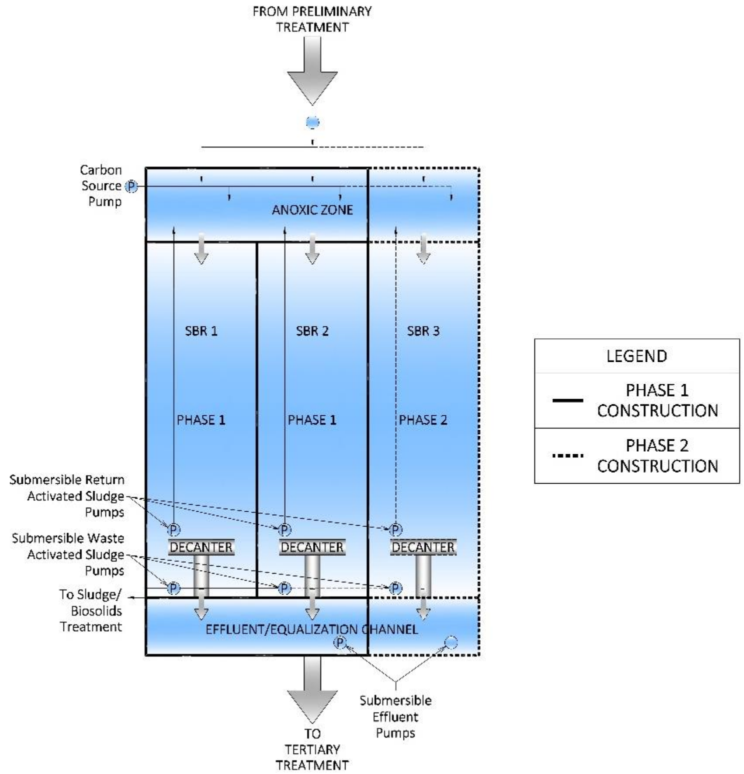

Figure 4 – Sequencing Batch Reactor Layout

The table below presents the advantages and disadvantages of the SBR treatment process.

Table 11 – Advantages and Disadvantages of the SBR Process

Advantages	Disadvantages
▪ Simple construction as reactors systems can come as prefabricated modules. ▪ Very resilient to extreme flow conditions by adjusting cycle times and/or adding an equalization tank upstream of the SBR. ▪ Relatively easy to expand. ▪ Small footprint as primary and final clarifiers not required.	▪ Operation is slightly more complex than CAS system. ▪ Tertiary treatment stage would be needed for the required advanced phosphorous removal. ▪ Equalization tank is required prior to downstream treatment processes. ▪ More frequent sludge wasting compared with CAS process.

Alternative 3: Membrane Biological Reactor (MBR)

A membrane bioreactor system combines the activated sludge process with a filtration process. Figure 5 presents a general flow schematic of an MBR system. Membranes used in an MBR system will be low-pressure microfiltration or ultrafiltration membranes. Through the filtration process and use of coagulants an MBR system can achieve the effluent limits, including phosphorous, without requiring a tertiary treatment step.

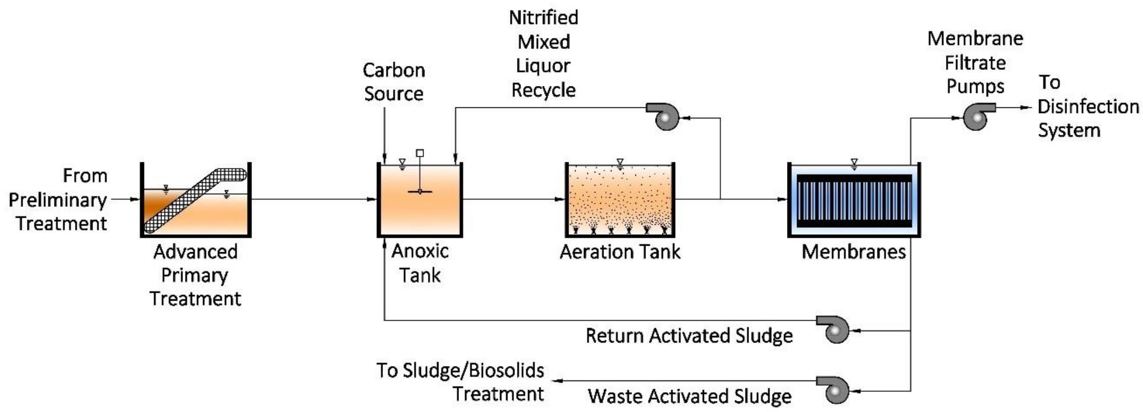

Figure 5 – Membrane Bioreactor Process Flow Schematic

For the MBR membranes to operate without excessive fouling and shutdowns for cleaning, an advanced primary clarification technology is needed for advanced solids and particle removal as compared with a traditional primary clarifier. A rotary belt filter (such as a Salsness filter) has been coupled with the MBR alternative because of its ability to remove fine particles, including hair, which is a common cause of excessive membrane fouling.

Wastewater from the preliminary treatment stage would flow to the belt filter which incorporates a rotating, polyethylene filter mesh/belt, which is partially submerged in the wastewater at approximately a 45-degree angle. As wastewater flows across the filter mesh particulates are collected on the mesh and carried upwards out of the liquid. A jet of compressed air is used to blow the screenings off the mesh and into a collection bin. The screenings can be disposed of at a landfill.

From the advanced primary treatment step, wastewater flows into the bioreactor, which consists of an anoxic zone and an aerobic zone. The anoxic zone is designed for denitrification and the aerobic zone is designed for nitrification and BOD reduction. A coagulant is added at the bioreactor step to facilitate phosphorous precipitation and removal by the membranes.

The MBR membranes can either be submerged in the aerobic zone of the biological reactor tank or housed in separate tanks downstream of the aerobic zone. This evaluation used membranes submerged in separate tanks. However, various vendor variations are available. Effluent from the biological reactor flows to the membrane tanks where pollutants are filtered out of the wastewater. Filtrate from the membranes is pumped to the disinfection system.

Filtration occurs in an aerobic environment and a continuous supply of air is required in the membrane tanks.

Figure 6 shows a general layout of the membrane biological reactor process.

The table below presents the advantages and disadvantages of the MBR treatment process.

Table 12 – Advantages and Disadvantages of the MBR Process

Advantages	Disadvantages
▪ The pore size of Ultrafiltration Membranes (MF) acts as an absolute barrier to suspended solids containing particulate phosphorus, bacteria and viruses, and large molecules. ▪ Tertiary treatment stage would not be needed to achieve the required advanced phosphorous removal. ▪ Smaller footprint than other technologies.	▪ Complex operation requiring advanced control systems. ▪ Aeration costs are higher than other technologies, due to aeration requirement in the bioreactor tank and the membrane tank. ▪ Membrane modules require replacement every 5 to 12 years, which is an added cost.

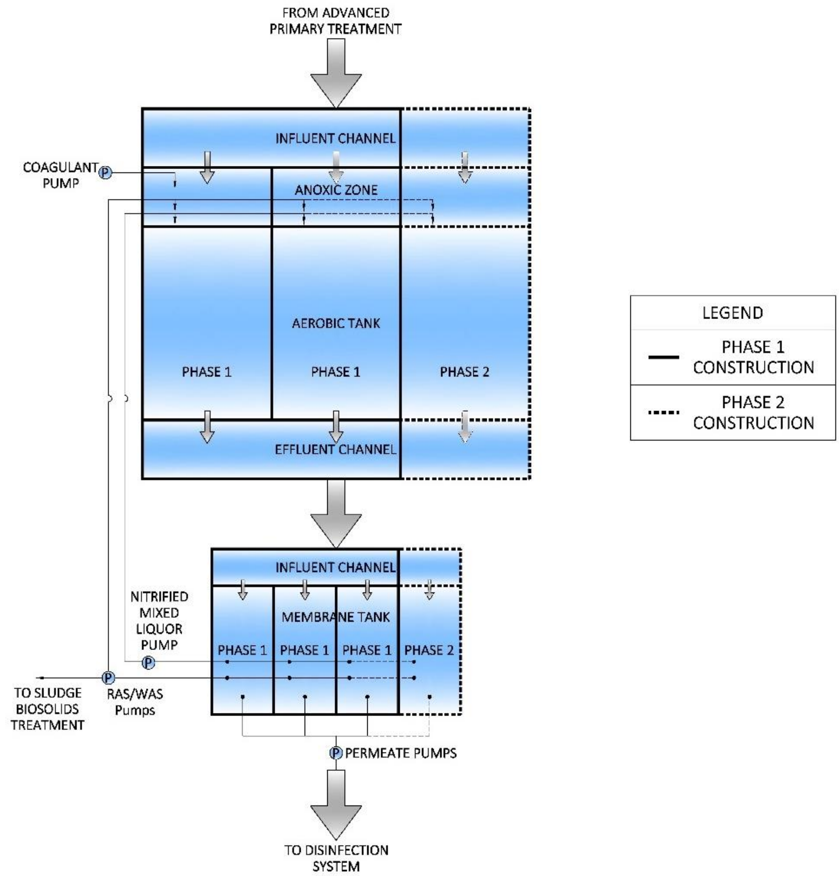

Figure 6 –Membrane Bioreactor Layout

5.4.3 Cost Comparison of Short Listed Primary/Secondary Treatment Alternatives

The table below summarizes the results of the life-cycle cost analyses for the three, short-listed primary/secondary treatment alternatives. Estimates have been rounded to the nearest thousand dollars. Details of the life-cycle cost analysis can be found in Appendix A.

An important factor in the cost of the membrane bioreactor system is the membrane replacement interval. The life cycle analysis includes replacement of the membrane modules at a ten-year frequency. There are examples of membranes having a lifespan greater than ten years, however, the more conservative approach was used in this evaluation.

Table 13 – Cost Estimates for Primary/Secondary Treatment Alternatives

	Modified Conventional Activated Sludge	Sequencing Batch Reactor	Membrane BioReactor
Capital Cost	$10,436,000	$11,749,000	$21,168,000
Annual Operation and Maintenance Cost	$3,251,000	$4,242,000	$6,850,000
Net Present Value	**$13,687,000**	**$15,991,000**	**$28,018,000**

5.4.4 Technology Alternatives for Tertiary Treatment

Alternative 1: Adsorptive Deep Bed Filtration

An adsorptive deep bed filter is configured and operated in a similar manner as a continuous up-flow sand filter. However, an adsorptive deep bed filter system applies a hydrous ferric oxide coating to the sand media. Phosphorous and other metals in the wastewater are chemically attracted to the coating and adsorb onto the coated sand particles.

An airlift transports media with the attached contaminants upwards into a washbox where the hydrous ferric oxide coating and contaminants are washed off. The used hydrous ferric oxide and contaminants flow out of the filter and the cleaned media settles back to the filter bed and is recoated with hydrous ferric oxide for another filter cycle.

It should be noted that this technology is primarily sold by one vendor.

Alternative 2: Two-Stage Continuous Up-Flow Sand Filtration

A continuous up-flow sand filter is a type of moving bed filter where the filter media (sand) is continuously cleaned, which avoids the need to shut down the unit for backwashing. Wastewater from the secondary treatment system enters the filter tank at the bottom and flows upwards through the filter bed. Suspended particles are filtered out of the wastewater stream. This technology as a single pass filter is successfully used at multiple locations throughout Ontario.

To achieve the advanced phosphorous removal required for Erin, two filters, connected in series, would be needed. Filtrate from the first unit is the influent to the second filter.

A coagulant is added to the wastewater, upstream of the first filter, to flocculate reactive phosphorous and facilitate its removal by the filter media.

It should be noted that this technology is primarily sold by two vendors.

Alternative 3: Tertiary Membranes

Membrane filtration uses pressure or vacuum to drive the wastewater through a permeable membrane to remove pollutants. Low-pressure membranes are categorized by the membrane pore size. Tertiary membrane systems typically use either microfiltration or ultrafiltration membranes. Microfiltration membranes have a pore size small enough to prevent the passage of bacteria and ultrafiltration membranes have a pore size small enough to prevent the passage of viruses. This evaluation was based on discussion with pressurized tertiary membranes vendors, however, implementation would involve bids from all types of membrane suppliers. These membranes are used in multiple drinking water treatment plants across Ontario and would produce a very high quality effluent.

Membranes can be installed in a dedicated tank where wastewater from the secondary treatment system is passed through the filter modules or, in the case of pressurized membranes, installed in a building and wastewater from the secondary treatment stage is pumped through the filter modules.

To prevent excessive fouling of the tertiary membranes a pre-filtration step is required upstream of the tertiary membranes to remove particulates that can clog the membranes. The pre-filter can be an automatic backwash type of filter and needs to be able to remove hair, which is a common cause of membrane fouling.

Cost Comparison of Short Listed Tertiary Treatment Alternatives

The table below summarizes the results of the life cycle-cost analysis of the three, short-listed tertiary treatment alternatives. Estimates have been rounded to the nearest thousand dollars. Details of the life-cycle cost analysis can be found in Appendix B.

It should be noted that pre-filters for the tertiary membranes have been include in the life-cycle costs of the tertiary membranes as well as filter module replacement at ten-year intervals.

Table 14 – Cost Estimates for Tertiary Treatment Alternatives

	Adsorptive Deep Bed Filtration	Two-Stage Up-Flow Sand Filtration	Tertiary Membranes
Capital Cost	$15,570,000	$9,795,000	$14,050,000
Annual Operation and Maintenance Cost	$6,037,000	$7,512,000	$5,082,000
Net Present Value	**$21,607,000**	**$17,307,000**	**$19,132,000**

5.4.5 Technology Alternatives for Disinfection

Alternative 1: Chlorination/De-Chlorination

A chlorination/de-chlorination disinfection system achieves disinfection by dosing the treated wastewater with a chlorine solution. Typically, a solution of chlorine gas or sodium hypochlorite is used as the chlorinating agent. Chlorine released into the receiving water stream negatively impacts all forms of life in the stream. For this reason, a de-chlorination process is needed to remove residual chlorine prior to discharge to the river. For the purposes of this evaluation, sodium hypochlorite was assumed as the disinfecting agent and sodium bisulphite was used as the de-chlorinating agent.

Treated wastewater from the tertiary treatment system would enter a chlorine contact tank, where chlorine would be metered into to wastewater at the contact tank's inlet channel. The contact tank would be designed to provide the required amount of contact time between the chlorine and wastewater to allow the disinfection process to take place.

Residual chlorine would be removed by adding a dechlorinating agent to the contact tank effluent channel. Sodium bisulphite is often used as the dechlorinating agent.

Advantages and disadvantages of the chlorination/de-chlorination alternative are listed in the table below.

Table 15 – Advantages and Disadvantages of Chlorination/De-Chlorination

Advantages	Disadvantages
▪ Proven effective and historically, extensively used. ▪ Well understood process. ▪ Effectiveness is not affected by water characteristics, such as turbidity.	▪ Negatively impacts all forms of life in receiving water. ▪ Over-dosing with the dechlorination chemical can reduce the dissolved oxygen concentrations in the wastewater and lower effluent DO levels. ▪ Operation requires skilled operators with a good understanding of chlorination chemistry. ▪ Added risk to worker health and safety due to handling of liquid or gaseous chlorine. ▪ Requires a building to house chemical dosing and storage systems.

Alternative 2: UV Disinfection

Disinfection via UV radiation involves exposing micro-organisms in wastewater to UV light within the 200 to 300 nanometer wavelength range. This range is called the germicidal range because micro-organisms, such as bacteria, viruses, and protozoa, are deactivated and lose the ability to reproduce after exposure.

A UV disinfection system consists of a bank of UV radiation emitting tubes, which are submerged in the wastewater, usually a concrete channel. As the wastewater flows across the UV tubes, micro-organisms are exposed to the radiation and become deactivated.

Advantages and disadvantages of the UV disinfection alternative are listed in the table below.

Table 16 – Advantages and Disadvantages of UV Disinfection

Advantages	Disadvantages
▪ Proven effective on multiple installations in Ontario ▪ Smaller footprint than chlorination ▪ Effective against a wide range of micro-organisms. ▪ Does not produce harmful by-products.	▪ Effectiveness depends on water quality, i.e. transmissivity and turbidity. ▪ Not very flexible to large variations in water quality. ▪ Requires building to house UV system.

Cost Comparison of Short Listed Disinfection Alternatives

The table below summarizes the results of the life-cycle cost analysis of the short-listed disinfection system alternatives. Estimates have been rounded to the nearest thousand dollars. Details of the life-cycle cost analysis can be found in Appendix C

Table 17 – Cost Estimate for Disinfection Alternatives

	Chlorination / De-Chlorination	UV Disinfection
Capital Cost	$1,761,000	$785,000
Annual Operation and Maintenance Cost	$873,000	$444,000
Net Present Value	**$2,634,000**	**$1,229,000**

5.5 Development of Alternatives for Liquid Treatment Train

There were three short-listed primary/secondary treatment technologies and three short-listed tertiary treatment technologies. Evaluating all possible combinations of the short-listed technologies would require detailed analyses of nine different liquid train treatment alternatives, however not all combinations are applicable.

To further narrow down the feasible alternatives, a preferred tertiary treatment technology was identified and paired with the applicable, short-listed primary/secondary treatment technologies to create overall liquid train treatment alternatives for detailed analysis. It is noted that the selection of the MBR technology for secondary treatment would preclude the need for tertiary treatment.

The alternative used for disinfection does not depend on or affect the alternatives for primary/secondary or tertiary treatment and was excluded from development of the liquid treatment train alternatives.

5.4.6 Detailed Evaluation of Tertiary Treatment Technologies

The weightings used for detailed analysis of the tertiary treatment alternatives were revised to more closely reflect the impacts related to the tertiary treatment system. At the point of tertiary treatment, the wastewater would be almost fully treated. Most of the solids and nutrients would be removed. Accordingly, it was decided that the Social/Cultural impacts of the tertiary treatment would not be as great as with the primary/secondary treatment and the weighting assigned to the Social/Culture criterion was reduced.

Weightings assigned to the Technical and Environmental criteria were increased to reflect the relative importance of these criteria for tertiary treatment.

The table below shows the criteria and weightings used to evaluate the tertiary treatment alternatives.

Table 18 – Tertiary Treatment Short-List Screening Criteria

Primary Criteria	Weight	Secondary Criteria	Weight
Social / Culture	5%	Aesthetic Impacts (plant appearance)	10%
		Traffic Impacts (during construction and operation)	10%
		Noise Impacts (during operation)	40%
		Odours Impacts (during operation)	40%
Technical	40%	Ability to Meet Regulatory Objectives	30%
		Technology / Process Robustness	30%
		Ease of Expansion and Phasing to Buildout	20%
		Energy Requirements	5%
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10%
		Site Requirements (plant footprint)	5%
Environmental	25%	Public Health and Safety	30%
		Sustainability	20%
		Climate Change Impacts / Greenhouse Gas Generation	20%
		Natural Environment Impacts	10%
		Waste Generation	20%
Economic	30%	Capital Cost	30%
		Operation and Maintenance Costs	40%
		Net Present Value	30%

The table below summarizes the results of the detailed evaluation of the tertiary treatment alternatives.

Table 19 – Detailed Evaluation of Tertiary Treatment Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED OPTIONS						COMMENTS
					Alternative 1 Adsorptive Deep-Bed Filtration		Alternative 2 2-Stage Up-Flow Sand Filtration		Alternative 3 Tertiary Membranes		
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	SCORE*	WT SCORE	
Social/Culture	5%	Aesthetic Impacts (plant apperance)	10	0.5	3	0.3	4.5	0.45	4	0.4	All equipment for the three Alternatives would be housed in a building. Aesthetic impacts would be related to the size of each building. Alternative 1 has the largest footprint (740m2), followed by Alternative 3 (336m2), then Alternative2(444m2).
		Traffic (during construction and operation)	10	0.5	3	0.3	3	0.3	4	0.4	Alternatives that have many components or require large tanks and/or buildings would create more traffic during construction. Alternatives that consume greater amounts of chemicals would result in the greater traffic during normal operation due to frequency of chemical deliveries. Alternative 1: # of units: 20 filters in Phase 1 , 8 filters in Ph2 and the most concrete. Highest chemical usage during operation at 977 kg/d. Alternative 2: 20 filters in Ph1, 10 filters in Ph2, moderate amount of concrete. Chemical consumption at 862 kg/d.
		Noise Impacts (during operation)	40	2	3	1.2	3	1.2	3.5	1.4	Alternatives 1 and 2 use air compressors. Alternative 3 uses blowers. Noise from blowers can be attenuated with silencers. Same level of noise attenuation not typically feasible for air compressors. Based on operator health and safety, the alternative with
		Odour Impacts (during operation)	40	2	3	1.2	3	1.2	3	1.2	No signifiant odours are expected during normal operation as the wastewater would be almost fully treated at this point of the tertiary treatment process.
Technical	40%	Ability to Meet Regulatory Objectives	30	12	4	9.6	3.5	8.4	3.5	8.4	Alternative 1: 4 installations meeting or exceeding Erin's TP Limit Alternative 2: 2 installations meeting Erin's TP limit Alternative 3: 2 installations meeting Erin's TP limit
		Technology/Process Robustness	30	12	3.5	8.4	4	9.6	3	7.2	Alternative 1: Performance could decreases with if TSS concentrations out of secondary stage too high. Alternative 2: Peformance not affected by exernal factors. Alternative 3: Could be subject to fouling if wastewater TS and TSS too high and peformance decreases at lower temperatures
		Ease of Expansion and Phasing to Buildout	20	8	3	4.8	3	4.8	4	6.4	Alternative 1: Requires a 40% increase in equipment and concrete tankage for to achieve Full Buildout capacity Alternative 2: Requires a 50% increase in equipment and concrete tankage to achieve Full Buildout capacity. Alternative 3: Requires 100% increase in equipment but no additional structures to achieve Full Buildout capacity. Construction of new structures considered more costly and complex than adding new additional pieces of equipment.
		Energy Requirements	5	2	3	1.2	4.5	1.8	3.5	1.4	Alternative 1: Highest energy requirement at 552 kWh/d. Alternative 2: Lowest energy requirement at 292 kWh/d. Alternative 3: Second highest energy requirement at 462 kWh/d.
		Operation & Maintenance Staffing Requirements (skill level/number)	10	4	4	3.2	4	3.2	3	2.4	More equipment could translate to more complex operations and would require increased maintenance. Alternative 1: System consists of filter, hydrous ferric oxide dosing pump skid, compressors Alternative 2: System consists of filters, coagulant dosing pump skid, compressors Alternative 3: System consists of numerous membranes modules, 5 chemical dosing pump skids, air compressors, membrane aeration blowers, backpulse system.
		Site Requirements (plant footprint)	5	2	3	1.2	4.5	1.8	4	1.6	Based on required buildling footprint
Environmental	25%	Public Health and Safety	30	7.5	3	4.5	3.5	5.25	4.5	6.75	[illegible] 1 the most
		Sustainability	20	5	3	3	3	3	3	3	Each Alternative is considered to have the same level of sustainability as they are all fairly new application for advanced phosphorous removal, without a long track record for perofrmance at this time.
		Greenhouse Gas Generation / Climate Change Impacts	20	5	3	3	3.5	3.5	3.5	3.5	required. Alternative 1 consumes the most energy and requires the most amount of tanks. Alternative 2 has the least energy consumption and less tankage than Alternative 1. Alternative 3 has the second highest energy consumption, but least tankage
		Natural Environment Impact	10	2.5	3	1.5	3	1.5	3	1.5	Since each technology would be housed in a dedicated building, each would have a similar level of impact on the natural environement (local flora and fauna).
		Waste Generation	20	5	3	3	3	3	4	4	Waste generated would be related to chemical usage and wasting. Alternative 1 has the highest chemical consumption and Alternative 3 the lowest.
Economic	30%	Capital Cost	30	9	2	3.6	4	7.2	2.5	4.5	Refer to NPV analysis spreadsheet
		Operation and Maintenance Costs	40	12	3.5	8.4	3	7.2	4.5	10.8	Refer to NPV analysis spreadsheet
		Net Present Value	30	9	2	3.6	3	5.4	2.5	4.5	Refer to NPV analysis spreadsheet
			TOTAL SCORE	100	62.0		68.8		69.4		

*Score is a number from 1 to 5

5.4.6.1 Preliminary Preferred Alternative for Tertiary Treatment

Based on the detailed evaluation of the short-listed tertiary treatment alternatives, tertiary membranes would be the preferred tertiary treatment alternative.

5.4.7 Liquid Treatment Train Alternatives

The alternatives developed for treatment of the liquid train, using tertiary membranes as the tertiary treatment technology, are:

- Modified Conventional Activated Sludge with Tertiary Membranes
- Sequencing Batch Reactor with Tertiary Membranes
- Membrane Bioreactor

Note that the membrane bioreactor option does not require a tertiary treatment step, since it is capable of achieving the required effluent limits, with appropriate coagulant dosing for phosphorous removal.

5.6 Evaluation of Liquid Treatment Train Alternatives

5.6.1. Cost Comparison of Liquid Train Treatment Alternatives

The table below summarizes the results of the life-cycle cost analysis of the three liquid treatment train alternatives, excluding disinfection, which is evaluated separately.

Table 20 – Cost Comparison of Liquid Treatment Train Alternatives

NPV	Modified Conventional Activated Sludge with Tertiary Membranes	Sequencing Batch Reactor with Tertiary Membranes	Membrane BioReactor
Capital Cost	$24,486,000	$25,799,000	$21,168,000
Annual Operation and Maintenance Cost	$8,333,000	$9,324,000	$6,850,000
Net Present Value	**$32,819,000**	**$35,123,000**	**$28,018,000**

5.6.2. Detailed Evaluation of Liquid Train Treatment Alternatives

The evaluation criteria and weightings used to evaluate the liquid treatment train alternatives were those presented in section 5.2.2.

The table below presents the detailed analysis of the liquid treatment train alternatives.

Table 21 – Detailed Evaluation of Liquid Treatment Train Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES						COMMENTS
					Alternative 1 Modified CAS with Tertiary Filters		Alternative 2 SBR with Tertiary Filters		Alternative 3 MBR		
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	SCORE*	WT SCORE	
Social/Culture	5%	Aesthetic Impacts (plant apperance)	10	0.5	3	0.3	3.5	0.35	4	0.4	CAS would greatest visual impact since it has the most tanks. SBR has only one tank and MBR would likelybe housed in a building.
		Traffic (during construction and operation)	30	1.5	3	0.9	3.5	1.05	4	1.2	CAS would have the highest construction traffic to increased tankage (concrete trucks) and equipment required for each tank/process and the lowest operation traffic due to chemical deliveries. MBR would have the least construction traffic as it has the least tankage and does not require a tertiary building like the other two alternatives. MBR will have more frequent chemical deliveries during normal operation.
		Noise Impacts (during operation)	30	1.5	4	1.2	4	1.2	3.5	1.05	Noise impacts would be limited to effects on worker health and safety and be due largely to blower operation. SBR would have the least noise emissions since the blower runs intermittently. MBR has two sets of blowers that operate continuously and CAS has one set of blowers that run continuously.
		Odour Impacts (during operation)	30	1.5	3	0.9	3.5	1.05	4	1.2	A higher potential for fugitive odours exist where there are open tanks. CAS has the most open tankage, followed by SBR, and MBR has the least.
Technical	40%	Ability to Meet Regulatory Objectives	30	12	5	12	5	12	4.5	10.8	All the alternatives are considered to have the same ability to meet regulatory objectives as they are all capable of meeting the advanced treatment required for Erin. MBR is slighly less sustainable.
		Technology/Process Robustness	30	12	4	9.6	5	12	2	4.8	The SBR alternative is considered the most robust since its operating cycles can be adjusted to respond to changes in flows or increases in wastewater strength, such as those from septage addition. The MBR alternative is considered the least robust as it only has one process.
		Ease of Expansion and Phasing to Buildout	10	4	3	2.4	4	3.2	4.5	3.6	The CAS alternative would involve the greatest amount of new construction due to the number of tanks to be expanded plus tertiary treatment expansion. The SBR alternative would require expansion of one tank plus the tertiary treatment. MBR would require expansion of two tanks, with a total footprint less than SBR expansion, but no expansion of a tertiary system and would be the least complex to expand to full buildout.
		Energy Requirements	15	6	5	6	4.5	5.4	5	6	The CAS alternative has approximately 1435 kWh/d energy requirement. The SBR alternative has approximately 1820 kWh/d energy requirement. The MBR alternative has approximately 1432 kWh/d energy requirement.
		Operation & Maintenance Staffing Requirements (skill level/number)	10	4	3	2.4	4	3.2	4	3.2	The CAS alternative has the most process units and resulting operation and maintainance requirements. The SBR alternative has the SBR and tertiary proces. The MBR alternative has the advanced fine filter for primary treatment, biological/aeration reactor, and the membrane reactor.
		Site Requirements (plant footprint)	5	2	3	1.2	4	1.6	4.5	1.8	The CAS alternative requires the greatest amount of land. The MBR option requires the least, since its tankage footprint is less than the SBR alternative and it does not require a tertiary treatment system/building.
Environmental	15%	Public Health	10	1.5	5	1.5	4.5	1.35	2	0.6	The risk to public health would be related to failure of the treatment systems, resulting in an environmental spill. MBR failure would have the most negative impact on public health and safety since the plant would lose both secondary and tertiary treatment. The CAS alternative would have the lowest impact since the increased number of tanks would provide more buffering than the single tank SBR.
		Sustainability	20	3	3.5	2.1	4	2.4	3.5	2.1	The SBR alternative is considered to be the most sustainable since it can most consistantly meet the effluent requiements. MBRs may also be approved as a disinfection system in the future, which would make the plant more efficient by removing the disinfection process. Since the SBR alternative is more flexible to fluctuating influent conditions than the CAS alternative, it is considered better in terms of long term sustainability.
		Greenhouse Gas Generation / Climate Change Impacts	20	3	3.5	2.1	3	1.8	4	2.4	For this high level evaluation, alternatives were scored based on energy usage and amount of tankage/construction required. The SBR alternative consumes the most energy. The CAS and MBR alternatives have approximately equal energy requirements. The CAS alternative has the highest amount of tankage/construction. SBR has more tankage footprint than the MBR alternative.
		Natural Environment Impact	10	1.5	3.5	1.05	4	1.2	4.5	1.35	The alternative with the largest footprint would result in the greatest impact to the natural environment, due to clearing of trees and other site works. The CAS alternative has the largest footprint, followed by the SBR alternative, and MBR has the smallest footprint.
		Waste Generation	40	6	4	4.8	4	4.8	4.5	5.4	Waste generated would be related to chemical usage and biological efficiency. The MBR alternative has approximately 10% less chemical consumption than CAS and SBR alternatives, which have approximately the same level of chemical usage.
Economic	40%	Capital Cost	40	16	4	12.8	4	12.8	5	16	Refer to NPV spreadsheets.
		Operation and Maintenance Costs	40	16	4	12.8	3.5	11.2	5	16	Refer to NPV spreadsheets.
		Net Present Value	20	8	4	6.4	3.5	5.6	5	8	Refer to NPV spreadsheets.
			TOTAL SCORE	100	80.5		82.2		85.9		

*Score is a number from 1 to 5

5.6.3. Preliminary Preferred Alternative for Liquid Treatment Train

Based on the detailed evaluation of the short-listed liquid treatment train alternatives, the preferred alternative is the Membrane Bioreactor system, which will perform secondary and tertiary treatment.

5.6.4. Detailed Evaluation of Disinfection Alternatives

The evaluation criteria and weightings used for evaluating disinfection alternatives were those presented in section 5. Results of the evaluation are presented in the table below.

Table 22 - Detailed Evaluation of Disinfection System Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES				COMMENTS
					Alternative 1 Chlorination / DeChlorination		Alternative 2 UV Disinfection		
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	
Social/Culture	15%	Aesthetic Impacts (plant apperance)	10	1.5	3	0.9	4.5	1.35	A chlorination system will require a contact tank and a building to house the chemical storage tanks and dosing systems. The UV system does not require as large a building and its contact tank is smaller than chlorination.
		Traffic (during construction and operation)	10	1.5	3	0.9	4.5	1.35	The chlorination alternative has more structures and tankage to construct than the UV alternative. Chlorination requires chemical deliveries during normal operation and UV does not.
		Noise Impacts (during operation)	40	6	3	3.6	3	3.6	Noise impacts are comparable
		Odour Impacts (during operation)	40	6	3	3.6	4	4.8	The chlorination alternative has a higher potential for odour impacts in the event of accidental high chlorine dosing or chemical spills.
Technical	35%	Ability to Meet Regulatory Objectives	30	10.5	4	8.4	4	8.4	Both are comparable.
		Technology/Process Robustness	30	10.5	4	8.4	3	6.3	The UV alternative is more responsive to fluctuations in system parameters, whereas, there is a 30 minute delay between the time a chlorination dose is changed and the the effect can be seen (react time in contact tank).
		Ease of Expansion and Phasing to Buildout	20	7	3	4.2	4	5.6	The chlorination alterative would be more complex and costly to expand, due to the need for increased tankage and chemical storage. For the UV system, additional lamp modules would be needed. The contact tank is small enough that it can be constructed for Phase 2 flow in Phase 1.
		Energy Requirements	5	1.75	5	1.75	3	1.05	The chlorination alternative requires the least energy at 12 kWh/d and the UV alternative requires 77 kWh/d.
		Operation & Maintenance Staffing Requirements (skill level/number)	10	3.5	3	2.1	4.5	3.15	The chlorination alternative requires more skilled operations staff and more maintenance attention than the UV alternative because it has more equipment and involves fairly complex chemistry.
		Site Requirements (plant footprint)	5	1.75	3	1.05	4	1.4	The chlorination alternative had a larger footprint.
Environmental	20%	Public Health and Safety	30	6	3	3.6	4.5	5.4	The chlorination system is considered to pose a greater risk to public health and safety due to the potential for accidental release of chlorine into the river if the de-chlorination system were to fail. In the natural environment, chlorine has been shown to produce by-products that are carcinogenic.
		Sustainability	20	4	3	2.4	4	3.2	The UV alternative is considered more sustainable since it does not use chemicals and is effective against micro-organisms that are resistant to chlorine.
		Greenhouse Gas Generation / Climate Change Impacts	20	4	3	2.4	3.5	2.8	The UV system uses 80% more energy than the chlorination system. However, the chemical deliveries required for chlorination/de-chlorination would generate comparable levels of greenhouse gases.
		Natural Environment Impact	10	2	3	1.2	4	1.6	The chlorination alternative has a larger footprint and would disrupt more of the natural environment.
		Waste Generation	20	4	3	2.4	4	3.2	The de-chlorination alternative could discharge excess sodium bisulphite to the effluent re-oxygenation system, which would negatively affect performance of the effluent re-oxygenation system. The UV alternative does not generate wastes.
Economic	30%	Capital Cost	30	9	3	5.4	5	9	Refer to NPV analysis
		Operation and Maintenance Costs	40	12	3	7.2	4.5	10.8	Refer to NPV analysis
		Net Present Value	30	9	3	5.4	5	9	Refer to NPV analysis
			TOTAL SCORE	100	64.9		82.0		

*Score is a number from 1 to 5

5.6.5. Preliminary Preferred Alternative for the Disinfection System

Based on the detailed evaluation of the short-listed disinfection system alternatives, the preferred alternative is UV disinfection.

5.7 Re-Oxygenation of Treated Effluent

5.7.1 Objectives and Overview

Dissolved oxygen levels in the treated effluent must be a minimum of 4 mg/L to comply with the effluent limits. In order to achieve this, it will be necessary to include a re-oxygenation step just prior to discharge to the West Credit River to elevate the DO levels.

The re-oxygenation capacity required will vary depending on how much oxygen the liquid treatment train strips from the wastewater. However, for the purposes of this evaluation, it was assumed that the DO level in the treated wastewater will be approximately 2 mg/L, which is the minimum required DO level in the aerobic/biological stage and none of the short-listed secondary treatment alternatives or tertiary alternatives involve an anoxic or anaerobic step following the aerobic stage that will remove oxygen from the treated wastewater.

5.7.2 Effluent Re-Oxygenation Technology Selection

Several alternatives to re-oxygenate the treated effluent were considered. The alternatives were:

- Coarse Bubble Aeration
- Fine Bubble Aeration
- Side Stream Dissolved Gas System
- Natural aeration via engineered waterfall from the WWTP to discharge point

Natural aeration was eliminated as it is not possible to readily calculate the amount of re-oxygenation that can be achieved using this method, which means there is no accurate way of sizing or pricing such a system. It also eliminates the ability to control the process and guarantee that the effluent limit is met.

The side stream dissolved gas system involves taking a side stream of the treated effluent, dissolving oxygen gas into the side stream and returning it to the main flow. The oxygen content in the side stream becomes distributed throughout the main flow and raises the DO levels. This alternative requires approximately 68 kg/day of oxygen. This is a large enough amount that an on-site oxygen storage facility would be needed. Additionally, the risks associated with handling oxygen gas make this alternative unattractive from an operator safety perspective and it was also eliminated from the evaluation.

Discussions with suppliers who have experience with effluent re-oxygenation systems revealed that fine bubble aeration is preferred over coarse bubble aeration, since fine bubble is a more efficient and cost-effective option. While fine bubble diffusers are more costly and have a shorter lifespan than coarse bubble diffusers, they have the lowest lifecycle cost due to the increased efficiency. For this re-oxygenation process, the treated wastewater will have less than 5 mg/L suspended solids and it is anticipated that this will greatly extend the life of the diffusers. In addition, fine bubble diffusers are recommended for the secondary treatment process and this selection provides the opportunity to streamline equipment selection.

The air required for re-oxygenation could be supplied from dedicated blowers or by increasing the capacity of the blowers used in the secondary treatment process. Preliminary sizing for dedicated blowers showed that the required blower capacity was likely smaller than any available on the market. It was decided that it would be more practical and less costly to increase the size of the secondary treatment blowers to include the oxygen demand of the re-oxygenation process rather than using dedicated blowers.

Fine bubble aeration, using upsized secondary treatment blowers, was selected as the preferred alternative for re-oxygenating the effluent.

The table below presents the results of the life-cycle analysis for this process. Estimates have been rounded to the nearest thousand dollars. Details of the life-cycle cost analysis can be found in Appendix D.

Table 23 – Life-Cycle Costs of Effluent Re-Oxygenation

	Effluent Re-Oxygenation Costs
Capital Cost	$86,000
Annual Operation and Maintenance Cost	$11,000
Net Present Value	**$97,000**

5.8 Preliminary Preferred Alternative for the Liquid Treatment Train

Based on the results of the detailed analyses of the alternatives for the liquid treatment processes, the preferred alternatives are:

- Primary, Secondary Treatment, and Tertiary – Membrane Bioreactor (MBR)
- Disinfection – UV Radiation (UV)
- Effluent Re-Oxygenation – Fine Bubble Diffusers, using upsized secondary treatment blowers

Figure 7 presents the flow schematic for the preliminary preferred alternative for the liquid treatment train.

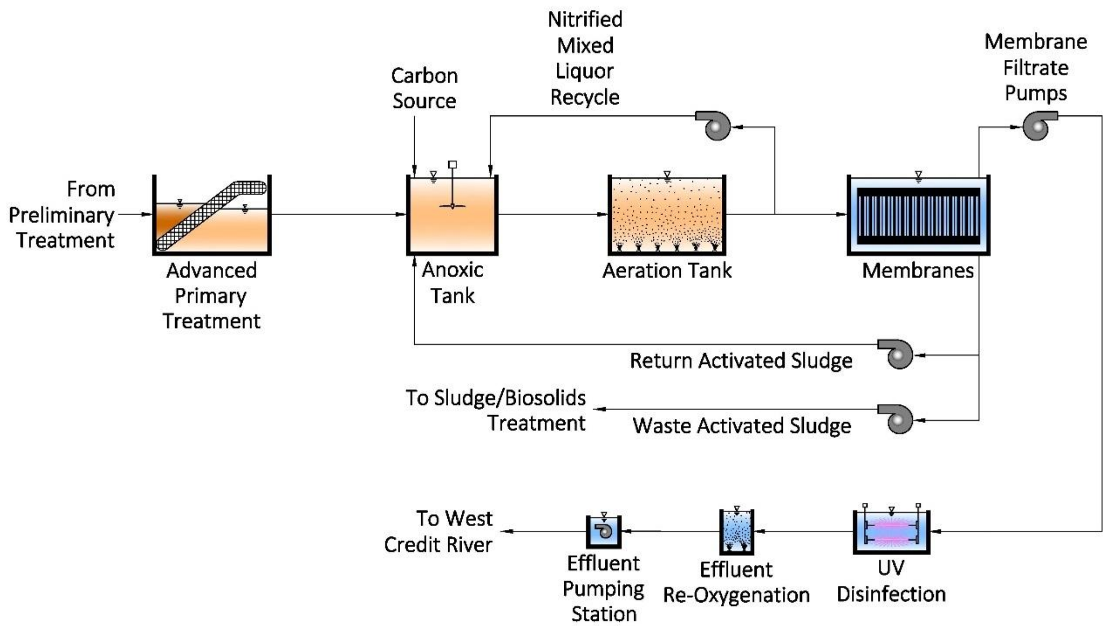

Figure 7 – Preferred Liquid Treatment Train Process Flow Schematic

6.0 Sludge/Biosolids Treatment and Management

6.1 Objectives and Overview

The objective of the sludge/biosolids component of the evaluation is to develop alternatives for treating and managing the sludge/biosolids generated at the WWTP.

Sludge/biosolids refers to the solids component in the wastewater. For the purposes of this assessment, sludge refers to wastewater solids that have not been stabilized and biosolids refers to wastewater solids that have been stabilized and are suitable for removal from the WWTP. Sludge does not include grit or solids that have been removed during preliminary treatment, as these solids are typically hauled off site for disposal at a landfill.

Sludge is progressively removed from the liquid stream during primary, secondary, and tertiary treatment. The quantity of sludge removed and/or generated in each process depends on the process itself. For example, processes that add coagulants to the liquid system will generate more sludge than processes that do not use coagulants.

Sludge from the WWTP is collected and can either be stabilized on site or hauled off-site for treatment by a biosolids management contractor. Sludge that is stabilized on site would be hauled off-site for use and/or disposal. If the sludge/biosolids were to be managed by a contractor, the contractor would choose the treatment and disposal methods.

Biosolids is a nutrient-rich product of the wastewater treatment process, with many options available for recovering and using the nutrients in a beneficial way, often termed as "beneficial reuse". Biosolids can be treated by various methods to produce products that can be used agriculturally, commercially marketed, or used as an energy source. Some of the possible end-use options for biosolids include:

- Applied to agricultural land as fertilizer;
- Used as a soil amendment, such as with compost;
- Commercially marketable fertilizer;
- Incinerated for heat and the ash used in the cement industry.

6.2 Sludge/Biosolids Train Evaluation Methodology

Several factors were considered when developing a management strategy for the sludge/biosolids generated. Factors considered included:

- Whether or not to stabilize the sludge on site or have unstabilized sludge hauled off-site for treatment and disposal at another facility,
- What on-site stabilization technology to use, and
- To what level should the biosolids be processed for beneficial re-use and/or commercial marketing.

6.2.1 Alternatives Related to Hauling Unstabilized Sludge Off-Site

Alternatives involving management /disposal of unstabilized sludge involve performing no on-site sludge stabilization. Unstabilized sludge would be hauled off-site for either disposal or treatment by another party.

The alternatives considered for management of unstabilized sludge were:

- Disposal at a landfill, licensed to accept unstabilized sludge;
- Treatment at another municipal facility, and
- Treatment/disposal by an independent, Biosolids Management Contractor.

All alternatives involving disposing or hauling unstabilized sludge off site were considered not sustainable as they carry a high degree of risk due to dependence on the receiving facility. Specifically, if the receiving facility were unable to accept Erin's unstabilized sludge, Erin would have no alternate means of disposing of the unstabilized sludge. The ability to expand Erin's plant would hinge on whether or not the off-site receiving facility has spare capacity to accept additional sludge. Alternatives related to hauling unstabilized sludge off-site were eliminated from the evaluation.

6.2.2 Alternatives Related to On-Site Sludge Stabilization

Unlike unstabilized sludge, stabilized sludge can be readily land applied to suitable agricultural lands. There are numerous contractors that offer land application services. End-use options related to stabilized sludge do not carry the same risk of dependence on a third part as alternatives related to unstabilized sludge.

Due to the flexibility associated with stabilizing the plant's sludge on site, it was decided that this alternative would serve the Town well and a long-list/short-list evaluation, as described previously in Section 4, was performed for sludge stabilization technologies. The evaluation and its results are presented in Section 7.3.

6.2.3 Alternatives Related to Revenue Generation from Biosolids

Biosolids can be processed to a level where they are suitable for commercial marketing and generate revenue. Typically, additional treatment systems are required after the sludge stabilization stage to produce a biosolids end-product of quality that matches the regulations as a commercially marketable product.

There are two options available for generating a marketable biosolids product. The first option consists of constructing an on-site treatment system then independently marketing the biosolids product. The second option is to retain the services of an independent Biosolids Management Contractor that would haul the stabilized sludge from the wastewater plant to their facility for treatment, after which the Contractor would market the biosolids product and return a portion of the revenue to the Town. The first alternative would require the capital expenditure of constructing a biosolids processing system, but would have the benefit that 100% of the revenue would go to the Town. The second alternative would not require the Town to finance the construction and operation of the biosolid treatment system. However, only a portion of the revenues would come back to the Town.

In either case, the amount of revenue generation possible depends on market conditions at the time of production and the amount of biosolids product available for marketing. It is difficult at this time to accurately predict what market conditions will be following Phase 1 construction. Also, the amount of sludge/biosolids generated by the plant depends on the characteristics of the raw wastewater and the treatment technologies implemented at the wastewater treatment plant.

Due to the degree of uncertainty this stage of the project with the major variables required to assess the cost benefits of producing a commercially marketable biosolids product, a long-list/short-list evaluation was not performed for revenue generation options. Instead, it is recommended that this evaluation be conducted after Phase 1 is operating and when the sludge production and quality will be known.

Section 7.4 presents an overview of the technologies available for processing biosolids to a level of commercial marketability and discusses the advantages and disadvantages of each.

Limiting the solution to generating stabilized sludge until marketability of the biosolids can be accurately assessed will provide the Town with a sufficiently secure solution for Phase 1 and incorporates a conservative approach to the cost estimate for the whole plant.

6.3 Evaluation of On-Site Sludge Stabilization Technologies

The methodology used to evaluate the technologies available for on-site sludge stabilization was a modified version of that used for the liquid train evaluation. A long-list set of screening criteria, specific to sludge/biosolids, was developed and used to short list the technology alternatives. This approach was used because the objectives for sludge/biosolids management vary from those associated with the liquid train. For example, the ability for beneficial reuse is a criterion that is specific to sludge/biosolids and is not relevant to the liquid treatment process.

6.3.1 Long-List Screening Criteria

The criteria selected for screening the long list of sludge stabilization technologies are presented in the table below and descriptions of each criterion follow.

Table 24 - Sludge Stabilization Short-List Screening Criteria

Criteria	Description
Regulatory Compliance	Ability to meet current and anticipated future regulations for processing and end-use / disposal.
Proven Reliability and Sustainability	Demonstrated successful projects of similar size and high level of flexibility to variations in sludge/biosolids quality and adverse weather conditions.
Staging / Phasing	Ability to easily expand to meet Erin WWTP's Full Buildout capacity.
Cost	Have value in terms of performance and/or operation and maintenance that are reflective of the capital costs.
Resource Recovery / Revenue Generation	Ability for end product to be used beneficially (e.g. land application) or to generate revenue (e.g. sold commercially as compost or fertilizer)

Regulatory Compliance

In order for an alternative to be carried forward for detailed analysis, the alternative must be one that produces a final product that meets the current and anticipated regulations for the intended use of the end product. For example, processes that produce compost must be able to adhere to the stringent metals content as prescribed by the Guidelines for the Production of Compost in Ontario, if the compost is to be commercially marketed in Ontario.

Proven Reliability and Sustainability

The preferred alternative must have a demonstrated history of reliably processing biosolids from a facility or facilities of a similar scale. The preferred alternative must be sustainable and be able to provide year-round treatment and/or storage, where required.

Staging/Phasing

The staging / phasing criterion reviews how easily an alternative can be expanded to match the planned expansion of the facility. Alternatives that require minimal component upgrades and financial investment were rated more favourably.

Cost

The cost criterion looks at the capital cost of the alternative and the costs associated with its operation and maintenance. Capital costs involve all initial construction costs including equipment purchase and installation. Operation and maintenance aspects include costs related to utilities (electricity, gas, potable water), chemicals, and the level of effort required for regular maintenance of the equipment.

Beneficial Use / Revenue Generation

This criterion relates to whether or not the final product produced by the alternative can be beneficially reused and/or commercially marketed. Alternatives that do not provide nutrient recovery or revenue generation from biosolids are excluded from the short-list.

6.3.2 Short-List Screening Criteria

The short-list screening criteria applied to the sludge stabilization technology alternatives were those used for the liquid train evaluation as they were considered relevant to both processes. Refer to section 4 for a list of the criteria and their descriptions.

6.3.3 Short-Listing of Sludge Stabilization Alternatives

The long list of alternatives considered for sludge stabilization technologies and the rationale used for short-listing are presented in the table below.

Table 25 – Evaluation of Long List of Sludge Stabilization Technology Alternatives

No.	Technology	Description	Screening Criteria: Regulatory Compliance	Proven Reliability & Sustainability	Staging / Phasing	Cost	Resource / Recovery / Revenue Generation	Carry Forward	Rationale
Primary Treatment									

1	Anaerobic Digestion	▪ This alternative involves stabilizing by anaerobic digestion. The digester is heated to a temperature between 35°C to 38°C and bacteria break down the organic matter in the sludge. The process produces methane gas as a by-product, which can be converted to heat and/or energy.
		▪ The biosolids produced is suitable for land application only. A local contractor would be retained for the services of land application.
		▪ The solids content of biosolids from an anaerobic digester is typically lower than 2%. Thickening from 2% to 4% would reduce haulage costs by 50%. This alternative includes a biosolids thickening system.
		▪ Regulations require that the facility include a means to store biosolids during the winter months when land application is not feasible. At least 240 days of storage is mandated, unless alternate methods of disposing of the biosolids are in place.
			✓	✓	✓	X	✓	No	▪ Anaerobic digestion not economically sound for smaller plants.
									  ▪ Digesters need specialized components, such as gas-tight covers
									  ▪ Needs heating, mixing, gas collection systems
									  ▪ Equipment needs to be designed for service in an explosive environment due to the presence of methane
									▪ Digester performance severely hindered if operated improperly
									▪ Requires fairly knowledgeable operators

2	Aerobic Digestion	▪ This alternative involves stabilizing the sludge using aerobic digestion. Micro-organisms consume the organics in the presence of oxygen. ▪ Generally considered unsuitable for primary sludge because of higher oxygen demand and larger amount of biomass produced ▪ The biosolids produced is suitable for land application only. A local contractor would be retained for the services of land application. ▪ This alternative also includes an on-site biosolids thickening system and 240 days of on-site biosolids storage.	✓	✓	✓	✓	✓	**Yes**	▪ Commonly used and well understood technology, especially for small plants ▪ Expansion is straightforward ▪ Capital costs are not high, but operating costs can be due to requirement for aeration ▪ Digested product can be land-applied in Ontario
3	Alkaline Stabilization	▪ This alternative involves stabilizing the sludge through the addition of alkaline material (typically lime) to raise and maintain the pH at 12 to destroy the pathogens. ▪ The biosolids produced is suitable for land application and unrestricted use as a fertilizer product. A local contractor would be retained for the services of land application. ▪ This alternative also includes an on-site biosolids thickening system and 240 days of on-site biosolids storage.	✓	X	✓	X	✓	No	▪ Potential for significant odour generation if system not operated properly ▪ Higher haulage costs due to lime addition ▪ Product has lower nitrogen content than other stabilization processes – may be less desirable as fertilizer

No.	Technology	Description	Screening Criteria						Rationale
			Regulatory Compliance	Proven Reliability & Sustainability	Staging / Phasing	Cost	Resource / Recovery / Revenue Generation	Carry Forward	
		▪ Regular importing of lime to the WWTP would be needed. ▪ Process produces 15% to 50% more material to be hauled off-side, due to the addition of lime.							
4	Stabilization with Autothermal Thermophillic Aerobic Digestion (ATAD)	▪ This alternative involves stabilizing the sludge using an auto-thermal aerobic digester (ATAD), which uses the heat generated by the digestion process to keep the digester temperature between 55°C and 65°C. No external heat source is required. ▪ The required hydraulic retention time is between 6 and 10 days as compared with 15 to 30 days for anaerobic or traditional aerobic digestion. ▪ The volatile solids destruction is higher than traditional aerobic and anaerobic digestion, which means less biosolids to haul off site. ▪ A sludge thickening system would be needed upstream of the ATAD, since the ATAD feed has to be above 3%. ▪ The biosolids produced is suitable for land application and unrestricted use as a fertilizer product. A local contractor would be retained for the services of land application. ▪ This alternative includes 240 days of on-site biosolids storage.	✓	✓	✓	✓	✓	**Yes**	▪ Well understood technology with several installations in Ontario ▪ No external heating system required ▪ Short hydraulic retention time results in smaller digester and lower construction costs ▪ Digested product can be land-applied in Ontario
5	Thermal Drying	▪ This alternative involves heating the sludge either through direct or indirect heating to reduce the pathogen level and evaporate water. Dryer types include rotary dryers, fluidized beds, hollow-flight dryers, and steam dryers. ▪ A sludge thickening system would be needed upstream of the dryer, since a thickened sludge removes water thereby reducing the amount of heat needed for drying. ▪ A biosolids cooling technology is needed prior to and during storage to prevent ignition of the dried product ▪ The biosolids produced is suitable for land application and unrestricted use as a fertilizer product. A local contractor would be retained for the services of land application.	✓	X	✓	X	✓	No	▪ Produces high quality product and reduces volume of biosolids to be hauled off site ▪ High capital costs ▪ Increased operational hazard due to risk of fires ▪ System is relatively complex and requires skilled operators

6.3.4 Summary of Short-Listed Sludge/Biosolids Alternatives

The on-site sludge stabilization technologies that were short-listed for detailed evaluation were:

- Aerobic Digestion
- Auto-Thermal Thermophilic Aerobic Digestion (ATAD)

6.3.5 Detailed Description of Short Listed Sludge Stabilization Alternatives

Alternative 1: Aerobic Digestion

Figure 8 shows a flow schematic of the process steps associated with the aerobic digestion alternative. Sludge and scum from the liquid train are directed to the aerobic digester, which is equipped with an aeration and mixing systems.

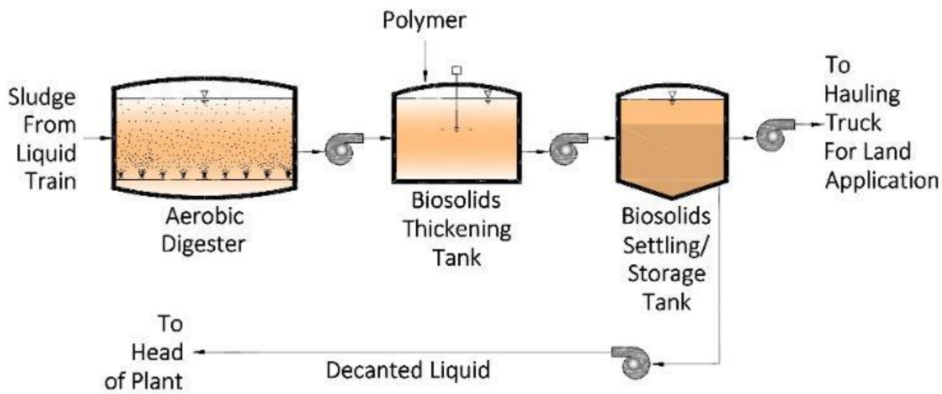

Figure 8 – Conventional Aerobic Digester Process Flow Schematic

Stabilized sludge is pumped from the digester to the biosolids thickening tank at approximately 1.5% solids. Polymer is added to the thickening tank, which is equipped with a mixing system to allow the polymer to react with the biosolids. From the thickening tank, the biosolids is pumped to the biosolids settling tanks.

The biosolids settling tank provide quiescence for settling and will be equipped with decanting systems to facilitate gravity thickening. Decanted liquid from the biosolids settling tank will be pumped to the head of the plant and thickened biosolids will be pumped to the biosolids storage tanks.

During summer months, thickened biosolids is pumped from the biosolids storage tanks then to the haulage trucks and hauled off-site for land application.

This alternative involves land applying of the biosolids as a liquid product rather than a biosolids cake, so the biosolids will need to be thickened to no more than 6%, as pumping of biosolids beyond this concentration, using traditional sludge pumps, becomes problematic. It is anticipated that thickening via polymer addition and gravity settling will achieve the desired solids concentration.

Advantages and disadvantage of this alternative are presented in the table below.

Table 26 – Advantages and Disadvantages of the Aerobic Digestion Alternative

Advantages	Disadvantages
▪ Requires simplest thickening system. ▪ Least amount of process equipment required. ▪ Biosolids produced is relatively odour-free. ▪ Well understood technology.	▪ Higher operation costs due to requirement of aeration. ▪ Degree of stabilization is weather dependent, with lower levels seen in the colder months.

Alternative 2: Auto-Thermal Thermophilic Aerobic Digestion (ATAD)

Figure 9 presents a flow schematic of the steps associated with the ATAD alternative. Unlike Alternative 1, sludge and scum cannot be pumped directly to the ATAD. It needs to be thickened to approximately 5% solids.

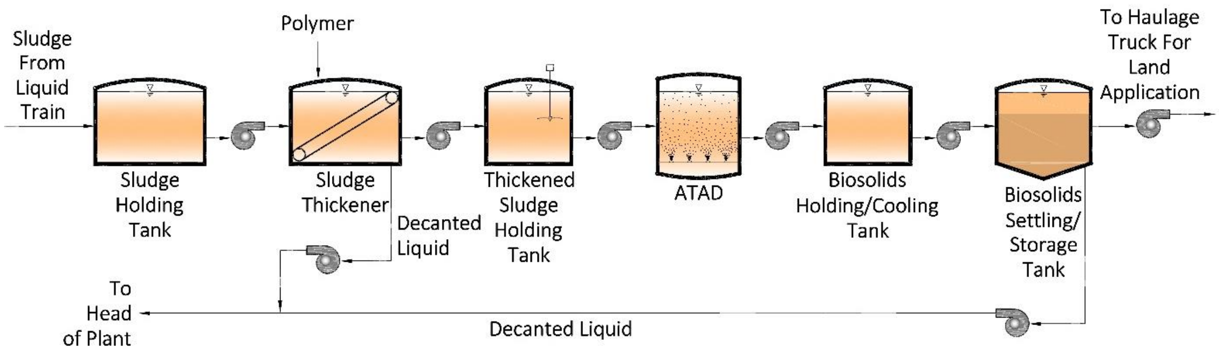

Figure 9 – ATAD Process Flow Schematic

From the liquid train, sludge and scum are pumped to an equalization tank then to a mechanical thickener. Polymer is added to the mechanical thickening process to improve thickening. Since sludge fed to the ATAD must be at a prescribed solids concentration, mechanical thickening is incorporated in this alternative to ensure that the required solids concentration can be achieved in a reasonable length of time.

Thickened sludge is then pumped to the ATAD for stabilization. The ATAD unit can be a single stage or double stage digestion system. A single stage process achieves sludge stabilization and the product is suitable for land application. If followed by a second stage, the second stage pasteurizes the biosolids to a quality level where the biosolids can be used as fertilizer without restrictions, as compared to land application only with the single stage ATAD. However, the pasteurized end-product has a lower nitrogen content, potentially making them a less desirable product in areas where high ammonia nitrogen fertilizer is desired.

From the ATAD, biosolids are transferred to biosolids holding/cooling tank, where excess heat from the stabilization process is removed to avoid possible over-heating.

Biosolids from the holding/cooling tank are pumped to the biosolids storage tanks, which provide the required 240 days of storage.

Advantages and disadvantage of this alternative are presented in the table below.

Table 27 – Advantages and Disadvantages of the ATAD Alternative

Advantages	Disadvantages
▪ Smaller digester size due to shorter retention times. ▪ Degree of stabilization is not weather dependent. ▪ Can produce a pasteurized biosolids product if second stage used.	▪ Higher capital costs due to requirement for mechanical thickening system. ▪ Slightly more complex operation. ▪ Biosolids product have higher odour than conventional aerobic digestion – odour control system may be needed.

6.3.6 Cost Comparison of Short Listed Sludge Stabilization Alternatives

The table below summarizes the results of the life-cycle costs analysis for the sludge stabilization alternatives. Details of the life-cycle cost analysis can be found in Appendix E.

Table 28– Cost Estimates for Sludge Stabilization Alternatives

	Conventional Aerobic Digestion	Autothermal Thermophilic Aerobic Digestion (ATAD)
Capital Cost	$8,540,000	$11,091,000
Annual Operation and Maintenance Cost	$2,340,000	$1,529,000
Net Present Value	**$10,880,000**	**$12,620,000**

6.3.7 Sludge Stabilization Alternatives Detailed Evaluation

The criteria and weightings used to evaluate the sludge stabilization alternatives were those presented in section 5.2.2. Results of the evaluation are presented in the table below.

Table 29 – Detailed Evaluation of Sludge Stabilization Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES				COMMENTS
					Alternative 1 Aerobic Digestion		Alternative 2 ATAD		
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	
Social/Culture	15%	Aesthetic Impacts (plant apperance)	10	1.5	5	1.5	3.5	1.05	The ATAD system has a higher visual impact due to the extra tankage associated with thickening of the sludge prior to digestion. ATAD has 5 major steps and conventional aerobic disgestion has 3 major steps.
		Traffic (during construction and operation)	10	1.5	4.5	1.35	5	1.5	The ATAD sysetm would have more traffic during construction due to the higher concrete requiement. Traffic during operation would be comparable. The ATAD has a higher solids destruction ratio that would result in less sludge being hauled from site during normal operation.
		Noise Impacts (during operation)	40	6	5	6	4	4.8	ATAD has more equipment than aerobic digestion and likely higher noise emissions.
		Odour Impacts (during operation)	40	6	5	6	4	4.8	The additional processing of sludge required by the ATAD system results in a higher potential for fugitive odour emissions and ATAD biosolids are inherently more odourous.
Technical	35%	Ability to Meet Regulatory Objectives	30	10.5	3	6.3	5	10.5	Since ATAD pasteurizes as well as stabilizes sludge, it achieves a higher standard of biosolids than aerobic digestion and is more likely to be able to comply if regulations become more stringent.
		Technology/Process Robustness	30	10.5	4	8.4	5	10.5	The ATAD process has more buffering ability due to the additional sludge storage tanks, i.e. sludge with strong characteristics would be slightly diluted in the two sludge storage tanks before entering the ATAD, whereas sludge enters the aerobic disgester directly from the liquid train.
		Ease of Expansion and Phasing to Buildout	20	7	5	7	3	4.2	The aerobic digestion process would be easier to expand since it has less equipment
		Energy Requirements	5	1.75	3	1.05	5	1.75	The aerobic digestion process requires more energy (1064 kWh/d) than the ATAD process (522 kWh/d) due to the fine bubble diffuser system in the aerobic digester.
		Operation & Maintenance Staffing Requirements (skill level/number)	10	3.5	5	3.5	3.5	2.45	The ATAD system has more equipment to operate and maintain and an ATAD unit is more complex to operate than an aerobic digester.
		Site Requirements (plant footprint)	5	1.75	5	1.75	4	1.4	The ATAD system has more equipment and requires more land.
Environmental	20%	Public Health and Safety	30	6	4	4.8	5	6	Public health and safety factors would be related to the amount off-site trucking of biosolids. The ATAD system produces a thicker biosolids due to the mechanical thickening process and would result in less sludge being transported from the site.
		Sustainability	20	4	3	2.4	5	4	The ATAD unit is more sustainable since it produces a product that can be used without restrictions, whereas biosolids from a conventional aerobic digester can only be land applied. ATAD would be able to comply if more stringent regulations were implemented in the future.
		Greenhouse Gas Generation / Climate Change Impacts	20	4	3	2.4	5	4	For this high level evaluation, alternatives were scored based on energy usage and amount of tankage/construction required. Conventional aerobic digestion woud have a greater impact on climate change due to the significantly higher energy usage, even though it requires less construction.
		Natural Environment Impact	10	2	5	2	4	1.6	The ATAD system would have a the greater impact on the natural environment due to the larger footprint required.
		Waste Generation	20	4	3	2.4	3	2.4	Waste generation would be similar for the two systems
Economic	30%	Capital Cost	30	9	4	7.2	3.5	6.3	Refer to NPV analysis spreadsheet
		Operation and Maintenance Costs	40	12	3	7.2	4	9.6	Refer to NPV analysis spreadsheet
		Net Present Value	30	9	5	9	4	7.2	Refer to NPV analysis spreadsheet
			TOTAL SCORE	100	80.3		84.1		

*Score is a number from 1 to 5

6.3.8 Preliminary Preferred Alternative for Sludge Stabilization

Based on the detailed evaluation of the short-listed sludge stabilization alternatives, stabilization by auto-thermal thermophilic digestion (ATAD) and land application of liquid biosolids would be the preferred alternative.

6.4 Options for Revenue Generation

The amount of revenue generation that is possible from commercial marketing biosolids produced at the wastewater treatment facility is dependent on the following parameters:

- Quantity of the biosolids.
- Characteristics of the biosolids (nutrient profile).
- Market value of the biosolids end-product at the time of marketing
- The life-cycle costs associated with the technology used to produce the biosolids product.

Once Phase 1 of the Erin WWTP is in operation, the first three variables listed above will be known and a life-cycle analysis will be feasible to determine if revenue can be generated.

Commercially marketable biosolids are either fertilizers or soil amendments, such as compost. There are several viable technologies that produce a biosolids product that can be marketed in Ontario. The following is a description of a few of these technologies, along with the advantages and disadvantages of each.

6.4.1 Thermal Drying

Thermal drying involves heating the biosolids to further reduce its pathogen levels, reduce its water content to almost zero, and achieve the quality required for commercial marketing. The end-product is a pelletized fertilizer which is approved for unrestricted use. The fertilizer pellets can be sold for residential use, such as direct application to lawns or gardens. The can also be directly applied in public areas, used as agricultural amendments, or mixed with other ingredients prior to application.

Heating can be either direct heating or indirect. Technologies used for thermal drying include rotary dryers, fluidized beds, hollow-flight dryers, and steam dryers. This option would require incorporating a thickening system upstream of the thermal dryer to reduce the water content from approximately 96% to 75%, thus reducing the amount of energy required to dry the biosolids.

In addition, a cooling system will be needed to prevent ignition of the dried pellets when they are being stored.

The table below presents the advantages and disadvantages of thermal drying.

Table 30 – Advantages and Disadvantages of Thermal Drying

Advantages	Disadvantages
▪ Fertilizer product is high in nutrients, such as nitrogen and phosphorous – increased value as fertilizer ▪ Product easily packed for marketing. ▪ Small footprint compared with other technologies. ▪ Achieves the highest volume reduction (pellets are at least 90% solids) – reduced trucking traffic. ▪ Does not require the addition of chemicals or other agents – reduced traffic to facility.	▪ Higher energy consumption. ▪ High capital cost. ▪ Dust generated in drying process creates an explosion hazard. ▪ Systems are complex and require skilled operations staff. ▪ Potential for odours.

6.4.2 Solar Drying

Solar drying also involves stabilization of the biosolids with heat. However, solar drying uses the sun's energy as the heat source. Stabilized sludge is spread across the floor of drying greenhouses, where the heat of the sun stabilizes and dries the biosolids. The greenhouses are equipped with a mechanical system to mix and turn the biosolids bed while gradually moving biosolids from the inlet end of the greenhouse to the discharge end. The end-product is a pelletized fertilizer which is approved for unrestricted use.

A thickening system will be needed upstream of the solar dryer to reduce the water content in the biosolids. A pellet cooling system may not be required with this technology since the heat applied for drying is significantly less than with traditional thermal drying technologies.

Since the heat applied is low compared to traditional thermal drying technologies, the process takes longer and, thus requires a large footprint to expose all of the biosolids to the sun.

This technology would incorporate supplemental heating to provide heat during the winter months where there is reduced levels of sunlight and the ambient temperature is low.

The table below presents the advantages and disadvantages of solar drying.

Table 31 – Advantages and Disadvantages of Solar Drying

Advantages	Disadvantages
▪ Reduced energy costs compared to traditional thermal drying methods. ▪ Fertilizer product is high in nutrients, such as nitrogen and phosphorous – increased value as fertilizer ▪ Product easily packed for marketing. ▪ Does not require the addition of chemicals or other agents – reduced traffic to facility.	▪ Large footprint. ▪ Requires supplemental heating for periods of low-sunshine ▪ Potential for fugitive odours

6.4.3 On-Site Composting

Composting is a process in which organic material undergoes biological degradation, generating a stabilized end product. The composting process naturally heats the material by microbial decomposition to temperatures of 50 to 65°C. At this temperature range, pasteurization of the biosolids will take place.

Typically, bulking agents are added to the biosolids to improve the structural integrity of the mixture. Bulking agents can be wood chips, straw, or sawdust. Other organic composting materials are possible, such as food scraps, yard trimmings, and paper products. The choice of bulking agent is dictated by the type of composting used.

There are three major types of composting: aerated windrow composting, aerated static pile composting, and in-vessel composting. Aerated windrow composting and aerated static pile involve making piles or windrows of the material to be composted and aerating it to support the micro-organisms that decompose the material. In windrow composting the composting piles are mixed, whereas in aerated static pile composting the compost piles are not mixed.

The mixing in windrow composting tends to release odours. To control fugitive odours, windrows can be covered with a semi-permeable geotextile material, which allows the passage of oxygen molecules but prevents passage of larger molecules, including odorous compounds.

In-vessel composting is performed within an enclosed container (tank, silo, concrete lined trench, etc.). The vessel includes mixing to keep the material aerated. In-vessel composting is versatile in that it can accept almost any type of organic waste (meat, animal manure, biosolids, food scraps). Other advantages include less potential for nuisance odours, smaller footprint than other composting methods, and faster processing times.

The table below presents the advantages and disadvantages of on-site composting.

Table 32 – Advantages and Disadvantages of On-Site Composting

Advantages	Disadvantages
▪ Reduced energy costs compared to other stabilization methods. ▪ High level of flexibility, robustness, and lower labour costs possible with in-vessel composting method. ▪ Compost product marketable, especially to local residents.	▪ Large footprint. ▪ Precipitation can slow down the degradation process of organics due to excessive moisture and evaporative cooling (except for in-vessel) ▪ High potential for fugitive odours (except for in-vessel). ▪ Windrow and static pile are labour intensive.

6.4.4 Retain Services of a Biosolids Management Contractor

Currently, there are two companies in Ontario that provide biosolids management services, including commercial marketing of the biosolids end-product. The two companies are Lystek International and Walker Industries. Both companies use alkaline stabilization to produce a commercially marketable fertilizer product.

The option of retaining the services of a biosolids management contractor means that the contractor would use their privately-owned stabilization system and then market the end-product through their marketing network. A portion of the revenue generated from sales would be returned to the Town.

Both contractors can process either unstabilized or stabilized sludge in their systems and can include haulage of the sludge/biosolids from the Town's wastewater treatment facility to their processing plant in their services. These contractors require that the hauled sludge/biosolids be at a minimum solids concentration between 15% and 20%.

The Town would have to construct a biosolids thickening facility to achieve the higher solids concentration required for haulage.

The amount of revenue generation possible with this option will depend on market conditions at the time of production, sludge/biosolids quality, sludge/biosolids quantity produced. The Town may need to issue a call for proposals for potential contractors to assess which contractor can offer the greater value.

The table below presents the advantages and disadvantages of on-site composting.

Table 33 – Advantages and Disadvantages of Biosolids Management Contractor

Advantages	Disadvantages
▪ Town would not have to finance construction and operation of a biosolids processing facility. ▪ Town would not to have manage marketing of biosolids end-product.	▪ Town would not receive 100% of profits from biosolids product sales. ▪ Town would be relying on a third-party.

6.4.5 Recommendations

It is recommended that a Biosolids Options Study be performed after Phase 1 is in operation to assess the profitability of moving towards marketing the biosolids produced by the Town's wastewater treatment facility. Sludge quantity and quality will be known once Phase 1 is in operation. Assessments that may affect Phase 2 can be performed with the more accurate information gained from Phase 1 operations.

It may be of value to consider implementing a county-wide biosolids processing facility and benefiting from the economies of scale that such a system could provide.

7.0 Septage Management

7.1 Objectives and Overview

Current residents who are outside the recommended service area of the proposed wastewater collection system will remain on septic systems. To provide service to these residents, Erin's WWTP will include a septage receiving and management system.

Treatment of septage is challenging because septage is significantly stronger than domestic sewage. The MOECC cites that BOD and total phosphorous levels in septage are on average thirty-six times higher than in domestic sewage. Other parameters can be as high as seventy times higher.

For wastewater treatment plants with larger flows, septage can be added to the main treatment process without negatively impacting the performance of the plant, as the dilution by the large plant flow buffers loadings from septage. However, for smaller treatment facilities, such as Erin's, addition of even small amounts of septage to the main treatment process could result in overloading of the treatment processes.

Where septage is added to the main treatment process, the rate of addition has to be carefully controlled to respond to instantaneous plant flows in order to prevent system overload.

7.2 Septage Flows

There are an estimated 2,500 existing, rural residents who will remain on septic systems. The estimated growth rate of this rural population is 0.5% per year. Over this next twenty years, the number of residents using septic systems will increase to approximately 2,762.

The estimated septage flow for the existing rural residents is 2,500 m^3/year, projected to increase to 2,762 m3/year by the year 2038.

Septage flows to the treatment facility and population served are presented in the table below.

Table 34 – Estimated Septage Flow to Erin WWTP

	2018	2038
Number of Rural Residents Using Septic Systems	2,500	2,762
Annual Septage Flow to the WWTP (m^3 / year)	2,500	2,762
Estimated Daily Flow to the WWTP ($m^{3/}$d)	9	10

The above flow rates were used in evaluating feasible alternatives for septage management and it was assumed that the plant will accept septage only from residents of the Town of Erin.

Since the projected increase in septage flow for the next 20 years is less than 1 m^3/d, it would be practical and cost effective to design the septage receiving and management system in Phase 1 to accommodate 2018 flows.

7.3 Septage Characteristics

The septage characteristics used in the evaluation of septage management alternatives for Erin were the suggested design values as cited in the MOE Design Guidelines for Sewage Works, Chapter 9 (Co-Treatment of Septage and Landfill Leachate at Sewage Treatment Plants), and are listed in the table below.

It should be noted that characteristics of septage received at the WWTP may vary widely, since septage haulers collect septage and waste from differing sources in addition to septic tanks, including construction and temporary toilets for special events. Once Erin's WWTP starts to receive septage, the septage can be tested to determine its specific characteristics and the septage management system can be adjusted accordingly.

Table 35 – Raw Septage Characteristics

Raw Septage Parameter	MOE Suggested Design Value (mg/L)
Biological Oxygen Demand (BOD)	7000
Total Suspended Solids (TSS)	15,000
Total Kjeldahl Nitrogen (TKN)	700
Total Ammonia Nitrogen (TAN)	150
Total Phosphorous (TP)	250
Alkalinity	1000

7.4 Overview of Septage Management Approaches

Three approaches were considered for management and treatment of septage at the wastewater treatment facility. The approaches are:

- Co-Treatment
- Pre-Treatment Followed by Co-Treatment
- Separate Treatment

Co-Treatment

Co-Treatment is the addition of raw septage to the WWTP's treatment process. Raw septage can be treated as either part of the plant's liquid or solid treatment system. This approach requires either careful monitoring or metering of the septage addition rate to ensure that the plant does not become overloaded or suffer system shock or designing the main treatment plant to be capable of treating the expected septage flows. Co-treatment is typically used in larger wastewater treatment facilities.

Pre-Treatment Followed by Co-Treatment

Pre-treatment followed by co-treatment involves partially treating the raw septage to reduce its strength prior to adding it to the main plant. This reduces the loading to the plant and has the added benefit of allowing the plant to accept and treat more septage. This approach is typically used in smaller wastewater treatment facilities.

Separate Treatment

Separate treatment involves treating the septage via a dedicated system to a level that matches the WWTP's effluent characteristics. This approach is not widely used since it tends to add significant capital cost to the plant or require a large amount of land, in the case of treatment via lagoons.

The alternatives considered in the evaluation of septage management were chosen based on the preferred technology alternative for the main treatment plant. If the preferred alternative for the treatment plant is changed then evaluation of the septage management alternatives may need to be revisited.

7.5 Septage Management Evaluation Criteria

7.5.1 Long-List Screening Criteria

The criteria selected for the long-list screening of the septage management alternatives are presented in the table below.

Table 36 – Septage Management Long-List Screening Criteria

Criteria	Description
Proven Reliability	Demonstrated track record of consistently meeting treatment objectives for septage.
Potential for Upset to Main Plant Process	The likelihood that this process would lead to an upset in the main plant's ability to meet effluent limits.
Site Requirements (footprint)	Amount of land required for the technology.
Potential for Odours	Likelihood of the alternative to generate odours at an unacceptable level during normal operation.
Cost	Have value in terms of performance and/or operation and maintenance that are reflective of the capital costs.

Proven Reliability

In order for an alternative to be carried forward for detailed analysis, the alternative must be one that achieves the required level of treatment for that particular alternative. For example, an alternative that would treat the septage independently from the plant would need to have a proven history of achieving the removal rates set out for the plant. However, an alternative that involves partially treating the septage before adding it to the main plant would only need to achieve a certain, prescribed level of treatment.

Potential for Upset to the Main Plant Process

This criterion reviews the impact that the septage management alternative might have on the main treatment process. Alternatives that treat the septage independently from the main plant would score higher as they would not contribute to the plant loadings. Alternatives that either add raw septage or partially treated septage to the plant would be scored according to the impact on the main plant process in the event of a septage system upset.

Site Requirements

Site requirements relate to the space that will be needed for the alternative as compared to the space available at the site for this system.

Cost

This cost criterion looks at the capital cost of the alternative and the costs associated with its operation and maintenance. Capital costs include equipment purchase and installation. Operation and maintenance aspects include costs related to utilities (electricity, gas, potable water), chemicals, and the level of effort required for regular maintenance of the equipment.

7.5.2 Short-List Screening Criteria

The criteria selected as the septage management short-list criteria are presented in the table below. Descriptions of each criterion can be found in section 5.2.2.

Table 37 – Septage Management Short-List Screening Criteria

Primary Criteria	Weight	Secondary Criteria	Weight
Social / Culture	10%	Aesthetic Impacts (plant appearance)	10%
		Traffic Impacts (during construction and operation)	10%
		Noise Impacts (during operation)	40%
		Odours Impacts (during operation)	40%
Technical	40%	Ability to Meet Treatment Objectives and Robustness	30%
		Potential for Upset to Main Plant Process	40%
		Energy Requirements	10%
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10%
		Site Requirements (plant footprint)	10%
Environmental	20%	Public Health and Safety	35%
		Sustainability	25%
		Climate Change Impacts / Greenhouse Gas Generation	25%
		Natural Environment Impacts	15%
Economic	30%	Capital Cost	30%
		Operation and Maintenance Costs	40%
		Net Present Value	30%

7.6 Evaluation of Septage Management Alternatives

7.6.1 Short-Listing of Sludge Stabilization Alternatives

The long list of alternatives considered for septage management and the rationale used for short-listing are presented in the table below.

Table 38 – Evaluation of Long List of Septage Management Technologies

No.	Technology	Description	Screening Criteria					Carry Forward	Rationale
			Track Record	Potential for Plant Upset	Site Require-ments	Potential for Odours	Cost		
1	Direct Co-Treatment in Main Treatment Plant Process	Raw septage would be received at a septage receiving/storage station and pumped to the main plant for treatment as part of the liquid treatment train. The flow of septage to the treatment plant would need to be controlled to prevent shock loading or overloading of plant treatment systems.	✓	✓	✓	✓	✓	**Yes**	▪ This a common practice in Ontario for septage management ▪ Has the highest potential for plant upset if not managed properly. ▪ Low foot print as only a septage receiving station would be needed ▪ Low potential for odours if receiving tanks are covered. ▪ Lower cost compared to other alternatives as only the septage receiving/storage station would be required
2	Stabilization Pond / Lagoon	This is a separate treatment alternative that would involve constructing a treatment lagoon/pond system at the site to receive and treat raw septage. Treated septage would then be disposed of off-site via land application.	X	✓	X	X	✓	No	▪ Ability to achieve advanced TAN removal is questionable ▪ No possibility of plant upset, since septage would be treated independently ▪ Requires larger amount of land ▪ High potential for odours as lagoon would be open to atmosphere ▪ Costs are comparable with other alternatives
3	Pre-Treat Raw Septage by Dewatering with GeoTube Followed by Co-Treatment	Raw septage would be received at a septage receiving station from where it would be pumped into permeable tubes (GeoTubes) for dewatering. Filtrate from the GeoTubes would be collected and pumped into the plant for co-treatment. The filtrate would be significantly weaker than raw septage, reducing the risk of plant overload and potentially increasing the facility's septage treatment capacity. The dewatered septage solids would be disposed of off-site via land application.	✓	✓	✓	✓	✓	**Yes**	▪ Dewatering as a pre-treatment is a common practice ▪ Low potential for plant upset ▪ Land requirements can be met ▪ Odour control incorporated into system ▪ Costs are comparable with other alternatives
4	Design Preferred Main Plant's MBR System to Include Septage Treatment	This alternative involves increasing the plant's treatment capacity to process the increased loading from septage. Raw septage would be received at a septage receiving station then pumped to the plant for treatment. The flow of septage to the treatment plant would need to be controlled to prevent shock loading or overloading of the plant's treatment systems, in the event that the septage characteristics are stronger than the design values.	✓	✓	✓	✓	✓	**Yes**	▪ MBR is a proven technology ▪ Some potential for plant upset if septage characteristic are significantly stronger than system is designed to treat ▪ MBR biological reactor tank size will increase slightly ▪ Costs are comparable with other alternatives.
5	Separate Treatment via Dedicated Treatment Process	This alternative involves incorporating a separate treatment system at the wastewater facility to treat the raw septage to meet the plant's effluent limits.	X	✓	✓	✓	X	No	▪ All technologies investigated are emerging without a track record for advanced nutrient removal from septage. Required phosphorous removal is challenging. ▪ No possibility of plant upset, since septage would be treated independently ▪ Land requirements can be met ▪ The systems considered were enclosed. Odour control systems can be included for the enclosure. ▪ Capital costs are high compared with other alternatives.

7.6.2 Summary of Short-Listed Septage Management Alternatives

The septage management alternatives that were short-listed for detailed evaluation were:

- Direct Co-Treatment of Raw Septage
- Design Main Plant's MBR process to Include Septage Treatment
- Pre-Treat Raw Septage by Dewatering with GeoTube Followed by Co-Treatment

7.6.3 Detailed Description of Short Listed Sludge Stabilization Alternatives

Alternative 1: Direct Co-Treatment of Raw Septage

Alternative 1 involves receiving raw septage at a septage receiving station and pumping it to the main plant for treatment as part of the liquid train. The septage receiving station would be a common system for all septage management alternatives considered and would include a bar screen and a septage holding tank. The bar screen would be designed to remove larger objects, rags, and other items that would be difficult to pump. The septage holding tank would store raw septage and submersible raw septage pumps would pump septage to the head of the main plant for co-treatment at an even, metered flow rate.

Raw septage would be introduced to the plant at the headworks area to allow mixing with the domestic sewage prior to the biological treatment stage. Since septage is significantly stronger than domestic sewage, the rate at which raw septage is pumped to the plant will need to carefully controlled to prevent shock-loading or overloading the plant's treatment processes.

Using the septage characteristics listed in section 8.3, at the plant's Phase 1 average flow of 4,780 m^3/d, raw septage could be added to the plant at approximately 6 L/min before the plant's influent characteristics would rise above the average range for domestic sewage. Additionally, the septage pumping rate would need to be modulated to mirror fluctuations in plant's instantaneous flow rate. Raw septage flow to the plant would need to be kept below 0.19% of the plant's instantaneous flow in order to prevent system overload.

A septage addition rate of 6 L/min equates to adding 9 m^3 (one small haulage truck) over a 24-hour period. It is proposed that two septage holding tanks be provided (standby and backup) and each tank sized to contain two day's worth of septage.

Advantages and disadvantage of this alternative are presented in the table below.

Table 39 – Advantages and Disadvantages of Direct Co-Treatment

Advantages	Disadvantages
▪ Least costly alternative ▪ Small footprint, since only the septage receiving station and holding tank would be required	▪ Highest potential for upset to main plant process ▪ Requires frequent operator involvement to analyze septage characteristics and determine acceptable transfer rate to main plant. ▪ Difficult to plan for variability of septage arrival at the WWTP. ▪ No potential to expand for revenue generation.

Alternative 2: Design Main Plant's MBR to Include Septage Treatment

Alternative 2 involves designing the plant's preferred secondary treatment technology (membrane bioreactor) to accommodate the increased loading from septage. The increase in design capacity would be to a level where the MBR could achieve the required treatment up to the point where addition of septage would drive the plant's influent characteristics above the average range for domestic sewage.

Raw septage would be received at the septage receiving station, stored in a septage holding tank, and pumped to the plant for treatment when the tank is full. The flow of septage to the treatment plant would need to be controlled to prevent shock loading or overloading of the plant's treatment system.

Using the septage characteristics in section 8.3, it is estimated that this alternative could accommodate a septage addition rate up to 0.42% of the plant's instantaneous flow. At the plant's Phase 1 average flow rate of 4,780 m^3/d, this septage addition rate equates to 14 L/min.

Advantages and disadvantage of this alternative are presented in the table below.

Table 40 – Advantages and Disadvantages of Increasing the Capacity of the Main Plant

Advantages	Disadvantages
▪ Minimizes potential for plant upset compared to direct co-treatment ▪ Slight increase in bioreactor size	▪ Potential for upset fairly high ▪ No potential to expand to achieve revenue generation, if desired.

Alternative 3: Pre-Treat Raw Septage by Dewatering with GeoTube Followed by Co-Treatment

Alternative 3 involves pre-treating the raw septage using a permeable membrane tube (Geotube) dewatering system and pumping the dewatering filtrate to the head of the main plant for co-treatment. The solids component of the dewatering operation would become stabilized in the Geotube and the stabilized product would be suitable for land application.

Pre-treatment decreases the strength of the raw septage, thus reducing the potential for shock-loading or overloading of the main plant and potentially increasing the plant's septage treatment capacity.

As with alternative 1, raw septage would be received at the septage receiving station and stored in the septage holding tank. Submersible pumps would pump the raw septage into the Geotube for dewatering on a batch basis for each tube. The Geotubes would be installed on an engineered laydown area, which would incorporate trenches to collect the filtrate and direct it to a filtrate holding tank, from where the filtrate would be pumped to the head of the plant.

This system also incorporates an odour control system which would draw air from the septage bar screen and holding tank when septage is being delivered, pumped into the Geotube, or mixed within the holding tank and treat the odourous air to prevent emission of fugitive odours.

The rate at which filtrate is pumped to the plant would need to be monitored to ensure that the characteristics of the raw sewage do not increase beyond the average range for domestic wastewater. Using the septage characteristics proposed is section 8.3, it is estimated that Geotube filtrate could be added to the plant at a maximum of 2.8% of the plant's instantaneous flow. At the Phase 1 average plant flow rate of 4,780 m^3/d, the maximum filtrate addition translates to approximately 92 L/min.

The Geotube® technology was selected for this alternative because it has been successfully used at the Eganville WWTP in Eganville, ON for the past seven years and the supplier was able to provide data on the characteristics of the filtrate and the dewatered solids, which were needed to determine the level of treatment possible with this system and the maximum allowable rate of filtrate addition to the main plant.

Additionally, this alternative produces a biosolids end-product that can be land-applied as opposed to disposed of at a landfill, which is the typical disposal method for dewatered septage solids. This feature of this alternative is in keeping with the potential for resource recovery criterion used in the solids treatment train evaluation for Erin's WWTP. If instances occur where the characteristics of the Geotube solids do not permit them to be land applied, those solids can be disposed of at a landfill.

Advantages and disadvantage of this alternative are presented in the table below.

Table 41 - Advantages and Disadvantages of Pre-Treatment with Geotubes®

Advantages	Disadvantages
▪ Minimizes potential for plant upset ▪ Produces a biosolids product that can be disposed of by land application ▪ Low operator involvement ▪ Can accommodate fluctuations in septage characteristics ▪ Easily expanded to accommodate septage from neighbouring communities (revenue generation potential)	▪ Higher capital cost ▪ Larger footprint than other alternatives

7.6.4 Cost Comparison of Short Listed Septage Management Alternatives

The table below presents the life cycle costs associated with the septage management alternatives evaluated. Estimates have been rounded to the nearest thousand dollars. Details of the analysis can be found in Appendix F.

Table 42 – Cost Estimates of Septage Management Alternatives

	Alternative 1 Direct Co-Treatment	Alternative 2 Design MBR to Treat Septage	Alternative 3 Pre-Treat with Geotube®
Capital Cost	$498,000	$504,000	$853,000
Annual Operation and Maintenance Cost	$38,000	$49,000	$243,000
Net Present Value	**$536,000**	**$553,000**	**$1,096,000**

7.6.5 Detailed Evaluation of Short Listed Septage Management Alternatives

The weightings used in the evaluation of septage management alternatives were tailored for this system and are presented in the table below.

Table 43 – Septage Management Short-List Screening Criteria

Primary Criteria	Weight	Secondary Criteria	Weight
Social / Culture	10%	Aesthetic Impacts (plant appearance)	10%
		Traffic Impacts (during construction and operation)	10%
		Noise Impacts (during operation)	40%
		Odours Impacts (during operation)	40%
Technical	40%	Ability to Meet Regulatory Objectives	30%
		Technology / Process Robustness	30%
		Ease of Expansion and Phasing to Buildout	20%
		Energy Requirements	5%
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10%
		Site Requirements (plant footprint)	5%
Environmental	25%	Public Health and Safety	30%
		Sustainability	20%
		Climate Change Impacts / Greenhouse Gas Generation	20%
		Natural Environment Impacts	10%
		Waste Generation	20%
Economic	25%	Capital Cost	30%
		Operation and Maintenance Costs	40%
		Net Present Value	30%

The table below summarizes the results of the detailed evaluation of the septage management alternatives.

Table 44 – Detailed Evaluation of Septage Management Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES						COMMENTS
					Alternative 1 Direct Co-Treatment		Alternative 2 Design MBR to Treat Septage		Alternative 3 Dewater with GeoTube & Co-Treat Filtrate		
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	SCORE*	WT SCORE	
Social/Culture	10%	Aesthetic Impacts (plant apperance)	10	1	4	0.8	4	0.8	3	0.6	Geotube has the most external components and would be more visable than other alternatives.
		Traffic (during construction and operation)	10	1	4	0.8	4	0.8	3.5	0.7	Geotube would have greater traffic during construction as it has more components than the other alternatives.
		Noise Impacts (during operation)	40	4	3	2.4	3	2.4	3	2.4	No significant difference.
		Odour Impacts (during operation)	40	4	4	3.2	4	3.2	3.5	2.8	Geotubes are installed outdoors and has potential for odour impacts, although no odour issues have been reported in previous installations.
Technical	40%	Ability to Meet Treatment Objectives & Robustness	30	12	2	4.8	3	7.2	4.5	10.8	Alternative 1 is the least flexible/robust. Alternative 2 is more robust than Alternative 1 because the MBR would be sized to accommodate the increased loading. Alternative 3 is considered the most robust because it's performance is not significantly affected by the septage characteristics or volume.
		Potential for Upset to Main Plant Process	30	12	2	4.8	3	7.2	4.5	10.8	Since the Geotube filtrate is significantly weaker than raw septage, this option has much less potential for system upset.
		Energy Requirements	10	4	4	3.2	3	2.4	3.5	2.8	Alternative 1: 35 kWh/d Alternative 2: 43 kWh/d Alternative 3: 39 kWh/d
		Operation & Maintenance Staffing Requirements (skill level/number)	15	6	4	4.8	4	4.8	4	4.8	No significant difference.
		Site Requirements (plant footprint)	15	6	4	4.8	4	4.8	3	3.6	Alternative 1 require the same amount of land. Alternative 2 requires slightly more land. Alternative 3 requirest the additional area for the Geotubes®.
Environmental	25%	Public Health and Safety	35	8.75	2.5	4.4	3	5.3	4.5	7.9	Public health and safety would be impacted if the main plant were unable to achieve its effluent limits, which may result from overloading by septage addition. Dewatering has very little chance of overloading the plant and the other alternatives have a high potential for plant upset.
		Sustainability	25	6.25	2	2.5	2.5	3.1	4	5.0	Alternative 1 and 2 are considered less sustainable than Alternative 3 since the amount of septage that can be added to the plant is limited and cannot be increased if needed and treatment capacity is would be affected by septage characteristics.
		Greenhouse Gas Generation / Climate Change Impacts	25	6.25	3.5	4.4	3.5	4.4	3	3.8	Energy consumption is comparable, however, Alterantive 3 would involve more construction due to the laydown area, which would lead to greater climate change impacts.
		Natural Environment Impact	15	3.75	4	3.0	4	3.0	3.5	2.6	Alternative 3 would have the greatest impact as it requires more land to be cleared for construction.
Economic	25%	Capital Cost	30	7.5	4	6.0	3.5	5.3	2.5	3.8	Refer to NPV analysis
		Operation and Maintenance Costs	40	10	4.5	9.0	4	8.0	2	4.0	Refer to NPV analysis
		Net Present Value	30	7.5	4	6.0	3.5	5.3	2	3.0	Refer to NPV analysis
			TOTAL SCORE	100	64.9		67.9		69.3		

*Score is a number from 1 to 5

7.6.6 Preliminary Preferred Alternative for Septage Management

Based on the results of the detailed evaluation of the septage management alternatives, pre-treatment with Geotube followed by co-treatment of the dewatering filtrate from the Geotubes is the preferred alternative.

8.0 Preliminary WWTP Preferred Design Concept

The results of the technologies alternative evaluation show that the MBR technology is the preferred alternative for the liquid train. The MBR technology can meet tertiary treatment requirements so a separate tertiary treatment process would not be required.

To prevent excessive membrane fouling during the operation of the MBR, an advanced primary treatment technology is needed to remove particles, including hair, that typically clog membrane filters. A rotary belt filter was coupled with the MBR alternative in this evaluation.

UV radiation was the preferred alternative for disinfection. A fine bubble aeration system that uses increased capacity from the MBR blowers was selected as the preferred alternative to elevate DO levels in the treated wastewater prior to discharge to the river.

On-site stabilization of sludge via an ATAD system, with land application of liquid biosolids was selected as the preferred alternative for Phase 1. It is recommended that the Town evaluate the potential for revenue generation through marketing of biosolids once Phase 1 is in operation and the nature and quantity of biosolids produced at the plant is known.

The wastewater treatment facility will incorporate a septage receiving and management/treatment system. The preferred alternative for septage management is dewatering by a dewatering membrane technology, such as GeoTubes® and treating the dewatering filtrate in the main plant.

Figure 10 shows the flow schematic of the preferred alternative for the liquid treatment train, including the septage receiving and treatment system.

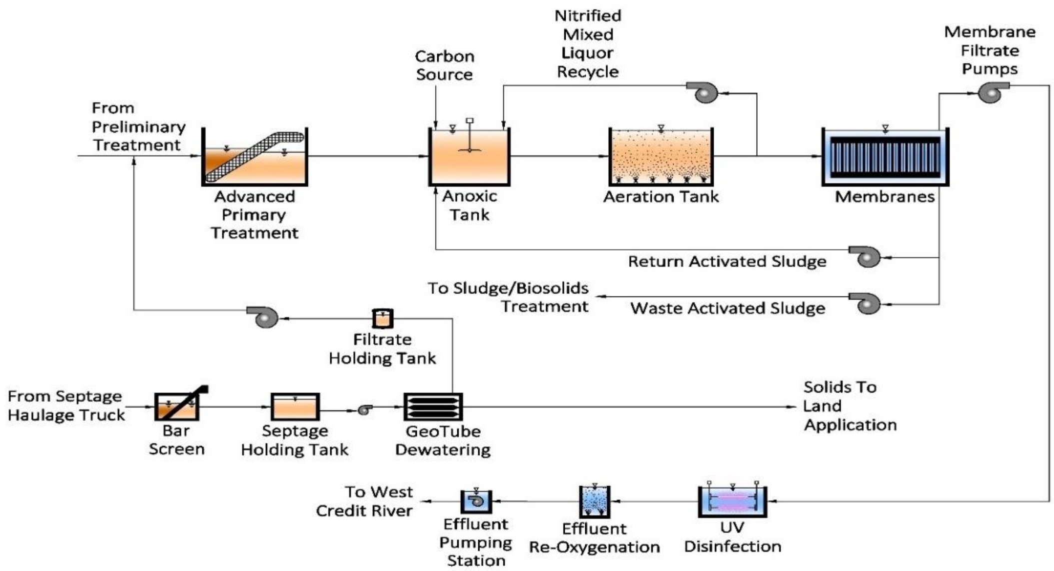

Figure 10 – Preferred Liquid Treatment Train Process Flow Schematic

Figure 11 shows the preferred alternative for the sludge/biosolids treatment train.

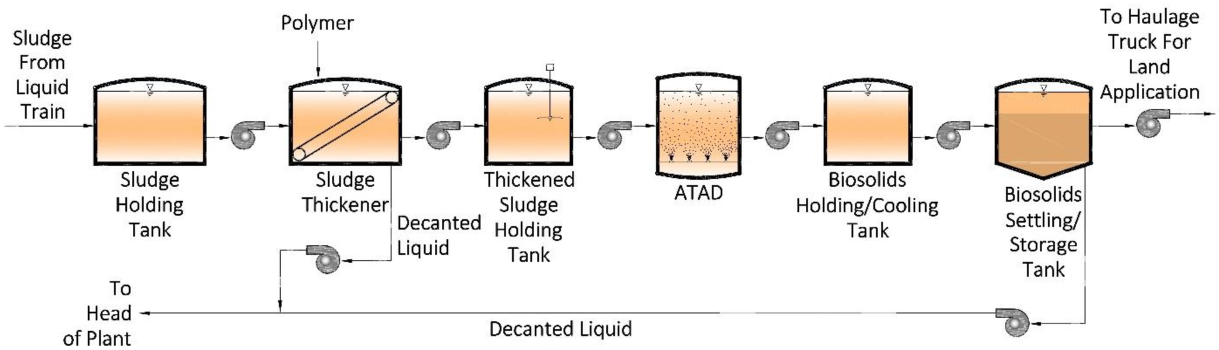

Figure 11 – Preferred Solids Treatment Train Process Flow Schematic

8.1 WWTP Site Plan

Figure 12 presents a conceptual plant layout, which is based on the preliminary preferred treatment alternatives. The plant layout includes common facilities such as the administration building, standby power, odour control, and the effluent pumping station.

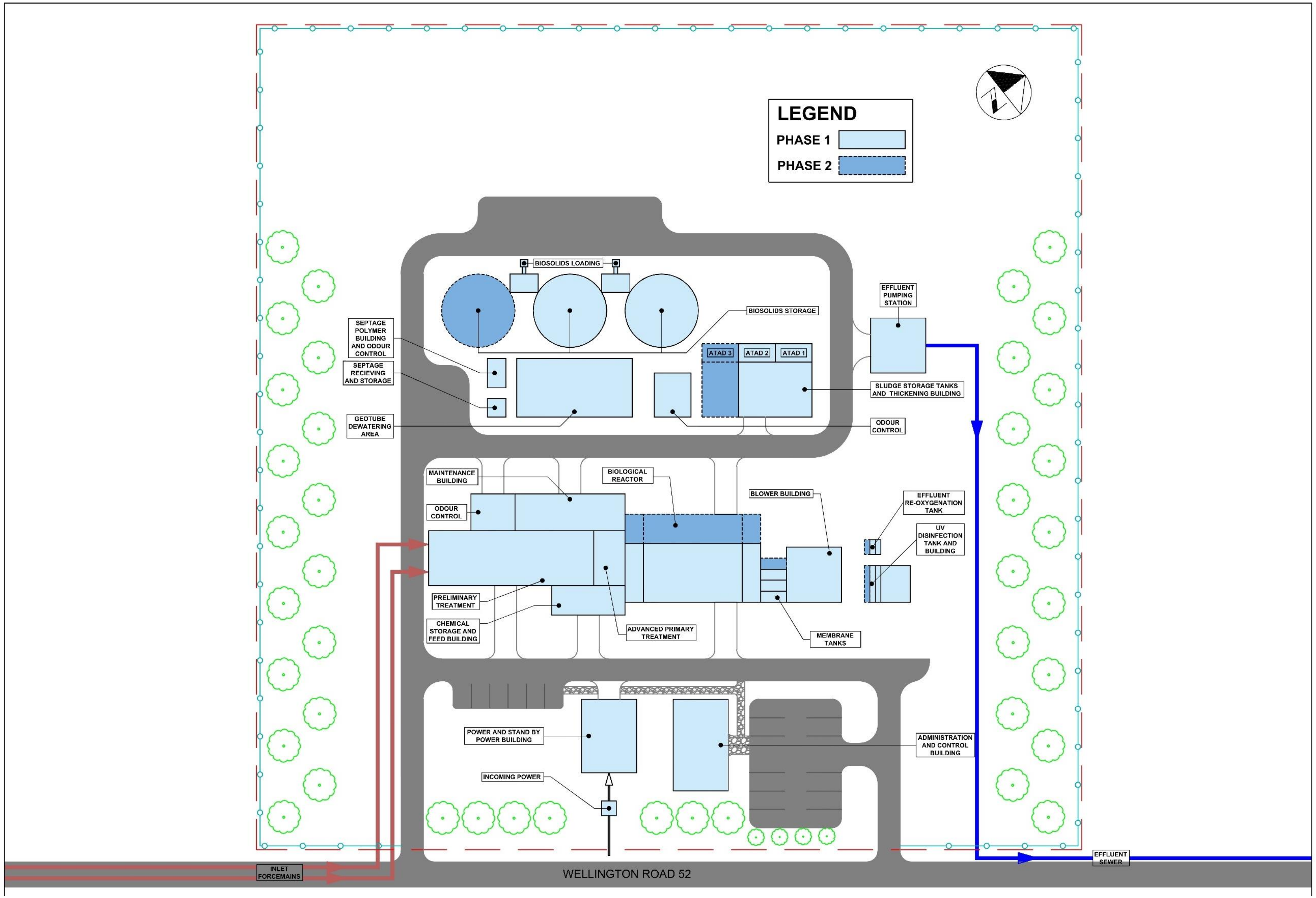

Figure 12 – Conceptual Site Layout of Preliminary Preferred Alternatives

8.2 Capital Costs of WWTP Construction

Based on the preliminary preferred alternatives, an estimate of the construction costs for the treatment plant was generated. The estimate incorporates factors such as equipment costs, tankage and building construction costs, site works, standby power, land acquisition, and engineering fees and permits.

A breakdown of the cost estimate is presented in the table below.

Table 45 – Estimated Capital Construction of Erin WWTP

	PHASE 1 CAPITAL COST ESTIMATE (2017 Dollars)	PHASE 2 CAPITAL COST ESTIIMATE (2017 Dollars)	FULL BUILDOUT CAPITAL COST ESTIMATE (2017 Dollars)
Preliminary Treatment / Headworks	$ 2,220,000	$ 1,092,000	$ 3,312,000
Primary/Secondary Treatment	$ 17,121,480	$ 7,665,000	$ 24,786,480
Tertiary Treatment (not needed with MBR)	$ -	$ -	$ -
UV Disinfection	$ 611,000	$ 148,000	$ 759,000
Effluent Re-Oxygenation	$ 69,000	$ 31,000	$ 100,000
Effluent Pumping	$ 1,800,000	$ 900,000	$ 2,700,000
Biosolids Treatment	$ 9,555,000	$ 4,163,000	$ 13,718,000
Septage Management	$ 1,315,000	$ -	$ 1,315,000
Odour Control	$ 2,187,000	$ 1,312,000	$ 3,499,000
Standby Power	$ 1,200,000	$ 600,000	$ 1,800,000
Administration and Maintenance Buildings	$ 960,000	$ -	$ 960,000
Site Works	$ 5,514,020	$ 2,133,000	$ 7,647,020
Land Acquisition	$ 500,000	$ -	$ 500,000
TOTAL COSTS:	**$ 43,052,500**	**$ 18,044,000**	**$ 61,096,500**

9.0 Conclusions and Recommendations

- The 2014 Servicing and Settlement Master Plan (SSMP) identified that a new wastewater collection system and treatment plant would be required to service the existing and expected growth population of Erin Village and Hillsburgh.
- The UCWS EA is a continuation of the Class EA process and includes establishment of the preferred treatment alternatives for the proposed new wastewater treatment plant.
- The updated Assimilative Capacity study completed for the UCWS Class EA study established the West Credit River as the receiving body for treated effluent from the wastewater treatment plant. The West Credit River is classified as a Policy 1 receiver.
- The updated ACS also established treatment effluent limits for pollutants that pose a threat to the river's ecosystem.
- It is proposed that construction of the wastewater treatment plant proceed in two phases. Phase 1 would service the existing population with some allotment for future growth and Phase 2 (Full Buildout) would be an expansion of Phase 1 to service the total population growth for the Town.
- This UCWS Class EA study evaluated technology alternatives for the primary, secondary, tertiary, disinfection, and sludge treatment stages of the wastewater treatment plant.
- The ACS included a minimum limit for dissolved oxygen in the plant's treated effluent. Alternatives for re-oxygenating the treated effluent, following disinfection, were also evaluated.
- The WWTP is to include a septage receiving and management system, to accept and treat septage from residents who will be outside the recommended service area of the proposed new collection system. Septage management alternatives were included in this evaluation.
- Life-cycle cost analysis were performed for each treatment stage considered in the evaluation. Life cycle analysis included equipment costs, building and tankage construction costs, operating cost associated with energy and chemical consumption, and a net present value analysis.
- The preferred treatment technologies for the wastewater treatment plant are summarized below:

Treatment Stage	Preferred Alternative
Primary Treatment	Advanced Primary Treatment (e.g. Rotary Belt Filter)
Secondary and Tertiary Treatment	Membrane Bioreactor
Disinfection	UV Radiation
Effluent Re-Oxygenation	Fine Bubble Aeration (using up-sized secondary treatment blowers)
Sludge Treatment / Management	Sludge Stabilization via Autothermal Thermophilic Aerobic Digestion (ATAD) and Land Application of Stabilized Biosolids
Septage Management	Pre-Treatment with GeoTubes Followed by Co-Treatment at the Main Plant and Land Application of Stabilized, Dewatered Biosolids

- It is recommended that the Town evaluate the potential for revenue generation through marketing of biosolids once Phase 1 is in operation and the nature and quantity of biosolids are known as well as market conditions at the time of production, as these factors are difficult to accurately assess at this time.
- Sensitivity analyses were performed on the detailed evaluation of each of the systems to assess how sensitive the results were to the weightings. For all but the septage management system, the evaluation results remained unchanged when the weightings were varied by 5% between pairs of criteria.
- For the septage management evaluation, a 5% increase in the environmental criterion with a 5% increase in the economic criterion results in the alternative of increasing the MBR capacity to directly co-treat septage without pre-treatment becoming the preferred septage alternative.
- The estimated total capital construction costs for Phase 1, including ancillary facilities, such as the administration building, siteworks, and yard piping, and standby power is $43,052,500 (2017 dollars)
- The estimated total capital construction costs for Phase 2/Full Buildout is $18,044,000 (2017 dollars)
- The estimated total cost for the wastewater treatment plant to Full Buildout is $61,096,500 (2017 dollars).
- Based on a conceptual plant layout, the proposed sites for the WWTP would both be large enough to accommodate the preliminary preferred treatment alternatives.

Appendix A

Life Cycle Cost Evaluation of Primary / Secondary Treatment Alternatives

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
MODIFIED CONVENTIONAL ACTIVATED SLUDGE PROCESS

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering and Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	Phase 1					Phase 2 (Full Buildout)				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Primary Clarifiers										
Sludge and Scum Removal Mechanism (including drives)	2	$ 36,667	$ 73,334	60%	$ 117,334	1	$ 36,667	$ 36,667	60%	$ 58,667
Weirs and Scum Baffles	2	$ 6,845	$ 13,690	60%	$ 21,904	1	$ 6,845	$ 6,845	60%	$ 10,952
Scum pumps	2	$ 17,908	$ 35,816	60%	$ 57,306	1	$ 17,908	$ 17,908	60%	$ 28,653
Raw Sludge Pumps	2	$ 9,050	$ 18,100	60%	$ 28,960	1	$ 9,050	$ 9,050	60%	$ 14,480
Conventional Activated Sludge Tank										$ -
Blowers	2	$ 31,554	$ 63,108	60%	$ 100,973	2	$ 31,554	$ 63,108	60%	$ 100,973
Aeration piping, valves, and diffusers	1	$ 266,400	$ 266,400	60%	$ 426,240	1	$ 133,200	$ 133,200	60%	$ 213,120
Secondary Clarifiers										
Sludge and Scum Removal Mechanism (including drives)	2	$ 44,000	$ 88,000	60%	$ 140,800	1	$ 44,000	$ 44,000	60%	$ 70,400
Weirs and Baffles	2	$ 7,524	$ 15,048	60%	$ 24,077	1	$ 7,524	$ 7,524	60%	$ 12,038
Scum pumps	2	$ 17,908	$ 35,816	60%	$ 57,306	1	$ 17,908	$ 17,908	60%	$ 28,653
RAS Pumps	2	$ 12,099	$ 24,198	60%	$ 38,717	1	$ 12,099	$ 12,099	60%	$ 19,358
WAS Pumps	2	$ 9,120	$ 18,240	60%	$ 29,184	1	$ 9,120	$ 9,120	60%	$ 14,592
Chemical Dosing										$ -
Chemical Storage Tanks	2	$ 22,200	$ 44,400	60%	$ 71,040	1	$ 22,200	$ 22,200	60%	$ 35,520
Day Tanks	1	$ 3,700	$ 3,700	60%	$ 5,920	1	$ 3,700	$ 3,700	60%	$ 5,920
Dosing Pumps	2	$ 2,200	$ 4,400	60%	$ 7,040	1	$ 2,200	$ 2,200	60%	$ 3,520
Chemical Transfer Pumps	2	$ 2,600	$ 5,200	60%	$ 8,320	1	$ 2,600	$ 2,600	60%	$ 4,160
Total Equipment Cost					$ 1,135,120					$ 621,006
CONSTRUCTION										
General			10%		$ 430,064			10%		$ 220,377
Site Work			15%		$ 645,096			15%		$ 330,565
Yard Piping			10%		$ 430,064			10%		$ 220,377
Primary Clarifier	1	$ 480,592	$ 480,592	10%	$ 528,651	1	$ 240,296	$ 240,296	10%	$ 264,326
Aeration Tanks	1	$ 834,048	$ 834,048	10%	$ 917,453	1	$ 417,024	$ 417,024	10%	$ 458,726
Secondary Clarifier	1	$ 708,628	$ 708,628	10%	$ 779,491	1	$ 354,314	$ 354,314	10%	$ 389,745
Blower/ RAS/ WAS Building	1	$ 854,478	$ 854,478	10%	$ 939,926	1	$ 427,239	$ 427,239	10%	$ 469,963
Total Construction Cost					$ 4,670,745					$ 2,354,079
Engineering & Contingency (25%)					$ 1,451,466					$ 743,771
Total Capital Cost					$ 7,257,331					$ 3,718,856

OPERATIONAL COST	Phase 1				Phase 2			
	Rating	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
Clarifier Mechanisms	36	kWh/d	$ 0.11	$ 1,426.13	53	kWh/d	$ 0.11	$ 2,139.19
Blower Operation	832	kWh/d	$ 0.11	$ 33,404.80	1248	kWh/d	$ 0.11	$ 50,107.20
WAS Pumps	8	kWh/d	$ 0.11	$ 321.20	12	kWh/d	$ 0.11	$ 481.80
RAS Pumps	85	kWh/d	$ 0.11	$ 3,412.75	128	kWh/d	$ 0.11	$ 5,119.13
Raw Sludge Pumps	12	kWh/d	$ 0.11	$ 481.80	18	kWh/d	$ 0.11	$ 722.70
Total Power Cost				$ 39,047				$ 58,570
Chemical Consumption								
Alum	33	kg/d	$ 4.00	$ 48,180.00	50	kg/d	$ 4.00	$ 72,270.00
Total Chemical Cost				$ 48,180				$ 72,270
Total Operational Costs				$ 87,227				$ 130,840

NPV CALCULATION	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
CAPITAL COSTS											
Equipment	$ 2,195,158			$ 425,670	$ 567,560	$ 425,670					
Construction Costs	$ 8,781,029			$ 1,751,529	$ 2,335,372	$ 1,751,529					
Major Equipment Replacement Cost	$ 4,390,316										
Total Capital Cost in 2017 Dollars	$ 15,366,503			$ 2,177,199	$ 2,902,932	$ 2,177,199	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 10,436,312	$ -	$ -	$ 2,054,565	$ 2,661,151	$ 1,938,839	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS											
Power Consumption Cost	$ 4,295,135						$ 39,047	$ 39,047	$ 39,047	$ 39,047	$ 39,047
Chemical Consumption Cost	$ 5,299,800						$ 48,180	$ 48,180	$ 48,180	$ 48,180	$ 48,180
Total Operational Cost in 2017 Dollars	$ 9,594,935						$ 87,227	$ 87,227	$ 87,227	$ 87,227	$ 87,227
Total Operational Cost NPV	$ 3,250,606			$ -	$ -	$ -	$ 75,458	$ 73,302	$ 71,207	$ 69,173	$ 67,197
Current Year Sub-total	$ 24,961,438			$ 2,177,199	$ 2,902,932	$ 2,177,199	$ 87,227	$ 87,227	$ 87,227	$ 87,227	$ 87,227
Inflation Adjusted	$ 50,058,347			$ 2,265,158	$ 3,080,615	$ 2,356,671	$ 96,305	$ 98,231	$ 100,196	$ 102,200	$ 104,244
NPV	**$ 13,686,918**			$ 2,054,565	$ 2,661,151	$ 1,938,839	$ 75,458	$ 73,302	$ 71,207	$ 69,173	$ 67,197

NPV CALCULATION	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
CAPITAL COSTS										
Equipment	$ 232,877	$ 310,503	$ 232,877							
Construction Costs	$ 882,779	$1,177,039	$ 882,779							
Major Equipment Replacement Cost										
Total Capital Cost in 2017 Dollars	$ 1,115,657	$1,487,543	$ 1,115,657	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 834,909	$1,081,407	$ 787,882	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS										
Power Consumption Cost	$ 39,047	$ 39,047	$ 39,047	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570
Chemical Consumption Cost	$ 48,180	$ 48,180	$ 48,180	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
Total Operational Cost in 2017 Dollars	$ 87,227	$ 87,227	$ 87,227	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840
Total Operational Cost NPV	$ 65,277	$ 63,412	$ 61,600	$ 89,760	$ 87,195	$ 84,704	$ 82,284	$ 79,933	$ 77,649	$ 75,431
Current Year Sub-total	$ 1,202,884	$1,574,769	$ 1,202,884	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840
Inflation Adjusted	$ 1,466,308	$1,958,028	$ 1,525,547	$ 169,256	$ 172,641	$ 176,093	$ 179,615	$ 183,208	$ 186,872	$ 190,609
NPV	$ 900,186	$1,144,818	$ 849,482	$ 89,760	$ 87,195	$ 84,704	$ 82,284	$ 79,933	$ 77,649	$ 75,431

AINLEY: 115157
MODIFIED CONVENTIONAL ACTIVATED SLUDGE PROCESS

2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052
														$ 1,418,900
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,418,900
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 529,568
$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570
$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840
$ 73,275	$ 71,182	$ 69,148	$ 67,172	$ 65,253	$ 63,389	$ 61,578	$ 59,818	$ 58,109	$ 56,449	$ 54,836	$ 53,269	$ 51,747	$ 50,269	$ 48,833
$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 1,549,740
$ 194,421	$ 198,310	$ 202,276	$ 206,322	$ 210,448	$ 214,657	$ 218,950	$ 223,329	$ 227,796	$ 232,352	$ 236,999	$ 241,739	$ 246,573	$ 251,505	$ 3,038,538
$ 73,275	$ 71,182	$ 69,148	$ 67,172	$ 65,253	$ 63,389	$ 61,578	$ 59,818	$ 58,109	$ 56,449	$ 54,836	$ 53,269	$ 51,747	$ 50,269	$ 578,400

2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067
							$ 776,258							
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 776,258	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 229,754	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570
$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840
$ 47,437	$ 46,082	$ 44,765	$ 43,486	$ 42,244	$ 41,037	$ 39,865	$ 38,726	$ 37,619	$ 36,544	$ 35,500	$ 34,486	$ 33,501	$ 32,543	$ 31,614
$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 907,098	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840
$ 261,666	$ 266,899	$ 272,237	$ 277,682	$ 283,235	$ 288,900	$ 294,678	$ 2,083,826	$ 306,583	$ 312,715	$ 318,969	$ 325,348	$ 331,855	$ 338,492	$ 345,262
$ 47,437	$ 46,082	$ 44,765	$ 43,486	$ 42,244	$ 41,037	$ 39,865	$ 268,479	$ 37,619	$ 36,544	$ 35,500	$ 34,486	$ 33,501	$ 32,543	$ 31,614

AINLEY: 115157
MODIFIED CONVENTIONAL ACTIVATED SLUDGE PROCESS

2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082
														$ 1,418,900
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,418,900
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 221,946
$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570
$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840
$ 30,710	$ 29,833	$ 28,981	$ 28,152	$ 27,348	$ 26,567	$ 25,808	$ 25,070	$ 24,354	$ 23,658	$ 22,982	$ 22,326	$ 21,688	$ 21,068	$ 20,466
$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 1,549,740
$ 352,167	$ 359,211	$ 366,395	$ 373,723	$ 381,197	$ 388,821	$ 396,598	$ 404,530	$ 412,620	$ 420,873	$ 429,290	$ 437,876	$ 446,633	$ 455,566	$ 5,503,891
$ 30,710	$ 29,833	$ 28,981	$ 28,152	$ 27,348	$ 26,567	$ 25,808	$ 25,070	$ 24,354	$ 23,658	$ 22,982	$ 22,326	$ 21,688	$ 21,068	$ 242,412

2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097
							$ 776,258							
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 776,258	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 96,292	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570	$ 58,570
$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840
$ 19,881	$ 19,313	$ 18,762	$ 18,226	$ 17,705	$ 17,199	$ 16,708	$ 16,230	$ 15,766	$ 15,316	$ 14,878	$ 14,453	$ 14,040	$ 13,639	$ 13,250
$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 907,098	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840	$ 130,840
$ 473,971	$ 483,450	$ 493,119	$ 502,982	$ 513,041	$ 523,302	$ 533,768	$ 3,774,562	$ 555,333	$ 566,439	$ 577,768	$ 589,323	$ 601,110	$ 613,132	$ 625,395
$ 19,881	$ 19,313	$ 18,762	$ 18,226	$ 17,705	$ 17,199	$ 16,708	$ 112,522	$ 15,766	$ 15,316	$ 14,878	$ 14,453	$ 14,040	$ 13,639	$ 13,250

AINLEY: 115157
MODIFIED CONVENTIONAL ACTIVATED SLUDGE PROCESS

2098
$ -
$ -
$ 58,570
$ 72,270
$ 130,840
$ 12,871
$ 130,840
$ 637,903
$ 12,871

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
SEQUENCING BATCH REACTOR PROCESS

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering and Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	Phase 1					Phase 2				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Sequencing Batch Reactor										
Packaged SBR System, including: *Blowers*, *Decanting system*, *Mixers*, *Aeration piping, valves, and diffusers*, *RAS & WAS Pumps*, *Decanter Air Compressor*	1	$ 730,700	$ 730,700	60%	$ 1,169,120	1	$ 404,000	$ 404,000	60%	$ 646,400
Equalization Pumps	2	$ 30,120	$ 60,240	60%	$ 96,384	1	$ 30,120	$ 30,120	60%	$ 48,192
Chemical Dosing										$ -
Chemical Storage Tanks	2	$ 22,200	$ 44,400	60%	$ 71,040	1	$ 22,200	$ 22,200	60%	$ 35,520
Day Tanks	1	$ 3,700	$ 3,700	60%	$ 5,920	1	$ 3,700	$ 3,700	60%	$ 5,920
Dosing Pumps (alum and carbon source)	4	$ 3,000	$ 12,000	60%	$ 19,200	2	$ 3,000	$ 6,000	60%	$ 9,600
Total Equipment Cost					$ 1,361,664					$ 745,632
CONSTRUCTION										
General			10%		$ 478,051	$ 1		10%		$ 249,254
Site Work (15% of Construction Costs)			15%		$ 717,076			15%		$ 373,881
Yard Piping (10% of Construction Costs)			10%		$ 478,051			10%		$ 249,254
SBR Tanks and Equalization Tanks	1	$ 2,494,652	$ 2,494,652	10%	$ 2,744,117	$ 1	$ 1,247,326	$ 1,247,326	10%	$ 1,372,059
Blower/ RAS/ WAS Building	1	$ 613,386	$ 613,386	10%	$ 674,725	$ 1	$ 340,770	$ 340,770	10%	$ 374,847
Total Construction Cost					$ 5,092,019					$ 2,619,294
Engineering & Contingency (25%)					$ 1,613,421					$ 841,231
Total Capital Cost					$ 8,067,104					$ 4,206,157

OPERATIONAL COST	Phase 1				Phase 2			
	Rating	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
Blower Operation	1000	kWh/d	$ 0.11	$ 40,150.00	2000	kWh/d	$ 0.11	$ 80,300.00
WAS Pumps	6.5	kWh/d	$ 0.11	$ 260.98	10	kWh/d	$ 0.11	$ 391.46
RAS Pumps	75	kWh/d	$ 0.11	$ 3,011.25	112.5	kWh/d	$ 0.11	$ 4,516.88
Mixers	264	kWh/d	$ 0.11	$ 10,599.60	396	kWh/d	$ 0.11	$ 15,899.40
Air Compressor	12	kWh/d	$ 0.11	$ 481.80	18	kWh/d	$ 0.11	$ 722.70
Total Power Cost				$ 54,504				$ 101,830
Chemical Consumption								
Alum	33	kg/d	$ 4.00	$ 48,180	49.5	kg/d	$ 4.00	$ 72,270
Total Chemical Cost				$ 48,180				$ 72,270
Total Operational Costs				$ 102,684				$ 174,100

NPV CALCULATION	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026
CAPITAL COSTS										
Equipment	$ 2,634,120			$ 510,624	$ 680,832	$ 510,624				
Construction Costs	$ 9,639,141			$ 1,909,507	$ 2,546,009	$ 1,909,507				
Major Equipment Replacement Cost	$ 5,268,240									
Total Capital Cost in 2017 Dollars	$ 17,541,501			$ 2,420,131	$ 3,226,841	$ 2,420,131	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 11,748,589	$ -	$ -	$ 2,283,813	$ 2,958,082	$ 2,155,174	$ -	$ -	$ -	$ -
OPERATIONAL COSTS										
Power Consumption Cost	$ 7,360,499						$ 54,504	$ 54,504	$ 54,504	$ 54,504
Chemical Consumption Cost	$ 5,299,800						$ 48,180	$ 48,180	$ 48,180	$ 48,180
Total Operational Cost in 2017 Dollars	$ 12,660,299						$ 102,684	$ 102,684	$ 102,684	$ 102,684
Total Operational Cost NPV	$ 4,241,504			$ -	$ -	$ -	$ 88,829	$ 86,291	$ 83,826	$ 81,431
Current Year Sub-total	$ 30,201,799			$ 2,420,131	$ 3,226,841	$ 2,420,131	$ 102,684	$ 102,684	$ 102,684	$ 102,684
Inflation Adjusted	$ 62,195,758			$ 2,517,904	$ 3,424,350	$ 2,619,628	$ 113,371	$ 115,638	$ 117,951	$ 120,310
NPV	**$ 15,990,093**			$ 2,283,813	$ 2,958,082	$ 2,155,174	$ 88,829	$ 86,291	$ 83,826	$ 81,431

NPV CALCULATION	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
CAPITAL COSTS										
Equipment		$ 279,612	$ 372,816	$ 279,612						
Construction Costs		$ 982,235	$1,309,647	$ 982,235						
Major Equipment Replacement Cost										
Total Capital Cost in 2017 Dollars	$ -	$ 1,261,847	$1,682,463	$ 1,261,847	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ -	$ 944,312	$1,223,109	$ 891,122	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS										
Power Consumption Cost	$ 54,504	$ 54,504	$ 54,504	$ 54,504	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830
Chemical Consumption Cost	$ 48,180	$ 48,180	$ 48,180	$ 48,180	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
Total Operational Cost in 2017 Dollars	$ 102,684	$ 102,684	$ 102,684	$ 102,684	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
Total Operational Cost NPV	$ 79,104	$ 76,844	$ 74,648	$ 72,516	$ 119,438	$ 116,025	$ 112,710	$ 109,490	$ 106,362	$ 103,323
Current Year Sub-total	$ 102,684	$ 1,364,531	$1,785,147	$ 1,364,531	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
Inflation Adjusted	$ 122,716	$ 1,663,355	$2,219,605	$ 1,730,555	$ 225,217	$ 229,722	$ 234,316	$ 239,003	$ 243,783	$ 248,658
NPV	$ 79,104	$ 1,021,156	$1,297,757	$ 963,638	$ 119,438	$ 116,025	$ 112,710	$ 109,490	$ 106,362	$ 103,323

AINLEY: 115157
SEQUENCING BATCH REACTOR PROCESS

2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830
$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
$ 100,371	$ 97,503	$ 94,717	$ 92,011	$ 89,382	$ 86,828	$ 84,347	$ 81,937	$ 79,596	$ 77,322	$ 75,113	$ 72,967	$ 70,882	$ 68,857	$ 66,890
$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
$ 253,631	$ 258,704	$ 263,878	$ 269,156	$ 274,539	$ 280,030	$ 285,630	$ 291,343	$ 297,170	$ 303,113	$ 309,175	$ 315,359	$ 321,666	$ 328,099	$ 334,661
$ 100,371	$ 97,503	$ 94,717	$ 92,011	$ 89,382	$ 86,828	$ 84,347	$ 81,937	$ 79,596	$ 77,322	$ 75,113	$ 72,967	$ 70,882	$ 68,857	$ 66,890

2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066
$ 1,702,080								$ 932,040						
$ 1,702,080	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 932,040	$ -	$ -	$ -	$ -	$ -	$ -
$ 635,257	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 275,862	$ -	$ -	$ -	$ -	$ -	$ -
$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830
$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
$ 64,978	$ 63,122	$ 61,318	$ 59,567	$ 57,865	$ 56,211	$ 54,605	$ 53,045	$ 51,530	$ 50,057	$ 48,627	$ 47,238	$ 45,888	$ 44,577	$ 43,303
$ 1,876,180	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 1,106,140	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
$ 3,678,582	$ 348,182	$ 355,145	$ 362,248	$ 369,493	$ 376,883	$ 384,421	$ 392,109	$ 2,541,075	$ 407,950	$ 416,109	$ 424,431	$ 432,920	$ 441,579	$ 450,410
$ 700,236	$ 63,122	$ 61,318	$ 59,567	$ 57,865	$ 56,211	$ 54,605	$ 53,045	$ 327,391	$ 50,057	$ 48,627	$ 47,238	$ 45,888	$ 44,577	$ 43,303

AINLEY: 115157
SEQUENCING BATCH REACTOR PROCESS

2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830
$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
$ 42,066	$ 40,864	$ 39,697	$ 38,563	$ 37,461	$ 36,390	$ 35,351	$ 34,341	$ 33,360	$ 32,406	$ 31,480	$ 30,581	$ 29,707	$ 28,859	$ 28,034
$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
$ 459,418	$ 468,607	$ 477,979	$ 487,538	$ 497,289	$ 507,235	$ 517,380	$ 527,727	$ 538,282	$ 549,047	$ 560,028	$ 571,229	$ 582,653	$ 594,307	$ 606,193
$ 42,066	$ 40,864	$ 39,697	$ 38,563	$ 37,461	$ 36,390	$ 35,351	$ 34,341	$ 33,360	$ 32,406	$ 31,480	$ 30,581	$ 29,707	$ 28,859	$ 28,034

2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096
$ 1,702,080								$ 932,040						
$ 1,702,080	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 932,040	$ -	$ -	$ -	$ -	$ -	$ -
$ 266,242	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 115,616	$ -	$ -	$ -	$ -	$ -	$ -
$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830	$ 101,830
$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270	$ 72,270
$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
$ 27,233	$ 26,455	$ 25,699	$ 24,965	$ 24,252	$ 23,559	$ 22,886	$ 22,232	$ 21,596	$ 20,979	$ 20,380	$ 19,798	$ 19,232	$ 18,683	$ 18,149
$ 1,876,180	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 1,106,140	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100	$ 174,100
$ 6,663,242	$ 630,683	$ 643,297	$ 656,162	$ 669,286	$ 682,671	$ 696,325	$ 710,251	$ 4,602,806	$ 738,945	$ 753,724	$ 768,799	$ 784,175	$ 799,858	$ 815,856
$ 293,475	$ 26,455	$ 25,699	$ 24,965	$ 24,252	$ 23,559	$ 22,886	$ 22,232	$ 137,212	$ 20,979	$ 20,380	$ 19,798	$ 19,232	$ 18,683	$ 18,149

AINLEY: 115157
SEQUENCING BATCH REACTOR PROCESS

2097	2098
$ -	$ -
$ -	$ -
$ 101,830	$ 101,830
$ 72,270	$ 72,270
$ 174,100	$ 174,100
$ 17,630	$ 17,127
$ 174,100	$ 174,100
$ 832,173	$ 848,816
$ 17,630	$ 17,127

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
MEMBRANE BIOREACTOR

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering and Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	**Phase 1**					**Phase 2**				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Advance Primary Treatment System										
Primary Fine Filter	2	$ 425,000	$ 850,000	60%	$ 1,360,000	1	$ 425,000	$ 425,000	60%	$ 680,000
Membrane Bioreactor										$ -
Packaged Membrane System, including:	3	$ 527,100	$ 1,581,300	60%	$ 2,530,080	1	$ 527,100	$ 527,100	60%	$ 843,360
Membranes and Cartridges										$ -
Aeration Tank Blowers										$ -
Membrane Tank Blowers										$ -
Permeate Pumps										$ -
Air Compressors										$ -
RAS Pumps										$ -
Aeration piping, valves, and diffusers										$ -
										$ -
Chemical Dosing										$ -
Chemical Storage Tanks	2	$ 22,200	$ 44,400	60%	$ 71,040	1	$ 11,100	$ 11,100	60%	$ 17,760
Day Tanks	2	$ 3,700	$ 7,400	60%	$ 11,840	1	$ 1,850	$ 1,850	60%	$ 2,960
Dosing Pumps (included in Membrane Package)										
Total Equipment Cost					$ 3,972,960					$ 1,544,080
CONSTRUCTION										
General			10%		$ 845,504	$ 1		10%		$ 378,512
Site Work			15%		$ 1,268,255			15%		$ 567,768
Yard Piping			10%		$ 845,504			10%		$ 378,512
Bioreactor (AerationTank)	1	$ 1,687,200	$ 1,687,200	10%	$ 1,855,920	1	$ 843,600	$ 843,600	10%	$ 927,960
MembraneTanks	1	$ 1,287,014	$ 1,287,014	10%	$ 1,415,716	1	$ 643,507	$ 643,507	10%	$ 707,858
Blower Building (Blower, RAS & Permeate Pumps, Compressors)	1	$ 630,000	$ 630,000	10%	$ 693,000	1	$ 315,000	$ 315,000	10%	$ 346,500
Primary Filter Building (Cost to Increase size of Headworks Building)	1	$ 470,400	$ 470,400	10%	$ 517,440	1	$ 235,200	$ 235,200	10%	$ 258,720
Total Construction Cost					$ 7,441,338					$ 3,565,829
Engineering & Contingency (25%)					$ 2,853,575					$ 1,277,477
Total Capital Cost					$ 14,267,873					$ 6,387,386

OPERATIONAL COST	**Phase 1**				**Phase 2**			
	Rating	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
Primary Fine Filter	175	kWh/d	$ 0.11	$ 7,026.25	88	kWh/d	$ 0.11	353320%
Aeration Tank Blowers	613	kWh/d	$ 0.11	$ 24,611.95	919	kWh/d	$ 0.11	$ 36,897.85
Membrane Tank Blowers	208	kWh/d	$ 0.11	$ 8,351.20	312	kWh/d	$ 0.11	$ 12,526.80
Permeate Pumps	53	kWh/d	$ 0.11	$ 2,127.95	26	kWh/d	$ 0.11	$ 1,043.90
RAS Pumps	379	kWh/d	$ 0.11	$ 15,216.85	569	kWh/d	$ 0.11	$ 22,845.35
Air Compressors	3	kWh/d	$ 0.11	$ 120.45	4	kWh/d	$ 0.11	$ 160.60
Total Power Cost				$ 57,455				$ 77,008
Chemical Consumption								
NaOCl	21	kg/d	$ 0.60	$ 4,599.00	$ 31	kg/d	$ 0.60	$ 6,789.00
Citric Acid	17	kg/d	$ 1	$ 8,067	$ 26	kg/d	$ 1	$ 12,337
Alum	358	kg/d	$ 4	$ 522,680	$ 6	kg/d	$ 4	$ 8,760
Total Chemical Cost				$ 535,346				$ 27,886
Total Operational Cost				$ 592,800				$ 104,894

NPV CALCULATION	**Total**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
CAPITAL COSTS											
Equipment	$ 6,896,300			$ 1,489,860	$ 1,986,480	$ 1,489,860					
Construction Costs	$ 13,758,959			$ 2,790,502	$ 3,720,669	$ 2,790,502					
Major Equipment Replacement Cost	$ 13,792,600										
Total Capital Cost in 2017 Dollars	$ 34,447,859			$ 4,280,362	$ 5,707,149	$ 4,280,362	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 21,168,471	$ -	$ -	$ 4,039,264	$ 5,231,809	$ 3,811,746	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS											
Power Consumption Cost	$ 5,696,161						$ 57,455	$ 57,455	$ 57,455	$ 57,455	$ 57,455
Chemical Consumption Cost	$ 6,179,012						$ 535,346	$ 535,346	$ 535,346	$ 535,346	$ 535,346
Membrane Replacement Cost (1/10 years)	$ 2,812,000										
Total Operational Cost in 2017 Dollars	$ 14,687,173			$ -	$ -	$ -	$ 592,800	$ 592,800	$ 592,800	$ 592,800	$ 592,800
Total Operational Cost NPV	$ 6,850,236			$ -	$ -	$ -	$ 512,817	$ 498,165	$ 483,932	$ 470,105	$ 456,674
Current Year Sub-total	$ 49,135,032			$ 4,280,362	$ 5,707,149	$ 4,280,362	$ 592,800	$ 592,800	$ 592,800	$ 592,800	$ 592,800
Inflation Adjusted	$ 94,796,031			$ 4,453,289	$ 6,056,472	$ 4,633,201	$ 654,499	$ 667,589	$ 680,941	$ 694,560	$ 708,451
NPV	**$ 28,018,707**			$ 4,039,264	$ 5,231,809	$ 3,811,746	$ 512,817	$ 498,165	$ 483,932	$ 470,105	$ 456,674

NPV CALCULATION	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
CAPITAL COSTS											
Equipment	$ 579,030	$ 772,040	$ 579,030								
Construction Costs	$ 1,337,186	$ 1,782,915	$ 1,337,186								
Major Equipment Replacement Cost											
Total Capital Cost in 2017 Dollars	$ 1,916,216	$ 2,554,955	$ 1,916,216	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 1,434,013	$ 1,857,389	$ 1,353,240	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS											
Power Consumption Cost	$ 57,455	$ 57,455	$ 57,455	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008
Chemical Consumption Cost	$ 535,346	$ 535,346	$ 535,346	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886
Membrane Replacement Cost (1/10 years)					$ 348,000						
Total Operational Cost in 2017 Dollars	$ 592,800	$ 592,800	$ 592,800	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894
Total Operational Cost NPV	$ 443,626	$ 430,951	$ 418,638	$ 71,960	$ 301,820	$ 67,907	$ 65,966	$ 64,082	$ 62,251	$ 60,472	$ 58,744
Current Year Sub-total	$ 2,509,016	$ 3,147,755	$ 2,509,016	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894
Inflation Adjusted	$ 3,058,477	$ 3,913,837	$ 3,182,039	$ 135,691	$ 597,584	$ 141,173	$ 143,997	$ 146,877	$ 149,814	$ 152,810	$ 155,867
NPV	$1,877,639	$ 2,288,340	$ 1,771,878	$ 71,960	$ 301,820	$ 67,907	$ 65,966	$ 64,082	$ 62,251	$ 60,472	$ 58,744

2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052
													$ 4,966,200
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,966,200
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,853,505
$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008
$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886
	$ 268,000		$ 348,000								$ 268,000		
$ 104,894	$ 372,894	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 372,894	$ 104,894	$ 104,894
$ 57,066	$ 197,072	$ 53,852	$ 225,869	$ 50,818	$ 49,366	$ 47,956	$ 46,586	$ 45,255	$ 43,962	$ 42,706	$ 147,480	$ 40,300	$ 39,149
$ 104,894	$ 372,894	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 372,894	$ 104,894	$ 5,071,094
$ 158,984	$ 576,486	$ 165,407	$ 728,451	$ 172,089	$ 175,531	$ 179,042	$ 182,622	$ 186,275	$ 190,000	$ 193,800	$ 702,733	$ 201,630	$ 9,942,772
$ 57,066	$ 197,072	$ 53,852	$ 225,869	$ 50,818	$ 49,366	$ 47,956	$ 46,586	$ 45,255	$ 43,962	$ 42,706	$ 147,480	$ 40,300	$ 1,892,654

2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067
							$ 1,930,100							
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,930,100	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 571,263	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008
$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886
									$ 348,000					
$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894
$ 38,030	$ 36,944	$ 35,888	$ 34,863	$ 33,867	$ 32,899	$ 31,959	$ 31,046	$ 30,159	$ 126,495	$ 28,460	$ 27,647	$ 26,857	$ 26,090	$ 25,344
$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 2,034,994	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894
$ 209,776	$ 213,971	$ 218,251	$ 222,616	$ 227,068	$ 231,609	$ 236,242	$ 4,674,878	$ 245,786	$ 1,082,440	$ 255,716	$ 260,830	$ 266,046	$ 271,367	$ 276,795
$ 38,030	$ 36,944	$ 35,888	$ 34,863	$ 33,867	$ 32,899	$ 31,959	$ 602,310	$ 30,159	$ 126,495	$ 28,460	$ 27,647	$ 26,857	$ 26,090	$ 25,344

AINLEY
MEMBRANE BIORE

2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082
														$ 4,966,200
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,966,200
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 776,819
$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008
$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886
		$ 268,000		$ 348,000								$ 268,000		
$ 104,894	$ 104,894	$ 372,894	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 372,894	$ 104,894	$ 104,894
$ 24,620	$ 23,917	$ 82,594	$ 22,570	$ 94,664	$ 21,298	$ 20,690	$ 20,099	$ 19,525	$ 18,967	$ 18,425	$ 17,898	$ 61,810	$ 16,890	$ 16,408
$ 104,894	$ 104,894	$ 372,894	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 372,894	$ 104,894	$ 5,071,094
$ 282,331	$ 287,977	$ 1,044,225	$ 299,612	$1,319,488	$ 311,716	$ 317,950	$ 324,309	$ 330,795	$ 337,411	$ 344,159	$ 351,043	$ 1,272,904	$ 365,225	$ 18,009,955
$ 24,620	$ 23,917	$ 82,594	$ 22,570	$ 94,664	$ 21,298	$ 20,690	$ 20,099	$ 19,525	$ 18,967	$ 18,425	$ 17,898	$ 61,810	$ 16,890	$ 793,227

2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098
							$ 1,930,100								
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,930,100	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 239,421	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008	$ 77,008
$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886	$ 27,886
									$ 348,000						
$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894
$ 15,939	$ 15,483	$ 15,041	$ 14,611	$ 14,194	$ 13,788	$ 13,394	$ 13,012	$ 12,640	$ 53,015	$ 11,928	$ 11,587	$ 11,256	$ 10,934	$ 10,622	$ 10,319
$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 2,034,994	$ 104,894	$ 452,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894	$ 104,894
$ 379,980	$ 387,579	$ 395,331	$ 403,238	$ 411,302	$ 419,528	$ 427,919	$ 8,467,894	$ 445,207	$ 1,960,690	$ 463,193	$ 472,457	$ 481,906	$ 491,544	$ 501,375	$ 511,403
$ 15,939	$ 15,483	$ 15,041	$ 14,611	$ 14,194	$ 13,788	$ 13,394	$ 252,433	$ 12,640	$ 53,015	$ 11,928	$ 11,587	$ 11,256	$ 10,934	$ 10,622	$ 10,319

: 115157
:ACTOR

Appendix B
Life Cycle Cost Evaluation of Tertiary Treatment Alternatives

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
ADSORPTIVE DEEP BED FILTERS (BluePro)

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering & Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	Phase 1					Phase 2				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
Ultra-Filtration Package										
Filtration System	1	$ 1,700,000	$ 1,700,000	60%	$ 2,720,000	1	$ 625,000	$ 625,000	60%	$ 1,000,000
Air Compressors (sized for Phase 2)										
Media										
Instrumentation and control										
Chemical Dosing (Ferric Oxide)										$ -
Chemical Storage Tanks	7	$ 115,000	$ 805,000	60%	$ 1,288,000	6	$ 115,000	$ 690,000	60%	$ 1,104,000
Chemical Day Tanks	2	$ 3,700	$ 7,400	60%	$ 11,840	2	$ 3,700	$ 7,400	60%	$ 11,840
Dosing System skids (Part of Filtration Package)										
Total Equipment Cost					$ 4,019,840					$ 2,115,840
CONSTRUCTION										
General		10%			$ 539,933		10%			$ 280,558
Site Work		15%			$ 809,899		15%			$ 420,837
Yard Piping		10%			$ 539,933		10%			$ 280,558
Tertiary Treatment Building & Filter Structure	1	$ 1,254,078	$ 1,254,078	10%	$ 1,379,486	1	$ 627,039	$ 627,039	10%	$ 689,743
Total Construction Cost					$ 3,269,250					$ 1,671,697
Engineering & Contingency (25%)					$ 1,822,272					$ 946,884
Total Capital Cost					$ 9,111,362					$ 4,734,421

OPERATIONAL COST	Phase 1				Phase 2			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
Compressor Operation	528	kWh/d	$ 0.11	$ 21,199	$ 792	kWh/d	$ 0.11	$ 31,799
Dosing Pumps	24	kWh/d	$ 0.11	$ 964	$ 36	kWh/d	$ 0.11	$ 1,445
Total Power Cost				$ 22,163				$ 33,244
Chemical Consumption								
Hydrous Ferric Oxide	977	kg/d	$ 0.39	$ 140,700	$ 1,465	kg/d	$ 0.39	$ 208,534.02
Total Chemical Cost				$ 140,700				$ 208,534
Total Operational Cost				$ 162,862				$ 241,778

NPV CALCULATION	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
CAPITAL COSTS																	
Equipment	$ 7,669,600			$ 1,507,440	$ 2,009,920	$ 1,507,440						$ 793,440	$ 1,057,920	$ 793,440			
Construction Costs	$ 6,176,183			$ 1,225,969	$ 1,634,625	$ 1,225,969						$ 626,886	$ 835,848	$ 626,886			
Major Equipment Replacement Cost	$ 15,339,200																
Total Capital Cost in 2017 Dollars	$ 29,184,983			$ 2,733,409	$ 3,644,545	$ 2,733,409	$ -	$ -	$ -	$ -	$ -	$ 1,420,326	$ 1,893,768	$ 1,420,326	$ -	$ -	$ -
Total Capital Cost NPV	$ 15,569,506	$ -	$ -	$ 2,579,445	$ 3,340,996	$ 2,434,154	$ -	$ -	$ -	$ -	$ -	$ 1,062,911	$ 1,376,723	$ 1,003,041	$ -	$ -	$ -
OPERATIONAL COSTS																	
Power Consumption Cost	$ 2,437,908						$ 22,163	$ 22,163	$ 22,163	$ 22,163	$ 22,163	$ 22,163	$ 22,163	$ 22,163	$ 33,244	$ 33,244	$ 33,244
Chemical Consumption Cost	$ 15,305,910						$ 140,700	$ 140,700	$ 140,700	$ 140,700	$ 140,700	$ 140,700	$ 140,700	$ 140,700	$ 208,534	$ 208,534	$ 208,534
Air Lift Pump Replacement Cost (1/5 years)	$ 60,000										$ 2,500			-		$ 2,500	
Total Operational Cost in 2014 Dollars	$ 17,803,818			$ -	$ -	$ -	$ 162,862	$ 162,862	$ 162,862	$ 162,862	$ 165,362	$ 162,862	$ 162,862	$ 162,862	$ 241,778	$ 244,278	$ 241,778
Total Operational Cost NPV	$ 6,037,154			$ -	$ -	$ -	$ 140,888	$ 136,863	$ 132,953	$ 129,154	$ 127,390	$ 121,879	$ 118,397	$ 115,014	$ 165,866	$ 162,793	$ 156,524
Current Year Sub-total	$ 46,988,802			$ 2,733,409	$ 3,644,545	$ 2,733,409	$ 162,862	$ 162,862	$ 162,862	$ 162,862	$ 165,362	$ 1,583,189	$ 2,056,631	$ 1,583,189	$ 241,778	$ 244,278	$ 241,778
Inflation Adjusted	$ 106,515,117			$ 2,843,838	$ 3,867,620	$ 2,958,729	$ 179,813	$ 183,410	$ 187,078	$ 190,819	$ 197,623	$ 1,929,898	$ 2,557,162	$ 2,007,866	$ 312,766	$ 322,320	$ 325,402
NPV	**$ 21,606,660**			$ 2,579,445	$ 3,340,996	$ 2,434,154	$ 140,888	$ 136,863	$ 132,953	$ 129,154	$ 127,390	$ 1,184,790	$ 1,495,120	$ 1,118,055	$ 165,866	$ 162,793	$ 156,524

Notes:
Equipment and Construction costs spread out over a 3-year construction period in 30%-40%-30% split for both Phases

AINLEY: 115157
ADSORPTIVE DEEP BED FILTERS (BluePro)

2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
																		$ 5,024,800								$ 2,644,800
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,024,800	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,644,800
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,875,376	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 782,798
$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244
$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534
	$ 2,500		$ 2,500			$ 2,500		$ 2,500			$ 2,500		$ 2,500			$ 2,500					$ 2,500		$ 2,500			
$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 241,778
$ 152,052	$ 149,235	$ 143,487	$ 140,829	$ 135,405	$ 131,536	$ 129,099	$ 124,127	$ 121,828	$ 117,136	$ 113,789	$ 111,681	$ 107,380	$ 105,390	$ 101,331	$ 98,436	$ 96,612	$ 92,892	$ 90,237	$ 87,659	$ 85,155	$ 83,577	$ 80,358	$ 78,869	$ 75,832	$ 73,665	$ 71,561
$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 5,266,578	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 2,886,578
$ 331,910	$ 342,048	$ 345,319	$ 355,867	$ 359,270	$ 366,455	$ 377,649	$ 381,260	$ 392,906	$ 396,663	$ 404,596	$ 416,955	$ 420,942	$ 433,800	$ 437,948	$ 446,707	$ 460,352	$ 464,754	$ 10,326,054	$ 483,530	$ 493,200	$ 508,266	$ 513,126	$ 528,800	$ 533,856	$ 544,533	$ 6,631,176
$ 152,052	$ 149,235	$ 143,487	$ 140,829	$ 135,405	$ 131,536	$ 129,099	$ 124,127	$ 121,828	$ 117,136	$ 113,789	$ 111,681	$ 107,380	$ 105,390	$ 101,331	$ 98,436	$ 96,612	$ 92,892	$ 1,965,614	$ 87,659	$ 85,155	$ 83,577	$ 80,358	$ 78,869	$ 75,832	$ 73,665	$ 854,358

AINLEY: 115157
ADSORPTIVE DEEP BED FILTERS (BluePro)

2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085
																					$ 5,024,800			
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,024,800	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 785,986	$ -	$ -	$ -
$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244
$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534
	$ 2,500			$ 2,500		$ 2,500			$ 2,500		$ 2,500			$ 2,500		$ 2,500			$ 2,500					$ 2,500
$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 241,778	$ 241,778	$ 244,278
$ 69,516	$ 68,228	$ 65,600	$ 63,726	$ 62,545	$ 60,137	$ 59,022	$ 56,749	$ 55,128	$ 54,107	$ 52,023	$ 51,059	$ 49,093	$ 47,690	$ 46,806	$ 45,004	$ 44,170	$ 42,469	$ 41,255	$ 40,491	$ 38,932	$ 37,819	$ 36,739	$ 35,689	$ 35,028
$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 5,266,578	$ 241,778	$ 241,778	$ 244,278
$ 566,532	$ 583,838	$ 589,420	$ 601,208	$ 619,573	$ 625,497	$ 644,604	$ 650,767	$ 663,783	$ 684,059	$ 690,600	$ 711,695	$ 718,500	$ 732,870	$ 755,257	$ 762,478	$ 785,769	$ 793,282	$ 809,147	$ 833,864	$ 841,837	#########	$ 875,847	$ 893,364	$ 920,654
$ 69,516	$ 68,228	$ 65,600	$ 63,726	$ 62,545	$ 60,137	$ 59,022	$ 56,749	$ 55,128	$ 54,107	$ 52,023	$ 51,059	$ 49,093	$ 47,690	$ 46,806	$ 45,004	$ 44,170	$ 42,469	$ 41,255	$ 40,491	$ 38,932	$ 823,805	$ 36,739	$ 35,689	$ 35,028

AINLEY: 115157
ADSORPTIVE DEEP BED FILTERS (BluePro)

2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098
				$ 2,644,800								
$ -	$ -	$ -	$ -	$ 2,644,800	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ 328,077	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244	$ 33,244
$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534	$ 208,534
	$ 2,500					$ 2,500			$ 2,500		$ 2,500	
$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778
$ 33,679	$ 33,055	$ 31,782	$ 30,874	$ 29,992	$ 29,135	$ 28,595	$ 27,494	$ 26,708	$ 26,213	$ 25,204	$ 24,737	$ 23,784
$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 2,886,578	$ 241,778	$ 244,278	$ 241,778	$ 241,778	$ 244,278	$ 241,778	$ 244,278	$ 241,778
$ 929,456	$ 957,848	$ 967,006	$ 986,346	#########	$ 1,026,195	$ 1,057,542	$ 1,067,653	$ 1,089,006	$ 1,122,272	$ 1,133,002	$ 1,167,611	$ 1,178,775
$ 33,679	$ 33,055	$ 31,782	$ 30,874	$ 358,069	$ 29,135	$ 28,595	$ 27,494	$ 26,708	$ 26,213	$ 25,204	$ 24,737	$ 23,784

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
TWO-STAGE UPFLOW SAND FILTERS (DynaSand)

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering & Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	Phase 1					Phase 2				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Upflow Sand Filter										
Filtration System										
3 Air Lift Pumps and Compressors	1	$ 659,537	$ 659,537	60%	$ 1,055,258	1	$ 659,537	$ 659,537	60%	$ 1,055,258
Process valves and piping										
Instrumentation and control	1	$ 12,124	$ 12,124	60%	$ 19,398	1	$ 12,124	$ 12,124	60%	$ 19,398
Chemical Dosing										$ -
Chemical Storage Tanks	6	$ 115,000	$ 690,000	60%	$ 1,104,000	5	$ 115,000	$ 575,000	60%	$ 920,000
Chemical Day Tanks	2	$ 3,700	$ 7,400	60%	$ 11,840	2	$ 3,700	$ 7,400	60%	$ 11,840
Dosing Pump skids	1	$ 15,000	$ 15,000	60%	$ 24,000	1	$ 15,000	$ 15,000	60%	$ 24,000
Total Equipment Cost					$ 2,214,497					$ 2,030,497
CONSTRUCTION										
General		10%			$ 313,415		10%			$ 47,167
Site Work		15%			$ 470,123		15%			$ 70,750
Yard Piping		10%			$ 313,415		10%			$ 47,167
Tertiary Treatment Building & Filter Structure	1	$ 836,052	$ 836,052	10%	$ 919,657	1	$ 418,026	$ 418,026	10%	$ 459,829
Total Construction Cost					$ 2,016,611					$ 624,913
Engineering & Contingency (25%)					$ 1,057,777					$ 663,852
Total Capital Cost					$ 5,288,885					$ 3,319,262

OPERATIONAL COST	Phase 1				Phase 2			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
Compressor/ Airlift Pumps Operation	268	kWh/d	$ 0.11	$ 10,778	403	kWh/d	$ 0.11	$ 16,168
Dosing Pumps	24	kWh/d	$ 0.11	$ 964	36	kWh/d	$ 0.11	$ 1,445
Total Power Cost				$ 11,742				$ 17,613
Chemical Consumption								
Ferric Chloride	862	kg/d	$ 0.59	$ 186,851	1293	kg/d	$ 0.59	$ 280,276
Total Chemical Cost				$ 186,851				$ 280,276
Total Operational Cost				$ 198,593				$ 297,889

NPV Calculation	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
CAPITAL COSTS																
Equipment	$ 5,306,241			$ 830,436	$ 1,107,248	$ 830,436						$ 761,436	$ 1,015,248	$ 761,436		
Construction Costs	$ 3,301,905			$ 756,229	$ 1,008,306	$ 756,229						$ 234,342	$ 312,456	$ 234,342		
Major Equipment Replacement Cost	$ 10,612,483															
Total Capital Cost in 2014 Dollars	$ 19,220,629			$ 1,586,665	$ 2,115,554	$ 1,586,665	$ -	$ -	$ -	$ -	$ -	$ 995,778	$ 1,327,705	$ 995,778	$ -	$ -
Total Capital Cost NPV	$ 9,795,421	$ -	$ -	$ 1,497,294	$ 1,939,352	$ 1,412,957	$ -	$ -	$ -	$ -	$ -	$ 745,198	$ 965,208	$ 703,223	$ -	$ -
OPERATIONAL COSTS																
Power Consumption Cost	$ 1,591,034						$ 11,742	$ 11,742	$ 11,742	$ 11,742	$ 11,742	$ 11,742	$ 11,742	$ 11,742	$ 22,016	$ 22,016
Chemical Consumption Cost	$ 20,553,588						$ 186,851	$ 186,851	$ 186,851	$ 186,851	$ 186,851	$ 186,851	$ 186,851	$ 186,851	$ 280,276	$ 280,276
Air Lift Pump Replacement Cost (1/5 years)	$ 60,000										$ 2,500			-		$ 2,500
Total Operational Cost in 2014 Dollars	$ 22,204,622			$ -	$ -	$ -	$ 198,593	$ 198,593	$ 198,593	$ 198,593	$ 201,093	$ 198,593	$ 198,593	$ 198,593	$ 302,292	$ 304,792
Total Operational Cost NPV	$ 7,511,670			$ -	$ -	$ -	$ 171,798	$ 166,889	$ 162,121	$ 157,489	$ 154,915	$ 148,618	$ 144,372	$ 140,247	$ 207,381	$ 203,122
Current Year Sub-total	$ 41,425,251			$ 1,586,665	$ 2,115,554	$ 1,586,665	$ 198,593	$ 198,593	$ 198,593	$ 198,593	$ 201,093	$ 1,194,371	$ 1,526,297	$ 1,194,371	$ 302,292	$ 304,792
Inflation Adjusted	$ 99,041,440			$ 1,650,767	$ 2,245,043	$ 1,717,458	$ 219,262	$ 223,648	$ 228,121	$ 232,683	$ 240,324	$ 1,455,932	$ 1,897,759	$ 1,514,751	$ 391,047	$ 402,167
NPV	**$ 17,307,091**			$ 1,497,294	$ 1,939,352	$ 1,412,957	$ 171,798	$ 166,889	$ 162,121	$ 157,489	$ 154,915	$ 893,816	$ 1,109,580	$ 843,470	$ 207,381	$ 203,122

Notes:

Equipment and Construction costs spread out over a 3-year construction period in 30%-40%-30% split for both Phases

AINLEY: 115157
TWO-STAGE UPFLOW SAND FILTERS (DynaSand)

2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
																			$ 2,768,121							
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,768,121	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,033,129	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016
$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276
		$ 2,500		$ 2,500			$ 2,500		$ 2,500			$ 2,500		$ 2,500			$ 2,500					$ 2,500		$ 2,500		
$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292
$ 195,700	$ 190,108	$ 186,204	$ 179,400	$ 175,716	$ 169,295	$ 164,458	$ 161,081	$ 155,195	$ 152,007	$ 146,453	$ 142,269	$ 139,347	$ 134,255	$ 131,498	$ 126,693	$ 123,073	$ 120,546	$ 116,141	$ 112,823	$ 109,599	$ 106,468	$ 104,281	$ 100,471	$ 98,407	$ 94,812	$ 92,103
$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 3,070,413	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292
$ 406,846	$ 414,983	$ 426,783	$ 431,748	$ 444,025	$ 449,191	$ 458,174	$ 471,203	$ 476,685	$ 490,239	$ 495,943	$ 505,861	$ 520,246	$ 526,298	$ 541,264	$ 547,561	$ 558,512	$ 574,394	$ 581,076	$ 6,020,085	$ 604,551	$ 616,642	$ 634,177	$ 641,555	$ 659,798	$ 667,474	$ 680,823
$ 195,700	$ 190,108	$ 186,204	$ 179,400	$ 175,716	$ 169,295	$ 164,458	$ 161,081	$ 155,195	$ 152,007	$ 146,453	$ 142,269	$ 139,347	$ 134,255	$ 131,498	$ 126,693	$ 123,073	$ 120,546	$ 116,141	$ 1,145,952	$ 109,599	$ 106,468	$ 104,281	$ 100,471	$ 98,407	$ 94,812	$ 92,103

AINLEY: 115157
TWO-STAGE UPFLOW SAND FILTERS (DynaSand)

2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084
$ 2,538,121																						$ 2,768,121		
$ 2,538,121	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,768,121	$ -	$ -
$ 751,223	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 432,993	$ -	$ -
$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016
$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276
		$ 2,500			$ 2,500		$ 2,500			$ 2,500		$ 2,500			$ 2,500		$ 2,500			$ 2,500				
$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 302,292	$ 302,292
$ 89,471	$ 86,915	$ 85,130	$ 82,019	$ 79,676	$ 78,040	$ 75,188	$ 73,644	$ 70,953	$ 68,926	$ 67,510	$ 65,043	$ 63,708	$ 61,380	$ 59,626	$ 58,401	$ 56,268	$ 55,112	$ 53,098	$ 51,581	$ 50,522	$ 48,676	$ 47,285	$ 45,934	$ 44,622
$ 2,840,413	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 3,070,413	$ 302,292	$ 302,292
$ 6,525,123	$ 708,328	$ 728,470	$ 736,945	$ 751,684	$ 773,058	$ 782,052	$ 804,290	$ 813,646	$ 829,919	$ 853,519	$ 863,448	$ 888,001	$ 898,331	$ 916,298	$ 942,354	$ 953,317	$ 980,425	$ 991,831	$ 1,011,667	$ 1,040,434	$ 1,052,538	#########	$ 1,095,061	$ 1,116,962
$ 840,694	$ 86,915	$ 85,130	$ 82,019	$ 79,676	$ 78,040	$ 75,188	$ 73,644	$ 70,953	$ 68,926	$ 67,510	$ 65,043	$ 63,708	$ 61,380	$ 59,626	$ 58,401	$ 56,268	$ 55,112	$ 53,098	$ 51,581	$ 50,522	$ 48,676	$ 480,278	$ 45,934	$ 44,622

AINLEY: 115157
TWO-STAGE UPFLOW SAND FILTERS (DynaSand)

2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098
					$ 2,538,121								
$ -	$ -	$ -	$ -	$ -	$ 2,538,121	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ 314,844	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016	$ 22,016
$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276	$ 280,276
$ 2,500		$ 2,500					$ 2,500			$ 2,500		$ 2,500	
$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292
$ 43,705	$ 42,108	$ 41,243	$ 39,736	$ 38,601	$ 37,498	$ 36,427	$ 35,679	$ 34,375	$ 33,393	$ 32,707	$ 31,512	$ 30,865	$ 29,737
$ 304,792	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 2,840,413	$ 302,292	$ 304,792	$ 302,292	$ 302,292	$ 304,792	$ 302,292	$ 304,792	$ 302,292
$ 1,148,724	$ 1,162,088	$ 1,195,132	$ 1,209,036	$ 1,233,217	#########	$ 1,283,039	$ 1,319,522	$ 1,334,873	$ 1,361,571	$ 1,400,288	$ 1,416,578	$ 1,456,859	$ 1,473,808
$ 43,705	$ 42,108	$ 41,243	$ 39,736	$ 38,601	$ 352,342	$ 36,427	$ 35,679	$ 34,375	$ 33,393	$ 32,707	$ 31,512	$ 30,865	$ 29,737

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
TERTIARY MEMBRANES

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering & Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

10%
15%
10%

CAPITAL COST	Phase 1					Phase 2				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Pre-Filters	2	$ 150,000	$ 300,000	60%	$ 480,000	$ 1	$ 150,000	$ 150,000	60%	$ 240,000
Tertiary Membrane Package										
UF System										
Instrumentation and control	1	$ 1,438,500	$ 1,438,500	60%	$ 2,301,600	1	$ 1,438,500	$ 1,438,500	60%	$ 2,301,600
Process valves and piping										
Chemical Dosing										
Chemical Storage Tanks	3	$ 115,000	$ 345,000	60%	$ 552,000	2	$ 115,000	$ 230,000	60%	$ 368,000
Dosing Pump skids (Part of Tertiary Membrane Package)										
Total Equipment Cost					$ 3,333,600					$ 2,909,600
CONSTRUCTION										
General		10%			$ 435,924		10%			$ 290,960
Site Work		15%			$ 653,886		15%			$ 436,440
Yard Piping		10%			$ 435,924		10%			$ 290,960
Tertiary Treatment Building (Sized for Phase 2 in Phase 1)	1	$ 932,400	$ 932,400	10%	$ 1,025,640	0	$ -	$ -		$ -
Total Construction Cost					$ 2,551,374					$ 1,018,360
Engineering & Contingency (25%)					$ 1,471,244					$ 981,990
Total Capital Cost					$ 7,356,218					$ 4,909,950

OPERATIONAL COST	Phase 1				Phase 2			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
Feed Pumps	318	kWh/d	$ 0.11	$ 12,788	478	kWh/d	$ 0.11	$ 19,182
Membrane Blowers	77	kWh/d	$ 0.11	$ 3,100	116	kWh/d	$ 0.11	$ 4,650
Air Compressors	8	kWh/d	$ 0.11	$ 319	12	kWh/d	$ 0.11	$ 478
Backpulse and CIP Pumps	38	kWh/d	$ 0.11	$ 1,539	57	kWh/d	$ 0.11	$ 2,309
CIP Heater	21	kWh/d	$ 0.11	$ 827	31	kWh/d	$ 0.11	$ 1,241
Total Power Cost				$ 18,573				$ 27,859
Chemical Consumption								
Sodium Hypochlorite	21	L/d	$ 0.50	$ 3,785	31	L/d	$ 0.50	$ 5,677
Citric Acid	3	kg/d	$ 1.50	$ 1,637	4	kg/d	$ 1.50	$ 2,455
Sodium Bisulphite	6	kg/d	$ 1.00	$ 2,187	9	kg/d	$ 1.00	$ 3,280
Sodium Hydroxide	2	kg/d	$ 0.55	$ 351	3	kg/d	$ 0.55	$ 527
Ferric Chloride	358	kg/d	$ 0.59	$ 77,095	537	kg/d	$ 0.59	$ 115,643
Total Chemical Cost				$ 85,055				$ 127,582
Total Operational Cost				$ 103,627				$ 155,441

NPV CALCULATION	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
CAPITAL COSTS																				
Equipment	$ 7,804,000			$ 1,250,100	$ 1,666,800	$ 1,250,100						$ 1,091,100	$ 1,454,800	$ 1,091,100						
Construction Costs	$ 4,462,168			$ 956,765	$ 1,275,687	$ 956,765						$ 381,885	$ 509,180	$ 381,885						
Major Equipment Replacement Cost (@ 30 years)	$ 15,608,000																			
Total Capital Cost in 2014 Dollars	$ 27,874,168			$ 2,206,865	$ 2,942,487	$ 2,206,865	$ -	$ -	$ -	$ -	$ -	$ 1,472,985	$ 1,963,980	$ 1,472,985	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 14,050,193	$ -	$ -	$ 2,082,560	$ 2,697,411	$ 1,965,257	$ -	$ -	$ -	$ -	$ -	$ 1,102,318	$ 1,427,765	$ 1,040,229	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS																				
Power Consumption Cost	$ 2,098,694			$ 18,573	$ 18,573	$ 18,573	$ 18,573	$ 18,573	$ 18,573	$ 18,573	$ 18,573	$ 18,573	$ 18,573	$ 18,573	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859
Chemical Consumption Cost	$ 9,611,188			$ 85,055	$ 85,055	$ 85,055	$ 85,055	$ 85,055	$ 85,055	$ 85,055	$ 85,055	$ 85,055	$ 85,055	$ 85,055	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582
Membrane Replacement Cost (1/10 years)	$ 2,732,400					-								-		$ 303,600				
Total Operational Cost in 2014 Dollars	$ 14,442,282			$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441	$ 155,441
Total Operational Cost NPV	$ 5,082,491			$ 97,790	$ 94,996	$ 92,282	$ 89,645	$ 87,084	$ 84,596	$ 82,179	$ 79,831	$ 77,550	$ 75,334	$ 73,182	$ 106,637	$ 305,917	$ 100,630	$ 97,755	$ 94,962	$ 92,249
Current Year Sub-total	$ 42,316,449			$ 2,310,493	$ 3,046,114	$ 2,310,493	$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 103,627	$ 1,576,612	$ 2,067,607	$ 1,576,612	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441	$ 155,441
Inflation Adjusted	$ 97,020,810			$ 2,403,836	$ 3,232,561	$ 2,500,951	$ 114,413	$ 116,701	$ 119,035	$ 121,416	$ 123,844	$ 1,921,882	$ 2,570,810	$ 1,999,526	$ 201,079	$ 605,695	$ 209,203	$ 213,387	$ 217,655	$ 222,008
NPV	**$ 19,132,684**			$ 2,180,350	$ 2,792,408	$ 2,057,539	$ 89,645	$ 87,084	$ 84,596	$ 82,179	$ 79,831	$ 1,179,869	$ 1,503,099	$ 1,113,411	$ 106,637	$ 305,917	$ 100,630	$ 97,755	$ 94,962	$ 92,249

Notes:
Equipment and Construction costs spread out over a 3-year construction period in 30%-40%-30% split for both Phases

2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859
$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582
			$ 303,600		$ 303,600								$ 303,600	
$ 155,441	$ 155,441	$ 155,441	$ 459,041	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 459,041	$ 155,441
$ 89,613	$ 87,053	$ 84,566	$ 242,600	$ 79,802	$ 228,935	$ 75,307	$ 73,156	$ 71,066	$ 69,035	$ 67,063	$ 65,147	$ 63,285	$ 181,551	$ 59,721
$ 155,441	$ 155,441	$ 155,441	$ 459,041	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 459,041	$ 155,441
$ 226,448	$ 230,977	$ 235,597	$ 709,668	$ 245,115	$ 738,338	$ 255,017	$ 260,118	$ 265,320	$ 270,626	$ 276,039	$ 281,560	$ 287,191	$ 865,081	$ 298,793
$ 89,613	$ 87,053	$ 84,566	$ 242,600	$ 79,802	$ 228,935	$ 75,307	$ 73,156	$ 71,066	$ 69,035	$ 67,063	$ 65,147	$ 63,285	$ 181,551	$ 59,721

2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067
$ 4,167,000								$ 3,637,000							
$ 4,167,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,637,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 1,555,225	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,076,465	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859
$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582
										$ 303,600					
$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441
$ 58,014	$ 56,357	$ 54,747	$ 53,182	$ 51,663	$ 50,187	$ 48,753	$ 47,360	$ 46,007	$ 44,692	$ 128,212	$ 42,175	$ 40,970	$ 39,799	$ 38,662	$ 37,558
$ 4,322,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 3,792,441	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441
$ 8,474,906	$ 310,865	$ 317,082	$ 323,424	$ 329,892	$ 336,490	$ 343,220	$ 350,084	$ 8,712,164	$ 364,227	$ 1,097,132	$ 378,942	$ 386,521	$ 394,252	$ 402,137	$ 410,179
$ 1,613,239	$ 56,357	$ 54,747	$ 53,182	$ 51,663	$ 50,187	$ 48,753	$ 47,360	$ 1,122,472	$ 44,692	$ 128,212	$ 42,175	$ 40,970	$ 39,799	$ 38,662	$ 37,558

AINLEY: 115157
TERTIARY MEMBRANES

2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859
$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582
		$ 303,600		$ 303,600								$ 303,600	
$ 155,441	$ 155,441	$ 459,041	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 459,041	$ 155,441
$ 36,485	$ 35,442	$ 101,676	$ 33,446	$ 95,949	$ 31,562	$ 30,660	$ 29,784	$ 28,933	$ 28,107	$ 27,303	$ 26,523	$ 76,090	$ 25,029
$ 155,441	$ 155,441	$ 459,041	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 459,041	$ 155,441
$ 418,383	$ 426,751	$ 1,285,465	$ 443,991	$ 1,337,398	$ 461,929	$ 471,167	$ 480,590	$ 490,202	$ 500,006	$ 510,006	$ 520,207	$ 1,566,975	$ 541,223
$ 36,485	$ 35,442	$ 101,676	$ 33,446	$ 95,949	$ 31,562	$ 30,660	$ 29,784	$ 28,933	$ 28,107	$ 27,303	$ 26,523	$ 76,090	$ 25,029

2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095
$ 4,167,000								$ 3,637,000					
$ 4,167,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,637,000	$ -	$ -	$ -	$ -	$ -
$ 651,807	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 451,155	$ -	$ -	$ -	$ -	$ -
$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859	$ 27,859
$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582	$ 127,582
										$ 303,600			
$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441
$ 24,314	$ 23,620	$ 22,945	$ 22,289	$ 21,652	$ 21,034	$ 20,433	$ 19,849	$ 19,282	$ 18,731	$ 53,735	$ 17,676	$ 17,171	$ 16,680
$ 4,322,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 155,441	$ 3,792,441	$ 155,441	$ 459,041	$ 155,441	$ 155,441	$ 155,441
$ 15,351,120	$ 563,088	$ 574,350	$ 585,837	$ 597,554	$ 609,505	$ 621,695	$ 634,129	$ 15,780,879	$ 659,748	$ 1,987,303	$ 686,401	$ 700,129	$ 714,132
$ 676,122	$ 23,620	$ 22,945	$ 22,289	$ 21,652	$ 21,034	$ 20,433	$ 19,849	$ 470,437	$ 18,731	$ 53,735	$ 17,676	$ 17,171	$ 16,680

AINLEY: 115157
TERTIARY MEMBRANES

2096	2097	2098
$ -	$ -	$ -
$ -	$ -	$ -
$ 27,859	$ 27,859	$ 27,859
$ 127,582	$ 127,582	$ 127,582
$ 155,441	$ 155,441	$ 155,441
$ 16,204	$ 15,741	$ 15,291
$ 155,441	$ 155,441	$ 155,441
$ 728,415	$ 742,983	$ 757,843
$ 16,204	$ 15,741	$ 15,291

Appendix C
Life Cycle Cost Evaluation of Disinfection System Alternatives

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
Chlorination/De-Chlorination

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering & Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	Phase 1					Phase 2				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Chemical Dosing System										
Chemical Storage Tanks	4.00	$ 30,000	$ 120,000	60%	$ 192,000	2.00	$ 30,000	$ 60,000	60%	$ 96,000
Dosing Pump skids (designed for Phase 2 flow in Phase 1)	2.00	$ 20,000	$ 40,000	60%	$ 64,000	0.00				
Total Equipment Cost					$ 256,000					$ 96,000
CONSTRUCTION										
General			10%		$ 73,149			10%		$ 33,379
Site Work			15%		$ 109,724			15%		$ 50,068
Yard Piping			10%		$ 73,149			10%		$ 33,379
Disinfection Building	1.00	$336,000	$ 336,000	10%	$ 369,600	1.00	$168,000	$ 168,000	10%	$ 184,800
Chlorine Contact Tank	1.00	$ 96,263.89	$ 96,264	10%	$ 105,890	1.00	$ 48,172.22	$ 48,172	10%	$ 52,989
Total Construciton Cost					$ 731,512					$ 354,616
Engineering & Contingency (25%)					$ 246,878					$ 112,654
Total Capital Cost					$ 1,234,390					$ 563,270

OPERATIONAL COST	Phase 1				Phase 2			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM								
Power Consumption								
Chlorination Pump	6	kWh/d	$ 0.11	$ 241	9	kWh/d	$ 0.11	$ 361
De-Chlorination Pump	6	kWh/d	$ 0.11	$ 241	9	kWh/d	$ 0.11	$ 361
Total Power Cost				$ 482				$ 723
Chemical Consumption								
Sodium Hypochlorite	80	L/d	$ 0.50	$ 14,523	119	L/d	$ 0.50	$ 21,784
Sodium Bisulphite	18	Kg/d	$ 1.00	$ 6,703	28	Kg/d	$ 1.00	$ 10,055
Total Chemical Cost				$ 21,226				$ 31,839
Total Operational Cost				$ 21,708				$ 32,562

NPV Calculation	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
CAPITAL COSTS															
Equipment	$ 440,000			$ 96,000	$ 128,000	$ 96,000						$ 36,000	$ 48,000	$ 36,000	
Construction Costs	$ 1,357,660			$ 274,317	$ 365,756	$ 274,317						$ 132,981	$ 177,308	$ 132,981	
Major Equipment Replacement Cost	$ 880,000														
Total Capital Cost in 2018 Dollars	$ 2,677,660	$ -	$ -	$ 370,317	$ 493,756	$ 370,317	$ -	$ -	$ -	$ -	$ -	$ 168,981	$ 225,308	$ 168,981	$ -
Capital Costs Total NPV	$ 1,761,340	$ -	$ -	$ 349,458	$ 452,632	$ 329,775	$ -	$ -	$ -	$ -	$ -	$ 126,458	$ 163,793	$ 119,335	$ -
OPERATIONAL COSTS															
Chemical Consumption Cost	$ 2,398,526			$ 21,226	$ 21,226	$ 21,226	$ 21,226	$ 21,226	$ 21,226	$ 21,226	$ 21,226	$ 21,226	$ 21,226	$ 21,226	$ 31,839
Total Operational Cost in 2018 Dollars	$ 2,466,580	$ -	$ -	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 32,742
Operational Costs Total NPV	$ 873,499	$ -	$ -	$ 20,599	$ 20,010	$ 19,438	$ 18,883	$ 18,343	$ 17,819	$ 17,310	$ 16,816	$ 16,335	$ 15,869	$ 15,415	$ 22,462
Current Year Sub-total	$ 5,144,239	$ -	$ -	$ 392,145	$ 515,584	$ 392,145	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 21,828	$ 190,809	$ 247,136	$ 190,809	$ 32,742
Inflation Adjusted	$ 10,849,276	$ -	$ -	$ 407,988	$ 547,142	$ 424,470	$ 24,100	$ 24,582	$ 25,074	$ 25,575	$ 26,087	$ 232,595	$ 307,283	$ 241,992	$ 42,356
NPV	**$ 2,634,839**	$ -	$ -	$ 370,057	$ 472,642	$ 349,213	$ 18,883	$ 18,343	$ 17,819	$ 17,310	$ 16,816	$ 142,793	$ 179,662	$ 134,750	$ 22,462

AINLEY: 115157
Chlorination/De-Chlorination

2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
																				$ 320,000							
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 320,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 119,432	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839
$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742
$ 21,820	$ 21,197	$ 20,591	$ 20,003	$ 19,431	$ 18,876	$ 18,337	$ 17,813	$ 17,304	$ 16,810	$ 16,329	$ 15,863	$ 15,410	$ 14,969	$ 14,542	$ 14,126	$ 13,723	$ 13,330	$ 12,950	$ 12,580	$ 12,220	$ 11,871	$ 11,532	$ 11,202	$ 10,882	$ 10,571	$ 10,269	$ 9,976
$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 352,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742
$ 43,203	$ 44,067	$ 44,948	$ 45,847	$ 46,764	$ 47,699	$ 48,653	$ 49,626	$ 50,619	$ 51,631	$ 52,664	$ 53,717	$ 54,791	$ 55,887	$ 57,005	$ 58,145	$ 59,308	$ 60,494	$ 61,704	$ 62,938	$ 691,613	$ 65,481	$ 66,790	$ 68,126	$ 69,489	$ 70,879	$ 72,296	$ 73,742
$ 21,820	$ 21,197	$ 20,591	$ 20,003	$ 19,431	$ 18,876	$ 18,337	$ 17,813	$ 17,304	$ 16,810	$ 16,329	$ 15,863	$ 15,410	$ 14,969	$ 14,542	$ 14,126	$ 13,723	$ 13,330	$ 12,950	$ 12,580	$ 131,652	$ 11,871	$ 11,532	$ 11,202	$ 10,882	$ 10,571	$ 10,269	$ 9,976

2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072
$ 120,000												
$ 120,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 35,517	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839
$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742
$ 9,691	$ 9,414	$ 9,145	$ 8,884	$ 8,630	$ 8,383	$ 8,144	$ 7,911	$ 7,685	$ 7,466	$ 7,252	$ 7,045	$ 6,844
$ 152,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742
$ 350,886	$ 76,721	$ 78,256	$ 79,821	$ 81,417	$ 83,045	$ 84,706	$ 86,401	$ 88,129	$ 89,891	$ 91,689	$ 93,523	$ 95,393
$ 45,208	$ 9,414	$ 9,145	$ 8,884	$ 8,630	$ 8,383	$ 8,144	$ 7,911	$ 7,685	$ 7,466	$ 7,252	$ 7,045	$ 6,844

2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085
									$ 320,000			
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 320,000	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,055	$ -	$ -	$ -
$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839
$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742
$ 6,648	$ 6,458	$ 6,274	$ 6,095	$ 5,920	$ 5,751	$ 5,587	$ 5,427	$ 5,272	$ 5,122	$ 4,975	$ 4,833	$ 4,695
$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 352,742	$ 32,742	$ 32,742	$ 32,742
$ 97,301	$ 99,247	$ 101,232	$ 103,257	$ 105,322	$ 107,428	$ 109,577	$ 111,768	$ 114,004	$ 1,252,762	$ 118,609	$ 120,982	$ 123,401
$ 6,648	$ 6,458	$ 6,274	$ 6,095	$ 5,920	$ 5,751	$ 5,587	$ 5,427	$ 5,272	$ 55,176	$ 4,975	$ 4,833	$ 4,695

AINLEY: 115157
Chlorination/De-Chlorination

2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098
				$ 120,000								
$ -	$ -	$ -	$ -	$ 120,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ 14,886	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839	$ 31,839
$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742
$ 4,561	$ 4,431	$ 4,304	$ 4,181	$ 4,062	$ 3,945	$ 3,833	$ 3,723	$ 3,617	$ 3,514	$ 3,413	$ 3,316	$ 3,221
$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 152,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742	$ 32,742
$ 125,869	$ 128,387	$ 130,954	$ 133,573	$ 635,582	$ 138,970	$ 141,749	$ 144,584	$ 147,476	$ 150,425	$ 153,434	$ 156,503	$ 159,633
$ 4,561	$ 4,431	$ 4,304	$ 4,181	$ 18,947	$ 3,945	$ 3,833	$ 3,723	$ 3,617	$ 3,514	$ 3,413	$ 3,316	$ 3,221

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
UV Disinfection

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering & Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	Phase 1					Phase 2				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
UV3000Plus bank										
banks *modules per bank* *ALC* *baffles*	1.00	$ 162,144	$ 162,144	60%	$ 259,430	$ 4	$ 7,500	$ 30,000	60%	$ 48,000
lamps per module	48.00	$ 372	$ 17,856	60%	$ 28,570	32.00	$ 372	$ 11,904	60%	$ 19,046
Transformer (sized for Phase 2 in Phase 1)	1.00	$ 3,000	$ 3,000	60%	$ 4,800	0.00				
Total Equipment Cost					$ 292,800					$ 67,046
CONSTRUCTION										
General			10%		$ 30,169			10%		$ 7,297
Site Work			15%		$ 45,254			15%		$ 10,946
Yard Piping			10%		$ 30,169			10%		$ 7,297
UV Contact Tank	1.00	$ 8,082.56	$ 8,083	10%	$ 8,891	1.00	$ 5,388.38	$ 5,388	10%	$ 5,927
Total Construciton Cost					$ 114,483					$ 31,468
Engineering & Contingency (20%)					$ 101,821					$ 24,629
Total Capital Cost					$ 509,103					$ 123,143

OPERATIONAL COST	Phase 1				Phase 2			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM								
Power Consumption								
Overall Power Consumption	77	kWh/d	$ 0.12	$ 3,364	115	kWh/d	$ 0.12	$ 5,046
Total Power Cost				$ 3,364				$ 5,046
Total Operational Cost				$ 3,364				$ 5,046

NPV Calculation	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
CAPITAL COSTS															
Equipment	$ 449,808			$ 109,800	$ 146,400	$ 109,800						$ 25,142	$ 33,523	$ 25,142	
Construction Costs	$ 182,438			$ 42,931	$ 57,241	$ 42,931						$ 11,800	$ 15,734	$ 11,800	
Major Equipment Replacement Cost	$ 899,616														
Total Capital Cost in 2018 Dollars	$ 1,531,862	$ -	$ -	$ 152,731	$ 203,641	$ 152,731	$ -	$ -	$ -	$ -	$ -	$ 36,943	$ 49,257	$ 36,943	$ -
Capital Costs Total NPV	$ 785,414	$ -	$ -	$ 144,128	$ 186,680	$ 136,010	$ -	$ -	$ -	$ -	$ -	$ 27,646	$ 35,809	$ 26,089	$ -
OPERATIONAL COSTS															
Power Consumption Cost	$ 370,022						$ 3,364	$ 3,364	$ 3,364	$ 3,364	$ 3,364	$ 3,364	$ 3,364	$ 3,364	$ 5,046
Lamp Replacement Cost (18/year)	$ 964,224						$ 6,696	$ 6,696	$ 6,696	$ 6,696	$ 6,696	$ 6,696	$ 6,696	$ 6,696	$ 13,392
Total Operational Cost in 2018 Dollars	$ 1,334,246	$ -	$ -	$ -	$ -	$ -	$ 10,060	$ 10,060	$ 10,060	$ 10,060	$ 10,060	$ 10,060	$ 10,060	$ 10,060	$ 18,438
Operational Costs Total NPV	$ 444,083	$ -	$ -	$ -	$ -	$ -	$ 8,703	$ 8,454	$ 8,212	$ 7,978	$ 7,750	$ 7,528	$ 7,313	$ 7,104	$ 12,649
Current Year Sub-total	$ 2,866,109	$ -	$ -	$ 152,731	$ 203,641	$ 152,731	$ 10,060	$ 10,060	$ 10,060	$ 10,060	$ 10,060	$ 47,003	$ 59,317	$ 47,003	$ 18,438
Inflation Adjusted	$ 6,739,448	$ -	$ -	$ 158,901	$ 216,106	$ 165,321	$ 11,107	$ 11,329	$ 11,556	$ 11,787	$ 12,022	$ 57,296	$ 73,753	$ 59,611	$ 23,851
NPV	**$ 1,229,497**	$ -	$ -	$ 144,128	$ 186,680	$ 136,010	$ 8,703	$ 8,454	$ 8,212	$ 7,978	$ 7,750	$ 35,175	$ 43,122	$ 33,194	$ 12,649

AINLEY: 115157
UV Disinfection

2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058
																				$ 366,000						
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 366,000	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 136,600	$ -	$ -	$ -	$ -	$ -	$ -
$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046
$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392
$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438
$ 12,287	$ 11,936	$ 11,595	$ 11,264	$ 10,942	$ 10,630	$ 10,326	$ 10,031	$ 9,744	$ 9,466	$ 9,195	$ 8,933	$ 8,677	$ 8,429	$ 8,189	$ 7,955	$ 7,727	$ 7,507	$ 7,292	$ 7,084	$ 6,881	$ 6,685	$ 6,494	$ 6,308	$ 6,128	$ 5,953	$ 5,783
$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 384,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438
$ 24,328	$ 24,815	$ 25,311	$ 25,817	$ 26,334	$ 26,860	$ 27,398	$ 27,945	$ 28,504	$ 29,074	$ 29,656	$ 30,249	$ 30,854	$ 31,471	$ 32,101	$ 32,743	$ 33,397	$ 34,065	$ 34,747	$ 35,442	$ 753,758	$ 36,873	$ 37,611	$ 38,363	$ 39,130	$ 39,913	$ 40,711
$ 12,287	$ 11,936	$ 11,595	$ 11,264	$ 10,942	$ 10,630	$ 10,326	$ 10,031	$ 9,744	$ 9,466	$ 9,195	$ 8,933	$ 8,677	$ 8,429	$ 8,189	$ 7,955	$ 7,727	$ 7,507	$ 7,292	$ 7,084	$ 143,481	$ 6,685	$ 6,494	$ 6,308	$ 6,128	$ 5,953	$ 5,783

AINLEY: 115157
UV Disinfection

2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085
	$ 83,808																						$ 366,000			
$ -	$ 83,808	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 366,000	$ -	$ -	$ -
$ -	$ 24,805	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 57,250	$ -	$ -	$ -
$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046
$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392
$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438
$ 5,618	$ 5,457	$ 5,301	$ 5,150	$ 5,003	$ 4,860	$ 4,721	$ 4,586	$ 4,455	$ 4,328	$ 4,204	$ 4,084	$ 3,967	$ 3,854	$ 3,744	$ 3,637	$ 3,533	$ 3,432	$ 3,334	$ 3,239	$ 3,146	$ 3,056	$ 2,969	$ 2,884	$ 2,802	$ 2,722	$ 2,644
$ 18,438	$ 102,246	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 384,438	$ 18,438	$ 18,438	$ 18,438
$ 41,526	$ 234,884	$ 43,203	$ 44,067	$ 44,949	$ 45,848	$ 46,764	$ 47,700	$ 48,654	$ 49,627	$ 50,619	$ 51,632	$ 52,664	$ 53,718	$ 54,792	$ 55,888	$ 57,006	$ 58,146	$ 59,309	$ 60,495	$ 61,705	$ 62,939	$ 64,198	$ 1,365,328	$ 66,791	$ 68,127	$ 69,490
$ 5,618	$ 30,262	$ 5,301	$ 5,150	$ 5,003	$ 4,860	$ 4,721	$ 4,586	$ 4,455	$ 4,328	$ 4,204	$ 4,084	$ 3,967	$ 3,854	$ 3,744	$ 3,637	$ 3,533	$ 3,432	$ 3,334	$ 3,239	$ 3,146	$ 3,056	$ 2,969	$ 60,134	$ 2,802	$ 2,722	$ 2,644

AINLEY: 115157
UV Disinfection

2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098
				$ 83,808								
$ -	$ -	$ -	$ -	$ 83,808	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ 10,396	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046	$ 5,046
$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392	$ 13,392
$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438
$ 2,568	$ 2,495	$ 2,424	$ 2,354	$ 2,287	$ 2,222	$ 2,158	$ 2,097	$ 2,037	$ 1,979	$ 1,922	$ 1,867	$ 1,814
$ 18,438	$ 18,438	$ 18,438	$ 18,438	$102,246	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438	$ 18,438
$ 70,879	$ 72,297	$ 73,743	$ 75,218	$425,459	$ 78,257	$ 79,822	$ 81,418	$ 83,046	$ 84,707	$ 86,402	$ 88,130	$ 89,892
$ 2,568	$ 2,495	$ 2,424	$ 2,354	$ 12,683	$ 2,222	$ 2,158	$ 2,097	$ 2,037	$ 1,979	$ 1,922	$ 1,867	$ 1,814

Appendix D
Life Cycle Cost Evaluation of Effluent Re-Oxygenation Alternatives

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
EFFLUENT RE-OXYGENATION

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering & Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	Phase 1					Phase 2				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Aeration Diffusers and Piping	1	$ 10,000	$ 10,000	50%	$ 15,000	1	$ 5,000	$ 5,000	50%	$ 7,500
(note: seondary treatment blowers will also supply air to this system)										
Chemical Dosing (not required)										$ -
	5		$ -	50%	$ -	5	$ -	$ -	50%	$ -
Total Equipment Cost					$ 15,000					$ 7,500
CONSTRUCTION										
General		10%			$ 3,414		10%			$ 1,516
Site Work		15%			$ 5,121		15%			$ 2,273
Yard Piping		10%			$ 3,414		10%			$ 1,516
Re-Oxygenation Tank	1	$ 17,400	$ 17,400	10%	$ 19,140	1	$ 6,960	$ 6,960	10%	$ 7,656
Total Construction Cost					$ 31,089					$ 12,961
Engineering & Contingency (25%)					$ 11,522					$ 5,115
Total Capital Cost					$ 57,611					$ 25,576

OPERATIONAL COST	Phase 1				Phase 2			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
Blower (capacity added to aeration blowers)	8	kWh/d	$ 0.11	$ 301	$ 11	kWh/d	$ 0.11	$ 452
Total Power Cost				$ 301				$ 452
Chemical Consumption (not required)								
Total Chemical Cost				$ -				$ -
Total Operational Cost				$ 301				$ 452

NPV CALCULATION	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026
CAPITAL COSTS										
Equipment	$ 29,063			$ 5,625	$ 7,500	$ 5,625				
Construction Costs	$ 55,062			$ 11,658	$ 15,545	$ 11,658				
Major Equipment Replacement Cost	$ 28,125									
Total Capital Cost in 2017 Dollars	$ 112,250			$ 17,283	$ 23,045	$ 17,283	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 85,994	$ -	$ -	$ 16,310	$ 21,125	$ 15,391	$ -	$ -	$ -	$ -
OPERATIONAL COSTS										
Power Consumption Cost	$ 33,124						$ 301	$ 301	$ 301	$ 301
Total Operational Cost in 2017 Dollars	$ 33,124			$ -	$ -	$ -	$ 301	$ 301	$ 301	$ 301
Total Operational Cost NPV	$ 11,222			$ -	$ -	$ -	$ 260	$ 253	$ 246	$ 239
Current Year Sub-total	$ 173,498			$ 17,283	$ 23,045	$ 17,283	$ 301	$ 301	$ 301	$ 301
Inflation Adjusted	$ 343,941			$ 17,982	$ 24,455	$ 18,708	$ 332	$ 339	$ 346	$ 353
NPV	**$ 97,216**			$ 16,310	$ 21,125	$ 15,391	$ 260	$ 253	$ 246	$ 239

NPV CALCULATION	2027	2028	2029	2030	2031	2032	2033	2034
CAPITAL COSTS								
Equipment		$ 3,750	$ 3,750	$ 2,813				
Construction Costs		$ 4,860	$ 6,480	$ 4,860				
Major Equipment Replacement Cost								
Total Capital Cost in 2017 Dollars	$ -	$ 8,610	$ 10,230	$ 7,673	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ -	$ 6,444	$ 7,437	$ 5,419	$ -	$ -	$ -	$ -
OPERATIONAL COSTS								
Power Consumption Cost	$ 301	$ 301	$ 301	$ 301	$ 452	$ 452	$ 452	$ 452
Total Operational Cost in 2017 Dollars	$ 301	$ 301	$ 301	$ 301	$ 452	$ 452	$ 452	$ 452
Total Operational Cost NPV	$ 232	$ 225	$ 219	$ 213	$ 310	$ 301	$ 292	$ 284
Current Year Sub-total	$ 301	$ 8,911	$ 10,531	$ 7,974	$ 452	$ 452	$ 452	$ 452
Inflation Adjusted	$ 360	$ 10,863	$ 13,095	$ 10,113	$ 584	$ 596	$ 608	$ 620
NPV	$ 232	$ 6,669	$ 7,656	$ 5,631	$ 310	$ 301	$ 292	$ 284

Notes:
Equipment and Construction costs spread out over a 3-year construction period in 30%-40%-30% split for both Phases

AINLEY: 115157
EFFLUENT RE-OXYGENATION

2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
																	$ 18,750							
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 18,750	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,998	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452
$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452
$ 276	$ 268	$ 260	$ 253	$ 246	$ 239	$ 232	$ 225	$ 219	$ 213	$ 207	$ 201	$ 195	$ 189	$ 184	$ 179	$ 174	$ 169	$ 164	$ 159	$ 155	$ 150	$ 146	$ 142	$ 138
$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 19,202	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452
$ 632	$ 645	$ 658	$ 671	$ 685	$ 698	$ 712	$ 727	$ 741	$ 756	$ 771	$ 786	$ 802	$ 818	$ 835	$ 851	$ 868	$ 37,648	$ 903	$ 921	$ 940	$ 959	$ 978	$ 997	$ 1,017
$ 276	$ 268	$ 260	$ 253	$ 246	$ 239	$ 232	$ 225	$ 219	$ 213	$ 207	$ 201	$ 195	$ 189	$ 184	$ 179	$ 174	$ 7,167	$ 164	$ 159	$ 155	$ 150	$ 146	$ 142	$ 138

AINLEY: 115157
EFFLUENT RE-OXYGENATION

2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087
$ 9,375																						$ 18,750					
$ 9,375	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 18,750	$ -	$ -	$ -	$ -	$ -
$ 2,775	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,933	$ -	$ -	$ -	$ -	$ -
$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452
$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452
$ 134	$ 130	$ 126	$ 123	$ 119	$ 116	$ 112	$ 109	$ 106	$ 103	$ 100	$ 97	$ 94	$ 92	$ 89	$ 87	$ 84	$ 82	$ 79	$ 77	$ 75	$ 73	$ 71	$ 69	$ 67	$ 65	$ 63	$ 61
$ 9,827	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 19,202	$ 452	$ 452	$ 452	$ 452	$ 452
$ 22,574	$ 1,058	$ 1,080	$ 1,101	$ 1,123	$ 1,146	$ 1,169	$ 1,192	$ 1,216	$ 1,240	$ 1,265	$ 1,290	$ 1,316	$ 1,342	$ 1,369	$ 1,397	$ 1,424	$ 1,453	$ 1,482	$ 1,512	$ 1,542	$ 1,573	$ 68,195	$ 1,636	$ 1,669	$ 1,702	$ 1,736	$ 1,771
$ 2,908	$ 130	$ 126	$ 123	$ 119	$ 116	$ 112	$ 109	$ 106	$ 103	$ 100	$ 97	$ 94	$ 92	$ 89	$ 87	$ 84	$ 82	$ 79	$ 77	$ 75	$ 73	$ 3,004	$ 69	$ 67	$ 65	$ 63	$ 61

AINLEY: 115157
EFFLUENT RE-OXYGENATION

2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098
		$ 9,375								
$ -	$ -	$ 9,375	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 1,163	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452
$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452
$ 59	$ 58	$ 56	$ 54	$ 53	$ 51	$ 50	$ 48	$ 47	$ 46	$ 44
$ 452	$ 452	$ 9,827	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452	$ 452
$ 1,807	$ 1,843	$ 40,890	$ 1,917	$ 1,955	$ 1,995	$ 2,034	$ 2,075	$ 2,117	$ 2,159	$ 2,202
$ 59	$ 58	$ 1,219	$ 54	$ 53	$ 51	$ 50	$ 48	$ 47	$ 46	$ 44

Appendix E
Life Cycle Cost Evaluation of Sludge Stabilization Alternatives

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
AEROBIC DIGESTION SYSTEM

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering and Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	Phase 1					Phase 2				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Aerobic Digester										
Diffusers and Aeration Piping	2	$ 70,000	$ 140,000	60%	$ 224,000	1	$ 70,000	$ 70,000	60%	$ 112,000
Biosolis Thickening Tank Mixing System	1	$ 165,750	$ 165,750	60%	$ 265,200	1	$ 82,875	$ 82,875	60%	$ 132,600
Biosolids Transfer and Truck Loading Pumps	6	$ 26,250	$ 157,500	60%	$ 252,000	3	$ 37,000	$ 111,000	60%	$ 177,600
Total Equipment Cost					$ 741,200					$ 422,200
CONSTRUCTION										
General			10%		$ 409,602			10%		$ 103,248
Site Work			15%		$ 614,403			15%		$ 154,872
Yard Piping			10%		$ 409,602			10%		$ 103,248
Aerobic Digester	2	$ 499,833	$ 999,666	10%	$ 1,099,633	1	$ 249,917	$ 249,917	10%	$ 274,908
Biosolids Thickening Tanks	1	$ 527,250	$ 527,250	10%	$ 579,975	1	$ 263,625	$ 263,625	10%	$ 289,988
Biosolids Settling/Storage Tanks	2	$ 527,250	$ 1,054,500	10%	$ 1,159,950	1	$ 263,625	$ 263,625	10%	$ 289,988
Biosolids Building (fully built in Phase 1)	1	$ 428,460	$ 428,460	10%	$ 471,306	0			10%	
Biosolids Truck Loading Pump Buidling (fully built in Phase 1)	1	$ 39,960	$ 39,960	10%	$ 43,956	0			10%	$ -
Total Construction Cost					$ 4,788,426					$ 1,216,252
Engineering & Contingency (25%)					$ 1,382,407					$ 409,613
Total Capital Cost					$ 6,912,033					$ 2,048,065

OPERATIONAL COST	Phase 1				Phase 2			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
Digester Aeration	1032	kWh/d	$ 0.11	$ 41,434.80	1548	kWh/d	$ 0.11	$ 62,152.20
Biosolids Thickening Tank Mixing System	16	kWh/d	$ 0.11	$ 642.40	24	kWh/d	$ 0.11	$ 963.60
Biosolids Transfer and Truck Loading Pumps	16	kWh/d	$ 0.11	$ 642.40	24	kWh/d	$ 0.11	$ 963.60
Total Power Cost				$ 42,720				$ 64,079
Chemical Consumption								
Polymer	11	kg/d	$ 5.00	$ 20,075.00	17	kg/d	$ 5.00	$ 30,112.50
Total Chemical Cost				$ 20,075				$ 30,113
Total Operational Costs								

NPV CALCULATION	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
CAPITAL COSTS																		
Equipment	$ 1,454,250			$ 277,950	$ 370,600	$ 277,950						$ 158,325	$ 211,100	$ 158,325				
Construction Costs	$ 7,505,848			$ 1,795,660	$ 2,394,213	$ 1,795,660						$ 456,095	$ 608,126	$ 456,095				
Major Equipment Replacement Cost	$ 2,908,500																	
Total Capital Cost in 2014 Dollars	$ 11,868,598			$ 2,073,610	$ 2,764,813	$ 2,073,610	$ -	$ -	$ -	$ -	$ -	$ 614,420	$ 819,226	$ 614,420	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 8,539,588	$ -	$ -	$ 1,956,811	$ 2,534,536	$ 1,846,590	$ -	$ -	$ -	$ -	$ -	$ 459,805	$ 595,557	$ 433,906	$ -	$ -	$ -	$ -
OPERATIONAL COSTS																		
Power Consumption Cost	$ 4,699,156						$ 42,720	$ 42,720	$ 42,720	$ 42,720	$ 42,720	$ 42,720	$ 42,720	$ 42,720	$ 64,079	$ 64,079	$ 64,079	$ 64,079
Chemical Consumption Cost	$ 2,208,250						$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 30,113	$ 30,113	$ 30,113	$ 30,113
Total Operational Cost in 2014 Dollars	$ 6,907,406						$ 62,795	$ 62,795	$ 62,795	$ 62,795	$ 62,795	$ 62,795	$ 62,795	$ 62,795	$ 94,192	$ 94,192	$ 94,192	$ 94,192
Total Operational Cost NPV	$ 2,340,116			$ -	$ -	$ -	$ 54,322	$ 52,770	$ 51,262	$ 49,798	$ 48,375	$ 46,993	$ 45,650	$ 44,346	$ 64,618	$ 62,772	$ 60,978	$ 59,236
Current Year Sub-total	$ 18,776,004			$ 2,073,610	$ 2,764,813	$ 2,073,610	$ 62,795	$ 62,795	$ 62,795	$ 62,795	$ 62,795	$ 677,214	$ 882,021	$ 677,214	$ 94,192	$ 94,192	$ 94,192	$ 94,192
Inflation Adjusted	$ 36,321,484			$ 2,157,384	$ 2,934,042	$ 2,244,542	$ 69,330	$ 70,717	$ 72,131	$ 73,574	$ 75,045	$ 825,520	$1,096,682	$ 858,871	$ 121,847	$ 124,284	$ 126,770	$ 129,305
NPV	**$ 10,879,703**			$ 1,956,811	$ 2,534,536	$ 1,846,590	$ 54,322	$ 52,770	$ 51,262	$ 49,798	$ 48,375	$ 506,798	$ 641,207	$ 478,252	$ 64,618	$ 62,772	$ 60,978	$ 59,236

AINLEY: 115157
AEROBIC DIGESTION SYSTEM

2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
																	$ 926,500								$ 527,750
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 926,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 527,750
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 345,792	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 156,201
$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079
$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113
$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192
$ 57,544	$ 55,900	$ 54,303	$ 52,751	$ 51,244	$ 49,780	$ 48,357	$ 46,976	$ 45,634	$ 44,330	$ 43,063	$ 41,833	$ 40,638	$ 39,477	$ 38,349	$ 37,253	$ 36,189	$ 35,155	$ 34,150	$ 33,175	$ 32,227	$ 31,306	$ 30,411	$ 29,543	$ 28,699	$ 27,879
$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 1,020,692	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 621,942
$ 131,891	$ 134,529	$ 137,220	$ 139,964	$ 142,763	$ 145,619	$ 148,531	$ 151,502	$ 154,532	$ 157,622	$ 160,775	$ 163,990	$ 167,270	$ 170,616	$ 174,028	$ 177,508	$ 181,059	$ 2,001,246	$ 188,373	$ 192,141	$ 195,984	$ 199,903	$ 203,901	$ 207,979	$ 212,139	$ 1,428,753
$ 57,544	$ 55,900	$ 54,303	$ 52,751	$ 51,244	$ 49,780	$ 48,357	$ 46,976	$ 45,634	$ 44,330	$ 43,063	$ 41,833	$ 40,638	$ 39,477	$ 38,349	$ 37,253	$ 36,189	$ 380,947	$ 34,150	$ 33,175	$ 32,227	$ 31,306	$ 30,411	$ 29,543	$ 28,699	$ 184,080

AINLEY: 115157
AEROBIC DIGESTION SYSTEM

2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085
																					$ 926,500			
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 926,500	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 144,924	$ -	$ -	$ -
$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079
$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113
$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192
$ 27,082	$ 26,308	$ 25,557	$ 24,826	$ 24,117	$ 23,428	$ 22,759	$ 22,108	$ 21,477	$ 20,863	$ 20,267	$ 19,688	$ 19,125	$ 18,579	$ 18,048	$ 17,533	$ 17,032	$ 16,545	$ 16,072	$ 15,613	$ 15,167	$ 14,734	$ 14,313	$ 13,904	$ 13,506
$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	########	$ 94,192	$ 94,192	$ 94,192
$ 220,709	$ 225,124	$ 229,626	$ 234,219	$ 238,903	$ 243,681	$ 248,555	$ 253,526	$ 258,596	$ 263,768	$ 269,044	$ 274,424	$ 279,913	$ 285,511	$ 291,221	$ 297,046	$ 302,987	$ 309,047	$ 315,227	$ 321,532	$ 327,963	########	$ 341,212	$ 348,037	$ 354,997
$ 27,082	$ 26,308	$ 25,557	$ 24,826	$ 24,117	$ 23,428	$ 22,759	$ 22,108	$ 21,477	$ 20,863	$ 20,267	$ 19,688	$ 19,125	$ 18,579	$ 18,048	$ 17,533	$ 17,032	$ 16,545	$ 16,072	$ 15,613	$ 15,167	$ 159,658	$ 14,313	$ 13,904	$ 13,506

2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098
				$ 527,750								
$ -	$ -	$ -	$ -	$ 527,750	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ 65,465	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079	$ 64,079
$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113
$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192
$ 13,121	$ 12,746	$ 12,382	$ 12,028	$ 11,684	$ 11,350	$ 11,026	$ 10,711	$ 10,405	$ 10,108	$ 9,819	$ 9,538	$ 9,266
$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 621,942	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192	$ 94,192
$ 362,097	$ 369,339	$ 376,726	$ 384,261	########	$ 399,785	$ 407,780	$ 415,936	$ 424,255	$ 432,740	$ 441,395	$ 450,222	$ 459,227
$ 13,121	$ 12,746	$ 12,382	$ 12,028	$ 77,149	$ 11,350	$ 11,026	$ 10,711	$ 10,405	$ 10,108	$ 9,819	$ 9,538	$ 9,266

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
ATAD SYSTEM

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering and Contingency	25%
Year to Begin Construction	2020
Estimated Phase 1 Construction Complete	2022
Estimated Phase 2 Construction Complete	2030

CAPITAL COST	Phase 1					Phase 2				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
ATAD										
Aeration/Mixing System	2	$ 84,015	$ 168,030	50%	$ 252,045	1	$ 84,015	$ 84,015	50%	$ 126,023
Sludge Thickener	2	$ 185,000	$ 370,000	60%	$ 592,000	1	$ 185,000	$ 185,000	60%	$ 296,000
Sludge and Thickened Sludge Holding Tanks Mixing System	2	$ 165,750	$ 331,500	60%	$ 530,400	2	$ 165,750	$ 331,500	60%	$ 530,400
Sludge and Biosolids Transfer and Loading Pumps	10	$ 26,250	$ 262,500	60%	$ 420,000	5	$ 26,250	$ 131,250	60%	$ 210,000
Total Equipment Cost					$ 1,794,445					$ 1,162,423
CONSTRUCTION										
General			10%		$ 471,845			10%		$ 205,567
Site Work			15%		$ 707,767			15%		$ 308,351
Yard Piping			10%		$ 471,845			10%		$ 205,567
ATAD Tanks	2	$ 574,092	$ 1,148,184	10%	$ 1,263,002	1	$ 287,046	$ 287,046	10%	$ 315,751
Sludge Holding Tanks	1	$ 262,500	$ 262,500	10%	$ 288,750	1	$ 131,250	$ 131,250	10%	$ 144,375
Thickened Sludge Holding Tank	1	$ 262,500	$ 262,500	10%	$ 288,750	1	$ 131,250	$ 131,250	10%	$ 144,375
Biosolids Settling/Storage Tanks	2	$ 262,500	$ 525,000	10%	$ 577,500	2	$ 131,250	$ 262,500	10%	$ 288,750
Thickening Building (built for Full Buildout in Phase 1)	1	$ 460,000	$ 460,000	10%	$ 506,000	0		$ -	10%	$ -
Total Construction Cost					$ 4,575,459					$ 1,612,736
Engineering & Contingency (25%)					$ 1,592,476					$ 693,790
Total Equipment Cost					$ 7,962,380					$ 3,468,948

OPERATIONAL COST	Phase 1				Phase 2			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
ATAD Aeration and Mixing (Aspirators)	360	kWh/d	$ 0.11	$ 14,454.00	540	kWh/d	$ 0.11	$ 21,681.00
Sludge and Thickened Sludge Tanks Mixing	105	kWh/d	$ 0.11	$ 4,215.75	158	kWh/d	$ 0.11	$ 6,323.63
Thickeners (inc feed and discharge pumps)	16	kWh/d	$ 0.11	$ 642.40	24	kWh/d	$ 0.11	$ 963.60
Thickened Sludge and Biosolids Transfer and Loading Pumps	41	kWh/d	$ 0.11	$ 1,646.15	62	kWh/d	$ 0.11	$ 2,469.23
Total Power Cost				$ 20,958				$ 31,437
Chemical Consumption								
Polymer	11	kg/d	$ 5.00	$ 20,075	17	kg/d	$ 5.00	$ 30,113
Total Chemical Cost				$ 20,075				$ 30,113
Total Operational Costs								

NPV CALCULATION	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
CAPITAL COSTS																			
Equipment	$ 3,696,084			$ 672,917	$ 897,223	$ 672,917						$ 435,908	$ 581,211	$ 435,908					
Construction Costs	$ 7,735,244			$ 1,715,797	$ 2,287,729	$ 1,715,797						$ 604,776	$ 806,368	$ 604,776					
Major Equipment Replacement Cost	$ 7,392,169																		
Total Capital Cost in 2014 Dollars	$ 18,823,497			$ 2,388,714	$ 3,184,952	$ 2,388,714	$ -	$ -	$ -	$ -	$ -	$ 1,040,685	$1,387,579	$ 1,040,685	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 11,090,744	$ -	$ -	$ 2,254,166	$ 2,919,682	$ 2,127,197	$ -	$ -	$ -	$ -	$ -	$ 778,803	$1,008,736	$ 734,936	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS																			
Power Consumption Cost	$ 2,305,413						$ 20,958	$ 20,958	$ 20,958	$ 20,958	$ 20,958	$ 20,958	$ 20,958	$ 20,958	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437
Chemical Consumption Cost	$ 2,208,250						$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 20,075	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113
Total Operational Cost in 2014 Dollars	$ 4,513,663			$ -	$ -	$ -	$ 41,033	$ 41,033	$ 41,033	$ 41,033	$ 41,033	$ 41,033	$ 41,033	$ 41,033	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550
Total Operational Cost NPV	$ 1,529,155			$ -	$ -	$ -	$ 35,497	$ 34,483	$ 33,498	$ 32,540	$ 31,611	$ 30,708	$ 29,830	$ 28,978	$ 42,225	$ 41,019	$ 39,847	$ 38,708	$ 37,602
Current Year Sub-total	$ 23,337,160			$ 2,388,714	$ 3,184,952	$ 2,388,714	$ 41,033	$ 41,033	$ 41,033	$ 41,033	$ 41,033	$ 1,081,718	$1,428,613	$ 1,081,718	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550
Inflation Adjusted	$ 46,224,772			$ 2,485,218	$ 3,379,897	$ 2,585,621	$ 45,304	$ 46,210	$ 47,134	$ 48,077	$ 49,039	$ 1,318,608	$1,776,300	$ 1,371,880	$ 79,621	$ 81,214	$ 82,838	$ 84,495	$ 86,185
NPV	**$ 13,151,003**			$ 2,254,166	$ 2,919,682	$ 2,127,197	$ 35,497	$ 34,483	$ 33,498	$ 32,540	$ 31,611	$ 809,511	$1,038,566	$ 763,914	$ 42,225	$ 41,019	$ 39,847	$ 38,708	$ 37,602

AINLEY: 115157
ATAD SYSTEM

2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437
$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113
$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550
$ 36,528	$ 35,484	$ 34,470	$ 33,485	$ 32,529	$ 31,599	$ 30,696	$ 29,819	$ 28,967	$ 28,140	$ 27,336	$ 26,555	$ 25,796	$ 25,059
$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550
$ 87,908	$ 89,667	$ 91,460	$ 93,289	$ 95,155	$ 97,058	$ 98,999	$ 100,979	$ 102,999	$ 105,059	$ 107,160	$ 109,303	$ 111,489	$ 113,719
$ 36,528	$ 35,484	$ 34,470	$ 33,485	$ 32,529	$ 31,599	$ 30,696	$ 29,819	$ 28,967	$ 28,140	$ 27,336	$ 26,555	$ 25,796	$ 25,059

2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063
		$ 2,243,056								$ 1,453,028			
$ -	$ -	$ 2,243,056	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,453,028	$ -	$ -	$ -
$ -	$ -	$ 837,163	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 430,062	$ -	$ -	$ -
$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437
$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113
$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550
$ 24,343	$ 23,648	$ 22,972	$ 22,316	$ 21,678	$ 21,059	$ 20,457	$ 19,872	$ 19,305	$ 18,753	$ 18,217	$ 17,697	$ 17,191	$ 16,700
$ 61,550	$ 61,550	$ 2,304,606	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 1,514,578	$ 61,550	$ 61,550	$ 61,550
$ 115,993	$ 118,313	$ 4,518,586	$ 123,093	$ 125,555	$ 128,066	$ 130,627	$ 133,240	$ 135,905	$ 138,623	$ 3,479,356	$ 144,223	$ 147,108	$ 150,050
$ 24,343	$ 23,648	$ 860,135	$ 22,316	$ 21,678	$ 21,059	$ 20,457	$ 19,872	$ 19,305	$ 18,753	$ 448,279	$ 17,697	$ 17,191	$ 16,700

AINLEY: 115157
ATAD SYSTEM

2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091
																		$ 2,243,056								$ 1,453,028	
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,243,056	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,453,028	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 350,862	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 180,242	$ -
$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437
$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113
$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550
$ 16,223	$ 15,759	$ 15,309	$ 14,872	$ 14,447	$ 14,034	$ 13,633	$ 13,244	$ 12,865	$ 12,498	$ 12,141	$ 11,794	$ 11,457	$ 11,129	$ 10,811	$ 10,502	$ 10,202	$ 9,911	$ 9,628	$ 9,353	$ 9,085	$ 8,826	$ 8,574	$ 8,329	$ 8,091	$ 7,860	$ 7,635	$ 7,417
$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 2,304,606	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 1,514,578	$ 61,550
$ 153,051	$ 156,112	$ 159,234	$ 162,419	$ 165,667	$ 168,980	$ 172,360	$ 175,807	$ 179,323	$ 182,910	$ 186,568	$ 190,299	$ 194,105	$ 197,988	$ 201,947	$ 205,986	$ 210,106	$ 214,308	$ 8,184,793	$ 222,966	$ 227,425	$ 231,974	$ 236,613	$ 241,346	$ 246,173	$ 251,096	$ 6,302,372	$ 261,240
$ 16,223	$ 15,759	$ 15,309	$ 14,872	$ 14,447	$ 14,034	$ 13,633	$ 13,244	$ 12,865	$ 12,498	$ 12,141	$ 11,794	$ 11,457	$ 11,129	$ 10,811	$ 10,502	$ 10,202	$ 9,911	$ 360,489	$ 9,353	$ 9,085	$ 8,826	$ 8,574	$ 8,329	$ 8,091	$ 7,860	$ 187,877	$ 7,417

AINLEY: 115157
ATAD SYSTEM

2092	2093	2094	2095	2096	2097	2098
$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437	$ 31,437
$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113	$ 30,113
$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550
$ 7,205	$ 6,999	$ 6,799	$ 6,605	$ 6,416	$ 6,233	$ 6,055
$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550	$ 61,550
$ 266,465	$ 271,794	$ 277,230	$ 282,775	$ 288,430	$ 294,199	$ 300,083
$ 7,205	$ 6,999	$ 6,799	$ 6,605	$ 6,416	$ 6,233	$ 6,055

Appendix F
Life Cycle Cost Evaluation of Septage Management Alternatives

Add the septage in controlled quantities to the treatment plant

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
DIRECT CO-TREATMENT OF SEPTAGE

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering & Contingency	25%
Year to Begin Construction	2020
Estimated Construction Complete	2022

CAPITAL COST	**Buildout**				
	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT					
Septage Receiving Station					
Bar Screen	1.00	$ 100,000	$ 100,000	60%	$ 160,000
Septage Pumps	2.00	$ 10,000	$ 20,000	60%	$ 32,000
Total Equipment Cost					$ 192,000
CONSTRUCTION					
General			10%		$ 23,985
Site Work			15%		$ 35,978
Yard Piping			10%		$ 23,985
Septage Holding Tank (45 m3 AT $2900 per m2)	1.00	$ 43,500.00	$ 43,500	10%	$ 47,850
Total Construction Cost					$ 131,798
Engineering & Contingency (25%)					$ 80,949
Total Capital Cost					$ 404,747

OPERATIONAL COST	**Buildout**			
	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM				
Power Consumption				
Septage pumps	35	kWh/d	$ 0.11	$ 1,422
Total Power Cost				$ 1,422
Total Operational Costs				$ 1,422

NPV Calculation	**Total**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
CAPITAL COSTS													
Equipment	$ 240,000			$ 72,000	$ 96,000	$ 72,000							
Construction Costs	$ 164,747			$ 49,424	$ 65,899	$ 49,424							
Major Equipment Replacement Cost (@ 30 years)	$ 480,000												
Total Capital Cost in 2018 Dollars	$ 884,747	$ -	$ -	$ 121,424	$ 161,899	$ 121,424	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 498,244	$ -	$ -	$ 114,585	$ 148,414	$ 108,131	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS													
Chemical Consumption Cost	$ -												
Power Consumption Cost	$ 108,083						$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
Total Operational Cost in 2018 Dollars	$ 108,083	$ -	$ -	$ -	$ -	$ -	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
Total Operational Costs NPV	$ 38,303	$ -	$ -	$ -	$ -	$ -	$ 1,230	$ 1,195	$ 1,161	$ 1,128	$ 1,096	$ 1,064	$ 1,034
Current Year Sub-total	$ 992,830	$ -	$ -	$ 121,424	$ 161,899	$ 121,424	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
Inflation Adjusted	$ 2,027,596	$ -	$ -	$ 126,330	$ 171,808	$ 131,433	$ 1,570	$ 1,602	$ 1,634	$ 1,666	$ 1,700	$ 1,734	$ 1,768
NPV	**$ 536,547**	$ -	$ -	$ 114,585	$ 148,414	$ 108,131	$ 1,230	$ 1,195	$ 1,161	$ 1,128	$ 1,096	$ 1,064	$ 1,034

AINLEY: 115157
DIRECT CO-TREATMENT OF SEPTAGE

2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052
																						$ 240,000
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 240,000
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 89,574
$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
$ 1,004	$ 976	$ 948	$ 921	$ 894	$ 869	$ 844	$ 820	$ 796	$ 774	$ 752	$ 730	$ 709	$ 689	$ 669	$ 650	$ 632	$ 614	$ 596	$ 579	$ 562	$ 546	$ 531
$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 241,422
$ 1,804	$ 1,840	$ 1,876	$ 1,914	$ 1,952	$ 1,991	$ 2,031	$ 2,072	$ 2,113	$ 2,155	$ 2,199	$ 2,243	$ 2,287	$ 2,333	$ 2,380	$ 2,427	$ 2,476	$ 2,526	$ 2,576	$ 2,628	$ 2,680	$ 2,734	$ 473,351
$ 1,004	$ 976	$ 948	$ 921	$ 894	$ 869	$ 844	$ 820	$ 796	$ 774	$ 752	$ 730	$ 709	$ 689	$ 669	$ 650	$ 632	$ 614	$ 596	$ 579	$ 562	$ 546	$ 90,105

AINLEY: 115157
DIRECT CO-TREATMENT OF SEPTAGE

2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
$ 516	$ 501	$ 487	$ 473	$ 459	$ 446	$ 433	$ 421	$ 409	$ 397	$ 386	$ 375	$ 364	$ 354	$ 344	$ 334	$ 324	$ 315	$ 306	$ 297	$ 289	$ 281	$ 272	$ 265	$ 257	$ 250	$ 243
$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
$ 2,844	$ 2,901	$ 2,959	$ 3,018	$ 3,079	$ 3,140	$ 3,203	$ 3,267	$ 3,332	$ 3,399	$ 3,467	$ 3,536	$ 3,607	$ 3,679	$ 3,753	$ 3,828	$ 3,904	$ 3,982	$ 4,062	$ 4,143	$ 4,226	$ 4,311	$ 4,397	$ 4,485	$ 4,575	$ 4,666	$ 4,759
$ 516	$ 501	$ 487	$ 473	$ 459	$ 446	$ 433	$ 421	$ 409	$ 397	$ 386	$ 375	$ 364	$ 354	$ 344	$ 334	$ 324	$ 315	$ 306	$ 297	$ 289	$ 281	$ 272	$ 265	$ 257	$ 250	$ 243

AINLEY: 115157
DIRECT CO-TREATMENT OF SEPTAGE

2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098
		$ 240,000																
$ -	$ -	$ 240,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 37,541	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
$ 236	$ 229	$ 222	$ 216	$ 210	$ 204	$ 198	$ 192	$ 187	$ 182	$ 176	$ 171	$ 166	$ 162	$ 157	$ 153	$ 148	$ 144	$ 140
$ 1,422	$ 1,422	$ 241,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422	$ 1,422
$ 4,855	$ 4,952	$ 857,409	$ 5,152	$ 5,255	$ 5,360	$ 5,467	$ 5,576	$ 5,688	$ 5,802	$ 5,918	$ 6,036	$ 6,157	$ 6,280	$ 6,406	$ 6,534	$ 6,664	$ 6,798	$ 6,934
$ 236	$ 229	$ 37,764	$ 216	$ 210	$ 204	$ 198	$ 192	$ 187	$ 182	$ 176	$ 171	$ 166	$ 162	$ 157	$ 153	$ 148	$ 144	$ 140

Increase the Sequencing Batch Reactor (SBR) size so it can treat the septage

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
CO-TREATMENT WITH MBR

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering & Contingency	25%
Year to Begin Construction	2020
Estimated Construction Complete	2022

CAPITAL COST	Buildout				
	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT					
Septage Receiving Station					
Bar Screen	1.00	$ 100,000	$ 100,000	60%	$ 160,000
Septage Pumps	2.00	$ 10,000	$ 20,000	60%	$ 32,000
Chemical Dosing					
Chemical Storage Tanks	2	$ 133	$ 266	60%	$ 426
Day Tanks	1	$ 22	$ 22	60%	$ 36
Dosing Pumps (alum and carbon source)	4	$ 18	$ 72	60%	$ 115
Total Equipment Cost					$ 192,577
CONSTRUCTION					
General			10%		$ 25,156
Site Work			15%		$ 37,734
Yard Piping			10%		$ 25,156
Septage Holding Tank	1.00	$ 43,500	$ 43,500	10%	$ 47,850
Increase is Biological Reactor Tankage	1.00	$ 10,122	$ 10,122	10%	$ 11,134
Total Construction Cost					$ 135,896
Engineering & Contingency (25%)					$ 82,118
Total Capital Cost					$ 410,592

OPERATIONAL COST	Buildout			
	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM				
Power Consumption				
Septage pumps	35	kWh/d	$ 0.11	$ 1,422
Primary Fine Filter	1.1	kWh/d	$ 0.11	$ 42
Aeration Tank Blowers	3.7	kWh/d	$ 0.11	$ 148
Membrane Tank Blowers	1.2	kWh/d	$ 0.11	$ 50
Permeate Pumps	0.3	kWh/d	$ 0.11	$ 13
RAS Pumps	2.3	kWh/d	$ 0.11	$ 91
Air Compressors	0.02	kWh/d	$ 0.11	$ 1
Total Power Cost				$ 1,767
Chemical Consumption				
Alum	0.198	kg/d	$ 0.55	$ 40
Total Chemical Cost				$ 40
Total Operational Cost				$ 1,807

$ -

0.01

NPV Calculation	Total	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
CAPITAL COSTS																			
Equipment	$ 240,721			$ 72,216	$ 96,288	$ 72,216													
Construction Costs	$ 169,871			$ 50,961	$ 67,948	$ 50,961													
Major Equipment Replacement Cost	$ 481,442																		
Total Capital Cost in 2017 Dollars	$ 892,034	$ -	$ -	$ 123,178	$ 164,237	$ 123,178	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Costs Total NPV	$ 503,986	$ -	$ -	$ 116,239	$ 150,558	$ 109,692	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS																			
Chemical Consumption Cost	$ 3,021						$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40
Power Consumption Cost	$ 134,282						$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767
Total Operational Cost in 2017 Dollars	$ 137,303	$ -	$ -	$ -	$ -	$ -	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807
Operational Costs Total NPV	$ 48,658	$ -	$ -	$ -	$ -	$ -	$ 1,563	$ 1,518	$ 1,475	$ 1,433	$ 1,392	$ 1,352	$ 1,313	$ 1,276	$ 1,239	$ 1,204	$ 1,170	$ 1,136	$ 1,104
Current Year Sub-total	$ 1,029,337	$ -	$ -	$ 123,178	$ 164,237	$ 123,178	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807
Inflation Adjusted	$ 2,112,149	$ -	$ -	$ 128,154	$ 174,289	$ 133,331	$ 1,995	$ 2,035	$ 2,075	$ 2,117	$ 2,159	$ 2,202	$ 2,246	$ 2,291	$ 2,337	$ 2,384	$ 2,431	$ 2,480	$ 2,530
NPV	**$ 552,644**	$ -	$ -	$ 116,239	$ 150,558	$ 109,692	$ 1,563	$ 1,518	$ 1,475	$ 1,433	$ 1,392	$ 1,352	$ 1,313	$ 1,276	$ 1,239	$ 1,204	$ 1,170	$ 1,136	$ 1,104

AINLEY: 115157
CO-TREATMENT WITH MBR

2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067
																$ 240,721															
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 240,721	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 89,843	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40
$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767
$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807
$ 1,072	$ 1,042	$ 1,012	$ 983	$ 955	$ 928	$ 901	$ 875	$ 850	$ 826	$ 802	$ 779	$ 757	$ 736	$ 715	$ 694	$ 674	$ 655	$ 636	$ 618	$ 600	$ 583	$ 567	$ 550	$ 535	$ 519	$ 505	$ 490	$ 476	$ 463	$ 449	$ 437
$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 242,528	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807
$ 2,580	$ 2,632	$ 2,685	$ 2,738	$ 2,793	$ 2,849	$ 2,906	$ 2,964	$ 3,023	$ 3,084	$ 3,145	$ 3,208	$ 3,272	$ 3,338	$ 3,405	$ 3,473	$ 475,518	$ 3,613	$ 3,685	$ 3,759	$ 3,834	$ 3,911	$ 3,989	$ 4,069	$ 4,150	$ 4,233	$ 4,318	$ 4,404	$ 4,492	$ 4,582	$ 4,674	$ 4,767
$ 1,072	$ 1,042	$ 1,012	$ 983	$ 955	$ 928	$ 901	$ 875	$ 850	$ 826	$ 802	$ 779	$ 757	$ 736	$ 715	$ 694	$ 90,517	$ 655	$ 636	$ 618	$ 600	$ 583	$ 567	$ 550	$ 535	$ 519	$ 505	$ 490	$ 476	$ 463	$ 449	$ 437

AINLEY: 115157
CO-TREATMENT WITH MBR

2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098
														$ 240,721																
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 240,721	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 37,654	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40	$ 40
$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767	$ 1,767
$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807
$ 424	$ 412	$ 400	$ 389	$ 378	$ 367	$ 356	$ 346	$ 336	$ 327	$ 317	$ 308	$ 299	$ 291	$ 283	$ 275	$ 267	$ 259	$ 252	$ 244	$ 237	$ 231	$ 224	$ 218	$ 211	$ 205	$ 200	$ 194	$ 188	$ 183	$ 178
$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 242,528	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807	$ 1,807
$ 4,863	$ 4,960	$ 5,059	$ 5,160	$ 5,264	$ 5,369	$ 5,476	$ 5,586	$ 5,697	$ 5,811	$ 5,928	$ 6,046	$ 6,167	$ 6,290	$ 861,336	$ 6,545	$ 6,675	$ 6,809	$ 6,945	$ 7,084	$ 7,226	$ 7,370	$ 7,518	$ 7,668	$ 7,821	$ 7,978	$ 8,137	$ 8,300	$ 8,466	$ 8,635	$ 8,808
$ 424	$ 412	$ 400	$ 389	$ 378	$ 367	$ 356	$ 346	$ 336	$ 327	$ 317	$ 308	$ 299	$ 291	$ 37,937	$ 275	$ 267	$ 259	$ 252	$ 244	$ 237	$ 231	$ 224	$ 218	$ 211	$ 205	$ 200	$ 194	$ 188	$ 183	$ 178

Use a Geotube dewatering system to remove the liquid part of the septage and treat only the liquid part, which is weaker at the main plant.

ERIN CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 115157
GeoTube Dewatering and CoTreatment of Filtrate

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	2%
Engineering & Contingency	25%
Year to Begin Construction	2020
Estimated Construction Complete	2022

CAPITAL COST	**Buildout**				
	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT					
Septage Receiving Station					
Bar Screen	1.00	$ 100,000	$ 100,000	60%	$ 160,000
Laydown Area					
Geosynthetic Pad					
liner	1.00	$ 4,036.70	$ 4,037	10%	$ 4,440
non-woven fabric					
GeoTube System					
GeoTube Units	2.00	$4,099	$ 8,197	10%	$ 9,017
Geotube Filtration Fabric Rolls	4.00	$959	$ 3,836	10%	$ 4,220
Filtrate Pumps	2.00	$5,000	$ 10,000	10%	$ 11,000
Chemical Dosing - Polymer Activation System					
Polymer injection system					
PLC Controls and Mag Flow Meter	1.00	$ 100,000	$ 100,000	60%	$ 160,000
Blending/Flocking System					
Septage Pumps					
Total Equipment Cost					$ 348,677
CONSTRUCTION					
General			10%		$ 40,202.67
Site Work			15%		$ 60,304.00
Yard Piping			10%		$ 40,202.67
Septage Holding Tank	1.00	$ 43,500.00	$ 43,500	10%	$ 47,850
Filtrate Holding Tank	1.00	$5,000	$ 5,000	10%	$ 5,500
Total Construction Cost					$ 194,059
Engineering & Contingency (25%)					$ 135,684
Total Capital Cost					$ 678,420

OPERATIONAL COST	**Buildout**			
	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM				
Power Consumption				
Septage pumps	35	kWh/d	$ 0.11	$ 1,422
Filtrate Pumps	4	kWh/d	$ 0.11	$ 161
Total Power Cost				$ 1,583
Chemical Consumption				
Polymer	1	Tote/yr	$ 6,587.00	$ 6,587
Total Chemical Cost				$ 6,587
Total Operational Cost				$ 8,170

NPV Calculation	**Total**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
CAPITAL COSTS										
Equipment	$ 435,846			$ 130,754	$ 174,338	$ 130,754				
Construction Costs	$ 242,574			$ 72,772	$ 97,030	$ 72,772				
Major Equipment Replacement Cost	$ 871,692									
Total Capital Cost in 2018 Dollars	$ 1,550,112	$ -	$ -	$ 203,526	$ 271,368	$ 203,526	$ -	$ -	$ -	$ -
Capital Costs Total NPV	$ 852,916	$ -	$ -	$ 192,062	$ 248,766	$ 181,244	$ -	$ -	$ -	$ -
OPERATIONAL COSTS										
Chemical Consumption Cost	$ 520,373			$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587
Power Consumption Cost	$ 125,037			$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583
Total Operational Cost in 2018 Dollars	$ 645,410	$ -	$ -	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170
Operational Costs Total NPV	$ 242,510	$ -	$ -	$ 7,710	$ 7,489	$ 7,275	$ 7,067	$ 6,866	$ 6,669	$ 6,479
Current Year Sub-total	$ 2,195,521	$ -	$ -	$ 211,696	$ 279,538	$ 211,696	$ 8,170	$ 8,170	$ 8,170	$ 8,170
Inflation Adjusted	$ 4,728,881	$ -	$ -	$ 220,248	$ 296,648	$ 229,146	$ 9,020	$ 9,200	$ 9,384	$ 9,572
NPV	**$ 1,095,426**	$ -	$ -	$ 199,772	$ 256,255	$ 188,519	$ 7,067	$ 6,866	$ 6,669	$ 6,479

NPV Calculation	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
CAPITAL COSTS								
Equipment								
Construction Costs								
Major Equipment Replacement Cost								
Total Capital Cost in 2018 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Costs Total NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS								
Chemical Consumption Cost	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587
Power Consumption Cost	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583
Total Operational Cost in 2018 Dollars	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170
Operational Costs Total NPV	$ 6,294	$ 6,114	$ 5,939	$ 5,770	$ 5,605	$ 5,445	$ 5,289	$ 5,138
Current Year Sub-total	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170
Inflation Adjusted	$ 9,764	$ 9,959	$ 10,158	$ 10,361	$ 10,568	$ 10,780	$ 10,995	$ 11,215
NPV	$ 6,294	$ 6,114	$ 5,939	$ 5,770	$ 5,605	$ 5,445	$ 5,289	$ 5,138

2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065
																	$ 435,846													
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 435,846	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 162,668	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587
$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583
$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170
$ 4,991	$ 4,848	$ 4,710	$ 4,575	$ 4,445	$ 4,318	$ 4,194	$ 4,074	$ 3,958	$ 3,845	$ 3,735	$ 3,628	$ 3,525	$ 3,424	$ 3,326	$ 3,231	$ 3,139	$ 3,049	$ 2,962	$ 2,877	$ 2,795	$ 2,715	$ 2,638	$ 2,562	$ 2,489	$ 2,418	$ 2,349	$ 2,282	$ 2,217	$ 2,153	$ 2,092
$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 444,016	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170
$ 11,440	$ 11,668	$ 11,902	$ 12,140	$ 12,383	$ 12,630	$ 12,883	$ 13,141	$ 13,403	$ 13,671	$ 13,945	$ 14,224	$ 14,508	$ 14,798	$ 15,094	$ 15,396	$ 15,704	$ 870,571	$ 16,339	$ 16,665	$ 16,999	$ 17,339	$ 17,685	$ 18,039	$ 18,400	$ 18,768	$ 19,143	$ 19,526	$ 19,917	$ 20,315	$ 20,721
$ 4,991	$ 4,848	$ 4,710	$ 4,575	$ 4,445	$ 4,318	$ 4,194	$ 4,074	$ 3,958	$ 3,845	$ 3,735	$ 3,628	$ 3,525	$ 3,424	$ 3,326	$ 3,231	$ 3,139	$ 165,717	$ 2,962	$ 2,877	$ 2,795	$ 2,715	$ 2,638	$ 2,562	$ 2,489	$ 2,418	$ 2,349	$ 2,282	$ 2,217	$ 2,153	$ 2,092

AINLEY: 115157
GeoTube Dewatering and CoTreatment of Filtrate

2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097
																$ 435,846															
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 435,846	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 68,176	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587	$ 6,587
$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583	$ 1,583
$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170
$ 2,032	$ 1,974	$ 1,918	$ 1,863	$ 1,810	$ 1,758	$ 1,708	$ 1,659	$ 1,611	$ 1,565	$ 1,521	$ 1,477	$ 1,435	$ 1,394	$ 1,354	$ 1,316	$ 1,278	$ 1,241	$ 1,206	$ 1,171	$ 1,138	$ 1,105	$ 1,074	$ 1,043	$ 1,013	$ 984	$ 956	$ 929	$ 902	$ 877	$ 852	$ 827
$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 444,016	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170	$ 8,170
$ 21,136	$ 21,558	$ 21,990	$ 22,429	$ 22,878	$ 23,336	$ 23,802	$ 24,278	$ 24,764	$ 25,259	$ 25,764	$ 26,280	$ 26,805	$ 27,341	$ 27,888	$ 28,446	$ 1,576,918	$ 29,595	$ 30,187	$ 30,791	$ 31,407	$ 32,035	$ 32,675	$ 33,329	$ 33,995	$ 34,675	$ 35,369	$ 36,076	$ 36,798	$ 37,534	$ 38,284	$ 39,050
$ 2,032	$ 1,974	$ 1,918	$ 1,863	$ 1,810	$ 1,758	$ 1,708	$ 1,659	$ 1,611	$ 1,565	$ 1,521	$ 1,477	$ 1,435	$ 1,394	$ 1,354	$ 1,316	$ 69,453	$ 1,241	$ 1,206	$ 1,171	$ 1,138	$ 1,105	$ 1,074	$ 1,043	$ 1,013	$ 984	$ 956	$ 929	$ 902	$ 877	$ 852	$ 827

AINLEY: 115157
GeoTube Dewatering and CoTreatment of Filtrate

2098
$ -
$ -
$ 6,587
$ 1,583
$ 8,170
$ 804
$ 8,170
$ 39,831
$ 804