An Evaluation of Biosolids Management in Maine and Recommendations for the Future

PREPARED FOR THE MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

December 15, 2023 // **FINAL REPORT**

PREPARED BY:

Brown AND Caldwell

IN COLLABORATION WITH:

MeWEA

Technical Memorandum

200 Brickstone Square
Suite 403
Andover, MA 01810
T: 978.794.0336

Prepared for: Maine Department of Environmental Protection (DEP)

Project Title: Study for Sustainable Management of Wastewater Solids, Septage & Leachate in the State of Maine

Project No.: 169895

Final Report

Subject: **An Evaluation of Biosolids Management in Maine and Recommendations for the Future**

Date: December 15, 2023

To: Commissioner Melanie Loyzim, DEP

From: Bill Brower, P.E., Brown and Caldwell (BC)

Copy to: Maine Department of Environmental Protection:

Brian W. Kavanah, Director, Bureau of Water Quality

Susanne Miller, Director, Bureau of Remediation and Waste Management

Victoria Eleftheriou, P.E., Deputy Director, Bureau of Remediation and Waste Management

Carla J. Hopkins, Director, Division of Materials Management

Tim A. MacMillan, P.E., Environmental Engineering Services Manager

Maine Water Environment Association representatives:

Travis Peaslee, P. E., General Manager, Lewiston Auburn Water Pollution Control Authority

Emily Cole-Prescott, City Planner, City of Saco

André Brousseau, Superintendent, Sanford Sewerage District

Prepared by: ______________________________
Bill Brower, P.E., Northeast Practice Leader for Solids and Energy, BC

Prepared by: ______________________________
Persephone Ma, Senior Staff, BC

Prepared by: ______________________________
Jessica Nekowitsch, EIT, Staff Environmental Engineer, BC

Reviewed by: ______________________________
Natalie Sierra, P.E., National Practice Leader for Solids and Energy, BC

Limitations:

This document was prepared solely for the Maine Department of Environmental Protection (DEP) in accordance with professional standards at the time the services were performed and in accordance with the contract between DEP and Brown and Caldwell dated May 2, 2023. This document is governed by the specific scope of work authorized by DEP; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by DEP and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Table of Contents

List of Figures iv
List of Tables v
Abbreviation List vi
Executive Summary 1
Section 1: Project Introduction and Background 5
1.1 Biosolids Generation in Maine 5
1.2 Biosolids PFAS Sampling Results 6
Section 2: Current Issues Impacting Biosolids Management 7
2.1 State Legislation and Regulations 7
  2.1.1 Ban on Sludge and Sludge-derived Products Land Application, Sale, and Distribution 8
  2.1.2 Out-of-State Waste and Recycling Targets 8
  2.1.3 Temporary Revision of Out-of-State Waste and Recycling Targets 9
  2.1.4 Air Quality Statutes, Regulation, and Permitting 9
2.2 Other Relevant Regulations 10
  2.2.1 Federal PFAS Regulations 10
  2.2.2 Regulations in Nearby States 10
  2.2.3 Regulations in Canada 11
2.3 Limiting Factors at Landfills 11
  2.3.1 Limits on Wet Wastes 11
  2.3.2 Bulking Agents 12
  2.3.3 Other Issues 12
Section 3: Future Drivers for Biosolids Management 13
3.1 Uncertain Future Landfill Capacity 13
3.2 Septage Land Application Restrictions 14
3.3 Effluent PFAS Limits at Publicly Owned Treatment Works 15
3.4 Climate Action 15
3.5 PFAS Source Control Laws 16
Section 4: Regional Facilities 18
4.1 Governance Structures 18
4.2 Financing 18
4.3 Materials Handling 19
4.4 Proposed Regional Facilities 19
4.5 Proposed BioHub 20
Section 5: Technology Alternatives Analysis 22
5.1 Overview of Selected Technologies 22
  5.1.1 Dewatering 22
  5.1.2 Anaerobic Digestion 22

5.1.3 Thermal Drying ... 23
5.2 Selection of Representative POTW Sizes ... 25
5.3 Cost Evaluation Methodology ... 27
5.3.1 Operations and Maintenance Costs ... 27
5.3.2 Capital Costs ... 27
5.3.3 Life-cycle Cost Analysis ... 28
5.3.4 Sensitivity Analysis ... 29
5.4 Cost Evaluation Results: Small POTW ... 29
5.4.1 Operations and Maintenance Costs ... 29
5.4.2 Capital Costs ... 30
5.4.3 Life-cycle Cost Analysis ... 30
5.4.4 Sensitivity Analysis ... 31
5.5 Cost Evaluation Results: Medium POTW ... 31
5.5.1 Operations and Maintenance Costs ... 32
5.5.2 Capital Costs ... 32
5.5.3 Life-cycle Cost Analysis ... 32
5.5.4 Sensitivity Analysis ... 33
5.6 Cost Evaluation Results: Large POTW ... 34
5.6.1 Operations and Maintenance Costs ... 34
5.6.2 Capital Costs ... 35
5.6.3 Life-cycle Cost Analysis ... 35
5.6.4 Sensitivity Analysis ... 36
5.7 Cost Evaluation Results: Regional Facility ... 37
5.7.1 Operations and Maintenance Costs ... 37
5.7.2 Capital Costs ... 38
5.7.3 Life-cycle Cost Analysis ... 39
5.7.4 Sensitivity Analysis ... 39
5.8 Summary of Cost Evaluation Results ... 40
Section 6: Piloting PFAS Treatment Technologies ... 41
6.1 Siting Considerations ... 41
6.2 Logistical Considerations ... 41
6.3 Pilot Location ... 42
6.4 Suggested Criteria for Selecting Pilots ... 42
6.5 Roles and Responsibilities During Piloting ... 43
6.5.1 Technology Vendor ... 43
6.5.2 Utility ... 43
6.5.3 State of Maine ... 43
6.6 PFAS Sampling Protocol ... 44
6.7 Pilot Outputs ... 44
6.8 Pilot Costs ... 44
Section 7: Recommendations ... 45

7.1 Biosolids Beneficial Use Screening Levels 45
7.2 Landfill Capacity for Biosolids 46
7.3 Bulking Agents 46
7.4 Piloting of PFAS Treatment Technologies 47
7.5 Volume Reduction and Dryer Projects 47
7.6 Biosolids Production Reporting 48

Section 8: Conclusion 49

References 50

Attachment A: Innovative Technology Provider Survey A-1

Attachment B: Process Flow Diagrams for Technology Alternatives B-1

Attachment C: Capital Cost Estimates C-1

Attachment D: Net Present Cost Calculations D-1

Attachment E: Suggested Sampling Protocol for Pilots of PFAS Treatment Technologies E-1

List of Figures

Figure 2-1. Historical biosolids disposal at Maine landfills 8
Figure 3-1. Estimated biosolids management capacity in Maine (wet-tons/year) 13
Figure 3-2. Blood levels of the most common PFAS in people in the U.S. over time 17
Figure 5-1. Distribution of POTWs by size 26
Figure 5-2. Net present cost for small-scale POTW alternatives 30
Figure 5-3. Sensitivity analysis for small-scale POTW alternatives 31
Figure 5-4. Net present costs for medium-scale POTW alternatives 33
Figure 5--5: Sensitivity analysis for medium-scale POTW alternatives 34
Figure 5-6. Net present costs for large-scale POTW alternatives 36
Figure 5-7. Sensitivity analysis of large-scale POTW alternatives 37
Figure 5-8. Net present costs for regional-scale alternatives 39
Figure 5-9. Sensitivity analysis for regional-scale POTW alternatives 40

List of Tables

Table ES-1. Levers Available to Maine State Government to Address Biosolids Challenges 2
Table 1-1. Biosolids Managed Out of State (wet-tons per year) 5
Table 1-2. PFAS Concentrations for Maine Biosolids[a], (parts per billion) 6
Table 1-3. Biosolids Screening Levels in Other States 6
Table 3-1. Landfill Owners Indicating a Willingness to Discuss Starting to Accept Biosolids[a] 14
Table 4-1. Regional Facility Survey Results 19
Table 5-1. Size and Count of Maine POTWs 25
Table 5-3. Construction Cost-estimating Markups 28
Table 5-4. Interest Rate Assumptions 28
Table 5-5. List of Small (0.5 mgd) POTW Alternatives 29
Table 5-6. O&M Costs for Small-scale POTW Alternatives ($ thousands) 29
Table 5-7. Class 5 Capital Cost Estimates for Small-scale POTWs ($ millions) 30
Table 5-8. List of Medium-scale (2.5 mgd) POTW Alternatives 31
Table 5-9. O&M Costs for Medium-scale POTW Alternatives ($ thousands) 32
Table 5-10. Class 5 Capital Costs for Medium-scale POTW Alternatives ($ millions) 32
Table 5-11. List of Large-scale (7.0 mgd) POTW Alternatives 34
Table 5-12. O&M Costs for Large-scale POTW Alternatives 35
Table 5-13. Class 5 Capital Costs for Large-scale POTW Alternatives ($ millions) 35
Table 5-14. List of Regional-scale (20 MGD) POTW Alternatives 37
Table 5-15. O&M Costs for Regional-scale Alternatives 38
Table 5-16. Class 5 Capital Cost Estimates for Regional-scale POTW Alternatives ($ millions) 38
Table 6-1. Suggested Pass/Fail Criteria for Screening Pilot Proposals 42
Table A-1. Technology Provider Survey Results A-2

Abbreviation List

AACE	Association for the Advancement of Cost Engineering International
BC	Brown and Caldwell
CDD	construction and demolition debris
CFR	Code of Federal Regulations
DEP	Department of Environmental Protection
EGLE	Environmental, Great Lakes, and Energy
EPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
JRL	Juniper Ridge Landfill
L.D.	Legislative Document
MAD	mesophilic anaerobic digestion
mgd	million gallons per day
NEBRA	North East Biosolids and Residuals Association
NG	natural gas
NPC	net present cost
O&M	operations and maintenance
PBD	Public Benefit Determination
PFAS	per- and polyfluorinated substances
PFBS	perfluorobutane sulfonic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
P.L.	Public Law
POTW	publicly owned treatment works
ppb	parts per billion
R&R	repair and rehabilitation
RFP	request for proposal
SCWO	supercritical water oxidation
SWEET	Solids-Water-Energy Evaluation Tool
THP	thermal hydrolysis process
TS	total solids

Executive Summary

Several factors have made the current situation for managing biosolids very challenging and uncertain for the Publicly Owned Treatment Works (POTW) who treat municipal wastewater and generate biosolids in Maine. Effective August 8, 2022, 38 M.R.S. §1306(7) banned the land application, sale, and distribution of "sludge and sludge-derived products" in Maine. POTWs were left with one option within the state to manage biosolids: disposal at landfills. Three landfills have provided for nearly all the biosolids disposal in the state, with the state-owned Juniper Ridge Landfill (JRL) in Old Town handling the vast majority. Not long after the ban took effect (February 2023), 38 M.R.S. §1310-N(5-A)(B) (Public Law 2021, Chapter 626) also went into effect, which set recycling deadlines that further exacerbated impacts to the overall management of sludge generated in Maine. Specifically, the operator of JRL asserted that there was consequently an insufficient amount of bulking agents—bulky materials that landfills mix with biosolids to achieve needed landfill stability—available to manage biosolids being added to the landfill and began turning away municipal biosolids. This left POTWs in a challenging situation in which they struggled to find a cost-effective outlet to remove and manage the biosolids generated from the continued treatment of incoming wastewater flows. In some cases, this led to sludge piling up on site, which in turn placed some of the POTWs at risk of being out of compliance with their wastewater discharge permits.

Due to swift action from the POTW community, the Department of Environmental Protection (DEP), and Hawk Ridge Composting Facility, emergency measures were put in place to store and transport sludge to a vendor in Canada. While this was intended as an emergency operation, it should be noted that hauling biosolids hundreds of miles out of the country resulted in greatly increased costs to POTWs (and ultimately ratepayers), and also increased greenhouse gas emissions. Virtually overnight, biosolids management costs for many POTWs doubled, which caused severe and unexpected strains on public utility budgets.

Definition of terms as used in this document:

Biosolids: While neither Maine law nor DEP rule defines the term "biosolids", it is a commonly understood term. Here it is used to refer generally to the treated or untreated solids residual resulting from wastewater treatment at publicly owned treatment works (POTWs).

Septage: The residual removed from septic tanks, cesspools, portable toilets, and similar facilities. When septage is managed at POTWs, much of it is converted via treatment to biosolids.

The root cause of this challenge was, at its heart, a solid waste management issue—having too much biosolids and too few outlets. **The following table shows suggested "levers"—tangible actions to address the underlying issues— available to Maine government to address the key challenges impacting biosolids management in Maine and help avoid similar situations in the future.** In particular, DEP, which oversees both wastewater treatment and sludge management, and the Bureau of General Services within the Department of Administrative and Financial Services, which is charged with administering state-owned landfills, will be integral in developing solutions.

Following the table is a graphic showing the projected biosolids management capacity in the state compared with the amount of biosolids currently generated. The graphic discusses the impact of key regulations, estimated landfill closures and regional biosolids facilities. **The key takeaway from this graphic is that as soon as 5 years from now there could be a drastic shortfall in capacity to accept biosolids in the state unless some of the actions in the table are implemented.**

Table ES-1. Levers Available to Maine State Government to Address Biosolids Challenges

Issue	Details	Lever to Address
SHORT TERM (2024-2025)		
Landfill Capacity	The state-owned Juniper Ridge Landfill (JRL) in Old Town was the outlet for nearly 90% of biosolids generated in Maine in 2022. The current permitted capacity of this facility is estimated to be fully used by 2028. The last time JRL was expanded it took nearly 6 years between submittal of the Public Benefit Determination and final approval, with additional time then needed to construct the new area. If JRL is not expanded, the state faces a dire situation for solid waste generally in the state. For biosolids, there is no current or proposed alternative outlet in the state that would be able to accept the tonnage currently handled at JRL (see the following figure). Out-of-state options would be very costly—with POTWs likely facing significantly higher costs than even those seen during 2022.	It is Brown and Caldwell's understanding that the next step in the process to expand JRL is for the current operator to submit a Public Benefit Determination application to DEP for approval (38 M.R.S. §1310-AA). Given the severity of the implications if the facility is not expanded, it is recommended that **the State work with the current operator to ensure that an application is submitted as soon as possible** to ensure sufficient time to pursue alternatives if the expansion is not pursued by the current operator.
		In a questionnaire sent to landfill operators in the state as part of this project, four facilities expressed interest in discussing with DEP the possibility of starting to accept biosolids (see Section 3.1). While smaller than JRL**, DEP should coordinate discussions with these regulated facilities** to provide supplemental or contingency capacity.
Bulking Agents	Biosolids are typically mixed with bulking agents when landfilled to ensure slope stability. Much of the bulking agent that was used at JRL originated from a single solid waste processing facility that handled a large amount of waste that originated from out of state. P.L. 2021, ch. 626 limited the ability of this facility to process out-of-state wastes as it prevented the facility from meeting its mandated recycling goals (which prioritized in-state waste generation over out-of-state waste generation). When the provisions of this law went into effect in February 2023, the operator of JRL claimed this resulted in insufficient availability of bulking agent necessary to manage the increased tonnages of biosolids being brought to the landfill, and JRL stopped accepting some biosolids. With very few other options available, biosolids management costs for many POTWs doubled virtually overnight, which caused severe strains on public utility budgets. During the 131st legislature, P.L. 2023, ch. 283 (codified at 38 M.R.S. §1310-N(5-A)(B)) delayed the recycling deadlines that the facility needed to meet and also allowed the facility to increase the overall quantity of out-of-state oversized bulky wastes until July 2025. The practical effect of this change provided some temporary relief in that a larger quantity of bulking agents would be able to come from out of state for 2 additional years; however, this change did not address the longer-term availability of bulking agents. From legislative testimony in 2023, it appeared that part of the challenge was not only a lack of bulking agents from out of state, but also that construction and demolition debris—the source of much of the bulking agent—is generally at a low generation rate during certain times of year, notably late spring, which coincides with spring runoff and increased precipitation, when bulking agent is needed most at a landfill. In a questionnaire sent to landfill operators in the state as part of this project, several landfills listed the lack of bulking agents as a limitation to accepting more biosolids.	**Fund an independent study evaluating the availability of bulking agents**. Restrictions impacting the availability of bulking agents go into effect in 2024 and 2025, so this study should be completed as soon as possible. If the study finds that insufficient quantities of bulking agents are available, then the extension on the restrictions in P.L. 2021, ch. 626 may need to be extended (see Sections 2.1.2, 2.1.3 and 7.3).

Table ES-1. Levers Available to Maine State Government to Address Biosolids Challenges

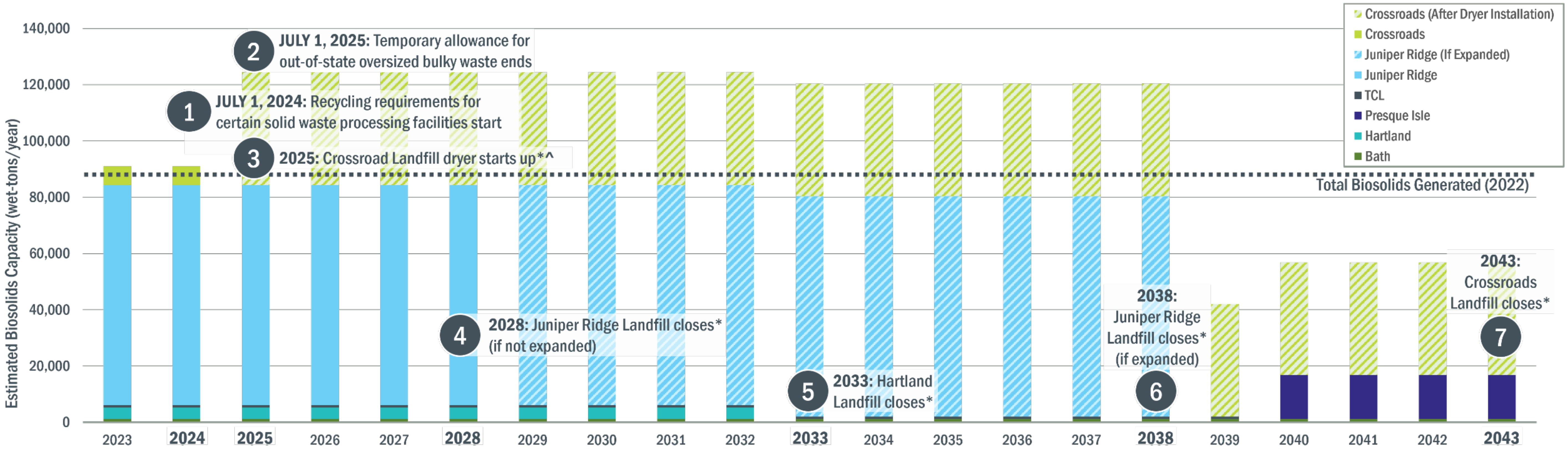
Issue	Details	Lever to Address
Pilot Treatment Technologies for Per- and Polyfluorinated Substances (PFAS)	The full fate of PFAS through biosolids treatment technologies is not known. By funding pilots, Maine can advance the understanding of the potential for cost-effective destruction of PFAS in biosolids and inform future permitting.	**Issue a Request for Proposals to select pilots of these technologies for the state to fund**. Within this request, identify necessary data collection to facilitate future permitting of full-scale facilities (see Section 6).
MEDIUM TERM (2024-2034)		
Support Volume Reduction and Dryer Projects	Current drivers in Maine lead to the need for fewer biosolids and/or biosolids dried to no longer fall under wet waste restrictions at landfills.	As Clean Water State Revolving Funds are already stretched, it is recommended to **issue a bond to provide state grants for volume reduction and drying projects** (similar to the Wastewater Treatment Facility Planning and Construction Grants Program the state undertook in 2019-2020) (see Section 7.5). This should include promising regional projects (see Section 4). The economic analysis in Section 5 shows the value in economies of scale.
Biosolids Beneficial Use Screening Levels	The current lack of management options for biosolids in Maine is not sustainable. Leaving landfill disposal as the sole outlet for biosolids in the state exacerbates landfill capacity issues, runs counter to the state's waste management hierarchy and climate goals, and leaves POTWs (and ultimately ratepayers) at the risk of drastic and sudden increases in biosolids management costs. The three landfills currently handling nearly all the biosolids generated in the state are all estimated to close in the next 20 years. There are several proposals being developed to install biosolids dryers or thermal treatment technologies in the state (Section 4.4), but under the ban on land application of sludge and sludge-derived products pursuant to 38 M.R.S. § 1306(7), the resulting products—even those that have been treated to reduce PFAS—would have essentially no outlet in the state once the major landfills are closed. This would leave POTWs with only options in other states or provinces—and beholden to their tightening regulations.	Maine should consider establishing revised screening levels to allow for a return to land application, provided that levels are consistent with U.S. Environmental Protection Agency (EPA) goals of being protective of human health and the environment. It may be determined that some land application is safe for both human health and the environment, and as such may provide an additional outlet for some of the biosolids generated in Maine. The EPA is conducting a very thorough risk assessment of PFAS in biosolids, scheduled to be completed in late 2024. **It is recommended that the State Legislature consider reevaluating the ban on land application to determine if DEP ought to adopt the federal biosolids PFAS limits once established.**
LONG TERM (2035 and beyond)		
Support PFAS Treatment Projects	Build on the results of the pilot and other research efforts to support the deployment of technologies that have been proven to provide cost-effective PFAS destruction.	**Issue a bond to provide state grants for PFAS treatment projects.**

An Overview of the Uncertain Future for Biosolids Management in Maine

To illustrate the urgency to implement effective solutions, the figure below shows the projected capacity to manage biosolids in Maine in the coming years—compared with the amount of biosolids generated in 2022 (horizontal dotted line)—and key events impacting that capacity.

Maine is facing a biosolids management challenge with too much biosolids and too few outlets.

The next two years present complications with bulking agent availability, which could limit the use of in-state landfills for biosolids. Looking towards the next twenty years, landfill closures will severely reduce outlets for biosolids. The challenge ahead is implementing a sustainable and functioning solution to manage biosolids while continuing to protect the environment.



① July 1, 2024	② July 1, 2025	③ 2025	④ 2028	⑤ 2033	⑥ 2038	⑦ 2043
Recycling requirements for certain solid waste processing facilities start	Temporary allowance for out-of-state oversized bulky waste ends	Crossroad Landfill dryer starts up*^	Juniper Ridge Landfill closes* (if not expanded)	Hartland Landfill closes*	Juniper Ridge Landfill closes* (if expanded)	Crossroads Landfill closes*
IMPACT + SIGNIFICANCE: With this requirement, solids processing facilities will have to recycle more of the waste they receive through methods other than use as a bulking agent or alternative daily cover at a landfill—potentially decreasing the amount of material available to mix with biosolids at landfills.	IMPACT + SIGNIFICANCE: When the temporary measure allowing oversized bulky waste derived from waste generated out of state to be placed in a state-owned landfill ends, there may be a further shortage of bulking agents to mix with biosolids. Similar to spring 2023, this could result in increased costs to POTWs if biosolids must be sent out of the state.	IMPACT + SIGNIFICANCE: After drying, biosolids can be introduced to the landfill without the need for bulking agents. When this dryer is fully operational, it will increase the capacity of the Crossroads Landfill for biosolids.	IMPACT + SIGNIFICANCE: The current permitted capacity of JRL is estimated to be used by 2028. If it isn't expanded, there will be no Maine landfill with enough capacity to meet solid waste needs and much of the biosolids produced will need to be sent out of state at greatly increased cost for utilities and ratepayers.	IMPACT + SIGNIFICANCE: When Hartland Landfill closes, the biosolids currently disposed there (historically about 5% of the biosolids generated annually) will need to be diverted to an alternate site.	IMPACT + SIGNIFICANCE: Even if expanded, JRL is estimated to use all available capacity by 2038. When JRL closes, Maine's available landfill capacity for biosolids (and solid waste generally) will be severely curtailed. Most biosolids would need to be managed in other states or provinces at greatly increased cost.	IMPACT + SIGNIFICANCE: Under current regulations, when the Crossroads Landfill uses its remaining permitted capacity, there will be nearly no outlets for biosolids—dried or not—in Maine.

**Estimated dates*

^While other biosolids facilities have been proposed in Maine, including those discussed in Section 3.2, this is the only facility for which permit applications have been formally submitted to DEP and so is the only one included in this graphic.

Section 1: Project Introduction and Background

The generation of biosolids is an unavoidable part of treating and cleaning wastewater before it is reintroduced into the environment. Biosolids management is covered under the discharge permit for Publicly Owned Treatment Works (POTWs), as well as state and federal laws specifically pertaining to biosolids management in landfills and beneficial use on land (Section 2.1).

POTWs are not active producers or users of per- and polyfluoroalkyl substances (PFAS) but are passive receivers of products containing these materials that are used by homeowners, businesses, and industry and find their way into public sewers. Biosolids represent a small fraction of the PFAS cycling in the environment but have generated concerns in Maine as a potential source of PFAS to soils, surface water, and groundwater (Maine PFAS Task Force, 2020).

This report looks at current and future issues impacting biosolids in Maine (Sections 2 and 3). Section 4 looks at the impact that regional facilities could have on the capacity within the state to manage biosolids. Current Maine regulations leave landfilling as essentially the only management option for biosolids, which exacerbates the need for fewer, drier biosolids. Section 5 provides a general economic analysis of installing anaerobic digestion and thermal dryers at various scales—two proven technologies for volume reduction and producing dryer material. Technologies for treating PFAS in biosolids are not yet ready for statewide adoption, and the research on the extent of destruction is still developing. Section 6 details the suggested approach to supporting pilots of PFAS treatment technologies in the state to further the research, inform the permitting approach for these technologies, and determine which would be worthwhile to fund at full scale. Sections 7 and 8 provide recommendations for concrete actions that Maine state government can take to help address the challenges for biosolids management in the state, and provides conclusions.

1.1 Biosolids Generation in Maine

Brown and Caldwell (BC) estimated that the State of Maine currently manages a total of 88,500 wet-tons of biosolids per year, or approximately 19,600 dry-tons of biosolids at 22 percent total solids (%TS). To estimate the total, tonnage values were pulled from multiple data sources, including Maine Department of Environmental Protection's (DEP) compiled data for generators permitted for agronomic utilization and composting, survey data compiled by the North East Biosolids and Residuals Association (NEBRA), and hauling data from biosolids management companies, as well as a compilation of data BC has from previous work for biosolids production at POTWs in southern Maine. For any facility for which data was not available, estimates for solids production were calculated based on estimated average wastewater flow.

This estimate was also verified by comparing it against the amount of biosolids accepted at landfills. In a technical memorandum produced as part of another part of this project (Batiste, 2023), it was shown that around 87,000 wet-tons of biosolids were landfilled in 2021 and 2022. Nearly all biosolids were landfilled in these years, so the estimated production correlates well with the known landfill acceptance data.

Biosolids managed out of state were primarily sent to a compost facility in Canada. Quantities of biosolids sent out of state are presented in Table 1-1. Note that this only includes tonnage from facilities with an Agronomic Utilization Program License.

Table 1-1. Biosolids Managed Out of State (wet-tons per year)

2017	2018	2019	2020	2021	2022	2023 (through July)
0	500	708	155	275	230	4,145

1.2 Biosolids PFAS Sampling Results

In March 2019, DEP issued a memorandum requiring all agronomic utilization licensees and biosolids compost facilities to test for three PFAS compounds. DEP has subsequently obtained additional PFAS sampling data for biosolids in the state. Data from the DEP Environmental and Geographic Analysis Database (EGAD) for the three PFAS compounds in the Screening Levels for Beneficial Use (06-096 C.M.R. Chapter 418, Appendix A, *Solid Waste Management Rules: Beneficial Use of Solid Wastes*) are presented in Table 1-2 as minimum, average, and maximum concentrations by year. It is anticipated that additional PFAS compounds will be added to the screening levels list, but these updates have not been published at the time of the report's drafting.

Table 1-2. PFAS Concentrations for Maine Biosolids[a], (parts per billion)

Compound	Acronym	Value	2019	2020	2021	2022
Perfluorooctanoic Acid	PFOA	Minimum	Non-detect	0.6	0.3	0.8
		Average	9.4	8.2	5.3	6.6
		Maximum	46	63	25	38.9
Perfluorooctane Sulfonate	PFOS	Minimum	2.2	2.5	2.1	1.2
		Average	27.2	16.6	22.7	19.3
		Maximum	120	51.9	111	66
Perfluorobutane Sulfonic Acid	PFBS	Minimum	0.8	0.2	0.5	0.4
		Average	3.3	1.4	2.7	21.7
		Maximum	10	3.9	7.3	86

[a] *Data available in EGAD at time of analysis only. Excludes biosolids compost.*

As of this report's drafting, Maine's soil beneficial use screening levels—which were applied to biosolids destined for agronomic utilization prior to the 2022 prohibition on the land application of biosolids and biosolids-derived products—were 5.2 parts per billion (ppb) for PFOS, 2.5 ppb for PFOA and 1,900 ppb for PFBS.

For reference, regulatory limits from other states are shown in Table 1-3. In 2022, the Michigan Department of Environment, Great Lakes, and Energy (EGLE) updated the threshold value, defining "industrially impacted" biosolids as those with PFOS levels greater than 125 ppb. The average PFOS and PFOA concentrations for Maine biosolids in 2022 are at levels that would be allowed to be land applied without remedial action (e.g., source control to reduce concentrations) under the interim guidelines finalized by New York in 2023—the most stringent numerical standards specifically for biosolids in the country.

Table 1-3. Biosolids Screening Levels in Other States

State	Limit Requiring Remedial Action	Limit Prohibiting Beneficial Reuse
Michigan (Interim Strategy)	PFOS: 50 ppb	PFOS: 125 ppb
New York (Interim Guidelines)	PFOS: 20 ppb PFOA: 20 ppb	PFOS: 50 ppb PFOA: 50 ppb

Section 2: Current Issues Impacting Biosolids Management

The following sections discuss the legislation and regulations in Maine and elsewhere that impact biosolids management in the state, as well as other factors that limit the ability of landfills to accept biosolids.

2.1 State Legislation and Regulations

Modern biosolids management authority in Maine was established in 1973 by the Maine Hazardous Waste, Septage, and Solid Waste Management Act, 38 M.R.S. 13. These statutes establish the authority of the state and Maine DEP to regulate waste management to protect the health and safety of its citizens and the environment. Residuals management in Maine is managed by the Material Management Program Division in the Bureau of Remediation and Waste Management of DEP. Biosolids are also regulated under Chapter 40 Part 503 of the Code of Federal Regulations (40 CFR 503); within this regulation is embedded the right for states to pass regulations more stringent than 40 CFR 503.

In 2016, milk from a Maine dairy farm was found to have high levels of PFOS, one of the more prevalent PFAS compounds, which led to a statewide effort to test and monitor PFAS concentrations in the environment. After investigation by multiple state agencies, two additional dairy farms were identified to have high levels of PFOS in milk, which supported a link between land application of municipal and industrial sludge and agricultural impacts from PFAS. To address concerns about food supply and drinking water, the state established a task force in March 2019 to develop a path forward for tackling PFAS contamination. The top two task force recommendations were to ensure provision of safe drinking water and to protect the food supply from PFAS contamination.

Also in March 2019, DEP issued a memorandum stating that biosolids agronomic utilization licensees and licensed sludge composters must first sample for three PFAS compounds (those identified in the recently updated 06-096 C.M.R. Chapter 418, Appendix A, *Solid Waste Management Rules: Beneficial Use of Solid Wastes)* prior to conducting any land application activity. Any PFAS samples above the screening concentrations and/or site-specific soil loading rate calculations would then result in restricted or no land application. In 2019, biosolids from only one POTW met the screening limits for all three PFAS compounds (without consideration of loading rate calculations), which either severely restricted the land application rate or, more commonly, pushed biosolids into landfill (see Figure 2-1).

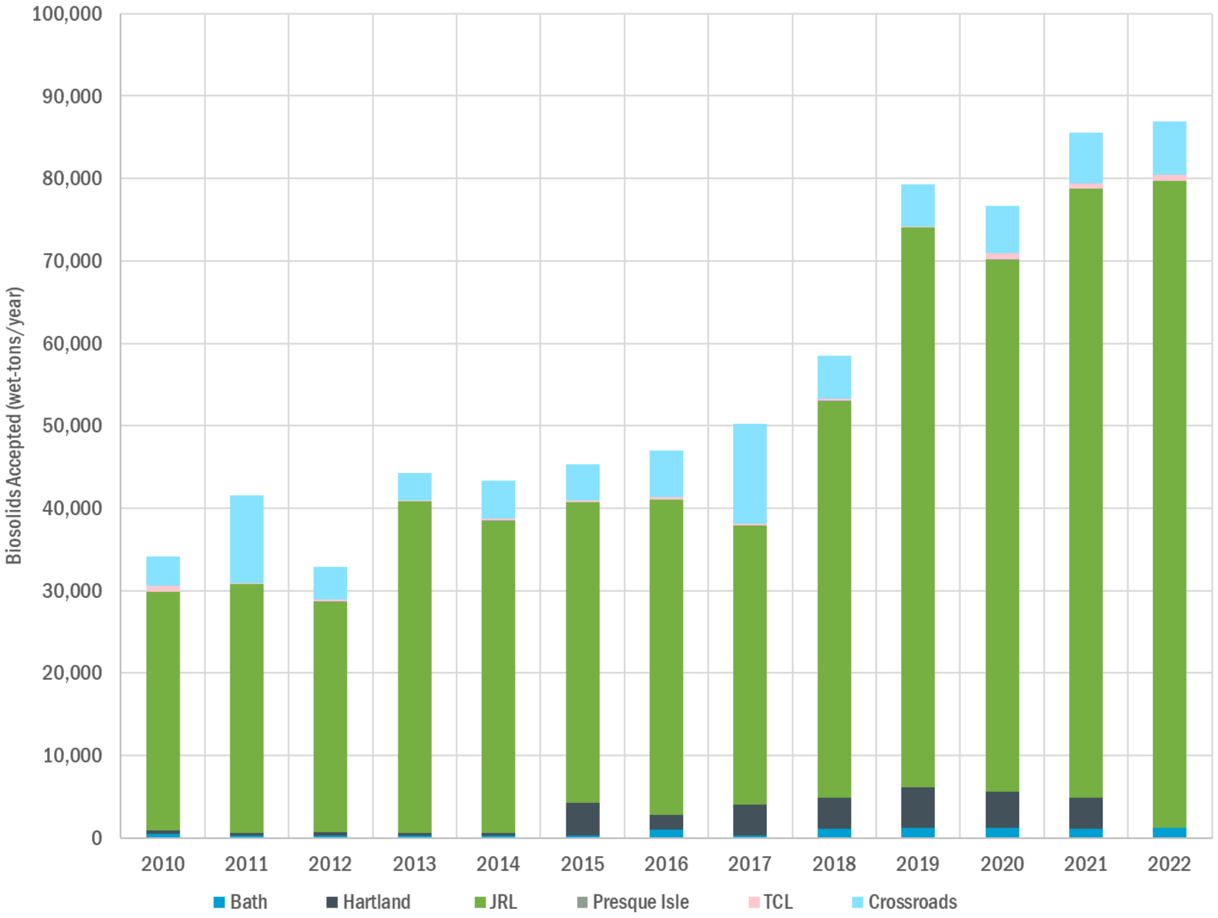


Figure 2-1. Historical biosolids disposal at Maine landfills

2.1.1 Ban on Sludge and Sludge-derived Products Land Application, Sale, and Distribution

In April 2022, the 130th Maine legislature passed Public Law (P.L.) 2021, ch. 641, “An Act to Prevent the Further Contamination of the Soils and Waters of the State with So-called Forever Chemicals” (often referred to by the name of the original bill, Legislative Document (L.D.) 1911, and codified at 38 M.R.S. § 1306 (7)). This legislation banned the land application, sales, and distribution of any products made with or mixed with biosolids and commercial and industrial sludges.

This legislation drove the little remaining agronomic utilization in the state (via land application and distribution as compost) to landfill disposal. In 2022, nearly all biosolids generated in the state were sent to in-state landfills, primarily the state-owned Juniper Ridge Landfill (JRL), which is operated by NEWSME Landfill Operations LLC, a wholly owned subsidiary of Casella Waste Systems, Inc. This was the culmination of a trend toward landfilling over the past few years as concerns about PFAS grew in the state (as shown previously on Figure 2-1).

2.1.2 Out-of-State Waste and Recycling Targets

At the same time as the biosolids land application, sale, and distribution ban the legislature passed P.L. 2021, ch. 626 (L.D. 1639), “An Act to Protect the Health and Welfare of Maine Communities and Reduce Harmful Solid Waste.” This law became effective in February 2023 and limited the tonnage that solid waste processing facilities could send to landfills in Maine to no more than what the facility accepted from in-state sources, with the goal of preserving landfill space for waste generated in Maine. The law also required that at least 50% of the material that certain solid waste processing facilities (those that accepted more than 200,000 tons in 2018) accepted be reused or recycled through methods other than placement in a landfill, with a gradually increasing percentage of the recycled amount going to outlets other than landfills (as a bulking agent or alternate daily cover).

As is discussed in further detail in Section 2.3.2, biosolids are typically mixed with bulking agents when landfilled to ensure slope stability. Much of the bulking agent that was used at JRL (construction and demolition debris (CDD), including oversized bulky waste) originated from a processing facility that handled a large amount of waste that originated from out of state. When the provisions of P.L. 2021, ch. 626 restricting out-of-state waste went into effect in February 2023, the operator of JRL claimed that there was insufficient bulking agent available, particularly with the increased tonnages of biosolids being landfilled due to the ban, and began turning away trucks with municipal biosolids.

As a result of the confluence of these events, POTWs were left with little to no outlets for the biosolids that are a byproduct of wastewater treatment. On-site sludge storage at POTWs filled up quickly, and several utilities were at risk of being out of compliance with their wastewater discharge permits. In March 2023, Casella sought temporary approval from the Maine DEP to use a backup alternative to manage the increasing need to store biosolids by collecting and sending the material for temporary storage at the Hawk Ridge Compost Facility, and within a prescribed turnaround, sending these materials to a compost facility in New Brunswick, Canada. This was all done at a significantly increased cost. Virtually overnight, biosolids management costs for many POTWs doubled, which caused severe strains on public utility budgets.

Historically, around 150 to 700 wet-tons per year of biosolids were managed out of state (see Section 1.1). During the March to early July 2023 timeframe, approximately 4,100 wet-tons of biosolids were sent to Canada for management—equivalent to approximately 14% of the biosolids generated in the state in a typical four-month period.

2.1.3 Temporary Revision of Out-of-State Waste and Recycling Targets

In June 2023, the Maine legislature passed P.L. 2023, ch. 283 (codified at 38 M.R.S. §1310-N(5-A)(B)), which allows solid waste processing facilities to continue sending up to 25,000 tons per 12-month period of oversized bulky waste that was originally generated out of state to state-owned landfills (i.e., JRL) until July 1, 2025. This was to ensure that enough bulky waste could be obtained throughout the year until better solutions were available for managing biosolids in Maine. The law also delays until July 1, 2024, the start date for when certain large solid waste processing facilities are required to ensure a portion of recycled material goes to an outlet other than landfills. These temporary measures helped alleviate the immediate challenge, but the underlying issues still need to be addressed.

2.1.4 Air Quality Statutes, Regulation, and Permitting

POTWs, project developers, and technology vendors have reported a lack of clarity in the requirements for air permitting for biosolids technologies in Maine, including thermal dryers and potential PFAS treatment technologies. There are no current PFAS limits for air emissions in Maine, though DEP anticipates there very likely will be in the future, likely based on federal guidance when it becomes available. In the interim, DEP has provided guidance that it will require a Best Available Control Technology analysis for new sources or major or minor modifications to existing licenses (as defined in 06-096 C.M.R. Chapter 115, *"Major and Minor Source Air Emission License Regulations"*). License renewals of minor sources will require Best Practical Treatment analysis.

2.2 Other Relevant Regulations

Separate and apart from Maine's actions, the federal government, Canadian provincial and federal governments, and other states within the region have been pursuing regulatory actions around PFAS and biosolids management that are distinct from Maine's approach.

2.2.1 Federal PFAS Regulations

In October 2021, U.S. Environmental Protection Agency (EPA) Administrator Michael S. Regan announced the agency's PFAS Strategic Roadmap, which lays out a whole-of-agency approach to addressing PFAS. The roadmap sets timelines by which EPA plans to take specific actions and commit to new policies. For wastewater, the Roadmap emphasizes the role of source control—keeping PFAS from entering sewer systems in the first place. For example, EPA plans to issue updated effluent limitation guidelines for several key industrial categories in the coming years. This pretreatment-based approach was further expanded in a December 2022 memorandum from EPA Assistant Administrator Radhika Fox, which emphasized the importance of industrial pretreatment for utilities land applying biosolids.

In 2020, the EPA began its risk assessment process to evaluate the need for PFOA and PFOS limits in biosolids under 40 CFR 503, the federal regulatory mechanism for biosolids management oversight. The results of this risk assessment are expected to be published in late 2024 and could result in regulatory limits for PFOA and PFOS in land-applied biosolids. Other PFAS compounds have been identified for further study, including potential future risk assessment.

2.2.2 Regulations in Nearby States

In general, biosolids management has been challenging in New England in recent years, particularly in Massachusetts, where the largest volumes of biosolids are generated due to higher population density. These management constraints mean there is limited opportunity to manage Maine biosolids in nearby states, primarily due to:

- Limited sites for Class B land application: Relative to the volumes generated, there is insufficient acreage for management of Class B biosolids on land. Short growing seasons in New England, as compared to other parts of the country, exacerbate this constraint.
- PFAS concerns and regulations under development: While Maine was the first New England state to regulate PFAS in biosolids, New Hampshire, Massachusetts, and Vermont have all begun the process of developing regulations related to PFAS in land-applied biosolids. New Hampshire, in coordination with the U.S. Geological Survey, is conducting a scientifically rigorous process for establishing biosolids screening standards, which could be informative for Maine.
- Limited landfill capacity.
- Vermont and New Hampshire have regulations stating that biosolids brought into those states for certain uses must meet the pollutant limits or chemical contaminant concentrations of that state or the state in which they were generated, whichever is more stringent.
- Exhausted regional incineration capacity: In southern New England, regional incinerators provide additional biosolids management capacity. The facilities are largely at capacity, with some older facilities experiencing higher downtime for maintenance. Many sewage sludge incinerators in the region have closed and new ones are difficult to develop due to more stringent air emissions controls necessary per new source performance standards and emission guidelines rules finalized by the EPA in 2016. Incinerators are also facing scrutiny as potential sources of PFAS air emissions. Connecticut, a state in

which incineration dominates as a biosolids management option, has begun a PFAS monitoring program with the potential for future regulation.

These constraints are a key reason why biosolids management companies have sought to manage Maine biosolids elsewhere, particularly in Canada.

Biosolids dried to U.S. EPA Class A standards (meaning they can be used in a wide variety of horticultural applications, as well as agricultural) would be easier to manage outside of Maine, as would the biochar produced by pyrolysis or partial gasification units.

2.2.3 Regulations in Canada

In Canada, biosolids are generally regulated at the provincial level; there is no federal equivalent to 40 CFR 503. Previously, biosolids from New England had been hauled to Canada, specifically Quebec and New Brunswick, for reuse. However, on March 2, 2023, the Quebec provincial government issued a temporary moratorium on the importation of land-applied biosolids from the U.S. while the Ministry of the Environment of Quebec works to develop PFAS standards in biosolids. The provincial government of Quebec is expected to issue a regulation on the land application of biosolids, including limits for certain PFAS compounds, in 2024. While biosolids are still accepted in New Brunswick, the Canadian Food Inspection Agency is expected in early 2024 to implement a PFOS limit (purported to be around 50 ppb) for biosolids that would impact beneficial use across all provinces.

Agronomically utilizing biosolids in Canada had been crucial in managing biosolids in New England for some time. Quebec and New Brunswick have historically been routine outlets for biosolids in northern Maine. The New Brunswick facility is often the backup option listed on many Casella contracts. In 2023, when biosolids land application in Maine was banned and landfills had insufficient bulking agent to accept biosolids, a facility in New Brunswick was an essential alternative outlet. The movement of biosolids to Canada has garnered significant negative press in the past year; thus, even biosolids that could be managed under the new federal and provincial laws may be challenged to find receivers.

2.3 Limiting Factors at Landfills

While landfills have generally had the capacity to manage nearly all biosolids generated in the state in recent years (see Figure 2-1), landfill capacity to receive biosolids is constrained by several key factors pertinent to this study. The importance of these factors was reinforced in a survey of landfills conducted as part of this project.

2.3.1 Limits on Wet Wastes

While landfills are currently managing essentially all of the biosolids produced in the state, the events of spring 2023 highlighted how dependent biosolids management is on a handful of landfill operations in Maine and in particular to Maine’s state-owned landfill, JRL. A separate report published as part of this project (Batiste, 2023) examined the potential for landfills currently permitted to accept biosolids to accept additional tonnage. A main limiting factor to biosolids acceptance is the proportion of “high-moisture content waste” or “wet waste” that landfill owners are permitted or willing to accept per internal operating guidelines. Wet waste is typically defined as materials having a moisture content greater than 60% (Georgia Department of Natural Resources, 2021); most biosolids have a moisture content of 75% or higher and thus fall into this category. If added in too great a proportion, wet wastes can affect the stability of landfill side slopes, leading to unsafe operating conditions, including slope failures. The maximum amount of wet waste accepted is typically no more than 10% of the total amount of waste accepted, and all other wet wastes (e.g., industrial sludges, industrial wastes) accepted at the landfill count toward this overall limit.

Based on historical data and the responses to a questionnaire sent to landfill operators in the state as part of this project (Batiste, 2023), there appears to be limited ability of landfills currently accepting biosolids to accept more due to limits on the acceptance of wet wastes.

It is important to note that biosolids that have been dried to a moisture content below 60% would no longer fall under this limitation. There are multiple POTWs in other states sending dried biosolids to landfill, either as a component of alternative daily cover or for direct burial, without issue. As with many materials, consideration would need to be given to how dried biosolids are placed in a landfill to avoid stability or heating issues.

2.3.2 Bulking Agents

As the challenges in finding outlets for biosolids in the spring of 2023 made clear, the acceptance of biosolids at landfills is heavily reliant on the availability of bulking agents to mix with the biosolids to provide needed stability (see Sections 2.1.2 and 2.1.3). The ratio of bulking agent to biosolids is typically 4:1 or more, depending on the moisture content of the biosolids, the bulking agent properties, and the workability goals of the landfill operator. Some bulking agents require a higher ratio, which reduces the number of biosolids trucks that can be accepted per hour.

From legislative testimony in 2023, it appeared that part of the challenge was not only a lack of bulking agents from out of state, but also that CDD—the source of much of the bulking agent—is generally at a low generation rate during certain times of year, notably late spring, which coincides with spring runoff and increased precipitation, when bulking agent is needed most at a landfill.

2.3.3 Other Issues

In addition to limits on the proportion of wet waste and the need for sufficient quantities of bulking agents (see Section 2.3.2), there are several other logistical factors that in practice limit the amount of biosolids that can or will be accepted at a landfill, including:

- Biosolids arriving for disposal at a landfill need to be promptly mixed with other solid waste and covered to minimize the potential for odors. Operators try to coordinate biosolids acceptance with the availability of sufficient waste available for mixing so trucks are able to enter and exit the facility as quickly as possible.
- Landfill gas and leachate production both have the potential to increase with the addition of biosolids to a landfill; therefore, additional attention to these systems is generally needed.
- Landfilling of biosolids has the potential to impact leachate quality, which may affect options for treating and managing the leachate.
- Landfills may at times be undergoing restrictions due to inclement weather (such as the heavy precipitation of summer 2023) or operational issues such as location and size of the working face that reduce the volume of biosolids that can be accepted.
- The potential requirement for PFAS treatment in leachate has made some landfill operators reluctant to accept biosolids.

Finally, a nationwide shortage of truck drivers and volatile fuel prices add uncertainty to the process of transporting biosolids to the landfill in the first place.

Section 3: Future Drivers for Biosolids Management

While biosolids management in Maine remains precarious today, uncertainty around future landfill capacity, the development of alternative management outlets, and competing state goals all impact available management options in the future.

3.1 Uncertain Future Landfill Capacity

Another report published as part of this project (Batiste, 2023) estimated when the permitted capacity at landfills accepting biosolids would be completely used (see Figure 3-1). At current consumption rates, it is estimated that the current permitted capacity for the two facilities accepting the vast majority of biosolids in the state, JRL and Crossroads, would be exhausted in 2028 and 2043, respectively. A proposed expansion at JRL, the permitting process for which has just formally begun, is estimated to extend the operating life by an estimated 10 years to 2038 (see Figure 3-1). Figure 3-1 additionally shows the potential impact of a planned thermal dryer for biosolids at the Crossroads Landfill.

This obviously presents a solid waste management challenge in the state well beyond biosolids, but after 2043, given the current legislation and these anticipated landfill closures, POTWs in Maine will be left with no in-state (and likely few out-of-state) options for managing biosolids. As will be discussed in Section 4.4, there are several proposals being developed to install biosolids dryers or thermal treatment technologies in the state so that the resulting material is no longer subject to wet waste restrictions. However, these options are only a near-term fix, as the two landfills will not be able to accept biosolids of any kind when they have reached capacity. Given the restrictions of Maine's biosolids land application ban, once landfills reach maximum capacity, there will be no outlet in the state even for dried material.

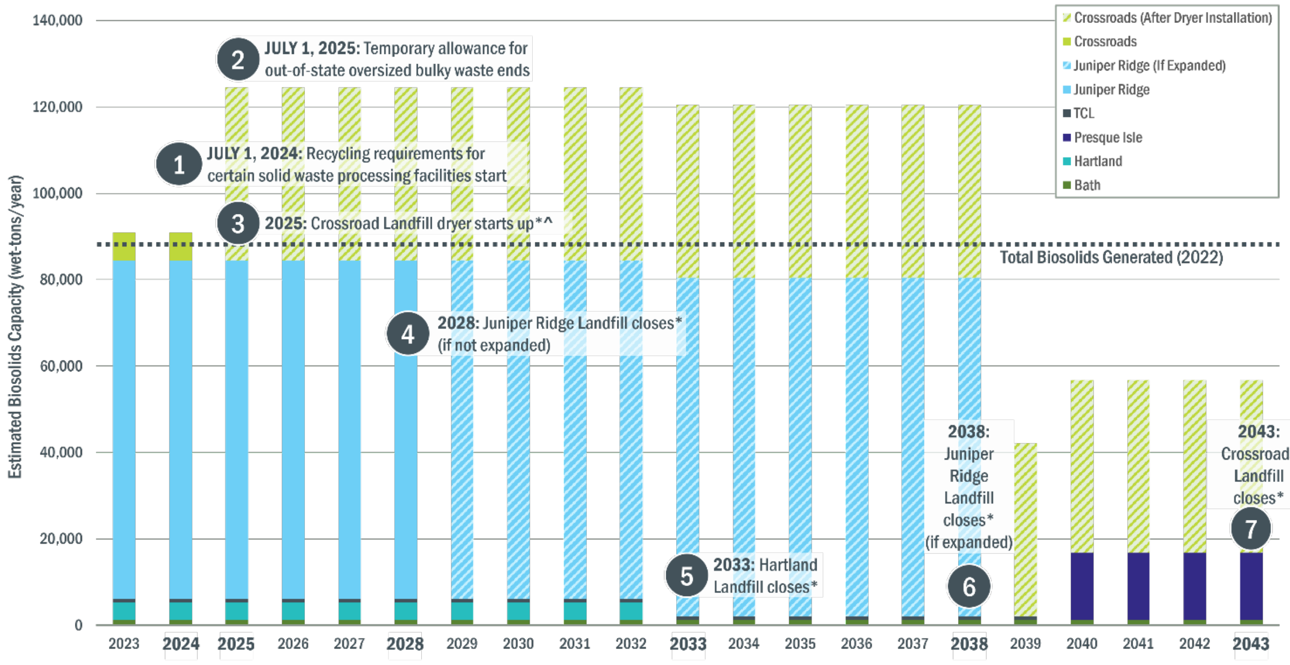


Figure 3-1. Estimated biosolids management capacity in Maine (wet-tons/year)

In the questionnaire responses, a few landfill owners not currently permitted to accept biosolids (City of Augusta, City of Lewiston, and Twin Rivers Paper Company LLC) expressed interest in discussing with DEP the possibility of accepting biosolids in the future. In addition, the Pixelle Androscoggin facility, which includes a landfill, is in the process of being sold. While the proposed plan for the facility is to close the landfill, the possibility of using the remaining permitted capacity at the site for biosolids disposal could be explored with the new owners as an alternative action if the proposed activity complies with state statutes and rules.

While additional restrictions on the amount of biosolids that could be accepted at these "additional" facilities are likely, an approximate maximum tonnage that each facility could accept was calculated based on questionnaire responses and annual reports (Table 3-1). Collectively it is estimated that these facilities could accept a maximum of almost 10,000 wet-tons/year, or around 11% of all the biosolids currently generated in the state. These facilities could provide another outlet for biosolids, particularly for POTWs located nearby. They could also provide contingency backup in the event issues arise at the landfills currently accepting biosolids.

Table 3-1. Landfill Owners Indicating a Willingness to Discuss Starting to Accept Biosolids[a]

Owner	Landfill	Public/Private	Location (city/town)	Typical Waste Acceptance Rate (wet-tons/year)	Estimated Maximum Biosolids Acceptance[b] (wet-tons/year)
City of Augusta	Hatch Hill Landfill	Public	Augusta	71,000	7,100
City of Lewiston	Lewiston Landfill	Public	Lewiston	11,000	1,100
Pixelle Androscoggin LLC	Pixelle Androscoggin Landfill	Private	Jay	7,000	700
Twin Rivers Paper Company LLC	Frenchville Landfill	Private	Madawaska	8,600	860
				TOTAL:	**9,760**

[a] *In study questionnaire response*

[b] *10% of total waste accepted based on questionnaire responses or annual reports*

It is not anticipated that new landfills will be constructed in Maine over the planning period of this study (20 years). Maine has had a moratorium on new commercial landfills since 1989, and BC was not made aware of any plans for new or expanded state landfills (with the exception of the possible JRL expansion).

3.2 Septage Land Application Restrictions

P.L. 2021, ch. 641 suspended issuance of new septage land application licenses, restricted land application of septage at existing sites based on whether groundwater concentrations exceeded the state's interim drinking water standards for PFAS, and tasked DEP with evaluating alternatives to the land application of septage. Maine DEP submitted the "Report on the Land Application of Septage" to the legislature on January 13, 2023, to provide information to the legislature on whether it was advisable to enact a similar ban on the land application of septage.

Another, separate, report produced as part of this project (Rebodos, 2023) provided further evaluation on management options other than land application of septage. That report estimated that if a septage land application ban were to be enacted in Maine and most of the septage currently land applied in the state were to be transferred to POTWs for treatment, an additional 3,000 wet-tons per year of biosolids (as dewatered cake) would be produced in the state, roughly a 3% increase. This additional material would require increased bulking agent at the landfill. At a biosolids management cost of $140/wet-ton, this represents an annual cost of $420,000 to the POTWs accepting this septage, a cost likely to be passed along to septage haulers and ultimately septage system owners. POTWs are not required to accept septage and may choose not to do so if management costs increase and as POTWs come under increasing PFAS regulation—leaving septage system owners with few management options.

3.3 Effluent PFAS Limits at Publicly Owned Treatment Works

According to a DEP presentation (Crowley, 2023), it is likely that the state will regulate PFAS concentrations in POTW effluent in the future. The intent would be to regulate PFAS compounds in Maine Pollutant Discharge Elimination System (MEPDES) permits (also known as Waste Discharge Licenses) held by the POTWs in the same manner as other regulated compounds.

This focus on PFAS in effluent will likely cause POTWs to work with industrial sewer users, through Industrial Pretreatment Programs or other means, to reduce PFAS entering the wastewater collection system. As discussed in Section 2.2.1, source control is one of the primary recommendations from the EPA for reducing PFAS at POTWs. Other states, including Michigan (EGLE, 2022), have had great success using pretreatment programs to reduce PFAS in POTW effluent and biosolids. Therefore, effluent PFAS limits will likely lead to reduced PFAS concentrations in biosolids.

Note that POTW effluent limits will be a disincentive for these facilities to accept materials such as landfill leachate and septage, which have few other outlets.

3.4 Climate Action

Maine has adopted ambitious climate goals:

- Decrease greenhouse gas (GHG) emissions by 45% by 2030 and 80% by 2050
- Achieve carbon neutrality by 2045

Disposing of organics in landfills generates a significant amount of methane, a potent GHG, a large percentage of which is released to the atmosphere in even modern landfills with methane capture systems. Most organics diversion legislation in the U.S. has focused on food waste; however, any organics degrading in anaerobic conditions like those of a landfill will emit methane—including biosolids. California has implemented a comprehensive organics recycling plan in an effort to reduce methane emissions, including a severe reduction in the amount of biosolids that can be landfilled.

Maine does not currently have an organic waste landfill ban or food waste recycling law; however, in recent years, several proposed legislative bills have been introduced to address concerns about GHGs and landfill capacity. In 2023, L.D. 1009 (“An Act Regarding the Reduction and Recycling of Food Waste”) was introduced and carried over to the next legislative session for further discussion by the Environment and Natural Resources Committee. Moreover, the Governor’s Office of Policy Innovation and the Future is embarking on a statewide study of food waste generation as part of its overall climate and waste management activity toward mitigating climate change.

Should Maine decide to adopt food waste recycling and reduction programming (including a landfill ban), it should be noted that the practical impact of continuing to enforce the sludge land application ban will run contrary to this movement toward reducing GHGs at landfills. As climate action goals get greater traction, the state may decide to reevaluate the ban on biosolids land application as a means of reducing methane emissions and preserving landfill capacity.

3.5 PFAS Source Control Laws

In 2021, Maine was the first state to pass a sweeping law to monitor and ultimately eliminate products that contain PFAS: P.L. 2021, ch. 477, “An Act To Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution.” The timeframes for this law were amended in 2023 by P.L. 2023, ch. 138, “An Act to Support Manufacturers Whose Products Contain Perfluoroalkyl and Polyfluoroalkyl Substances.” Starting in 2025, this legislation requires any manufacturer who intentionally adds PFAS to a product for sale in Maine to submit a description of the product, its use, and its PFAS concentration. There are exemptions for businesses smaller than 25 people and for products regulated at the federal level.

Starting at the beginning of 2023, carpets, rugs, and fabric treatments with intentionally added PFAS were banned from sale in Maine. The legislation allows DEP to add additional categories or product uses to this list and calls on the department to prioritize products that are most likely to cause environmental contamination. In 2030, this measure expands to all products not specifically designated as a “currently unavoidable use” by DEP.

This is similar to the approach used in addressing lead contamination in drinking water. The current focus is on removing lead service lines so lead is not in drinking water in the first place, rather than trying to remove lead after contamination.

This type of source control—reducing concentrations of a pollutant in the environment by avoiding its production in the first place—has shown to be very effective. In the U.S., PFOS was voluntarily phased out of production in 2002, and most uses of PFOA were phased out by the mid-2000s, completing the phase out in 2015. Figure 3-1 shows the results of the National Health and Nutrition Examination Survey blood PFAS sampling results in people in the U.S. The correlation between the phase outs and the blood serum levels is apparent in the graph, with PFOS and PFOA concentrations falling nearly an order of magnitude in a decade. PFAS source control laws should be expected to reduce the concentration of PFAS in the environment, in soils, and in biosolids.

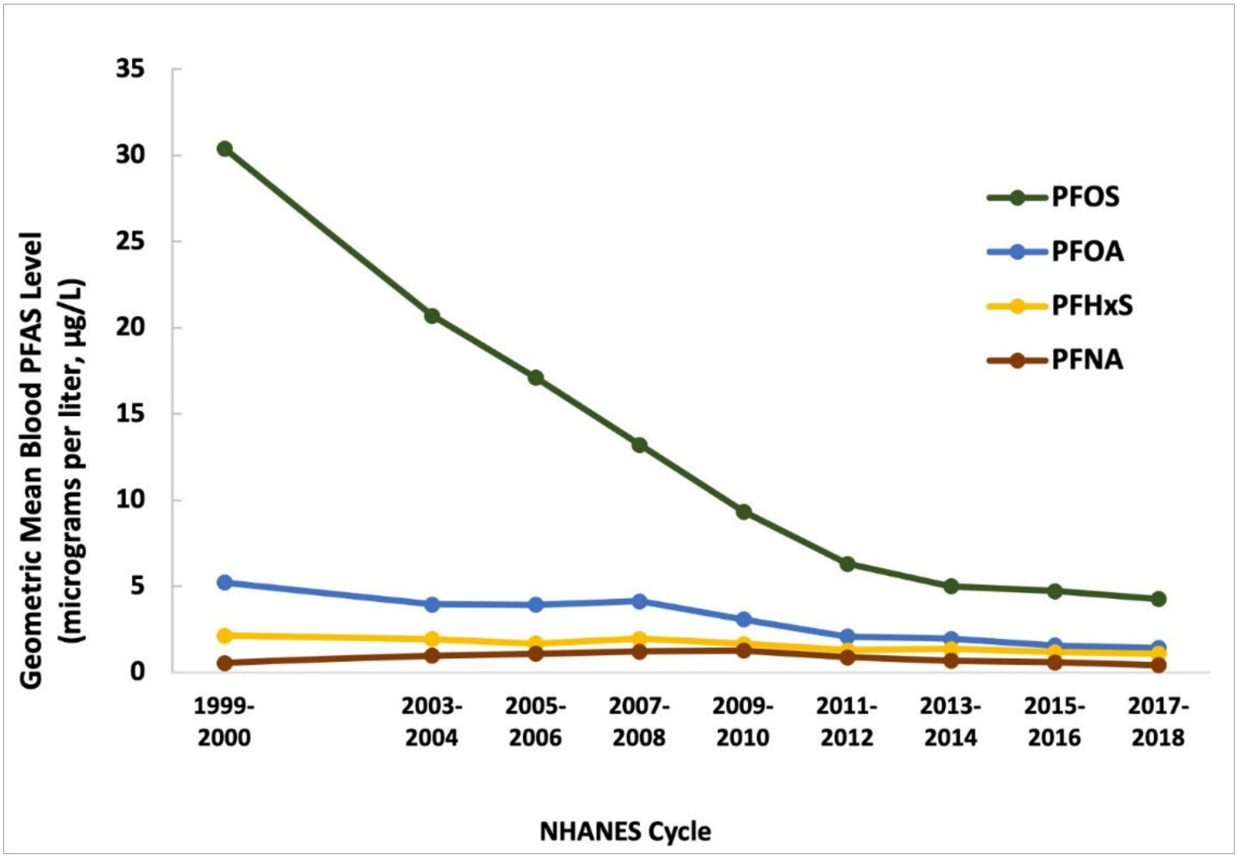


Figure 3-2. Blood levels of the most common PFAS in people in the U.S. over time

Source: Agency for Toxic Substances and Disease Registry, 2022

Section 4: Regional Facilities

As is discussed in the economic analysis in Section 5, regional facilities for biosolids treatment are able to benefit from economies of scale. While an appealing approach in theory, there are governance, finance, and basic materials handling challenges that need to be thoroughly addressed for such a facility to be successful.

4.1 Governance Structures

There are generally four options for a governance structure to undertake a regional biosolids project. Two options have two levels of participation, depending on the desires of the individual agencies regarding their method of participation. The selection of a governance option may limit the delivery method or process selection for the project.

- Private Entity Contracts: Each individual alliance member contracts directly with a company(s) that owns, designs, builds, and/or operates the biosolids facility.
- Lead Agency Contract: One agency takes the lead to deliver the project, and each individual alliance member contracts with the lead agency for use of the facility.
- Joint Powers Agreement: Alliance members enter into a joint agreement to deliver the project within the power and authority of one identified alliance member agency. A core of alliance members could enter into the joint contract, and the remaining alliance members would contract with the core group for use of the facility.
- Joint Powers Agency: Alliance members form a new joint powers agency that functions independently with the power and authority required. A core of alliance members could form the joint powers agency, and the remaining alliance members would contract with the core group for use of the facility.

One important aspect in choosing the right governance structure will involve determining which structure helps to best define, communicate, and agree upon expectations of and between all parties. Understanding what each agency seeks to achieve and is willing to contribute will shape the relationships between agencies, the relationship between the alliance and a merchant, and whether a lead agency or core leadership structure is necessary.

4.2 Financing

There are several factors agencies may be able to leverage that have the potential to reduce the capital expenditures and operating costs of the biosolids facility, and thereby reduce associated tipping fees. However, it is worth bearing in mind that while these factors may reduce the cost of processing biosolids at a regional facility, agencies may incur increased internal costs. The primary factor to consider is whether an agency within the alliance has available land or space within its existing plants or has abandoned or underused buildings or existing infrastructure.

Considerations in determining a member agency's appropriateness to serve as a host facility include:

- Existing transportation corridors.
- Physical boundaries with an existing level of staff presence or oversight.
- On-site or nearby utilities.
- Available heat, energy, steam, and process water.

Additional cost savings may be achieved by:

- Operational know-how and other existing skills agency staff possess, such as communications, finance, and legal or business skills.
- The ability to secure capital at a fraction of the cost to the private sector.
- Traditionally strong creditworthiness.
- Homogeneity of material delivered to the regional plant.

4.3 Materials Handling

Some regional biosolids facilities that have been constructed in other parts of the country have failed or been significantly challenged by seemingly straightforward solids handling issues. The methods for accepting biosolids with varying characteristics coming at an unsteady rate and conveying the material in and out of various treatment steps must be carefully designed. For instance, an inability by the facility to accept hauled material at a rate at least as fast as the rate at which haulers are accustomed to at landfills has the potential to strain agency relationships with their haulers. When used as a conditioning step ahead of pyrolysis or gasification, a thermal dryer must be selected that is able to handle the characteristics of the incoming biosolids and is well matched to the needs of the thermal treatment step.

4.4 Proposed Regional Facilities

There are several entities considering or actively pursuing projects that would serve as a regional biosolids processing facility. To understand these efforts, BC developed an 11-question survey that included questions regarding planned location, volume, design and permitting progress, and partnerships. This survey was not comprehensive, but rather was designed to illuminate the high-level landscape of PFAS solutions under discussion. DEP sent the survey to 16 contacts, and eight companies responded. A summary of the responses is shown in Table 4-1.

Table 4-1. Regional Facility Survey Results

Company Name	Planned Location	Estimated/Planned Capacity (dry tons/day)	Design Phase	Permitting Status	Technology	Confirmed Partners
ecomaine	Scarborough	Unknown	Exploration	None	Unknown	None
Heartland Water Technology	Various	>1	Preliminary Planning	None	Dewatering, Drying, Gasification, Pyrolysis	Confidential
Synagro	Portland	40	Preliminary Planning	In discussion with DEP	Digestion, Dewatering, Drying, Pyrolysis	Andritz, CHAR
374Water	Various	2-25	Preliminary Planning	None	Supercritical Water Oxidation	In discussion
Waste Management (WM)	Norridgewock	44	30% Design	Permit applications submitted	Drying	None
Kiewit	Various	Unknown	Preliminary Planning	None	Digestion, Dewatering, Drying, others	None

Table 4-1. Regional Facility Survey Results

Company Name	Planned Location	Estimated/Planned Capacity (dry tons/day)	Design Phase	Permitting Status	Technology	Confirmed Partners
Viridi RNG	Brunswick	46	60% Design	Existing permit; updates will be required	Digestion, Dewatering, Drying, Pyrolysis	None
NORESCO	Sanford	22	Preliminary Planning	None	Drying, potentially pyrolysis/gasification	None

The facility that is furthest along in the permitting process is for a thermal dryer at the Waste Management Crossroads Landfill in Norridgewock. Waste Management is at the preliminary design stage (30%) for a 200-wet-tons/day belt dryer. Accounting for the operating schedule and planned and unplanned outages, the annual throughput is estimated to be approximately 40,000 wet-tons per year of biosolids—equivalent to around 45% of the total biosolids generated in the state. Their proposal includes using existing landfill biogas power generation to power three heat pump belt dryers. A permit application for this facility has been submitted to, and approved by, the Town of Norridgewock Planning Board; the permit application has been submitted to DEP and is being reviewed.

Viridi RNG reports that it is at the intermediate design stage (60%) of its to upgrade the digestion facility in Brunswick that was previously operated by Village Green Ventures but is not currently operating. Viridi RNG reports that the upgraded facility—which is permitted to accept septage, food waste, and biosolids—could process up to 46 dry-tons per day. The facility would include digestion, dewatering, drying, and pyrolysis. DEP is in receipt of an application for the transfer of licenses from the current owner. Updates would be required for the new facilities. As of the writing of this report, DEP has not been contacted about permitting the additional equipment. When the facility was in operation, there were reportedly issues with off-site odors, ability to accept hauled material, and nutrient loading to the Brunswick Sewer District Wastewater Treatment Facility. These issues would need to be addressed to ensure this was a consistent outlet for biosolids in southern Maine.

While the Crossroads dryer will provide a welcome alternative in the state if completed and be able to handle a significant portion of the biosolids generated, other options need to be developed to ensure reliable and redundant biosolids management options in the state.

4.5 Proposed BioHub

In 2022, NEIWPCC, NEBRA, and the Maine Water Environment Association led a group of Northeast stakeholders proposing the long-term placement of a PFAS/Biosolids Bio-Technology Hub (BioHub) in Maine. The BioHub concept started as a research facility to prove destruction technologies' effectiveness for emerging contaminants for fast-paced deployment throughout the U.S. The BioHub concept was developed to address the current lack of approved, proven, or established methods to treat PFAS in biosolids on a large scale.

On behalf of the stakeholders from Northeast states' health and environment departments, numerous POTWs, environmental consulting and law firms, E2Tech, universities, and national environmental organizations, NEIWPCC submitted a Congressionally Directed Spending Request through Senator Angus King's office for the BioHub project. With much demand for funding in this highly competitive process, the BioHub project was not selected for inclusion in the Senate's appropriations bill for Fiscal Year 2024.

Unfortunately, seeking and securing funding and then studying, locating, permitting, and constructing the BioHub project would take many years, possibly a decade. And as each year passes, information has become more critical for POTW financial budgeting, planning, and assessment to support their fiscal responsibility to ratepayers. Therefore, the stakeholders pivoted from a physical facility to an information clearinghouse concept. The BioHub clearinghouse's goal is to serve as a resource of information on research and funding for piloting, planning, and permitting treatment of PFAS in municipal biosolids. This information will be available publicly for other entities to inform proof of concept, demonstration, testing, design and construction at physical facilities. Once available, this will be a valuable resource for those wishing to pursue regional facilities.

Section 5: Technology Alternatives Analysis

Current drivers in Maine lead to the need for less material and/or material dried to no longer fall under wet waste restrictions at landfills. There are mature technologies for these purposes: anaerobic digestion and drying. This section provides a generalized economic analysis of a series of alternatives employing these technologies at different scales of POTWs. While the exact economics of a project are site-specific, this analysis is provided to give POTWs across the state an idea of the level of capital and annual costs associated with reasonable approaches to reducing biosolids generation.

PFAS treatment technologies have gotten a lot of attention in the past few years and the market offerings are maturing; however, there are only a handful of current installations running at commercial scale, most for less than a year. The long-term reliability and operations and maintenance (O&M) costs associated with these technologies is not yet known. An estimate from Minnesota put the total cost to install PFAS treatment at POTWs around that state at $1.6 billion to $3.3 billion (Barr, 2023). These technologies are not yet ready for statewide adoption. It is also not fully known what the full PFAS destruction potential is through these units, although data to support such claims is being collected at the few operational facilities. Section 6 lays out a piloting effort that Maine could fund to help answer these questions.

5.1 Overview of Selected Technologies

5.1.1 Dewatering

Dewatering technologies are often used at wastewater treatment facilities to separate solids and water to make processing and hauling more efficient. For the alternatives used in this analysis, centrifuge dewatering technologies were used. In addition to centrifuge dewatering, belt filter presses and screw presses are often used and have been installed throughout New England. Centrifuge dewatering is a process that uses centrifugal forces to separate water from sludge particles conditioned with polymer. These forces are generated by rapidly rotating a cylindrical bowl, which causes suspended solids to move outward, away from the rotation axis and towards the bowl’s walls. As the sludge enters the centrifuge, a scroll conveyor inside the cylinder continuously conveys it from the inlet to the outlet, while simultaneously liquid drains out from the opposite end of the centrifuge. The resulting “dewatered cake” typically has a total solids content of 15% to 30% (the remaining 70% to 85% being water).

POTWs that do not have dewatering are typically unable to send their (thickened) liquid sludge to a landfill as it will not pass the required paint filter liquids test. The crucial role dewatering can play in biosolids management was highlighted in 2019 when some smaller POTWs in the state that did not have on-site dewatering were left with no options for biosolids management when restrictions on land application due to PFAS concerns went into effect. The state supported a number of these facilities with Emergency Sludge Dewatering State Wastewater Infrastructure Planning and Construction Grants to offset the cost of one-time contracted dewatering.

5.1.2 Anaerobic Digestion

Mesophilic anaerobic digestion (MAD) is the most common solids stabilization technology in the U.S. Digestion breaks down a significant portion of the organic matter in the biosolids into biogas, thereby reducing the amount of solids to manage and producing a valuable fuel source. Digesters operate continuously and result in fewer solids downstream, which opens the possibility for smaller dewatering and drying equipment and storage. When coupled with drying, the biogas produced from digestion can be used to offset some of the dryer’s fuel requirements.

MAD employs operating temperatures of 35° to 39°Celsius (95° to 102°Farenheit) and solids are digested under anaerobic conditions. This stabilization process has the longest operational history of all the processes under consideration, with the most supporting operational data to date. Digestion reduces odors and pathogens but has the most significant benefit in plants that produce primary solids, which degrade more readily in anaerobic digesters. MAD is relatively easy to operate and maintain, but it is capital intensive and requires significant ancillary equipment and instrumentation.

5.1.2.1 Pre-digestion Thermal Hydrolysis

The thermal hydrolysis process (THP) is an anaerobic digestion pretreatment system that enhances wastewater solids processing and energy production, even achieving Class A biosolids standards in certain configurations. THP is generating interest for regional digestion facilities because the process typically requires feed solids at 15% to 18%TS, which is similar to the solids concentration of typical dewatered cake produced by most POTWs. THP ahead of digestion at regional facilities facilitates the acceptance of biosolids hauled to the facility for processing from POTWs. It is therefore included in one of the regional alternatives (see Section 5.7).

THP is a mature technology in Europe, dating back to 1995, and has been adopted in the U.S. since late 2014. THP uses medium-pressure steam to create high-temperature and high-pressure conditions that break down bacterial cells and solubilize organic material in wastewater solids, thus making them more digestible. This process accelerates digestion, reduces digester residence time, increases gas production by 10% to 20%, lowers sludge viscosity, allows for higher solids concentrations to digestion (9% to 12%), and improves dewaterability and odor control in the digested solids.

5.1.3 Thermal Drying

For traditional thermal dryers, there are three main types used for biosolids applications in the U.S.: belt, indirect, and rotary drum. Belt and rotary drum technologies advance product through the dryer vessel via a rotating belt or drum, respectively, while hot gases are passed through the product to facilitate evaporation. Indirect dryers use metal discs or paddles to advance product while transferring heat to the product through the disc or paddle surface using thermal oil or steam to heat the metal surfaces. Each dryer technology has unique operational characteristics.

A primary differentiator between technologies is product throughput. Rotary drum dryers have a substantially higher throughput than the other two technologies, which makes them most efficient at large facilities and limits their applications at small- to medium-sized facilities. For this reason, rotary drum dryers were only considered for regional alternatives, and not at smaller scales.

Because belt and indirect dryers are both commonly installed at POTWs of a range of sizes at least one was included for further analysis at all scales. Thin film dryers are indirect dryers that are widely used internationally and in a variety of industries but have not been used as frequently in the U.S. for wastewater solids. Thin film dryers have fewer issues with processing undigested solids and so were included in this analysis as a representative technology for indirect dryers. Thermal dryers work best when paired with anaerobic digestion. The anaerobic digestion process produces a stabilized sludge, which is less likely to cause mechanical issues in dryers and results in a better-quality solids product. In Maine, most biosolids will be sent to landfill, so a 90% TS end product, as could be achieved with the highest quality of drying in order to meet EPA Class A pathogen reduction requirements, will not be necessary. A lesser percentage of total solids will significantly reduce the risk of dust and dust-related issues. Paddle dryers, another type of indirect dryer, were not considered in this analysis because the sole current paddle dryer vendor will not supply a unit for un-stabilized solids because paddle dryers have a more turbulent dryer chamber, which leads to more dust generation, particularly with un-stabilized primary sludge. There are a limited number of dryer installations in the U.S. processing un-stabilized primary sludge, which may pose a challenge for use of dryers on un-stabilized sludge in Maine.

5.1.3.1 Belt Dryer

Belt dryer installations are common in both in the U.S. and Europe. They can be either direct or indirect. Indirect and direct thermal dryers are established technologies. Heat is typically supplied by a fuel-burning furnace that serves to heat a thermal fluid, water, or flue gas. Belt dryers can be fueled by natural gas (NG), biogas, propane, thermal oil, or electricity. Because of the lower temperature operation, (lower grade, i.e., lower temperature) waste heat from other POTW processes can be used. Dewatered biosolids are distributed via nozzles or perforated plates onto a slow-moving porous belt that provides a large surface area exposed to the hot heat exchanger fluid or process air. Belt dryers shape and distribute dewatered solids into noodle or granule shaped particles onto a slow-moving porous belt. Warm process gases are circulated through the belt chamber to evaporate the water content in the feed solids. The material’s shape provides a large surface for exposure to the warm process gas, and the slow-moving belt provides contact time and generates minimal dust and fines. Belt dryers without further processing generate a product with irregular size distribution and low density. The resulting TS concentration after belt drying is typically higher than 90%. This product typically has a limited market but is acceptable for landfilling purposes. The low density can mean more trucking as well, since vehicles that are full of product are below the truck’s weight limit. Pelletizers can be added following the dryer to obtain a more dense and uniform product, but these systems are typically expensive to buy and operate, and the added complexity may not be balanced by additional sales revenue.

Wastewater solids with high amounts of fibrous and stringy materials can plug some types of extruders and may need to be screened for use with these types of extrusion systems. The slow-moving belts provide contact time and generate minimal dust and fines in the dryer cabinet. Belt dryer exhaust is commonly dehumidified with a condenser, then reheated and mixed with incoming air to minimize exhaust volume and reuse waste heat. Alternatively, some belt dryers use an air-to-water heat exchanger in the exhaust to capture waste heat and return it to the dryer inlet to heat the incoming process gas stream. Most belt dryers are operated automatically and only require roughly half a full-time employee for the first shift. To maintain this equipment, weekly and quarterly cleaning is recommended, as is replacing limited-wear items every 1 to 5 years. The footprint required for belt dryers is relatively large and operating complexity is moderate. Additionally, the end product is dependent on the belt dryer manufacturer.

5.1.3.2 Thin Film Dryer

Thin film dryers are indirect dryers that are widely used internationally and in a variety of industries but are not yet established in the U.S. for biosolids. These dryers can be used with a wide variety of sludge, including digested or undigested, high-strength waste, fibrous, and blended sludges. The thin film dryer allows partial to full drying operations for TS concentrations between 30% and 95%. Typical operation of a thin film dryer pumps sludge into the rotating blades within the dryer where the sludge is pressed into a thin film across the dryer’s outer heating surface. Thin film dryers evenly distribute the solids above the heated zone and over the unit’s inner surface. The material is then transferred to the thermal surface. The solids are pushed by the dryer blades to the discharge section. The resulting dried biosolids can be Class A, used for landfilling, or be processed further through incineration, gasification, and pyrolysis. Moisture released from the sludge flows out of the dryer to a condenser where an exhaust fan extracts the moisture. Thin film dryers generate a particle that is more uniform and dense than a belt-dried product, but not as high quality as a rotary drum dryer.

These dryers can be heated by steam, hot water, or thermal oil that flows on the outside of the heating surface. The thermal efficiency of thin film dryers depends on the heating fuel and is typically higher than 85%. Approximately half of the installations in Europe run unattended because the controls are set up with interlocks that can shut down the equipment if there is an issue with the system.

5.1.3.3 Rotary Drum Dryer

Rotary drum dryers are an established technology in the U.S. and internationally, particularly at large-scale facilities. Drum dryers operate by heating sludge using process air at roughly 1,100° Fahrenheit in a large drum. This is the highest temperature drying equipment; therefore, these dryers have the highest throughput compared to other drying technologies, which makes them the most efficient for large-scale facilities. In addition, they have a moderately sized footprint for their capacity, and relatively high operations and maintenance complexity. They typically require 1 to 2 full-time employees on all three shifts with hourly sampling and checks while the equipment is running to ensure smooth execution.

5.2 Selection of Representative POTW Sizes

To determine the four facility sizes to be evaluated as representative POTWs in this study, the total number of facilities in the state was determined, and sizing categories were developed based on Maine POTW Waste Discharge License Type codes, as shown in Table 5-1. In addition to this analysis, a map of the POTW sizes in the state of Maine was developed to gain a better understanding of where these facilities are located in relation to one another, as well as their potential hauling and disposal routes. The map of POTWs is shown in Figure 5-1.

Table 5-1. Size and Count of Maine POTWs

Size of POTW (gpd)	Type Code	Number of POTWs
More than 5 million	5M[a]	13
1 to 5 million	6D	35
100,000 to 1 million	6C	62
10,000 to 100,000	6B	32
Less than 10,000	6A	10

[a] Or any size with significant industrial waste

mgd = million gallons per day

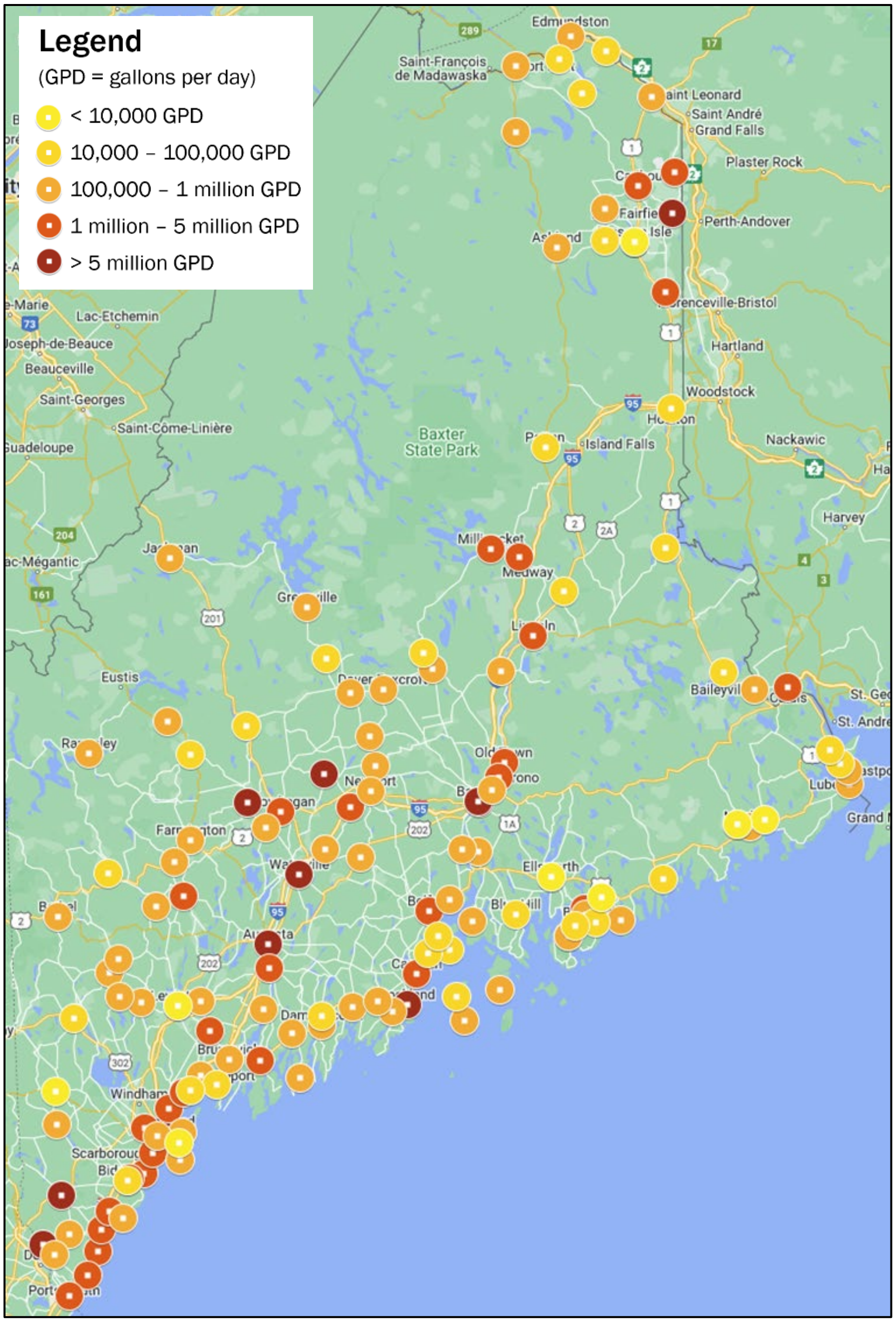


Figure 5-1. Distribution of POTWs by size

Based on the distribution of POTW sizes in Maine, the following were chosen as the conceptual facility sizes (in million gallons per day, [mgd]) for the alternatives analysis portion of this study:

- Small: 0.5 mgd
- Medium: 2.5 mgd
- Large: 7.0 mgd
- Regional: 20 mgd

5.3 Cost Evaluation Methodology

5.3.1 Operations and Maintenance Costs

Annual O&M costs were estimated for each alternative. General assumptions, along with their reasoning, are shown in Table 5-2; assumptions specific to each alternative are shown in tables in the following sections. Costs in the following sections are shown for the estimated solids production and costs in 2026, which is assumed to be the earliest year by which a project of this sort could be implemented. All operating costs are escalated annually by 4.2% for the life-cycle cost analysis (see Section 5.3.3).

Table 5-2. General Operation and Maintenance Cost Assumptions (2023)

Cost	Units	Value in Model	Basis
Electricity	$/kWh	$0.14	maine.gov
Natural gas	$/mmBtu	$14.78	maine.gov
Polymer	$/lb	$1.25	Typical value
Labor	$/hour	$36.53	ziprecruiter.com
Major equipment repair and rehabilitation (R&R)	%	2% of capital cost	Cost factor based on similar projects
Dewatered biosolids hauling and landfilling	$/wet-ton	$140	Typical current rate
Dried product hauling and management	$/wet-ton	$100	Assumption based on discussion with biosolids management companies
Hauling cost to regional facility	$/wet-ton	$15	Typical value

kWh = kilowatt hour

mmBtu = million British thermal units

It was assumed that biogas generated was used only for digester heating and offsetting energy needs for the dryer (if applicable). No additional value was assumed for the gas. There are incentive programs for renewable power and renewable fuel generation from beneficial use of biogas that could help the economics of projects like the ones under consideration in these alternatives.

5.3.2 Capital Costs

In accordance with the Association for the Advancement of Cost Engineering International (AACE) criteria, Class 5 capital estimates were developed as a means of comparing costs for the different alternatives. In a Class 5 estimate, engineering is typically 0% to 2% complete. Class 5 estimates are used to prepare planning-level cost scopes or to evaluate alternatives in design conditions and form the base work for the Class 4 project budget or funding estimate. Development of Class 4 estimates would be recommended if a project were advanced for inclusion in a capital plan.

Expected accuracy for Class 5 estimates typically range from -50 to +100%, depending on the project’s technological complexity, appropriate reference information, and the inclusion of an appropriate contingency determination. In unusual circumstances, ranges could exceed those shown.

The factors in Table 5-3 were used to estimate total project cost for each alternative. Major equipment costs were developed based on vendor budgetary estimates and comparable recent project costs. These are purely planning numbers that should be vetted as part of a more complete design assessment. Detailed cost estimate calculations for each alternative are shown in Appendix C. These assumptions are based on historical cost factors; recent price instabilities could have a disproportionate impact on certain factors. More analysis would be needed in further design.

Table 5-3. Construction Cost-estimating Markups

Markup	%	Basis
Installation	20%	of equipment cost
Electrical, Instrumentation & Controls	30%	of major mechanical equipment
Misc. Demolition	5%	of equipment installed in existing areas
Site Civil	10%	of equipment cost
Piping	15%	of equipment cost
Shipping and Handling	2%	of materials and equipment
General Conditions, Contractor Overhead and Profit	30%	of subtotal of items above
Sales Tax	5.5%	
Bonds and Insurance	2.5%	
Construction Management	10%	
Contingency	30%	
Engineering	10%	

5.3.3 Life-cycle Cost Analysis

BC created a process and cost model in its Solids-Water-Energy Evaluation Tool (SWEET) to evaluate the technical performance and economic viability of installing the different alternatives. The economic analysis considered capital and operating costs and produced a 20-year net present cost (NPC) life-cycle cost analysis of the alternatives.

For NPC calculations, the interest rates in Table 5-4 were used. These values were obtained from the most recent version of the United States Office of Management and Budget Circular A-94, Appendix C (December 2022). All operating costs are escalated by 4.2% per year to account for inflation and other price increases. Future costs are brought back to 2023 dollars via a 2.2% discount rate. These calculations assume capital, construction, and operation costs start in 2026, and operation continues for 20 years to 2046. Appendix D shows the NPC calculations for each alternative.

Table 5-4. Interest Rate Assumptions

Escalation Rate	4.2%
Discount Rate	2.2%

5.3.4 Sensitivity Analysis

The effect of a change in one of three cost factors that can vary significantly was used to determine the sensitivity of the results obtained in the life-cycle analysis. These factors are:

- Dewatered biosolids management cost (increase to $190/wet-ton): As discussed, there is significant uncertainty about the future management options in Maine and nearby states and provinces. Under some scenarios (e.g., JRL is not expanded), biosolids management costs would likely increase far more, but $190/wet-ton is in the range of the increased cost many utilities were paying during the challenges of spring 2023.
- NG cost (+50%): A non-renewable resource, for which supply and demand heavily influence prices, and which is predicted to increase in price over time.
- Funding (-30% in capital cost): State and federal grants and no- or low-interest loans can have a significant impact on the overall project payback, but funds are limited.

5.4 Cost Evaluation Results: Small POTW

The small-scale (0.5 mgd) alternatives are listed in Table 5-5. The first alternative at this scale is considered the baseline alternative, which assumes the addition of dewatering. The second and third alternatives add a raw sludge belt dryer or raw sludge thin film dryer. Digestion is unlikely to be feasible for small facilities. Thin film dryers and belt dryers have been proven to be effective at processing undigested sludge, so they were chosen as the best equipment to achieve sludge volume reduction for these alternatives.

Table 5-5. List of Small (0.5 mgd) POTW Alternatives

Alternative	Major Solids Processing Equipment
1-A (Baseline)	Dewatering
1-B	Dewatering + Raw Sludge Belt Dryer
1-C	Dewatering + Raw Sludge Thin Film Dryer

5.4.1 Operations and Maintenance Costs

O&M costs for small-scale facilities were analyzed based on biosolids hauling and landfill tip fees, electricity, NG, polymer, labor, and repair and rehabilitation (R&R) costs. The total costs for each of these factors and their given alternatives are shown in Table 5-6.

Table 5-6. O&M Costs for Small-scale POTW Alternatives ($ thousands)

Alternative ID	Description	Biosolids Management	Electric	NG	Polymer	Labor	R&R	TOTAL
1-A (Baseline)	Dewatering Only	$122k	$7k	--	$14k	--	$16k	$160k
1-B	Raw Sludge Belt Dryer	$29k	$210k	$36k	$14k	$76k	$42k	$408k
1-C	Raw Sludge Thin Film Dryer	$29k	$210k	$36k	$14k	$76k	$42k	$408k

5.4.2 Capital Costs

Capital costs for the small-scale POTW alternatives were estimated using AACE Class 5 estimating standards. Budgetary quotes from vendors as well as recent project data and the markup assumptions shown in Section 5.3.2 were used to estimate capital costs for these alternatives. It was assumed that new buildings would be needed for new equipment.

Table 5-7. Class 5 Capital Cost Estimates for Small-scale POTWs ($ millions)

Alternative ID	Description	Major Equipment Cost	Capital Cost Estimate[a]	Estimating Range
1-A (Baseline)	Dewatering Only	Dewatering Centrifuge: $0.8M	$2.9M	$1.5M to $6M
1-B	Raw Sludge Belt Dryer	Dewatering Centrifuge: $0.8M Belt Dryer: $1.3M	$10.3M	$5M to $21M
1-C	Raw Sludge Thin Film Dryer	Dewatering Centrifuge: $0.8M Thin Film Dryer: $1.3M	$10.3 M	$5M to $21M

a. *AACE Class 5 Capital Cost Estimate*

5.4.3 Life-cycle Cost Analysis

Results of a 20-year life-cycle cost analysis of the small-scale facility alternatives are shown in Figure 5-2. These life-cycle costs are based on NPCs in 2023-equivalent dollar values. Figure 5-2 shows that for smaller facilities, the most economically feasible alternative is the baseline dewatering alternative, which will have the least overall capital costs and O&M costs compared to the other two alternatives. The belt drying and thin film drying options (1-B and 1-C) are closer in terms of NPC, but still double that of the baseline alternative, 1-A.

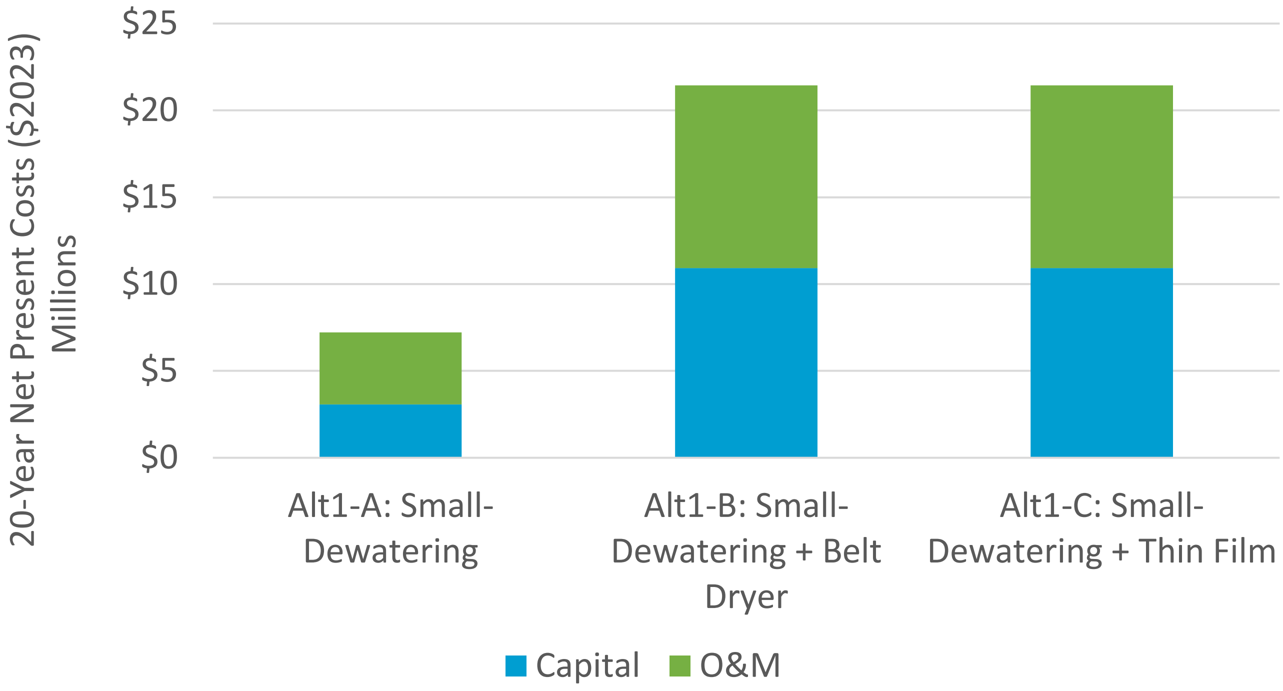


Figure 5-2. Net present cost for small-scale POTW alternatives

5.4.4 Sensitivity Analysis

The results of a sensitivity analysis on the small-scale alternatives' NPCs are shown in Figure 5-3. None of the variables changes the overall result. This matches with previous experience; dryers typically do not have a sufficient payback at this scale to make up for the capital cost within the dryer's life cycle.

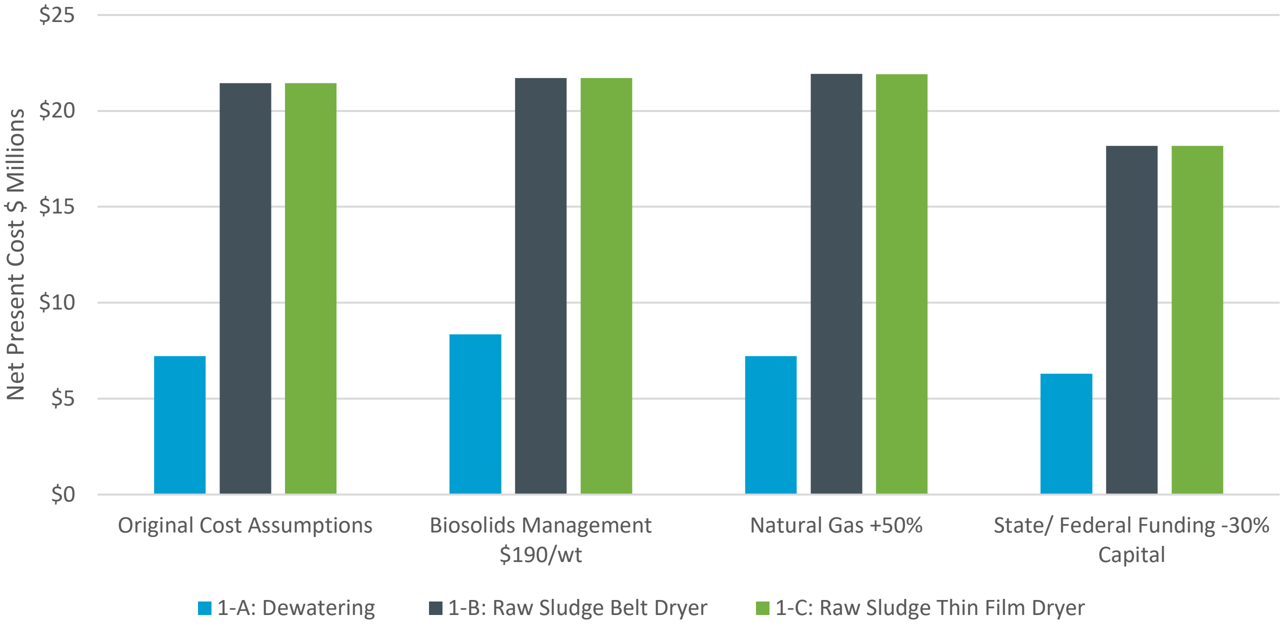


Figure 5-3. Sensitivity analysis for small-scale POTW alternatives

5.5 Cost Evaluation Results: Medium POTW

The medium-scale (2.5 mgd) alternatives are listed in Table 5-8. All alternatives assume that the facility already has dewatering. The first alternative at this scale is the baseline alternative, which assumes no new equipment is added. Alternative 2-A includes the addition of a raw sludge (i.e., undigested) thin film dryer. Alternative 2-B adds mesophilic anaerobic digestion for volume reduction, and assumes the existing dewatering will be used after digestion. Alternative 2-C adds a belt dryer to the equipment from 2-B.

Table 5-8. List of Medium-scale (2.5 mgd) POTW Alternatives

Alternative	Major Solids Processing Equipment
2-Baseline	No new equipment
2-A	Raw Sludge Thin Film Dryer
2-B	Mesophilic Anaerobic Digestion (MAD)
2-C	MAD + Belt Dryer

5.5.1 Operations and Maintenance Costs

O&M costs for medium-scale facilities were analyzed based on biosolids hauling and landfilling, electricity, NG, polymer, labor, and repair and rehabilitation (R&R) costs. The total costs for each of these factors and their given alternatives are shown in Table 5-9. Dewatering power and polymer costs are calculated for all alternatives, including the baseline, since digestion upstream has an impact on dewatering (fewer solids and typically higher polymer usage). It should be noted that the O&M cost for the baseline scenarios (continued landfilling of dewatered biosolids) is predominantly driven by volatile biosolids management costs. There is an advantage to the alternatives that are more distributed to several, more stable costs (e.g., electricity, NG, polymer, and maintenance).

Table 5-9. O&M Costs for Medium-scale POTW Alternatives ($ thousands)

Alternative ID	Description	Biosolids Management	Electric	NG	Polymer	Labor	R&R	TOTAL
2-Baseline	Dewatering Only	$610k	$35k	--	$75k	--	--	$720k
2-A	Raw Sludge Thin Film Dryer	$151k	$239k	$169k	$75k	$76k	$37k	$747k
2-B	MAD	$387k	$234k	--	$46k	$153k	$75k	$895k
2-C	MAD + Belt Dryer	$91k	$437k	$62k	$46k	$229k	$104k	$968k

5.5.2 Capital Costs

Capital costs for the medium-scale POTW alternatives were estimated using AACE Class 5 estimating standards. Budgetary quotes from vendors as well as recent project data and the markup assumptions shown in Section 5.3.2 were used to estimate capital costs for these alternatives. It was assumed that new buildings would be needed for new equipment.

Table 5-10. Class 5 Capital Costs for Medium-scale POTW Alternatives ($ millions)

Alternative ID	Description	Major Equipment Cost	Capital Cost Estimate[a]	Estimating Range
2-A	Raw Sludge Thin Film Dryer	Thin Film Dryer: $2M	$10M	$5M to $20M
2-B	MAD	Digesters: $4M	$12M	$6M to $24M
2-C	MAD + Belt Dryer	Digesters: $4M Belt Dryer: $4M	$22M	$11M to $44M

[a] *AACE Class 5 Capital Cost Estimate*

5.5.3 Life-cycle Cost Analysis

The results of a 20-year lifecycle cost analysis of the medium-scale facility alternatives are shown in Figure 5-4. These life-cycle costs are based on NPCs in 2023-equivalent dollar values. Figure 5-4 shows that for medium-sized facilities, the most economically feasible alternative is the baseline dewatering alternative, which will have the least overall capital and O&M costs compared to the other two alternatives. The raw sludge thin film drying alternative (2-A) is the second most economically feasible alternative for medium-scale facilities, with O&M costs that are roughly the same as the baseline O&M costs. Alternatives 2-B and 2-C are the most-costly alternatives, with the addition of anaerobic digestion.

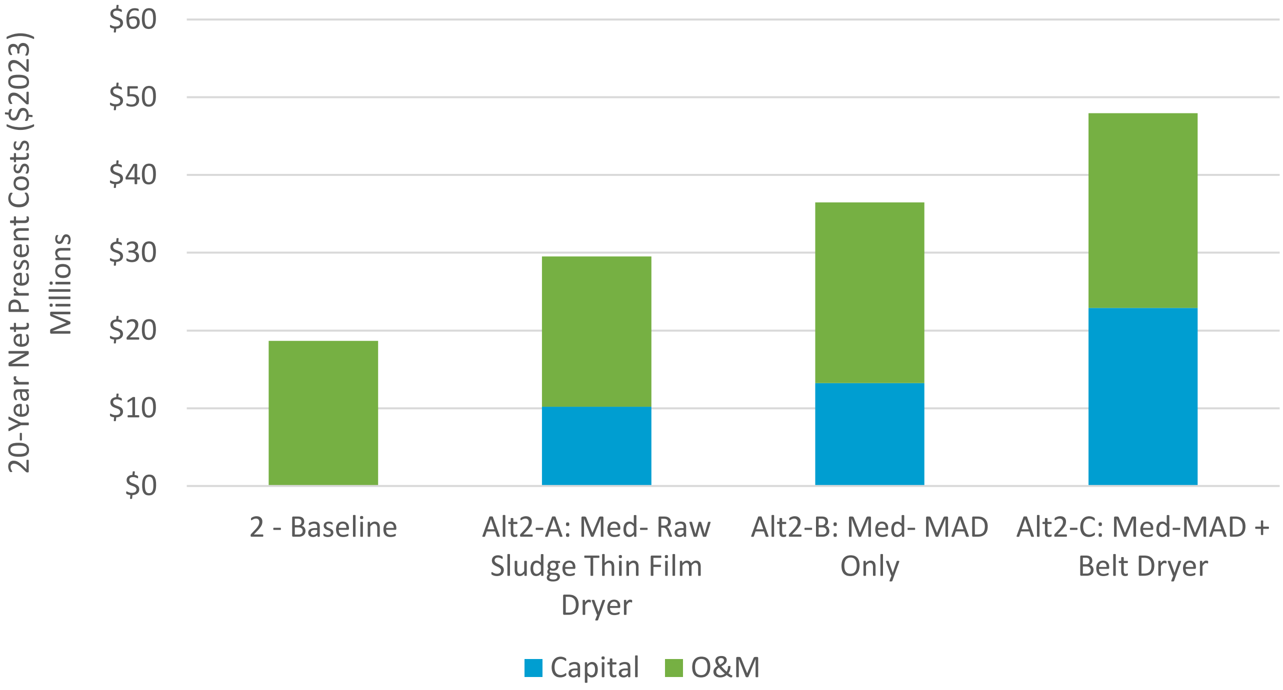


Figure 5-4. Net present costs for medium-scale POTW alternatives

5.5.4 Sensitivity Analysis

The results of a sensitivity analysis on the medium-scale alternatives' NPCs are shown in Figure 5-5. For these alternatives, the NG increasing by 50% or the biosolids hauling costs increasing to $190/wet ton had minimal impact on their NPCs compared to the original cost assumptions. The most impactful variable on these relative costs is funding from the state, which in this case was assumed to be 30% of the overall capital cost. Higher rates of funding could make dryer projects economically feasible. The value to the state in supporting dryer projects is that dryer projects free up landfill capacity for biosolids from other POTWs.

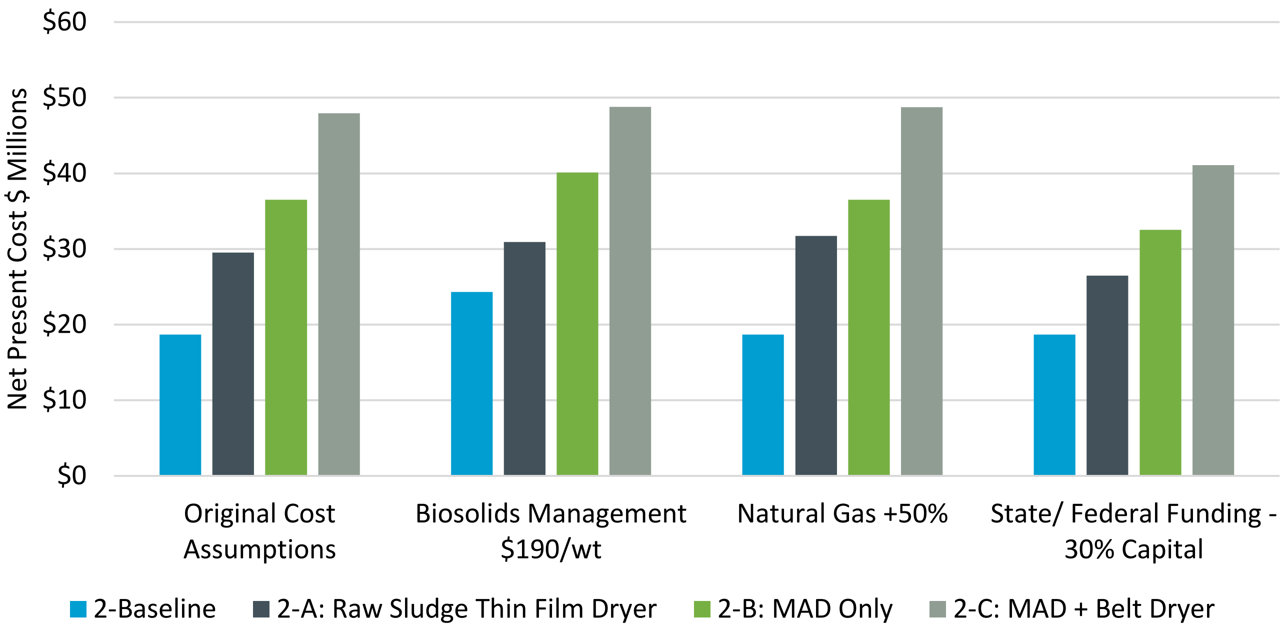


Figure 5–5: Sensitivity analysis for medium-scale POTW alternatives

5.6 Cost Evaluation Results: Large POTW

The large-scale (7.0 mgd) alternatives are listed in Table 5-11. All alternatives assume that the facility already has dewatering. The first alternative at this scale is the baseline alternative, which assumes no new equipment is added. Alternative 3-A includes the addition of a raw sludge belt dryer. Alternative 3-B adds mesophilic anaerobic digestion for volume reduction and assumes the existing dewatering will be used after digestion. Alternative 3-C adds a belt dryer to the equipment from 3-B.

Table 5-11. List of Large-scale (7.0 mgd) POTW Alternatives

Alternative	Major Solids Processing Equipment
3-Baseline	No new equipment
3-A	Raw Sludge Belt Dryer
3-B	MAD
3-C	MAD + Belt Dryer

5.6.1 Operations and Maintenance Costs

O&M costs for large-scale facilities were analyzed using the SWEET model based on biosolids hauling and landfilling, electricity, NG, polymer, labor, and R&R costs. The total costs for each of these factors and their given alternatives are shown in Table 5-12.

Table 5-12. O&M Costs for Large-scale POTW Alternatives

Alternative ID	Description	Biosolids Management	Electric	NG	Polymer	Labor	R&R	TOTAL
3-Baseline	Dewatering Only	$1.7M	$99k	--	$201k	--	--	$2.0M
3-A	Raw Sludge Belt Dryer	$423k	$303k	$472k	$201k	$153k	$126k	$1.8M
3-B	MAD	$1.1M	$297k	--	$127k	$153k	$107k	$1.8M
3-C	MAD + Belt Dryer	$255k	$500k	$207k	$127k	$305k	$210k	$1.6M

5.6.2 Capital Costs

Capital costs for the large-scale POTW alternatives were estimated using AACE Class 5 estimating standards. Budgetary quotes from vendors as well as recent project data and the markup assumptions shown in Section 5.3.2 were used to estimate capital costs for these alternatives. It was assumed that new buildings would be needed for new equipment.

Table 5-13. Class 5 Capital Costs for Large-scale POTW Alternatives ($ millions)

Alternative ID	Description	Major Equipment Cost	Capital Cost Estimate[a]	Estimating Range
3-A	Raw Sludge Belt Dryer	Belt Dryer: $5.6M	$29M	$15M to $58M
3-B	MAD	Digesters: $5M	$18M	$9M to $36M
3-C	MAD + Belt Dryer	Belt Dryer: $5.6M Digesters: $5M	$42M	$21M to $84M

[a] *AACE Class 5 Estimate*

Note that privately developed projects do not typically have the same redundancy and materials of construction as municipal facilities, which are constructed for reliability and longevity. In addition, some private owners or operators may be able to realize further capital and operational savings via management decisions, including use of landfill gas or maintenance of backup outlets to manage cake in case of process upset or shutdown.

5.6.3 Life-cycle Cost Analysis

The results of a 20-year life-cycle cost analysis of the large-scale facility alternatives are shown in Figure 5-6. These life-cycle costs are based on NPCs in 2023-equivalent dollar values. Figure 5-6 shows that for large-sized facilities, the most economically feasible alternative is digestion only (3-B), which is slightly above the baseline dewatering costs.

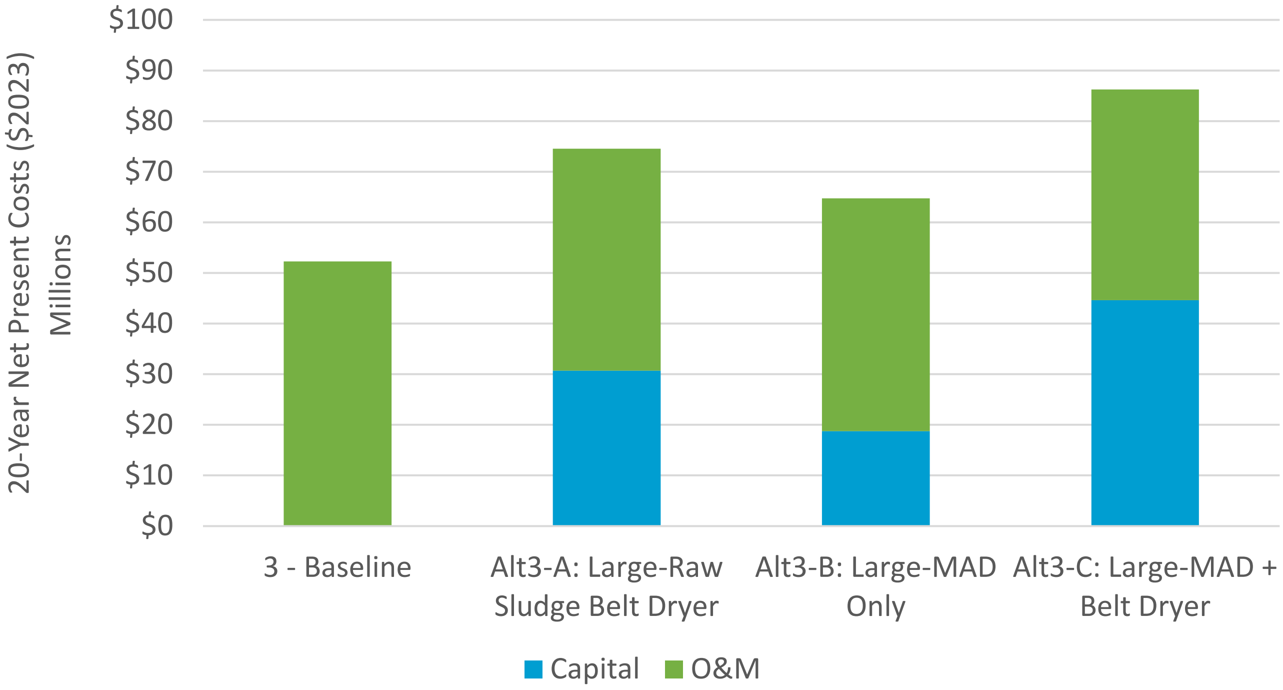


Figure 5-6. Net present costs for large-scale POTW alternatives

5.6.4 Sensitivity Analysis

The results of a sensitivity analysis on the large-scale alternatives' NPCs are shown in Figure 5-7. For these alternatives, the NG increasing by 50% or the biosolids hauling costs increasing to $190/wet ton had minimal impacts on their NPCs compared to the original cost assumptions. The most impactful variable on these relative costs is funding from the state, which in this case was assumed to be 30% of the overall capital cost. Higher rates of funding could make dryer or digestion projects economically feasible.

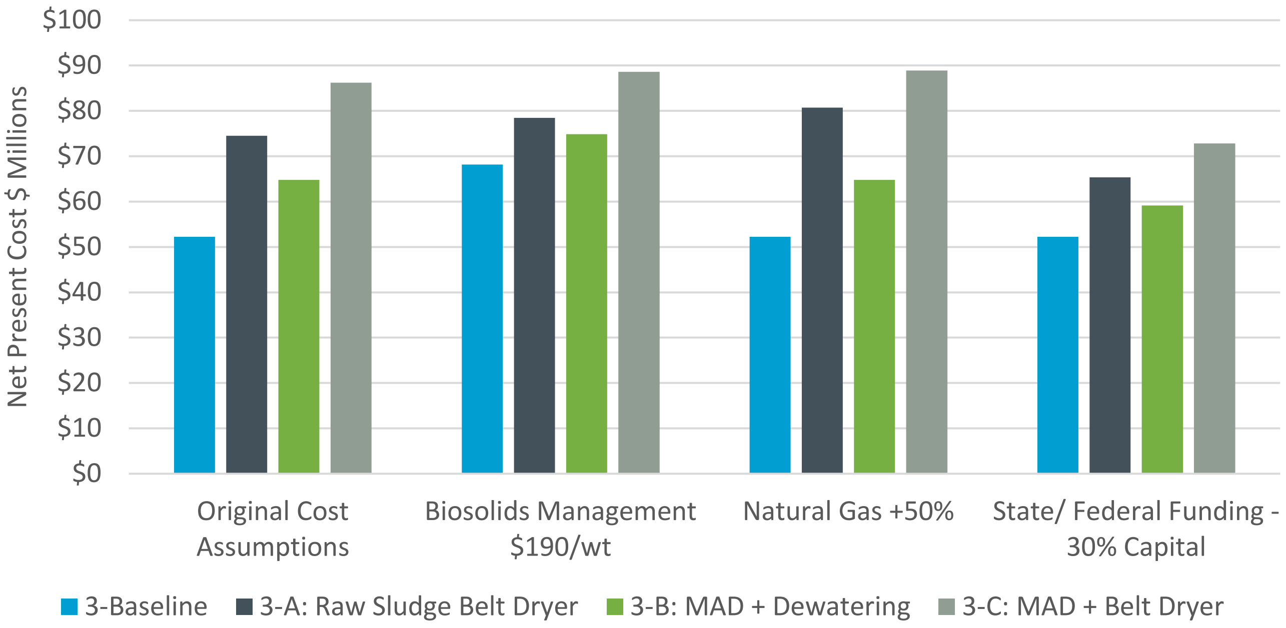


Figure 5-7. Sensitivity analysis of large-scale POTW alternatives

5.7 Cost Evaluation Results: Regional Facility

The regional-scale (20 mgd) alternatives are listed in Table 5-14. The first alternative at this scale is considered the baseline alternative, which assumes that the facility in question has a dewatering process in place. Alternative 4-A includes the addition of a raw sludge belt dryer. Alternative 4-B pairs dewatering with a raw sludge belt dryer, and Alternative 4-C is the most complex alternative, with thermal hydrolysis, anaerobic digestion, dewatering, and a belt dryer.

Table 5-14. List of Regional-scale (20 MGD) POTW Alternatives

Alternative	Major Solids Processing Equipment
4-Baseline	No new equipment
4-A	Raw Sludge Belt Dryer
4-B	Raw Sludge Drum Dryer
4-C	Thermal Hydrolysis Process + Anaerobic Digestion + Dewatering + Belt Dryer

5.7.1 Operations and Maintenance Costs

O&M costs for regional-scale facilities were analyzed using the SWEET model based on biosolids hauling and landfilling, electricity, NG, polymer, labor, R&R, and cake hauling costs to the regional facility. The total costs for each of these factors and their given alternatives are shown in Table 5-15.

Note that for a facility like the dryer proposed at the Crossroads Landfill that has access to very-low-cost power (in that case from on-site landfill gas power generation) the operating costs would be significantly reduced from what is shown in the table.

Table 5-15. O&M Costs for Regional-scale Alternatives

Alternative ID	Description	Biosolids Management	Electric	NG	Polymer	Labor	R&R	Hauling Cake to Regional Facility	TOTAL
4-Baseline	Dewatering Only	$4.7M	--	--	--	--	--	--	$4.7M
4-A	Raw Sludge Belt Dryer	$1.2M	$203k	$1.3M	--	$305k	$190k	$498k	$3.8M
4-B	Raw Sludge Drum Dryer	$1.2M	$203k	$1.2M	--	$381k	$302k	$498k	$3.8M
4-C	THP + MAD + Dewatering + Belt Dryer	$543k	$629k	$138k	$271k	$517k	$1.1M	$498k	$3.7M

5.7.2 Capital Costs

Capital costs for the regional-scale POTW alternatives were estimated using AACE Class 5 estimating standards. Budgetary quotes from vendors as well as recent project data and the markup assumptions shown in Section 5.3.2 were used to estimate capital costs for these alternatives. It was assumed that new buildings would be needed for new equipment.

Table 5-16. Class 5 Capital Cost Estimates for Regional-scale POTW Alternatives ($ millions)

Alternative ID	Description	Major Equipment Cost Estimate	Capital Cost Estimate[a]	Estimating Range
4-A	Raw Sludge Belt Dryer	Cake Receiving: $4.1M Belt Dryer: $5.5M	$44M	$22M to $88M
4-B	Raw Sludge Drum Dryer	Cake Receiving: $4.1M Drum Dryer: $11M	$71M	$36M to $142M
4-C	THP + MAD + Dewatering + Belt Dryer	Cake Receiving: $4.1M THP: $30M Digesters: $9M Centrifuges: $3.5M Belt Dryer: $3M	$199M	$100M to $398M

[a] *AACE Class 5 Capital Cost Estimate*

Note that privately developed projects do not typically have the same redundancy and materials of construction as municipal facilities, which are constructed for reliability and longevity. In addition, some private owners or operators may be able to realize further capital and operational savings via management decisions, including use of landfill gas or maintenance of backup outlets to manage cake in case of process upset or shutdown.

5.7.3 Life-cycle Cost Analysis

The results of a 20-year life-cycle cost analysis of the regional-scale facility alternatives are shown in Figure 5-8. These life-cycle costs are based on NPCs in 2023-equivalent dollar values. Figure 5-8 shows that for regional-sized facilities, the most economically feasible alternative is the raw sludge belt dryer alternative (4-A); however, it is still higher than the baseline of individual POTWs continuing to dewater and send biosolids cake to the landfill directly.

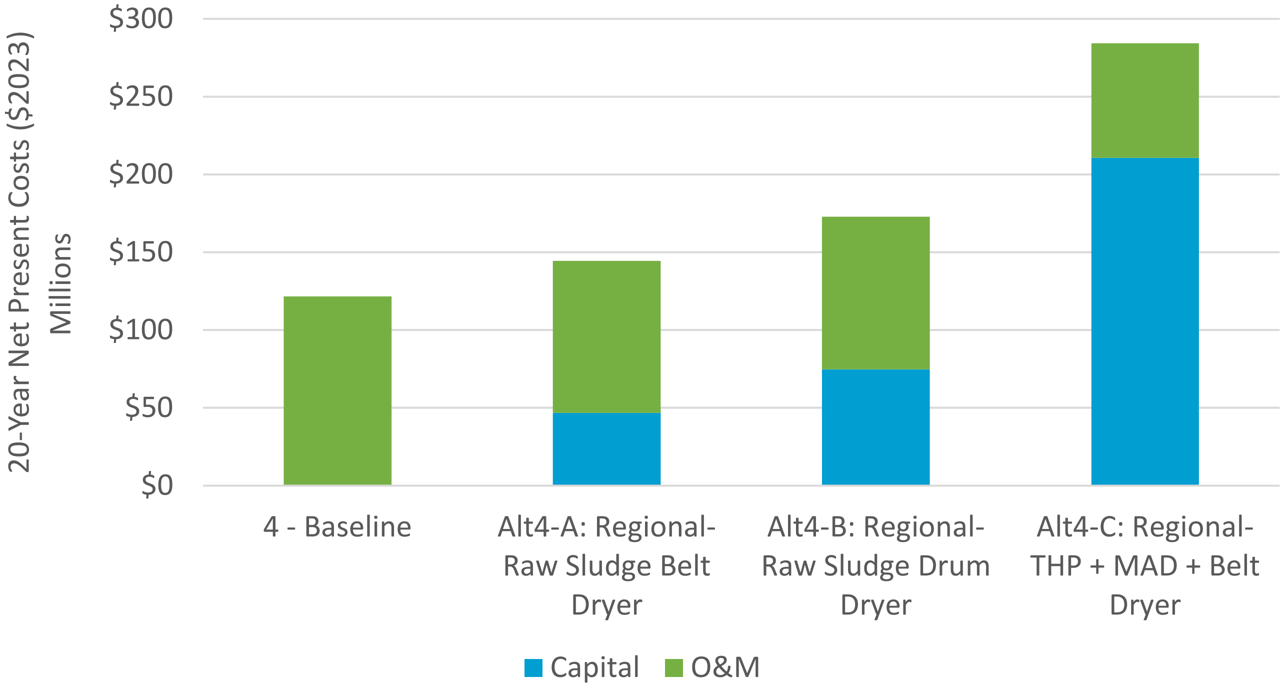


Figure 5-8. Net present costs for regional-scale alternatives

5.7.4 Sensitivity Analysis

The results of a sensitivity analysis on the regional-scale alternatives' NPCs are shown in Figure 5-9. For these alternatives, the NG increasing by 50% had minimal impacts on the relative NPC compared to the original cost assumptions. The most impactful variable on these costs is increasing biosolids management costs. If biosolids costs were to return to the levels seen in spring 2023 ($190/wet-ton), regional drying alternatives would be competitive with individual POTWs continuing to dewater and landfill biosolids cake directly. State or federal funding also brings the NPC closer to parity with the baseline.

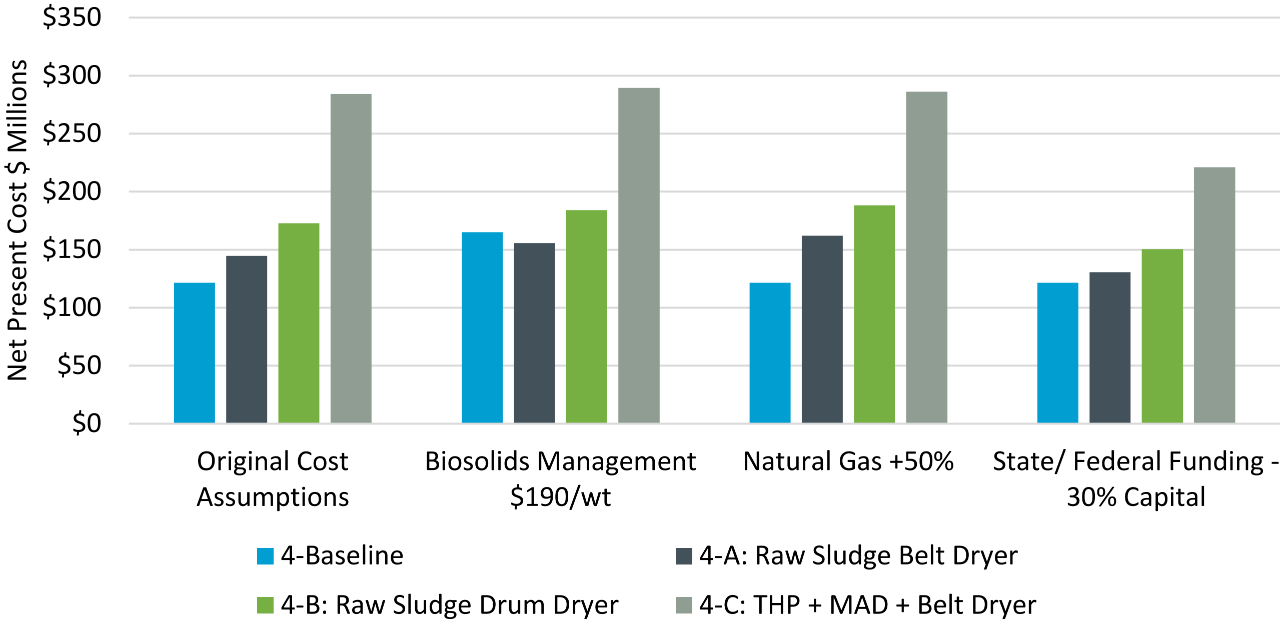


Figure 5-9. Sensitivity analysis for regional-scale POTW alternatives

5.8 Summary of Cost Evaluation Results

This analysis shows the importance of economies of scale for the technologies under consideration. Dryers and digestion typically do not make sense economically at small facilities, but can have a payback at larger facilities, particularly with state or federal support to offset some of the construction costs. Economies of scale are especially apparent for regional-scale facilities, which have the benefit of managing more material and hence having a more meaningfully impact on the overall state of biosolids capacity in the state. If biosolids costs increase to the levels seen in spring 2023 or if sufficient funding is provided, regional drying facilities appear to be cost effective according to the assumptions in this analysis.

Section 6: Piloting PFAS Treatment Technologies

Across the U.S. there is a need to identify cost-effective technologies to reduce the levels of PFAS in biosolids. While several technologies have shown promising results in reducing PFAS in biosolids, this is an emerging area of research (Winchel, 2020). Using knowledge gained from other studies, Maine can develop a pilot study that matches the specific needs of utilities in the state and answers questions still remaining regarding the fate of PFAS in these treatment processes. The pilot project will contribute to the advancement of scientific knowledge and the development of best practices for PFAS treatment in biosolids. The results of the study, as well as results of studies elsewhere in the U.S., can be used to determine if these technologies are able to provide levels of PFAS reduction that the state would want to support for full-scale development in the state, and inform the required regulatory approach.

To select a pilot(s), BC recommends that the state of Maine authorize funding for and issue a request for proposal (RFP) from interested vendors. Sections 6.1 and 6.2 discuss some of the particular considerations for this type of piloting, which will be significantly more involved than pilots of more traditional wastewater treatment equipment. Vendors of the technologies under consideration reportedly can charge hundreds of thousands of dollars for on-site pilots lasting 2 to 3 months. Costs can be less for shorter-term piloting at out-of-state demonstration facilities or existing installations. Section 6.4 provides the suggested screening criteria for selecting proposals that are eligible for funding. Also presented are suggested responsibilities during piloting for the vendor, the host POTW (if applicable) and the state (Section 6.5; PFAS sampling protocols specific to these technologies (Section 6.6); and intended pilot outputs (Section 6.7).

As one of the state's piloting goals would be to determine which technologies could provide significant PFAS reduction in biosolids and be worth supporting for full-scale development, if funding allows, it is recommended that DEP select at least one pilot from at least two technologies. If possible, for consistency, the biosolids used in the multiple pilots should come from the same POTW at the same time. For instance, if one pilot were being performed on site at a POTW and one at a remote site, the biosolids sent to the remote facility should be collected and sent at the same time as the biosolids were fed to the on-site pilot.

These technologies and vendors are not as mature as traditional processing equipment so there is the possibility that one pilot could fail. Funding more than one pilot would help ensure some results were obtained, even if one of the pilots should fail.

6.1 Siting Considerations

Siting considerations for the pilot study are important to ensure that the treatment technologies are tested under conditions where results are reliable and meaningful. Ideally, the pilot study will be located at a facility that accepts landfill leachate and/or septage. This will allow the pilot study to demonstrate the potential for disrupting the PFAS cycle, as landfill leachate and septage are common sources of PFAS contamination in wastewater and biosolids. Another siting option to consider would be to process solids from a facility with consistent, moderately elevated levels of a range of PFAS. This will ensure the treatment technologies are evaluated against elevated concentrations of PFAS so the impact of treatment is more apparent in the results.

6.2 Logistical Considerations

Piloting pyrolysis, gasification, and supercritical water oxidation (SCWO) is different from piloting other technologies, such as centrifuges, and thus requires several logistical considerations. Firstly, most PFAS reduction technologies require NG or another fuel source. This means that the pilot site should have access to a reliable and sufficient supply of NG or other suitable fuel source. For pyrolysis and gasification specifically, dewatered solids typically must be dried to less than 20% moisture content first. Each treatment technology will produce various solid and liquid residues that need to be monitored, collected, and disposed of properly, and air emissions that need to be monitored, collected, and treated properly. Maine DEP should work with host locations and technology vendors to establish a plan to handle these emissions prior to pilot startup.

6.3 Pilot Location

As many of these vendors do not have mobile pilot units, treatment technologies may not be readily available or transportable to the pilot site. Vendors should be evaluated on their readiness and availability to install technology at the selected host site. Some of the vendors may only have demonstration facilities or existing installations in other locations. These vendors should be considered if it is not feasible or economically viable to install the technology at a host plant in Maine.

6.4 Suggested Criteria for Selecting Pilots

BC recommends limiting piloting to the following technologies, which have commercially available units and have shown promising results for PFAS removal: pyrolysis, gasification, and SCWO. BC has published several literature reviews (e.g., Ross, et al., 2022) that show strong support for the significant reduction of PFAS in biosolids through pyrolysis and gasification units. For SCWO, the EPA showed a greater than 99% reduction of the PFAS compounds identified in a targeted analysis (Krause, 2022). Other technologies can be considered if peer-reviewed scientific literature showing significant PFAS reduction (i.e., >90%) in all phases (solid, liquid and air) is provided.

Table 6-1 shows suggested criteria that a proposer must meet to be considered for pilot funding.

Table 6-1. Suggested Pass/Fail Criteria for Screening Pilot Proposals

Category	Criteria
Willingness to Share Data	Is the respondent willing to share all operating, cost, PFAS, and other data associated with the pilot?
Technology with Proven Ability to Reduce PFAS	Is the respondent proposing one of the following technologies? • Pyrolysis • Gasification • SCWO • Others showing an overall destruction removal efficiency >90% as supported by submitted peer-reviewed scientific literature
Vendor Maturity	Has the respondent operated a full-scale unit (>3 wet-tons/day capacity) within the last 3 years that is functionally equivalent to the one proposed?
Availability of a Unit for Piloting	Does the vendor have a full-scale unit meeting one of the criteria below available for this pilot in the timeframe indicated in the RFP? • Mobile pilot unit • Demonstration facility • Existing installation

Respondents should also provide:

- A list of other installations, current and in development
- Life-cycle cost estimates

- Prior PFAS fate and transport research for their proposed pilot
- Staff qualifications to operate all aspects of the pilot, including relevant sampling of waste streams
- Information pertaining to the pilot's ability to handle other materials (e.g., PFAS treatment residuals)
- All-in costs per month (shipping, mobilization, interconnections, utilities, staff time, sampling)

In addition, if the pilot will be on site at a POTW in Maine, the respondent should also provide:

- Identification of a host site
- Required utilities
- Footprint size requirements
- Requirements for feedstock solids (e.g., is drying or slurrying of dewatered cake required before feeding?)

6.5 Roles and Responsibilities During Piloting

6.5.1 Technology Vendor

The vendor would be responsible for the following aspects of the pilot:

- Arranging all shipping and setup (for mobile units)
- Running all aspects of the pilot
- For out-of-state pilots, performing PFAS sampling per established protocol (Appendix E and send all samples as directed to an approved lab

6.5.2 Utility

The host plant of the pilot project plays a vital role in providing the necessary resources and support for the successful implementation and evaluation of the treatment technologies for PFAS in biosolids. The host plant will allocate a suitable area within its premises for pilot equipment installation and operation. The host plant will also supply the biosolids that will be used as the treatment technologies' feedstock. The biosolids should have a consistent quality and should be representative of the typical biosolids produced by the host plant. The host plant will collect and share the relevant operating data from the plant (e.g., total and volatile solids of dewatered cake) at the time of the pilot. The operability of the technology should also be evaluated, and feedback should be based on the experience and observations of the plant staff who are trained on the use of the pilot equipment. The overall ease of the technology's use is an important aspect in evaluating the feasibility on a larger scale.

6.5.3 State of Maine

State government is a key partner and stakeholder of the pilot project, as it provides support and resources for evaluating treatment technologies for PFAS in biosolids. Maine will fund the pilot project, covering the equipment installation costs and disposal costs for the end product.

Additionally, for in-state pilots, the state will provide personnel (staff or contractors) to conduct PFAS sampling and will cover the cost of laboratory analysis. Data associated with the pilot study will be compiled and analyzed by the state unless otherwise agreed. The state will grant the necessary regulatory approval for the pilot project.

6.6 PFAS Sampling Protocol

BC's research to date indicated that all inputs and outputs must be measured to ensure the full fate and transport of PFAS through the technology is determined. To truly understand what happens to the thousands of PFAS compounds, detailed analyses must be performed. A suggested PFAS sampling protocol, provided in Appendix F, includes the following items:

- All inputs and outputs, including stack emissions: This will involve collecting representative samples of the biosolids before and after treatment, as well as the air emissions from the treatment process. The samples will be stored and transported according to standard procedures and quality assurance/quality control measures.
- Targeted PFAS analysis: This will involve measuring the concentrations of specific PFAS compounds in the samples using validated analytical methods.
- Targeted byproducts analysis: This will involve measuring the concentrations of byproducts of the treatment technologies.
- Non-targeted analysis: This will involve identifying and characterizing unknown or emerging PFAS and byproducts in the samples using advanced analytical techniques.
- Total organic fluorine balance: This will involve measuring the total amount of organic fluorine in the samples. The total organic fluorine balance will help in evaluating the mass balance and removal efficiency of the treatment technologies for PFAS and byproducts.

6.7 Pilot Outputs

The pilot project aims to test the performance and feasibility of different treatment technologies for reducing PFAS in biosolids. To evaluate the effectiveness of these technologies, the pilot output should include publishing PFAS fate and transport data, which will show PFAS levels before and after treatment. Additionally, the pilot operating parameters and costs should be published, including energy usage and any added chemicals. Such considerations will provide information on the technical and economic aspects of the treatment technologies. This information will help to compare the advantages and disadvantages of each technology and to identify the most cost-effective and sustainable options for PFAS management in biosolids. Ideally, the data collected is sufficient to allow DEP to develop a regulatory and permitting strategy around these technologies and determine which could be beneficial to support for full-scale development.

6.8 Pilot Costs

Vendors of the technologies under consideration reportedly can charge hundreds of thousands of dollars for on-site pilots lasting 2 to 3 months. Costs can be less for shorter-term piloting at out-of-state demonstration facilities or existing installations.

Comprehensive PFAS treatment testing will add considerable cost as well, particularly air emissions testing. BC recommends running these studies on 3 consecutive days at the same operating parameters to have triplicate results. In the research projects BC is performing on pyrolysis units and incinerators, vendors have charged $50,000 for a 3-day test (4 hours each day). A targeted PFAS sample analysis for solids and liquid is around $500 per sample. Four sampling points (incoming cake, dryer exhaust, condensate, dried biosolids) over 3 days is an additional $6,000. One comprehensive round of sampling and analysis would, therefore, total approximately $56,000 to pilot.

Section 7: Recommendations

7.1 Biosolids Beneficial Use Screening Levels

The current situation for biosolids management in Maine is not sustainable. Leaving landfill disposal as the sole outlet for biosolids in the state exacerbates landfill capacity issues, runs counter to the state's solid waste management hierarchy as well as the state's climate goals, and leaves POTWs (and ultimately ratepayers) at the risk of drastic and sudden increases in biosolids management costs (as seen during the "sludge crisis" in 2023). The three landfills currently handling nearly all the biosolids generated in the state are all estimated to be exhausted in, at best, the next 20 years, with JRL (which handled nearly 90% of biosolids disposal in 2022) exhausted as soon as 2028. There are several proposals being developed to install biosolids dryers or thermal treatment technologies in the state (Section 4.4) but under the absolute restrictions on land application of biosolids and biosolids-derived products in Maine, the resulting dried biosolids, biochar, or other products would also have no outlet in the state when landfills are exhausted.

In the coming years, the state may, therefore, want to consider establishing screening levels to allow the use of biosolids and biosolids-derived products outside of landfills in a manner that protects human health and the environment. This is the approach being pursued by the EPA and every other state that has regulated PFAS in biosolids.

While some pushback to reversing the ban on the agronomic utilization of biosolids should be expected, several important factors have changed since the passing of Maine's biosolids land application ban:

- Maine has conducted significant sampling of biosolids and land application sites, which has shown that the significant impacts to particular dairy farms that ultimately led to the ban appear to be the exception rather than the rule. In particular, while the Department of Agriculture, Conservation, and Forestry has noted that about 70 farms have had varying levels of impacts from PFAS, there are almost 800 farms in Maine. At least four dairy farms that have had annual applications of biosolids for 30 years or more showed no detectable PFAS in their milk (NEBRA, 2019).
- The significant biosolids management challenges in 2023 have exposed the risk to utilities and ultimately ratepayers to having only one outlet for biosolids available in the state.
- As the requirements for reporting and restricting products containing PFAS (see Section 3.5) take effect in Maine (and elsewhere), the amount of PFAS in the state and consequently in biosolids should dramatically decrease in line with previous PFAS phase-outs. The Maine PFAS Task Force final report envisioned this reduction, stating "reduc[ing] uses of PFAS is expected to reduce concentrations of PFAS in residuals [biosolids] so that utilization can resume" (2020).
- The EPA is conducting a very thorough risk assessment of PFAS in biosolids, scheduled to be completed in late 2024, which is evaluating 18 human and ecological exposure pathways based on the latest research (Tobias, 2023). The anticipated result is the establishment of science-based PFAS limits for beneficially reused biosolids consistent with EPA' s mission to protect human health and the environment.

It is therefore recommended that the State Legislature consider reevaluating the ban on land application to determine if DEP ought to adopt the federal biosolids PFAS limits once established. Many other states are deferring to this comprehensive federal process for regulating PFAS in biosolids (Hughes, 2023). For instance, the New York interim strategy for controlling PFAS in recycled biosolids (i.e., those that are not landfilled) explicitly states that the state will incorporate federal standards when available (pending state review of the federal standards).

7.2 Landfill Capacity for Biosolids

The state-owned Juniper Ridge Landfill in Old Town was the outlet for nearly 90% of biosolids generated in Maine in 2022. This facility's current permitted capacity is estimated to be fully used by 2028. It is BC's understanding that the next step in the JRL expansion process is for the current JRL operator to submit a Public Benefit Determination (PBD) application (38 M.R.S. § 1310-AA) to DEP for approval. The last time JRL was expanded it took nearly 6 years between PBD submittal and final approval, with additional time needed to then construct the new area. For another state-owned landfill, the former Maine State Planning Office estimated 7 years would be needed to prepare the PBD and expansion applications, have them reviewed by DEP, address legal challenges, and construct the expansion. Using these timelines and to meet landfill expansion needs, the PBD should have been submitted by 2021 at the latest.

If JRL is not expanded, the state faces a dire situation for solid waste generally in the state. For biosolids, there is no current or proposed alternative outlet in the state that would be able to accept the tonnage currently handled at JRL. Regional facilities (Sections 4 and 5.7) and installation of digesters and dryers at POTWs (Section 5) will help, but it is unlikely more than one or two of these facilities will be operational by 2028. Out-of-state options would be very costly, with POTWs likely facing significantly higher costs than even those seen during mid-2023.

Given the severity of the implications if the facility is not expanded, it is recommended that **the State work with the current operator to ensure that an application is submitted as soon as possible** to ensure sufficient time to pursue alternatives if the expansion is not pursued by the current operator.

In a questionnaire sent to landfill operators in the state as part of this project, three additional landfill facilities expressed interest in discussing with DEP the possibility of obtaining authorization to accept biosolids (see Section 3.1). While these facilities are significantly smaller than JRL, **DEP should coordinate discussions with the owners of these facilities to provide supplemental or contingency capacity for biosolids.** Possibilities for future use at the facility in Jay, which is currently in the process of a real estate transfer, should also be discussed with the new owners once closing has occurred.

7.3 Bulking Agents

To avoid another "sludge crisis" in the coming 2 years when the restrictions on out-of-state waste and recycling requirements for certain large solid waste processing facilities go back into effect (as described in Sections 2.1.2 and 2.1.3), the state can take several immediate and longer-term actions. Most pressing, the state needs to verify that ReSource Lewiston (the solid waste processing facility producing much of the bulking agent for JRL) and Casella anticipate having sufficient and consistent amounts of bulking agent available to support continued acceptance of the current levels of biosolids (and other wet wastes). **BC recommends that the state fund an independent study evaluating the availability of traditional and alternative bulking agents.** If the study finds that insufficient quantities of bulking agent are available, then the extension on the restrictions in P.L. 2021, ch. 626 may need to be extended until reliable alternatives are secured.

Given the current state of development, design, and permitting (Section 4), the only new facility that could reasonably be operational by July 1, 2025, when the restriction on out-of-state oversized bulky waste goes back into effect is the Crossroads Landfill biosolids dryer. BC is not aware of any digestion or drying projects at individual POTWs in Maine that are scheduled to be operational by this time. These projects take several years to develop. Many dryers, for instance, currently have manufacturing lead times of 12 to 18 months—which does not include the installation and ramp-up time needed for full-scale operation.

In the longer term, it is recommended that the state incentivize increased recycling of CDD produced in the state, including by supporting increased processing capacity in the state. This will also help extend the available landfill capacity generally in the state.

7.4 Piloting of PFAS Treatment Technologies

The full fate of PFAS through biosolids treatment technologies is not known. By funding pilots, Maine can advance the understanding of the potential for cost-effective destruction of PFAS in biosolids and inform future permitting. **It is recommended that the state issue an RFP to select pilots of these technologies for the state to fund.** Within this RFP, the state should identify necessary data collection to facilitate future permitting of full-scale facilities (see Section 6 for more details).

7.5 Volume Reduction and Dryer Projects

Current drivers in Maine lead to the need for less material and/or material dried to no longer fall under wet waste restrictions at landfills. There are mature technologies for these purposes: anaerobic digestion and drying. Section 5 provided a generalized economic analysis of a series of alternatives employing these technologies at different scales of POTWs and for regional facilities. This analysis showed that using generalized cost factors for Maine, thermal drying and anaerobic digestion can be economically viable at sufficient scale. It should also be noted that the O&M cost for baseline scenarios (continued landfilling of dewatered biosolids) is predominantly driven by volatile biosolids management costs. Alternatives with similar overall O&M costs to the baseline would have the advantage of being less risky as the overall O&M costs for the alternatives are made up of a more even distribution of several relatively more stable costs (e.g., electricity, NG, polymer and maintenance).

According to the members of the Maine Water Environment Association who were involved in this project (representatives of three wastewater utilities), the Clean Water State Revolving Fund (CWSRF), which is the typical method for providing state support to wastewater infrastructure projects, is stretched each year to support the basic capital improvement projects that POTWs need to repair and replace aging infrastructure and keep plants meeting discharge limits. The Bipartisan Infrastructure Law (BIL) provides additional funding allocations to CWSRF for fiscal years 2022-2026; however, for FY23, the base CWSRF plus supplement BIL funding was insufficient to fund approximately two-thirds of projects that applied for funding (Maine DEP, 2023).BIL also provides Emerging Contaminant funding specifically for treatment of PFAS and other contaminants of emerging concern; however, the funds are, again, limited. For FY23 there was $1.5M allocated for these projects.

It is therefore recommended to create a separate program to fund the capital projects recommended in this report to address biosolids challenges through volume reduction and the production of drier material. Similar to the Wastewater Treatment Facility Planning and Construction Grants Program for state FY19-20, a bond could be issued to provide funding for these projects, including regional solutions. Under this previous program, up to 80% of the construction costs of wastewater infrastructure projects were eligible for grant funding.

As the market matures, the research improves, and the state feels confident in PFAS treatment technologies, a similar program could be set up to fund these projects. Having a fund dedicated to PFAS treatment would facilitate the separate tracking of PFAS expenditures.

7.6 Biosolids Production Reporting

DEP does not currently have readily available comprehensive data on biosolids production in the state. These data would provide needed context for legislators, regulators, and solutions providers, particularly in uncertain times, for biosolids management. POTWs with an Agronomic Utilization Program License are required to report annual tonnages by destination, but this only covers around one-third of the approximately 150 POTWs in the state. With the ban on biosolids agronomic utilization under P.L. 2021, ch. 641, this reporting will gradually phase out as licenses that are no longer able to be used are surrendered. While landfills are required to report the annual amount of biosolids received, this data is not always broken out by generator.

The reporting form provided by the state (DEP Form 49) to aid with submitting Discharge Monitoring Reports (DMRs) required of all POTWs in Maine (Section D.1.d of the standard permit conditions) includes “sludge disposal,” including the site used. It is recommended that DEP evaluate the structure and purpose of this form and how it is currently being used and **develop a tool for mining biosolids management data from existing DMR submittals.**

Section 8: Conclusion

While the situation for biosolids management in Maine is challenging and uncertain, there are several actions the state can take to provide more options for POTWs responsible for managing the biosolids generated by treating the wastewater from homes, businesses, and industry. In the short term, the state needs to support efforts to provide additional, reliable landfill capacity for biosolids—by prioritizing the landfill application process for the expansion at JRL, discussing accepting biosolids with landfills not currently accepting biosolids, and helping to ensure bulking agents are available.

The state can also make POTWs less reliant on landfills by supporting projects to reduce the quantity of biosolids produced as well as opening up additional outlets. It is recommended that the state adopt the federal biosolids limits for PFAS when available and reevaluate whether the land application of biosolids can once again become an option for Maine.

While source control has often proven to be the most effective approach to reducing environmental pollutants, the state can also support the deployment of new technologies to reduce PFAS in biosolids. These technologies are not yet widely proven, and the level of PFAS destruction is an open area of research. Maine can contribute to filling knowledge gaps, determine permitting pathways, and select technologies to support full-scale deployment by funding pilots that include comprehensive PFAS testing. Maine can become a leader in implementing some of these new technologies, which in turn could help local businesses and create jobs.

By taking these recommended actions, the State of Maine can play a more proactive role in managing its biosolids capacity.

References

Agency for Toxic Substances and Disease Registry. *PFAS in the U.S. Population*. https://www.atsdr.cdc.gov/pfas/health-effects/us-population.html (Accessed October 22, 2023).

Barr. *Evaluation of Current Alternatives and Estimated Cost Curves for PFAS Removal and Destruction from Municipal Wastewater, Biosolids, Landfill Leachate, and Compost Contact Water*. May 2023. https://www.pca.state.mn.us/sites/default/files/c-pfc1-26.pdf (Access November 15, 2023).

Batiste, Stephen; et al. *Assessment of Landfill Capacity for Biosolids and Initial Evaluation of Leachate Treatment Approaches in Maine*. 2023.

Beecher, Ned. *PFAS Update September 2019*. North East Biosolids & Residuals Association, Sept. 26, 2019, www.nebiosolids.org/pfas-update-september-2019. (Accessed November 10, 2023).

Crowley, Jim. *PFAS Testing Update*. Maine Water Environment Association Fall Conference. Sept. 21, 2023.

Department of Energy. *Standard Review Plan, Technology Readiness Assessment Report*. Mar. 2010. https://www.energy.gov/sites/prod/files/em/Volume_I/O_SRP.pdf (Accessed October 15, 2023).

Georgia Department of Natural Resources. *High Moisture Content Waste Management Plans at Solid Waste Facilities Guidance Document.* July 2021, https://epd.georgia.gov/document/document/hmcw-guidance-72021pdf/download (Accessed July 15, 2023).

Hughes, Sarah G. *PFAS in Biosolids: A Review of State Efforts & Opportunities for Action*, ECOS, Jan. 2023. https://www.ecos.org/wp-content/uploads/2023/01/PFAS-in-Biosolids-A-Review-of-State-Efforts-and-Opportunities-for-Action.pdf (Accessed September 12, 2023).

Krause, Max J., et al. *Supercritical Water Oxidation as an Innovative Technology for PFAS Destruction*. Journal of Environmental Engineering, vol. 148, no. 2, Feb. 2022, https://doi.org/10.1061/(asce)ee.1943-7870.0001957. (Accessed October 17, 2023).

Maine Department of Environmental Protection. *Report on the Land Application of Septage*. January 13, 2023.

Maine Department of Environmental Protection. *Clean Water State Revolving Fund Federal Fiscal Year 2023 Intended Use Plan*, Sep. 2023. https://www.maine.gov/dep/water/grants/SRF/cwsrf/Final%20FFY%202023%20IUP.pdf (Accessed November 10, 2023).

Maine PFAS Task Force. *Managing PFAS in Maine: Final Report from the Maine PFAS Task Force*. Jan. 2020. https://static1.squarespace.com/static/54806478e4b0dc44e1698e88/t/5e2b15d84e43bc1f2fe5a4ef/1579881955942/Maine-PFAS-Task-Force-Report-FINAL-Jan2020.pdf (Accessed November 15, 2023).

Michigan Department of Environment, Great Lakes, and Energy. *Land Application of Biosolids Containing PFAS: Interim Strategy*, Apr. 2022. p. 6.

Rebodos, Robert. *Maine Septage Management Evaluation*. 2023.

Ross, John, et al. *Biosolids Pyrolysis and Gasification: Technology Advancements and an Updated Assessment.* Water Environment Federation, Residuals and Biosolids Conference Proceedings, May 2022. https://www.accesswater.org/publications/proceedings/-10082009/biosolids-pyrolysis-and-gasification--technology-advancements-and-an-updated-assessment (Accessed November 3, 2023).

Tobias, David. EPA Tools and Resources Webinar: *Chemical Risk Assessment for PFOA/PFOS in Biosolids*. United States Environmental Protection Agency Office of Water. June 21, 2023. https://www.epa.gov/system/files/documents/2023-07/508%20Compliant%20-%20PFAS%20in%20Biosolids_Tobias%20%28final%29.pdf.

United States Office of Management and Budget. *Circular A-94, Appendix C*. Dec. 2022.

Winchell, Lloyd; et al. Per*- and polyfluoroalkyl substances thermal destruction at water resource recovery facilities: A state of the science review*. Nov. 15, 2020. Water Environment Federation, Water Environment Research.

Attachment A: Innovative Technology Provider Survey

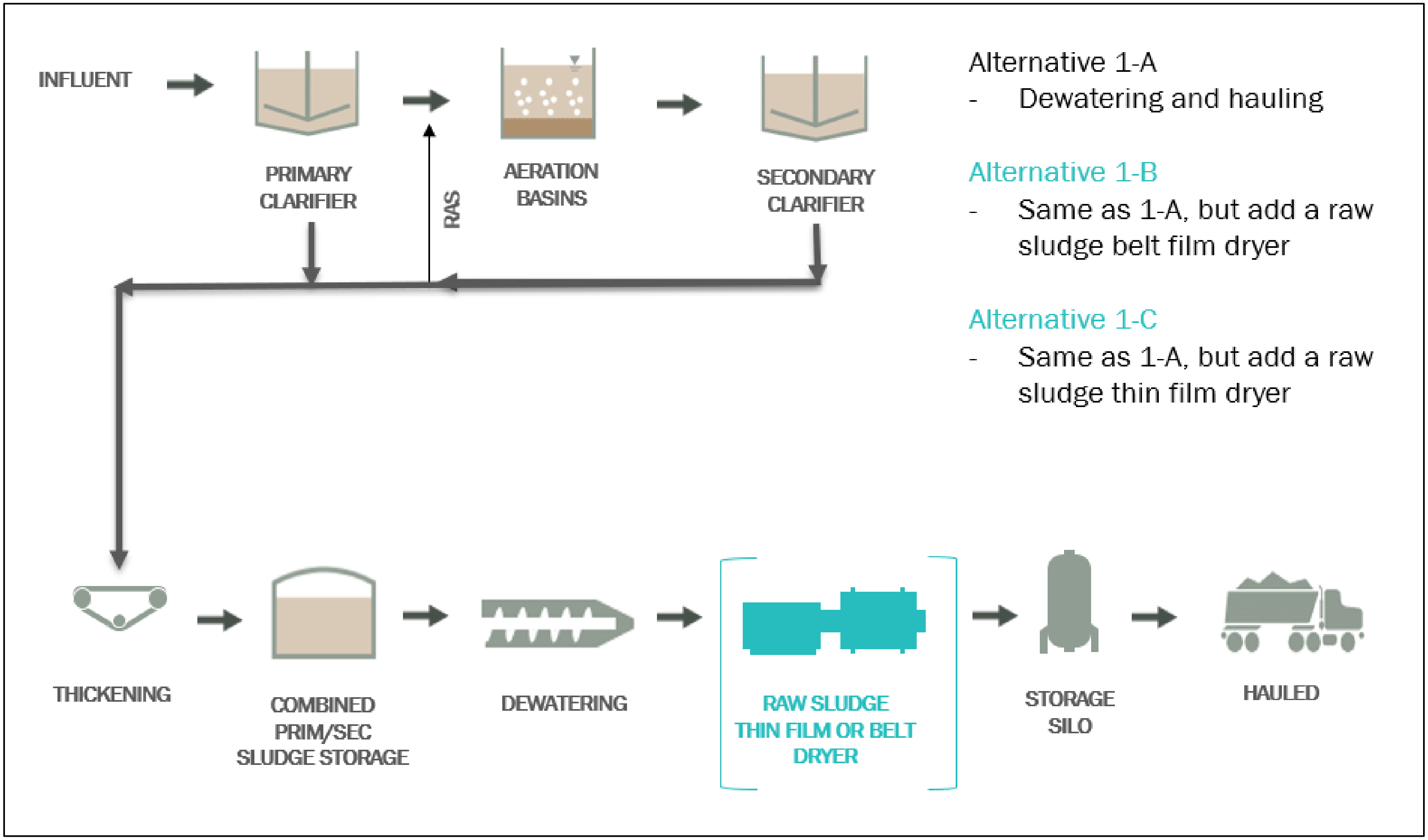
Several technologies on the market seek to address the issue of PFAS in the environment. To understand the state of the technology and the options available to Maine as they move forward, BC sent out a survey to twenty-three high-temperature technology companies. The survey was comprised of 10 questions and asked companies to assess their own Technology Readiness Level (TRL), as defined by the Department of Energy (2023), and to discuss the technological impacts on PFAS concentrations on the processing stream. For both of these pieces, BC requested supporting documents, with a preference for peer-reviewed publications supporting the claims. Of the twenty-three who received the survey, thirteen responded. Responses are summarized below.

Table A-1. Technology Provider Survey Results

Company	Company Age (years)	Technology Description	TRL (1-9)	Operating Parameters	PFAS Destruction (as reported by company)	Supporting Info
SoniQ Force	4	Supersonic drying	3		No/unknown	
SoMax Circular Solutions	6	Hydrothermal carbonization	7		Yes, per operating parameters	General literature*
C-Green/ Next Rung	7	Hydrothermal carbonization and wet oxidation	7		Unconfirmed, testing in progress	
374 Water	5	Supercritical water oxidation	7	374˚C, 218 atm (H_2O supercritical conditions)	Yes, per internal tests	Verbal/Conference data
Stircor Services	4	Gasification, drying	9		Drying – no Gasification – yes	Publicly available PFAS results
Aries Clean Technologies	12	Gasification (fluidized bed)	7	Gasifier: 675˚C Thermal oxidizer: 980˚C	Yes, per operating parameters	General literature*
CTEC Energy	13	Gasification	9	1400˚C	Yes, per operating parameters	General literature*
Heartland Water	15	Gasification (ultra-high-temperature ionic)	7	5000˚C	Yes, per operating parameters	General literature*
Biowaste Pyrolysis Solutions	8	Pyrolysis	6	850˚C, 15 sec	Reduction	
Green Waste Energy	8	Pyrolysis	6	> 900˚C	Yes, per operating parameters	General literature*
Aquagreen	8	Pyrolysis, steam drying	8	Pyrolysis: 650˚C, 10 min Burner: 900˚C, 2 sec	Yes	Public pilot study data
CharTech	10	Pyrolysis	6	> 850˚C	Yes	Public pilot study data
Bioforcetech	11	Pyrolysis, bio drying	7	Pyrolysis: 450-750˚C Burner: 900-1100˚C	Reduction	Public pilot study data

** PFAS destruction has been observed for a particular technology broadly but not tested on a company's specific unit and operating parameters.*

Attachment B: Process Flow Diagrams for Technology Alternatives



Alternative 1-A
- Dewatering and hauling

Alternative 1-B
- Same as 1-A, but add a raw sludge belt film dryer

Alternative 1-C
- Same as 1-A, but add a raw sludge thin film dryer

Figure 1: Alternative 1-A, 1-B, and 1-C Process Flow Diagrams

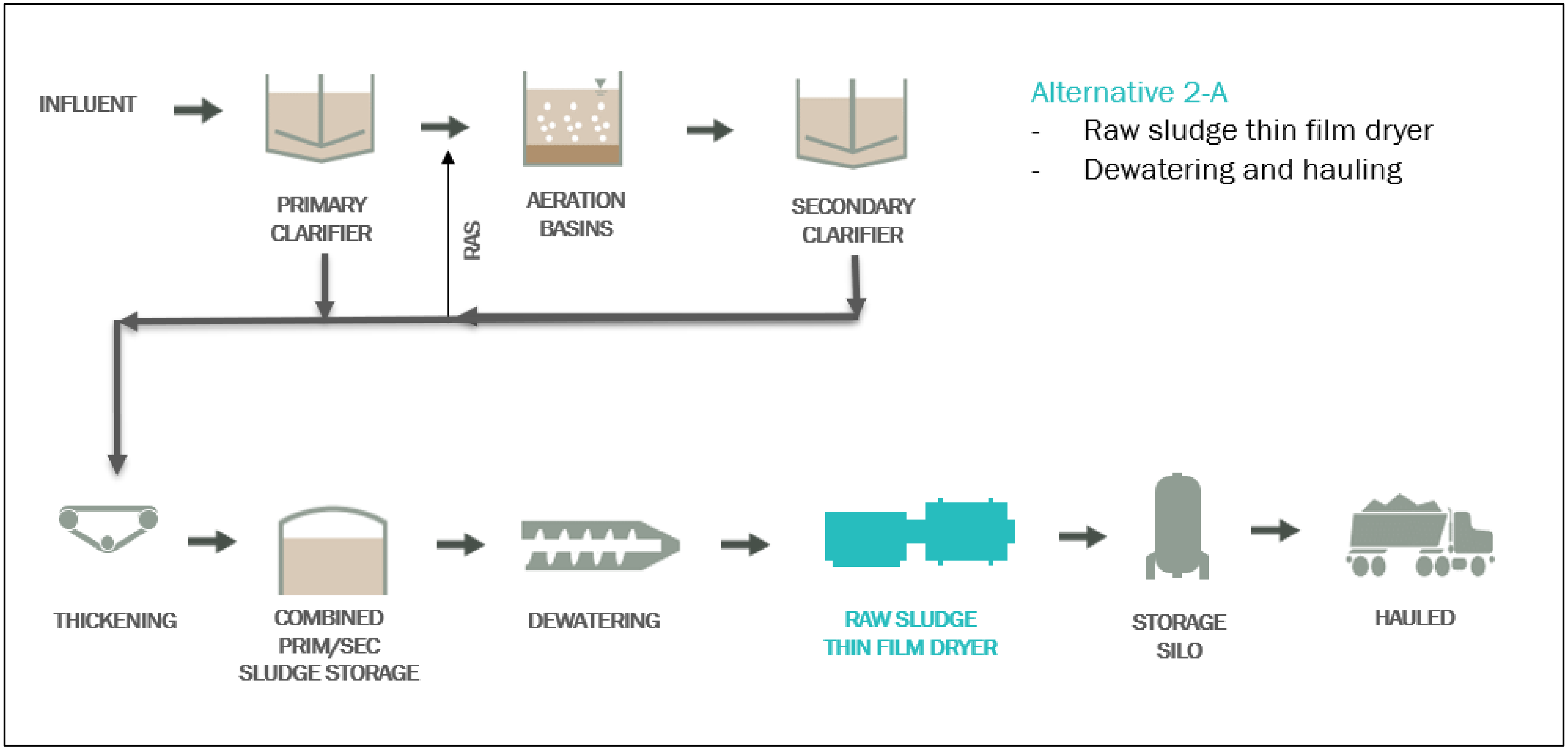


Figure 2: Alternative 2-A Process Flow Diagram

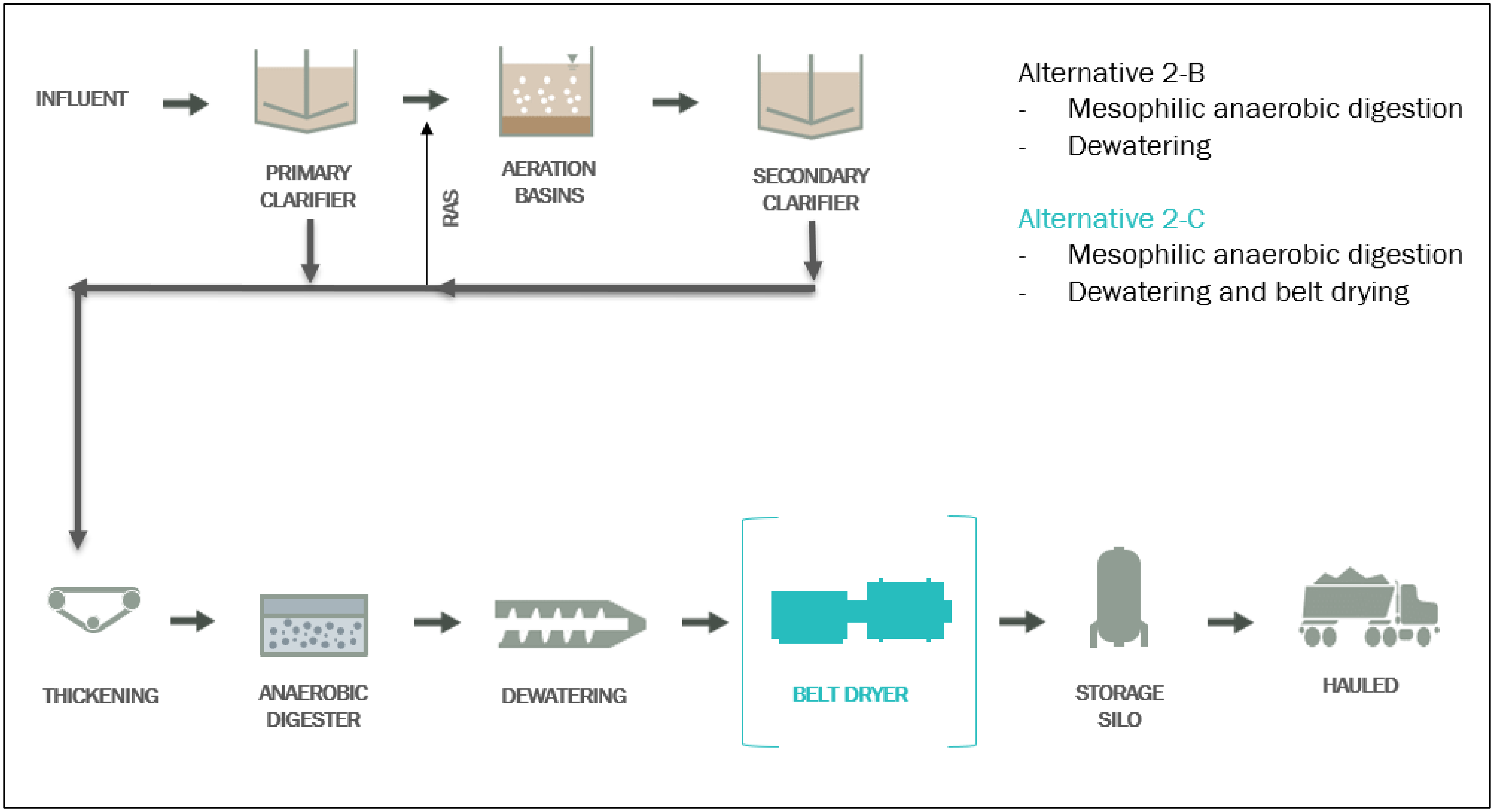


Figure 3: Alternatives 2-B and 2-C Process Flow Diagrams

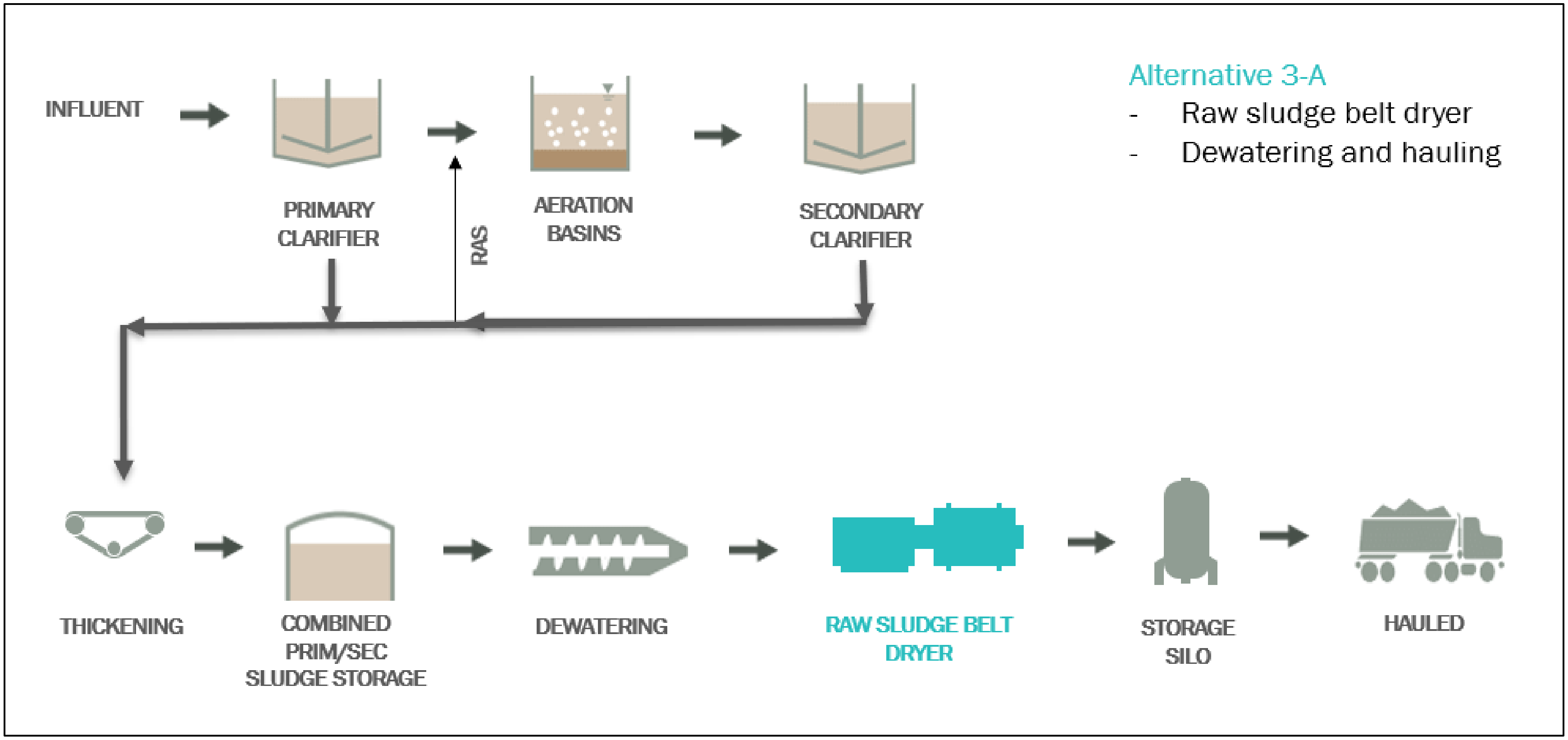
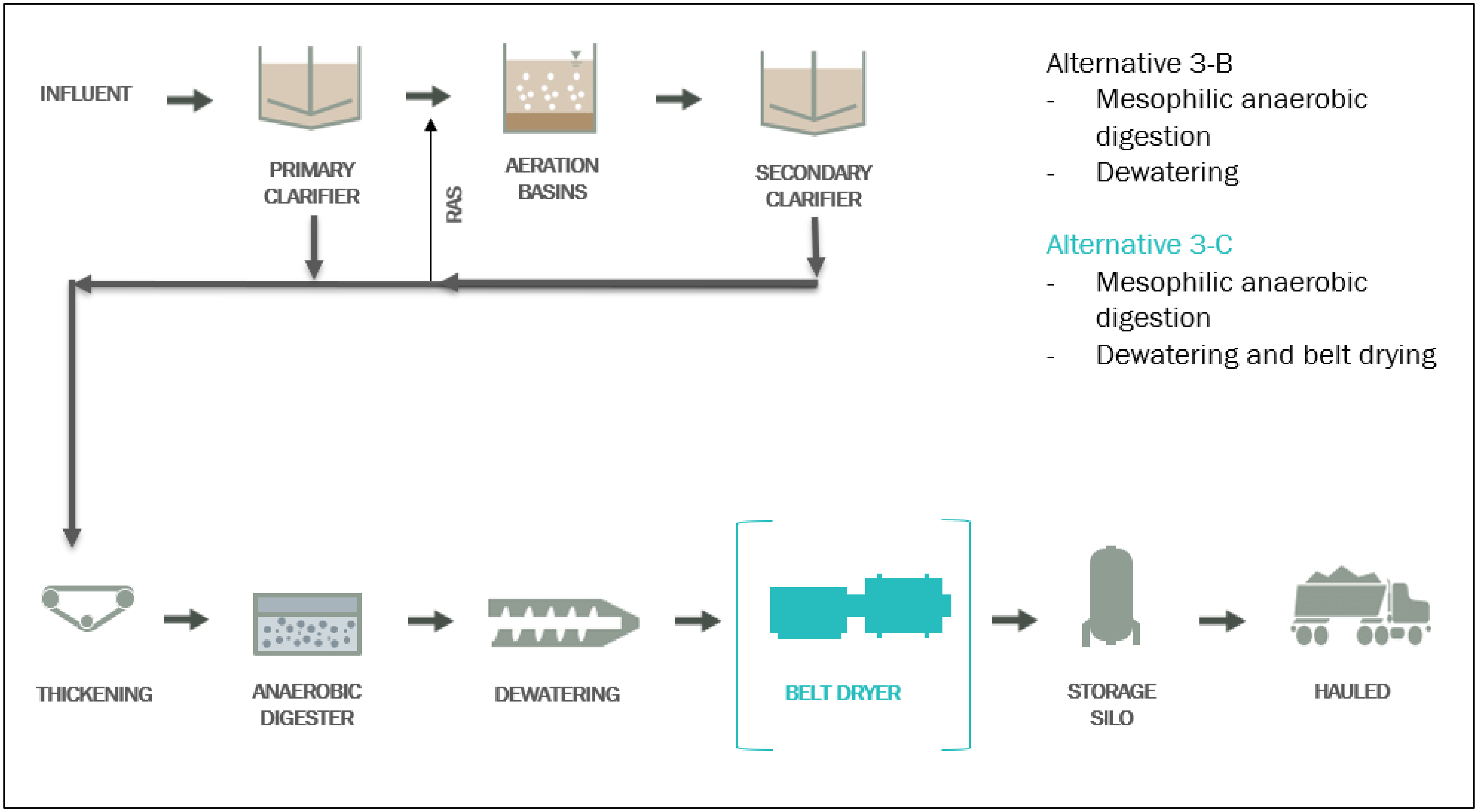


Figure 4: Alternative 3-A Process Flow Diagram



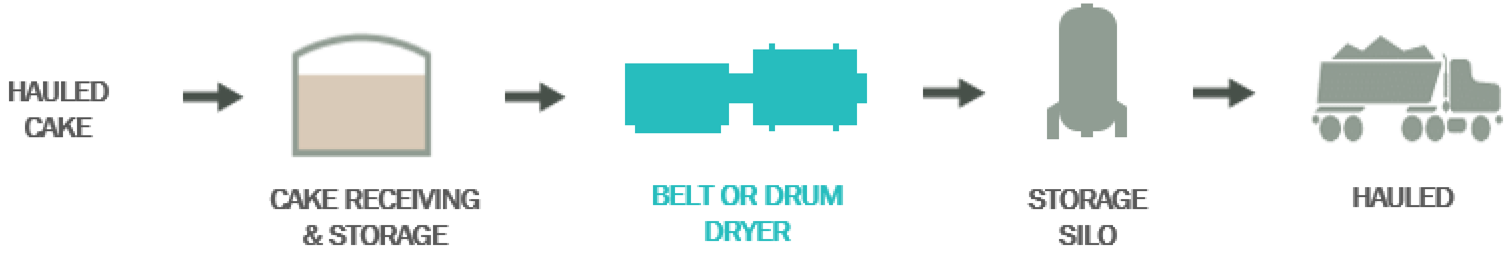
Alternative 3-B

- Mesophilic anaerobic digestion
- Dewatering

Alternative 3-C

- Mesophilic anaerobic digestion
- Dewatering and belt drying

Figure 5: Alternatives 3-B and 3-C Process Flow Diagrams



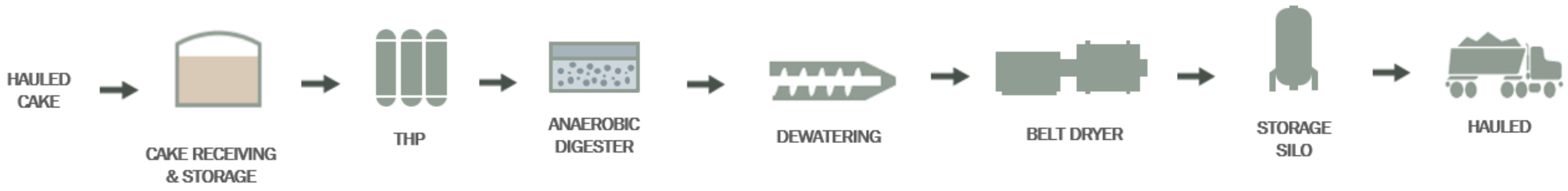
Alternative 4-A

- Accepting undigested primary and secondary dewatered cake and digested dewatered cake
- Belt dryer

Alternative 4-B

- Same as 4-A, but using a drum dryer

Figure 6: Alternatives 4-A and 4-B Process Flow Diagrams



Alternative 4-C

- Thermal Hydrolysis Process (THP)
- Mesophilic Anaerobic Digestion (MAD)
- Dewatering and belt drying

Figure 7: Alternative 4-C Process Flow Diagram

Attachment C: Capital Cost Estimates

DISCLAIMERS AND ASSUMPTIONS TO PROVIDE ON THE COVER PAGE FOR THE COST ESTIMATING APPENDIX:

In accordance with the Association for the Advancement of Cost Engineering International (AACE) criteria, this is a Class 5 estimate. A Class 5 estimate is defined as a Conceptual Level or Project Viability Estimate. Typically, engineering is from 0 to 2 percent complete. Class 5 estimates are used to prepare planning level cost scopes or evaluation of alternative schemes, long range capital outlay planning and can also form the base work for the Class 4 Planning Level or Design Technical Feasibility Estimate.

Expected accuracy for Class 5 estimates typically ranges from -50 to +100 percent, depending on the technological complexity of the project, appropriate reference information and the inclusion of an appropriate contingency determination. In unusual circumstances, ranges could exceed those shown.

The following assumptions were used in the development of this estimate.

1. Contractor performs the work during normal daylight hours, nominally 7 a.m. to 5 p.m., Monday through Friday.
2. Contractor has complete access for lay-down areas and mobile equipment.
3. Major equipment costs are based on both vendor supplied price quotes obtained by the project design team and/or estimators, and on historical pricing of like equipment.
4. There is sufficient electrical power to feed the specified equipment. The local power company will supply power and transformers suitable for this facility.
5. Soils are of adequate nature to support the structures. No piles have been included in this estimate.
6. The Estimating Contingency line item does not include changed conditions or large scope changes.

The following estimating exclusions were assumed in the development of this estimate.

1. Hazardous materials remediation and/or disposal.
2. Utility agency costs for incoming power modifications.
3. Permits beyond those normally needed for the type of project and project conditions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 1-A: Dewatering Only

Item	Unit Costs		Quantity		Class 5 Total	Notes
1-A: Dewatering Only						
Sludge Storage	$3	/gallon	1,766	gallon	$5,298	assumes 4 hrs of storage for each tank, n+1
Dewatering	$810,000	/unit	1	unit	$810,000	
Subtotal A					$820,000	
Piping	15%	of "A"			$123,000	
Site Civil	10%	of "A"			$82,000	
Misc. Demolition	5%	of "A"			$41,000	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$246,000	
Shipping and Handling	2%	of Materials and Processing Equipment			$106	
Subtotal B					$1,310,000	
Startup and Construction Sequencing	2%	of "B"			$26,200	
General Conditions	15%	of "B"			$196,500	
Contractor Overhead and Profit	15%	of "B"			$196,500	
Sales Tax	5.50%	of "B"			$72,050	
Bonds and Insurance	2.5%	of "B"			$32,750	
Subtotal C Construction Costs					$1,830,000	
Engineering	10%	of total construction costs			$183,000	
Construction Management	10%	of total construction costs			$183,000	
Subtotal Project Costs					$2,200,000	
Estimating Contingency	30%	of subtotal Project Costs			$660,000	
Total Project Cost					$2,900,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 1-B: Dewatering + Raw Sludge Belt Dryer

Item	Unit Costs		Quantity		Class 5 Total	Notes
1-B: Dewatering + Raw Sludge Belt Dryer						
Sludge Storage	$3	/gallon	1,766	gallon	$5,298	assumes 4 hrs of storage for each tank, n+1
Dewatering	$810,000	/unit	1	unit	$810,000	
Dryer Equipment						
Huber Belt Dryer	$1,290,439	/package	1	package	$1,290,439	Vendor Quote, assuming this includes conveyance
Installation of dryers	20%	percent			$258,088	
Dryer Building	$325	/sf	2000	sf	$650,000	
Subtotal A					$3,010,000	
Piping	15%	of "A"			$451,500	
Site Civil	10%	of "A"			$301,000	
Misc. Demolition	5%	of "A"			$150,500	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$708,000	
Shipping and Handling	2%	of Materials and Processing Equipment			$42,115	
Subtotal B					$4,700,000	
Startup and Construction Sequencing	2%	of "B"			$94,000	
General Conditions	15%	of "B"			$705,000	
Contractor Overhead and Profit	15%	of "B"			$705,000	
Sales Tax	5.50%	of "B"			$258,500	
Bonds and Insurance	2.5%	of "B"			$117,500	
Subtotal C Construction Costs					$6,600,000	
Engineering	10%	of total construction costs			$660,000	
Construction Management	10%	of total construction costs			$660,000	
Subtotal Project Costs					$7,900,000	
Estimating Contingency	30%	of subtotal Project Costs			$2,370,000	
Total Project Cost					$10,300,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 1-C: Dewatering + Raw Sludge Thin Film Dryer

Item	Unit Costs		Quantity		Class 5 Total	Notes
1-C: Dewatering + Raw Sludge Thin Film Dryer						
Sludge Storage	$3	/gallon	1,766	gallon	$5,298	assumes 4 hrs of storage for each tank, n+1
Dewatering	$810,000	/unit	1	unit	$810,000	
Dryer Equipment						
Thin Film Dryer	$1,286,214	/package	1	package	$1,286,214	Scaled based on vendor quote, package includes conveyance and hopper
Installation of dryers	20%	percent			$257,243	
Dryer Building	$325	/sf	1800	sf	$585,000	
Subtotal A					$2,940,000	
Piping	15%	of "A"			$441,000	
Site Civil	15%	of "A"			$441,000	
Misc. Demolition	5%	of "A"			$147,000	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$706,500	
Shipping and Handling	2%	of Materials and Processing Equipment			$42,030	
Subtotal B					$4,700,000	
Startup and Construction Sequencing	2%	of "B"			$94,000	
General Conditions	15%	of "B"			$705,000	
Contractor Overhead and Profit	15%	of "B"			$705,000	
Sales Tax	5.50%	of "B"			$258,500	
Bonds and Insurance	2.5%	of "B"			$117,500	
Subtotal C Construction Costs					$6,600,000	
Engineering	10%	of total construction costs			$660,000	
Construction Management	10%	of total construction costs			$660,000	
Subtotal Project Costs					$7,900,000	
Estimating Contingency	30%	of subtotal Project Costs			$2,370,000	
Total Project Cost					$10,300,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 2-A: Dewatering + Raw Sludge Thin Film Dryer

Item	Unit Costs		Quantity		Class 5 Total	Notes
2-A: Dewatering + Raw Sludge Thin Film Dryer						
Sludge Storage	$3	/gallon	4,320	gallon	$12,960	assumes 4 hrs of storage for each tank, 18gpm
Dryer Equipment						
Thin Film Dryer	$1,827,310	/package	1	package	$1,827,310	Vendor Quote, assumes dried product conveyance and silos are included
Installation of dryers	20%	percent			$365,462	
Dryer Building	$325	/sf	2000	sf	$650,000	
Subtotal A					$2,860,000	
Piping	15%	of "A"			$429,000	
Site Civil	10%	of "A"			$286,000	
Misc. Demolition	5%	of "A"			$143,000	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$663,000	
Shipping and Handling	2%	of Materials and Processing Equipment			$36,805	
Subtotal B					$4,400,000	
Startup and Construction Sequencing	2%	of "B"			$88,000	
General Conditions	15%	of "B"			$660,000	
Contractor Overhead and Profit	15%	of "B"			$660,000	
Sales Tax	5.50%	of "B"			$242,000	
Bonds and Insurance	2.5%	of "B"			$110,000	
Subtotal C Construction Costs					$6,200,000	
Engineering	10%	of total construction costs			$620,000	
Construction Management	10%	of total construction costs			$620,000	
Subtotal Project Costs					$7,400,000	
Estimating Contingency	30%	of subtotal Project Costs			$2,220,000	
Total Project Cost					$9,600,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 2-B: Dewatering + MAD

Item	Unit Costs		Quantity		Class 5 Total	Notes
2-B: Dewatering + MAD						
Digester						
Digesters	$3	/gal	400,000	unit	$1,200,000	
Control Building & Ancillary Equipment	$3	/gal	400,000	unit	$1,200,000	
Digested Sludge Storage	$3	/gal	400,000	unit	$1,200,000	
Waste Gas Burner						
Waste Gas Burner	$50,000	/unit	1	unit	$50,000	scaled off of the cost for a new flare (1500 scfm)
Gas flare concrete, assumes 18in thick slab	$800	/cy	0.22	cy	$178	Assumed 18 inch slab, costs from Dan Goddard, includes installation
Gas Conditioning	$3,583	/scfm	30	scfm	$107,503	assumes Hydrogen Sulfide removal and moisture
Subtotal A					$3,760,000	
Piping	15%	of "A"			$564,000	
Site Civil	10%	of "A"			$376,000	
Misc. Demolition	5%	of "A"			$188,000	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$768,000	
Shipping and Handling	2%	of Materials and Processing Equipment			$51,150	
Subtotal B					$5,700,000	
Startup and Construction Sequencing	2%	of "B"			$114,000	
General Conditions	15%	of "B"			$855,000	
Contractor Overhead and Profit	15%	of "B"			$855,000	
Sales Tax	5.50%	of "B"			$313,500	
Bonds and Insurance	2.5%	of "B"			$142,500	
Subtotal C Construction Costs					$8,000,000	
Engineering	10%	of total construction costs			$800,000	
Construction Management	10%	of total construction costs			$800,000	
Subtotal Project Costs					$9,600,000	
Estimating Contingency	30%	of subtotal Project Costs			$2,880,000	
Total Project Cost					$12,500,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 2-C: MAD + Dewatering + Belt Dryer

Item	Unit Costs		Quantity		Class 5 Total	Notes
2-C: MAD + Dewatering + Belt Dryer						
Digester						
Digesters	$3	/gal	400,000	unit	$1,200,000	
Control Building & Ancillary Equipment	$3	/gal	400,000	unit	$1,200,000	
Digested Sludge Storage	$3	/gal	400,000	unit	$1,200,000	
Waste Gas Burner						
Waste Gas Burner	$50,000	/unit	1	unit	$50,000	scaled off of the cost for a new flare (1500 scfm)
Gas flare concrete, assumes 18in thick slab	$800	/cy	0.22	cy	$178	Assumed 18 inch slab, costs from Dan Goddard, includes installation
Gas Conditioning	$3,583	/scfm	30	scfm	$107,503	assumes Hydrogen Sulfide removal and moisture
Dryer Equipment						
Huber Belt Dryer	$1,422,870	/package	1	package	$1,422,870	Vendor Quote, assumes dried product conveyance and silos are included
Installation of dryers	20%	percent			$284,574	
Dryer Building	$325	/sf	2500	sf	$812,500	
Subtotal A					$6,280,000	
Piping	15%	of "A"			$942,000	
Site Civil	10%	of "A"			$628,000	
Misc. Demolition	5%	of "A"			$314,000	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$1,640,250	
Shipping and Handling	2%	of Materials and Processing Equipment			$79,607	
Subtotal B					$9,900,000	
Startup and Construction Sequencing	2%	of "B"			$198,000	
General Conditions	15%	of "B"			$1,485,000	
Contractor Overhead and Profit	15%	of "B"			$1,485,000	
Sales Tax	5.50%	of "B"			$544,500	
Bonds and Insurance	2.5%	of "B"			$217,500	
Subtotal C Construction Costs					$13,800,000	
Engineering	10%	of total construction costs			$1,380,000	
Construction Management	10%	of total construction costs			$1,380,000	
Subtotal Project Costs					$16,600,000	
Estimating Contingency	30%	of subtotal Project Costs			$4,980,000	
Total Project Cost					$21,600,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management

Alternative 3-A: Raw Sludge Belt Dryer

Item	Unit Costs		Quantity		Class 5 Total	Notes
3-A: Raw Sludge Belt Dryer						
Sludge Storage	$3	/gallon	216,480	gallon	$649,440	assumes 4 hrs of storage for each tank
Dryer Equipment						
Huber BT8 Belt Dryer	$5,651,865	/package	1	package	$5,651,865	Vendor Quote, conveyance and pumps included
Installation of dryers	20%	percent			$1,130,373	
Dryer Building	$325	/sf	3000	sf	$975,000	
Subtotal A					$8,410,000	
Piping	15%	of "A"			$1,261,500	
Site Civil	10%	of "A"			$841,000	
Misc. Demolition	5%	of "A"			$420,500	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$2,230,500	
Shipping and Handling	2%	of Materials and Processing Equipment			$126,026	
Subtotal B					$13,300,000	
Startup and Construction Sequencing	2%	of "B"			$266,000	
General Conditions	15%	of "B"			$1,995,000	
Contractor Overhead and Profit	15%	of "B"			$1,995,000	
Sales Tax	5.50%	of "B"			$731,500	
Bonds and Insurance	2.5%	of "B"			$332,500	
Subtotal C Construction Costs					$18,600,000	
Engineering	10%	of total construction costs			$1,860,000	
Construction Management	10%	of total construction costs			$1,860,000	
Subtotal Project Costs					$22,300,000	
Estimating Contingency	30%	of subtotal Project Costs			$6,690,000	
Total Project Cost					$29,000,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 3-B: Dewatering + MAD

Item	Unit Costs		Quantity		Class 5 Total	Notes
3-B: Dewatering + MAD						
Digester						
Lipp Digesters	$2	/gal	1100000	unit	$1,650,000	
Control Building & Ancillary Equipment	$2	/gal	1100000	unit	$1,650,000	
Digested Sludge Storage	$2	/gal	1100000	unit	$1,650,000	
Waste Gas Burner						
Waste Gas Burner	$100,000	/unit	1	unit	$100,000	assumes to be the same cost of new flare
Gas flare concrete, assumes 18in thick slab	$800	/cy	0.22	cy	$178	Assumed 18 inch slab, costs from Dan Goddard, includes installation
Gas Conditioning	$3,583	/scfm	83	scfm	$295,634	assumes Hydrogen Sulfide removal and moisture
Subtotal A					$5,350,000	
Piping	15%	of "A"			$802,500	
Site Civil	10%	of "A"			$535,000	
Misc. Demolition	5%	of "A"			$267,500	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$1,110,000	
Shipping and Handling	2%	of Materials and Processing Equipment			$73,913	
Subtotal B					$8,100,000	
Startup and Construction Sequencing	2%	of "B"			$162,000	
General Conditions	15%	of "B"			$1,215,000	
Contractor Overhead and Profit	15%	of "B"			$1,215,000	
Sales Tax	5.50%	of "B"			$445,500	
Bonds and Insurance	2.5%	of "B"			$202,500	
Subtotal C Construction Costs					$11,300,000	
Engineering	10%	of total construction costs			$1,130,000	
Construction Management	10%	of total construction costs			$1,130,000	
Subtotal Project Costs					$13,600,000	
Estimating Contingency	30%	of subtotal Project Costs			$4,080,000	
Total Project Cost					$17,700,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 3-C: Dewatering + MAD + Belt Dryer

Item	Unit Costs		Quantity		Class 5 Total	Notes
3-C: Dewatering + MAD + Belt Dryer						
Digester						
Digesters	$2	/gal	1100000	unit	$2,200,000	
Control Building & Ancillary Equipment	$2	/gal	1100000	unit	$2,200,000	
Digested Sludge Storage	$2	/gal	1100000	unit	$2,200,000	
Waste Gas Burner						
Waste Gas Burner	$100,000	/unit	1	unit	$100,000	assumes to be the same cost of new flare
Gas flare concrete, assumes 18in thick slab	$800	/cy	0.22	cy	$178	Assumed 18 inch slab, costs from Dan Goddard, includes installation
Gas Conditioning	$3,583	/scfm	83	scfm	$295,634	assumes Hydrogen Sulfide removal and moisture
Dryer Equipment						
Huber BT8 Belt Dryer	$3,485,290	/package	1	package	$3,485,290	Vendor Quote includes conveyance and pumps
Installation of dryers	20%	percent			$697,058	
Dryer Building	$325	/sf	3000	sf	$975,000	
Subtotal A					$12,150,000	
Piping	15%	of "A"			$1,822,500	
Site Civil	15%	of "A"			$1,822,500	
Misc. Demolition	5%	of "A"			$607,500	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$2,692,500	
Shipping and Handling	2%	of Materials and Processing Equipment			$165,618	
Subtotal B					$19,300,000	
Startup and Construction Sequencing	2%	of "B"			$386,000	
General Conditions	15%	of "B"			$2,895,000	
Contractor Overhead and Profit	15%	of "B"			$2,895,000	
Sales Tax	5.50%	of "B"			$1,061,500	
Bonds and Insurance	2.5%	of "B"			$482,500	
Subtotal C Construction Costs					$27,000,000	
Engineering	10%	of total construction costs			$2,700,000	
Construction Management	10%	of total construction costs			$2,700,000	
Subtotal Project Costs					$32,400,000	
Estimating Contingency	30%	of subtotal Project Costs			$9,720,000	
Total Project Cost					$42,100,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 4-A: Dewatering + Belt Dryer

Item	Unit Costs		Quantity		Class 5 Total	Notes
4-A: Dewatering + Belt Dryer						
Sludge Storage	$3	/gallon	5,520	gallon	$16,560	assumes 4 hrs of storage for each tank
Cake Receiving	$4,129,500	/package	1	package	$4,129,500	
Installation	20%	percent			$825,900	
Dryer Equipment						
Andritz Belt Dryers BDS40	$5,390,543	/package	1	package	$5,390,543	Vendor Quote, cake pump, silos, hoppers and conveyance included
Installation of dryers	20%	percent			$1,078,109	
Dryer Building	$325	/sf	4000	sf	$1,300,000	
Subtotal A					$12,740,000	
Piping	15%	of "A"			$1,911,000	
Site Civil	10%	of "A"			$1,274,000	
Misc. Demolition	5%	of "A"			$637,000	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$3,432,000	
Shipping and Handling	2%	of Materials and Processing Equipment			$190,732	
Subtotal B					$20,200,000	
Startup and Construction Sequencing	2%	of "B"			$404,000	
General Conditions	15%	of "B"			$3,030,000	
Contractor Overhead and Profit	15%	of "B"			$3,030,000	
Sales Tax	5.50%	of "B"			$1,111,000	
Bonds and Insurance	2.5%	of "B"			$505,000	
Subtotal C Construction Costs					$28,300,000	
Engineering	10%	of total construction costs			$2,830,000	
Construction Management	10%	of total construction costs			$2,830,000	
Subtotal Project Costs					$34,000,000	
Estimating Contingency	30%	of subtotal Project Costs			$10,200,000	
Total Project Cost					$44,200,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 4-B: Dewatering + Drum Dryer

Item	Unit Costs		Quantity		Class 5 Total	Notes
4-B: Dewatering + Drum Dryer						
Sludge Storage	$3	/gallon	5,520	gallon	$16,560	assumes 4 hrs of storage for each tank
Cake Receiving	$4,129,500	/package	1	package	$4,129,500	
Installation	40%	percent			$1,651,800	
Dryer Equipment						
Andritz DDS80 Drum Dryers	$10,966,215	/package	1	package	$10,966,215	Vendor Quote, cake pump, silos, hoppers and conveyance included
Installation of dryers	20%	percent			$2,193,243	
Dryer Building	$325	/sf	4000	sf	$1,300,000	
Subtotal A					$20,260,000	
Piping	15%	of "A"			$3,039,000	
Site Civil	10%	of "A"			$2,026,000	
Misc. Demolition	5%	of "A"			$1,013,000	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$5,688,000	
Shipping and Handling	2%	of Materials and Processing Equipment			$302,246	
Subtotal B					$32,300,000	
Startup and Construction Sequencing	2%	of "B"			$646,000	
General Conditions	15%	of "B"			$4,845,000	
Contractor Overhead and Profit	15%	of "B"			$4,845,000	
Sales Tax	5.50%	of "B"			$1,776,500	
Bonds and Insurance	2.5%	of "B"			$807,500	
Subtotal C Construction Costs					$45,200,000	
Engineering	10%	of total construction costs			$4,520,000	
Construction Management	10%	of total construction costs			$4,520,000	
Subtotal Project Costs					$54,200,000	
Estimating Contingency	30%	of subtotal Project Costs			$16,260,000	
Total Project Cost					$70,500,000	

Note: Refer to title sheet for additional assumptions.

Class 5 Capital Cost Estimate for Biosolids Management
Alternative 4-C: THP + MAD + Belt Dryer

Item	Unit Costs		Quantity		Class 5 Total	Notes
4-C: THP + MAD + Belt Dryer						
Sludge Storage	$3	/gallon	5,520	gallon	$16,560	assumes 4 hrs of storage for each tank
Digester						
Digesters	$3	/gal	990000	unit	$2,970,000	
Control Building & Ancillary Equipment	$3	/gal	990000	unit	$2,970,000	
Digested Sludge Storage	$3	/gal	990000	unit	$2,970,000	
Waste Gas Burner						
Waste Gas Burner	$285,000	/unit	1	unit	$285,000	assumes to be the same cost of new flare
Gas flare concrete, assumes 18in thick slab	$800	/cy	0.50	cy	$400	Assumed 18 inch slab, costs from Dan Goddard, includes installation, 3x3 ft
Gas Conditioning	$3,583	/scfm	588	scfm	$2,107,068	assumes Hydrogen Sulfide removal and moisture
Cake Receiving	$4,129,500	/package	1	package	$4,129,500	
Installation	20%	percent			$825,900	
Cambi THP	$29,500,000	/package	1	package	$29,500,000	Vendor quote
Dewatering Units						
Dewatering Centrifuges	$864,000	/unit	4	unit	$3,456,000	assumes n+1
Installation of dewatering centrifuges	20%	percent			$691,200	
Polymer units	$420,895	/unit	4	unit	$1,683,580	assumes 1 system per centrifuge
Installation of polymer	20%	percent			$336,716	
Cake Conveyance	$1,080	/lf	100	lf	$108,000	assumes 100 lf for regional facilities
Dryer Equipment						
Andritz BDS 40 Belt Dryers	$3,057,730	/package	1	package	$3,057,730	Vendor Quote, cake pump, silos, hoppers and conveyance included
Installation of dryers	20%	percent			$611,546	
Dryer Building	$325	/sf	4300	sf	$1,397,500	
Subtotal A					$57,120,000	
Piping	15%	of "A"			$8,568,000	
Site Civil	10%	of "A"			$5,712,000	
Misc. Demolition	5%	of "A"			$2,856,000	
Electrical, Instrumentation & Controls	30%	of Subtotal A minus building construction			$15,825,750	
Shipping and Handling	2%	of Materials and Processing Equipment			$900,717	
Subtotal B					$91,000,000	
Startup and Construction Sequencing	2%	of "B"			$1,820,000	
General Conditions	15%	of "B"			$13,650,000	
Contractor Overhead and Profit	15%	of "B"			$13,650,000	
Sales Tax	5.50%	of "B"			$5,005,000	
Bonds and Insurance	2.5%	of "B"			$2,275,000	
Subtotal C Construction Costs					$127,400,000	
Engineering	10%	of total construction costs			$12,740,000	
Construction Management	10%	of total construction costs			$12,740,000	
Subtotal Project Costs					$152,900,000	
Estimating Contingency	30%	of subtotal Project Costs			$45,870,000	
Total Project Cost					$198,800,000	

Note: Refer to title sheet for additional assumptions.

Attachment D: Net Present Cost Calculations

Year of analysis	**2023**	**Risk adjustments (+/- percent):**		
Start of NPV	**2026**	**Benefits**	**0%**	
Escalation rate	**4.20%**	**Capital costs**	**0%**	
Discount rate	**2.20%**	**Running costs**	**0%**	

Alt1-A
Life Cycle Alternative Cost Analysis ($)

Alternative 1-A: Dewatering Only

Expressed in 2023 dollars, unescalated -- dollars

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1	2,900,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**2,900,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$121,927	$122,115	$122,303	$122,491	$122,679	$122,867	$123,056	$123,244	$123,432	$123,620	$123,808	$123,996	$124,184	$124,372	$124,560	$124,749	$124,937	$125,125	$125,313	$125,501
electrical demand	$7,099	$7,110	$7,121	$7,132	$7,143	$7,154	$7,165	$7,176	$7,187	$7,198	$7,209	$7,220	$7,231	$7,241	$7,252	$7,263	$7,274	$7,285	$7,296	$7,307
NG demand (lhv)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
polymer use	$14,324	$14,346	$14,368	$14,390	$14,413	$14,435	$14,457	$14,479	$14,501	$14,523	$14,545	$14,567	$14,589	$14,611	$14,634	$14,656	$14,678	$14,700	$14,722	$14,744
Labor	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**143,350**	**143,571**	**143,792**	**144,014**	**144,235**	**144,456**	**144,677**	**144,898**	**145,119**	**145,341**	**145,562**	**145,783**	**146,004**	**146,225**	**146,446**	**146,667**	**146,889**	**147,110**	**147,331**	**147,552**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306	$16,306
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**	**16,306**
Net Benefit/(cost)	**(3,059,656)**	**(159,877)**	**(160,098)**	**(160,319)**	**(160,541)**	**(160,762)**	**(160,983)**	**(161,204)**	**(161,425)**	**(161,646)**	**(161,868)**	**(162,089)**	**(162,310)**	**(162,531)**	**(162,752)**	**(162,973)**	**(163,195)**	**(163,416)**	**(163,637)**	**(163,858)**

Expressed in escalated dollars with sensitivity adjustments

195,877

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1	3,280,962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**3,280,962**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	137,944	143,959	150,237	156,787	163,623	170,757	178,201	185,969	194,076	202,535	211,363	220,575	230,188	240,219	250,687	261,610	273,009	284,903	297,316	310,268
electrical demand	8,032	8,382	8,747	9,129	9,527	9,942	10,376	10,828	11,300	11,792	12,306	12,843	13,402	13,987	14,596	15,232	15,896	16,588	17,311	18,065
NG demand (lhv)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

polymer use	16,206	16,913	17,650	18,420	19,223	20,061	20,935	21,848	22,800	23,794	24,831	25,913	27,043	28,221	29,451	30,734	32,073	33,471	34,929	36,451
Labor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**162,181**	**169,254**	**176,634**	**184,336**	**192,373**	**200,760**	**209,512**	**218,645**	**228,176**	**238,122**	**248,501**	**259,331**	**270,633**	**282,427**	**294,734**	**307,576**	**320,978**	**334,962**	**349,556**	**364,784**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	18,448	19,223	20,030	20,871	21,748	22,661	23,613	24,605	25,638	26,715	27,837	29,006	30,225	31,494	32,817	34,195	35,631	37,128	38,687	40,312
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**18,448**	**19,223**	**20,030**	**20,871**	**21,748**	**22,661**	**23,613**	**24,605**	**25,638**	**26,715**	**27,837**	**29,006**	**30,225**	**31,494**	**32,817**	**34,195**	**35,631**	**37,128**	**38,687**	**40,312**
Net escalated benefit/(cost)	**(3,461,591)**	**(188,477)**	**(196,664)**	**(205,207)**	**(214,121)**	**(223,421)**	**(233,125)**	**(243,250)**	**(253,815)**	**(264,837)**	**(276,338)**	**(288,337)**	**(300,858)**	**(313,921)**	**(327,551)**	**(341,771)**	**(356,609)**	**(372,090)**	**(388,243)**	**(405,096)**

Life cycle cost analysis

PVs in 2023	(3,242,822)	(172,764)	(176,389)	(180,089)	(183,867)	(187,723)	(191,660)	(195,679)	(199,782)	(203,971)	(208,247)	(212,612)	(217,069)	(221,618)	(226,263)	(231,004)	(235,844)	(240,786)	(245,830)	(250,979)
NPV as of 2023	**(7,224,998)**																			

Year of analysis	2023	**Risk adjustments (+/- percent):**	
Start of NPV	2026	**Benefits**	0%
Escalation rate	4.20%	**Capital costs**	0%
Discount rate	2.20%	**Running costs**	0%

Alt1-B
Life Cycle Alternative Cost Analysis ($)

Alternative 1-B: Raw Sludge Belt Dryer

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	10,300,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**10,300,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$28,689	$28,733	$28,777	$28,821	$28,866	$28,910	$28,954	$28,998	$29,043	$29,087	$29,131	$29,176	$29,220	$29,264	$29,308	$29,353	$29,397	$29,441	$29,485	$29,530
electrical demand	$210,409	$210,420	$210,431	$210,442	$210,453	$210,464	$210,475	$210,486	$210,497	$210,508	$210,518	$210,529	$210,540	$210,551	$210,562	$210,573	$210,584	$210,595	$210,606	$210,617
NG demand (lhv)	$36,381	$36,437	$36,493	$36,549	$36,605	$36,661	$36,718	$36,774	$36,830	$36,886	$36,942	$36,998	$37,054	$37,110	$37,167	$37,223	$37,279	$37,335	$37,391	$37,447
polymer use	$14,324	$14,346	$14,368	$14,390	$14,413	$14,435	$14,457	$14,479	$14,501	$14,523	$14,545	$14,567	$14,589	$14,611	$14,634	$14,656	$14,678	$14,700	$14,722	$14,744
Labor	$76,325	$76,443	$76,561	$76,679	$76,796	$76,914	$77,032	$77,150	$77,267	$77,385	$77,503	$77,621	$77,738	$77,856	$77,974	$78,092	$78,209	$78,327	$78,445	$78,563
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**366,128**	**366,379**	**366,630**	**366,881**	**367,133**	**367,384**	**367,635**	**367,886**	**368,137**	**368,389**	**368,640**	**368,891**	**369,142**	**369,393**	**369,645**	**369,896**	**370,147**	**370,398**	**370,649**	**370,901**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115	$42,115
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**	**42,115**
Net Benefit/(cost)	**(10,708,243)**	**(408,494)**	**(408,745)**	**(408,996)**	**(409,247)**	**(409,499)**	**(409,750)**	**(410,001)**	**(410,252)**	**(410,503)**	**(410,755)**	**(411,006)**	**(411,257)**	**(411,508)**	**(411,759)**	**(412,011)**	**(412,262)**	**(412,513)**	**(412,764)**	**(413,015)**
Expressed in escalated dollars with sensitivity adjustments																				
Capital Outlays																				
Capital outlay 1	11,653,071	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**11,653,071**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	32,457	33,873	35,350	36,891	38,500	40,178	41,930	43,758	45,665	47,655	49,732	51,900	54,162	56,522	58,985	61,555	64,237	67,036	69,957	73,004
electrical demand	238,050	248,061	258,493	269,363	280,691	292,495	304,796	317,614	330,971	344,890	359,394	374,508	390,257	406,669	423,772	441,593	460,164	479,516	499,681	520,695
NG demand (lhv)	41,160	42,955	44,828	46,783	48,822	50,951	53,172	55,490	57,909	60,433	63,067	65,816	68,684	71,677	74,800	78,060	81,461	85,010	88,714	92,578

polymer use	16,206	16,913	17,650	18,420	19,223	20,061	20,935	21,848	22,800	23,794	24,831	25,913	27,043	28,221	29,451	30,734	32,073	33,471	34,929	36,451
Labor	86,352	90,117	94,047	98,148	102,427	106,893	111,553	116,415	121,490	126,786	132,312	138,078	144,096	150,375	156,928	163,766	170,901	178,347	186,117	194,225
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**414,225**	**431,918**	**450,367**	**469,604**	**489,663**	**510,578**	**532,386**	**555,125**	**578,835**	**603,558**	**629,336**	**656,215**	**684,242**	**713,465**	**743,936**	**775,708**	**808,837**	**843,380**	**879,398**	**916,954**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	47,647	49,648	51,734	53,906	56,170	58,530	60,988	63,549	66,218	69,000	71,898	74,917	78,064	81,343	84,759	88,319	92,028	95,893	99,921	104,118
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**47,647**	**49,648**	**51,734**	**53,906**	**56,170**	**58,530**	**60,988**	**63,549**	**66,218**	**69,000**	**71,898**	**74,917**	**78,064**	**81,343**	**84,759**	**88,319**	**92,028**	**95,893**	**99,921**	**104,118**
Net escalated benefit/(cost)	**(12,114,942)**	**(481,566)**	**(502,101)**	**(523,511)**	**(545,833)**	**(569,107)**	**(593,373)**	**(618,674)**	**(645,054)**	**(672,557)**	**(701,234)**	**(731,132)**	**(762,305)**	**(794,807)**	**(828,695)**	**(864,027)**	**(900,865)**	**(939,273)**	**(979,319)**	**(1,021,071)**

Life cycle cost analysis

PVs in 2023	(11,349,289)	(441,421)	(450,336)	(459,431)	(468,709)	(478,175)	(487,832)	(497,683)	(507,734)	(517,987)	(528,447)	(539,117)	(550,004)	(561,109)	(572,439)	(583,998)	(595,789)	(607,819)	(620,091)	(632,610)
NPV as of 2023	**(21,450,019)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**	
Start of NPV	**2026**	**Benefits**	**0%**
Escalation rate	**4.20%**	**Capital costs**	**0%**
Discount rate	**2.20%**	**Running costs**	**0%**

Alt1-C
Life Cycle Alternative Cost Analysis ($)

Alternative 1-C: Raw Sludge Thin Film Dryer

Expressed in 2023 dollars, unescalated -- dollars

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1	10,300,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**10,300,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$28,689	$28,733	$28,777	$28,821	$28,866	$28,910	$28,954	$28,998	$29,043	$29,087	$29,131	$29,176	$29,220	$29,264	$29,308	$29,353	$29,397	$29,441	$29,485	$29,530
electrical demand	$210,409	$210,420	$210,431	$210,442	$210,453	$210,464	$210,475	$210,486	$210,497	$210,508	$210,518	$210,529	$210,540	$210,551	$210,562	$210,573	$210,584	$210,595	$210,606	$210,617
NG demand (lhv)	$36,381	$36,437	$36,493	$36,549	$36,605	$36,661	$36,718	$36,774	$36,830	$36,886	$36,942	$36,998	$37,054	$37,110	$37,167	$37,223	$37,279	$37,335	$37,391	$37,447
polymer use	$14,324	$14,346	$14,368	$14,390	$14,413	$14,435	$14,457	$14,479	$14,501	$14,523	$14,545	$14,567	$14,589	$14,611	$14,634	$14,656	$14,678	$14,700	$14,722	$14,744
Labor	$76,325	$76,443	$76,561	$76,679	$76,796	$76,914	$77,032	$77,150	$77,267	$77,385	$77,503	$77,621	$77,738	$77,856	$77,974	$78,092	$78,209	$78,327	$78,445	$78,563
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**366,128**	**366,379**	**366,630**	**366,881**	**367,133**	**367,384**	**367,635**	**367,886**	**368,137**	**368,389**	**368,640**	**368,891**	**369,142**	**369,393**	**369,645**	**369,896**	**370,147**	**370,398**	**370,649**	**370,901**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030	$42,030
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**	**42,030**
Net Benefit/(cost)	**(10,708,158)**	**(408,409)**	**(408,660)**	**(408,912)**	**(409,163)**	**(409,414)**	**(409,665)**	**(409,916)**	**(410,168)**	**(410,419)**	**(410,670)**	**(410,921)**	**(411,172)**	**(411,424)**	**(411,675)**	**(411,926)**	**(412,177)**	**(412,428)**	**(412,680)**	**(412,931)**

Expressed in escalated dollars with sensitivity adjustments

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1	11,653,071	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**11,653,071**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	32,457	33,873	35,350	36,891	38,500	40,178	41,930	43,758	45,665	47,655	49,732	51,900	54,162	56,522	58,985	61,555	64,237	67,036	69,957	73,004
electrical demand	238,050	248,061	258,493	269,363	280,691	292,495	304,796	317,614	330,971	344,890	359,394	374,508	390,257	406,669	423,772	441,593	460,164	479,516	499,681	520,695
NG demand (lhv)	41,160	42,955	44,828	46,783	48,822	50,951	53,172	55,490	57,909	60,433	63,067	65,816	68,684	71,677	74,800	78,060	81,461	85,010	88,714	92,578

polymer use	16,206	16,913	17,650	18,420	19,223	20,061	20,935	21,848	22,800	23,794	24,831	25,913	27,043	28,221	29,451	30,734	32,073	33,471	34,929	36,451
Labor	86,352	90,117	94,047	98,148	102,427	106,893	111,553	116,415	121,490	126,786	132,312	138,078	144,096	150,375	156,928	163,766	170,901	178,347	186,117	194,225
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**414,225**	**431,918**	**450,367**	**469,604**	**489,663**	**510,578**	**532,386**	**555,125**	**578,835**	**603,558**	**629,336**	**656,215**	**684,242**	**713,465**	**743,936**	**775,708**	**808,837**	**843,380**	**879,398**	**916,954**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	47,552	49,549	51,630	53,798	56,058	58,412	60,866	63,422	66,086	68,861	71,753	74,767	77,907	81,179	84,589	88,142	91,844	95,701	99,720	103,909
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**47,552**	**49,549**	**51,630**	**53,798**	**56,058**	**58,412**	**60,866**	**63,422**	**66,086**	**68,861**	**71,753**	**74,767**	**77,907**	**81,179**	**84,589**	**88,142**	**91,844**	**95,701**	**99,720**	**103,909**
Net escalated benefit/(cost)	**(12,114,847)**	**(481,467)**	**(501,997)**	**(523,402)**	**(545,720)**	**(568,990)**	**(593,251)**	**(618,547)**	**(644,921)**	**(672,419)**	**(701,089)**	**(730,982)**	**(762,149)**	**(794,644)**	**(828,525)**	**(863,850)**	**(900,680)**	**(939,081)**	**(979,118)**	**(1,020,862)**

Life cycle cost analysis

PVs in 2023	(11,349,200)	(441,329)	(450,243)	(459,336)	(468,613)	(478,076)	(487,731)	(497,581)	(507,629)	(517,880)	(528,338)	(539,007)	(549,891)	(560,994)	(572,322)	(583,878)	(595,667)	(607,694)	(619,964)	(632,481)
NPV as of 2023	**(21,447,853)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**	
Start of NPV	**2026**	**Benefits**	**0%**
Escalation rate	**4.20%**	**Capital costs**	**0%**
Discount rate	**2.20%**	**Running costs**	**0%**

Alt2-A
Life Cycle Alternative Cost Analysis ($)

Alternative 2-A: Raw Sludge Thin Film Dryer

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	9,600,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**9,600,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$150,993	$151,226	$151,459	$151,692	$151,925	$152,158	$152,391	$152,624	$152,857	$153,090	$153,323	$153,556	$153,788	$154,021	$154,254	$154,487	$154,720	$154,953	$155,186	$155,419
electrical demand	$238,805	$238,860	$238,915	$238,970	$239,024	$239,079	$239,134	$239,189	$239,243	$239,298	$239,353	$239,408	$239,462	$239,517	$239,572	$239,627	$239,681	$239,736	$239,791	$239,846
NG demand (lhv)	$168,715	$168,975	$169,235	$169,496	$169,756	$170,016	$170,277	$170,537	$170,797	$171,057	$171,318	$171,578	$171,838	$172,099	$172,359	$172,619	$172,879	$173,140	$173,400	$173,660
polymer use	$75,390	$75,506	$75,623	$75,739	$75,855	$75,972	$76,088	$76,204	$76,321	$76,437	$76,553	$76,670	$76,786	$76,902	$77,018	$77,135	$77,251	$77,367	$77,484	$77,600
Labor	$76,325	$76,443	$76,561	$76,679	$76,796	$76,914	$77,032	$77,150	$77,267	$77,385	$77,503	$77,621	$77,738	$77,856	$77,974	$78,092	$78,209	$78,327	$78,445	$78,563
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**710,228**	**711,010**	**711,792**	**712,575**	**713,357**	**714,139**	**714,921**	**715,703**	**716,485**	**717,267**	**718,049**	**718,831**	**719,613**	**720,395**	**721,178**	**721,960**	**722,742**	**723,524**	**724,306**	**725,088**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805	$36,805
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**	**36,805**
Net Benefit/(cost)	**(10,347,034)**	**(747,816)**	**(748,598)**	**(749,380)**	**(750,162)**	**(750,944)**	**(751,726)**	**(752,508)**	**(753,290)**	**(754,072)**	**(754,855)**	**(755,637)**	**(756,419)**	**(757,201)**	**(757,983)**	**(758,765)**	**(759,547)**	**(760,329)**	**(761,111)**	**(761,893)**
Expressed in escalated dollars with sensitivity adjustments																				
Capital Outlays																				
Capital outlay 1	10,861,114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**10,861,114**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	170,828	178,278	186,052	194,164	202,630	211,464	220,683	230,303	240,342	250,818	261,750	273,158	285,062	297,485	310,448	323,975	338,091	352,821	368,193	384,233
electrical demand	270,176	281,588	293,482	305,878	318,798	332,264	346,298	360,926	376,171	392,059	408,619	425,879	443,867	462,616	482,156	502,521	523,747	545,869	568,925	592,955
NG demand (lhv)	190,878	199,202	207,888	216,953	226,412	236,283	246,584	257,333	268,550	280,256	292,471	305,218	318,519	332,400	346,885	362,000	377,772	394,231	411,407	429,329

polymer use	85,294	89,013	92,895	96,945	101,172	105,583	110,186	114,989	120,001	125,232	130,690	136,386	142,330	148,533	155,005	161,759	168,807	176,162	183,837	191,846
Labor	86,352	90,117	94,047	98,148	102,427	106,893	111,553	116,415	121,490	126,786	132,312	138,078	144,096	150,375	156,928	163,766	170,901	178,347	186,117	194,225
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**803,528**	**838,198**	**874,363**	**912,088**	**951,439**	**992,486**	**1,035,303**	**1,079,966**	**1,126,554**	**1,175,151**	**1,225,842**	**1,278,719**	**1,333,875**	**1,391,408**	**1,451,421**	**1,514,021**	**1,579,319**	**1,647,431**	**1,718,479**	**1,792,588**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	41,640	43,389	45,212	47,111	49,089	51,151	53,299	55,538	57,870	60,301	62,834	65,473	68,222	71,088	74,073	77,185	80,426	83,804	87,324	90,992
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**41,640**	**43,389**	**45,212**	**47,111**	**49,089**	**51,151**	**53,299**	**55,538**	**57,870**	**60,301**	**62,834**	**65,473**	**68,222**	**71,088**	**74,073**	**77,185**	**80,426**	**83,804**	**87,324**	**90,992**
Net escalated benefit/(cost)	**(11,706,283)**	**(881,588)**	**(919,575)**	**(959,198)**	**(1,000,528)**	**(1,043,637)**	**(1,088,602)**	**(1,135,504)**	**(1,184,424)**	**(1,235,452)**	**(1,288,676)**	**(1,344,191)**	**(1,402,097)**	**(1,462,496)**	**(1,525,494)**	**(1,591,205)**	**(1,659,745)**	**(1,731,235)**	**(1,805,803)**	**(1,883,580)**

Life cycle cost analysis

PVs in 2023	(10,966,457)	(808,094)	(824,770)	(841,789)	(859,158)	(876,884)	(894,975)	(913,439)	(932,282)	(951,514)	(971,140)	(991,171)	(1,011,614)	(1,032,477)	(1,053,769)	(1,075,499)	(1,097,676)	(1,120,310)	(1,143,409)	(1,166,982)
NPV as of 2023	**(29,533,408)**																			

Year of analysis	**2023**
Start of NPV	**2026**
Escalation rate	**4.20%**
Discount rate	**2.20%**

Risk adjustments (+/- percent):

Benefits	**0%**
Capital costs	**0%**
Running costs	**0%**

Alt2-B
Life Cycle Alternative Cost Analysis ($)

Alternative 2-B: MAD + Dewatering

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	12,500,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**12,500,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$387,423	$388,020	$388,618	$389,216	$389,813	$390,411	$391,009	$391,607	$392,204	$392,802	$393,400	$393,998	$394,595	$395,193	$395,791	$396,388	$396,986	$397,584	$398,182	$398,779
electrical demand	$233,908	$234,175	$234,441	$234,708	$234,975	$235,242	$235,508	$235,775	$236,042	$236,309	$236,576	$236,842	$237,109	$237,376	$237,643	$237,909	$238,176	$238,443	$238,710	$238,977
NG demand (lhv)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
polymer use	$45,515	$45,585	$45,655	$45,726	$45,796	$45,866	$45,936	$46,006	$46,077	$46,147	$46,217	$46,287	$46,358	$46,428	$46,498	$46,568	$46,638	$46,709	$46,779	$46,849
Labor	$152,651	$152,886	$153,122	$153,357	$153,593	$153,828	$154,064	$154,299	$154,535	$154,770	$155,006	$155,241	$155,477	$155,712	$155,948	$156,183	$156,419	$156,654	$156,890	$157,125
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**819,496**	**820,666**	**821,836**	**823,006**	**824,177**	**825,347**	**826,517**	**827,687**	**828,858**	**830,028**	**831,198**	**832,368**	**833,539**	**834,709**	**835,879**	**837,049**	**838,220**	**839,390**	**840,560**	**841,730**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**
Net Benefit/(cost)	**(13,394,646)**	**(895,816)**	**(896,986)**	**(898,157)**	**(899,327)**	**(900,497)**	**(901,667)**	**(902,837)**	**(904,008)**	**(905,178)**	**(906,348)**	**(907,518)**	**(908,689)**	**(909,859)**	**(911,029)**	**(912,199)**	**(913,370)**	**(914,540)**	**(915,710)**	**(916,880)**
Expressed in escalated dollars with sensitivity adjustments																				
Capital Outlays																				
Capital outlay 1	14,142,076	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**14,142,076**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	438,317	457,431	477,377	498,192	519,913	542,580	566,234	590,918	616,676	643,556	671,606	700,877	731,421	763,295	796,557	831,266	867,485	905,280	944,720	985,876
electrical demand	264,635	276,065	287,987	300,424	313,398	326,931	341,048	355,775	371,137	387,162	403,878	421,316	439,505	458,480	478,273	498,920	520,457	542,924	566,360	590,806
NG demand (lhv)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

polymer use	51,494	53,740	56,083	58,528	61,080	63,743	66,522	69,422	72,448	75,606	78,901	82,340	85,928	89,673	93,580	97,658	101,913	106,353	110,987	115,822
Labor	172,704	180,235	188,094	196,295	204,854	213,785	223,105	232,831	242,980	253,571	264,623	276,156	288,191	300,750	313,856	327,532	341,803	356,695	372,235	388,451
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**927,150**	**967,470**	**1,009,541**	**1,053,439**	**1,099,245**	**1,147,039**	**1,196,910**	**1,248,946**	**1,303,241**	**1,359,895**	**1,419,008**	**1,480,688**	**1,545,046**	**1,612,199**	**1,682,266**	**1,755,375**	**1,831,658**	**1,911,252**	**1,994,302**	**2,080,955**

Annual Risk Costs (optional):

Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

R&R Costs:

R&R 1	85,022	88,593	92,314	96,191	100,231	104,441	108,828	113,398	118,161	123,124	128,295	133,683	139,298	145,149	151,245	157,597	164,216	171,113	178,300	185,789
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**85,022**	**88,593**	**92,314**	**96,191**	**100,231**	**104,441**	**108,828**	**113,398**	**118,161**	**123,124**	**128,295**	**133,683**	**139,298**	**145,149**	**151,245**	**157,597**	**164,216**	**171,113**	**178,300**	**185,789**

Net escalated benefit/(cost)	**(15,154,248)**	**(1,056,063)**	**(1,101,855)**	**(1,149,631)**	**(1,199,476)**	**(1,251,480)**	**(1,305,737)**	**(1,362,344)**	**(1,421,402)**	**(1,483,019)**	**(1,547,303)**	**(1,614,372)**	**(1,684,344)**	**(1,757,347)**	**(1,833,511)**	**(1,912,972)**	**(1,995,874)**	**(2,082,366)**	**(2,172,602)**	**(2,266,744)**

Life cycle cost analysis

PVs in 2023	(14,196,514)	(968,024)	(988,257)	(1,008,911)	(1,029,995)	(1,051,518)	(1,073,489)	(1,095,917)	(1,118,812)	(1,142,183)	(1,166,041)	(1,190,395)	(1,215,255)	(1,240,633)	(1,266,538)	(1,292,982)	(1,319,977)	(1,347,532)	(1,375,661)	(1,404,374)
NPV as of 2023	**(36,493,009)**																			

Alt2-C
Life Cycle Alternative Cost Analysis ($)

Year of analysis	**2023**	**Risk adjustments (+/- percent):**	
Start of NPV	**2026**	**Benefits**	**0%**
Escalation rate	**4.20%**	**Capital costs**	**0%**
Discount rate	**2.20%**	**Running costs**	**0%**

Alternative 2-C: MAD + Belt Dryer

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	21,600,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**21,600,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$387,423	$388,020	$388,618	$389,216	$389,813	$390,411	$391,009	$391,607	$392,204	$392,802	$393,400	$393,998	$394,595	$395,193	$395,791	$396,388	$396,986	$397,584	$398,182	$398,779
electrical demand	$233,908	$234,175	$234,441	$234,708	$234,975	$235,242	$235,508	$235,775	$236,042	$236,309	$236,576	$236,842	$237,109	$237,376	$237,643	$237,909	$238,176	$238,443	$238,710	$238,977
NG demand (lhv)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
polymer use	$45,515	$45,585	$45,655	$45,726	$45,796	$45,866	$45,936	$46,006	$46,077	$46,147	$46,217	$46,287	$46,358	$46,428	$46,498	$46,568	$46,638	$46,709	$46,779	$46,849
Labor	$152,651	$152,886	$153,122	$153,357	$153,593	$153,828	$154,064	$154,299	$154,535	$154,770	$155,006	$155,241	$155,477	$155,712	$155,948	$156,183	$156,419	$156,654	$156,890	$157,125
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**819,496**	**820,666**	**821,836**	**823,006**	**824,177**	**825,347**	**826,517**	**827,687**	**828,858**	**830,028**	**831,198**	**832,368**	**833,539**	**834,709**	**835,879**	**837,049**	**838,220**	**839,390**	**840,560**	**841,730**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150	$75,150
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**	**75,150**
Net Benefit/(cost)	**(22,494,646)**	**(895,816)**	**(896,986)**	**(898,157)**	**(899,327)**	**(900,497)**	**(901,667)**	**(902,837)**	**(904,008)**	**(905,178)**	**(906,348)**	**(907,518)**	**(908,689)**	**(909,859)**	**(911,029)**	**(912,199)**	**(913,370)**	**(914,540)**	**(915,710)**	**(916,880)**

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in escalated dollars with sensitivity adjustments																				
Capital Outlays																				
Capital outlay 1	24,437,508	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**24,437,508**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	438,317	457,431	477,377	498,192	519,913	542,580	566,234	590,918	616,676	643,556	671,606	700,877	731,421	763,295	796,557	831,266	867,485	905,280	944,720	985,876
electrical demand	264,635	276,065	287,987	300,424	313,398	326,931	341,048	355,775	371,137	387,162	403,878	421,316	439,505	458,480	478,273	498,920	520,457	542,924	566,360	590,806
NG demand (lhv)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

polymer use	51,494	53,740	56,083	58,528	61,080	63,743	66,522	69,422	72,448	75,606	78,901	82,340	85,928	89,673	93,580	97,658	101,913	106,353	110,987	115,822
Labor	172,704	180,235	188,094	196,295	204,854	213,785	223,105	232,831	242,980	253,571	264,623	276,156	288,191	300,750	313,856	327,532	341,803	356,695	372,235	388,451
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**927,150**	**967,470**	**1,009,541**	**1,053,439**	**1,099,245**	**1,147,039**	**1,196,910**	**1,248,946**	**1,303,241**	**1,359,895**	**1,419,008**	**1,480,688**	**1,545,046**	**1,612,199**	**1,682,266**	**1,755,375**	**1,831,658**	**1,911,252**	**1,994,302**	**2,080,955**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	85,022	88,593	92,314	96,191	100,231	104,441	108,828	113,398	118,161	123,124	128,295	133,683	139,298	145,149	151,245	157,597	164,216	171,113	178,300	185,789
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**85,022**	**88,593**	**92,314**	**96,191**	**100,231**	**104,441**	**108,828**	**113,398**	**118,161**	**123,124**	**128,295**	**133,683**	**139,298**	**145,149**	**151,245**	**157,597**	**164,216**	**171,113**	**178,300**	**185,789**
Net escalated benefit/(cost)	**(25,449,679)**	**(1,056,063)**	**(1,101,855)**	**(1,149,631)**	**(1,199,476)**	**(1,251,480)**	**(1,305,737)**	**(1,362,344)**	**(1,421,402)**	**(1,483,019)**	**(1,547,303)**	**(1,614,372)**	**(1,684,344)**	**(1,757,347)**	**(1,833,511)**	**(1,912,972)**	**(1,995,874)**	**(2,082,366)**	**(2,172,602)**	**(2,266,744)**

Life cycle cost analysis

PVs in 2023	(23,841,283)	(968,024)	(988,257)	(1,008,911)	(1,029,995)	(1,051,518)	(1,073,489)	(1,095,917)	(1,118,812)	(1,142,183)	(1,166,041)	(1,190,395)	(1,215,255)	(1,240,633)	(1,266,538)	(1,292,982)	(1,319,977)	(1,347,532)	(1,375,661)	(1,404,374)
NPV as of 2023	**(46,137,779)**																			

Year of analysis	2023	**Risk adjustments (+/- percent):**	
Start of NPV	2026	**Benefits**	0%
Escalation rate	4.20%	**Capital costs**	0%
Discount rate	2.20%	**Running costs**	0%

Alt2-D
Life Cycle Alternative Cost Analysis ($)

Alternative 2-D: Baseline

Expressed in 2023 dollars, unescalated -- dollars

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1																				
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Running Costs:																				
Hauled solids	$609,634	$610,575	$611,515	$612,456	$613,396	$614,337	$615,278	$616,218	$617,159	$618,099	$619,040	$619,980	$620,921	$621,861	$622,802	$623,743	$624,683	$625,624	$626,564	$627,505
electrical demand	$35,495	$35,550	$35,605	$35,660	$35,714	$35,769	$35,824	$35,879	$35,934	$35,988	$36,043	$36,098	$36,153	$36,207	$36,262	$36,317	$36,372	$36,426	$36,481	$36,536
NG demand (lhv)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
polymer use	$71,621	$71,731	$71,842	$71,952	$72,063	$72,173	$72,284	$72,394	$72,505	$72,615	$72,726	$72,836	$72,947	$73,057	$73,168	$73,278	$73,389	$73,499	$73,610	$73,720
Labor	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	716,750	717,856	718,962	720,068	721,173	722,279	723,385	724,491	725,597	726,703	727,808	728,914	730,020	731,126	732,232	733,337	734,443	735,549	736,655	737,761
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R Costs:																				
R&R 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Benefit/(cost)	(716,750)	(717,856)	(718,962)	(720,068)	(721,173)	(722,279)	(723,385)	(724,491)	(725,597)	(726,703)	(727,808)	(728,914)	(730,020)	(731,126)	(732,232)	(733,337)	(734,443)	(735,549)	(736,655)	(737,761)

Expressed in escalated dollars with sensitivity adjustments

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Running Costs:																				
Hauled solids	689,719	719,796	751,183	783,937	818,117	853,785	891,006	929,847	970,380	1,012,677	1,056,815	1,102,874	1,150,938	1,201,094	1,253,433	1,308,050	1,365,043	1,424,517	1,486,578	1,551,340
electrical demand	40,158	41,909	43,737	45,644	47,634	49,711	51,878	54,140	56,499	58,962	61,532	64,214	67,012	69,933	72,980	76,160	79,478	82,941	86,555	90,325
NG demand (lhv)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

polymer use	81,029	84,563	88,250	92,098	96,113	100,304	104,676	109,240	114,001	118,970	124,156	129,567	135,214	141,106	147,255	153,671	160,367	167,354	174,645	182,253
Labor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**810,907**	**846,269**	**883,170**	**921,679**	**961,864**	**1,003,799**	**1,047,560**	**1,093,226**	**1,140,881**	**1,190,609**	**1,242,503**	**1,296,655**	**1,353,164**	**1,412,133**	**1,473,668**	**1,537,881**	**1,604,889**	**1,674,812**	**1,747,778**	**1,823,918**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net escalated benefit/(cost)	**(810,907)**	**(846,269)**	**(883,170)**	**(921,679)**	**(961,864)**	**(1,003,799)**	**(1,047,560)**	**(1,093,226)**	**(1,140,881)**	**(1,190,609)**	**(1,242,503)**	**(1,296,655)**	**(1,353,164)**	**(1,412,133)**	**(1,473,668)**	**(1,537,881)**	**(1,604,889)**	**(1,674,812)**	**(1,747,778)**	**(1,823,918)**

Life cycle cost analysis

PVs in 2023	(759,658)	(775,719)	(792,118)	(808,862)	(825,957)	(843,412)	(861,234)	(879,430)	(898,008)	(916,977)	(936,345)	(956,119)	(976,309)	(996,922)	(1,017,969)	(1,039,457)	(1,061,397)	(1,083,797)	(1,106,668)	(1,130,019)
NPV as of 2023	**(18,666,377)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**		
Start of NPV	**2026**		**Benefits**	**0%**
Escalation rate	**4.20%**		**Capital costs**	**0%**
Discount rate	**2.20%**		**Running costs**	**0%**

Alt3-A
Life Cycle Alternative Cost Analysis ($)

Alternative 3-A: Raw Sludge Belt Dryer

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	29,000,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**29,000,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$422,780	$423,433	$424,085	$424,737	$425,389	$426,042	$426,694	$427,346	$427,999	$428,651	$429,303	$429,955	$430,608	$431,260	$431,912	$432,565	$433,217	$433,869	$434,521	$435,174
electrical demand	$302,697	$302,850	$303,004	$303,157	$303,310	$303,464	$303,617	$303,770	$303,924	$304,077	$304,230	$304,384	$304,537	$304,690	$304,844	$304,997	$305,150	$305,304	$305,457	$305,610
NG demand (lhv)	$472,401	$473,130	$473,859	$474,588	$475,317	$476,045	$476,774	$477,503	$478,232	$478,961	$479,690	$480,418	$481,147	$481,876	$482,605	$483,334	$484,063	$484,791	$485,520	$486,249
polymer use	$211,092	$211,418	$211,744	$212,069	$212,395	$212,721	$213,046	$213,372	$213,698	$214,023	$214,349	$214,675	$215,000	$215,326	$215,652	$215,977	$216,303	$216,629	$216,954	$217,280
Labor	$152,651	$152,886	$153,122	$153,357	$153,593	$153,828	$154,064	$154,299	$154,535	$154,770	$155,006	$155,241	$155,477	$155,712	$155,948	$156,183	$156,419	$156,654	$156,890	$157,125
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**1,561,621**	**1,563,717**	**1,565,813**	**1,567,908**	**1,570,004**	**1,572,099**	**1,574,195**	**1,576,291**	**1,578,386**	**1,580,482**	**1,582,578**	**1,584,673**	**1,586,769**	**1,588,865**	**1,590,960**	**1,593,056**	**1,595,152**	**1,597,247**	**1,599,343**	**1,601,438**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026	$126,026
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**	**126,026**
Net Benefit/(cost)	**(30,687,647)**	**(1,689,743)**	**(1,691,839)**	**(1,693,934)**	**(1,696,030)**	**(1,698,126)**	**(1,700,221)**	**(1,702,317)**	**(1,704,412)**	**(1,706,508)**	**(1,708,604)**	**(1,710,699)**	**(1,712,795)**	**(1,714,891)**	**(1,716,986)**	**(1,719,082)**	**(1,721,178)**	**(1,723,273)**	**(1,725,369)**	**(1,727,465)**
Expressed in escalated dollars with sensitivity adjustments																				
Capital Outlays																				
Capital outlay 1	32,809,617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**32,809,617**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	478,319	499,178	520,944	543,659	567,363	592,098	617,911	644,848	672,957	702,290	732,899	764,842	798,174	832,957	869,254	907,131	946,655	987,900	1,030,940	1,075,852
electrical demand	342,461	357,025	372,209	388,038	404,540	421,744	439,679	458,377	477,870	498,191	519,377	541,464	564,490	588,494	613,520	639,609	666,808	695,163	724,723	755,541
NG demand (lhv)	534,459	557,765	582,087	607,467	633,953	661,592	690,434	720,532	751,940	784,716	818,918	854,609	891,854	930,720	971,277	1,013,599	1,057,762	1,103,848	1,151,939	1,202,122

polymer use	238,823	249,237	260,105	271,446	283,281	295,632	308,520	321,969	336,004	350,650	365,933	381,882	398,524	415,891	434,014	452,926	472,660	493,254	514,743	537,167
Labor	172,704	180,235	188,094	196,295	204,854	213,785	223,105	232,831	242,980	253,571	264,623	276,156	288,191	300,750	313,856	327,532	341,803	356,695	372,235	388,451
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**1,766,765**	**1,843,440**	**1,923,439**	**2,006,906**	**2,093,991**	**2,184,851**	**2,279,649**	**2,378,557**	**2,481,751**	**2,589,418**	**2,701,751**	**2,818,953**	**2,941,233**	**3,068,813**	**3,201,921**	**3,340,796**	**3,485,689**	**3,636,859**	**3,794,579**	**3,959,133**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	142,582	148,570	154,810	161,312	168,087	175,147	182,503	190,168	198,155	206,478	215,150	224,186	233,602	243,413	253,636	264,289	275,389	286,956	299,008	311,566
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**142,582**	**148,570**	**154,810**	**161,312**	**168,087**	**175,147**	**182,503**	**190,168**	**198,155**	**206,478**	**215,150**	**224,186**	**233,602**	**243,413**	**253,636**	**264,289**	**275,389**	**286,956**	**299,008**	**311,566**
Net escalated benefit/(cost)	**(34,718,964)**	**(1,992,010)**	**(2,078,249)**	**(2,168,218)**	**(2,262,078)**	**(2,359,998)**	**(2,462,152)**	**(2,568,725)**	**(2,679,906)**	**(2,795,896)**	**(2,916,901)**	**(3,043,139)**	**(3,174,835)**	**(3,312,226)**	**(3,455,557)**	**(3,605,085)**	**(3,761,078)**	**(3,923,815)**	**(4,093,587)**	**(4,270,699)**

Life cycle cost analysis

PVs in 2023	(32,524,757)	(1,825,946)	(1,863,988)	(1,902,819)	(1,942,456)	(1,982,916)	(2,024,216)	(2,066,373)	(2,109,404)	(2,153,328)	(2,198,164)	(2,243,930)	(2,290,645)	(2,338,329)	(2,387,002)	(2,436,685)	(2,487,398)	(2,539,163)	(2,592,001)	(2,645,935)
NPV as of 2023	**(74,555,457)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**	
Start of NPV	**2026**	**Benefits**	**0%**
Escalation rate	**4.20%**	**Capital costs**	**0%**
Discount rate	**2.20%**	**Running costs**	**0%**

Alt3-B
Life Cycle Alternative Cost Analysis ($)

Alternative 3-B: MAD + Dewatering

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	17,700,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**17,700,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$1,084,783	$1,086,457	$1,088,130	$1,089,804	$1,091,478	$1,093,151	$1,094,825	$1,096,498	$1,098,172	$1,099,846	$1,101,519	$1,103,193	$1,104,867	$1,106,540	$1,108,214	$1,109,888	$1,111,561	$1,113,235	$1,114,908	$1,116,582
electrical demand	$296,984	$297,349	$297,713	$298,077	$298,441	$298,805	$299,169	$299,533	$299,897	$300,261	$300,625	$300,989	$301,354	$301,718	$302,082	$302,446	$302,810	$303,174	$303,538	$303,902
NG demand (lhv)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
polymer use	$127,442	$127,638	$127,835	$128,031	$128,228	$128,425	$128,621	$128,818	$129,015	$129,211	$129,408	$129,604	$129,801	$129,998	$130,194	$130,391	$130,588	$130,784	$130,981	$131,177
Labor	$152,651	$152,886	$153,122	$153,357	$153,593	$153,828	$154,064	$154,299	$154,535	$154,770	$155,006	$155,241	$155,477	$155,712	$155,948	$156,183	$156,419	$156,654	$156,890	$157,125
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**1,661,860**	**1,664,330**	**1,666,799**	**1,669,269**	**1,671,739**	**1,674,209**	**1,676,679**	**1,679,149**	**1,681,619**	**1,684,088**	**1,686,558**	**1,689,028**	**1,691,498**	**1,693,968**	**1,696,438**	**1,698,908**	**1,701,377**	**1,703,847**	**1,706,317**	**1,708,787**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913	$106,913
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**	**106,913**
Net Benefit/(cost)	**(19,468,772)**	**(1,771,242)**	**(1,773,712)**	**(1,776,182)**	**(1,778,652)**	**(1,781,122)**	**(1,783,592)**	**(1,786,061)**	**(1,788,531)**	**(1,791,001)**	**(1,793,471)**	**(1,795,941)**	**(1,798,411)**	**(1,800,881)**	**(1,803,350)**	**(1,805,820)**	**(1,808,290)**	**(1,810,760)**	**(1,813,230)**	**(1,815,700)**
Expressed in escalated dollars with sensitivity adjustments																				
Capital Outlays																				
Capital outlay 1	20,025,180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**20,025,180**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	1,227,287	1,280,806	1,336,656	1,394,937	1,455,757	1,519,225	1,585,456	1,654,570	1,726,694	1,801,957	1,880,496	1,962,454	2,047,980	2,137,227	2,230,359	2,327,544	2,428,958	2,534,785	2,645,217	2,760,454
electrical demand	335,998	350,539	365,709	381,535	398,045	415,269	433,238	451,983	471,539	491,940	513,223	535,426	558,589	582,753	607,961	634,259	661,693	690,314	720,171	751,318
NG demand (lhv)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

polymer use	144,183	150,471	157,032	163,879	171,024	178,480	186,261	194,381	202,854	211,696	220,923	230,551	240,599	251,084	262,025	273,443	285,357	297,790	310,763	324,301
Labor	172,704	180,235	188,094	196,295	204,854	213,785	223,105	232,831	242,980	253,571	264,623	276,156	288,191	300,750	313,856	327,532	341,803	356,695	372,235	388,451
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**1,880,172**	**1,962,051**	**2,047,491**	**2,136,647**	**2,229,680**	**2,326,759**	**2,428,060**	**2,533,765**	**2,644,067**	**2,759,164**	**2,879,265**	**3,004,588**	**3,135,359**	**3,271,814**	**3,414,201**	**3,562,777**	**3,717,811**	**3,879,583**	**4,048,385**	**4,224,524**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	120,957	126,038	131,331	136,847	142,595	148,584	154,824	161,327	168,102	175,163	182,520	190,185	198,173	206,497	215,169	224,206	233,623	243,435	253,660	264,313
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**120,957**	**126,038**	**131,331**	**136,847**	**142,595**	**148,584**	**154,824**	**161,327**	**168,102**	**175,163**	**182,520**	**190,185**	**198,173**	**206,497**	**215,169**	**224,206**	**233,623**	**243,435**	**253,660**	**264,313**
Net escalated benefit/(cost)	**(22,026,309)**	**(2,088,088)**	**(2,178,822)**	**(2,273,494)**	**(2,372,275)**	**(2,475,343)**	**(2,582,884)**	**(2,695,092)**	**(2,812,169)**	**(2,934,327)**	**(3,061,785)**	**(3,194,774)**	**(3,333,532)**	**(3,478,311)**	**(3,629,371)**	**(3,786,984)**	**(3,951,434)**	**(4,123,018)**	**(4,302,045)**	**(4,488,837)**

Life cycle cost analysis

PVs in 2023	(20,634,267)	(1,914,015)	(1,954,192)	(1,995,209)	(2,037,083)	(2,079,832)	(2,123,473)	(2,168,027)	(2,213,510)	(2,259,944)	(2,307,348)	(2,355,741)	(2,405,145)	(2,455,580)	(2,507,068)	(2,559,631)	(2,613,291)	(2,668,071)	(2,723,994)	(2,781,084)
NPV as of 2023	**(64,756,503)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**	
Start of NPV	**2026**	**Benefits**	**0%**
Escalation rate	**4.20%**	**Capital costs**	**0%**
Discount rate	**2.20%**	**Running costs**	**0%**

Alt3-C
Life Cycle Alternative Cost Analysis ($)

Alternative 3-C: MAD + Belt Dryer

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	42,100,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**42,100,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$255,243	$255,637	$256,031	$256,424	$256,818	$257,212	$257,606	$258,000	$258,393	$258,787	$259,181	$259,575	$259,969	$260,362	$260,756	$261,150	$261,544	$261,938	$262,331	$262,725
electrical demand	$500,294	$500,658	$501,023	$501,387	$501,751	$502,115	$502,479	$502,843	$503,207	$503,571	$503,935	$504,299	$504,663	$505,028	$505,392	$505,756	$506,120	$506,484	$506,848	$507,212
NG demand (lhv)	$207,077	$207,396	$207,715	$208,035	$208,354	$208,674	$208,993	$209,313	$209,632	$209,952	$210,271	$210,591	$210,910	$211,230	$211,549	$211,869	$212,188	$212,508	$212,827	$213,147
polymer use	$127,442	$127,638	$127,835	$128,031	$128,228	$128,425	$128,621	$128,818	$129,015	$129,211	$129,408	$129,604	$129,801	$129,998	$130,194	$130,391	$130,588	$130,784	$130,981	$131,177
Labor	$305,301	$305,772	$306,243	$306,714	$307,185	$307,656	$308,127	$308,598	$309,069	$309,540	$310,011	$310,482	$310,953	$311,424	$311,895	$312,366	$312,838	$313,309	$313,780	$314,251
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**1,395,357**	**1,397,102**	**1,398,847**	**1,400,592**	**1,402,337**	**1,404,082**	**1,405,827**	**1,407,572**	**1,409,317**	**1,411,062**	**1,412,807**	**1,414,552**	**1,416,297**	**1,418,042**	**1,419,787**	**1,421,532**	**1,423,277**	**1,425,022**	**1,426,767**	**1,428,512**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618	$209,618
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**	**209,618**
Net Benefit/(cost)	**(43,704,975)**	**(1,606,720)**	**(1,608,465)**	**(1,610,210)**	**(1,611,955)**	**(1,613,700)**	**(1,615,445)**	**(1,617,190)**	**(1,618,935)**	**(1,620,680)**	**(1,622,425)**	**(1,624,170)**	**(1,625,915)**	**(1,627,660)**	**(1,629,405)**	**(1,631,150)**	**(1,632,895)**	**(1,634,640)**	**(1,636,385)**	**(1,638,130)**

Expressed in escalated dollars with sensitivity adjustments

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1	47,630,512	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**47,630,512**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	288,773	301,366	314,507	328,221	342,531	357,465	373,048	389,311	406,281	423,990	442,470	461,754	481,878	502,877	524,790	547,657	571,520	596,420	622,404	649,519
electrical demand	566,016	590,218	615,454	641,769	669,209	697,822	727,658	758,769	791,210	825,037	860,310	897,091	935,444	975,436	1,017,137	1,060,620	1,105,961	1,153,241	1,202,541	1,253,948
NG demand (lhv)	234,279	244,496	255,157	266,283	277,892	290,008	302,651	315,844	329,612	343,979	358,972	374,617	390,943	407,980	425,758	444,310	463,669	483,870	504,951	526,949

polymer use	144,183	150,471	157,032	163,879	171,024	178,480	186,261	194,381	202,854	211,696	220,923	230,551	240,599	251,084	262,025	273,443	285,357	297,790	310,763	324,301
Labor	345,407	360,470	376,188	392,591	409,708	427,570	446,210	465,662	485,960	507,142	529,246	552,313	576,383	601,501	627,712	655,063	683,605	713,389	744,469	776,901
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**1,578,659**	**1,647,020**	**1,718,338**	**1,792,742**	**1,870,365**	**1,951,345**	**2,035,829**	**2,123,967**	**2,215,917**	**2,311,845**	**2,411,921**	**2,516,326**	**2,625,246**	**2,738,877**	**2,857,422**	**2,981,093**	**3,110,112**	**3,244,710**	**3,385,128**	**3,531,618**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	237,155	247,116	257,495	268,309	279,578	291,321	303,556	316,306	329,590	343,433	357,857	372,887	388,549	404,868	421,872	439,591	458,054	477,292	497,338	518,226
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**237,155**	**247,116**	**257,495**	**268,309**	**279,578**	**291,321**	**303,556**	**316,306**	**329,590**	**343,433**	**357,857**	**372,887**	**388,549**	**404,868**	**421,872**	**439,591**	**458,054**	**477,292**	**497,338**	**518,226**
Net escalated benefit/(cost)	**(49,446,327)**	**(1,894,136)**	**(1,975,833)**	**(2,061,052)**	**(2,149,943)**	**(2,242,666)**	**(2,339,385)**	**(2,440,272)**	**(2,545,508)**	**(2,655,278)**	**(2,769,779)**	**(2,889,213)**	**(3,013,795)**	**(3,143,745)**	**(3,279,294)**	**(3,420,684)**	**(3,568,166)**	**(3,722,002)**	**(3,882,466)**	**(4,049,844)**

Life cycle cost analysis

PVs in 2023	(46,321,365)	(1,736,231)	(1,772,131)	(1,808,771)	(1,846,166)	(1,884,332)	(1,923,285)	(1,963,041)	(2,003,616)	(2,045,028)	(2,087,293)	(2,130,429)	(2,174,454)	(2,219,387)	(2,265,245)	(2,312,048)	(2,359,815)	(2,408,567)	(2,458,323)	(2,509,104)
NPV as of 2023	**(86,228,629)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**	
Start of NPV	**2026**	**Benefits**	**0%**
Escalation rate	**4.20%**	**Capital costs**	**0%**
Discount rate	**2.20%**	**Running costs**	**0%**

Alt3-D
Life Cycle Alternative Cost Analysis ($)

Alternative 3-D: Baseline

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1																				
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$1,706,976	$1,709,609	$1,712,243	$1,714,876	$1,717,510	$1,720,144	$1,722,777	$1,725,411	$1,728,044	$1,730,678	$1,733,311	$1,735,945	$1,738,578	$1,741,212	$1,743,846	$1,746,479	$1,749,113	$1,751,746	$1,754,380	$1,757,013
electrical demand	$99,387	$99,540	$99,694	$99,847	$100,000	$100,154	$100,307	$100,460	$100,614	$100,767	$100,920	$101,074	$101,227	$101,381	$101,534	$101,687	$101,841	$101,994	$102,147	$102,301
NG demand (lhv)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
polymer use	$200,538	$200,847	$201,156	$201,466	$201,775	$202,085	$202,394	$202,703	$203,013	$203,322	$203,632	$203,941	$204,250	$204,560	$204,869	$205,178	$205,488	$205,797	$206,107	$206,416
Labor	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**2,006,900**	**2,009,997**	**2,013,093**	**2,016,189**	**2,019,286**	**2,022,382**	**2,025,478**	**2,028,574**	**2,031,671**	**2,034,767**	**2,037,863**	**2,040,960**	**2,044,056**	**2,047,152**	**2,050,249**	**2,053,345**	**2,056,441**	**2,059,537**	**2,062,634**	**2,065,730**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Benefit/(cost)	**(2,006,900)**	**(2,009,997)**	**(2,013,093)**	**(2,016,189)**	**(2,019,286)**	**(2,022,382)**	**(2,025,478)**	**(2,028,574)**	**(2,031,671)**	**(2,034,767)**	**(2,037,863)**	**(2,040,960)**	**(2,044,056)**	**(2,047,152)**	**(2,050,249)**	**(2,053,345)**	**(2,056,441)**	**(2,059,537)**	**(2,062,634)**	**(2,065,730)**
Expressed in escalated dollars with sensitivity adjustments																				
Capital Outlays																				
Capital outlay 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	1,931,214	2,015,430	2,103,313	2,195,023	2,290,727	2,390,597	2,494,816	2,603,572	2,717,063	2,835,495	2,959,082	3,088,048	3,222,627	3,363,064	3,509,613	3,662,540	3,822,121	3,988,647	4,162,418	4,343,751
electrical demand	112,443	117,347	122,464	127,803	133,376	139,190	145,258	151,591	158,199	165,094	172,290	179,799	187,635	195,811	204,344	213,248	222,540	232,235	242,353	252,911
NG demand (lhv)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

polymer use	226,881	236,775	247,100	257,874	269,117	280,850	293,094	305,871	319,204	333,117	347,636	362,788	378,598	395,097	412,314	430,280	449,027	468,591	489,006	510,309
Labor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**2,270,539**	**2,369,552**	**2,472,877**	**2,580,701**	**2,693,220**	**2,810,638**	**2,933,169**	**3,061,034**	**3,194,466**	**3,333,706**	**3,479,008**	**3,630,634**	**3,788,860**	**3,953,973**	**4,126,271**	**4,306,067**	**4,493,688**	**4,689,473**	**4,893,777**	**5,106,971**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net escalated benefit/(cost)	**(2,270,539)**	**(2,369,552)**	**(2,472,877)**	**(2,580,701)**	**(2,693,220)**	**(2,810,638)**	**(2,933,169)**	**(3,061,034)**	**(3,194,466)**	**(3,333,706)**	**(3,479,008)**	**(3,630,634)**	**(3,788,860)**	**(3,953,973)**	**(4,126,271)**	**(4,306,067)**	**(4,493,688)**	**(4,689,473)**	**(4,893,777)**	**(5,106,971)**
Life cycle cost analysis																				
PVs in 2023	(2,127,043)	(2,172,014)	(2,217,931)	(2,264,812)	(2,312,680)	(2,361,553)	(2,411,454)	(2,462,403)	(2,514,423)	(2,567,536)	(2,621,765)	(2,677,133)	(2,733,664)	(2,791,382)	(2,850,313)	(2,910,481)	(2,971,912)	(3,034,633)	(3,098,671)	(3,164,052)
NPV as of 2023	**(52,265,855)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**		
Start of NPV	**2026**		**Benefits**	**0%**
Escalation rate	**4.20%**		**Capital costs**	**0%**
Discount rate	**2.20%**		**Running costs**	**0%**

Alt4-A
Life Cycle Alternative Cost Analysis ($)

Alternative 4-A: Raw Sludge Belt Dryer

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	44,200,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**44,200,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$1,207,944	$1,209,808	$1,211,671	$1,213,535	$1,215,398	$1,217,262	$1,219,126	$1,220,989	$1,222,853	$1,224,717	$1,226,580	$1,228,444	$1,230,308	$1,232,171	$1,234,035	$1,235,899	$1,237,762	$1,239,626	$1,241,490	$1,243,353
electrical demand	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310
NG demand (lhv)	$1,349,718	$1,351,800	$1,353,883	$1,355,965	$1,358,047	$1,360,130	$1,362,212	$1,364,294	$1,366,377	$1,368,459	$1,370,542	$1,372,624	$1,374,706	$1,376,789	$1,378,871	$1,380,954	$1,383,036	$1,385,118	$1,387,201	$1,389,283
polymer use	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$305,301	$305,772	$306,243	$306,714	$307,185	$307,656	$308,127	$308,598	$309,069	$309,540	$310,011	$310,482	$310,953	$311,424	$311,895	$312,366	$312,838	$313,309	$313,780	$314,251
transferred cake	$500,042	$500,813	$501,585	$502,356	$503,128	$503,899	$504,671	$505,442	$506,214	$506,985	$507,756	$508,528	$509,299	$510,071	$510,842	$511,614	$512,385	$513,157	$513,928	$514,700
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**3,566,314**	**3,571,503**	**3,576,691**	**3,581,880**	**3,587,068**	**3,592,257**	**3,597,446**	**3,602,634**	**3,607,823**	**3,613,011**	**3,618,200**	**3,623,388**	**3,628,577**	**3,633,765**	**3,638,954**	**3,644,142**	**3,649,331**	**3,654,519**	**3,659,708**	**3,664,896**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401	$190,401
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**	**190,401**
Net Benefit/(cost)	**(47,956,715)**	**(3,761,904)**	**(3,767,092)**	**(3,772,281)**	**(3,777,469)**	**(3,782,658)**	**(3,787,846)**	**(3,793,035)**	**(3,798,223)**	**(3,803,412)**	**(3,808,601)**	**(3,813,789)**	**(3,818,978)**	**(3,824,166)**	**(3,829,355)**	**(3,834,543)**	**(3,839,732)**	**(3,844,920)**	**(3,850,109)**	**(3,855,297)**

Expressed in escalated dollars with sensitivity adjustments

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1	50,006,381	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**50,006,381**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	1,366,627	1,426,222	1,488,413	1,553,311	1,621,036	1,691,710	1,765,460	1,842,422	1,922,734	2,006,542	2,093,998	2,185,262	2,280,497	2,379,877	2,483,583	2,591,802	2,704,730	2,822,572	2,945,542	3,073,862
electrical demand	230,018	239,679	249,745	260,234	271,164	282,553	294,420	306,786	319,671	333,097	347,087	361,665	376,855	392,683	409,176	426,361	444,268	462,927	482,370	502,630
NG demand (lhv)	1,527,025	1,593,615	1,663,105	1,735,621	1,811,294	1,890,262	1,972,669	2,058,663	2,148,401	2,242,046	2,339,767	2,441,741	2,548,154	2,659,199	2,775,076	2,895,996	3,022,179	3,153,852	3,291,254	3,434,635

polymer use	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labor	345,407	360,470	376,188	392,591	409,708	427,570	446,210	465,662	485,960	507,142	529,246	552,313	576,383	601,501	627,712	655,063	683,605	713,389	744,469	776,901
transferred cake	565,730	590,400	616,145	643,010	671,046	700,302	730,832	762,691	795,937	830,630	866,834	904,613	944,037	985,177	1,028,107	1,072,905	1,119,653	1,168,435	1,219,339	1,272,459
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**4,034,807**	**4,210,386**	**4,393,595**	**4,584,768**	**4,784,248**	**4,992,397**	**5,209,592**	**5,436,224**	**5,672,704**	**5,919,458**	**6,176,933**	**6,445,594**	**6,725,926**	**7,018,436**	**7,323,653**	**7,642,127**	**7,974,435**	**8,321,175**	**8,682,974**	**9,060,487**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	215,413	224,460	233,888	243,711	253,947	264,613	275,726	287,307	299,374	311,948	325,049	338,701	352,927	367,750	383,195	399,289	416,060	433,534	451,743	470,716
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**215,413**	**224,460**	**233,888**	**243,711**	**253,947**	**264,613**	**275,726**	**287,307**	**299,374**	**311,948**	**325,049**	**338,701**	**352,927**	**367,750**	**383,195**	**399,289**	**416,060**	**433,534**	**451,743**	**470,716**
Net escalated benefit/(cost)	**(54,256,601)**	**(4,434,846)**	**(4,627,483)**	**(4,828,479)**	**(5,038,195)**	**(5,257,010)**	**(5,485,318)**	**(5,723,531)**	**(5,972,077)**	**(6,231,405)**	**(6,501,982)**	**(6,784,295)**	**(7,078,853)**	**(7,386,186)**	**(7,706,848)**	**(8,041,417)**	**(8,390,494)**	**(8,754,709)**	**(9,134,717)**	**(9,531,202)**

Life cycle cost analysis

PVs in 2023	(50,827,634)	(4,065,135)	(4,150,404)	(4,237,454)	(4,326,321)	(4,417,043)	(4,509,660)	(4,604,209)	(4,700,733)	(4,799,271)	(4,899,865)	(5,002,559)	(5,107,395)	(5,214,419)	(5,323,676)	(5,435,212)	(5,549,074)	(5,665,312)	(5,783,973)	(5,905,110)
NPV as of 2023	**(144,524,458)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**	
Start of NPV	**2026**	**Benefits**	**0%**
Escalation rate	**4.20%**	**Capital costs**	**0%**
Discount rate	**2.20%**	**Running costs**	**0%**

Alt4-B
Life Cycle Alternative Cost Analysis ($)

Alternative 4-B: Raw Sludge Drum Dryer

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	70,500,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**70,500,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$1,207,944	$1,209,808	$1,211,671	$1,213,535	$1,215,398	$1,217,262	$1,219,126	$1,220,989	$1,222,853	$1,224,717	$1,226,580	$1,228,444	$1,230,308	$1,232,171	$1,234,035	$1,235,899	$1,237,762	$1,239,626	$1,241,490	$1,243,353
electrical demand	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310	$203,310
NG demand (lhv)	$1,181,003	$1,182,825	$1,184,647	$1,186,469	$1,188,291	$1,190,114	$1,191,936	$1,193,758	$1,195,580	$1,197,402	$1,199,224	$1,201,046	$1,202,868	$1,204,690	$1,206,512	$1,208,334	$1,210,156	$1,211,979	$1,213,801	$1,215,623
polymer use	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$381,626	$382,215	$382,804	$383,393	$383,981	$384,570	$385,159	$385,748	$386,337	$386,925	$387,514	$388,103	$388,692	$389,281	$389,869	$390,458	$391,047	$391,636	$392,224	$392,813
transferred cake	$500,042	$500,813	$501,585	$502,356	$503,128	$503,899	$504,671	$505,442	$506,214	$506,985	$507,756	$508,528	$509,299	$510,071	$510,842	$511,614	$512,385	$513,157	$513,928	$514,700
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**3,473,925**	**3,478,971**	**3,484,017**	**3,489,063**	**3,494,109**	**3,499,155**	**3,504,201**	**3,509,247**	**3,514,293**	**3,519,339**	**3,524,385**	**3,529,431**	**3,534,477**	**3,539,523**	**3,544,569**	**3,549,615**	**3,554,661**	**3,559,707**	**3,564,753**	**3,569,799**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246	$302,246
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**	**302,246**
Net Benefit/(cost)	**(74,276,170)**	**(3,781,216)**	**(3,786,262)**	**(3,791,308)**	**(3,796,354)**	**(3,801,400)**	**(3,806,446)**	**(3,811,492)**	**(3,816,538)**	**(3,821,584)**	**(3,826,630)**	**(3,831,676)**	**(3,836,722)**	**(3,841,768)**	**(3,846,814)**	**(3,851,860)**	**(3,856,906)**	**(3,861,952)**	**(3,866,998)**	**(3,872,044)**

Expressed in escalated dollars with sensitivity adjustments

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1	79,761,309	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**79,761,309**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	1,366,627	1,426,222	1,488,413	1,553,311	1,621,036	1,691,710	1,765,460	1,842,422	1,922,734	2,006,542	2,093,998	2,185,262	2,280,497	2,379,877	2,483,583	2,591,802	2,704,730	2,822,572	2,945,542	3,073,862
electrical demand	230,018	239,679	249,745	260,234	271,164	282,553	294,420	306,786	319,671	333,097	347,087	361,665	376,855	392,683	409,176	426,361	444,268	462,927	482,370	502,630
NG demand (lhv)	1,336,147	1,394,413	1,455,217	1,518,668	1,584,882	1,653,980	1,726,085	1,801,330	1,879,851	1,961,790	2,047,296	2,136,524	2,229,635	2,326,799	2,428,192	2,533,997	2,644,406	2,759,620	2,879,847	3,005,305

polymer use	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labor	431,759	450,587	470,235	490,739	512,135	534,463	557,763	582,077	607,450	633,928	661,558	690,391	720,479	751,876	784,640	818,829	854,507	891,737	930,587	971,127
transferred cake	565,730	590,400	616,145	643,010	671,046	700,302	730,832	762,691	795,937	830,630	866,834	904,613	944,037	985,177	1,028,107	1,072,905	1,119,653	1,168,435	1,219,339	1,272,459
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**3,930,281**	**4,101,301**	**4,279,754**	**4,465,963**	**4,660,263**	**4,863,007**	**5,074,561**	**5,295,307**	**5,525,643**	**5,765,988**	**6,016,774**	**6,278,454**	**6,551,503**	**6,836,412**	**7,133,696**	**7,443,894**	**7,767,564**	**8,105,291**	**8,457,685**	**8,825,383**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	341,950	356,312	371,277	386,871	403,120	420,051	437,693	456,076	475,231	495,191	515,989	537,660	560,242	583,772	608,291	633,839	660,460	688,199	717,104	747,222
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**341,950**	**356,312**	**371,277**	**386,871**	**403,120**	**420,051**	**437,693**	**456,076**	**475,231**	**495,191**	**515,989**	**537,660**	**560,242**	**583,772**	**608,291**	**633,839**	**660,460**	**688,199**	**717,104**	**747,222**
Net escalated benefit/(cost)	**(84,033,540)**	**(4,457,613)**	**(4,651,032)**	**(4,852,834)**	**(5,063,383)**	**(5,283,058)**	**(5,512,254)**	**(5,751,382)**	**(6,000,874)**	**(6,261,178)**	**(6,532,762)**	**(6,816,115)**	**(7,111,745)**	**(7,420,184)**	**(7,741,987)**	**(8,077,732)**	**(8,428,024)**	**(8,793,490)**	**(9,174,789)**	**(9,572,605)**

Life cycle cost analysis

PVs in 2023	(78,722,699)	(4,086,004)	(4,171,525)	(4,258,828)	(4,347,950)	(4,438,929)	(4,531,804)	(4,626,614)	(4,723,400)	(4,822,201)	(4,923,061)	(5,026,021)	(5,131,126)	(5,238,420)	(5,347,948)	(5,459,757)	(5,573,894)	(5,690,407)	(5,809,346)	(5,930,761)
NPV as of 2023	**(172,860,696)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**	
Start of NPV	**2026**	**Benefits**	**0%**
Escalation rate	**4.20%**	**Capital costs**	**0%**
Discount rate	**2.20%**	**Running costs**	**0%**

Alt4-C
Life Cycle Alternative Cost Analysis ($)

Alternative 4-C: THP + MAD + Belt Dryer

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1	198,800,000																			
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**198,800,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$4,667,056	$4,674,256	$4,681,457	$4,688,657	$4,695,858	$4,703,058	$4,710,259	$4,717,459	$4,724,660	$4,731,860	$4,739,060	$4,746,261	$4,753,461	$4,760,662	$4,767,862	$4,775,063	$4,782,263	$4,789,464	$4,796,664	$4,803,865
electrical demand	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NG demand (lhv)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
polymer use	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
transferred cake	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**4,667,056**	**4,674,256**	**4,681,457**	**4,688,657**	**4,695,858**	**4,703,058**	**4,710,259**	**4,717,459**	**4,724,660**	**4,731,860**	**4,739,060**	**4,746,261**	**4,753,461**	**4,760,662**	**4,767,862**	**4,775,063**	**4,782,263**	**4,789,464**	**4,796,664**	**4,803,865**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Benefit/(cost)	**(203,467,056)**	**(4,674,256)**	**(4,681,457)**	**(4,688,657)**	**(4,695,858)**	**(4,703,058)**	**(4,710,259)**	**(4,717,459)**	**(4,724,660)**	**(4,731,860)**	**(4,739,060)**	**(4,746,261)**	**(4,753,461)**	**(4,760,662)**	**(4,767,862)**	**(4,775,063)**	**(4,782,263)**	**(4,789,464)**	**(4,796,664)**	**(4,803,865)**

Expressed in escalated dollars with sensitivity adjustments

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Capital Outlays																				
Capital outlay 1	224,915,578	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**224,915,578**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	5,280,149	5,510,404	5,750,685	6,001,431	6,263,094	6,536,151	6,821,097	7,118,448	7,428,745	7,752,549	8,090,448	8,443,056	8,811,011	9,194,981	9,595,662	10,013,779	10,450,092	10,905,391	11,380,502	11,876,284
electrical demand	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NG demand (lhv)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

polymer use	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Labor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
transferred cake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**5,280,149**	**5,510,404**	**5,750,685**	**6,001,431**	**6,263,094**	**6,536,151**	**6,821,097**	**7,118,448**	**7,428,745**	**7,752,549**	**8,090,448**	**8,443,056**	**8,811,011**	**9,194,981**	**9,595,662**	**10,013,779**	**10,450,092**	**10,905,391**	**11,380,502**	**11,876,284**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net escalated benefit/(cost)	**(230,195,727)**	**(5,510,404)**	**(5,750,685)**	**(6,001,431)**	**(6,263,094)**	**(6,536,151)**	**(6,821,097)**	**(7,118,448)**	**(7,428,745)**	**(7,752,549)**	**(8,090,448)**	**(8,443,056)**	**(8,811,011)**	**(9,194,981)**	**(9,595,662)**	**(10,013,779)**	**(10,450,092)**	**(10,905,391)**	**(11,380,502)**	**(11,876,284)**
Life cycle cost analysis																				
PVs in 2023	(215,647,571)	(5,051,029)	(5,157,808)	(5,266,832)	(5,378,147)	(5,491,803)	(5,607,847)	(5,726,330)	(5,847,303)	(5,970,817)	(6,096,926)	(6,225,685)	(6,357,148)	(6,491,372)	(6,628,415)	(6,768,336)	(6,911,194)	(7,057,052)	(7,205,972)	(7,358,018)
NPV as of 2023	**(332,245,605)**																			

Year of analysis	**2023**	**Risk adjustments (+/- percent):**	
Start of NPV	**2026**	**Benefits**	**0%**
Escalation rate	**4.20%**	**Capital costs**	**0%**
Discount rate	**2.20%**	**Running costs**	**0%**

Alt4-D
Life Cycle Alternative Cost Analysis ($)

Alternative 4-D: Baseline

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Expressed in 2023 dollars, unescalated -- dollars																				
Capital Outlays																				
Capital outlay 1																				
Capital outlay 2																				
Capital outlay 3																				
Capital outlay 4																				
Capital outlay 5																				
Capital outlay 6																				
Capital outlay 7																				
Capital outlay 8																				
Total capital outlays	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	$543,363	$544,202	$545,040	$545,878	$546,717	$547,555	$548,393	$549,232	$550,070	$550,908	$551,747	$552,585	$553,423	$554,261	$555,100	$555,938	$556,776	$557,615	$558,453	$559,291
electrical demand	$628,910	$629,049	$629,188	$629,327	$629,466	$629,605	$629,744	$629,883	$630,022	$630,162	$630,301	$630,440	$630,579	$630,718	$630,857	$630,996	$631,135	$631,274	$631,413	$631,552
NG demand (lhv)	$137,810	$138,023	$138,236	$138,448	$138,661	$138,874	$139,086	$139,299	$139,511	$139,724	$139,937	$140,149	$140,362	$140,574	$140,787	$141,000	$141,212	$141,425	$141,638	$141,850
polymer use	$271,299	$271,717	$272,136	$272,554	$272,973	$273,392	$273,810	$274,229	$274,647	$275,066	$275,484	$275,903	$276,321	$276,740	$277,159	$277,577	$277,996	$278,414	$278,833	$279,251
Labor	$516,610	$486,221	$455,832	$425,443	$395,054	$364,666	$334,277	$303,888	$273,499	$243,110	$212,722	$182,333	$151,944	$121,555	$91,166	$60,778	$30,389	$0	($30,389)	($60,778)
Annual O&M 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual O&M 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total running costs	**2,097,992**	**2,069,212**	**2,040,431**	**2,011,651**	**1,982,871**	**1,954,091**	**1,925,311**	**1,896,530**	**1,867,750**	**1,838,970**	**1,810,190**	**1,781,409**	**1,752,629**	**1,723,849**	**1,695,069**	**1,666,288**	**1,637,508**	**1,608,728**	**1,579,948**	**1,551,168**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Annual Risk Costs 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909	$1,062,909
R&R 2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
R&R 8	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total refurbishments	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**	**1,062,909**
Net Benefit/(cost)	**(3,160,901)**	**(3,132,120)**	**(3,103,340)**	**(3,074,560)**	**(3,045,780)**	**(3,017,000)**	**(2,988,219)**	**(2,959,439)**	**(2,930,659)**	**(2,901,879)**	**(2,873,098)**	**(2,844,318)**	**(2,815,538)**	**(2,786,758)**	**(2,757,977)**	**(2,729,197)**	**(2,700,417)**	**(2,671,637)**	**(2,642,857)**	**(2,614,076)**

Expressed in escalated dollars with sensitivity adjustments

Capital Outlays																				
Capital outlay 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital outlay 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total capital outlays	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benefits:																				
Benefits 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benefits 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total benefits	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Annual Running Costs:																				
Hauled solids	614,743	641,550	669,525	698,718	729,183	760,973	794,148	828,767	864,894	902,593	941,933	982,985	1,025,825	1,070,528	1,117,178	1,165,857	1,216,655	1,269,663	1,324,978	1,382,700
electrical demand	711,527	741,575	772,892	805,532	839,550	875,004	911,956	950,468	990,606	1,032,439	1,076,039	1,121,480	1,168,840	1,218,200	1,269,644	1,323,261	1,379,142	1,437,382	1,498,082	1,561,346
NG demand (lhv)	155,914	162,713	169,808	177,212	184,939	193,002	201,416	210,196	219,359	228,920	238,898	249,309	260,175	271,513	283,344	295,690	308,574	322,018	336,047	350,687

polymer use	306,938	320,323	334,291	348,867	364,077	379,950	396,514	413,800	431,837	450,660	470,302	490,800	512,189	534,510	557,801	582,107	607,470	633,937	661,555	690,375
Labor	584,475	573,198	559,942	544,563	526,903	506,800	484,078	458,554	430,032	398,305	363,155	324,349	281,643	234,778	183,479	127,457	66,405	0	(72,100)	(150,257)
Annual O&M 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual O&M 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total running costs	**2,373,597**	**2,439,359**	**2,506,459**	**2,574,892**	**2,644,652**	**2,715,729**	**2,788,112**	**2,861,785**	**2,936,728**	**3,012,917**	**3,090,327**	**3,168,924**	**3,248,672**	**3,329,528**	**3,411,446**	**3,494,372**	**3,578,246**	**3,663,001**	**3,748,563**	**3,834,851**
Annual Risk Costs (optional):																				
Annual Risk Costs 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual Risk Costs 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total risk costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
R&R Costs:																				
R&R 1	1,202,539	1,253,046	1,305,673	1,360,512	1,417,653	1,477,195	1,539,237	1,603,885	1,671,248	1,741,440	1,814,581	1,890,793	1,970,207	2,052,955	2,139,179	2,229,025	2,322,644	2,420,195	2,521,843	2,627,761
R&R 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R&R 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total refurbishments	**1,202,539**	**1,253,046**	**1,305,673**	**1,360,512**	**1,417,653**	**1,477,195**	**1,539,237**	**1,603,885**	**1,671,248**	**1,741,440**	**1,814,581**	**1,890,793**	**1,970,207**	**2,052,955**	**2,139,179**	**2,229,025**	**2,322,644**	**2,420,195**	**2,521,843**	**2,627,761**
Net escalated benefit/(cost)	**(3,576,136)**	**(3,692,405)**	**(3,812,132)**	**(3,935,404)**	**(4,062,305)**	**(4,192,924)**	**(4,327,349)**	**(4,465,670)**	**(4,607,976)**	**(4,754,358)**	**(4,904,908)**	**(5,059,717)**	**(5,218,878)**	**(5,382,484)**	**(5,550,626)**	**(5,723,397)**	**(5,900,890)**	**(6,083,196)**	**(6,270,406)**	**(6,462,612)**

Life cycle cost analysis

PVs in 2023	(3,350,127)	(3,384,588)	(3,419,113)	(3,453,694)	(3,488,320)	(3,522,977)	(3,557,655)	(3,592,342)	(3,627,023)	(3,661,686)	(3,696,317)	(3,730,901)	(3,765,423)	(3,799,867)	(3,834,217)	(3,868,457)	(3,902,568)	(3,936,533)	(3,970,332)	(4,003,947)
NPV as of 2023	**(73,566,087)**																			

Attachment E: Suggested Sampling Protocol for Pilots of PFAS Treatment Technologies

Suggested Sampling Protocol for Pilots of PFAS Treatment Technologies

1.1 Introduction

To better understand the fate and transport of PFAS through each of these technologies, it is recommended that a PFAS sampling plan be developed. Typically, a sampling plan is developed to investigate PFAS levels at key inputs and outputs to a system, which are considered individual sampling locations. At each sampling location, samples are taken in triplicate, meaning that four samples should be taken per sampling run, with a total of 3 runs. It is important that the samples taken capture the PFAS levels in all phases, gas, solid, and liquid, of emissions and end products. If there are multiple phases to test at each sampling location, three samples should be taken of each phase of end product or emission. For PFAS sampling, it is recommended that these be 4-hour composite samples, and that field and proof blanks be taken on ten percent of the samples collected. An example of sampling procedures for pyrolysis systems is included in section 1.3. Although this is specific to pyrolysis, the PFAS sampling protocol for other equipment follows a similar process, with minor changes to sampling locations.

There are several publicly available sources which include a more involved description PFAS sampling and general guidance, including:

- ASTM D4448-01. “Standard Guide for Sampling Ground-Water Monitoring Wells”
- ASTM D6452-99. “Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations”
- EGLE, Groundwater Perfluoroalkyl and Polyfluoroalkyl (PFAS) Sampling Guidance
- EGLE, MDEQ PFAS Sampling Quick Reference Field Guide
- EGLE, Residential Well Perfluoroalkyl and Polyfluoroalkyl (PFAS) Sampling Guidance
- Interstate Regulatory Technology Council (ITRC). “Site Characterization Considerations, Sampling Precautions, and Laboratory Analytical Methods for Per- and Polyfluoroalkyl Substances (PFAS).”

PFAS sampling is an expensive process. Each sample analysis of solid or liquid substances costs roughly $500, for a total of (3 x 4 x $500) $6,000 per sampling location. Air emissions is even more cost prohibitive. One round of air emissions testing costs roughly $50,000 for a three-run sampling event. Therefore, it is important to follow PFAS sampling methods and protocols as closely as possible, so as not to waste any samples.

1.2 General Guidelines

Sample contamination presents a real concern given the ubiquity of PFAS in the environment and consumer products, but also because of the low levels being measured. The list below includes basic guidance.

- Samples should be stored in coolers with ice in zip lock style bags. Use of synthetic cooling packs is prohibited.
- Field documentation should be restricted to plain paper and ball point pens. Waterproof paper, felt tip markers, sticky notes, or other components suspect of containing PFAS should not be used.
- Sampling personnel should not wear water resistant clothing.
- Nitrile gloves are acceptable and should always be worn during sample collection.
- Food or beverages should not be consumed while sampling, other than water. Sampling staff should thoroughly wash hands after meal breaks.
- Personal care products should not be used on the day of sampling.

1.3 Pyrolysis Sampling Procedure

Sampling protocols for both full-scale and laboratory-scale pyrolysis systems are similar to each other. First, the sampling points of the system are identified. These include the inputs and output locations of the system in all of their phases, gas, solid, and liquid. For a typical pyrolysis system, this includes five locations. PFAS exist in volatile, semi-volatile, and non-volatile forms so the sampling approach aims to characterize these classes in the specific phases.

1. Dewatered biosolids
2. Dryer combustion air
3. Dried biosolids
4. Biochar
5. Pyrolysis combustion air
6. Flue gas emissions

1.3.1 Dewatered Biosolids

The main PFAS load to the pyrolysis systems will enter with the dewatered biosolids, or cake. During a full-scale sampling event, three composite dewatered biosolids samples are collected. Because the dryers operate as a batch system and require a multi-day processing time, dewatered biosolids samples should be taken several days in advance of the main sampling event. One of the larger pyrolysis suppliers (BFT) has indicated that a single dryer's worth of biosolids can feed the pyrolysis system for 28–34 hours, and possibly up to 48 hours if dewatering achieves 20 percent TS. Dewatered biosolids are sampled during the loading of the dryer which generally takes 3–4 hours.

1.3.2 Dryer Combustion Air

Combustion processes require oxygen, usually supplied from an air stream. Dryer furnaces combust natural gas fuel to directly heat a process airstream (consisting of leak air and recycled, conditioned dryer exhaust) drawn through the drum dryer system to convey heat and product through downstream separation devices. Combustion air to the furnace represents a small fraction of the process airstream (5 – 10%) and likely contains little to no PFAS but requires sampling as an input for confirmation. The sampling location should be assumed to be representative for the dryer system leak air as well.

1.3.3 Cooling Water (Plant Water and Potable)

Some dryers, such as drum dryer systems, use cooling water in a saturator and venturi scrubber to remove evaporated water and pollutants from the process airstream. At typical testing sites, the majority of the cooling water is provided by secondary effluent from the WRRF process, or plant water, which provides a practically free supply of water. This water will contain some PFAS as the WRRF liquid stream processes do not significantly transform the PFAS content. Plant water exists as a two-phase sample, containing some, but likely less than 30 mg/L TSS depending on the liquid stream and dedicated screening system performance. A small fraction of potable, or protected, water is used in the venturi scrubber for fine misting nozzles.

1.3.4 Saturator and Scrubber Drain

The cooling water supply, condensate, and captured particulate drains from the saturator and venturi scrubber to a plant drain for discharge to the local WRRF. This drain may contain several thousand milligrams per liter of TSS due to captured particulates. The drain from the venturi scrubber will have less particulates as most are expected to be removed in the saturator upstream. Each drain will contain PFAS from the cooling water but also potentially PFAS escaping the dryer in moisture droplets entrained in the dryer exhaust that would be captured by the scrubbing process.

1.3.5 Exhaust Emissions

Airstream exhaust emissions are arguably the most critical output to be evaluated as there is no published data on whether PFAS can be transferred to the gas-phase and consequently be discharged to the environment. In a drum drying WRRF study example, exhaust emissions were studied at two points: (1) dryer exhaust directly after the dried product is separated in the pre-separator and poly-cyclone to identify whether PFAS are present in the direct gas-phase discharge and (2) after the saturator, venturi scrubber, and RTO to determine whether the APC train can remove the PFAS that may exist in the direct exhaust stream.

1.3.6 Dried Biosolids

The drying step removes the bulk of water from the dewatered biosolids. The drying step targets roughly 80 percent TS for a full-scale operation for a relatively single-phase matrix. Samples from the system are taken on the same day as the gas-phase and biochar sampling. The sampling site should aim to dedicate a single dryer for feeding the pyrolysis reactors during the sampling event. At 20 percent TS, technology providers expect 48 hours of operation possible which would cover the sampling schedule necessary for gas phase sampling. These samples shall represent the dried dewatered biosolids sampled several days prior. Three samples of the laboratory dried dewatered biosolids should be taken associated with each experimental run.

1.3.7 Biochar

The pyrolysis process intentionally leaves a portion of the combustible matter present in the biosolids as a solid residual along with the non-combustible fraction, known as biochar. The biochar differs from ash generated during a combustion process by the combustible fraction still present. Biochar sampling from the system should occur on the same day as gas-phase and dried biosolid sample collection. The short retention time, roughly 20 minutes, of pyrolysis reactors allows coincidental sampling. A sample should be collected from each experimental run.

1.3.8 Combustion Air

Combustion processes require oxygen, usually supplied from an air stream. While air likely contains little to no PFAS, the load to the thermal oxidizer warrants sampling. Both full-scale and laboratory-scale sampling events would collect combustion air samples in concert with each flue gas emission sample.

1.3.9 Flue Gas Emissions

Flue gas emissions are arguably the most critical output of the process because they are directly discharged to the environment. Samples should be taken of flue gas after the thermal oxidizer and prior to the wet scrubber.

1.3.10 Solid-Phase Samples

Samples of dewatered biosolids, dried biosolids, and biochar should be collected by taking representative samples of the material fed to, or resulting from, the process run. Samples should be stored at 4°C.

Subsequent laboratory extraction should occur within 14 days and subsequent analysis within 28 days, or up to one year if extracts are frozen.

1.3.11 Gas-Phase

Gas phase sampling should include flue gas and combustion air. Flue gas sampling should include Modified Method OTM-45 for semi-volatile and non-volatile compounds and Fourier-transform infrared spectroscopy (FTIR) for specific volatile compounds. All sampling should be conducted in triplicate.

1.3.12 Quality Assurance and Control

A series of duplicates and blanks should be taken to provide quality control for the sampling process. A total of three field duplicates should be collected, one each of the dewatered biosolids, dried biosolids, and biochar. Blind field duplicates should be subjected to the polar targeted analysis. The collected samples should represent roughly 20 percent of the samples taken. The duplicate samples should be prepared in the same way as the base samples. Extracts should be held for additional analyses if results warrant.

Brown AND Caldwell

Boston

200 Brickstone Square, Suite 403
Andover, MA, 01810

T 978.794.0336