City of Santa Rosa

Biosolids Management Strategic Plan

September 2024



Flow and Loading & Capacity Evaluation • Condition Assessment • Digester 3 Visual Assessment
Regulatory and Market Assessment • Biosolids Screening and Alternatives Evaluation
Estimate of Fugitive Methane Emissions • Capital Improvements Implementation Plan

FINAL

Biosolids Management Strategic Plan: Capital Improvements Implementation Plan

Prepared for
City of Santa Rosa, Santa Rosa, California
September 11, 2024

Stamp to be added after confirmation from City that Final Report is ready for print.

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Acknowledgements

Brown and Caldwell acknowledges the valuable contributions made by the City of Santa Rosa in conducting the Biosolids Management Strategic Plan.

Specifically, the project team recognizes the following personnel for their efforts:

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List of Abbreviations

BC	Brown and Caldwell
BIL	Bipartisan Infrastructure Law
BMSP	Biosolids Management Strategic Plan
BP	belt presses
CAP	Climate Action Plan
CEQA	California Environmental Quality Act
CHP	combined heat and power
CIP	capital improvements plan
City	City of Santa Rosa
CLEEN	California Lending for Energy and Environmental Needs
CPRG	Climate Pollution Reduction Grant
CWSRF	Clean Water State Revolving Fund
DBE	Disadvantaged Business Enterprise
EPA	Environmental Protection Agency
FY	Fiscal Year
GBT	gravity belt thickeners
GHG	greenhouse gas
GHGRF	Greenhouse Gas Reduction Fund
H_2S	hydrogen sulfide
HSW	high-strength waste
IBank	Infrastructure and Economic Development Bank
IRA	Inflation Reduction Act
IRS	Internal Revenue Service
ISRF	Infrastructure State Revolving Fund
ITC	Investment Tax Credit
LTP	Laguna Treatment Plant
MCC	motor control center
PFAS	per- and polyfluoroalkyl substances
PLC	programmable logic control
PTC	Production Tax Credits
R&R	repair and replacement
SB	Senate Bill
SCR	selective catalytic reduction
SWOT	strengths, weaknesses, opportunities, and threats
SWRCB	State Water Resources Control Board
TM	technical memorandum
TWAS	thickened waste activated sludge
WAS	waste activated sludge
WIFIA	Water Infrastructure Finance and Innovation Act
wtpd	wet ton per day
WTPY	wet tons per year

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Section 1

Introduction

The City of Santa Rosa (City) developed their Biosolids Management Strategic Plan (BMSP) for the Laguna Treatment Plant (LTP) to provide short- and long-term options that incorporate and align with the City's Climate Action Plan and help the City achieve its goals to:

- Reduce LTP and biosolids management operational costs
- Mitigate risk of non-compliance with future regulatory requirements
- Provide solutions that best meet the needs of the regional community
- Maintain LTP operational flexibility
- Determine the best use of the composting facility

The goal of the BMSP is to provide recommendations for the solids treatment system, including replacements, optimizations, or improvements. It culminates with this capital improvements plan (CIP) for the City to use as a roadmap for the next 20 years.

The BMSP included the following tasks and technical memorandums (TM), which are attached to this report as Appendix A through Appendix F. The attached TMs were developed and finalized during the project prior to the development of this CIP TM. Subsequent changes or decisions described in this TM may have resulted in refinements to costs, descriptions, or recommendations from the prior work.

- **Flows and Loads and Capacity Evaluation (TM1)** – project flows and loads and evaluate capacity
- **Condition Assessment and Evaluation (TM2)** – provide recommendations based on visual observations
- **Digester 3 Visual Assessment TM –** provide recommendations based on visual observations of the interior of Digester 3
- **Regulatory Review and Market Assessment (TM3)** – evaluate market conditions for regional biosolids management solutions
- **Biosolids Screening and Alternatives Evaluation (TM4)** – evaluate and identify optimal solutions using a 30-year lifecycle cost analysis
- **Estimate of Greenhouse Gas Emissions from Fugitive Methane TM** – estimate range of greenhouse gas emissions from fugitive methane associated with floating digester covers

Figure 1-1 shows the project flow chart for the BMSP. Each task within the BMSP was followed by a workshop with the City and Brown and Caldwell (BC) to ensure the City's goals are being met within each task's deliverable. Workshop notes were documented in meeting minutes (see Appendix G). This report summarizes results from all four TMs and presents the CIP roadmap.

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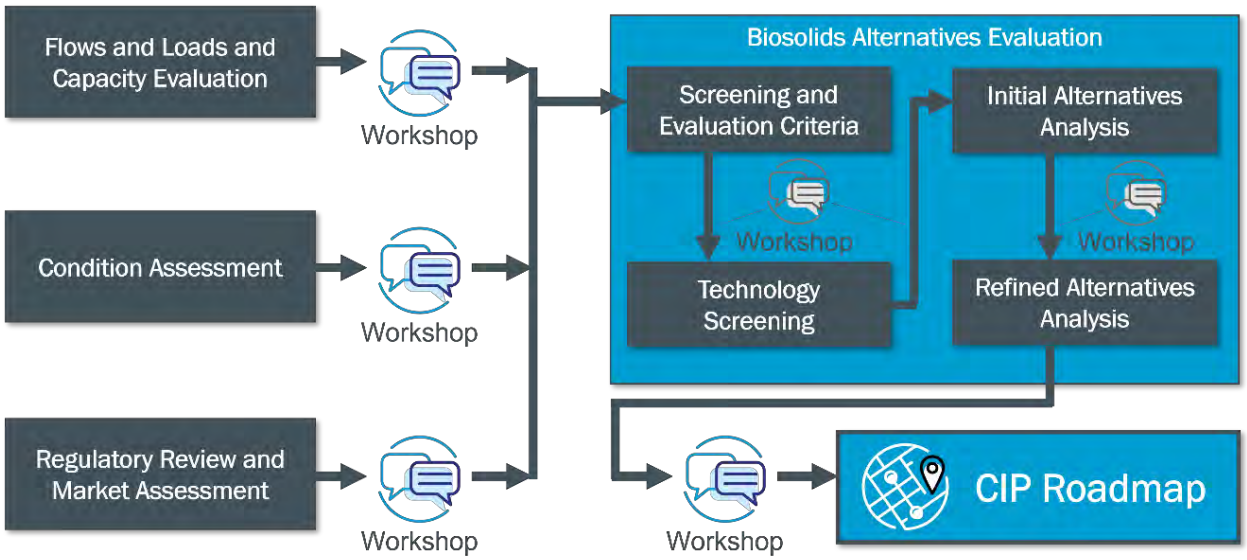


Figure 1-1. Project flow chart

1.1 Background

This section provides background on the LTP operations, biosolids management practices, and the City's CIP review and approval process. Additional details are provided in the appendices.

1.1.1 Laguna Treatment Plant Operations

The LTP solids treatment system uses a combination of thickening, anerobic digestion, and dewatering to produce a Class B cake product. Biogas is sent to either the biogas conditioning system and combined heat and power (CHP) engines for beneficial reuse, or to a flare. Figure 1-2 shows a process flow diagram with the LTP's major components. Biosolids are sent to landfill or beneficial reuse. The City also has a third-party contract that allows up to 150 wet tons per day (wtpd) and 11,200 wet tons per year (WTPY) of biosolids to be sent to Lystek's Fairfield facility.

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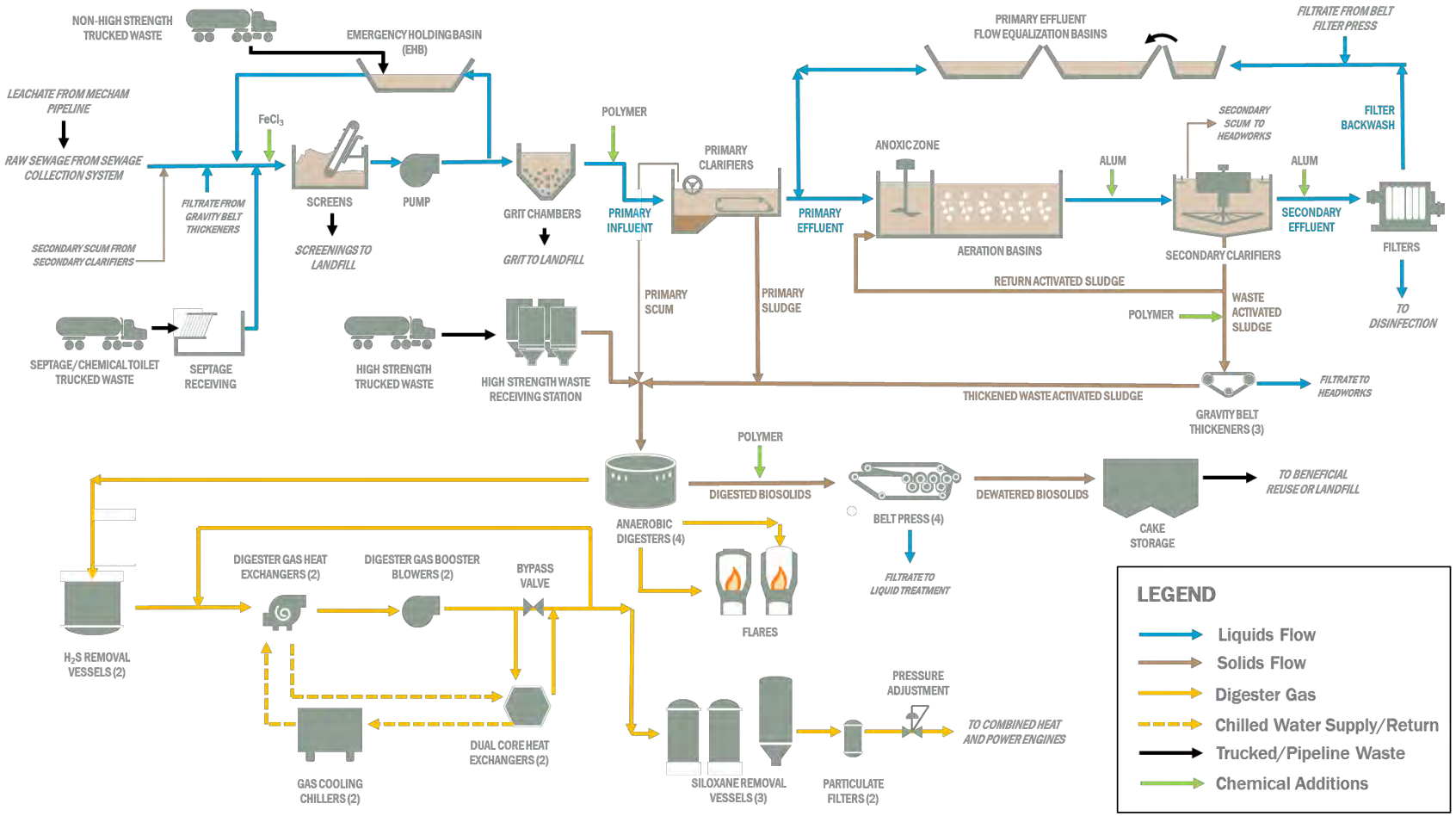


Figure 1-2. LTP process flow diagram

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1.1.2 Laguna Treatment Plant Biosolids Management

The City manages biosolids end-use and wet weather storage. The LTP produces a Class B cake product at around 13 to 16 percent total solids. Biosolids are beneficially reused via land application on agricultural land. The City also owns a barn that is used for wet weather storage. Historically, the City owned and operated a composting facility, and the Redwood landfill was used to dispose a portion of biosolids. These outlets augmented the City's wet weather storage, which does not have enough capacity to store all biosolids produced at the LTP in winter months. The composting facility is no longer operational, and the Redwood landfill has greatly limited or eliminated biosolids receiving. The City currently sends biosolids to Lystek when necessary. In recent years, about 20 percent of biosolids are sent to Lystek.

1.1.3 City of Santa Rosa's Capital Improvements Program

The City's CIP is a five-year plan that is revised annually. The plan identifies necessary public infrastructure improvements. The plan includes a design and construction schedule, identifies budgetary cost estimates, and identifies funding sources for each project. The City's CIP includes bridges, drainage systems, parks, pedestrian and bicycle facilities, the sewer system, traffic systems, the water distribution system, and the Regional System. The Regional System includes the LTP, biosolids management facilities, Geysers, and recycled water distribution systems. The Regional System is only one component of the City's overall CIP budget.

Funding for CIP projects are approved annually. Each year, projects listed in the first year of a five-year plan are reviewed through the City's budget approval process. Budget approval is required to allocate funding for year-one costs associated with projects in the five-year plan. Project costs associated with years two through five in the five-year plan are approved on a planning basis only.

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Section 2

BMSP Technical Investigations

This section summarizes technical investigations documented in the following memorandums:

- **TM1 BMSP Flow and Loading and Capacity Evaluation (Appendix A).** This includes projected flows, projected loadings, and predicted capacity limitations for each unit process.
- **TM2 BMSP Condition Assessment and Evaluation (Appendix B).** This includes an index of all equipment and structures that were observed and key findings from the visual observations. BC was also tasked with a visual assessment of Digester 3 (Appendix C).
- **TM3 BMSP Regulatory Review and Market Assessment (Appendix D).** This includes a review of current and potential regulatory challenges that could impact the City's LTP operations and biosolids management. This also includes a review of market conditions and recommendations for biosolids product or treatment process changes.
- **TM4 Biosolids Alternatives Evaluation (Appendix E).** This includes the development of screening and evaluation criteria, results from initial and refined analyses, and final recommendations for the City's LTP.

The recommendations from each investigation are summarized within this section. Additional details can be found in Appendices A through E. Meeting minutes and slides from technical workshops associated with each TM are included in Appendix G.

2.1 Projected Flows and Loadings and Capacity Evaluation

The flows and loads and capacity evaluation TM (TM1) provided flow and load projections and evaluated the capacity of the LTP's solids treatment system unit processes for the next 30 years.

Historical data, population estimates, and a solids-water-energy balance analysis were used to project the flows and loads of primary sludge, thickened waste activated sludge (TWAS), and high-strength waste (HSW). Peaking factors were developed based on historical data. The City provided a buildout population estimate for the year 2050 of 263,742 people based on the City's General Plan. Growth was estimated assuming a constant annual growth rate between 2019 (population of 197,976 people) and buildout. This resulted in a 0.93 percent growth rate for sludge projections.

Sludge projections were used with peaking factor to evaluate the capacity of primary sludge pumping, thickening, anaerobic digestion, dewatering, cake storage, biogas conditioning system, flare, and CHP engines. Evaluations were based on unit process and equipment design criteria. Capacities were evaluated considering one unit out of service for redundancy. Multiple capacity limitations within the solids treatment system were identified:

- **Thickening capacity limitation in 2023** when one gravity belt thickener (GBT) is offline
- **Anaerobic digestion capacity limitation in 2023** when one digester is offline
- **Cake storage capacity limitation in 2023** when peak day flow and loading condition occurs
- **Biogas conditioning system capacity limitation in 2023** when peak biogas flow conditions occur

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2.2 Condition Assessment and Evaluation

The condition assessment and evaluation TM (TM2) evaluated the condition of solids treatment system assets and structures at the LTP. The purpose of the assessment is to identify repair and replacement (R&R) projects for the BMSP.

A risk-based approach was used that considers the likelihood and consequence of failure of biosolids assets and structures. The assessment included a review of existing data, a site visit by a multi-disciplinary team, and a desktop evaluation of the assets observed. The assessment focused on the solids handling and treatment processes at the LTP, such as HSW receiving, septage receiving, primary and waste activated sludge (WAS) pumps, anaerobic digesters, GBTs, belt presses (BP), cake pumps and storage, gas conditioning system and piping, CHP engines and emission controls, biogas flare, and compost facility.

Likelihood and consequence of failure scores were determined for of each asset. These scores (shown in Appendix B) were based on criteria such as remaining useful life, condition, redundancy, visual observation, public and employee safety, regulatory compliance, and system disruption. Visual observation scores were based on corrosion, leakage, damage, or other defects. A single "risk" score was calculated for each asset based on the product of the likelihood and consequence of failure scores. Risk scores were used to prioritize the assets for R&R projects. A total of 12 projects were recommended:

Critical, High Risk Projects (rehab/replacement recommended):

- **Structural improvements** – crack sealing; joint, water infiltration, and rust repairs
- **Digester dewatering pump replacement** – replace single pump with two smaller pumps
- **Ferric chloride improvements** – replace existing tanks
- **Electrical site improvements** – replace motor control centers (MCCs), panelboards, transformers, and programmable logic control (PLC)

Critical, Low Risk Projects (proactive condition monitoring recommended):

- **HSW odor scrubber improvements** – install new vessel

High Priority Projects (reactive/proactive actions recommended; lower frequency routine inspection):

- **GBT sludge pump replacement** – replace 2 existing pumps and add capacity
- **BP cake pump replacement** – replace existing pumps with either conveyors or piston pumps
- **Digester gas mixing improvements** – replace existing mixing system on all four digesters
- **WAS pump replacement** – reduce suction lift or replace existing pump with submersible pump
- **Compost facility improvements** – replace roof; purlins; heating, ventilation, and air conditioning; fire suppression; and equipment
    - Compost facility improvements are applicable if the City were to choose to reactivate the facility. Biosolids alternatives analysis identified potential uses for composting facility in the biosolids roadmap, but near-term use and improvements were not recommended.
- **Scum pot replacement** – replace with progressive cavity or hose pump

Lower Priority Projects (managed strategies recommended):

- **Selective catalytic reduction (SCR) installation for CHP engines 1 and 2** – add two SCRs

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2.2.1 Digester 3 Visual Assessment

BC also performed a visual assessment of Digester 3 (Appendix C). The visual assessment of the interior of Digester 3 resulted in the following recommendations:

- Recoat the interior and underside of the digester's concrete cover to avoid further degradation
- Complete minor repair of concrete wall surfaces above the water line.
- Fully recoat all piping and appurtenances within the digester.
- Reseal concrete slab joints that show signs of failure.
- Clean and exercise all pressure release valves to ensure functional operation with minimal leaking.
- Replace corroded anchors on the digester mixing pipe straps.

If recoating is not completed as recommended, then a follow-up assessment of the interior digester condition is recommended with a focus on the upper portion of the digester walls and support columns.

2.3 Regulatory Review and Market Assessment

The regulatory and market assessment TM (TM3) evaluated current and potential regulations and market conditions that could impact the City's biosolids end-use. The City's current biosolids end-use practices were also summarized.

2.3.1 Review of City's Existing Biosolids Management

The City's current biosolids program relies on agricultural land application, which is influenced by county ordinances, certified-organic farming practices, and endangered species protections. A strengths, weaknesses, opportunities, and threats (SWOT) framework was used to analyze the City's existing biosolids management and end-use:

- **Strengths** included strong oversight, personal relationships with end users, agricultural application, land acquisition and ownership, winter storage, and participation in regional organizations
- **Weaknesses** included risk of Class B only, heavy reliance on land application, and limited end-use diversity
- **Opportunities** included outlets to soil blenders and landscape suppliers, statewide incentives for composting, local partnerships, and regionalization
- **Threats** included PFAS limitations, maintaining farm for land application, wetland conservation, California tiger salamander habitat, regional biosolids limitations, and sea level rise.

2.3.2 Regulatory Review: Senate Bill 1383 and PFAS

The City complies with federal, state, and local regulations governing biosolids land application and beneficial use. Senate Bill (SB) 1383 set organics diversion targets and limits local jurisdictions' ability to restrict biosolids recycling. Current county ordinances that restrict biosolids land application may be overturned due to the increase in biosolids required for recycling under SB 1383. Relatively poor quality green/food waste compost has been incentivized by SB 1383. This compost competes with biosolids composts and is being sold at a lower price.

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Per- and polyfluoroalkyl substances (PFAS) are a group of emerging contaminants that may impact biosolids management for the City. The Environmental Protection Agency (EPA) announced a strategic roadmap that suggests the City's pollution prevention program may be required to monitor and limit PFAS from industrial dischargers. This type of action would be a proactive approach toward minimization of PFAS in the biosolids management program. The EPA's risk assessment associated with potential regulatory limits for PFAS was still in development.

2.3.3 Market Assessment: Class A Biosolids and Regional Partnerships

Phone interviews with agricultural agents, soil blenders, landscape suppliers, compost facilities, and biosolids service providers were conducted as part of the market assessment. Class A cake could reclaim about 800 acres of land lost to California Tiger Salamander habitat; however, Class A cake product could not be used for any certified-organic crop. The City could explore the commercial demand for a Class A biosolids product within 150 miles of LTP, such as the hay market in Sacramento and Glenn County. Class A product was of interest to soil blenders and landscape suppliers, but appropriate packaging would be necessary for product stabilization and storage. Using soil blenders and landscape suppliers as an outlet can help with seasonal demand by diversifying end-use markets but would require Class A biosolids since these markets distribute to the public.

Interviews with the City's regional peers and suggest potential areas for collaboration and partnership:

- **Windsor** has started design for a pyrolysis unit. They have no regional commitments from other utilities but have discussed the idea with several regional associations.
- **Las Gallinas** is performing a biosolids market assessment. They have encountered biosolids land application issues due to limited markets for conventional hay. Las Gallinas has some interest in composting but is waiting for conclusions from their biosolids market assessment.
- **Central Marin Sanitary Agency** has a similar biosolids management approach as the City: land application in the summer, Lystek use for winter months, and Redwood Landfill as a final outlet. They are interested in regional solutions if there are favorable economics.

2.4 Biosolids Alternatives Analysis

The biosolids alternatives analysis TM (TM4) evaluated alternatives that were developed to address the City's capacity and condition deficiencies. Alternatives to achieve Class A compliance were also evaluated. Screening criteria were developed to eliminate technologies and processes that are not compatible with the LTP or the City's biosolids management strategy. Non-economic and economic evaluations were used to conduct an initial and a refined analysis. Results from the analysis were used to recommend a single alternative for the BMSP roadmap. The roadmap included on-ramps to other alternatives if regulatory or economic triggers occur.

2.4.1 Technology Screening

Various biosolids stabilization technologies were screened using criteria developed with the City. A list of initial alternatives were created to evaluate non-economic and lifecycle costs associated with different strategies the City could implement to alleviate capacity constraints and address market and regulatory drivers

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2.4.2 Initial Analysis

Performance predictions and lifecycle cost estimates were reviewed for 19 initial alternatives. Three alternatives were advanced for refinement based on lifecycle costs and biosolids management benefits: centrifuges and conveyors, thermal dryers, and on-site Lystek.

2.4.3 Refined Analysis

Refined capital and lifecycle cost estimates were prepared. Site layouts, greenhouse gas (GHG) emission estimates, non-economic scoring, and impacts to upstream and downstream processes were also reviewed. One alternative was recommended: the status quo with a new anaerobic digester. The status quo provides the greatest flexibility and lowest risk to the City because on-ramps to achieve lower hauling costs, Class A biosolids, or PFAS mitigation are left open for the City to consider as future drivers emerge and are better defined. The status quo alternative requires construction of a new anaerobic digester to alleviate capacity constraints when one digester is out of service.

2.5 Key Takeaways from Technical Investigations

Technical investigations informed the list of projects to be implemented in the City's CIP over the next 20 years. Critical capacity and condition deficiencies were identified in TM1 and TM2. Alternatives for the City's solids treatment system and biosolids end-use were evaluated in TM4. The list of projects address critical deficiencies.

The following items are key takeaways from the technical investigations:

- **Several unit processes are out of capacity within the solids treatment system. Capital projects are needed to expand anaerobic digestion, gravity belt thickening, and the gas conditioning system capacities.** Operational strategies could be used to mitigate less critical capacity limitations, such as more regularly scheduled hauling from biosolids hoppers in lieu of constructing additional hopper storage.
- **The digester dewatering pump has no redundancy and is a single point of failure.** Replacing the pump with two, smaller pumps was a critical project recommended based on the condition assessment.
- **Critical and priority condition deficiencies were identified, and 11 projects were recommended to repair or replace assets.** The digester dewatering pump replacement, listed above, is included in this list. Composting facility improvements were recommended in the condition assessment but were not carried into the CIP due to lifecycle cost results from the biosolids alternatives analysis.
- **Status quo solids treatment and end-use strategy has lowest lifecycle cost compared to other alternatives.** Other viable treatment and end-use alternatives were evaluated but found to be less economically favorable than continuing with the status quo. These alternatives included composting a portion of the City's biosolids, improving dewatering for drier Class B cake product, installing thermal dryers to minimize biosolids production and produce a Class A cake product, or leasing an on-site Lystek facility to achieve Class A cake product.
- **A roadmap was recommended to provide the City with on-ramps to a Class A product and potential PFAS mitigation.** If market or regulatory triggers prompt the City to consider these on-ramps, regionalization opportunities (e.g., Las Gallinas or Central Marin Sanitary District) and new end-use outlets (e.g., soil blenders or landscape suppliers) should be reconsidered.

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Section 3

Capital Improvements Program Projects and Implementation Plan

This section documents recommended capital improvement projects. Project are listed with a unique identifier (i.e., project number), prioritized, and ranked. The estimated design cost, total capital cost, and project duration are provided for ease of CIP programming.

3.1 Recommended Capital Improvements Projects

Capital improvement project were prioritized and ranked. The project number reflects ranking of projects, where lower numbers are higher priority. The following prioritization categories were assigned to project components:

- **Tier 1 (Highest Priority)** – These projects are the highest priority between all BMSP project components being considered. Condition or capacity constraints justify spending in the near term. BC recommends these projects are programmed in the next 1 to 5 years. More substantial projects such as digester construction or improvements may take longer to implement if funding is required to catalyze project construction.
- **Tier 2 (Lower Priority)** – These projects are within the 20-year CIP horizon, but are lower priority. BC recommends these project costs are tracked and considered in tandem with a full-plant master planning effort. Implementation is recommended in either the next 3-5 years or 10-20 years for projects in this category.

Table 3-1 presents a list of capital improvement projects. Appendix H summarizes these projects in a single 11 by 17 sheet, and Appendix I provides additional details and components for each project.

Total project costs are for planning-level budgeting purposes and are considered mid-point of Class V capital cost estimates (-50 percent/+100 percent accuracy). Appendix J shows calculations used to develop the values in the capital projects summary sheet (Appendix H). Cost estimates would be refined as projects develop through preliminary and detailed design where constructability and other factors can be considered.

All costs are presented in 2023 dollars and do not include escalation for projects programmed for design and construction in later years.

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Table 3-1. Summary of Capital Improvement Implementation Plan Projects

Project Number	Project Component	Prioritization	Duration[a] (Years)	Planning, Design, and Permitting Cost (2023 USD)[b]	Total Project Cost (2023 USD)[b]
Tier 1 Projects – Near term and/or High Priority					**$94.6 mil**
1 [c]	Solids Expansion Project – Pre-Design	1 year	1 + 0	$ 0.5 mil	$ 0.5 mil
2 [d]	Digester Sludge to Dewatering Pump	1-3 years	1 + 1	$ 0.1 mil	$ 0.6 mil
3 [d]	Ferric Chloride Improvements	1-3 years	1 + 1	$ 0.2 mil	$ 0.8 mil
4 [d]	GBT Sludge Pump Replacement	1-3 years	1 + 1	$ 0.1 mil	$ 0.4 mil
5 [c]	Add 1 GBT to Existing Thickening Building	1-3 years	1 + 2	$ 0.4 mil	$ 2.9 mil
6 [c]	Electrical Site Improvements	1-3 years	1 + 3	$ 0.3 mil	$ 2.3 mil
7 [c]	Structural Improvements [f]	1-3 years	1 + 1	$ 0.1 mil	$ 0.6 mil
8 [c]	Increase Gas Conditioning System Capacity	1-3 years	1 + 1	$ 0.7 mil	$ 6.2 mil
9 [c,e]	SCR Installation for CHP Engines 1 & 2	1-3 years	1 + 2	$ 0.3 mil	$ 1.9 mil
10 [c,e]	New Anaerobic Digester and Gallery	3-5 years	1 + 2	$ 4.0 mil	$ 30.0 mil
11 [c,e]	Digester 1 & 2 Cover Replacement, Mixing Improvements, and Coating	3-5 years	2 + 3	$ 3.0 mil	$ 20.0 mil
12 [c,e]	Digester 3 & 4 Mixing Improvements and Coating	3-5 years	1 + 3	$ 2.0 mil	$ 15.0 mil
13 [c]	BP Cake Pump Replacement	3-5 years	1 + 2	$ 1.7 mil	$ 11.5 mil
14 [d]	WAS Pump Replacement	3-5 years	1 + 1	$ 0.1 mil	$ 0.5 mil
15 [d]	Scum Pot Replacement	3-5 years	1 + 1	$ 0.1 mil	$ 0.9 mil
16	Emergency Holding Basin Flow Control Improvements	3-5 years	1 + 1	$ 0.1 mil	$ 0.6 mil
Tier 2 Projects – Long-term and/or Lower Priority					**$9.1 mil**
17	Paving and Signage to Re-route Trucked Waste Program Traffic	3-5 years	0 + 1	--	$ 1.0 mil
18	New Waste Hauler Station	10-20 years	1 + 2	$ 0.1 mil	$ 0.8 mil
19	Utility Performance System Integration and Analytics	10-20 years	2 + 0	--	$ 0.4 mil
20	New Septage Receiving Station	10-20 years	1 + 2	$ 0.3 mil	$ 1.8 mil
21	New HSW Receiving Station	10-20 years	1 + 2	$ 0.6 mil	$ 5.1 mil

Notes:

a. *Duration in years; Years reflect "Planning/Design/Permitting" + "Construction" for budgetary purposes. Actual schedules may vary.*

b. *Costs rounded to nearest 0.1 million dollars; See Appendix H for additional details.*

c. *Recommended to group these projects in a single "Solids Expansion Project" to consolidate project management and delivery. Pursue funding (grants and/or low interest loans) as they are announced.*

d. *Recommended to group these projects and complete construction in-house.*

e. *Project has potential for greenhouse gas emission reductions by mitigating fugitive methane. Fugitive methane mitigation potential is quantified for the replacement of floating digester covers (Project Number 11) in Appendix F.*

f. *Structural improvements include crack sealing (septage receiving station, digester galleries, gravity belt thickener room), joint repairs (digester galleries, belt press room, engine room), conduit water infiltration repair (digester galleries), and rust repair (selective catalytic reducer and old flare).*

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3.2 Additional Capital Improvements Recommendations

This section documents recommendations for the City's BMSP roadmap that were not included in the CIP project list.

3.2.1 Existing Composting Facility

The BMSP evaluated best use of the composting facility. One viable option was to rehabilitate the facility for City-operated composting. The second viable option was to lease the land to Lystek for a 50,000 WTPY facility. City-operated composting would provide an outlet for only a fraction of biosolids, and the alternative was not advanced because of relatively high capital and lifecycle costs. On-site Lystek was a viable alternative, but this alternative was not recommended due to risk associated with annual operating costs.

BC recommends the City keeps this land available as a potential on-ramp for Class A compliance via leasing the land to Lystek for a regional on-site facility. Leasing the land to Lystek can also be an on-ramp if the City elects: 1) to defer digester construction, 2) to offload biosolids management operations, or 3) to transfer biosolids management risk to a third party.

3.2.2 Regional Solutions

Regional solutions were evaluated by reaching out to other facilities in the region. On-site Lystek could serve as a regional solution, as the facility would be sized to accommodate approximately twice as much biosolids as the City generates. A thermal drying facility could also be sized to accommodate biosolids from other facilities. Potential regional partners could include North Bay agencies including Windsor, Las Gallinas, Central Marin Sanitary District, or other agencies in Marin County.

3.2.3 Regulatory and Market Triggers

Regulatory and market triggers were evaluated based on local and nation-wide trends. Potential land application limitations due to PFAS are one risk to the City's biosolids management program. Thermal dryers and pyrolysis are placeholder technologies in the City's roadmap to address these potential regulatory risks. Class A biosolids were found to provide marginal benefit to the City in terms of lifecycle costs. However, thermal dryers or on-site Lystek alternatives evaluated in TM4 were two potential on-ramps the City could use to achieve Class A compliance if a regulatory or market trigger makes Class A biosolids more attractive.

3.2.4 Trucked Waste Program Recommendations

Trucked waste program expansion is not recommended until after anaerobic digestion and biogas conditioning system capacities are increased. Increasing biogas conditioning system capacity will allow the City to maximize biogas utilization and offset electricity costs. Constructing a new anaerobic digester will allow the City to consider accepting additional trucked waste. BC recommends using revenue from the trucked waste program to invest in the capacity improvement projects associated with the trucked waste program (see Appendix H).

The trucked waste program revenue and costs were evaluated in 2022 (BC, 2022). The evaluation identified an annual revenue of $2.26 million dollars and a profit of $438,000. The difference between revenue and profit equals $1.82 million dollars in annual operating costs to maintain the trucked waste program. Annual operating costs cover treatment, administration, laboratory analyses, staffing, maintenance, and biosolids hauling.

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Discussions during the biosolids alternatives analysis revealed that the LTP invests trucked waste program revenue into operations, but does not set aside revenue for capital improvements. BC recommends allocating enough profit from the program to invest in necessary program improvements (BC, 2022) and capital projects (e.g., biogas conditioning system improvements and a new anaerobic digester). Program improvements are necessary to increase staffing and provide additional oversight.

Currently, non-compliant trucked waste is a risk that can cause plant upsets. Additional staffing, constructing a waste hauler station, and integrating monitoring systems are projects that were recommended in the Trucked Waste Program Evaluation Report to increase security and reduce risk (BC, 2022). These improvements require profit from the trucked waste program to be re-invested. In turn, improvements will facilitate the long-term operation and health of the trucked waste program.

3.2.5 Incorporation of Biosolids Projects from Previous Capital Improvements Plan

The City's previous capital improvements plan (City, 2023) included line items for:

- Plant paving at various locations ($300,000 between fiscal year (FY) 2023 and FY 2026
- Digester Nos. 3 and 4 interior repairs ($1,000,000) between FY 2024 and FY 2025
- SCR and Gas Conditioning Improvements ($500,000) for FY 2024

Components from these line items were included in the list of projects recommended in this report. Digester interior repairs are required, as recommended by the Digester 3 Visual Assessment TM (Appendix C). Interior repairs were grouped with other digester improvements (e.g., cover replacement or mixing improvements) in the CIP projects recommended in this report. Projects to address paving, SCR, and gas conditioning system improvements are also included in this report.

Earlier master planning efforts included costs for potential projects such as compost building roof and ventilation replacement, biosolids seasonal storage expansion, or conversion to a Class A biosolids program. Costs for these potential projects are not included in this report because they were not recommended for implementation due to the lifecycle cost analysis completed as part of TM4 (Appendix E); constructing a new digester was identified as the recommended alternative to address the City's digestion capacity constraints, and alternatives to achieve Class A biosolids had higher lifecycle costs than the status quo.

3.3 Capital Improvements Plan Roadmap

Figure 3-1 summarizes results from the capacity evaluation, condition assessment, and biosolids alternatives analysis in a roadmap graphic. There are two implementation phases of capital improvement projects: near term projects (1-5 years) and long-term projects (10-20 years). The additional capital improvements recommendations, such as reserving the composting facility location as a potential site for a Class A on-ramp or regional facility, are included in this graphic.

Starting immediately on a pre-design is recommended for project components grouped in the "Solids Expansion Project." These projects include:

- Add 1 GBT to Existing Thickening Building
- Electrical Site Improvements
- Structural Improvements – crack sealing (septage receiving station, digester galleries, gravity belt thickener room), joint repairs (digester galleries, belt press room, engine room), conduit water infiltration repair (digester galleries), and rust repair (selective catalytic reducer and old flare)

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- New Anaerobic Digester and Gallery
- Digesters 1 and 2 Cover Replacement, Mixing Improvements, and Coating
- Digesters 3 and 4 Mixing Improvements and Coating
- Increase Gas Conditioning System Capacity
- SCR Installation for CHP Engines 1 and 2
- BP Cake Pump Replacement (e.g., piston pumps or conveyors)

Design, permitting, and refined cost estimation documents associated with a pre-design can be leveraged by the City to pursue funding for a Solids Expansion Project. Appendix K documents grant and funding opportunities that may be applicable.

The City could group and complete other near term projects in-house with design and construction support from consultant(s) and/or vendor(s) as needed. These projects include:

- Digester Sludge to Dewatering Pump
- Ferric Chloride Improvements
- GBT Sludge Pump Replacement
- WAS Pump Replacement
- Scum Pot Replacement

Long-term projects are associated with the City's trucked waste program. These projects will be needed to improve trucked waste program monitoring and management. A new HSW receiving station is included in the roadmap anticipating program expansion.

On-ramps for Class A biosolids or implementation of technologies with the potential to mitigate PFAS are included in the roadmap. The City's current roadmap continues with City-managed Class B biosolids and prioritizes addressing capacity constraints and condition deficiencies within the solids treatment system.

3.4 Capital Improvements Project Locations

Figure 3-2 shows where capital improvements projects will be implemented at the LTP. The new anaerobic digester is sited adjacent to existing digesters to minimize sludge and biogas piping. This location will require crossing an existing roadway within the LTP to tie into the existing systems.

The majority of projects address condition deficiencies, and therefore these projects are located where the existing assets are currently located. Projects that expand the gas conditioning system or SCR units will require additional footprint to add additional units, but this has minimal impact on available land at the LTP.

Projects that improve the trucked waste program are located where there are no other existing facilities to minimize demolition costs. A new waste hauler station would be located between the entrance to the plant and the discharge locations so that staff can intercept haulers for increased monitoring and compliance. If the City elects to relocate their septage receiving station or expand their HSW receiving, then the new facilities would be located further away from highly trafficked areas that currently interfere with chemical deliveries. It should be noted that a new HSW receiving facility is only feasible if anaerobic digestion capacity is increased.

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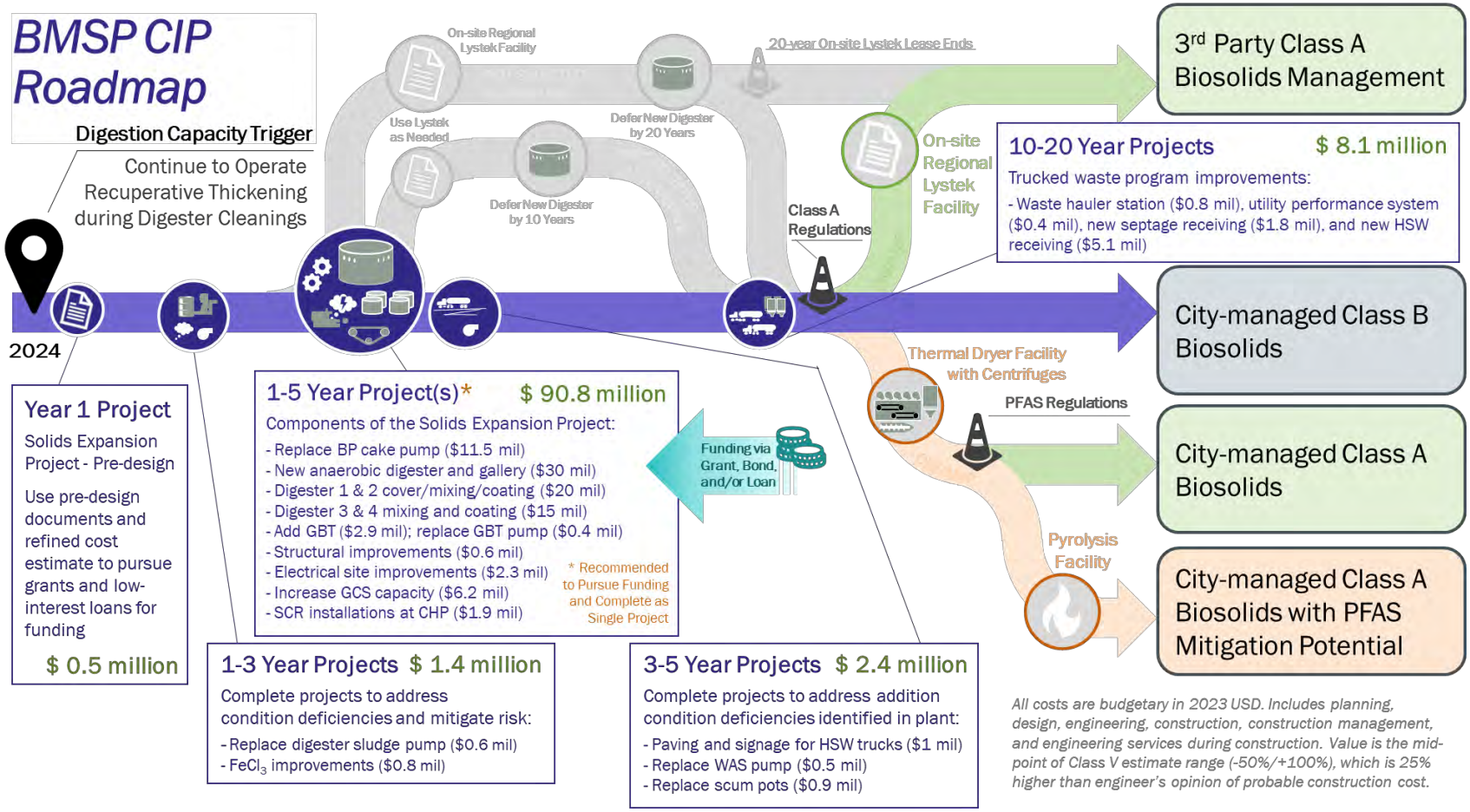


Figure 3-1. Capital improvements implementation plan roadmap

Grey alternatives shown in roadmap were considered as part of the biosolids alternatives analysis (TM4) but were not selected due to non-economic and lifecycle costs.
On-ramps for Class A biosolids or PFAS mitigation are shown on roadmap but not included in 20-year CIP. Refer to TM4 for additional biosolids management roadmap details.

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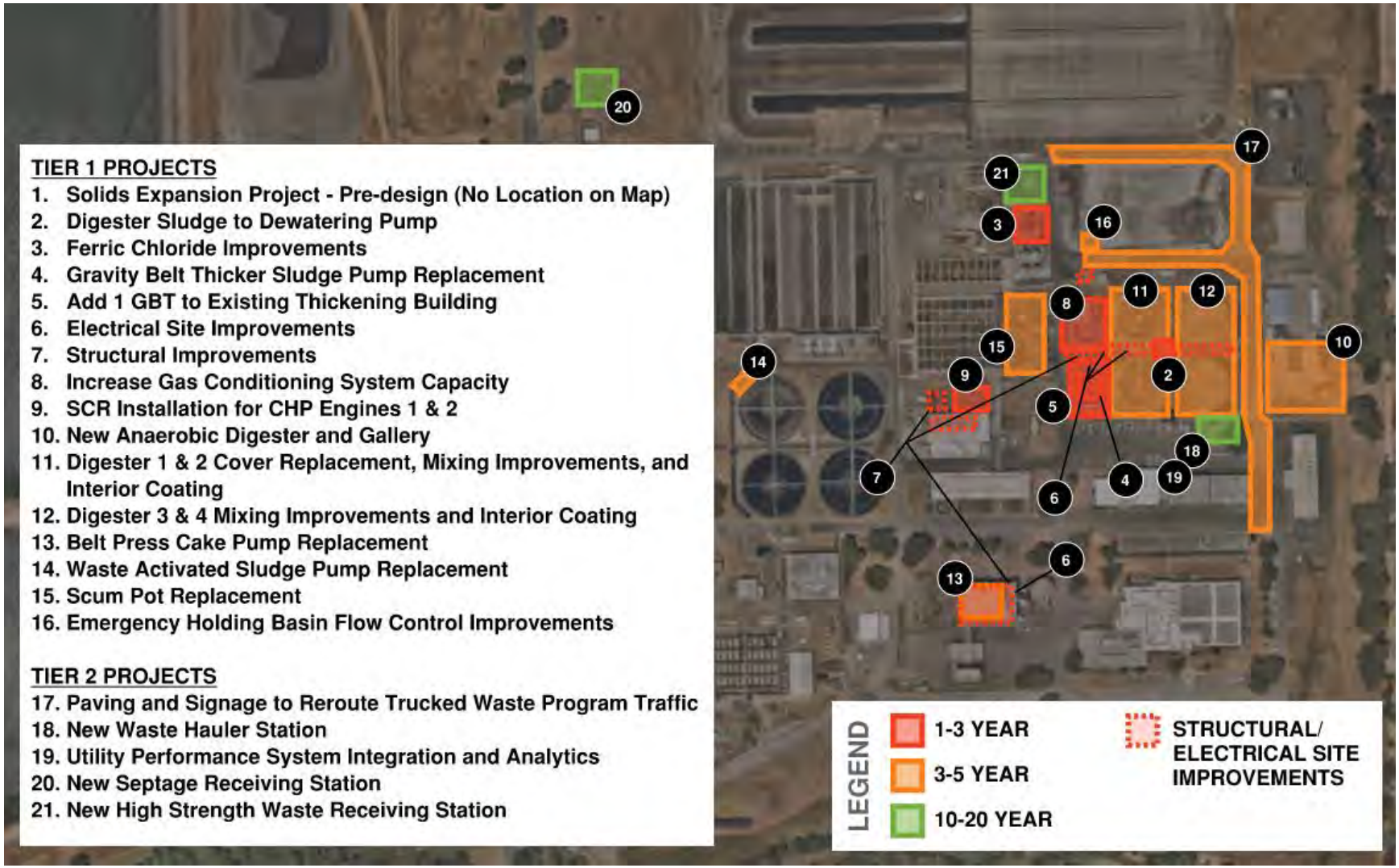


Figure 3-2. Capital improvements implementation plan project locations

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3.4.1 Risks of Deferring Digester Construction

Operational strategies can be used to extend the life of current infrastructure to defer certain capital projects. Digester capacity is currently exceeded whenever one digester is taken out of service; however, the City can operate in recuperative thickening mode in the near term to defer capital costs. Whenever one digester is out of service, it is recommended that recuperative thickening is operated to maintain the minimum solids retention time for Class B compliance.

Use of recuperative thickening is not the typical mode of operation for the LTP and is not common practice across the industry. This requires one GBT to be used for anaerobic digestion, which impacts thickening capacity and incurs additional operating costs. Furthermore, if there is insufficient capacity or condition to perform recuperative thickening, then the LTP is at risk of falling below the required solids retention time for Class B compliance.

Ensuring that Lystek is available as an outlet during digester cleanings is important. This will allow the City to maintain or exceed Class B compliance until a new digester is constructed. Constructing a new anaerobic digester sooner in the CIP roadmap is recommended to alleviate capacity constraints, which will minimize risks associated with compliance, operation and maintenance, and cost.

Appendix L documents a business case evaluation that was conducted to evaluate whether deferring digester construction is beneficial for the City. The business case evaluation resulted in a recommendation to avoid deferring constructing a new digester.

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Section 4

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Section 5

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Appendix A: TM1 Flows and Loads and Capacity Evaluation

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Technical Memorandum

FINAL

Prepared for: City of Santa Rosa

Project Title: Biosolids Management Strategic Plan

Project No.: 157568.006.003

Technical Memorandum 1

Subject: Flows and Loads and Capacity Evaluation

Date: June 30, 2023

To: Tetyana Mokvyts, P.E., Project Manager, City of Santa Rosa

From: Alison Nojima, P.E., Project Manager, Brown and Caldwell



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Executive Summary

Background

The City of Santa Rosa (City) is preparing a biosolids management strategic plan (BMSP) for the Laguna Treatment Plant (LTP). The BMSP will provide short- and long-term options to achieve the City's goals to 1) reduce operational costs, 2) mitigate future regulatory risks, 3) provide solutions that best meet the needs of the regional community, 4) maintain operational flexibility, 5) incorporate and align with the City's Climate Action Plan, and 6) determine the best use of the composting facility.

The BMSP will provide recommendations for the solids treatment system, including replacements, optimizations, or improvements. The BMSP will culminate with a capital implementation plan (CIP) for the City to use as a roadmap for the next 20 years. This roadmap will be based on results from a 30-year lifecycle cost analysis and will consider future biosolids market and regulatory risks.

Purpose

The purpose of this technical memorandum (TM) was to develop flow and load projections and evaluate solids treatment system capacities through a 30-year planning horizon (i.e., through 2053). Flow and load projections developed in the first part of this TM were based on review of historical data and population estimates. The second part of this TM evaluated thickening, digestion, dewatering, biogas utilization, and combined heat and power (CHP) capacities at the LTP. Flow and load projections will also be used in the biosolids screening and alternatives evaluation. The biosolids alternatives evaluation will use a 30-year lifecycle cost analysis.

Flow and Load Projections

Figure ES-1 shows the annual average flow and load projections for primary sludge (PS) and thickened waste activated sludge (TWAS) in pounds per day (lb/d) from 2023 through 2053. A growth rate of 0.93 percent was used based on population projections from the City's General Plan. The analysis of historical data via a calibrated mass balance suggested that the 5 percent decrease in baseline PS and TWAS flow rates was appropriate to predict future biosolids and biogas production more accurately. Non-HSW trucked waste expansion is also recommended for consideration in the biosolids alternatives evaluation. The high-strength waste (HSW) receiving station received an average annual 16,900 gallons per day (gpd), based on historical data, and is permitted for a maximum flow of 46,000 gpd. These values were used in capacity evaluation calculations. An average annual HSW flow of 30,000 gpd is recommended for use in the biosolids alternatives evaluation to represent current loading observed by the City from January to May in 2023. An average annual HSW flow up to 92,000 gpd (twice the permitted capacity) will also be evaluated in the biosolids alternatives evaluation. This number represents HSW expansion and would likely require a new receiving station.

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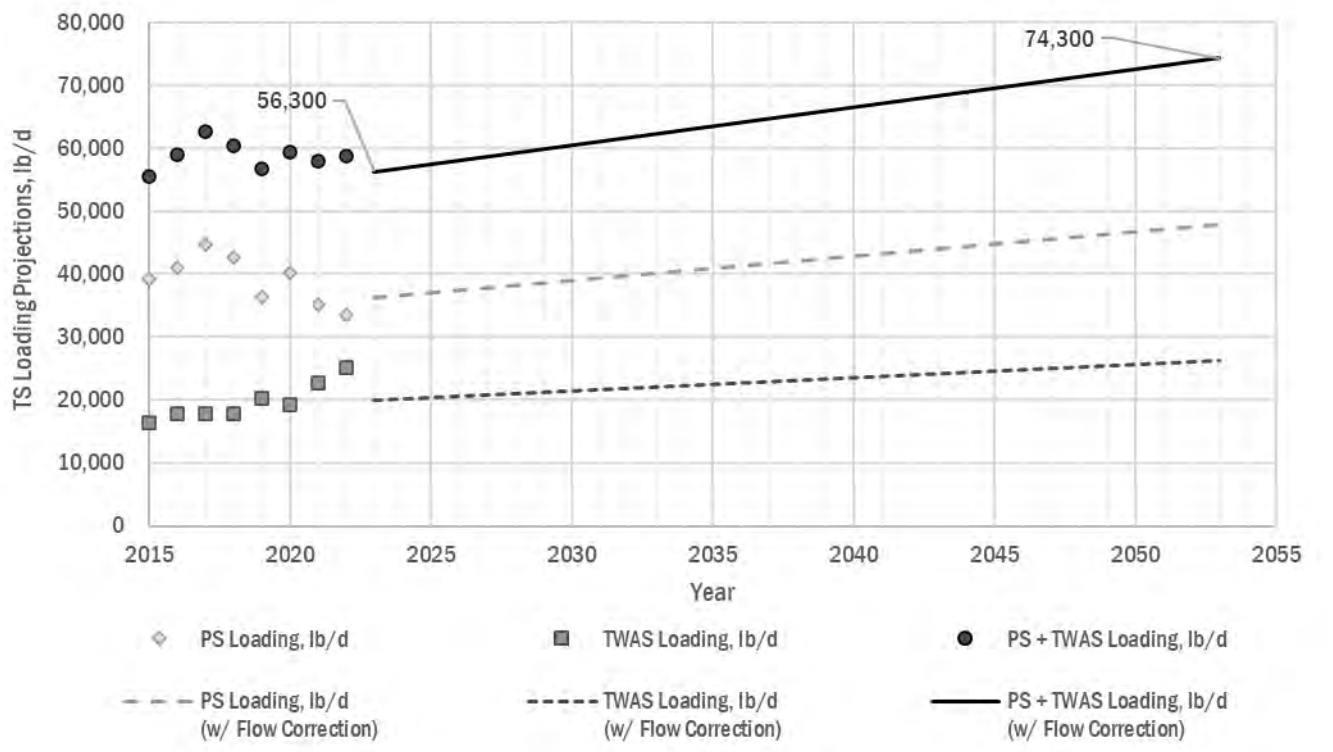


Figure ES-1. PS and TWAS loading projections

TS = total solids

Capacity Evaluation

The capacity evaluation included an analysis of the existing solids treatment units, including PS pumping, thickening, anaerobic digestion, dewatering, cake storage, biogas conditioning system (GCS), flare, and CHP engines. Unit process capacities were evaluated against projected flows and loads from the mass balance. Flows and loads were projected for maximum loading conditions (e.g., max 7-day, max 1-day, or max 1-hour). Capacity limitations were evaluated based on PS and TWAS loads only. Additional capacity for HSW was calculated after determining limitations based on PS and TWAS only. The evaluation considered capacity with all units online and capacity with one unit offline for maintenance.

Figure ES-2 shows the capacity evaluation results, which suggest several capacity limitations within the solids treatment system. Capacities were evaluated considering only PS, WAS, and/or TWAS. Thickening and anaerobic digestion have sufficient capacity through 2045 or beyond when all units are online, but capacity is limited in the near term for these processes if one unit is brought offline for maintenance. The cake storage and GCS are currently capacity limited, which may impact upstream or downstream treatment processes on days with maximum loading. PS pumping, dewatering, and CHP engines have sufficient capacity through the planning horizon (2053), and the flare has sufficient capacity through 2046.

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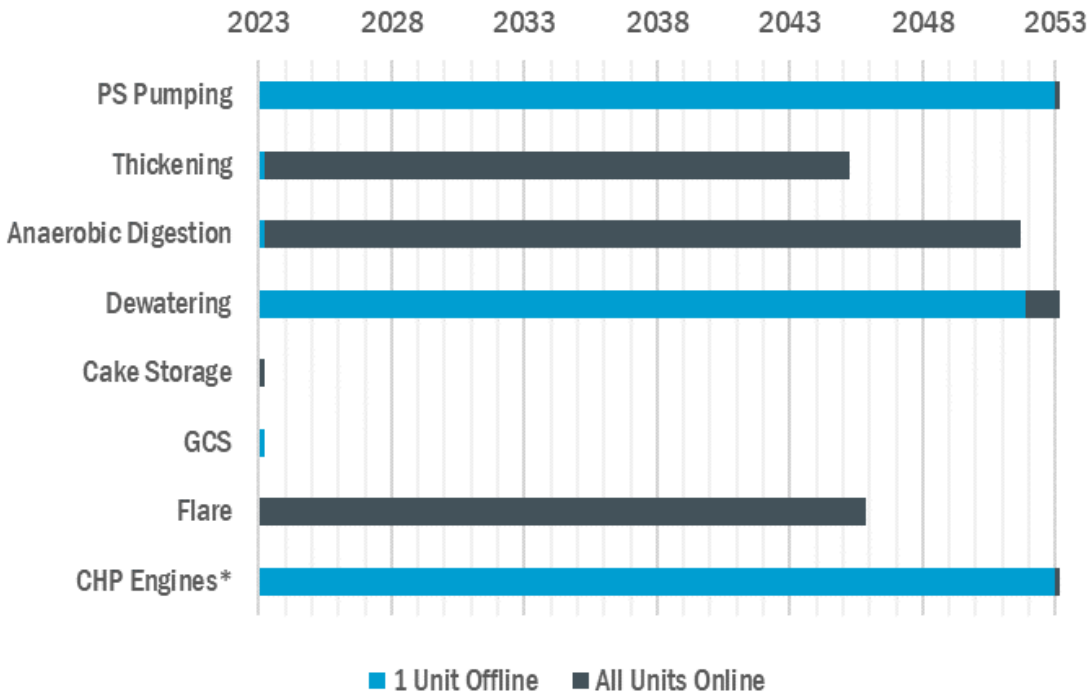


Figure ES-2. Capacity evaluation results with one unit offline and all units online

**CHP Engines capacity with "1 Unit Offline" reflects 2 CHP engines with selective catalytic reduction, assuming the second set of engines are offline because of periodic limitations in engine operations based on the air permit. Results shown are based on PS and TWAS loads only.*

Next Steps

Opportunities to improve unit processes will be evaluated as part of the biosolids alternatives evaluation and documented in the Biosolids Screening and Alternatives Evaluation (TM 4). Synergies within the solids treatment system and potential changes to upstream processes (e.g., primary treatment performance or HSW receiving volumes) will be considered. Findings from the condition assessment, regulatory review, and market assessment will also be considered during the biosolids alternatives evaluation to identify cost-effective solutions, address critical needs, and provide a roadmap that is resilient to regulatory and market uncertainties.

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Section 1: Introduction

The City of Santa Rosa (City) is conducting a biosolids management strategic plan (BMSP) for the Laguna Treatment Plant (LTP) to provide short- and long-term options to achieve the City's goals to:

- Reduce operational costs
- Mitigate future regulatory risks
- Provide solutions that best meet the needs of the regional community
- Maintain operational flexibility
- Incorporate and align with the City's Climate Action Plan
- Determine the best use of the composting facility

The BMSP will provide recommendations for the solids treatment system, including replacements, optimizations, or improvements. The BMSP will culminate with a capital implementation plan (CIP) for the City to use as a roadmap for the next 20 years.

The BMSP includes the following tasks and technical memorandums (TM):

- **Flows and Loads and Capacity Evaluation (TM 1)** – project flows and loads and evaluate capacity
- **Condition Assessment and Evaluation (TM 2)** – provide recommendations based on visual observations
- **Regulatory Review and Market Assessment (TM 3)** – evaluate market conditions for regional solutions
- **Biosolids Screening and Alternatives Evaluation (TM 4)** – evaluate and identify optimal solutions using a 30-year lifecycle cost analysis

Figure 1-1 shows the project flow chart for the BMSP. Each task within the BMSP is followed by a workshop with the City and BC to ensure the City's goals are being met within each task's deliverable.

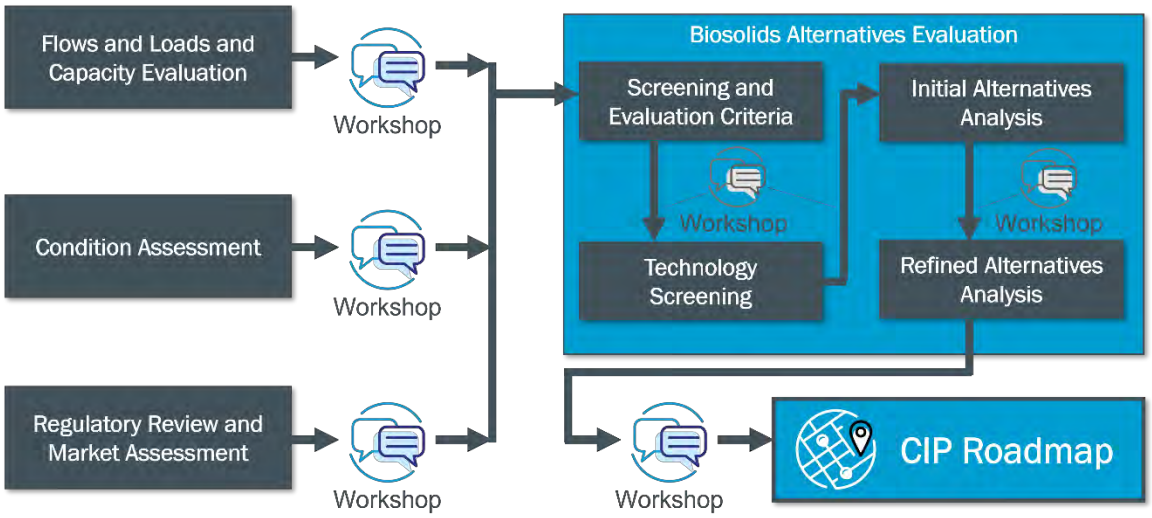


Figure 1-1. Project flow chart

1.1 Laguna Treatment Plant Process Flow Diagram

The LTP solids treatment system uses a combination of thickening, anerobic digestion, and dewatering to produce a Class B cake product. Additionally, biogas is sent to either the biogas conditioning system (GCS) and combined heat and power (CHP) engines for beneficial reuse, or to a flare. Figure 1-2 shows a process flow diagram with the LTP's major components. The City also has a third-party contract that allows up to 150 wet tons per day and 11,200 wet tons per year of biosolids to be sent to Lystek's Fairfield facility.

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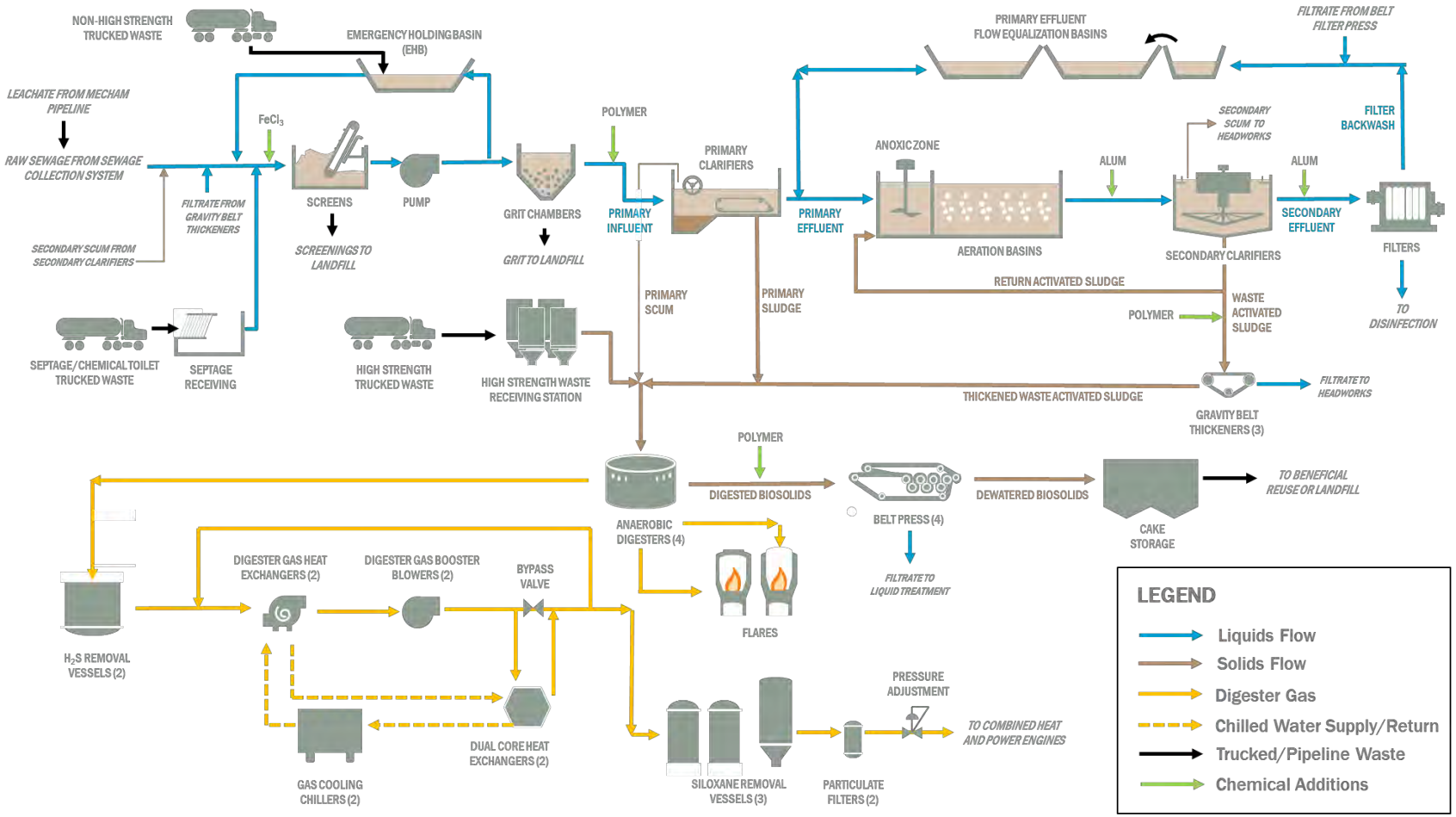


Figure 1-2. LTP process flow diagram

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Waste activated sludge (WAS) is thickened using gravity belt thickeners (GBT) to produce thickened waste activated sludge (TWAS). TWAS is sent to the anaerobic digesters in addition to primary sludge (PS) and high-strength waste (HSW) and primary scum. Waste haulers trucks deliver HSW to the LTP about 5 to 6 days per week. The HSW receiving station was brought online in August 2016. After anaerobic digestion, digested sludge is dewatered using belt presses (BP). Dewatered cake is pumped to cake storage hoppers. Class B biosolids cake is hauled directly to beneficial-use sites.

1.2 Flows and Loads

Flows and loads were projected to evaluate unit process capacities at the LTP. Projections and peaking factors were calculated based on City-provided process data from 2013 to 2022. Projections and peaking factors were used in the capacity evaluation, and projections were also developed for use in the biosolids screening and alternatives evaluation.

1.3 Capacity Evaluation

The capacity evaluation included an analysis of the existing solids treatment units, including PS pumping, thickening, anaerobic digestion, dewatering, cake storage, gas conditioning system (GCS), flare, and CHP engines. Maximum flows and loads were used to calculate capacity utilization for each unit process. Flows and loads were compared against design criteria. The evaluation considered capacity with all units online and with one unit offline for maintenance.

Section 2: Flows and Loads

To determine appropriate projections, historical data was reviewed to determine the basis for future flows and loads. The historical data review included a solids-water-energy balance analysis (a mass balance with digester gas and energy production calibration), calculation of peaking factors, analysis of historical population changes, and recommendations for flow and load projections.

2.1 Baseline Flows and Loads and Unit Process Performances

Historical data was reviewed for outliers and to verify historical trends (Attachment A). Periods were identified from the historical data to calibrate performance parameters using a solids-water-energy balance analysis (Attachment B). The analysis considered three scenarios:

- **Before HSW** – average annual data from 2013-2015 was used to calibrate PS and TWAS volatile solids reduction (VSR) values, solids capture rates, digester inert deposition rates, and CHP performance assumptions.
- **After HSW** – average annual data from 2017-2022 was used to calibrate HSW VSR, update solids capture rates, and verify digester inert deposition rates and CHP performance assumptions.
- **Validation** – 1 year of data from 2019 was used to validate model results. The calibrated parameters from the previous two scenarios were left unchanged to verify satisfactory prediction using the calibrated parameters.

The calibration effort found a **5 percent derating of PS and TWAS flows was necessary** to better predict digested sludge characteristics, CHP engine energy recovery, and cake hauling weights. This finding is carried into the flow and load projections for a more accurate prediction of biogas and biosolids production in the capacity evaluation and biosolids alternatives evaluation.

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Figure 2-1 summarizes the baseline performance in 2023 based on the calibrated solids-water-energy balance. Baseline values were based on the average annual values from 2020-2022, increased by 0.93 percent to account for population growth in 2023. Figure 2-1 demonstrates assumptions recommended for use in the BMSP based on calibration results, including PS, TWAS, HSW, and cake characteristics.

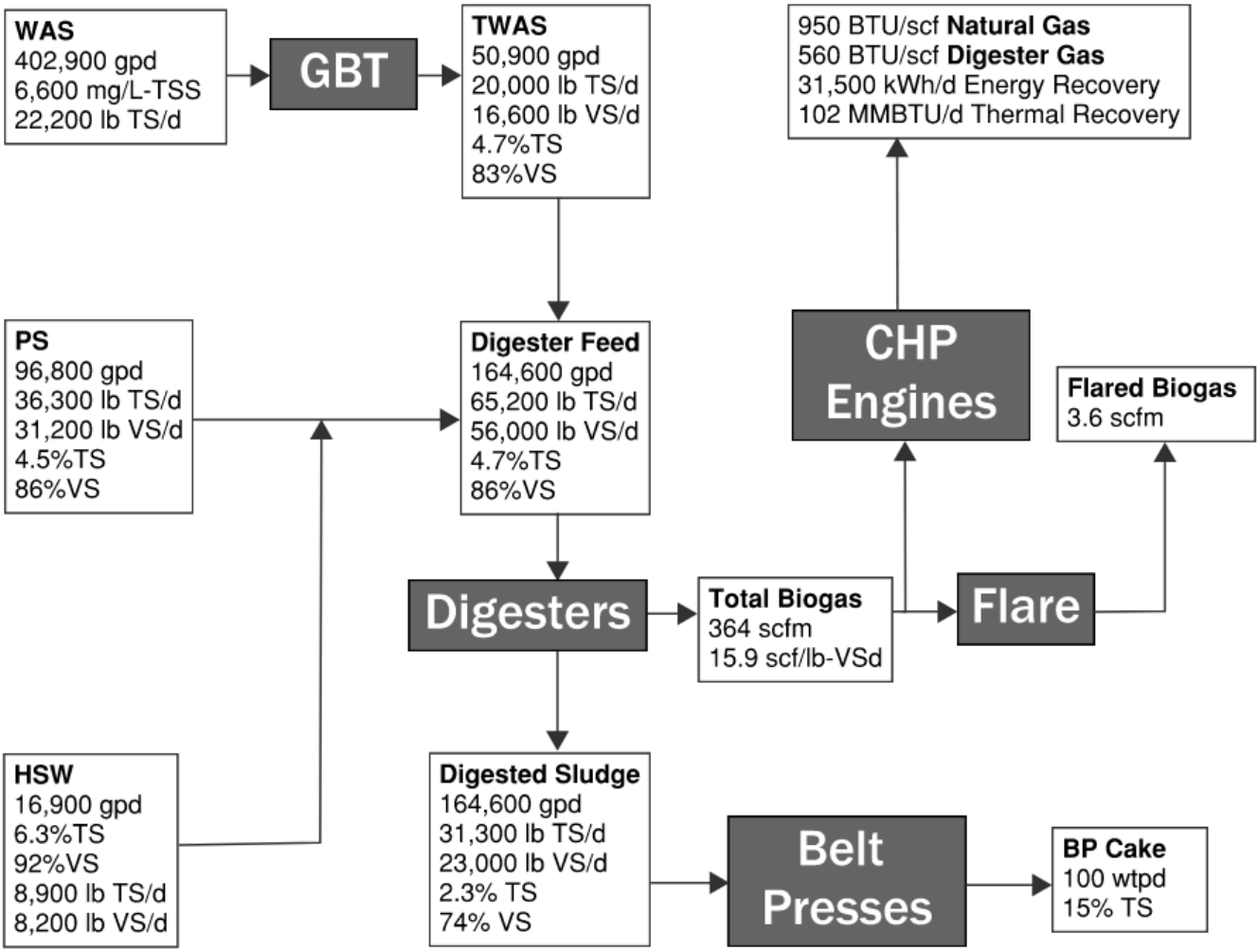


Figure 2-1. Baseline (2023) solids and energy balance process flow diagram for average annual conditions

Calibrated solids treatment assumptions are shown in Table 2-1. These values were used for sludge, cake, and biogas projections (Section 2.3.3). The solids-water-energy mass balance attributes a unique VSR and specific biogas production value for each of the three solids streams (PS, TWAS, and HSW). These values were used with digester loading projections to predict the digested sludge loading to dewatering and total biogas production. The model was calibrated without considering synergistic impacts of HSW on other solids streams. The historical data review suggested inert solids deposit in digesters at a rate of 11 to 12 percent relative to the digester feed. An inert solids removal rate of 10 percent was used in the calibration to match the total solids (TS) load reduction observed across digestion. This assumption provided a closer calibration to average annual cake production documented in biosolids hauling records (see Attachment B). The CHP engines were calibrated with an electrical and heat recovery efficiency of 37 and 35 percent, respectively. The lower heating value (LHV) of natural gas was assumed as 952 British thermal units (BTU) per cubic foot

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(ft^3) for the solids-water-energy balance. The digester gas LHV was calculated by multiplying the biogas methane content by 1,000 BTU/ft3 (HHV of methane gas) and dividing by 1.108 (approximate conversion factor for HHV to LHV). For example, biogas with 62 percent methane content would have approximately 560 BTU/ft^3.

Table 2-1. Calibrated Solids Treatment Assumptions

Parameter	VSR	Inert Solids Deposition	Biogas (scf/lb-VSd)	Capture Efficiency	Electrical Efficiency	Thermal Efficiency
PS	65%	10%	15	N/A	N/A	N/A
TWAS	32%	10%	15	N/A	N/A	N/A
HSW	90%	10%	19	N/A	N/A	N/A
Thickening	N/A	N/A	N/A	90%	N/A	N/A
Dewatering	N/A	N/A	N/A	96%	N/A	N/A
CHP Engines	N/A	N/A	N/A	N/A	37%	35%

scf/lb-VSd = standard cubic foot per pound of volatile solids destroyed

2.2 Peaking Factors

Peaking factors were calculated based on the ratio of daily, weekly (7-day [d]), biweekly (14-d), and monthly (30-d) maximum values relative to the average annual flow or load. All values are shown to the nearest three significant figures. Peaking factors are applied to projected average annual flows and loads to determine maximum loading rates to unit processes for the capacity evaluation (Section 3).

2.2.1 Primary Sludge

Table 2-2 shows PS peaking factors calculated for use in the PS pumping capacity evaluation. Each tank has a single PS pump, and pumps are operated on a loop based on a target sludge bed depth of 1.5 to 1.8 feet.

Table 2-2. Summary of PS Peaking Factors

Parameter	Max Month	Max 14-d	Max 7-d	Max Day
PS Flow	1.42	1.47	1.56	1.95
PS TS Loading	1.33	1.48	1.56	2.14

2.2.2 Waste Activated Sludge

WAS peaking factors were calculated for use in the thickening process capacity evaluation. Thickening is a 24/7 operation. Table 2-3 provides a summary of WAS peaking factors.

Table 2-3. Summary of WAS Peaking Factors

Parameter	Max Month	Max 14-d	Max 7-d	Max Day
WAS Flow	1.46	1.49	1.59	1.65
WAS TS Loading	1.42	1.50	1.48	1.60

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2.2.3 Thickened Waste Activated Sludge

TWAS peaking factors are calculated for comparison with WAS peaking factors. Higher max 7-d and max day peaking factors may be influenced by recuperative thickening, which is used if a digester is brought offline to maintain a sufficient digester solids residence time for Class B biosolids. Table 2-4 provides a summary of TWAS peaking factors.

Table 2-4. Summary of TWAS Peaking Factors

Parameter	Max Month	Max 14-d	Max 7-d	Max Day
TWAS Flow	1.39	1.47	1.73	1.88
TWAS TS Loading	1.44	1.49	1.49	1.85

2.2.4 Primary and Thickened Waste Activated Sludge

Combined PS and TWAS sludge peaking factors were calculated for use in the anaerobic digestion process capacity evaluation. These peaking factors do not account for HSW flows. Additional loading from HSW was layered onto this baseline load because imported materials (e.g., fats, oils, and grease [i.e., FOG], brewery waste, etc.) can be increased or decreased at the LTP in future years at the City's discretion. Table 2-5 provides a summary of digester influent peaking factors.

Table 2-5. Summary of Digester Influent Peaking Factors

	Max Month	Max 14-d	Max 7-d	Max Day
PS+TWAS Flow	1.35	1.40	1.49	1.64
PS+TWAS TS Loading	1.29	1.37	1.41	1.72
PS+TWAS VS Loading	1.29	1.37	1.41	1.75

2.2.5 Digested Sludge

Digested sludge peaking factors were calculated for use in the dewatering process capacity evaluation. The BP units and cake pumps were evaluated based on digested sludge peaking factors. Dewatering is a 24/7 operation; however, the City has shut down dewatering on occasion from Sunday evening through Monday morning if the cake storage hopper is full (cake is not hauled on Sundays). Table 2-6 provides a summary of BP feed peaking factors.

Table 2-6. Summary of BP Feed Peaking Factors

Parameter	Max Month	Max 14-d	Max 7-d	Max Day
BP Feed Flow[a]	1.35	1.40	1.49	1.64
BP Feed TS Loading	1.24	1.26	1.33	1.99

a. Set identical to digester influent flow peaking factor, assuming constant digester volume in capacity calculations

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2.2.6 Dewatered Sludge

Dewatered sludge peaking factors were calculated for use in the cake storage hopper capacity evaluation. The higher max 7-d and max day peaking factors may be influenced by dewatering shutdowns due to a full cake storage hopper on Sunday evening through Monday morning. Table 2-7 provides a summary of cake peaking factors.

Table 2-7. Summary of Cake Peaking Factors

Parameter	Max Month	Max 14-d	Max 7-d	Max Day
Cake Flow	1.19	1.25	1.42	2.04
Cake TS Loading	1.23	1.27	1.38	1.90

2.2.7 Biogas

Biogas peaking factors were calculated for use in the GCS and flare process capacity evaluations. Table 2-8 provides a summary of biogas peaking factors. The max 3-hour and max hour peaking factors are relative to average daily values.

Table 2-8. Summary of Biogas Peaking Factors

Parameter	Max Month	Max 14-d	Max 7-d	Max Day	Max 3-hour[a]	Max Hour[a]
Biogas	1.14	1.16	1.20	1.33	1.3	1.5

a. Max 3-hour and Max Hour peaking factors represent max hourly flow divided by daily flow.

2.3 Projection of Flows and Loads

Flows and loads were projected to provide an estimate of future growth in the LTP's service area. Historical population estimates and sludge loading data were reviewed to provide a basis for projections. Flows and loads were projected for PS and TWAS, which feed into the solids treatment system. WAS flows and loads were calculated based on TWAS loads and the GBT solids capture rate because more information was available for TWAS. The City controls HSW flows, and therefore three scenarios were considered in projections: 1) no HSW, 2) 16,900 gallons per day (gpd) HSW (historical, baseline flow), and 3) 46,000 gpd HSW (permitted capacity of the HSW receiving station). A scenario of twice the permitted capacity of HSW of 92,000 gpd will be evaluated as a part of the biosolids alternatives evaluation, and a HSW flow of 30,000 gpd will be used to represent current conditions based on the City's operational experience in 2023. Solids treatment assumptions from the solids-water-energy balance calibration (Section 2.1) were used to determine solids treatment performance projections (e.g., BP feed, biogas production, biosolids production, etc.).

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2.3.1 Basis of Projections

The City provided 2019 population estimates and buildout (2050) population projections. These values were developed by a separate consulting firm for the City's General Plan. The 2019 population within the City's urban growth boundary was estimated as 197,976 people, and the buildout population was projected as 263,742 people. An annual average growth rate of 0.93 percent was calculated using these numbers. Therefore, a 0.93 percent growth per year was used as the basis of projections.

2.3.2 Flows and Loads Projections

PS and TWAS flows and loads were projected from 2023 through 2053. The 2023 value was projected based on average values from 2020-2022, applying a 5 percent decrease evaluated as part of the solids-water-energy balance analysis (Section 2.1), and adding 0.93 percent for growth in 2023. Figure 2-2 shows TS loading projections relative to historical average annual TS loading. Table 2-9 shows projections recommended for the capacity evaluation and biosolids alternatives evaluation.

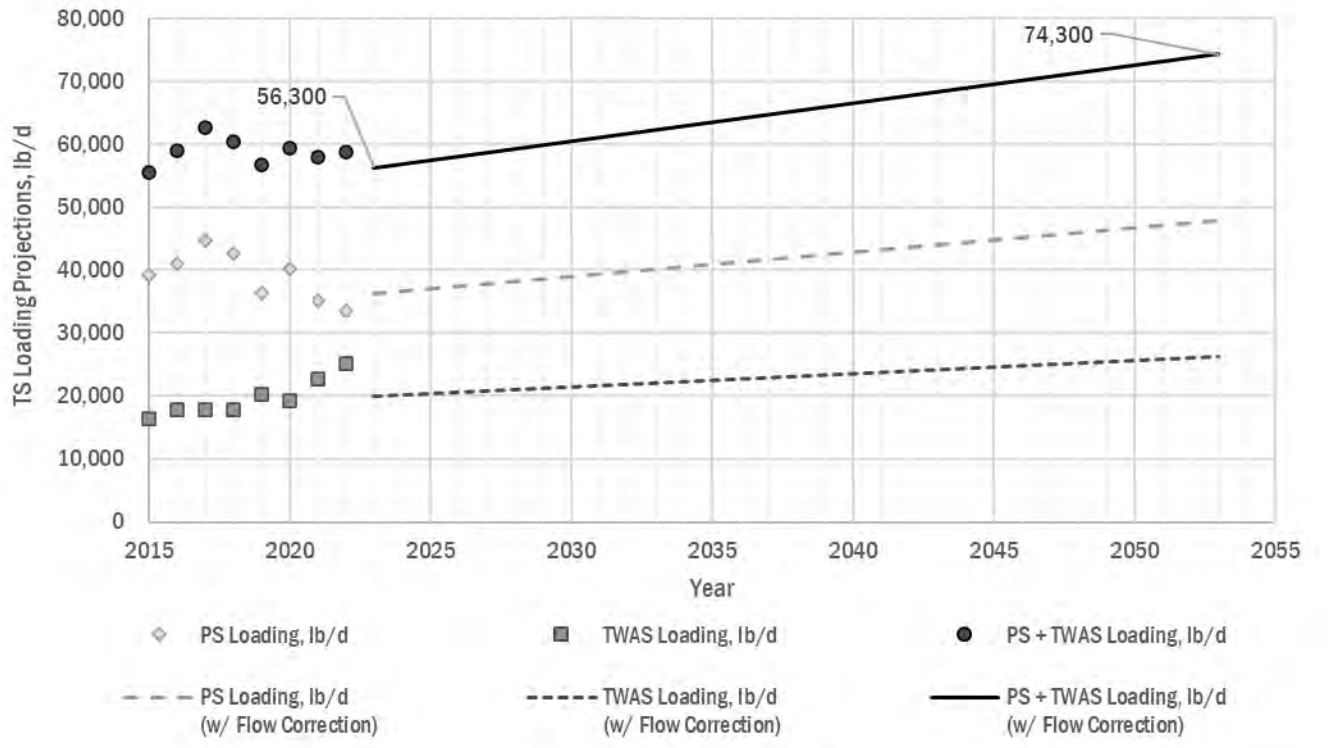


Figure 2-2. PS, TWAS, and PS+TWAS TS loading projections with historical average annual loading

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Table 2-9. Flow and Load Projections

Parameter[a]	Units	2019-21 Average	2023			2053		
			PS+TWAS	with 16,900 gpd HSW	with 46,000 gpd HSW	PS+TWAS	with 16,900 gpd HSW	with 46,000 gpd HSW
Primary Sludge Flows and Loads								
PS Flow	gpd	99,400	96,800	96,800	96,800	127,800	127,800	127,800
PS TS Loading	lb/d	36,500	36,300	36,300	36,300	48,000	48,000	48,000
PS TVS Loading	lb/d	31,300	31,200	31,200	31,200	41,200	41,200	41,200
Thickened Waste Activated Sludge Flows and Loads								
TWAS Flow	gpd	58,300	50,900	50,900	50,900	67,200	67,200	67,200
TWAS TS Loading	lb/d	22,400	20,000	20,000	20,000	26,300	26,300	26,300
TWAS TVS Loading	lb/d	18,200	16,600	16,600	16,600	21,900	21,900	21,900
Combined Digester Feed Sludge Flows and Loads								
Digester Feed Flow	gpd	174,600	147,700	164,600	193,700	195,000	211,900	241,000
Digester Feed TS Loading	lb/d	64,200	56,300	65,200	80,500	74,300	83,200	98,500
Digester Feed TVS Loading	lb/d	54,500	47,800	56,000	70,000	63,100	71,300	85,300
Digester Feed TS Concentration	%TS	N/A	4.6	4.7	5.0	4.6	4.7	4.9

a. Loading calculated based on measured flow rates and sludge concentrations.
b. Digester feed flow is a sum of annual average measured PS and TWAS flows.
c. Digester feed TS concentration not directly measured.
TVS = total volatile solids

Based on review of HSW data, a value of 16,900 gpd was assumed to represent historical operating conditions. The solids-water-energy balance analysis suggested a TS value of 6.3 percent and VS value of 92 percent was appropriate to represent the current blend of HSW material. Any future changes to HSW characteristics due to decisions stemming from the City's Trucked Waste Program management could impact these assumptions.

2.3.3 Solids Treatment Performance Projections

Table 2-10 shows solids treatment performance projections based on PS and TWAS projections with HSW scenarios. Projections represent average annual performance. Changes to CHP and SCRs are recommended to be assessed in the biosolids alternatives analysis in conjunction with these projections.

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Table 2-10. Solids Treatment Performance Projections

Parameter	Units	2019-21[a] Average	2023			2053		
			PS+TWAS	with 16,900 gpd HSW	with 46,000 gpd HSW	PS+TWAS	with 16,900 gpd HSW	with 46,000 gpd HSW
Digested Sludge (Belt Press Feed)								
Digested Sludge Flow	gpd	157,112	147,700	164,600	193,700	195,000	211,900	241,000
Digested Sludge TS Loading	lb/d	29,190	29,800	31,300	33,800	39,400	40,800	43,300
Digested Sludge TVS Loading	lb/d	21,099	22,200	23,000	24,400	29,300	30,100	31,500
Digester Feed TS Concentration	%TS	2.2	2.4	2.3	2.1	2.4	2.3	2.2
Dewatered Sludge								
BP Cake TS[b]	lb/d	N/A	28,600	30,000	32,400	37,800	39,200	41,600
Cake Wet Tons Loading	wet ton	94	95	100	108	126	131	139
Cake Volumetric Loading[b]	ft^3	N/A	3,100	3,200	3,500	4,000	4,200	4,400
Belt Press Filtrate (includes wash water)								
BP Filtrate Flow[c]	gpd	379,885	308,900	345,600	409,000	407,600	444,400	507,800
BP Filtrate TSS	mg/L	423	463	434	396	463	441	409
Biogas Production								
Biogas	cfm	370	267	364	531	352	449	616
Energy and Heat Recovery								
CHP Energy Recovery[d]	kWh/d	37,825	23,100	31,500	45,900	30,500	38,800	53,300
CHP Thermal Recovery[d]	MMBTU/d	383	74	102	148	98	125	172

a. Loading calculated based on measured flow rates and sludge concentrations.
b. Parameter not directly measured; assumes a density of 62.4 lb/ft^3.
c. BP filtrate flow includes BP wash water.
d. CHP energy and thermal recovery measured by LTP includes natural-gas fuel source; projections assume 99 percent utilization of biogas only.
mg/L = milligrams per liter
cfm = cubic feet per minute
kWh/d = kilowatt hours per day
MMBTU/d = million British thermal units per day

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Section 3: Capacity Evaluation

The capacity evaluation compared projected PS, WAS, and/or TWAS flows and loads (see Section 2.3) against unit process capacities. Capacities were determined using flow or solids loading rates specified by equipment manufacturers, treatment requirements, or maximum permitted flow rates. Capacities were evaluated from 2023 through the planning horizon (2053). More detailed calculations are provided in Attachment C. This section documents key design criteria, calculation assumptions, and capacity evaluation results.

3.1 Redundancy and Capacity Evaluation Assumptions

Calculations were completed assuming all units in service and with one standby unit offline. A standby unit is assumed for maintenance purposes. Unit processes and equipment were evaluated based on the following scenarios:

- **Primary sludge pumping** – Max 1-d flow
- **Thickening** – Max 7-d hydraulic loading rate (HLR) and solids loading rate (SLR)
- **Anaerobic digestion** – Min 14-d hydraulic retention time (HRT) and max 14-d organic loading rate (OLR)
- **Dewatering** – Max 1-d HLR and SLR
- **Cake Storage** – Max 1-d and max 7-d loading
- **HSW Receiving** – Permitted receiving capacity
- **Biogas Conditioning System** – Annual average and max 1-d biogas flow rate
- **Flare** – Max 1-hour (hr) biogas flow rate
- **CHP engines** – Average annual and max 1-d biogas flow rate

3.2 Primary Sludge Pumping

LTP has eight primary clarifiers. Three PS pumps are dedicated to sludge pumping from three clarifiers, and another three PS pumps are dedicated to three other clarifiers. The last two PS pumps are from a different manufacturer and service the last two primary clarifiers. A conservative PS pumping rate of 50 gallons per minute (gpm) was assumed based on an observed pumping rate at the LTP. The evaluation assumed one primary clarifier out of service and one PS pump out of service for each group (i.e., PS Pumps 1-3, PS Pumps 4-6, or PS Pumps 7-8). Table 3-1 shows results from the PS pumping capacity evaluation. There is sufficient capacity through the planning horizon.

Table 3-1. Primary Sludge Pumping Capacity Evaluation Results

Parameter	Capacity per Unit	PS Flow Projections		Year of Capacity Limit
		2023	2053	
PS Pumps 1-3 Capacity	50 gpm	28 gpm	37 gpm	2053+
PS Pumps 4-6 Capacity	50 gpm	28 gpm	37 gpm	2053+
PS Pumps 7-8 Capacity	50 gpm	37 gpm	49 gpm	2053+

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3.3 Thickening

Table 3-2 shows thickening design criteria. Both GBTs and TWAS pumps were evaluated based on HLR, and the GBTs were evaluated based on SLR. Each GBT was assumed to have a maximum HLR capacity of 225 gpm and SLR capacity of 14,400 lb/d (600 lb/hr) based on the LTP GBT operating manual. Each TWAS pump has an HLR capacity of 115 gpm.

Table 3-2. Thickening Design Criteria

Parameter	Units	Value
Gravity Belt Thickeners		
Number of GBTs	#	3
Belt width	meter	2
Hydraulic capacity	gpm/meter	113
Solids loading rate capacity	lb/d-meter	7,200
Thickened Sludge Pumps		
Number of pumps	#	2
Hydraulic capacity per pump	gpm	115

gpm/meter = gallons per minute per meter of belt

lb/d-meter = pounds per day per meter of belt

Table 3-3 shows results from the thickening evaluation. Capacities were evaluated based on maximum 7-d loading, assuming max 1-day loading could be managed by wasting less sludge from the liquid treatment stream if necessary. The GBT capacity is limited in 2023 based on the SLR capacity if one unit is offline. This suggests a potential for performance deterioration (e.g., lower solids capture rates) when one unit is offline. There is sufficient capacity through 2045 with all GBT units online. TWAS pumps have sufficient capacity through the planning horizon.

Table 3-3. Thickening Capacity Evaluation Results

Parameter	Capacity per Unit	Projections with 1 Unit Offline		Projections with All Units Online		Year of Capacity Limit	
		2023	2053	2023	2053	1 Unit Offline	All Units Online
GBT Hydraulic Loading Rate (HLR) Capacity	225 gpm	222 gpm	305 gpm	148 gpm	203 gpm	2024	2053+
GBT Solids Loading Rate (SLR) Capacity	14,400 lb/d	16,410 lb/d	23,417 lb/d	10,940 lb/d	15,611 lb/d	2023	2045
TWAS Pumping Capacity	115 gpm	61 gpm	81 gpm	31 gpm	40 gpm	2053+	2053+
Thickening Capacity						2023	2045

The LTP will operate one GBT for recuperative thickening during digester cleaning when one digester is offline. Recuperative thickening is required to maintain a minimum 15-d solids retention time in anaerobic digestion for Class B biosolids. Therefore, if recuperative thickening is required, there is effectively one less GBT available for WAS thickening.

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3.4 Anaerobic Digestion

Table 3-4 shows anaerobic digestion design criteria. There are four digesters total. Two digesters (Digesters 1 and 2) have floating covers with a maximum process volume of 1.06 million gallons (MG). The other two digesters (Digesters 3 and 4) have fixed covers with a maximum process volume of 1.06 MG. Digesters were evaluated based on the following criteria:

- Minimum HRT of 15 days. This is required for Class B biosolids and assumes solids and liquids are well mixed.
- Maximum OLR of 0.20 pounds of volatile solids per cubic feet of digester volume per day (lb-VS/ft^3-d). This is required to maintain treatment performance and mitigate digester upsets for mesophilic digesters. Higher values may be tolerated with co-digestion or with process intensification.

Table 3-4. Anaerobic Digestion Design Criteria

Parameter	Units	Value
Digesters 1 and 2		
Number of digesters	#	2
Type		Floating cover
Volume at max side water depth (SWD)	MG	1.06
Volume at min SWD	MG	0.76
Digesters 3 and 4		
Number of digesters	#	2
Type		Fixed cover
Volume at max SWD	MG	1.06
Dig. 3 volume at min SWD	MG	0.96
Dig. 4 volume at min SWD	MG	0.86

Table 3-5 shows results from the anaerobic digestion capacity evaluation. The HRT is limiting when one digester is offline, and a capacity limitation was calculated in 2023 (i.e., now) based on a maximum 14-d flow rate. This aligns with the City's experience during digester cleaning when recuperative thickening is needed to maintain a minimum 15-d HRT. There is sufficient anaerobic digestion capacity to treat PS and TWAS through the planning horizon when all digesters are online.

Table 3-5. Digestion Capacity Evaluation Results

Parameter	Capacity Criteria	Projections with 3 Digesters		Projections with 4 Digesters		Year of Capacity Limit	
		2023	2053	2023	2053	3 Digesters	4 Digesters
OLR Capacity Based on Maximum 14-d VS Loading	0.2 lb-VS/ft3-d	0.16 lb-VS/ft3-d	0.21 lb-VS/ft3-d	0.12 lb-VS/ft3-d	0.16 lb-VS/ft3-d	2045	2053+
HRT Capacity Based on Maximum 14-d Flow to Digesters	15 days	15 days	11 days	20 days	15 days	2023	2052
Digestion Capacity						2023	2052

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Capacity evaluation calculations also considered the ability for LTP digesters to accommodate HSW with either three or four digesters online (Attachment C). Without recuperative thickening, there is no capacity for additional HSW with three digesters online. There is sufficient capacity for approximately 42,000 gpd of HSW in 2023, and approximately 10,000 gpd of HSW in 2052, with four digesters online assuming max 14-d PS and TWAS flows and loads. If one digester is offline, there is sufficient capacity for approximately 52,000 gpd of HSW assuming average annual PS and TWAS flows and loads.

3.5 Dewatering

Table 3-6 shows dewatering design criteria. There are four BPs and four BP cake pumps. Two BP feed pumps are used, and there is a 0.13-MG blend tank upstream of dewatering. The blend tank was not accounted for in the capacity calculation; instead, calculations assumed a constant volume in the blending tank for mixing purposes. Dewatering was evaluated based on maximum 1-day HLR and SLR.

Table 3-6. Dewatering Design Criteria

Parameter	Units	Value
BP Feed Pumps		
Number of cake pumps	#	2
Hydraulic capacity per pump	gpm	800
Blend Tank		
Number of tanks	#	1
Volume	gallons	130,000
BPs		
Number of BPs	#	4
Belt width	meter	2
Hydraulic capacity	gpm/meter	100
Solids loading rate capacity	lb/d-meter	19,200
BP Cake Pumps		
Number of cake pumps	#	4
Hydraulic capacity per pump	gpm	20

Table 3-7 shows results from the dewatering capacity evaluation. Dewatering has sufficient capacity through the planning horizon (2053) all units online and through 2052 with one unit offline.

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Table 3-7. Dewatering Capacity Evaluation Results							
		Projections with 1 Unit Offline		Projections with All Units Online		Year of Capacity Limit	
Parameter	Capacity per Unit	2023	2053	2023	2053	1 Unit Offline	All Units Online
BP Hydraulic Loading Rate (HLR) Capacity	200 gpm	153 gpm	202 gpm	115 gpm	151 gpm	2052	2053+
BP Solids Loading Rate (SLR) Capacity	38,400 lb/d	19,789 lb/d	26,120 lb/d	14,842 lb/d	19,590 lb/d	2053+	2053+
Cake Pumping Capacity	20 gpm	10 gpm	14 gpm	8 gpm	10 gpm	2053+	2053+
Dewatering Capacity						2052	2053+

Capacity evaluation calculations also considered the ability for dewatering to accommodate HSW with either three or four BP units online (Attachment C). With all units online there is sufficient capacity to accept over 46,000 gpd of HSW. With one unit offline, there is sufficient capacity to accept over 46,000 gpd of HSW in 2023 and zero gpd of HSW in 2053.

3.6 Cake Storage

Table 3-8 shows cake storage hopper design criteria. Hoppers provide cake storage throughout the day, which allows for constant dewatering. Biosolids haulers are contracted by the City and are assumed to be on call to haul biosolids once per day except Sunday. Therefore, a 1.5-d minimum cake storage duration was assumed for this evaluation.

Table 3-8. Cake Storage Hopper Design Criteria		
Parameter	Units	Value
Number of hoppers	#	1
Volumetric storage capacity	ft^3	8,100
Solids storage capacity	tons	280

Table 3-9 shows results from the cake storage hopper capacity evaluation. For scenarios with sufficient capacity, the amount of additional HSW flow that could be accepted at the LTP was calculated. Cake storage capacity is at risk during max 1-day cake loading, which suggests upstream storage/equalization is required during max day loads. Without upstream equalization, the calculations suggest shutdown of dewatering is required during max 1-day conditions.

Table 3-9. Cake Storage Capacity Evaluation Results						
		Predicted Storage Capacity			Additional Capacity for HSW, gpd	
Parameter	Capacity Criteria	2023	2053	Capacity Limitation	2023	2053
Average annual storage capacity	1.5 days	2.6 days	2.0 days	2053+	>46,000	>46,000
Maximum 7-d storage capacity	1.5 days	1.9 days	1.5 days	2050	>46,000	0
Maximum 1-d storage capacity	1.5 days	1.3 days	1.0 days	2023	0	0

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Cake storage is sufficient through 2050 based on the max 7-d cake loading scenario, which suggests sufficient capacity for a large percentage of the year in the near term. The evaluation assumed cake solids content of 15 percent TS with a density equal to water (62.4 lb/ft^3).

3.7 HSW Receiving Facility

The HSW receiving facility has four receiving tanks totaling 48,000 gallons. The facility is regulated to a maximum receiving volume of 46,000 gpd based on a permit (A1403) from the Bay Area Air Quality Management District (BAAQMD). There may not be sufficient capacity through the planning horizon, as the City does plan to expand HSW soon which may trend to more than 46,000 gpd within the next 30 years. The flows and loads analysis evaluated a baseline HSW receiving volume of 16,900 gpd, which is 37 percent of the permitted capacity. The City observed an increased HSW flow of 29,300 gpd between January and May in 2023. Therefore, an average annual HSW flow of 30,000 gpd is recommended to represent current conditions in the biosolids alternatives analysis. Furthermore, the City has expressed interest in evaluating an average annual HSW flow up to 92,000 gpd. This is twice the current permitted capacity, and would likely require a new receiving station.

3.8 Biogas Conditioning System and Flare

The biogas conditioning system, or GCS, was evaluated using process calculations and a gas fluid model (Applied Flow Technology [AFT] Arrow™ 9 gas flow simulation software). This section describes capacity limitations identified via unit process calculations and modeling.

3.8.1 GCS and Flare Unit Process Calculations

A comparison between rated design criteria and projected gas flows was completed to evaluate current and future capacity. Average annual and max 1-d biogas flows were considered for the GCS. The flare capacity of 660 standard cubic feet per minute (scfm) was also evaluated against max 1-hr biogas flows. Calculations assumed operation according to original design criteria (e.g., lead/lag operation for iron oxide and siloxane removal processes). Table 3-10 shows design criteria for the GCS. All treatment units and equipment were evaluated based on their rated capacities in scfm.

Table 3-10. Biogas Conditioning System Design Criteria

Parameter	Units	Value
Iron Sponge Media		
Number	#	1/1 (Lead/Lag)
Vessel Dimensions	ft	8 (diameter), 9 (height)
Media volume	ft^3	300
Rated airflow capacity, each	scfm	365
Digester Gas Heat Exchangers		
Number	#	1/1 (Duty/Standby)
Blowers		
Number	#	1/1 (Duty/Standby)
Discharge capacity, each	cfm	120 (min) to 365 (max)

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Table 3-10. Biogas Conditioning System Design Criteria		
Parameter	**Units**	**Value**
Dual Core Heat Exchanger		
Number	#	1/1 (Duty/Standby)
Rated airflow capacity, each	scfm	347
Temperature	degree Fahrenheit (deg F)	160 (inlet); 75 (average outlet)
Siloxane Removal (Segmented Activity Gradient) – Two Vessels		
Number of 3.5-ft diameter vessels	#	2 (Lead/Lag)
Vessel Dimensions	ft	3.5 (diameter), 7 (height)
Rated airflow capacity, each	scfm	365
Siloxane Removal (Segmented Activity Gradient) – Third Vessel		
Number of 4.5-ft diameter vessels	#	1
Vessel Dimensions	ft	4.5 (diameter), 12 (height)
Rated airflow capacity	scfm	365
Particle Filters		
Number	#	1/1 (Duty/Standby)

Table 3-11 shows results from the GCS and flare capacity evaluation. The GCS was evaluated based on max 1-d flow rate, and the flare was evaluated based on max 1-hr flow rate. The GCS evaluation determined the dual-core heat exchanger has a capacity limitation in 2023, and other unit processes have capacity limitations by 2026. The addition of 16,900 gpd of HSW limits the GCS's capacity in 2023.

Table 3-11. Biogas Flow Capacity Evaluation Results								
		PS+TWAS Biogas Flow		With HSW (16.9 – 46 kgal/d)		Year of Capacity Limit		
Parameter	**Capacity Criteria**	**2023**	**2053**	**2023**	**2053**	**PS+ TWAS**	**with 16.9 kgal/d HSW**	**with 46 kgal/d HSW**
Iron Sponge Capacity	365 scfm	354 scfm	467 scfm	451 scfm - 618 scfm	564 scfm - 731 scfm	2026	2023	2023
Blower Capacity	365 scfm	354 scfm	467 scfm	451 scfm - 618 scfm	564 scfm - 731 scfm	2026	2023	2023
Dual Core Heat Exchanger Capacity	347.3 scfm	354 scfm	467 scfm	451 scfm - 618 scfm	564 scfm - 731 scfm	2023	2023	2023
Siloxane Removal Capacity	365 scfm	354 scfm	467 scfm	451 scfm - 618 scfm	564 scfm - 731 scfm	2026	2023	2023
Flare Capacity	660 scfm	531 scfm	700 scfm	628 scfm - 795 scfm	797 scfm - 964 scfm	2046	2029	2023

kgal/d = thousand gallons per day

Flare capacity is sufficient through 2046. Max 1-hr biogas flows exceed the flare capacity in 2029 with 16,900 gpd of HSW. This finding suggests that HSW flows to anaerobic digestion may need to be stopped during max 1-d biogas flows if the GCS is offline.

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3.8.2 GCS Model

The GCS was modeled using AFT Arrow™ 9 gas flow simulation software to identify capacity limitations. The City has observed issues with low operating pressure at the CHP engines and vacuum conditions upstream of blowers. Two simulation scenarios are captured in this TM:

- Recorded flow (439 scfm) during site visit field observations used for model calibration (Figure 3-1).
- Maximum flow capacity through the GCS before a vacuum condition (Figure 3-2).

Figure 3-1 shows the biogas flow of 439 scfm (345 cfm) that was observed on December 22, 2022. This flow was used for model calibration in tandem with temperature and pressure gauge readings upstream and downstream of vessels and equipment. Key assumptions made during model calibration include:

- all pressure gauges and temperature gauges were assumed to be accurate excepting the iron sponge differential pressure gauge,
- the blower submittal curve was modified by increasing differential pressure by 47 inches water column (in WC) to match observed pressures downstream of blower and heat exchanger,
- the iron sponge vessel pressure drop was assumed as 4 in WC based on product data from a similarly sized system and assuming the differential pressure reading of 2.1 in WC was inaccurate compared to gauge pressures observed upstream and downstream of digester gas heat exchangers,
- the 4.5-ft diameter siloxane removal vessel pressure drop was assumed as 8 in WC based on the observed pressure drops across 3.5-ft diameter siloxane removal vessels, and
- the model assumed digester headspace at 98 deg F and 8 in WC for typical operating conditions.

Overall, model results suggest the GCS is operating near the system's threshold regularly based on historical hourly biogas flowrates. Biogas velocities were modeled between 12 and 80 ft/second through pipes with nominal diameters between 10 and 4 inches, respectively. In addition to unit capacity limitations suggested by results presented in Section 3.8.1, model results suggest the pressure drop from the iron sponge and piping upstream of the blowers is limiting to maximum biogas flow rates. An increase to pipe sizing would decrease biogas velocities and pressure losses. Further refinement of the model via calibration at different operating scenarios (e.g., lower biogas flow rates) is recommended before using the model for GCS design.

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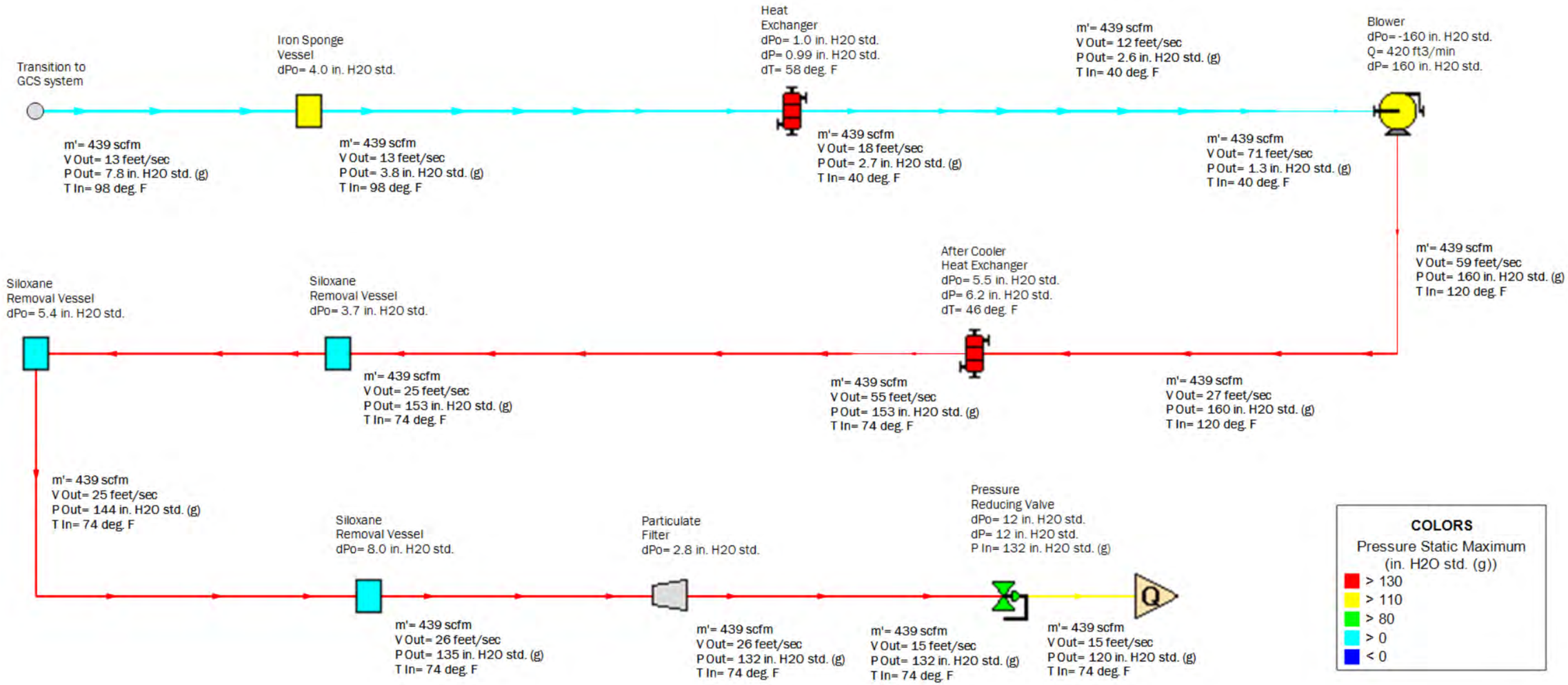


Figure 3-1. GCS at 439 scfm (345 cfm to engines)

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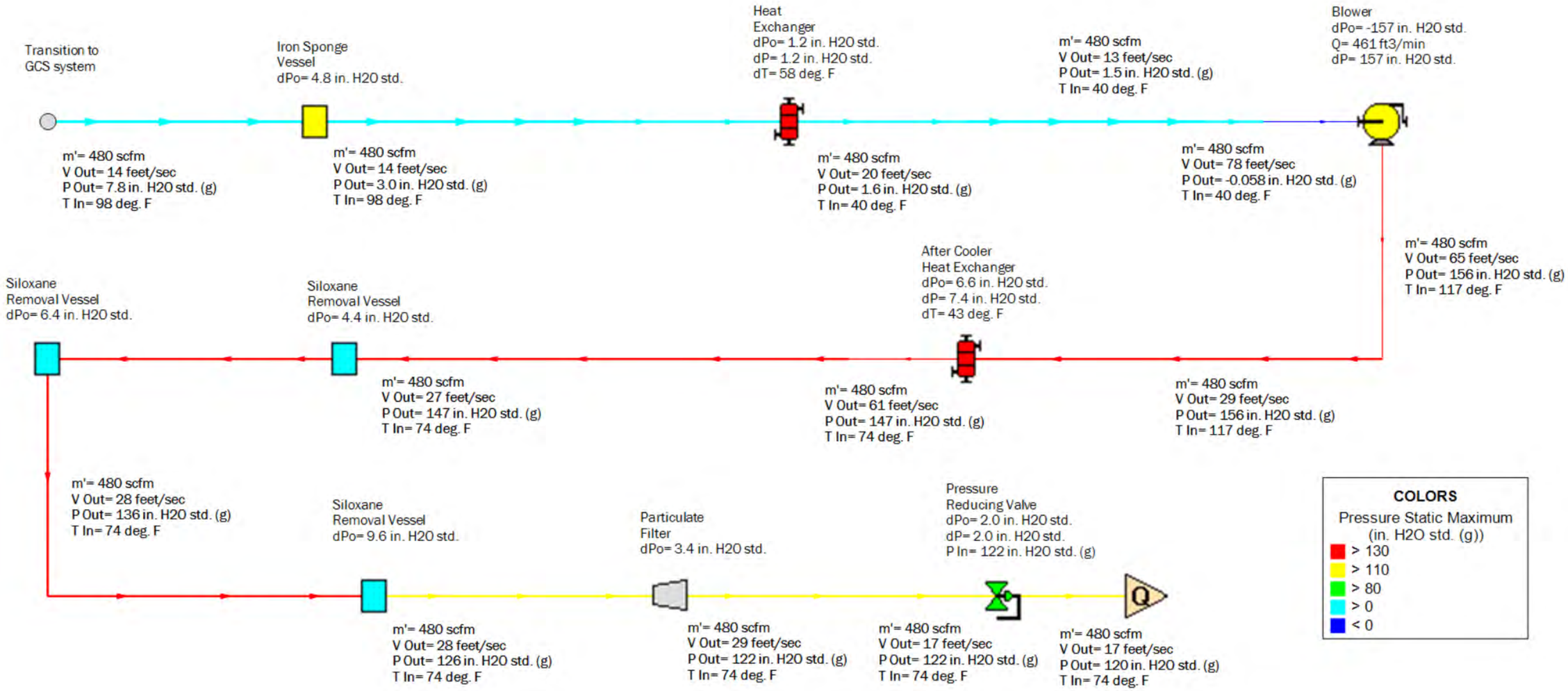


Figure 3-2. GCS at 480 scfm (373 cfm to engines)

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3.9 Combined Heat and Power Engines

Table 3-12 shows CHP engine design criteria. Each unit has an LHV fuel consumption capacity of 9.32 MMBTU/hr, which is the maximum limit specified by the BAAQMD air permit. The LTP has blended natural gas at an average annual rate of approximately 12 percent of digester biogas flow. Addition of natural gas was assumed for capacity calculation when evaluating fuel consumption capacity; however, operation without supplemental natural gas is preferred by the City. Only two CHP engines have selective catalytic reduction (SCR), and therefore the City is required to operate CHP engines as two separate sets of engines. The capacity evaluation focuses on results with 2 engines in operation because of limitations imposed by the air permit on engines without SCR.

Table 3-12. CHP Engine Design Criteria

Parameter	Units	Value
Number of engines[a]	#	4
Number of engines with SCR	#	2
Gas supply pressure to engine	psig	2.9
Fuel consumption (LHV) capacity per unit	MMBTU/hr	9.32

a. *Two engines may use 100 percent natural gas; two engines are limited to a total of 15.55 million scfm of natural gas per consecutive 12-month period.*

Table 3-13 show sufficient capacity with two CHP engines online through 2033 for PS and TWAS only. The peak day capacity is limited with even 16,900 gpd HSW (the historical HSW receiving flow). These capacity evaluation results are based on two CHP engines during peak day conditions. Two CHP engines were used in the evaluation to reflect periodic limitations in engine operations based on the air permit. Adding SCR to two more engines would allow for all engines to be operated identically. This could increase capacity, as shown in Table 3-13. Three CHP engines in operation has sufficient peak day capacity through the planning horizon (2053) for PS and TWAS only. The biosolids alternatives analysis (TM 4) will explore CHP technology changes and consider addition of SCR to all engines for increased operational flexibility.

Table 3-13. CHP Engine Capacity Evaluation Results

Parameter	Capacity Criteria	PS+TWAS Biogas Flow		With HSW (16.9 – 46 kg/d)		Year of Capacity Limit		
		2023	2053	2023	2053	PS+ TWAS	With 16.9 kg/d HSW	With 46 kg/d HSW
2 CHP Engines at Average Annual Conditions	447 MMBTU/d	255 MMBTU/d	337 MMBTU/d	348 MMBTU/d - 508 MMBTU/d	429 MMBTU/d - 589 MMBTU/d	2053+	2053+	2023
2 CHP Engines at Peak Day Conditions	447 MMBTU/d	338 MMBTU/d	446 MMBTU/d	431 MMBTU/d - 591 MMBTU/d	539 MMBTU/d – 699 MMBTU/d	2053+	2028	2023
3 CHP Engines at Average Annual Conditions	671 MMBTU/d	255 MMBTU/d	337 MMBTU/d	348 MMBTU/d - 508 MMBTU/d	429 MMBTU/d - 589 MMBTU/d	2053+	2053+	2053+
3 CHP Engines at Peak Day Conditions	671 MMBTU/d	338 MMBTU/d	446 MMBTU/d	431 MMBTU/d - 591 MMBTU/d	539 MMBTU/d – 699 MMBTU/d	2053+	2053+	2045

kg/d = kilograms per day

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Section 4: Recommendations

This section summarizes recommendations for the BMSP based on the flow and load projections and capacity evaluation. Recommendations should be considered in tandem with results from the condition assessment, regulatory review, and market assessment tasks when screening and evaluating biosolids alternatives.

4.1.1 Recommended Solids Treatment Assumptions

Solids treatment performance was evaluated using a solids-water-energy balance. Performance parameters were calibrated using data before and after HSW to provide confidence that assumptions are appropriate to represent average annual predictions both with and without HSW. The following assumptions are recommended:

- LTP mesophilic anaerobic digestion assumptions:
  - PS VSR of 65 percent and biogas production rate of 15 scf/lb-VSd
  - TWAS VSR of 32 percent and biogas production rate of 15 scf/lb-VSd
  - HSW VSR of 90 percent and biogas production rate of 19 scf/lb-VSd
  - Inert solids deposition of 10 percent in anaerobic digesters
- LTP CHP engine assumptions:
  - Energy recovery efficiency of 37 percent
  - Heat recovery efficiency of 35 percent
- LTP thickening and dewatering assumptions:
  - GBT capture efficiency of 90 percent
  - BP capture efficiency of 96 percent

4.1.2 Future Flows and Loads

Flow and load projections assume a growth of 0.93 percent, which is considered reasonably conservative based on historical changes in average annual sludge production and population growth from 2013 through 2022. The flow and load projections incorporated PS and TWAS flow deratings of 5 percent. Based on the solids-water-energy balance, this assumption sufficiently predicts biogas and biosolids production. Table 4-1 shows the recommended average annual PS and TWAS flows, loads, and characteristics. Recommended projections may be modified appropriately if upstream technologies that impact PS and TWAS characteristics are assumed in the biosolids alternatives analysis. For example, chemically enhanced primary treatment (CEPT) is expected to increase PS loading and decrease TWAS loading, or alternatives to improve WAS thickening may assume a higher TWAS TS concentration and lower TWAS flow.

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Table 4-1. Recommended Average Annual Flows and Loads for 2023 and 2053			
Parameter	Units	2023	2053
Primary Sludge			
PS Flow	gpd	96,800	127,800
PS TS Loading	lb/d	36,300	48,000
PS VS Loading	lb/d	31,200	41,200
PS TS Concentration	%	4.5	4.5
PS VS/TS Ratio	%	86	86
Thickened Waste Activated Sludge			
TWAS Flow	gpd	50,800	67,200
TWAS TS Loading	lb/d	19,900	26,300
TWAS VS Loading	lb/d	16,500	21,900
TWAS TS Concentration	%	4.7	4.7
TWAS VS/TS Ratio	%	83	83

The current HSW flow and loading characteristics are recommended when evaluating future alternatives. Table 4-2 shows flows and loads for the historical HSW flows and loads, current HSW flows, permitted HSW receiving station capacity, and a potential expanded HSW receiving station capacity. These values are based on current HSW characteristics (i.e., TS concentration and VS/TS ratio). The City may elect to add other HSW feedstocks, such as a food waste slurry. A different set of assumptions is recommended for food waste slurry if added to the alternatives analysis.

Table 4-2. Recommended HSW Flows and Loads for Baseline and HSW Receiving Capacity					
Parameter	Units	Historical HSW Flows and Loads	Current HSW Flows[a]	HSW Receiving Station Capacity	Expanded HSW Receiving Station Capacity
HSW Flow	gpd	16,900	30,000	46,000	92,000
HSW TS Loading	lb/d	8,900	15,800	24,200	48,300
HSW VS Loading	lb/d	8,200	14,500	22,200	44,500
HSW TS Concentration	%	6.3	6.3	6.3	6.3
HSW VS/TS Ratio	%	92	92	92	92

a. *Email from the City noted an average HSW flow of 29,284 gpd for the 2023 calendar year through May 30, 2023. An average annual HSW flow of 30,000 gpd is recommended to represent current conditions in the biosolids alternatives analysis.*

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4.1.3 Capacity Evaluation

Capacity evaluation findings are summarized on Figure 4-1. The evaluation suggested several capacity limitations within the LTP solids treatment system.

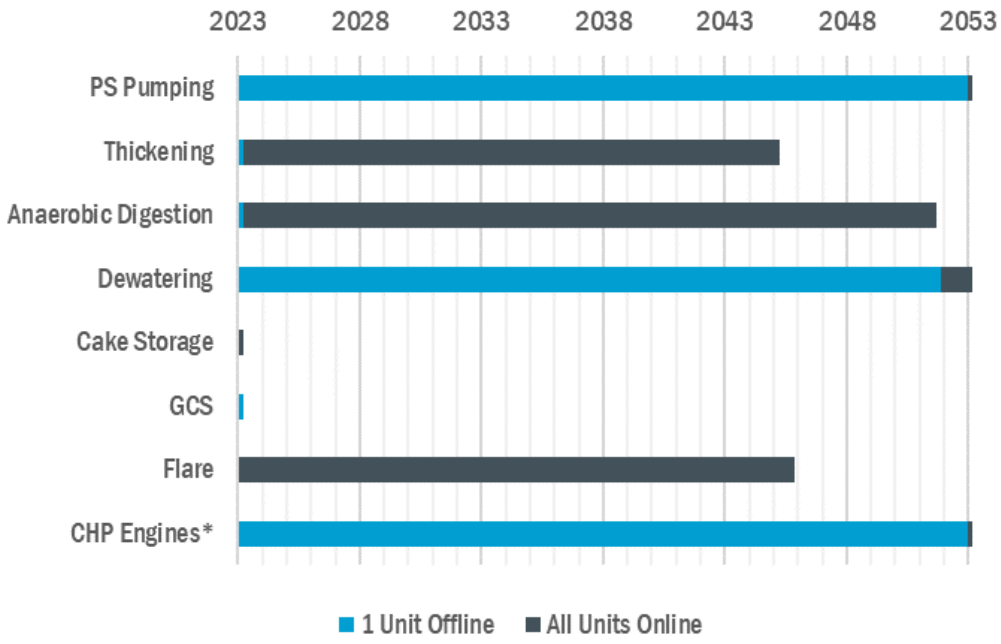


Figure 4-1. Capacity evaluation results with one unit offline and all units online

**CHP Engines capacity with "1 Unit Offline" reflects 2 CHP engines with selective catalytic reduction, assuming the second set of engines are offline because of periodic limitations in engine operations based on the air permit. Results shown are based on PS and TWAS loads only.*

Capacities were evaluated considering only PS, WAS, and/or TWAS. Thickening and anaerobic digestion have sufficient capacity through 2045 when all units are online, but capacity is limited in the near term for these processes if one unit is brought offline for maintenance. This may impact operation of upstream units. For example, SRT control in the liquid treatment stream may be impacted if thickening is capacity limited, or WAS thickening may be impacted if digestion is capacity limited and requires recuperative thickening.

The cake storage and GCS are currently capacity limited, which may impact upstream or downstream treatment processes on days with maximum loading. PS pumping, dewatering, and CHP engines have sufficient capacity through the planning horizon (2053), and the flare has sufficient capacity through 2046.

4.1.4 Next Steps

Opportunities to improve unit processes will be evaluated as part of the biosolids alternatives evaluation (TM 4). Synergies within the solids treatment system and potential changes to upstream processes (e.g., primary treatment performance or HSW receiving volumes) will be considered. Findings from the condition assessment, regulatory review, and market assessment will also be considered during the biosolids alternatives evaluation (TM 4) to identify cost-effective solutions, address critical needs, and provide a roadmap that is resilient to regulatory and market uncertainties.

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Attachment A: Supplemental Data

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Historical Data

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Primary Sludge

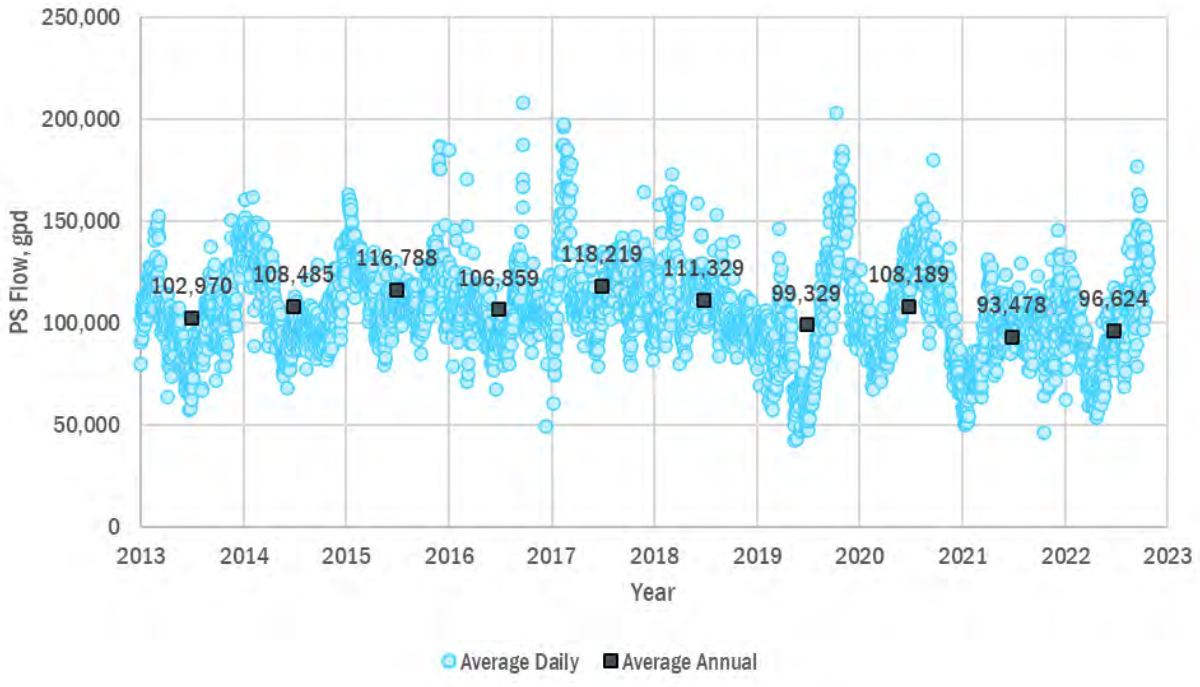


Figure A-1. Historical PS flow

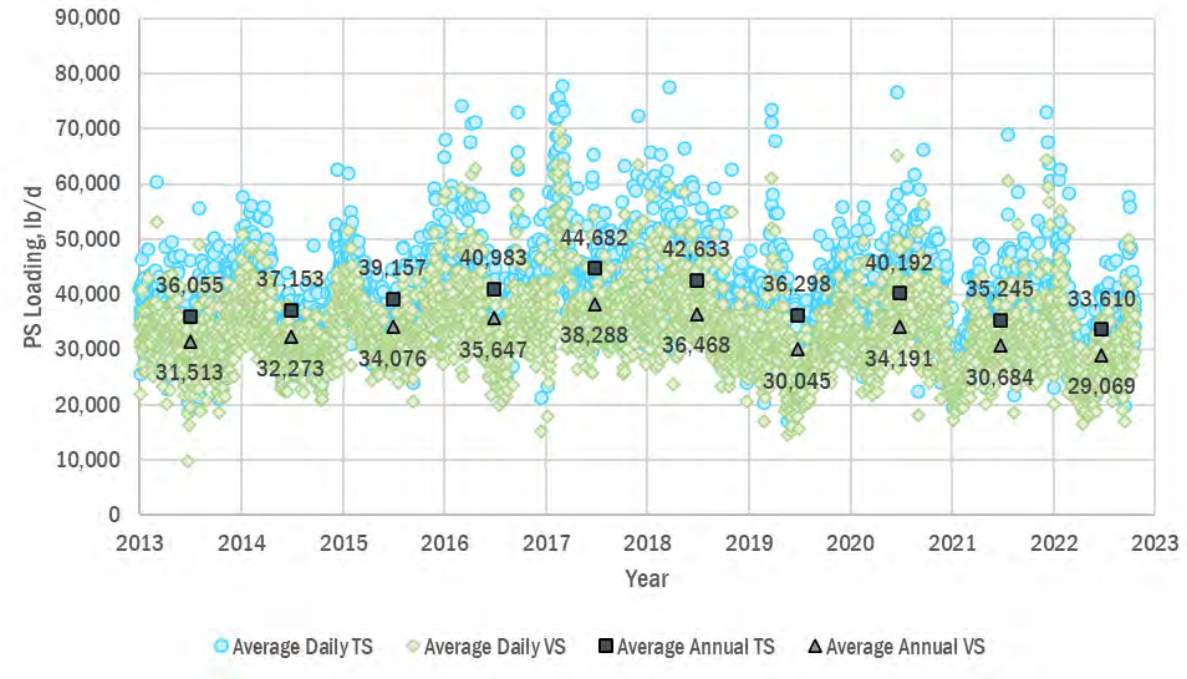


Figure A-2. Historical PS loading

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Figure A-3. Historical PS TS concentration

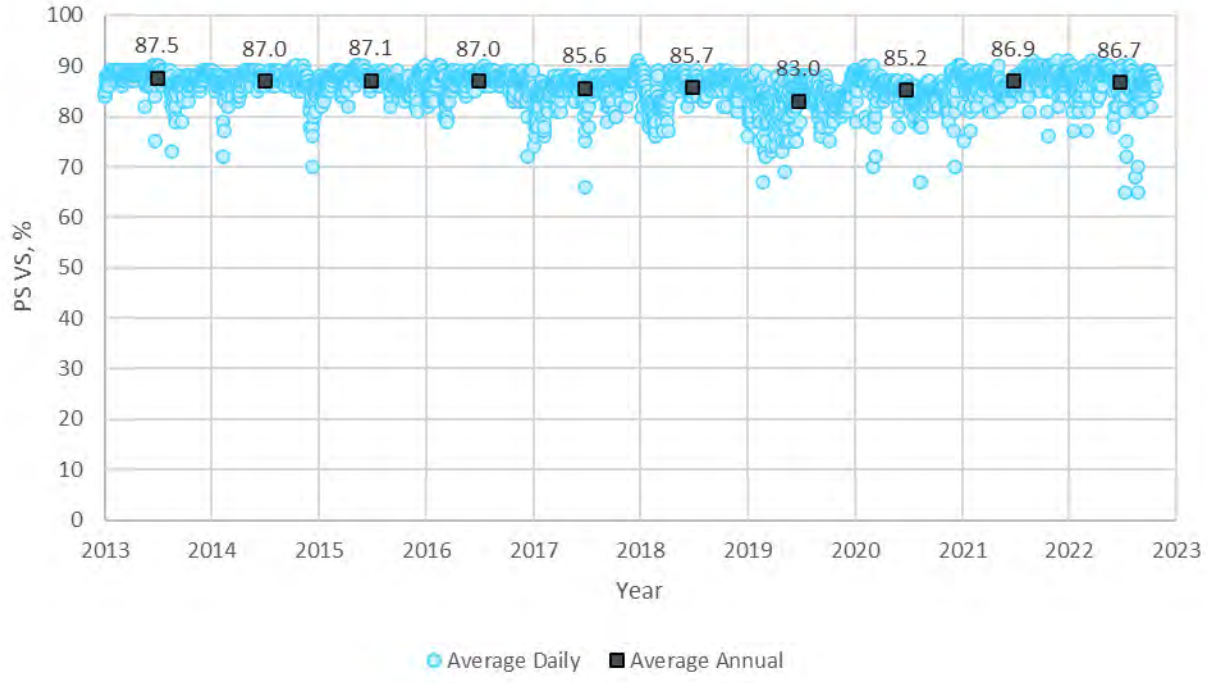


Figure A-4. Historical PS VS concentration

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Waste Activated Sludge

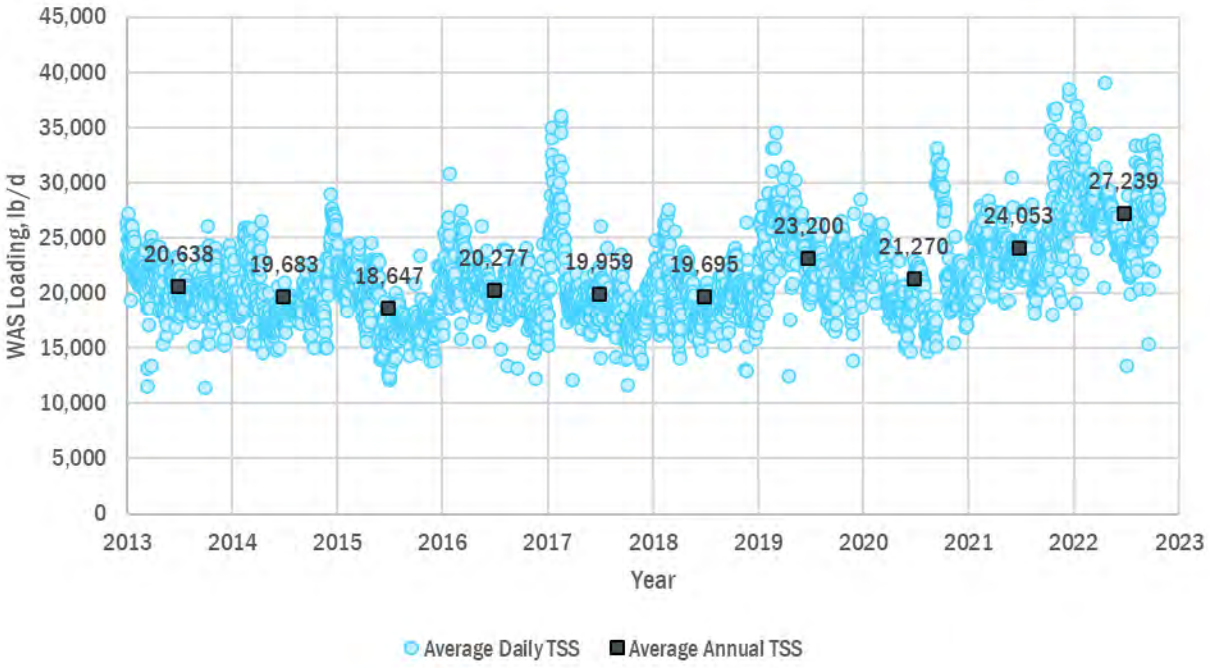


Figure A-5. Historical WAS Loading



Figure A-6. Historical WAS flow

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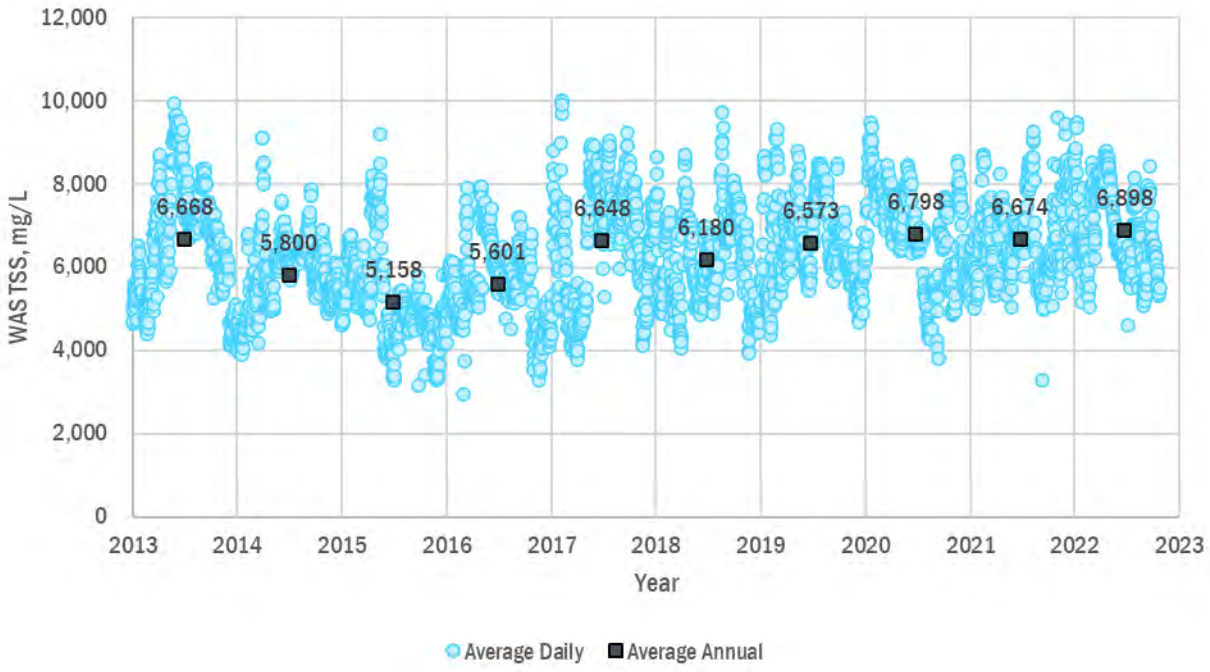


Figure A-7. Historical WAS TSS concentration

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Thickened Waste Activated Sludge

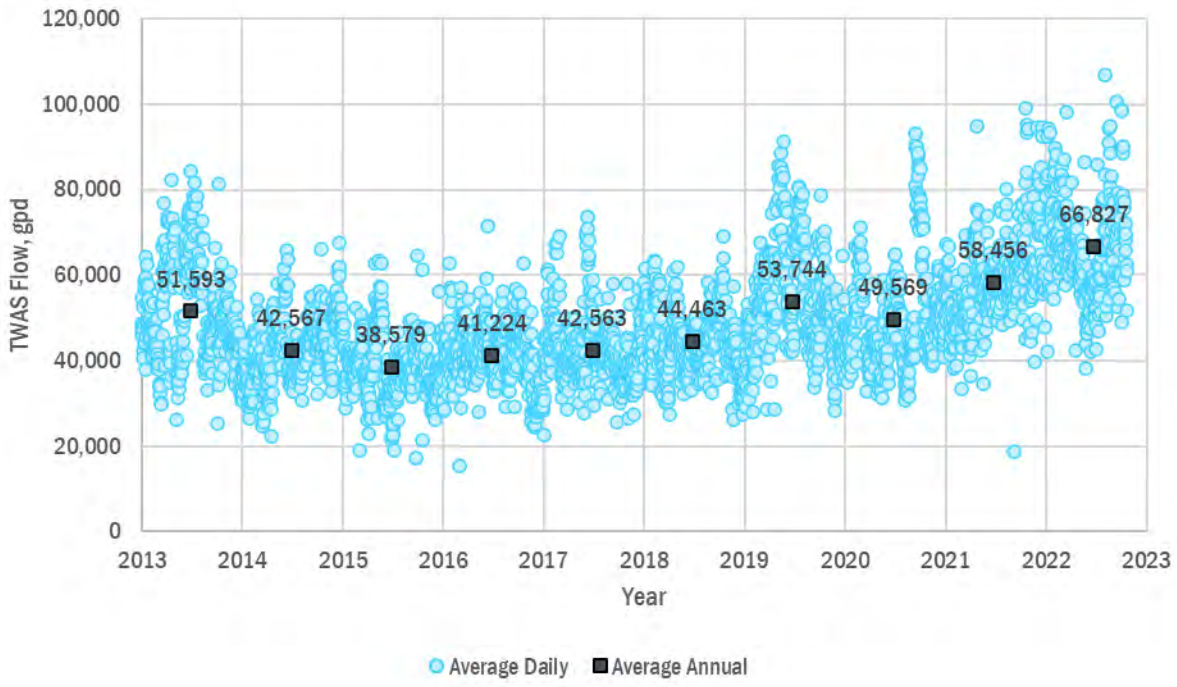


Figure A-8. Historical TWAS flow

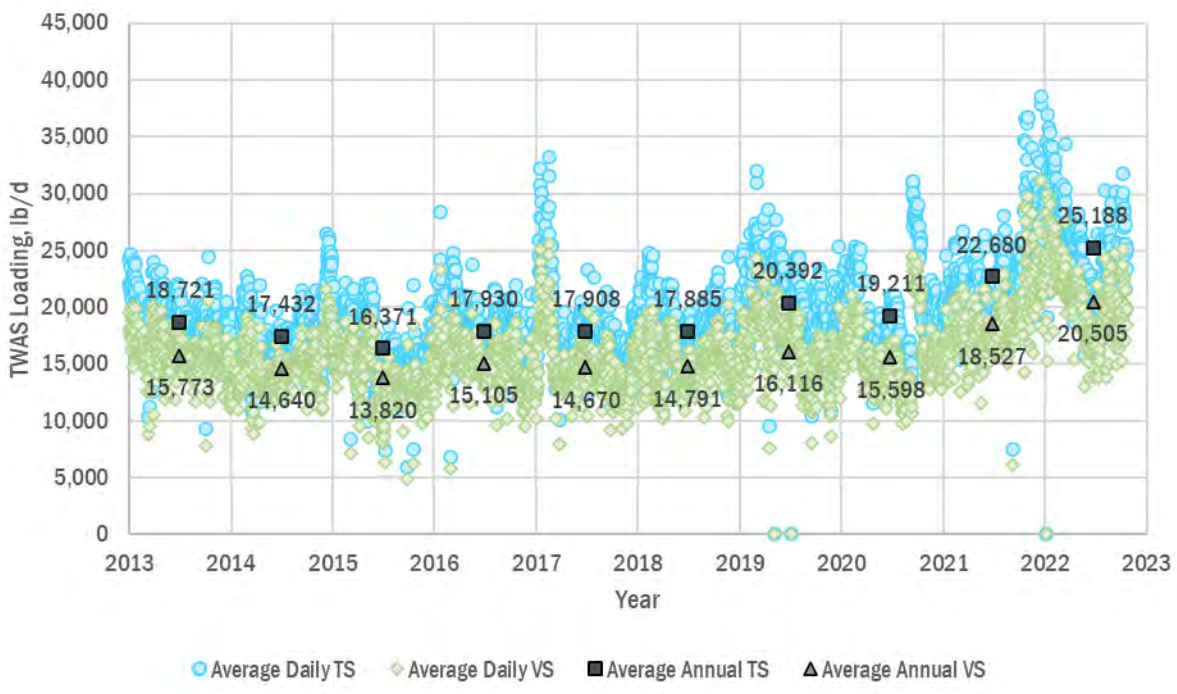


Figure A-9. Historical TWAS loading

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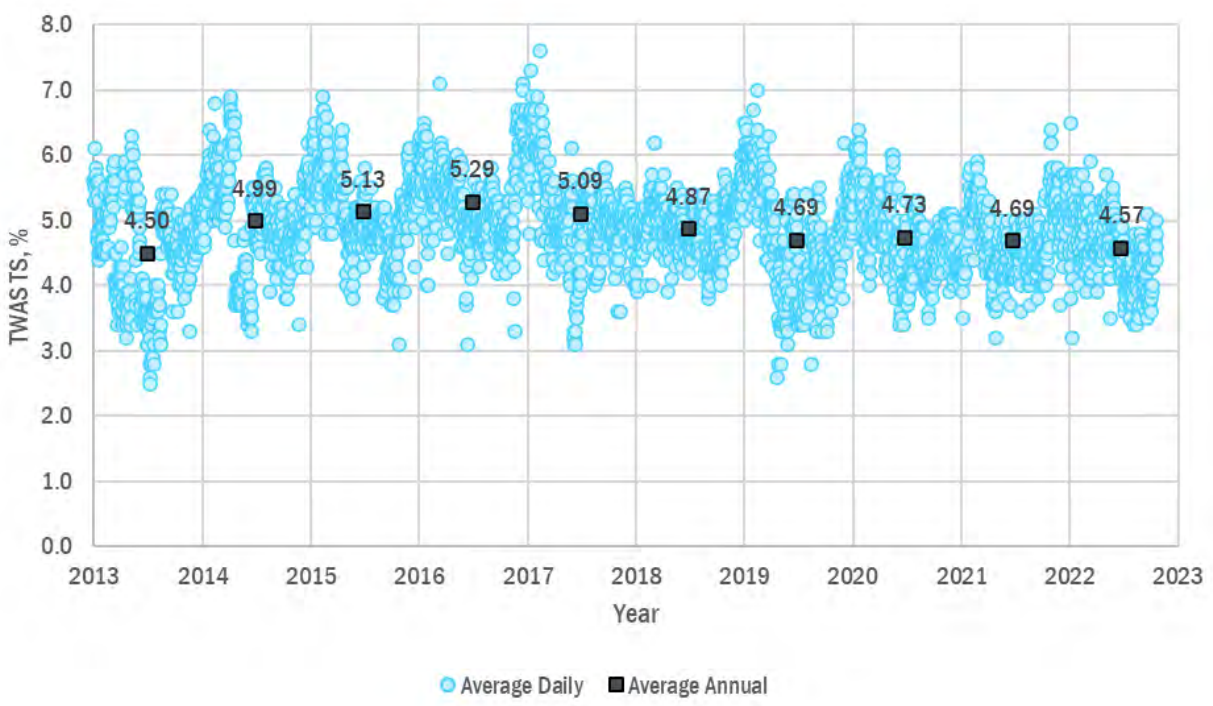


Figure A-10. Historical TWAS TS concentration

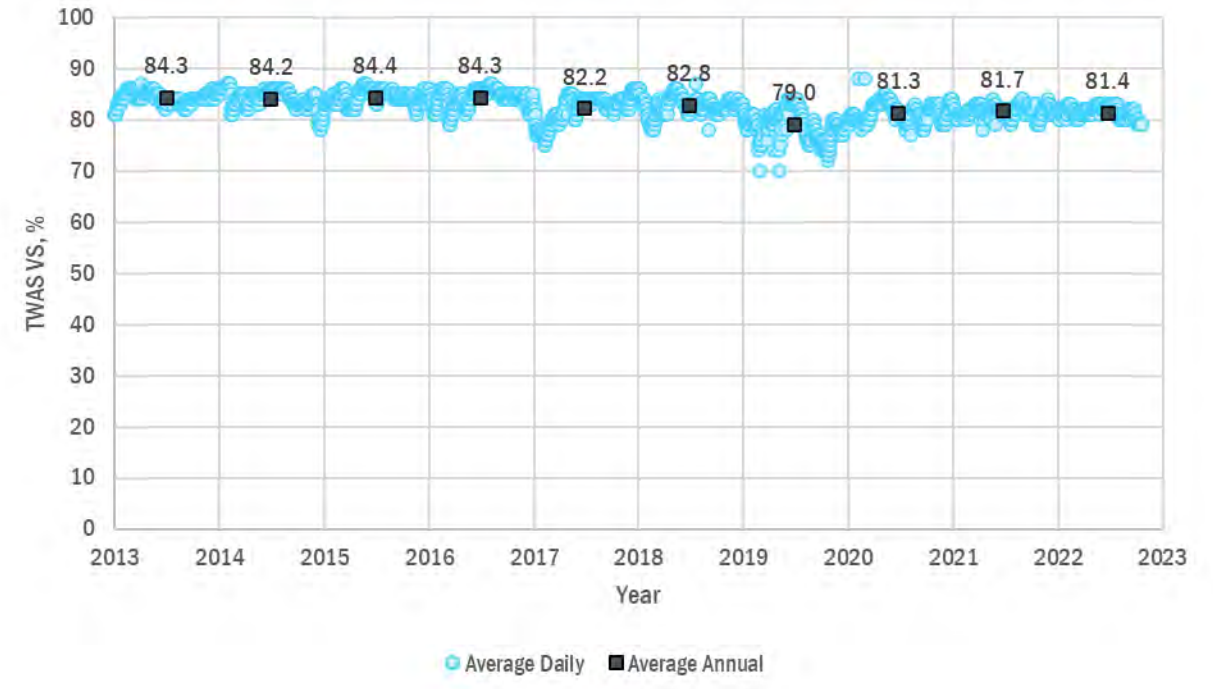


Figure A-11. Historical TWAS VS concentration

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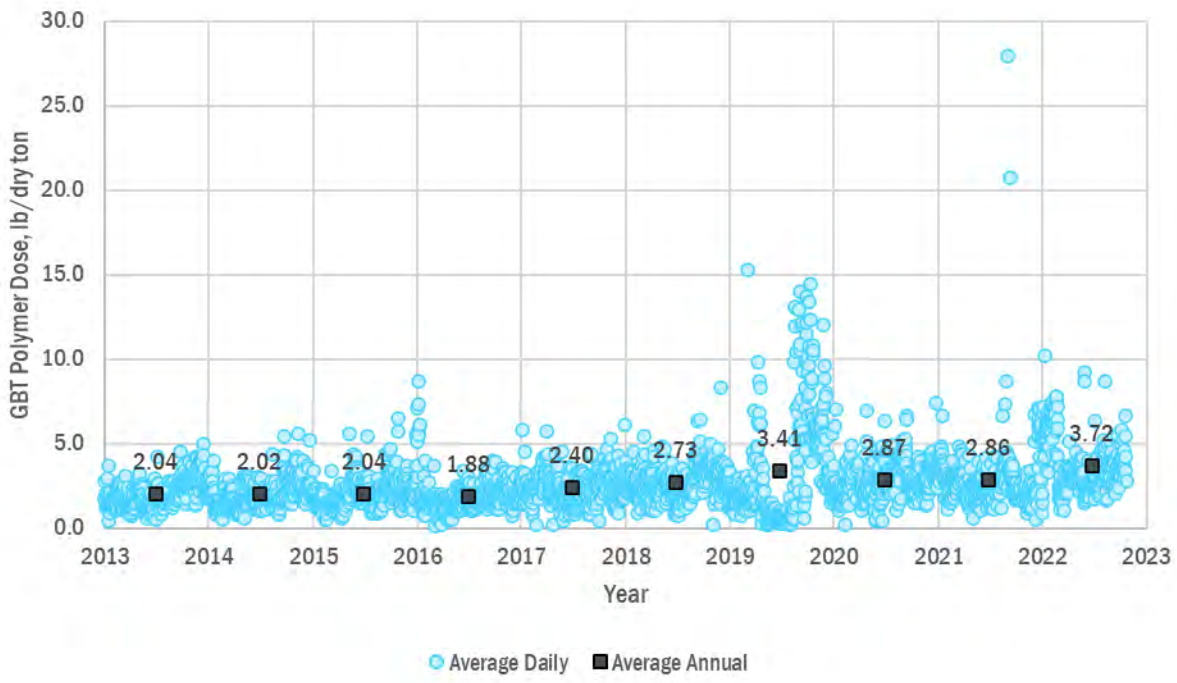


Figure A-12. Historical GBT polymer dose

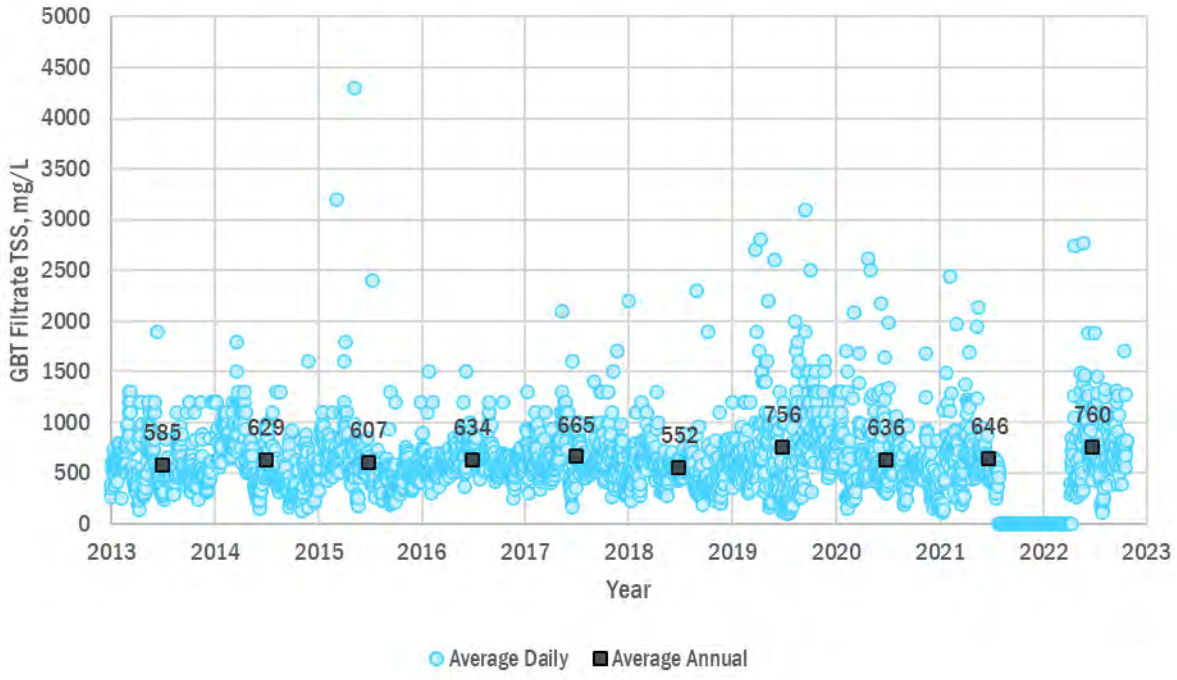


Figure A-13. Historical GBT filtrate TSS concentration

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Primary Sludge and Thickened Waste Activated Sludge

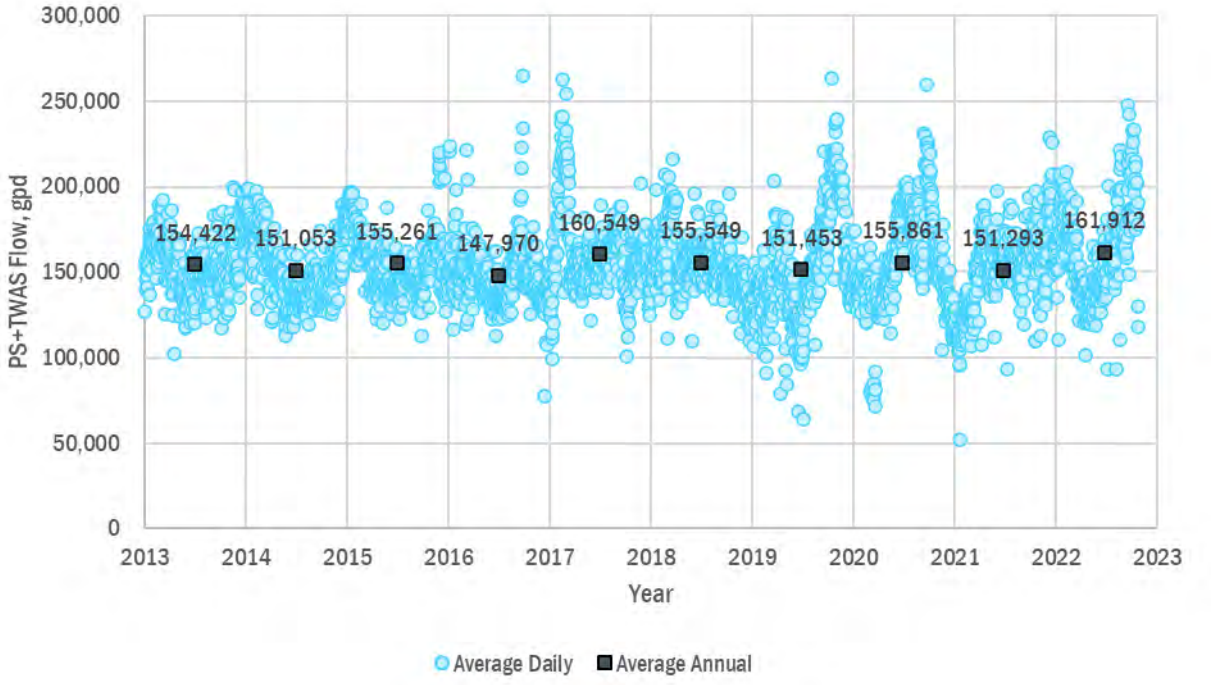


Figure A-14. Historical PS plus TWAS flow

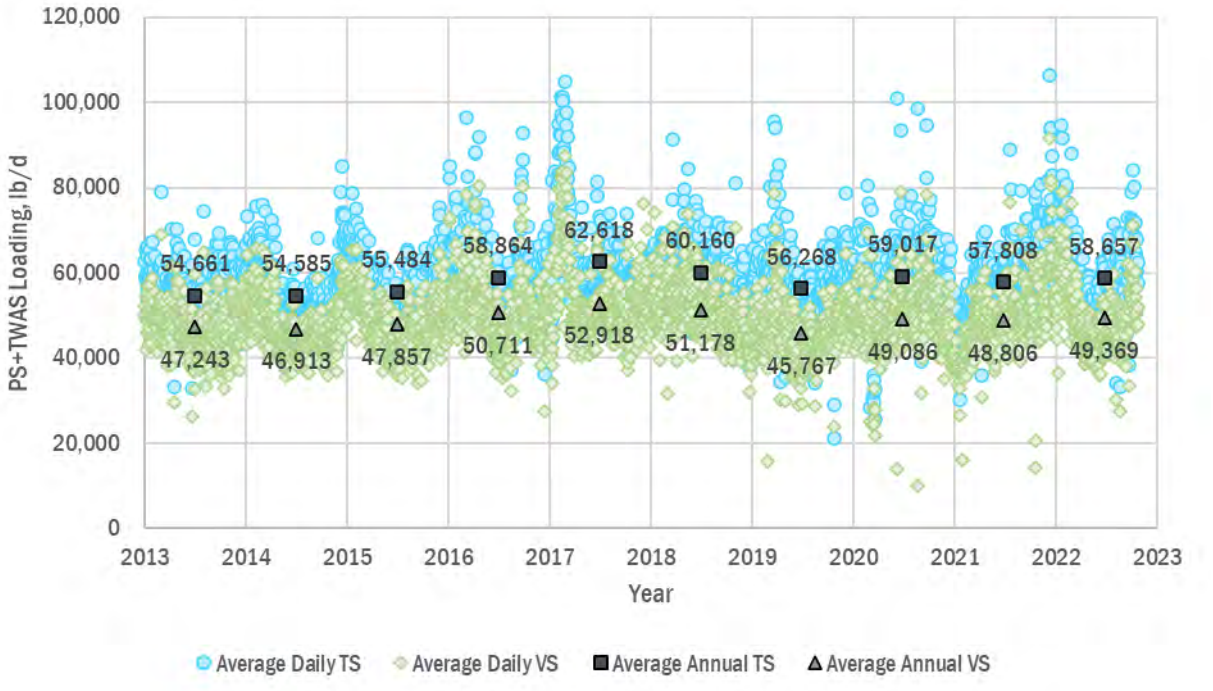


Figure A-15. Historical PS plus TWAS loading

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Figure A-16. Historical PS percentage of PS plus TS loading

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High Strength Waste

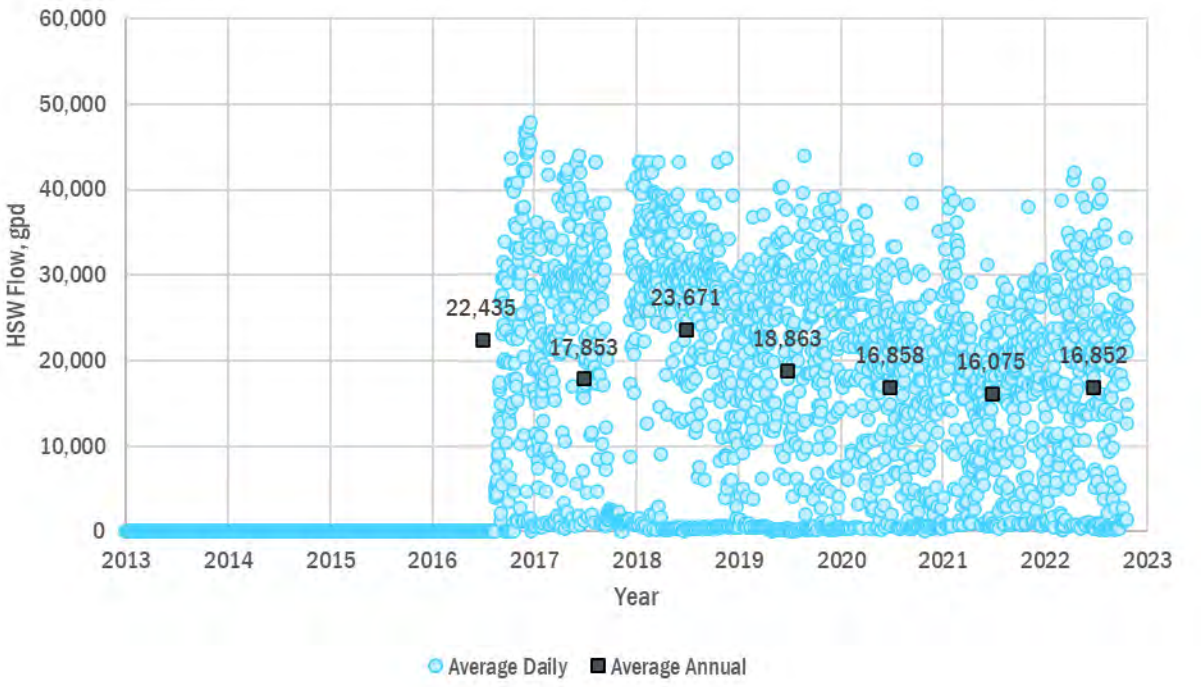


Figure A-17. Historical HSW flow

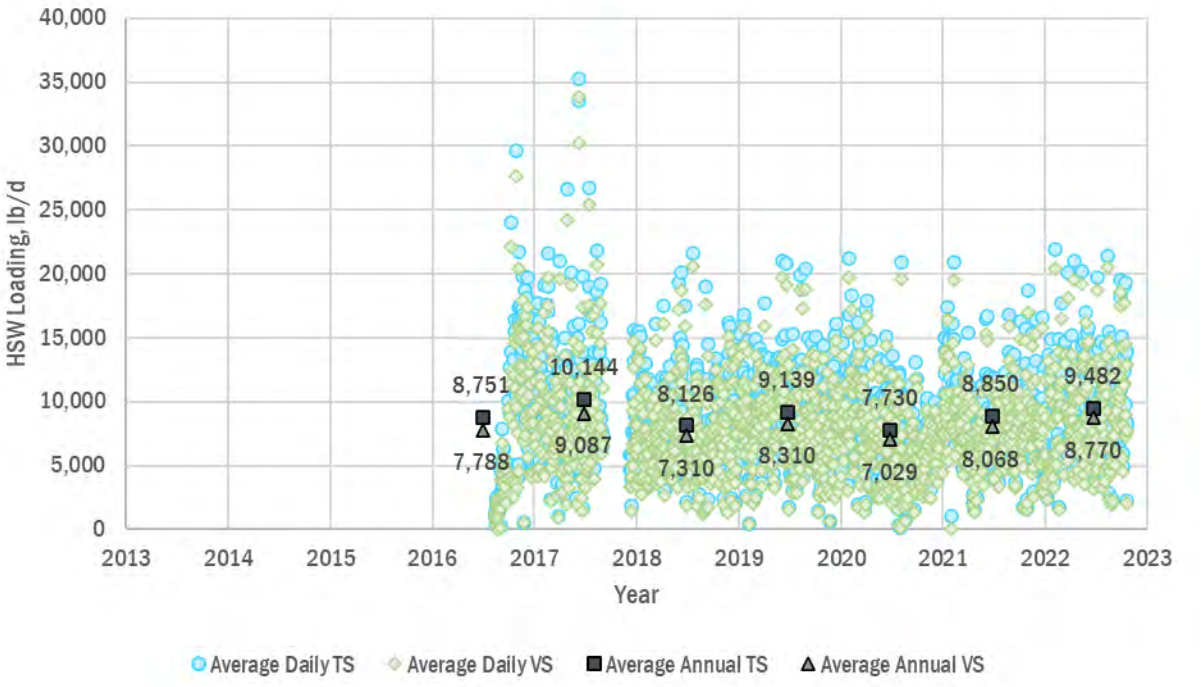


Figure A-18. Historical HSW loading

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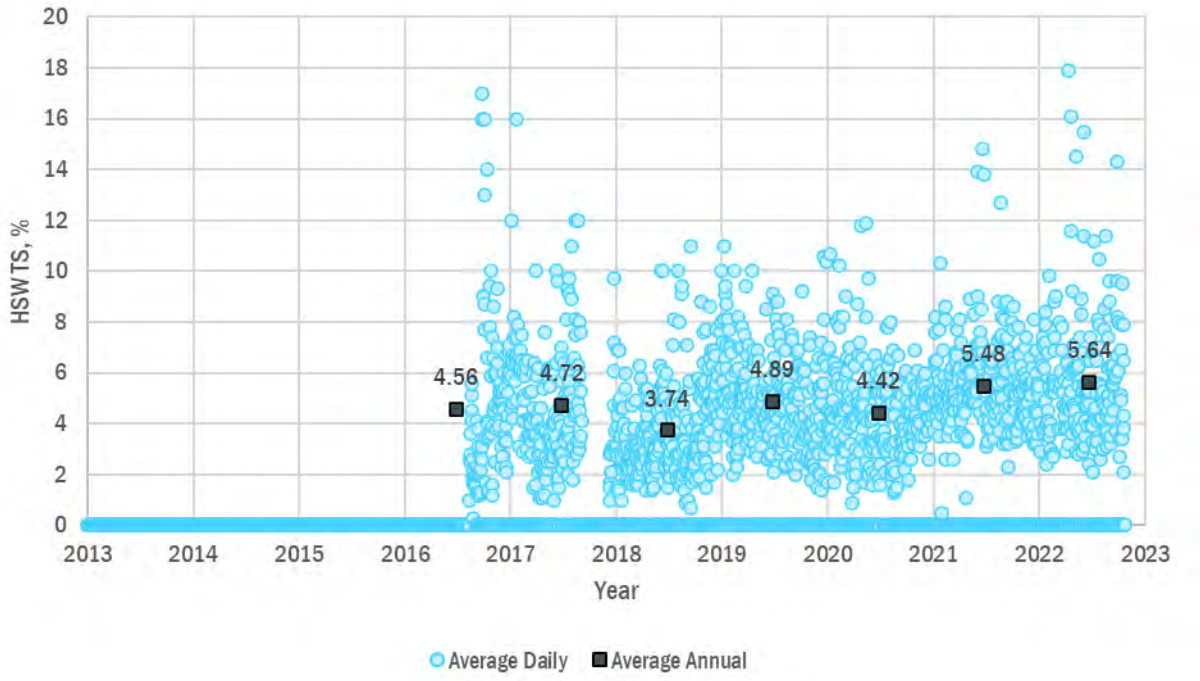


Figure A-19. Historical HSW TS concentration

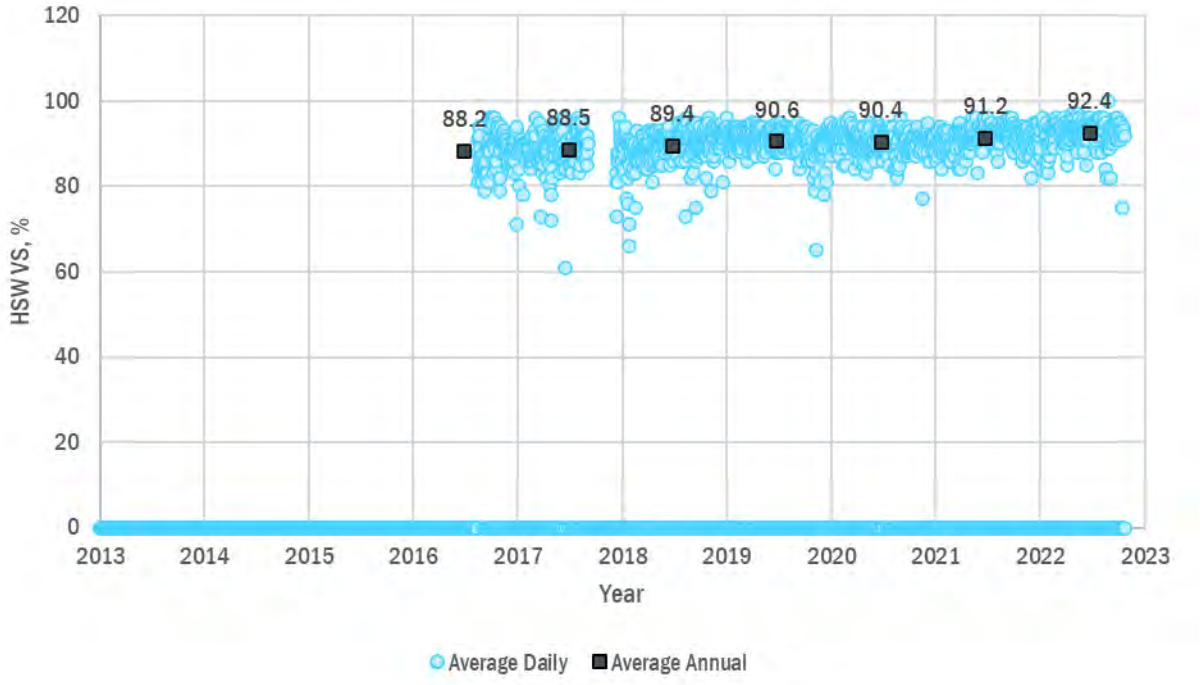


Figure A-20. Historical HSW VS concentration

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Thickening and Dewatering

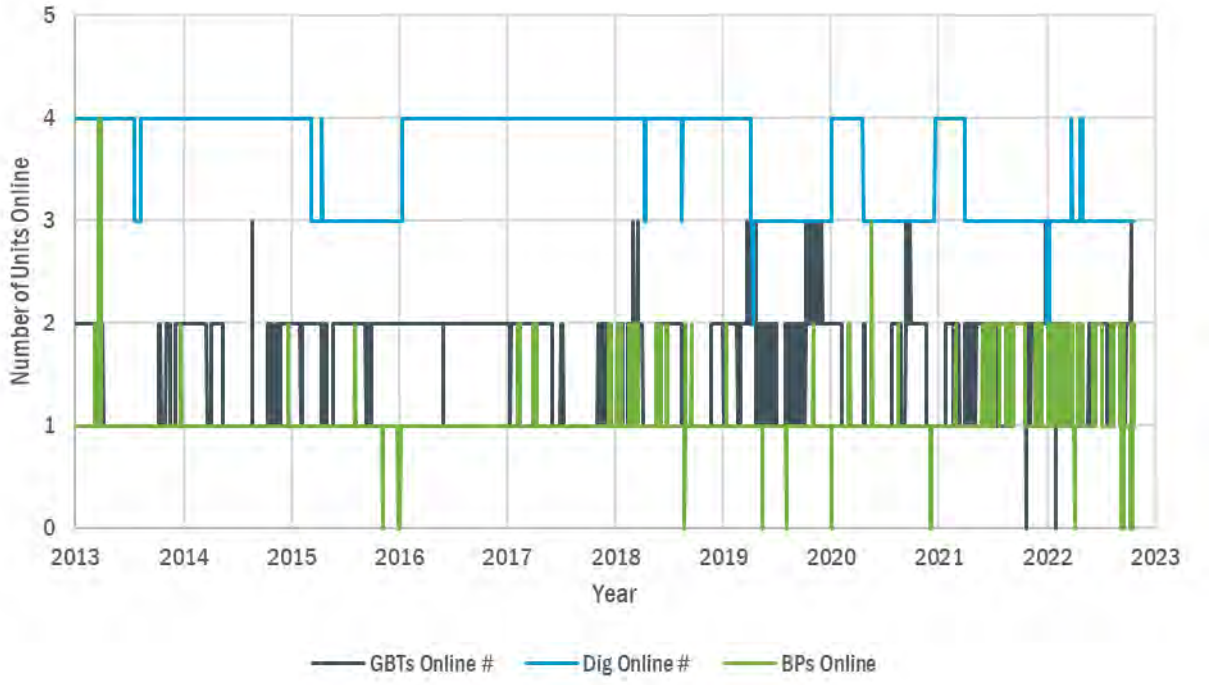


Figure A-21. Historical GBT, Digester, and BP Operations

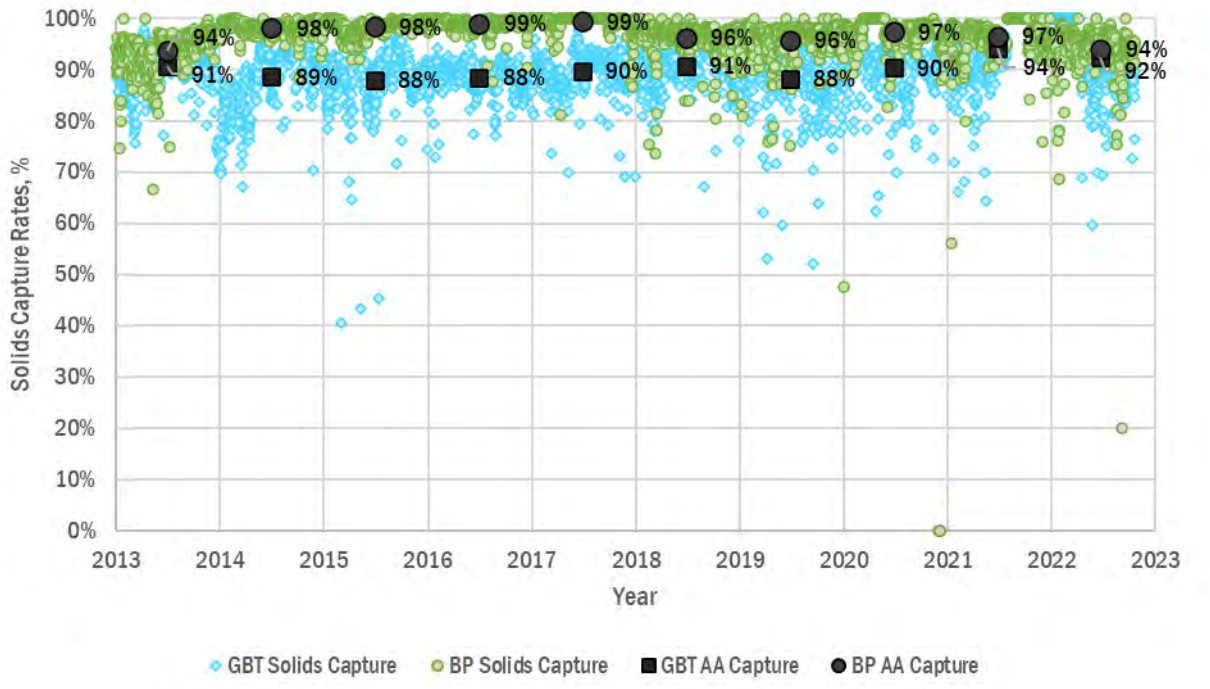


Figure A-22. Historical Solids Capture Rates

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Digester Feed

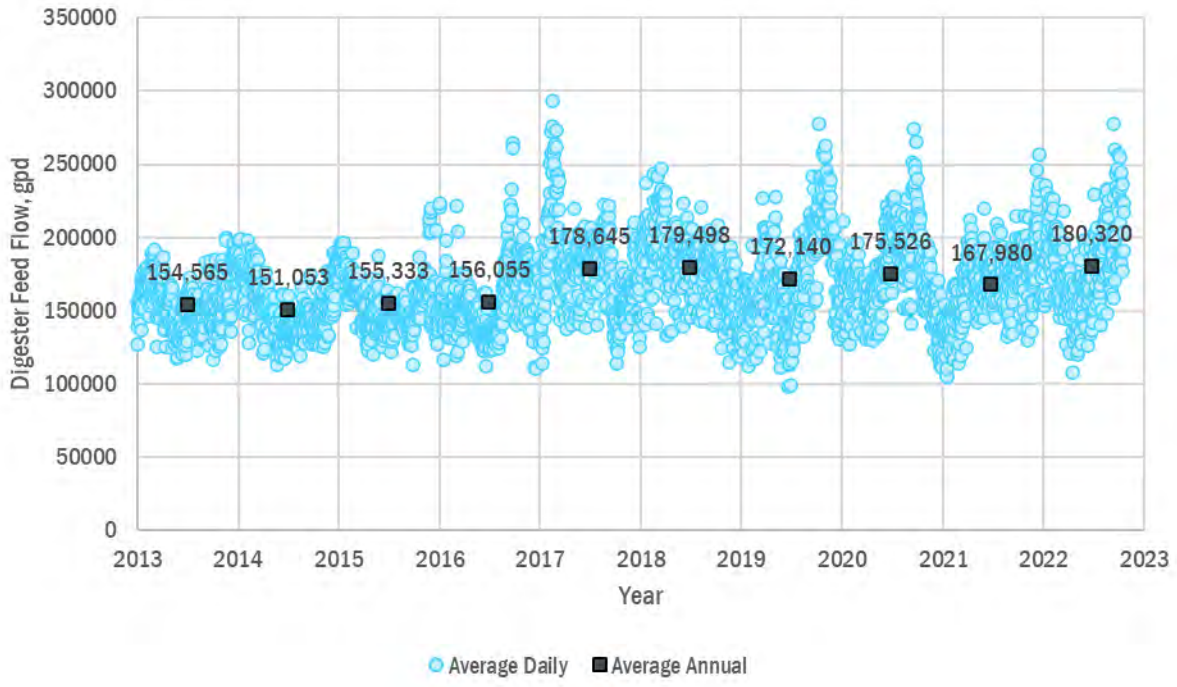


Figure A-23. Historical digester feed flow

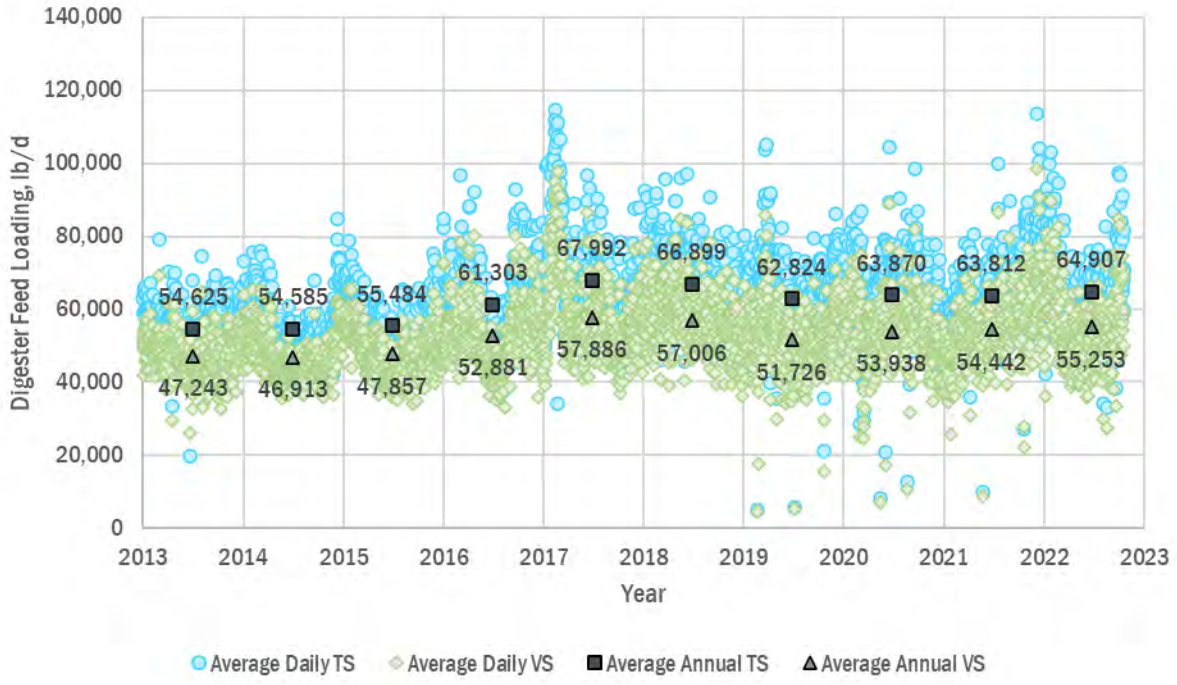


Figure A-24. Historical digester feed loading

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Anaerobic Digesters

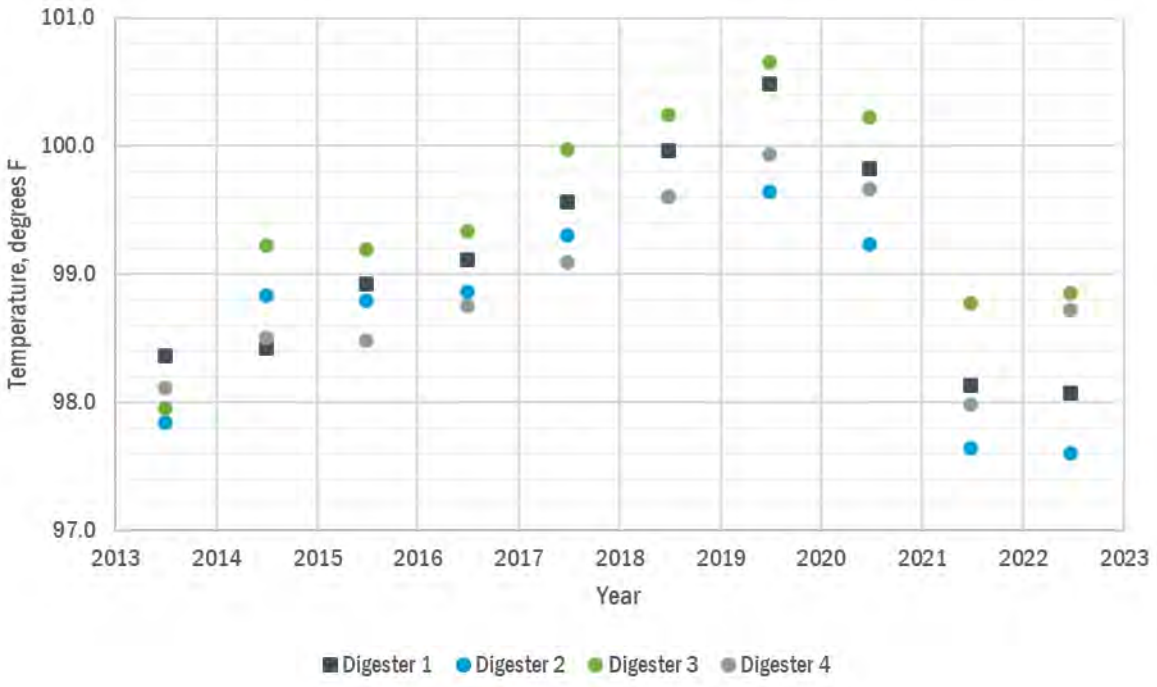


Figure A-25. Historical average annual digester temperature

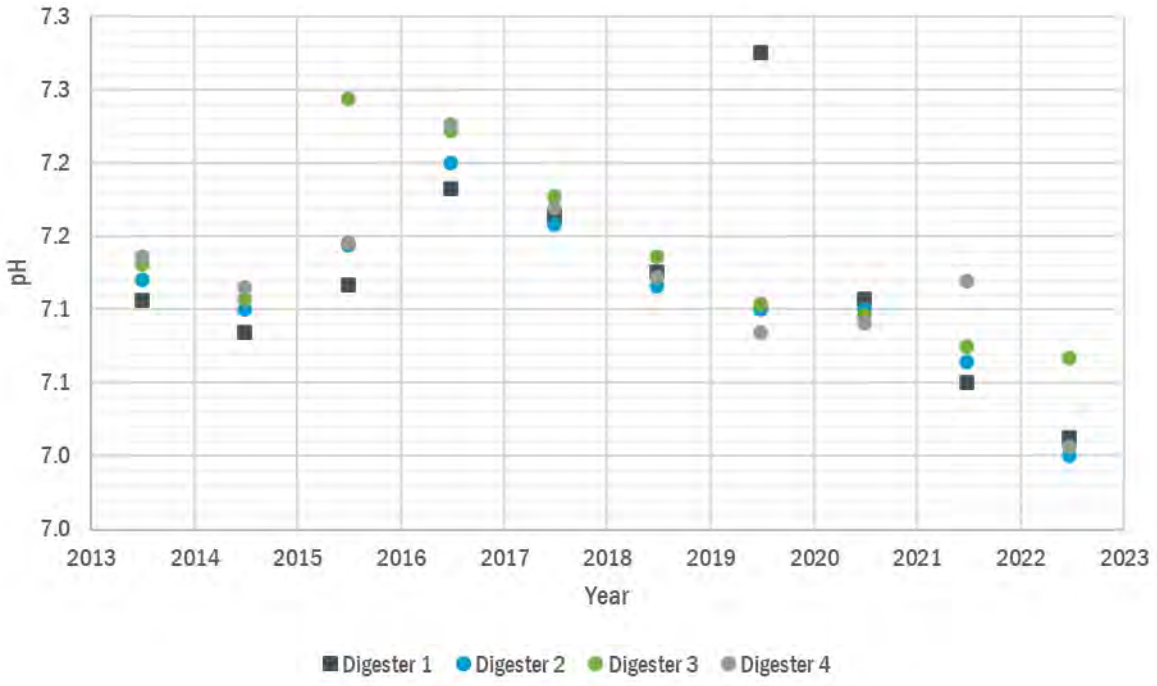


Figure A-26. Historical average annual digester pH

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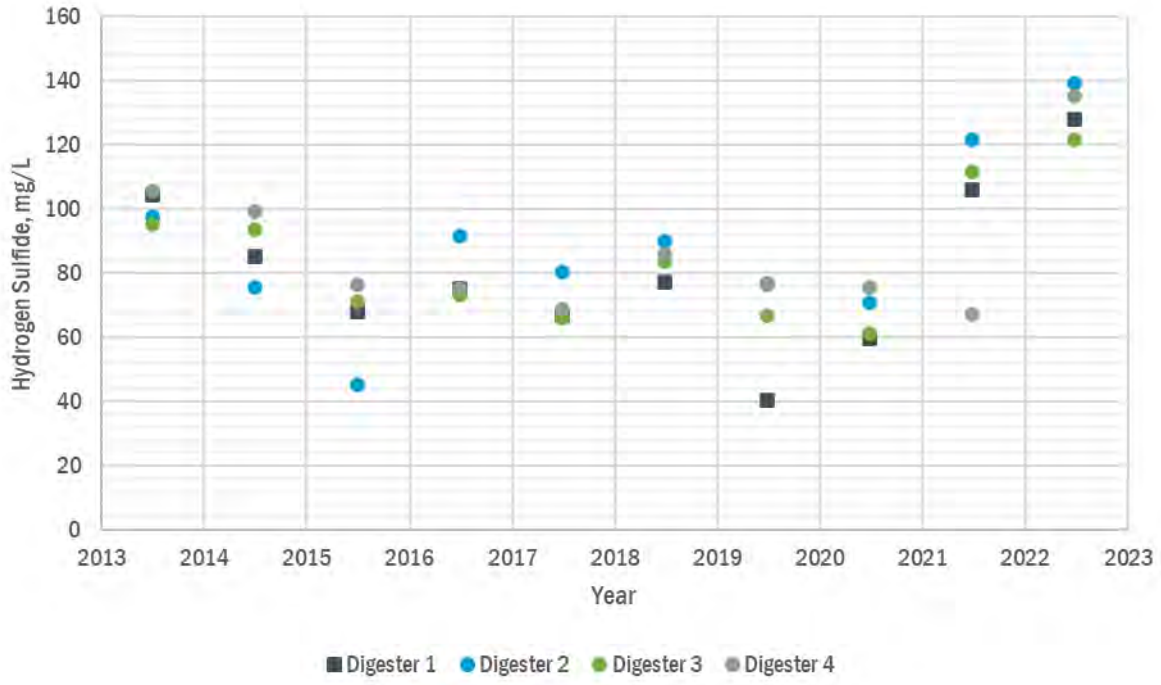


Figure A-27. Historical average annual digester hydrogen sulfide

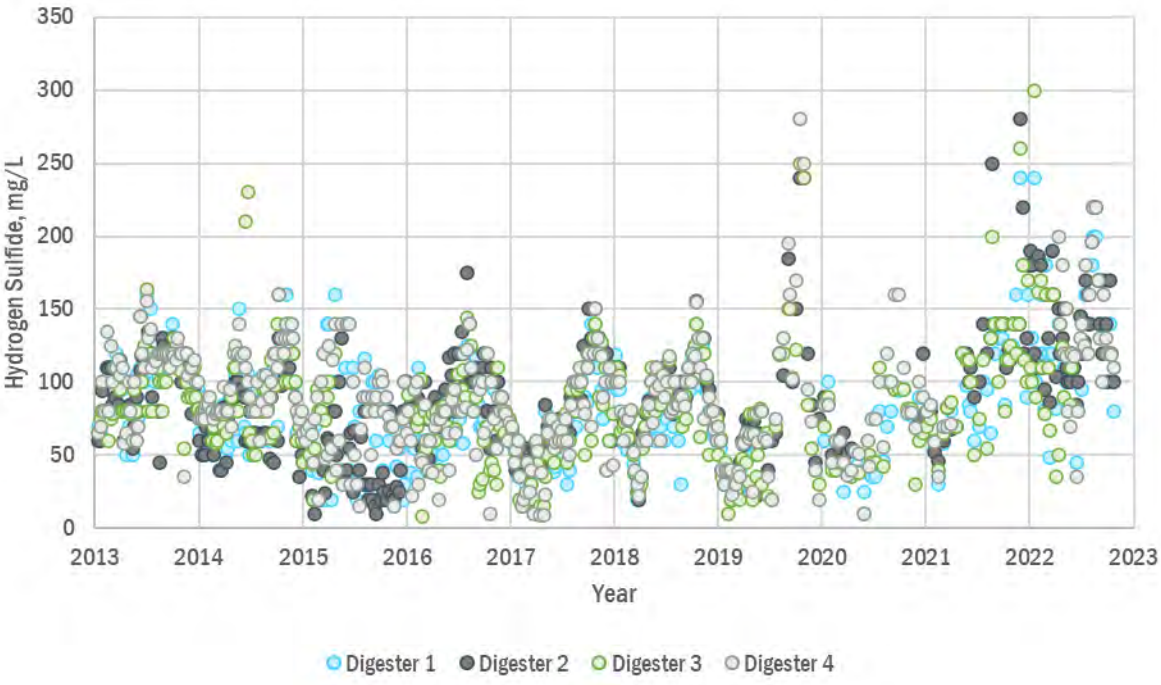


Figure A-28. Historical digester hydrogen sulfide

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Belt Press

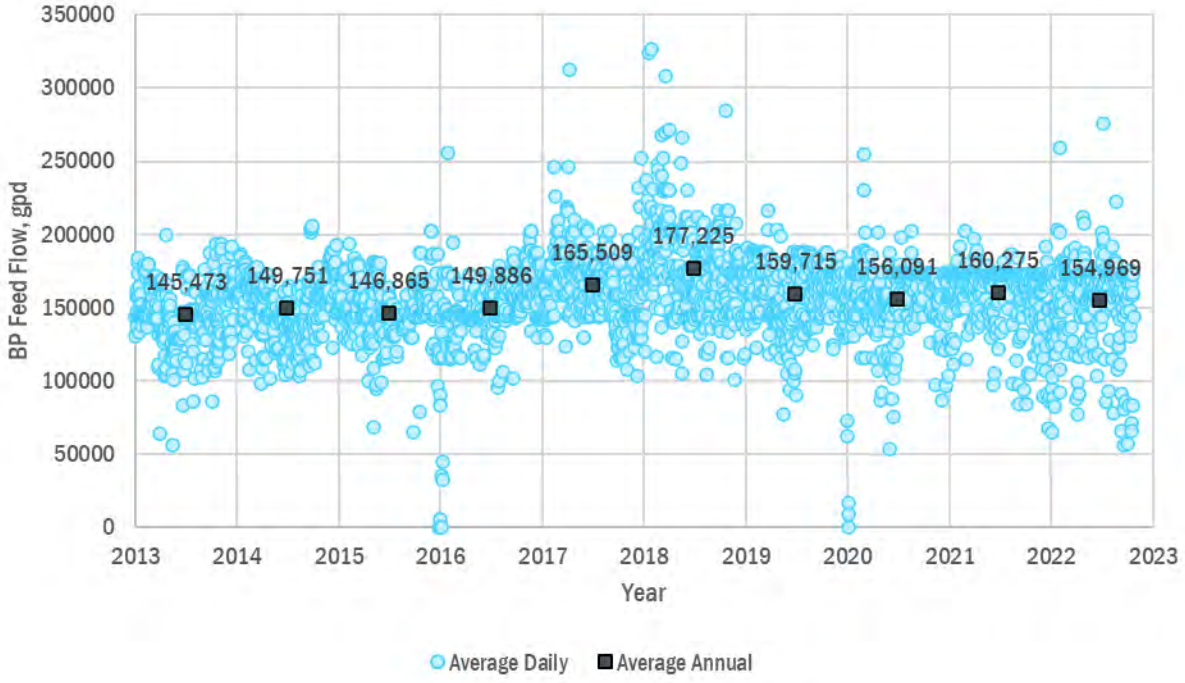


Figure A-29. Historical BP feed flow

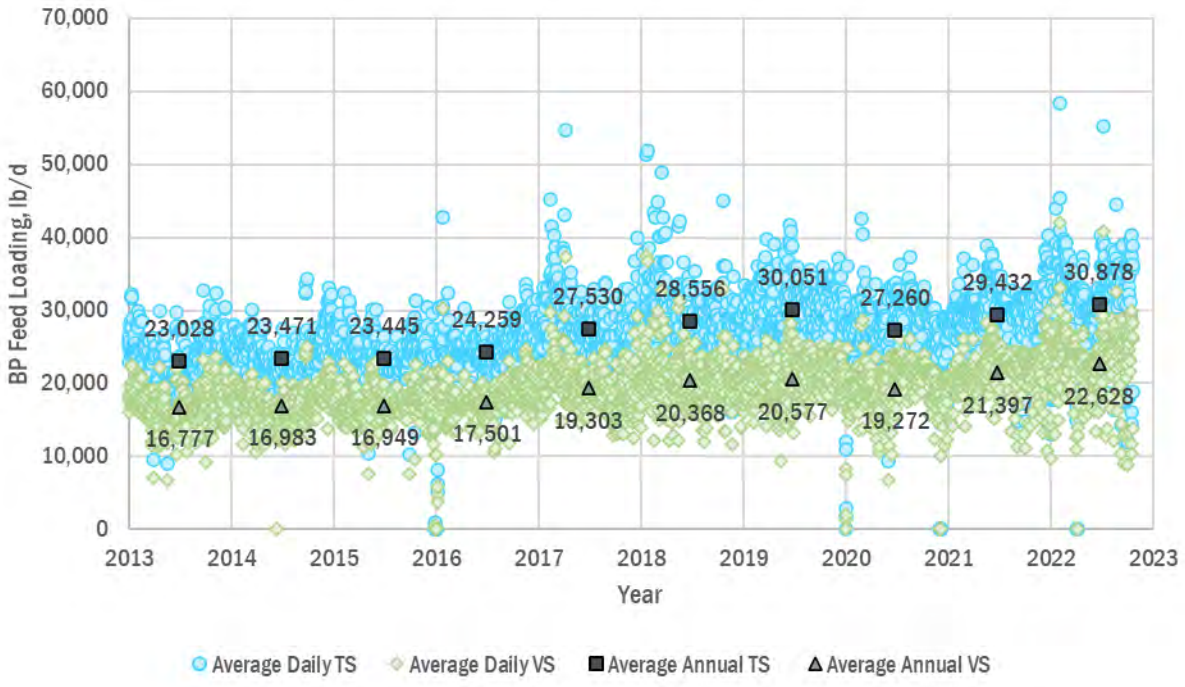


Figure A-30. Historical BP feed loading

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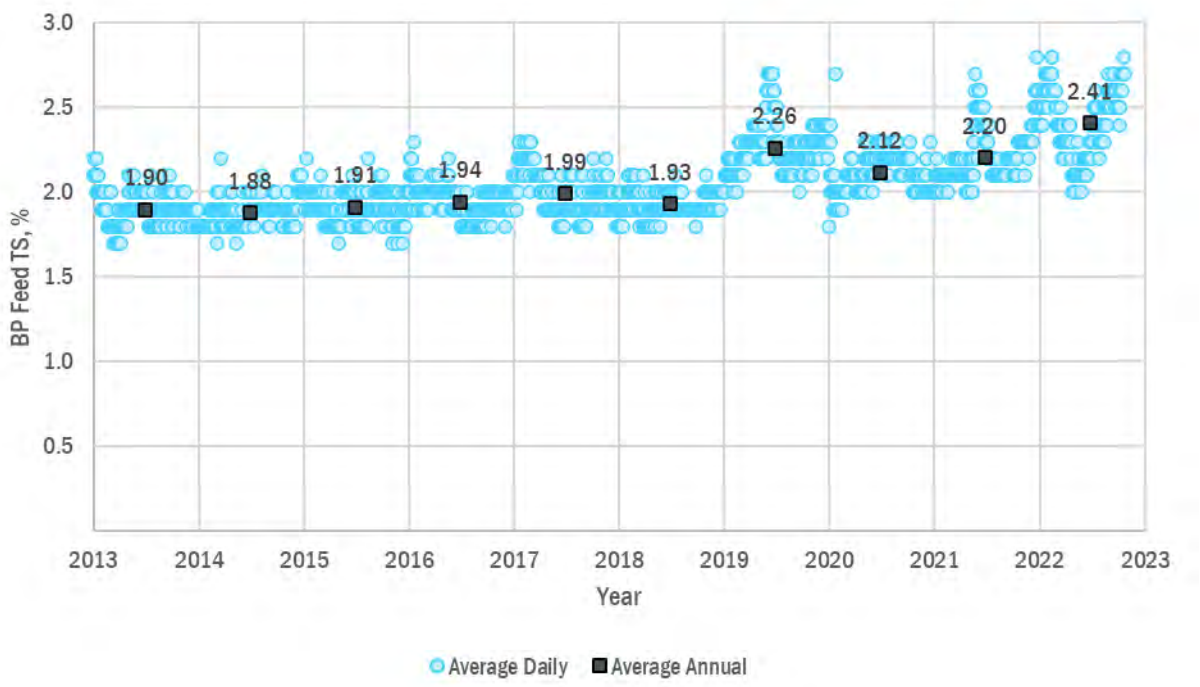


Figure A-31. Historical BP feed TS concentration

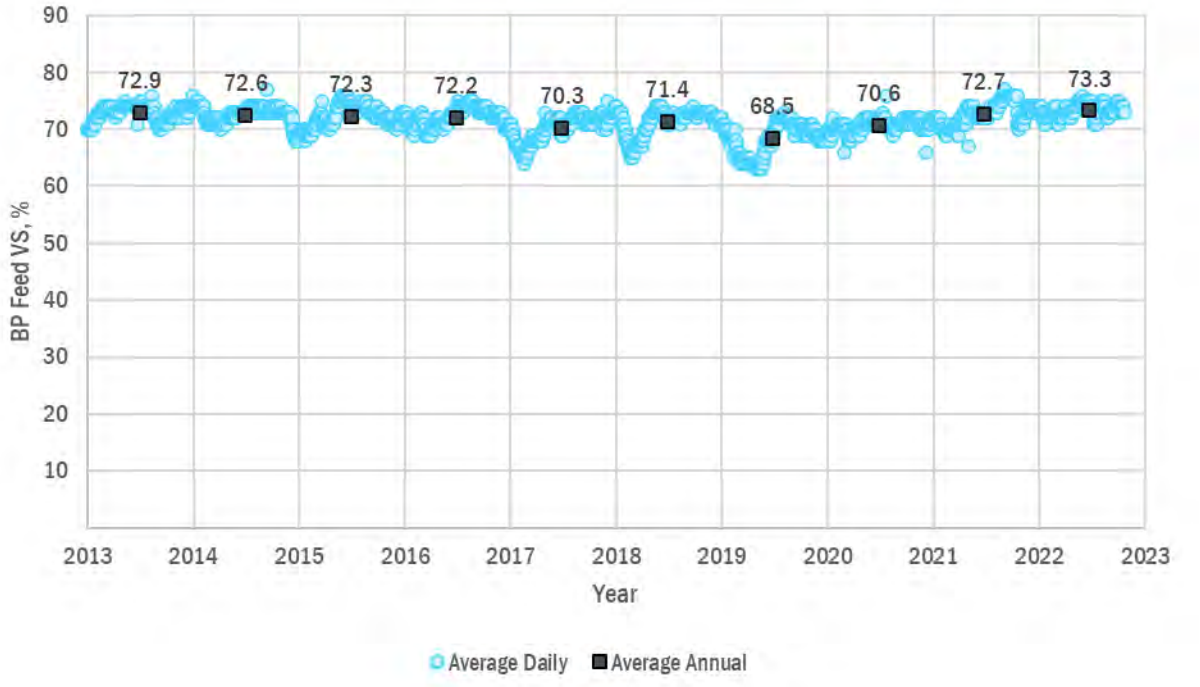


Figure A-32. Historical BP feed VS concentration

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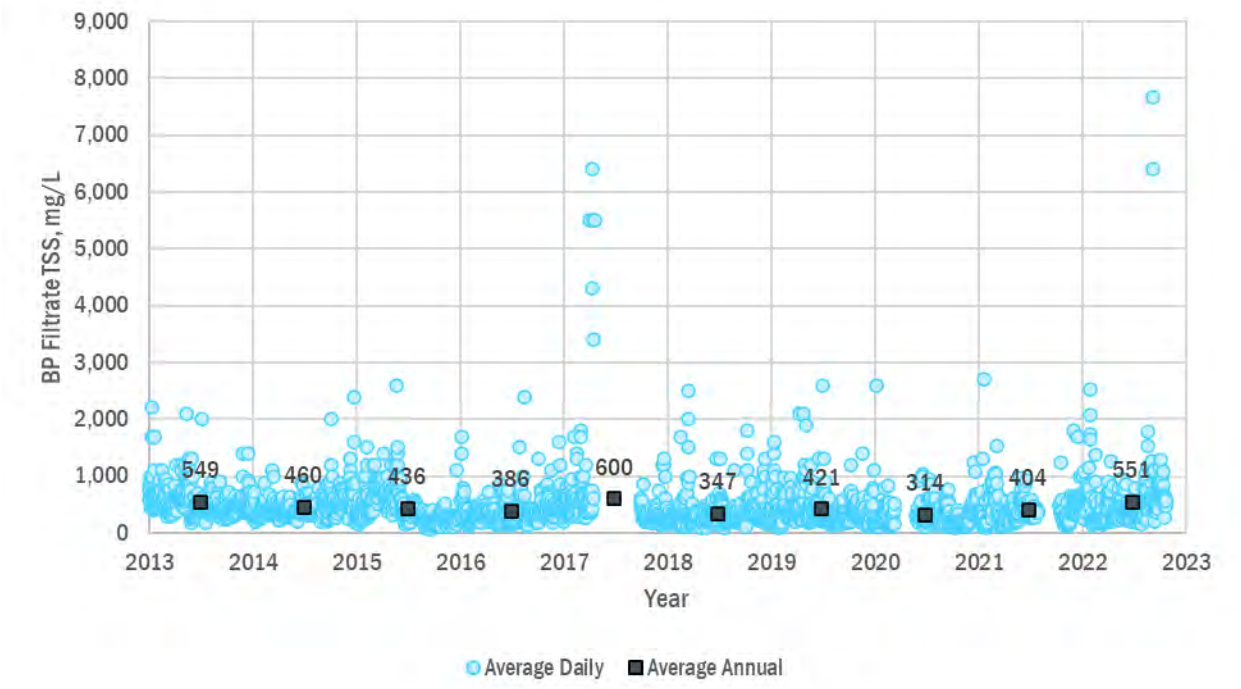


Figure A-33. Historical BP filtrate TSS concentration



Figure A-34. Historical BP polymer dose relative to digester feed TS loading

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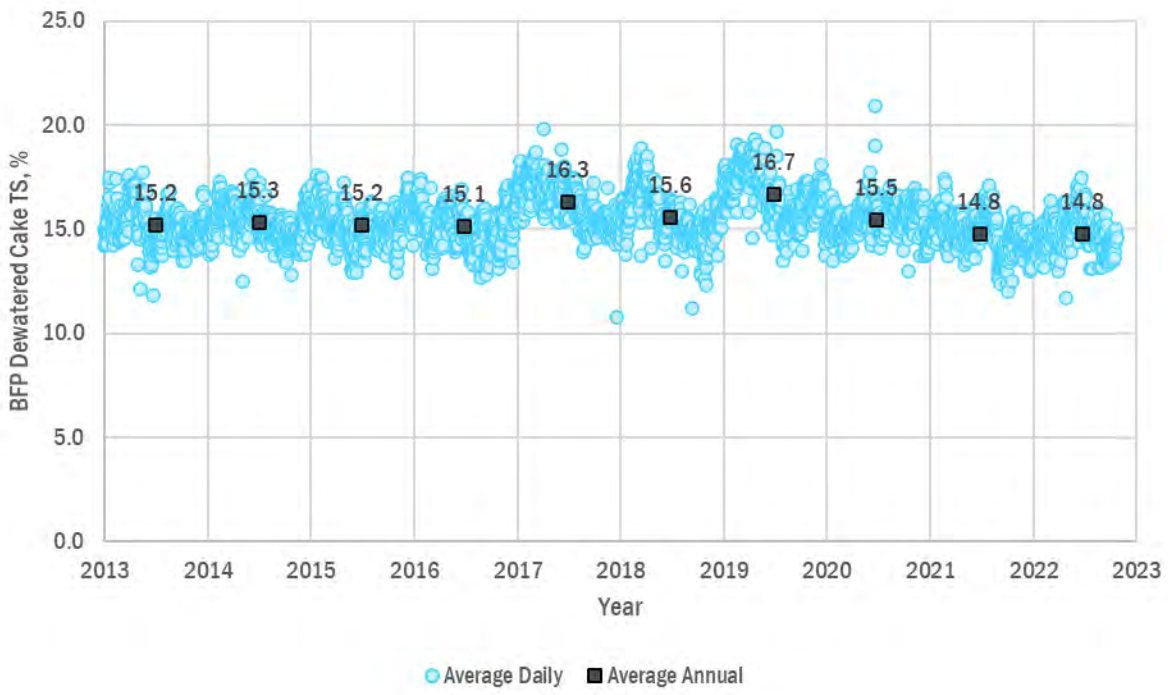


Figure A-35. Historical dewatered sludge TS concentration

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Biogas

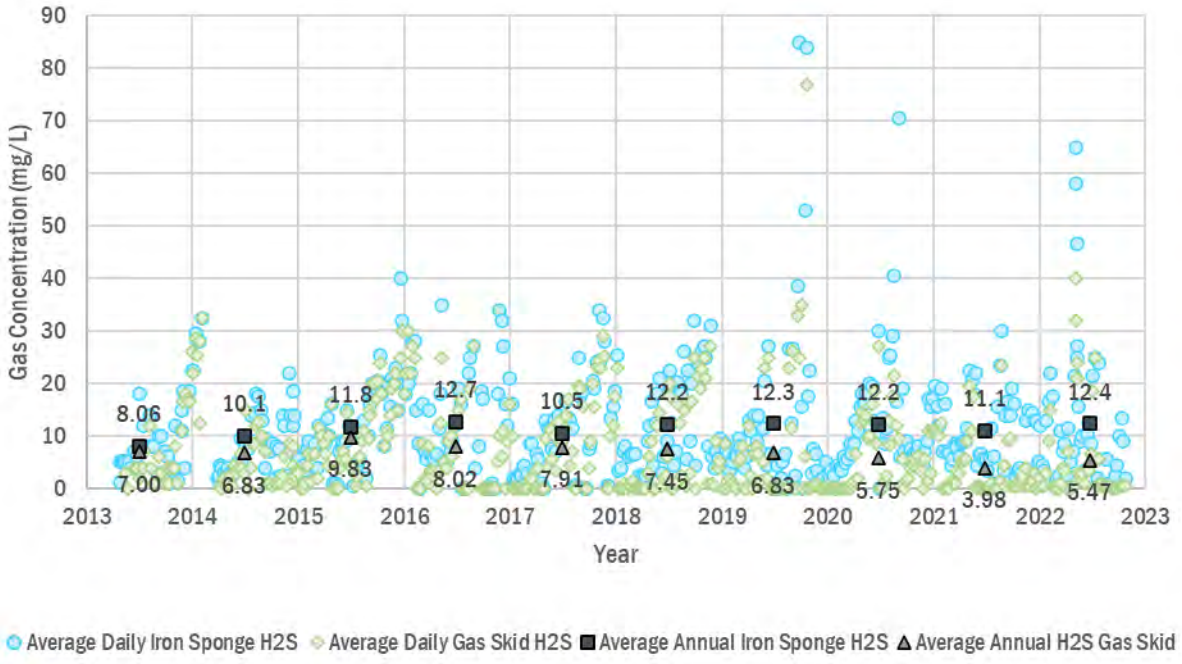


Figure A-36. Historical biogas and iron sponge hydrogen sulfide concentrations

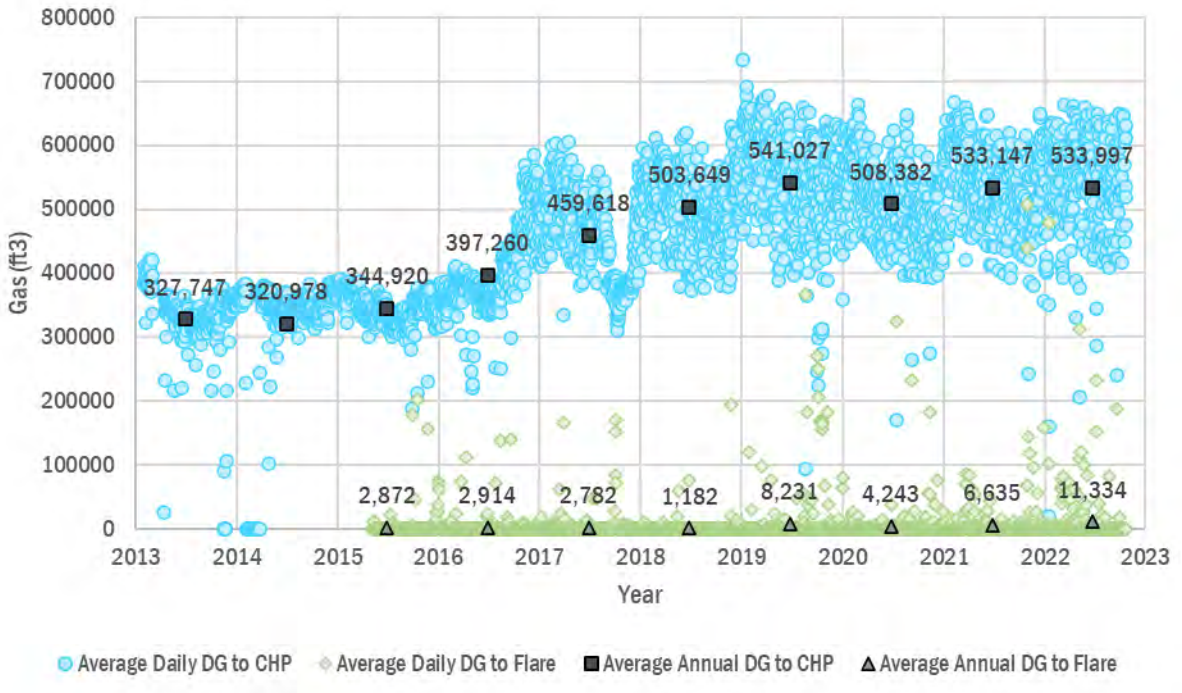


Figure A-37. Historical biogas production, biogas used by CHP, and biogas flared

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Attachment B: Solids Water Energy Balance

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B.1 Solids-Water-Energy Balance

Model inputs shown in Figures B-1, B-2, and B-3 were calibrated by matching digested sludge (mgd and lb/d), biosolids production (wet tons) and energy production (kWh/d) with PS, TWAS, and HSW loading to the solids treatment system. Three periods were modeled:

1. Before HSW (Figure B-1) – Average annual values from 2014-2016 modeled.
2. After HSW (Figure B-2) – Average annual values from 2017-2019 modeled.
3. After HSW for Validation (Figure B-3) – Average annual values from 1 year (2018) modeled to validate model.

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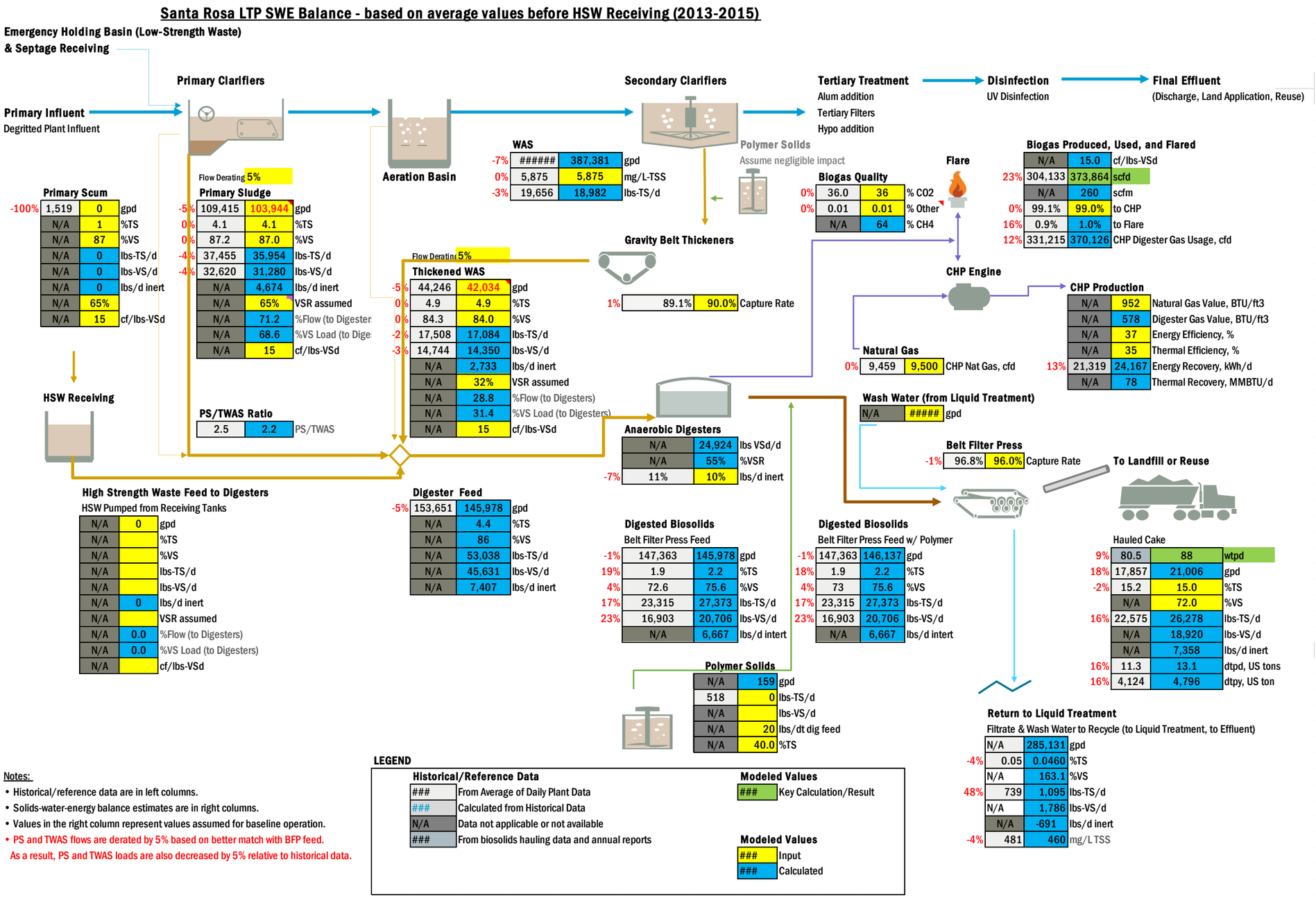


Figure B-1. Solids-water-energy balance for period before HSW is online (2013-2015)

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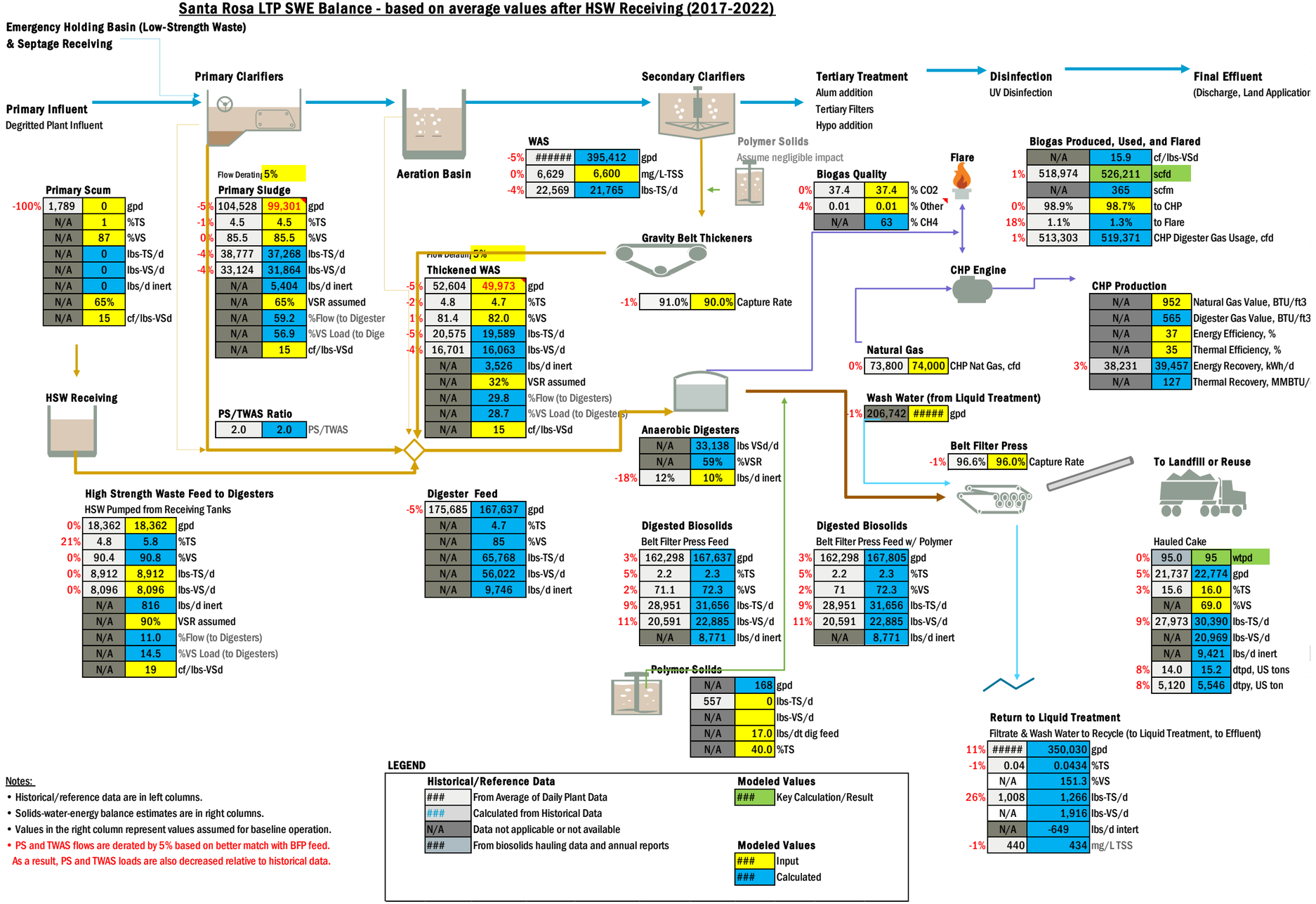


Figure B-2. Solids-water-energy balance for period after HSW is online (2017-2022)

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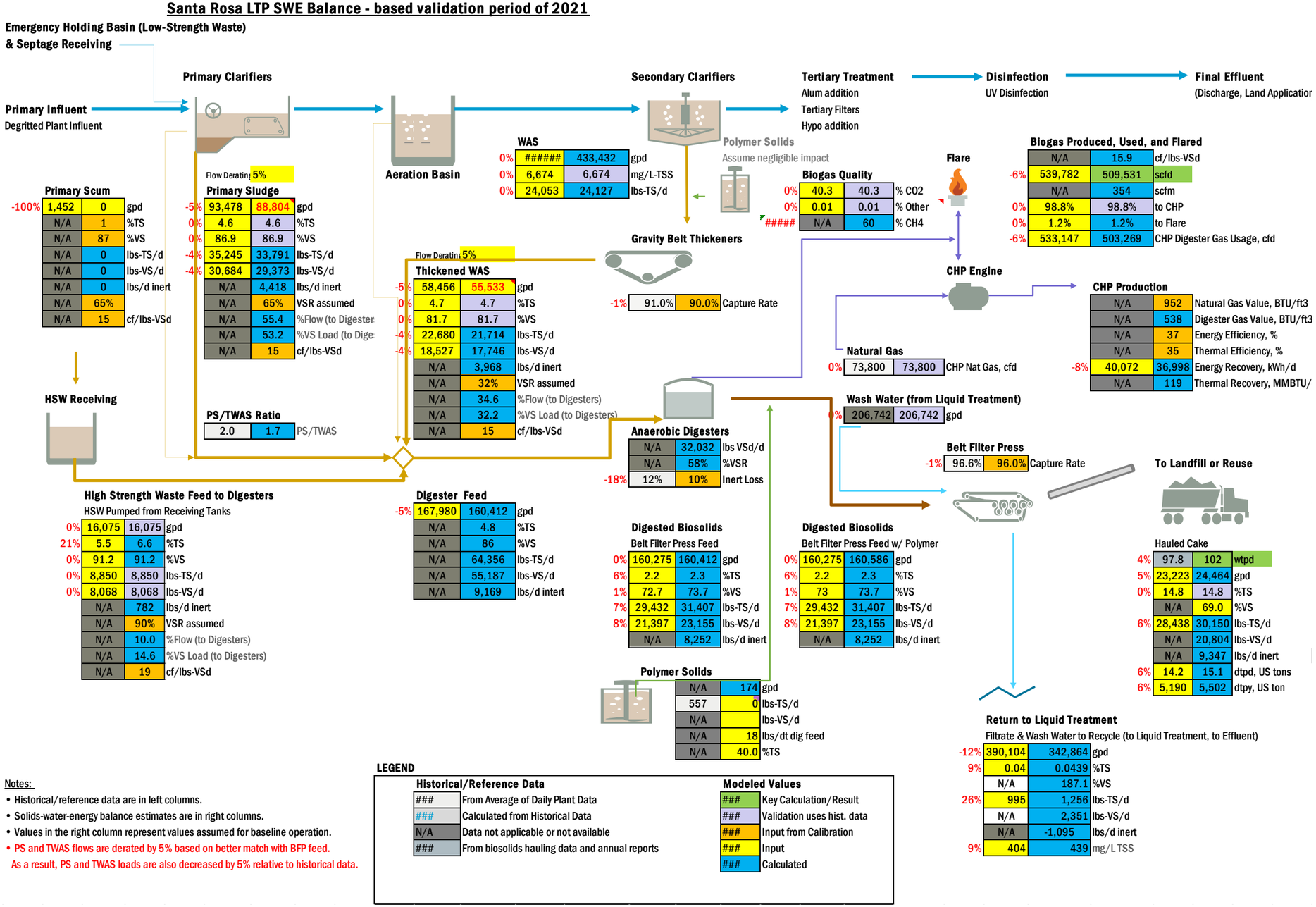


Figure B-3. Solids-water-energy balance for 2021 validation period

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Attachment C: Capacity Evaluation Calculations

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Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	1
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Primary Sludge Pumping Calculations		

Problem Statement

Evaluate the existing capacity of PS pumping at the LTP for projected flows.

Assume 1 primary clarifier and pump is offline per group (clarifiers/pumps 1-3 are one group, clarifiers/pumps 4-6 are another group, and clarifiers/pumps 7-8 are the last group).

Unit Process Information

Design criteria and capacity limitations

Parameter	Design Criteria		Reference
Pumps 1-3 Manufacturer	Netzsch / Progressive Cavity		
Total units	3		
With one offline	2		
Pumps 3-6 Manufacturer	Netzsch / Progressive Cavity		
Total units	3		
With one offline	2		
Pumps 7-8 Manufacturer/Type	Monyo / Progressive Cavity		
Total units	2		
With one offline	1		
Assumed operating flowrate	50	gpm	observed operating pumping rate of 53.5 gpm at 75% speed; 50 gpm conservative assumption
Total number of primary tanks	8		
Assumed number of primary tanks offline	1		

Peaking Factors

Peaking factors developed based on historical data

Peaking Factor	30d	14d	7d	1d	Notes
PS Flow	1.42	1.47	1.56	1.95	Based on 2013-2022 historical data

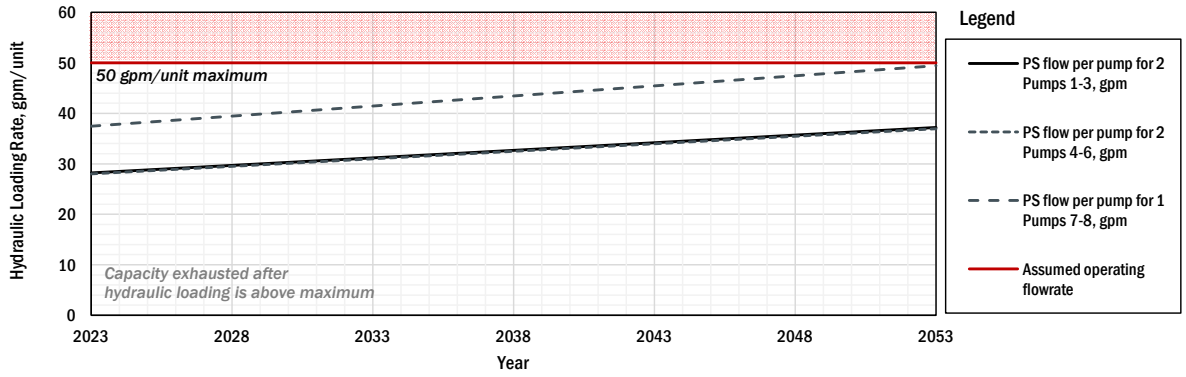
Primary Sludge Pumping Predictions

Calculations for maximum rates for comparison with capacity limitation and design criteria presented above. Appropriate flow and loading projections are stated.

	Average Annual		Maximum 7-d		Maximum 1-d	
Parameter	2023	2053	2023	2053	2023	2053
PS flow, gpd	96,810	127,782	151,024	199,340	188,780	249,175
PS flow per pump for 2 Pumps 1-3, gpm	15	19	23	30	28	37
PS flow per pump for 2 Pumps 4-6, gpm	14	19	22	30	28	37
PS flow per pump for 1 Pumps 7-8, gpm	19	25	30	40	37	49

Capacity Plots

Hydraulic Loading Capacity with 1 Primary Clarifier and 1 Pump (per group) Offline at Maximum 1-d Flow



Interpolate to determine year at which capacity runs out based on PS flow	Year of Capacity Limitation		
Condition	PS Pumps 1-3	PS Pumps 4-6	PS Pumps 7-8
Peak 1-d PS Flow with 1 PS Pump Offline per Group and 1 Primary Tank Offline	2053+	2053+	2053+

Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	2
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Thickening Capacity Calculations		

Problem Statement

Evaluate the existing capacity of thickening process at the LTP for WAS based on TWAS projections.

For purposes of capacity, assume City-provided hydraulic and solids loading capacity values from O&M manual and City's experience. No additional derating is assumed.

Unit Process Information

Design criteria and capacity limitations

Parameter	Design Criteria		Reference
Thickening Equipment	Gravity Belt Thickener (GBT)		
Manufacturer	Ashbrook-Simon-Hartley		
Belt Width	2	m	LTP solids thickening O&M manual
Hydraulic Loading Rate Capacity per Unit	225	gpm	LTP solids thickening O&M manual
Solids Loading Rate Capacity per Unit	14,400	lb/d	600 lb/hr-machine per LTP O&M manual; 13.5-21.6 klb/hr at 5-8 g/L and 225 gpm
Total Quantity	3		LTP solids thickening O&M manual
Quantity with Redundancy	2		Assumes 1 standby unit for redundancy
Thickening Pumps Type	Constant-Speed, Progressing Cavity		
Pumping Capacity per Pump	115	gpm	LTP solids thickening O&M manual
Total Quantity	2		LTP solids thickening O&M manual
Quantity with Redundancy	1		
Performance Assumptions			
Digested Sludge TS Concentration	2.3	%	Assumed for calculation of recuperative thickening (RT) capacity

Peaking Factors

Peaking factors developed based on historical data

Peaking Factor	30d	14d	7d	1d	Notes
WAS Feed Flow	1.46	1.49	1.59	1.65	Based on 2013-2022 historical data
WAS Feed TS Loading	1.42	1.50	1.48	1.60	Based on 2013-2022 historical data
TWAS Flow	1.39	1.47	1.73	1.88	

GBT Feed Predictions

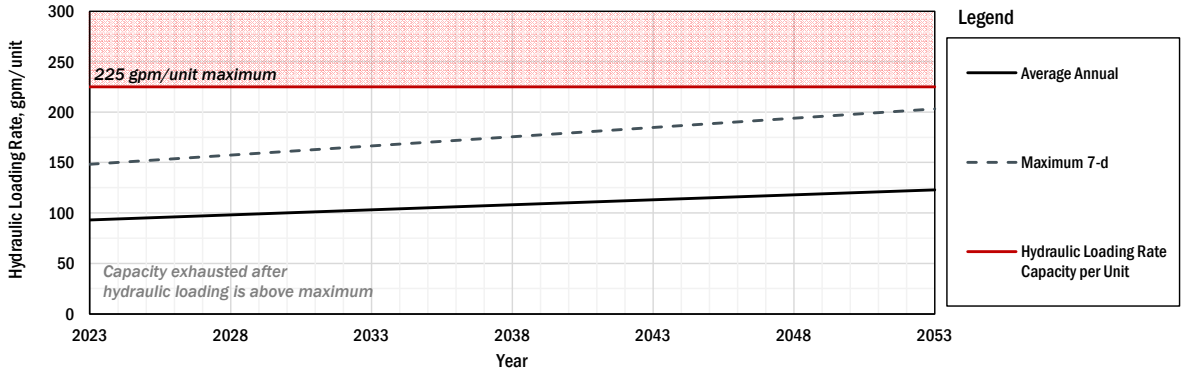
Calculations for maximum rates for comparison with capacity limitation and design criteria presented above. Appropriate flow and loading projections are stated.

	Average Annual		Maximum 30-d		Maximum 7-d	
Parameter	2023	2053	2023	2053	2023	2053
WAS flow to thickening, gpd	402,884	531,775	588,210	776,391	640,585	877,429
WAS TSS load to thickening, lb/d	22,176	29,271	31,490	41,565	32,821	46,834
TWAS flow, gpd	50,918	67,207	70,776	93,418	88,088	116,269
Hydraulic Loading Rate with 1 Unit Offline						
WAS flow per unit, gpm	140	185	204	270	222	305
TWAS flow per unit, gpm	35	47	49	65	61	81
Solids Loading Rate with 1 Unit Offline						
WAS TS load per unit, lb/d	11,088	14,636	15,745	20,782	16,410	23,417
Hydraulic Loading Rate with All Units						
WAS flow per unit, gpm	93	123	136	180	148	203
TWAS flow per unit, gpm	18	23	25	32	31	40
Solids Loading Rate with All Units						
WAS TS load per unit, lb/d	7,392	9,757	10,497	13,855	10,940	15,611

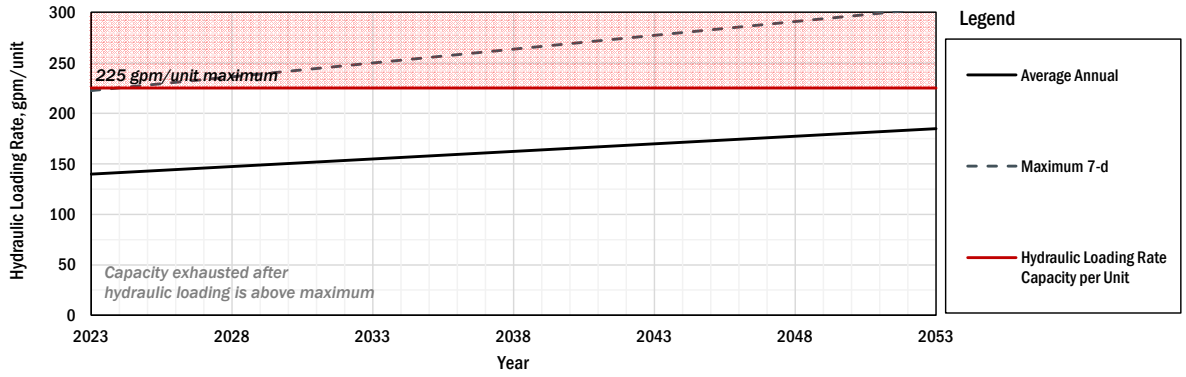
Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	2
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Thickening Capacity Calculations		

Capacity Plots

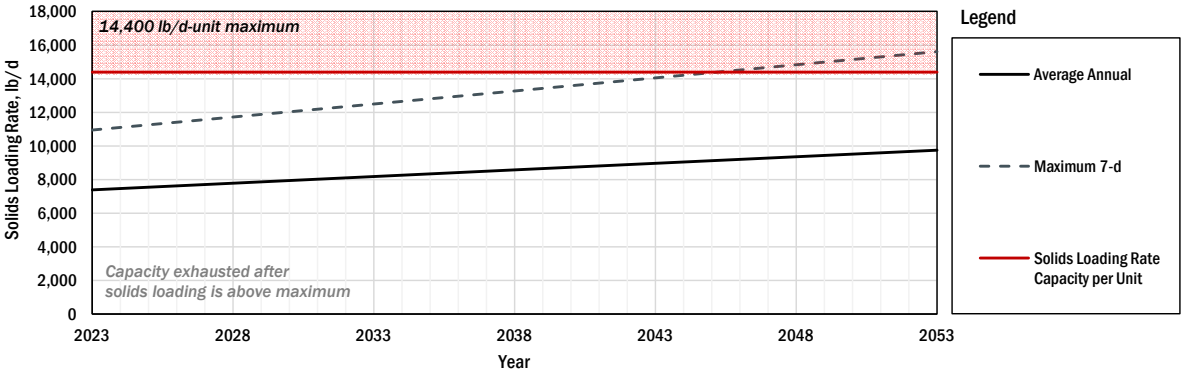
Hydraulic Loading Capacity with All Units Online



Hydraulic Loading Capacity with Redundant Unit Offline

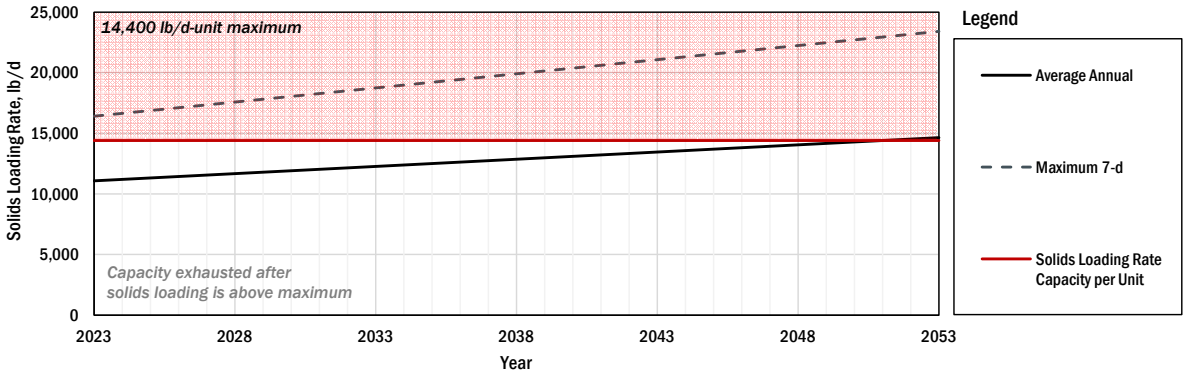


Solids Loading Capacity with All Units

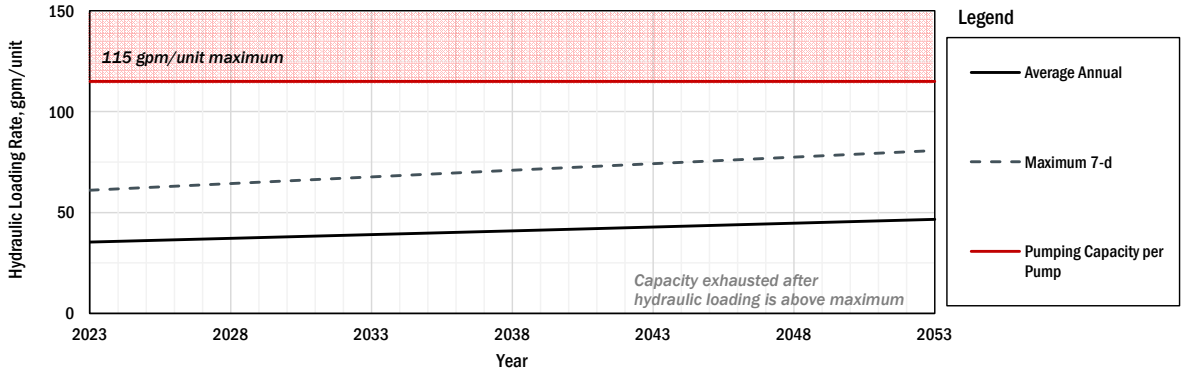


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6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	2
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Thickening Capacity Calculations		

Solids Loading Capacity with Redundant Unit Offline



TWAS Pump Hydraulic Capacity per Pump



Interpolate to determine year at which capacity runs out based on PS+TWAS loading only	Year of Capacity Limitation	
Condition	**1 Unit Offline**	**All Units Online**
GBT Hydraulic Loading Rate (HLR) Capacity	2024	2053+
GBT Solids Loading Rate (SLR) Capacity	2023	2045
TWAS Pumping Capacity	2053+	2053+
Capacity Limitation	2023	2045

Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	3
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Anaerobic Digester Capacity Calculations		

Problem Statement

Evaluate the existing process capacity of anaerobic digestion with 3 and 4 digesters online at the LTP for projected flows and loads.
Evaluate capacities with and without HSW in 2023 and 2053.
For purposes of capacity, assume all digesters are heated and well-mixed.

Unit Process Information

Design criteria and capacity limitations

Parameter	Design Criteria		Reference
Type	(2) Fixed Covers (2) Floating Covers		
Digesters 1+2 Volume - Floating Covers (Max)	1.010	MG	Digester volume discounted by 5% for grit accumulation
Digesters 3+4 Volume - Fixed Covers	1.010	MG	Digester volume discounted by 5% for grit accumulation
Digesters 1+2 Volume - Floating Covers (Max)	134,954	ft3	
Digesters 3+4 Volume - Fixed Covers	134,954	ft3	
Quantity of Floating Cover Digesters	2		
Quantity of Fixed Cover Digesters	2		
Total Quantity	4		
Floating Cover Digesters with Redundancy	2		
Operating Fixed Cover Digesters with Redundancy	1		
Quantity with Redundancy	3		
Design Condition			
Maximum OLR	0.2	lb-VS/ft3-d	Typical criteria for organic loading rate (OLR) of mesophilic digester
Minimum HRT	15	days	Typical minimum HRT required to produce Class B biosolids

Peaking Factors

Peaking factors developed based on historical data

Peaking Factor	30d	14d	7d	1d	Notes
Digester Feed Flow	1.35	1.40	1.49	1.64	Based on 2013-2022 historical data
Digester Feed VS Loading	1.29	1.37	1.41	1.75	Based on 2013-2022 historical data
HSW Flow	1.61	1.63	1.70	2.58	Based on 2013-2022 historical data
HSW VS Loading	1.17	1.20	1.35	1.93	Based on 2013-2022 historical data

Anerobic Digestion Predictions

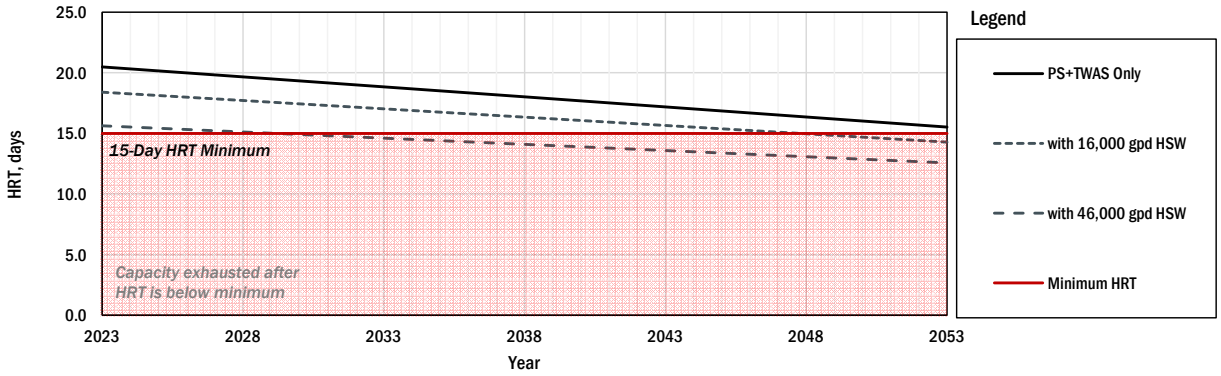
Calculations for maximum rates for comparison with capacity limitation and design criteria presented above. Appropriate flow and loading projections are stated.

	Average Annual		Maximum 30-d		Maximum 14-d	
Parameter	2023	2053	2023	2053	2023	2053
PS+TWAS flow to digestion, gpd	147,728	194,989	199,433	263,236	206,819	272,985
PS+TWAS VS loading to digestion, lb/d	47,812	63,108	61,678	81,409	65,502	86,458
HSW (16.9 kgpd) flow to digestion, gpd	16,900	16,900	27,209	27,209	27,547	27,547
HSW (16.9 kgpd) VS loading to digestion, lb/d	8,880	8,880	10,389	10,389	10,656	10,656
HSW (46 kgpd) flow to digestion, gpd	46,000	46,000	74,060	74,060	74,980	74,980
HSW (46 kgpd) VS loading to digestion, lb/d	22,236	22,236	26,016	26,016	26,683	26,683
HRT with 3 Digesters						
Digester HRT with PS+TWAS only, d	20.5	15.5	15	12	14.6	11
Digester HRT with HSW (16.9 kgpd), d	18.4	14.3	13	10	13	10
Digester HRT with HSW (46 kgpd), d	15.6	12.6	11	9	11	9
OLR with 3 Digesters						
Digester OLR with PS+TWAS only, lb-VS/ft3-d	0.12	0.16	0.15	0.20	0.16	0.21
Digester OLR with HSW (16.9 kgpd), lb-VS/ft3-d	0.14	0.18	0.18	0.23	0.19	0.24
Digester OLR with HSW (46 kgpd), lb-VS/ft3-d	0.17	0.21	0.22	0.27	0.23	0.28
HRT with 4 Digesters						
Digester HRT with PS+TWAS only, d	27	21	20	15	20	15
Digester HRT with HSW (16.9 kgpd), d	25	19	18	14	17	13
Digester HRT with HSW (46 kgpd), d	21	17	15	12	14.3	12
OLR with 4 Digesters						
Digester OLR with PS+TWAS only, lb-VS/ft3-d	0.09	0.12	0.11	0.15	0.12	0.16
Digester OLR with HSW (16.9 kgpd), lb-VS/ft3-d	0.11	0.13	0.13	0.17	0.14	0.18
Digester OLR with HSW (46 kgpd), lb-VS/ft3-d	0.13	0.16	0.16	0.20	0.17	0.21

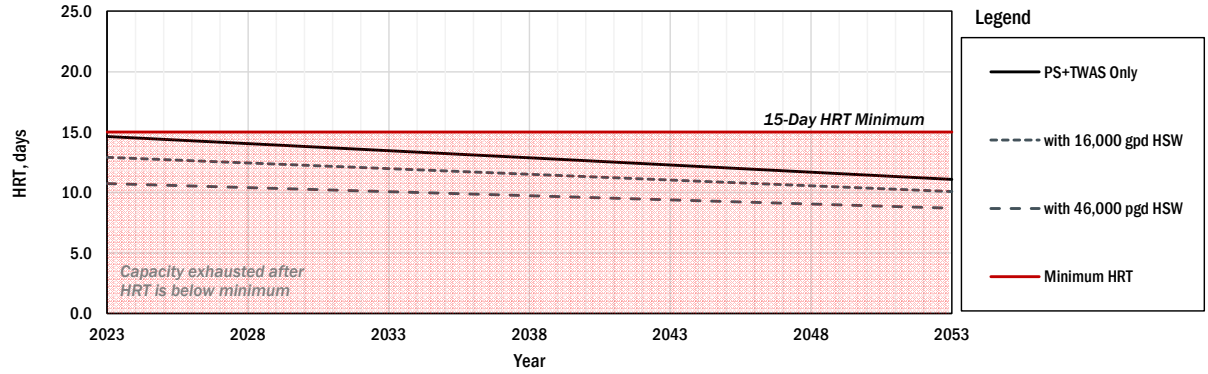
Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	3
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Anaerobic Digester Capacity Calculations		

Capacity Plots

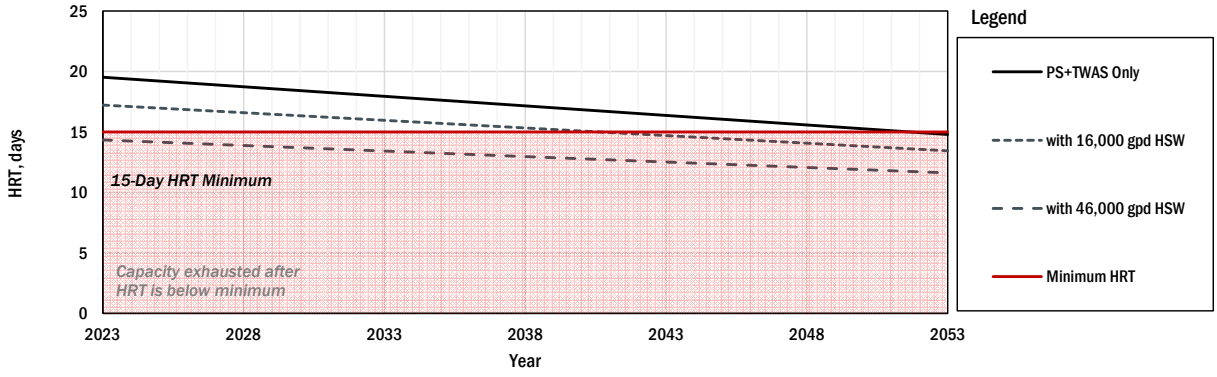
Hydraulic Residence Time with 3 Digesters in Service at Average Annual Hydraulic Loading



Hydraulic Residence Time with 3 Digesters in Service at Maximum 14-day Hydraulic Loading

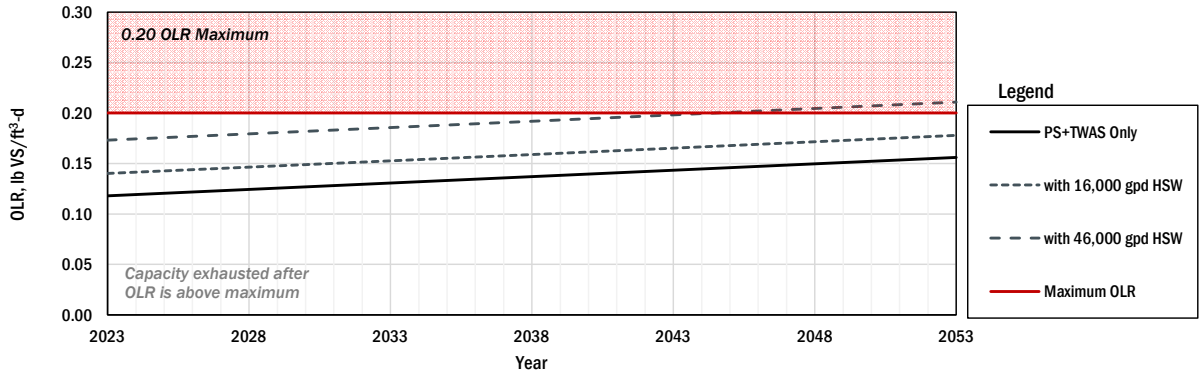


Hydraulic Residence Time with 4 Digesters in Service at Maximum 14-day Hydraulic Loading

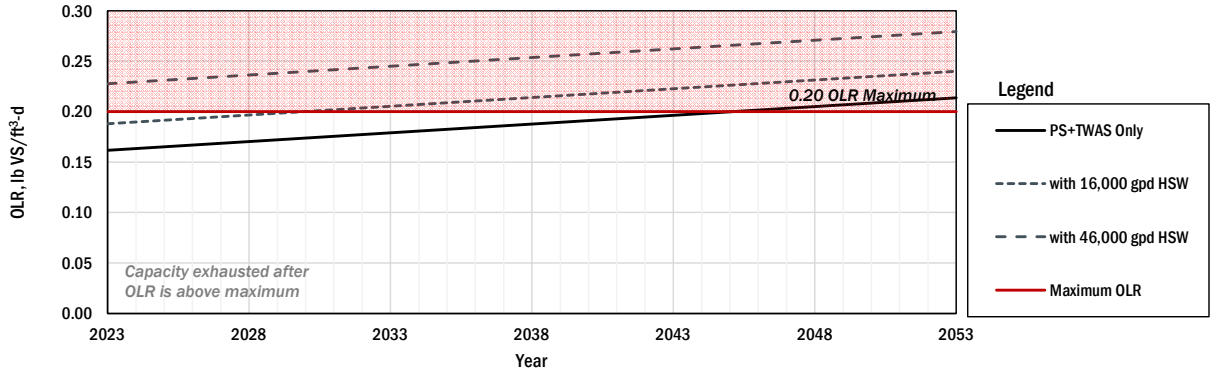


Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	3
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Anaerobic Digester Capacity Calculations		

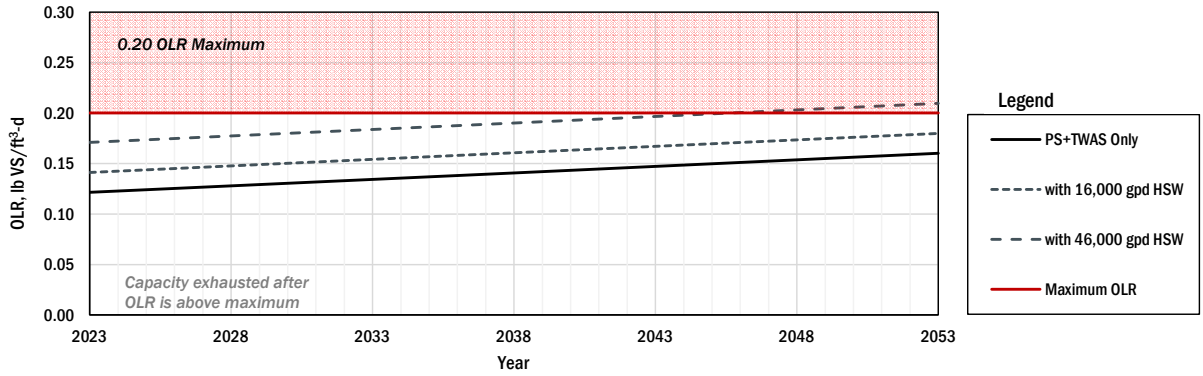
Organic Loading Rate with 3 Digesters at Average Annual Volatile Solids Loading



Organic Loading Rate with 3 Digesters at Maximum 14-d Volatile Solids Loading



Organic Loading Rate with 4 Digesters at Maximum 14-d Volatile Solids Loading



Interpolate to determine year at which capacity runs out based on PS+TWAS loading only	Year of Capacity Limitation	
Condition	**3 Digesters**	**4 Digesters**
OLR Capacity Based on Maximum 14-d VS Loading	2045	2053+
HRT Capacity Based on Maximum 14-d Flow to Digesters	2023	2052
Digestion Capacity	2023	2052

Calculate capacity available for HSW	HSW Capacity with 3 Digesters		HSW Capacity with 4 Digesters	
Condition	**2023**	**2053**	**2023**	**2053**
Additional HSW Capacity based on Maximum 14-d OLR, gpd	25,641	0	74,646	36,598
Additional HSW Capacity based on Maximum 14-d Flow (Minimum 15-d HRT), gpd	0	0	39,274	0
Additional HSW Capacity, gpd	0	0	39,300	0

Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	4
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Dewatering Capacity Calculations		

Problem Statement

Evaluate the existing capacity of dewatering process at the LTP for projected flows and loads.
Evaluate capacities with and without HSW in 2023 and 2053.
For purposes of capacity, assume City-provided hydraulic and solids loading capacity values from O&M manual and City's experience. No additional derating is assumed.

Unit Process Information

Design criteria and capacity limitations

Parameter	Design Criteria		Reference
Dewatering Equipment	Belt Press (BP)		
Manufacturer/Equipment	Ashbrook		
Belt Width	2	m	LTP biosolids dewatering manual
Hydraulic Loading Rate Capacity per Unit	200	gpm	per max range of satisfactory operation in LTP manual
Solids Loading Rate Capacity per Unit	38,400	lb/d	per max range of satisfactory operation in LTP manual (1,600 lb/hr per BP)
Total Quantity	4		LTP biosolids dewatering manual
Quantity with Redundancy	3		Assumes 1 standby unit for redundancy
Dewatering Feed Pump	Screw Induced Centrifugal		
Pumping Capacity per Pump	800	gpm	per max range of satisfactory operation in LTP manual
Total Quantity	2		LTP biosolids dewatering manual
Quantity with Redundancy	1		Assumes 1 standby unit for redundancy
Cake Pump	Progressive Cavity		
Pumping Capacity per Pump	20	gpm	average per seepex product data (20 gpm min and 30 gpm max)
Total Quantity	4		LTP biosolids dewatering manual
Quantity with Redundancy	3		Assumes 1 standby unit for redundancy
Performance Assumptions			
BFP Capture Efficiency	96	%	based on solids-water-energy balance from flow and loads task
Dewatered Biosolids TS	13	%	based on solids-water-energy balance from flow and loads task

Peaking Factors

Peaking factors developed based on historical data

Peaking Factor	30d	14d	7d	1d	Notes
BP Feed Flow	1.35	1.40	1.49	1.64	Based on 2013-2022 historical data
BP Feed TS Loading	1.24	1.26	1.33	1.99	Based on 2013-2022 historical data
BP Cake Flow	1.23	1.27	1.38	1.97	Based on 2013-2022 historical data

Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	4
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Dewatering Capacity Calculations		

BP Feed Predictions

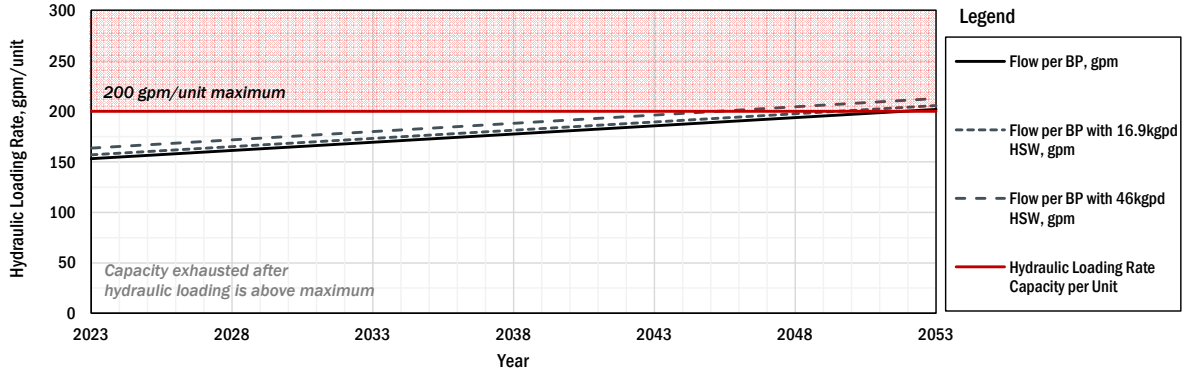
Calculations for maximum rates for comparison with capacity limitation and design criteria presented above. Appropriate flow and loading projections are stated.

	Average Annual		Maximum 7-d		Maximum 1-d	
Parameter	**2023**	**2053**	**2023**	**2053**	**2023**	**2053**
Flow to BP, gpd	402,884	531,775	600,297	792,345	660,729	872,111
TS load to BP, lb/d	29,833	39,377	39,677	52,371	59,367	78,359
HSW (16.9 kgpd) flow to BP, gpd	16,900	16,900	16,900	16,900	16,900	16,900
HSW (16.9 kgpd) TS load to BP, lb/d	1,456	1,456	1,456	1,456	1,456	1,456
HSW (46 kgpd) flow to BP, gpd	46,000	46,000	46,000	46,000	46,000	46,000
HSW (46 kgpd) TS load to BP, lb/d	3,964	3,964	3,964	3,964	3,964	3,964
Cake flow, gpd	22,893	30,217	31,592	41,700	45,099	59,528
HSW (16.9 kgpd) cake flow, gpd	1,118	1,118	1,118	1,118	1,118	1,118
HSW (46 kgpd) cake flow, gpd	3,042	3,042	3,042	3,042	3,042	3,042
Hydraulic Loading Rates with 3 Units Online						
Flow per BP, gpm	93	123	139	183	153	202
Flow per BP with 16.9kgpd HSW, gpm	97	127	143	187	157	206
Flow per BP with 46kgpd HSW, gpm	104	134	150	194	164	213
Cake pump flow, gpm	5.3	7.0	7.3	9.7	10.4	13.8
Cake pump flow with 16.9kgpd HSW, gpm	5.6	7.3	7.6	9.9	10.7	14.0
Cake pump flow with 46kgpd HSW, gpm	6.0	7.7	8.0	10.4	11.1	14.5
Solids Loading Rates with 3 Units Online						
TS load to BP, lb/d	9,944	13,126	13,226	17,457	19,789	26,120
TS load to BP with 16.9kgpd HSW, lb/d	10,430	13,611	13,711	17,942	20,274	26,605
TS load to BP with 46kgpd HSW, lb/d	11,265	14,447	14,547	18,778	21,110	27,441
Hydraulic Loading Rates with 4 Units Online						
Flow per BP, gpm	70	92	104	138	115	151
Flow per BP with 16.9kgpd HSW, gpm	73	95	107	140	118	154
Flow per BP with 46kgpd HSW, gpm	78	100	112	146	123	159
Cake pump flow, gpm	4.0	5.2	5.5	7.2	7.8	10.3
Cake pump flow with 16.9kgpd HSW, gpm	5.7	7.5	7.8	10.3	8.0	10.5
Cake pump flow with 46kgpd HSW, gpm	5.8	7.6	7.9	10.4	8.4	10.9
Solids Loading Rates with 4 Units Online						
TS load to BP, lb/d	7,458	9,844	9,919	13,093	14,842	19,590
TS load to BP with 16.9kgpd HSW, lb/d	7,822	10,208	10,283	13,457	15,206	19,954
TS load to BP with 46kgpd HSW, lb/d	8,449	10,835	10,910	14,084	15,833	20,581

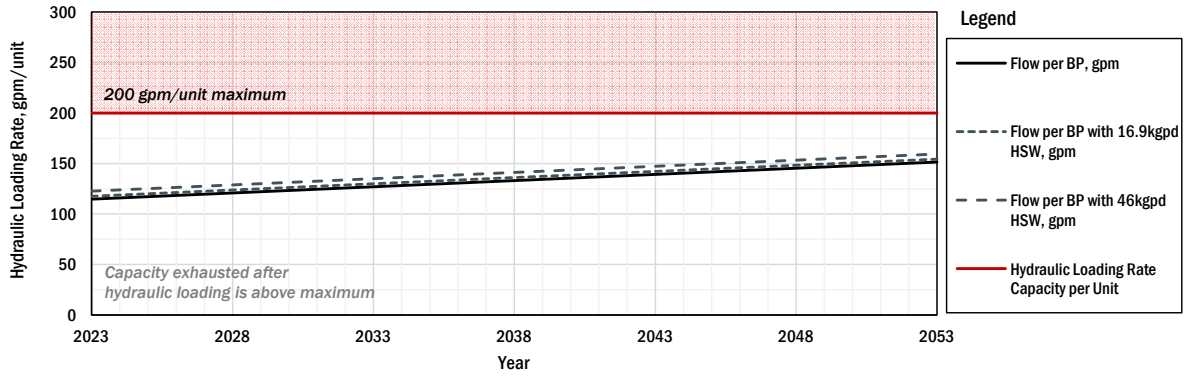
Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	4
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Dewatering Capacity Calculations		

Capacity Plots

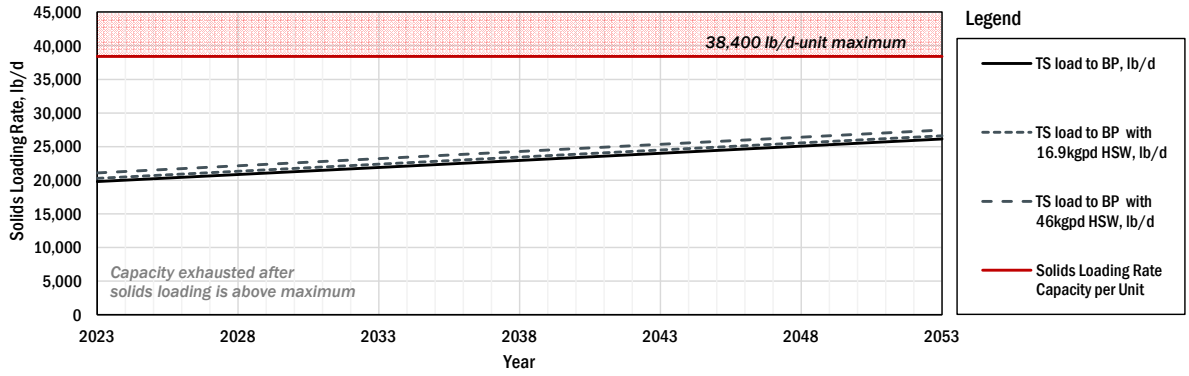
Hydraulic Loading Rate with 3 BP in Service at Maximum 1-day Flow



Hydraulic Loading Rate with 4 BP in Service at Maximum 1-day Flow

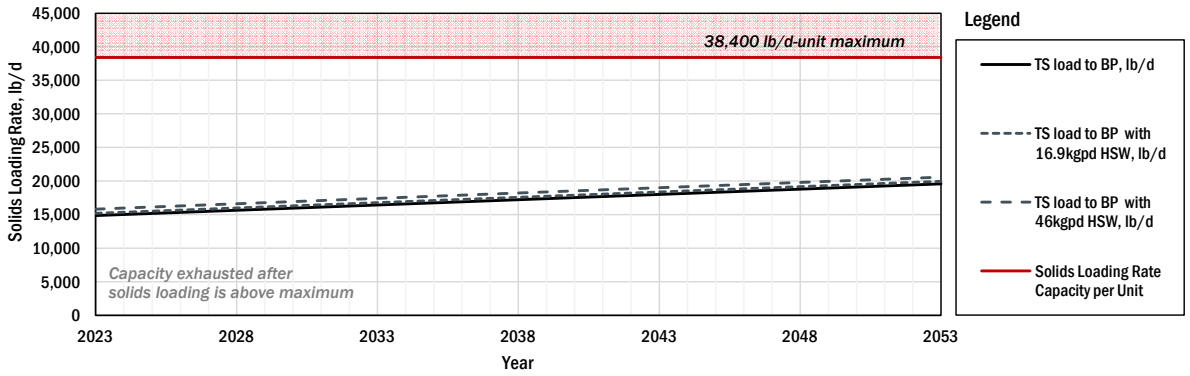


Solids Loading Rate with 3 BP in Service at Maximum 1-day Load

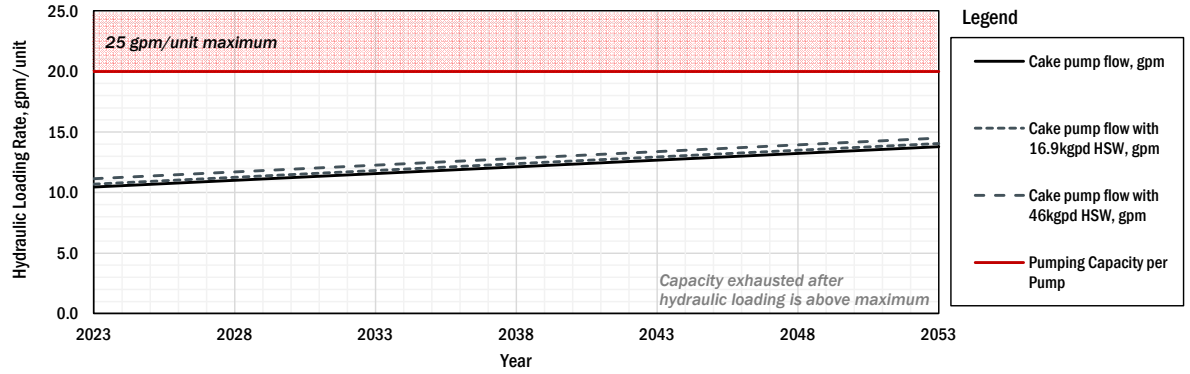


Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	4
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Dewatering Capacity Calculations		

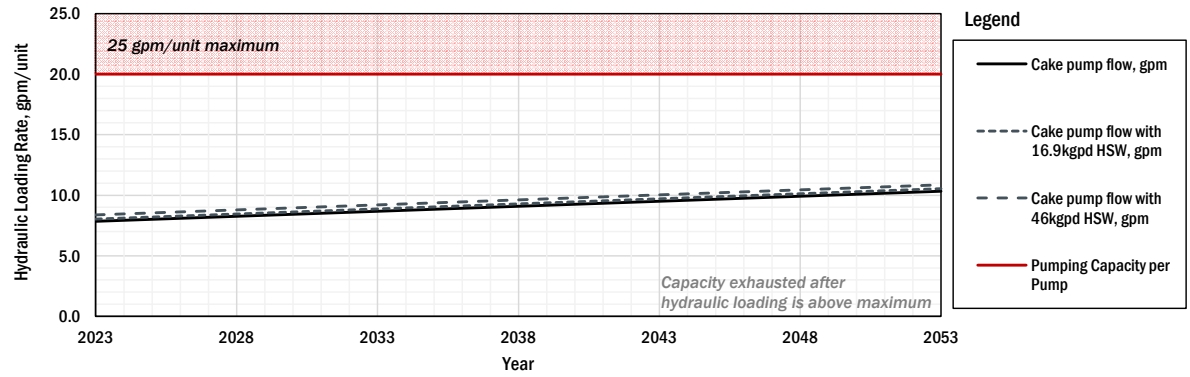
Solids Loading Rate with 4 BP in Service at Maximum 1-day Load



Hydraulic Loading Rate with 3 Cake Pumps in Service at Maximum 1-day Flow



Hydraulic Loading Rate with 4 Cake Pumps in Service at Maximum 1-day Flow



Interpolate to determine year at which capacity runs out based on PS+TWAS loading only	Year of Capacity Limitation	
Condition	**1 Unit Offline**	**All Units Online**
BP Hydraulic Loading Rate (HLR) Capacity	2052	2053+
BP Solids Loading Rate (SLR) Capacity	2053+	2053+
Cake Pumping Capacity	2053+	2053+
Dewatering Capacity	2052	2053+

Calculate capacity available for HSW	HSW Capacity with 1 Unit Offline		HSW Capacity with All Units Online	
Condition	**2023**	**2053**	**2023**	**2053**
Additional HSW based on BP Hydraulic Loading Rate (HLR) Capacity, gpd	>46,000	0	>46,000	>46,000
Additional HSW based on BP Solids Loading Rate (SLR) Capacity, gpd	>46,000	>46,000	>46,000	>46,000
Additional HSW based on Cake Pumping Capacity, gpd	>46,000	>46,000	>46,000	>46,000
Additional HSW Capacity, gpd-HSW	>46,000	0	>46,000	>46,000

Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	5
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Cake Hopper Storage Capacity Calculations		

Problem Statement

Evaluate the existing capacity of cake storage hoppers at the LTP for projected flows and loads.
Evaluate capacities with and without HSW in 2023 and 2053.

Unit Process Information

Design criteria and capacity limitations

Parameter	Design Criteria		Reference
Volumetric Storage Capacity	8,100	ft3	per LTP biosolids dewatering O&M manual
Weight Storage Capacity	280	tons	per LTP biosolids dewatering O&M manual
Number of Hoppers	1		
Performance Assumptions			
Minimum storage requirement	1.5	days	assumed as sufficient storage for scheduled daily hauling
Cake TS content	15	% TS	
Cake density	62.4	lb/ft3	assumed density of water. Lower densities observed for higher %TS due to air entrainment.

Peaking Factors

Peaking factors developed based on historical data

Peaking Factor	30d	14d	7d	1d	Notes
BP Cake Flow	1.23	1.27	1.38	1.97	Based on 2013-2022 historical data

Cake Loading and Hopper Storage Predictions

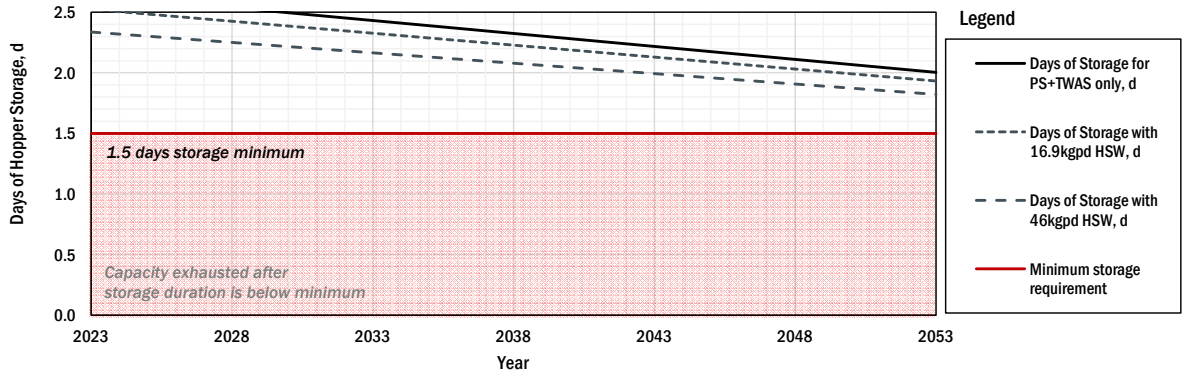
Calculations for maximum rates for comparison with capacity limitation and design criteria presented above. Appropriate flow and loading projections are stated.

	Average Annual		Maximum 7-d		Maximum 1-d	
Parameter	**2023**	**2053**	**2023**	**2053**	**2023**	**2053**
Cake loading to hoppers, wtpd	95	126	132	174	188	248
Cake volume to hoppers, ft3/d	3,060	4,039	4,222	5,573	6,028	7,956
HSW (16.9 kgpd) Cake loading to hoppers, wtpd	4.7	4.7	5	5	5	5
HSW (16.9 kgpd) Cake volume to hoppers, ft3/d	149	149	149	149	149	149
HSW (46 kgpd) Cake loading to hoppers, wtpd	13	13	13	13	13	13
HSW (46 kgpd) Cake volume to hoppers, ft3/d	407	407	407	407	407	407
Volumetric Loading Rate						
Cake from PS+TWAS only, ft3/d	3,060	4,039	4,222	5,573	6,028	7,956
Cake with 16.9kgpd HSW, ft3/d	3,209	4,188	4,372	5,723	6,177	8,105
Cake with 46kgpd HSW, ft3/d	3,466	4,445	4,629	5,980	6,434	8,363
Mass Loading Rate						
Cake from PS+TWAS only, wtpd	95	126	132	174	188	248
Cake with 16.9kgpd HSW, wtpd	100	131	136	179	193	253
Cake with 46kgpd HSW, wtpd	108	139	144	187	201	261
Maximum Storage Duration based on Volumetric and Mass Loading Rates						
Days of Storage for PS+TWAS only, d	2.6	2.0	1.9	1.5	1.3	1.0
Days of Storage with 16.9kgpd HSW, d	2.5	1.9	1.9	1.4	1.3	1.0
Days of Storage with 46kgpd HSW, d	2.3	1.8	1.7	1.4	1.3	1.0

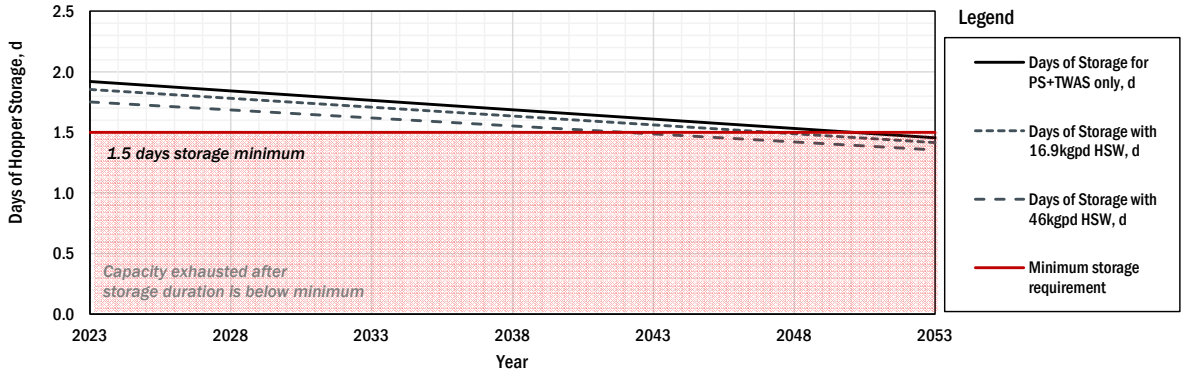
Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	5
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Cake Hopper Storage Capacity Calculations		

Capacity Plots

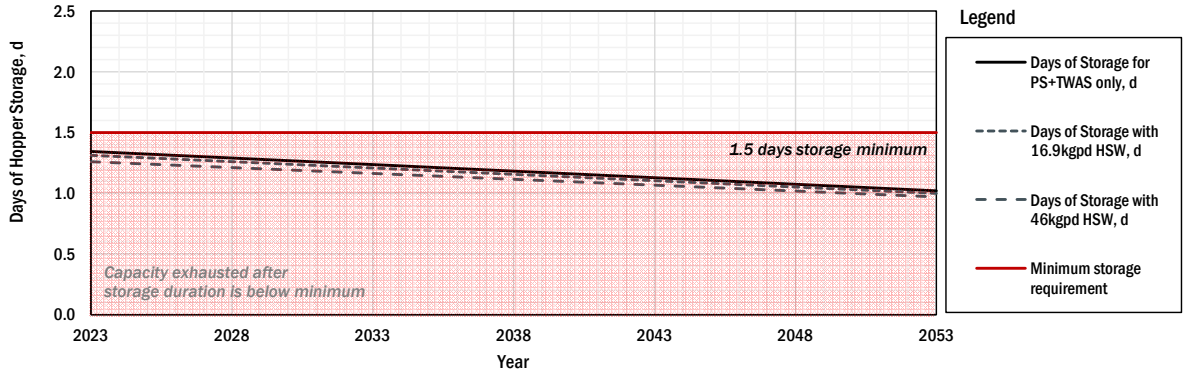
Storage Capacity for Annual Average Conditions



Storage Capacity for Maximum 7-d Conditions



Storage Capacity for Maximum 1-d Conditions



Interpolate to determine year at which capacity runs out based on PS+TWAS loading only	Year of Limitation
Condition	**Hopper**
Average annual storage capacity	2053+
Maximum 7-d storage capacity	2050
Maximum 1-d storage capacity	2023
Capacity Limitation	2023

Additional Capacity for HSW, gpd	
2023	2053
>46,000	>46,000
>46,000	0
0	0
0	0

Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	6
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Biogas Conditioning System and Flare Capacity Calculations		

Problem Statement

Evaluate the existing capacity of biogas conditioning system (GCS) and flare at the LTP based on biogas projections.
Evaluate capacities with and without HSW in 2023 and 2053.
Evaluated GCS and flare based on rated capacities in scfm. The GCS system is also modeled separately to evaluate limitations based on pressure predictions.

Unit Process Information

Design criteria and capacity limitations

Parameter	Design Criteria		Reference
Iron Sponge Rated Flow Capacity	365	scfm	per vendor submittal
Blower Rated Flow Capacity	365	scfm	per submittal (icfm =inlet cfm, assumed as scfm)
Dual Core Heat Exchanger Rated Flow Capacity	347	scfm	per vendor submittal
Siloxane Removal Rated Flow Capacity	365	scfm	per vendor submittal
Flare Rated Flow Capacity	660	scfm	per vendor submittal

Peaking Factors

Peaking factors developed based on historical data. The peak 3-hr and 1-hr biogas flows were updated to 1.3 and 1.5.

Peaking Factor	7d (d/AA)	1d (d/AA)	3hr (hr/d)	1hr (hr/d)	Notes
Digester biogas flow	1.20	1.33	1.30	1.50	Based on 2017-2022 historical data

Biogas and GCS Predictions

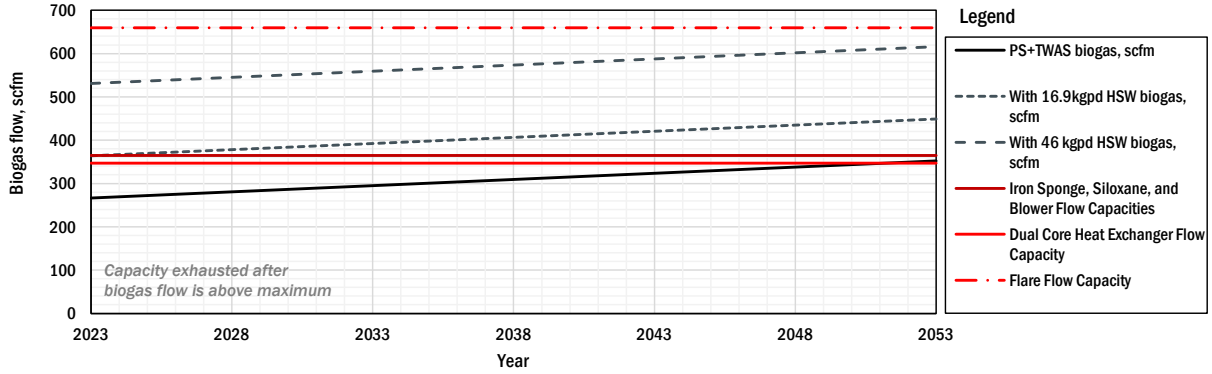
Calculations for maximum rates for comparison with capacity limitation and design criteria presented above. Appropriate flow and loading projections are stated.

	Average Annual		Maximum 1-d		Maximum 1-hr	
Parameter	**2023**	**2053**	**2023**	**2053**	**2023**	**2053**
Biogas flow from PS+TWAS, scfm	267	352	354	467	531	700
Biogas flow from 16.9kgpd HSW, cfm	97	97	97	97	97	97
Biogas flow from 46kgpd HSW, cfm	264	264	264	264	264	264
Biogas Production						
PS+TWAS biogas, scfm	267	352	354	467	531	700
With 16.9kgpd HSW biogas, scfm	364	449	451	564	628	797
With 46 kgpd HSW biogas, scfm	531	616	618	731	795	964
GCS and Flare Capacities						
Iron Sponge Capacity	365	365	365	365	365	365
Dual Core Heat Exchanger Capacity	347	347	347	347	347	347
Siloxane Removal Capacity	365	365	365	365	365	365
Flare Capacity					660	660

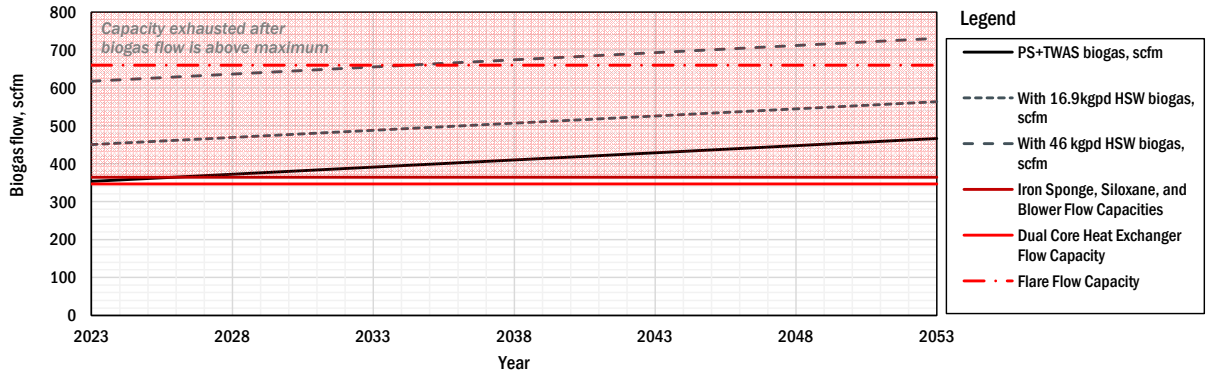
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6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	6
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Biogas Conditioning System and Flare Capacity Calculations		

Capacity Plots

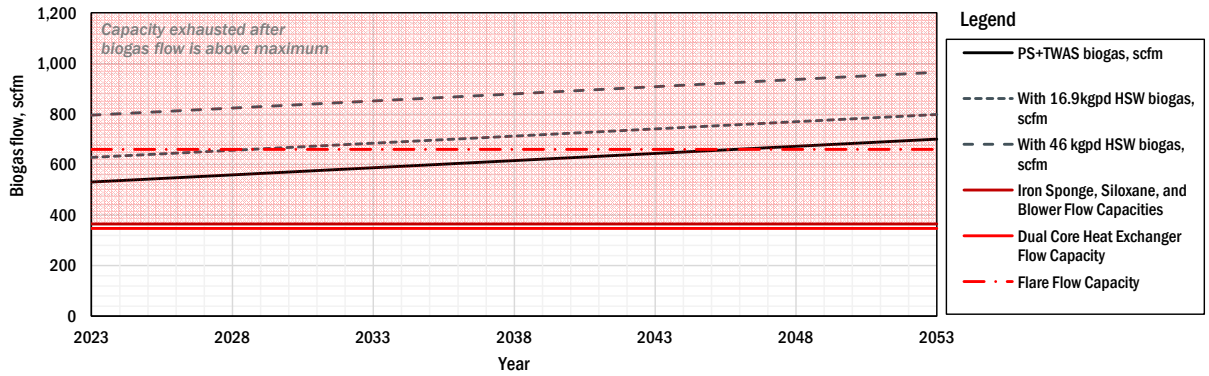
Capacity of Units Rated based on SCFM at Average Annual Conditions



Capacity of Units Rated based on SCFM at Peak 1-day Conditions



Capacity of Units Rated based on SCFM at Peak 1-hour Conditions



Capacity limitation for annual average conditions

	Year of Capacity Limitation		
Unit Process in Gas Conditioning System	**PS+TWAS**	**w/16.9 kgpd HSW**	**w/ 46 kgpd HSW**
Iron Sponge Capacity	2053+	2023	2023
Blower Capacity	2053+	2023	2023
Dual Core Heat Exchanger Capacity	2051	2023	2023
Siloxane Removal Capacity	2053+	2023	2023
Flare Capacity	2053+	2053+	2053+
GCS Capacity	2051	2023	2023

Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	6
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Biogas Conditioning System and Flare Capacity Calculations		

Capacity limitation for Max 1-day conditions

	Year of Capacity Limitation		
Unit Process in Gas Conditioning System	**PS+TWAS**	**w/16.9 kgpd HSW**	**w/ 46 kgpd HSW**
Iron Sponge Capacity	2026	2023	2023
Blower Capacity	2026	2023	2023
Dual Core Heat Exchanger Capacity	2023	2023	2023
Siloxane Removal Capacity	2026	2023	2023
Flare Capacity	2053+	2053+	2034
GCS Capacity	2023	2023	2023

Capacity limitation for Max 1-hour conditions

	Year of Capacity Limitation		
Unit Process in Gas Conditioning System	**PS+TWAS**	**w/16.9 kgpd HSW**	**w/ 46 kgpd HSW**
Iron Sponge Capacity	2023	2023	2023
Blower Capacity	2023	2023	2023
Dual Core Heat Exchanger Capacity	2023	2023	2023
Siloxane Removal Capacity	2023	2023	2023
Flare Capacity	2046	2029	2023
GCS Capacity	2023	2023	2023

Date Checked	Checked By	Job Number	By	Date	Calc No
6/15/2023	Tom Chapman	157568-006-002	M. Armenta	5/22/2022	7
Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Combined Heat and Power Engine Capacity Calculations		

Problem Statement

Evaluate the existing capacity of CHP engines at the LTP for Influent+HSW projections.

Assume 2 sets of 2 engines for the capacity evaluation. If selective catalytic reduction (SCR) is added to 2 more engines, analysis could result in greater capacity.

Unit Process Information

Design criteria and capacity limitations

Parameter	Design Criteria		Reference
Number of Engines	4		
Number of Engines with SCR	2		
Required minimum pressure	2.9	psig	
Fuel capacity consumption per unit	9.32	MMBTU/hr	
Performance Assumptions			
Biogas LHV	550	BTU/scf	based on solid-water-energy balance, rounded
Natural Gas LHV	950	BTU/scf	based on solid-water-energy balance, rounded
Natural Gas Blending Rate	12%	of biogas	based on historical data, relative to biogas production

Peaking Factors

Peaking factors developed based on historical data

Peaking Factor	30d	14d	7d	1d	Notes
Digester biogas flow	1.14	1.16	1.20	1.33	Based on 2017-2022 historical data

CHP Engine Fuel Predictions

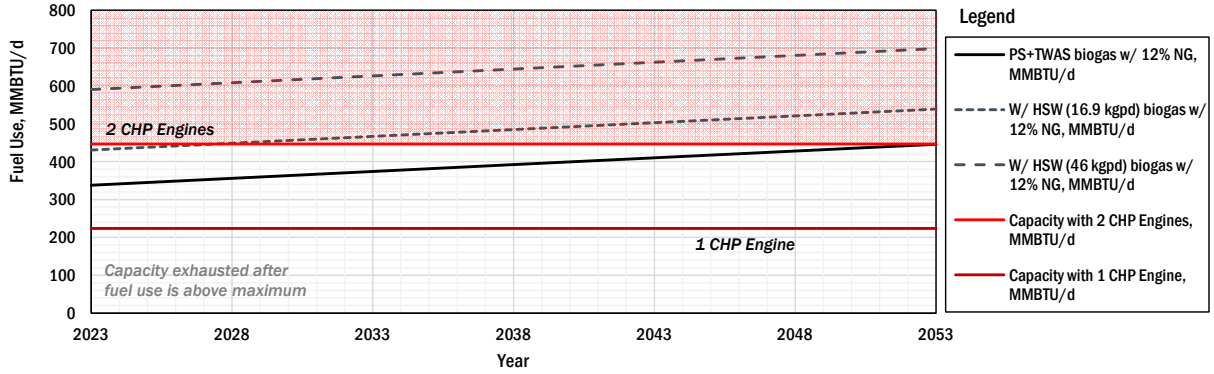
Calculations for maximum rates for comparison with capacity limitation and design criteria presented above. Appropriate flow and loading projections are stated.

	Average Annual		Maximum 7-d		Maximum 1-d	
Parameter	**2023**	**2053**	**2023**	**2053**	**2023**	**2053**
PS+TWAS biogas, scfm	267	352	320	423	354	467
With 16.9kgpd HSW biogas, scfm	364	449	417	520	451	564
With 46 kgpd HSW biogas, scfm	531	616	584	687	618	731
MMBTU production per day, including natural gas						
PS+TWAS biogas w/ 12% NG, MMBTU/d	255	337	306	404	338	446
W/ HSW (16.9 kgpd) biogas w/ 12% NG, MMBTU/d	348	429	399	497	431	539
W/ HSW (46 kgpd) biogas w/ 12% NG, MMBTU/d	508	589	559	657	591	699
Engine Capacities						
Capacity with 1 CHP Engine, MMBTU/d	224	224	224	224	224	224
Capacity with 2 CHP Engines, MMBTU/d	447	447	447	447	447	447
Capacity with 3 CHP Engines, MMBTU/d	671	671	671	671	671	671
Capacity with 4 CHP Engines, MMBTU/d	895	895	895	895	895	895

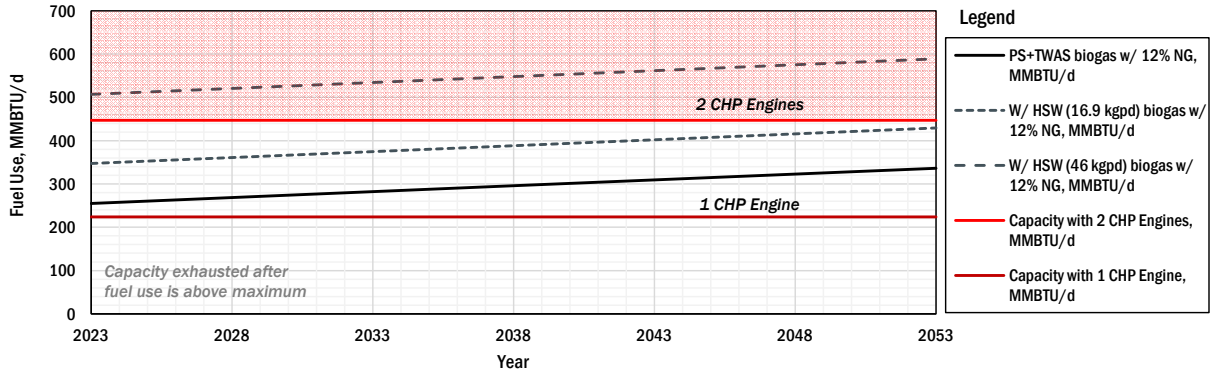
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Project			Subject		
Santa Rosa BMSP Capacity Evaluation			Combined Heat and Power Engine Capacity Calculations		

Capacity Plots

Fuel Capacity of Engines at Peak Day Biogas and Natural Gas Use



Fuel Capacity of Engines at Annual Average Biogas and Natural Gas Use



Capacity limitations	Year of Capacity Limitation		
Condition	**PS+TWAS**	**with 16.9 kgpd HSW**	**with 46 kgpd HSW**
2 CHP Engines at Average Annual Conditions	2053+	2053+	2023
2 CHP Engines at Peak Day Conditions	2053+	2028	2023
3 CHP Engines at Average Annual Conditions	2053+	2053+	2053+
3 CHP Engines at Peak Day Conditions	2053+	2053+	2045

Appendix B: TM2 Condition Assessment and Evaluation

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BMSP Cap Impr Impl Plan Final

Brown AND Caldwell

201 North Civic Drive, Suite 300
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T: 925.937.9010

Technical Memorandum
FINAL

Prepared for: City of Santa Rosa

Project Title: Biosolids Management Strategic Plan

Project No.: 157568.007.003

Technical Memorandum 2

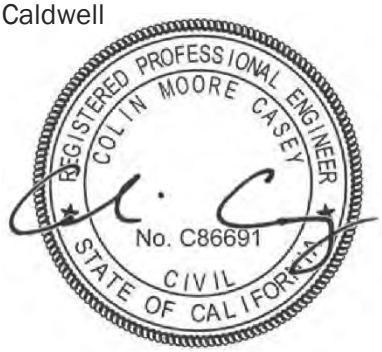
Subject: Condition Assessment and Evaluation

Date: July 11, 2023

To: Tetyana Mokvyts, P.E., Project Manager, City of Santa Rosa

From: Alison Nojima, P.E., Project Manager, Brown and Caldwell

Prepared by: _____
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Limitations:

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Section 1: Introduction

The City of Santa Rosa (City) is developing a biosolids management strategic plan (BMSP) for the Laguna Treatment Plant (LTP) to provide short- and long-term options to achieve the City's goals to:

- Reduce operational costs
- Mitigate future regulatory risks
- Provide solutions that best meet the needs of the regional community
- Maintain operational flexibility
- Incorporate and align with the City's Climate Action Plan
- Determine the best use of the composting facility

The BMSP will provide recommendations for the solids treatment system, including replacements, optimizations, or improvements. The BMSP will culminate with a capital implementation plan (CIP) for the City to use as a roadmap for the next 20 years.

The BMSP includes the following tasks and technical memorandums (TM):

- **Flows and Loads and Capacity Evaluation (TM1)** – projects flows and loads and evaluates capacity.
- **Condition Assessment and Evaluation (TM2)** – documents the condition and recommendation for rehabilitation and replacement (R&R) of biosolids unit processes.
- **Regulatory Review and Market Assessment (TM3)** – evaluates market conditions for regional solutions.
- **Biosolids Screening and Alternatives Evaluation (TM4)** – evaluates and identifies optimal solutions using a 30-year lifecycle cost analysis.

The project flow chart in Figure 1-1 shows how each task fits into the larger context of the BMSP. Each task is followed by a workshop to ensure the City's BMSP goals are being met during each phase of the project.

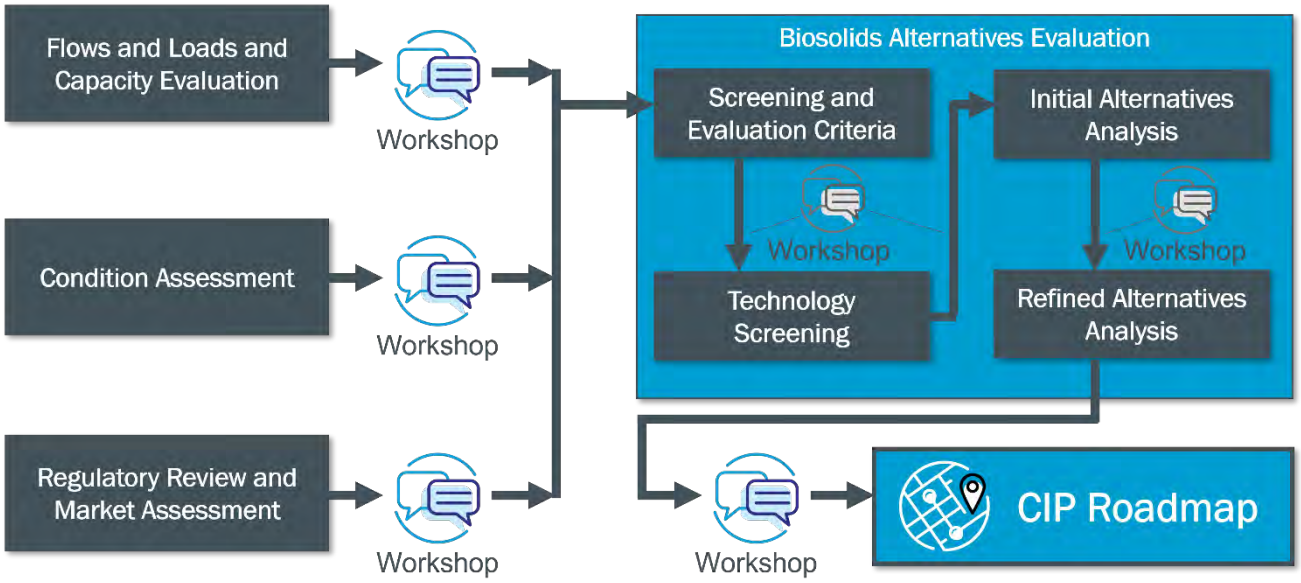


Figure 1-1. Project flow chart

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The purpose of the condition assessment task is to complete a comprehensive evaluation of selected biosolids assets and unit processes at the LTP and to identify repair and replacement (R&R) projects. Ultimately, the recommended R&R projects will be prioritized alongside projects identified in other BMSP tasks.

This Condition Assessment and Evaluation TM includes the following sections:

1. **Introduction** – presents an overview of the purpose and content of the TM.
2. **Approach** – summarizes the approach, scope, assessment funnel, and risk matrix.
3. **Methods** – outlines BC's condition assessment methods, including likelihood of failure (LoF) and consequence of failure (CoF) assessment scoring criteria, method descriptions, weighting factors, and observation forms used by BC's multi-disciplinary condition assessment team.
4. **Visual Observations** – provides a summary of BC's visual observation findings of the assets and structures observed during a site visit; the summary includes notes, photos, and recommendations.
5. **Results and Recommendations** – summarizes BC's condition assessment results, including the estimated remaining useful life, observed condition, LoF and CoF scores, and risk scores. It also includes a list of R&R projects recommended to be included in the BMSP CIP Roadmap.

Section 2: Approach

Section 2 outlines BC's approach to the LTP condition assessment. It summarizes BC's condition assessment scope, assessment team, condition assessment funnel, and risk matrix. For the assessment, BC used a risk-based approach that considers the LoF and CoF of biosolids assets and structures at the LTP. Results include a list of high-risk assets and structures in need of R&R. Guidelines for LoF and CoF scoring were developed to standardize the assessment scoring across the assessment team and to identify assets for further evaluation and R&R.

2.1 Project Scope

BC's condition assessment scope for the BMSP included a review of the LTP's existing solids handling and treatment processes based on available as-built drawings, historical data, and reports. The assessment also included a 1-day site visit by a multi-disciplinary condition assessment team to perform visual observations, followed by a desktop evaluation of the assets observed and recorded during the site visit. The following assumptions were included in BC's condition assessment scope.

- Field data, observations, and photos were collected through BC's Fulcrum mobile application tool.
- City staff familiar with the unit processes included in the scope accompanied BC during the site visit and were available for questions.
- Visual observations were made from walkways and platforms that did not require fall protection or confined space entry. No physical testing was performed.
- The condition assessment was based on visual observations of the portions of assets that could be viewed without removing it or other equipment, and was based on the viewed portions only.
- The City was responsible for providing the age and maintenance history of all assets and structures to be assessed.
- Seismic evaluations were not included.

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2.2 Condition Assessment Funnel

BC employed a multi-phase "funnel" approach for its condition assessment efforts. The approach, depicted in Figure 2-1, was developed using three phases of condition assessment, including a Level 1 Desktop Evaluation, Level 2 Visual Observations, and a Level 3 Physical Assessment. Typically, a Level 1 Desktop Evaluation is completed first with a broad review of a client's asset database, followed by a shorter list of assets requiring visual observations and physical testing. For this project, however, Level 2 Visual Observations were completed first on a select list of biosolids assets and structures, followed the desktop evaluation of these assets. A Level 3 Physical Assessment, often requiring a shutdown of unit processes and destructive assessment methods, was not performed. The cost of Level 3 Physical Assessments is also typically much greater than Level 1 and Level 2, often requiring support from a general contractor or specialty firm to perform inspections and testing of equipment and materials. During each phase of assessment, a narrower scope of assets allows the team to focus on high risk, high priority assets.

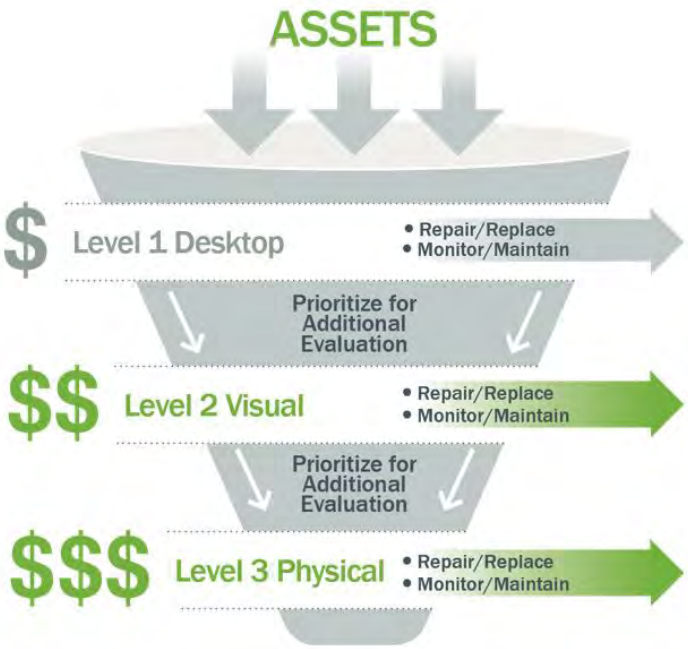


Figure 2-1. Multi-phase condition assessment funnel

2.3 Risk Matrix

Within the context of condition assessment, risk is defined as the "likelihood" that an asset or structure is unable to provide the function for which it was installed, combined with the "consequence" that results from that asset's failure. Risk scores are the product of an asset's LoF and CoF scores (LoF x CoF); higher risk scores correlate to higher risk, whether it be LoF-based, CoF-based, or a combination of the two. An example of this is shown in the risk matrix in Figure 2-2. Each circle within the risk matrix represents an asset, and the green, orange, and red areas in the matrix represent increasing levels of risk. Assets with the least risk are those shown in the bottom left quadrant of the risk matrix, and those with the greatest risk are those shown in the top right quadrant.

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Figure 2-2. Sample asset risk matrix

Thresholds for LoF and CoF scores were established to determine what combination of scores would be recommended for various response actions and prioritization. The response actions were divided into four risk matrix zones. Assets that had a low LoF and CoF score (located in Zone 1 in lower left corner of the risk matrix) would not require an immediate response, while assets with a high LoF and CoF score (located in Zone 4 in the upper right corner of the risk matrix) may be recommended for further assessment, monitoring, or R&R. These responses include varying levels of maintenance strategies and recommendations. A sample risk matrix with risk zones is shown in Figure 2-3, and includes:

- **Risk Zone 1: Low Priority.** These assets have low LoF and CoF scores and are managed through routine and normal operations and maintenance (O&M) strategies. These assets have a low risk of failing and either have sufficient redundancy or are not critical to operations.
- **Risk Zone 2: High Priority.** These assets have a high LoF score and a low CoF score and require a mix of reactive and proactive O&M activities. Because they have a low CoF, routine inspection is not required as frequently as assets that have a high CoF.
- **Risk Zone 3: Critical, Low Risk.** These assets have a low LoF score and a high CoF score and require routine condition monitoring. Because these assets are critical to operations and/or do not have sufficient redundancy, proactive planning for condition monitoring is highly recommended.
- **Risk Zone 4: Critical, High Risk.** These assets have high LoF and CoF scores and have the highest risk of failure of all assets. These assets require routine inspection and condition monitoring and planning for R&R.

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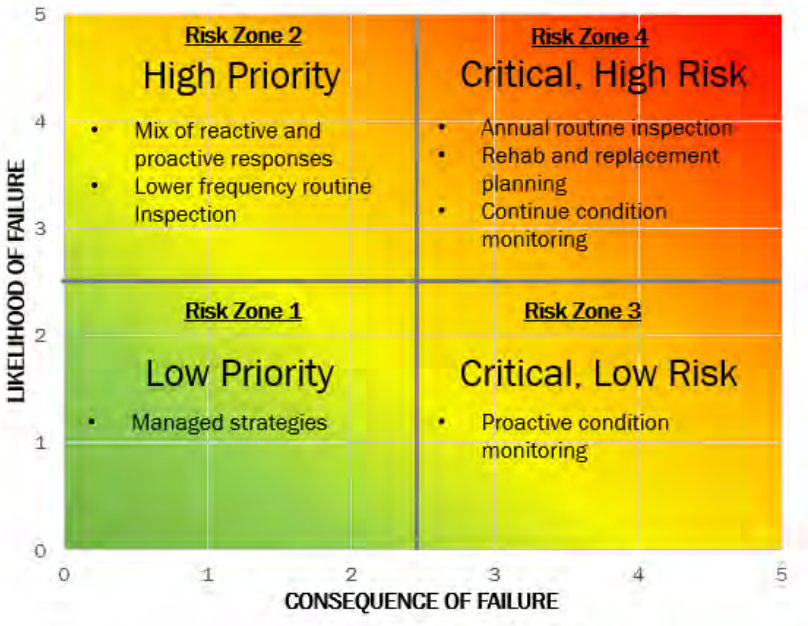


Figure 2-3. Risk matrix zones and response actions

Section 3: Methods

Assessing the risk of failure requires evaluating the combination of an asset's LoF and CoF. For this assessment, asset failure was defined as the inability of the asset to provide the function for which it was intended. This section identifies the condition assessment areas included in this project's scope of work and the establishment of LoF and CoF scoring criteria and weighting factors used to the determine the risk of failure of the assets inspected.

3.1 Priority Areas

This condition assessment focused on the LTP's solids handling and treatment assets and structures. Assets in and associated with these unit processes included the following areas:

- High strength waste (HSW) receiving station
- Ferric chloride storage
- Septage receiving station
- Primary sludge pumps
- Waste activated sludge (WAS) pumps
- Anaerobic digesters
- Gravity belt thickeners (thickening process)
- Belt presses (dewatering processes)
- Cake pumps and storage
- Gas conditioning system and piping
- CHP engines and emission control systems
- Biogas flare
- Compost facility

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Process-based assets within these areas were prioritized and included process equipment, pumps, tanks, electrical equipment, and visible concrete channels and structures. Smaller assets, such as instrumentation, controls, and appurtenances were not prioritized. Buried assets or assets requiring confined-space entry for visual observation were not assessed.

3.2 Biosolids Asset Data

For this assessment, an asset database was developed for the assets in the priority unit process areas that were then assessed during Level 2 Visual Observations. Assets in a database are typically classified by an asset identification number, physical location (i.e., process area), sub-location(s), asset/equipment type, installation year, description, maintenance history/work orders, specific manufacturer information, etc. Specifically for this assessment, assets were tagged by their asset description and process area and were categorized as being a mechanical, electrical, or structural, according to their asset/equipment type or function and which discipline lead led the assessment. The highest number of assets at wastewater treatment facilities tend to be electrical, instrumentation, and mechanical by nature, with a fewer number of large structures and buildings.

3.3 Likelihood of Failure

A number of criteria may be used to estimate the LoF of a certain asset. For the purposes of this assessment, the LoF scoring criteria took into consideration an asset's estimated remaining useful life, current physical condition, redundancy, and discipline-specific observation score, with input from City staff. A summary of LoF criteria scoring descriptions and the weighting factors used to calculate the LoF criteria score is defined in Table 3-1.

The steps followed to estimate an asset's LoF included:

1. Identifying the asset during Level 2 Visual Observations.
2. Confirming with the City the age, condition, redundancy, and any known issues of the asset.
3. Reviewing each scoring criterion and reviewing the criterion description to determine what best describes the situation for that specific asset.
4. Calculating remaining useful life based on the asset's installation date and typical useful life.
5. Assigning a score (1 to 5 with 1= best and 5= worst) to each LoF criteria based on discussions with City staff and available information.
6. Confirming each criterion's weighting factor with the City.
7. Multiplying each LoF criterion score by its corresponding weighting factor.
8. Calculating the sum of the individual weighted LoF scores to obtain the final overall LoF score for that asset, which will range from 1 to 5.

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Table 3-1. LoF Criteria and Weighting Factors						
		Criteria Score				
Criteria	Weight	1	2	3	4	5
Remaining Useful Life	0.2	Greater than 75% of typical life	Between 51% and 75% of typical life	Between 26% and 50% of typical life	Between 1% and 25% of typical life	Less than 1% of typical life
Condition	0.3	Excellent – New or like-new condition	Good – Cosmetic defects but in good working order, maintenance not anticipated	Fair – Asset needs or will soon need rebuilding or replacing	Poor – Replacement or rebuilding is required. Failure is imminent.	Out of Service – Asset is longer in service and needs to be replaced
Redundancy	0.2	Full redundancy for peak operating and service condition	Full redundancy for average operating and service condition	Full redundancy for low operating and service condition	Some redundancy	No redundancy
Visual Observation	0.3	Dependent on discipline-specific observation criteria				

3.3.1 Remaining Useful Life

The "remaining useful life" criterion considers the time remaining until an asset ceases to provide the required service level. The estimated remaining useful life helps in determining when an asset should be replaced and was developed to help identify highest-risk assets. For this assessment, the remaining useful life is estimated based on the age of an asset from a base year of 2023 using industry-standard typical lives for different types of equipment and structures. Assets with a lower remaining useful life are typically considered more likely to fail. For example, if the remaining useful life of an asset has less than 1 percent of its typical life remaining, a score of 5 would be selected. Conversely, if an asset had 75 percent or more of its typical life remaining, a score of 1 would be selected. A weighting factor of 0.2 was selected for the remaining useful life calculation.

BC compiled typical life estimates from numerous sources and developed for assets included in the database developed during Level 2 Visual Observations. The typical lives assume an asset is maintained and operated per the manufacturer's recommendation and is typically used in the absence of asset condition data. The typical lives used for this assessment by equipment type are included in Table 3-2.

Table 3-2. Typical Life of Assets by Equipment Type			
Equipment Type	Typical Life (years)	Equipment Type	Typical Life (years)
Actuator – Valve	25	Gate - Slide	30
Air Handling Unit - Small wall-mounted	25	Gate - Sluice	30
Air Handling Unit - Large (Supply, exhaust)	25	Gear Reducer	25
Analyzer	12	Generator - Cogeneration	20
Auto Transfer Switch	25	Generator - Standby, Diesel Engine	20
Barscreen - Bar and Rack	25	Generator - Emergency Portable	20
Blower/Compressor - Centrifugal	25	Grinder - Digested Sludge	17
Blower/Compressor - Rotary Screw	25	Grit Auger unit	20
Blower/Compressor - Rotary Vane	20	Grit Screening dewatering unit	20

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Table 3-2. Typical Life of Assets by Equipment Type			
Equipment Type	Typical Life (years)	Equipment Type	Typical Life (years)
Boiler - Gas fired	27	Heat exchanger - oil	15
Boiler - Hot water	27	Heat exchanger - water	12
Boiler - Oil fired	27	Hydraulic Lubrication system	25
Burner - Waste gas	15	Hydraulic Operator	25
Centrifuge	13	Hydraulic Press	25
Chiller	25	Hydraulic System Skid	25
Chlorinator	25	Indicator - Flow level	12
Clutch - Electromagnetic/eddy current	27	Indicator - Pressure	12
Compressor - Reciprocating, Large Capacity	25	Indicator - Temperature control	12
Compressor - Reciprocating, Methane gas	25	Injector	15
Compressor - Reciprocating, All others	25	Level control system	12
Controller	15	Mixer - Centrifugal	25
Control Valve	25	Mixer - Static	25
Conveyor	20	Motor - Greater than 5 hp	25
Crane	30	Motor - Greater than 5 hp and low speed (500)	30
Cyclone	20	Motor Control Center	30
Dryer – Air	25	Odor Control unit	12
Ejector	20	Odor Reduction Tower	25
Evaporator	20	Panel - Bubbler	15
Feeder - Dry Chemical	15	Panel - Lighting	25
Belt filter press	22	Panel - Local control	25
Fire alarm panel	12	Panel - Power distribution	25
Flow recorder	10	Panel - annunciator	15
Flowmeter – Magnetic	15	Power Supply	20
Flowmeter	12	Pressure vessel	25
Gravity Belt Thickener	20	SCADA	12
Programmable controller	15	Scale - Truck	25
Pump, centr. - Small circulating close coupled units	15	Scrubber systems	25
Pump, centr. - 60 mgd and above (raw sewage)	40	Skimmer - Mechanical	20
Pump, centr. - Recessed Impeller type (WEMCO)	30	Strainer - Water	25
Pumps - All others, centr.	27	Structures – concrete	50
Pump – Chemical	10	Switchgear	30
Pump – Diaphragm	10	Tank - Chemical	25
Pump – Hydraulic	20	Tank - collector drive unit	25
Heat exchanger – air	15	Pump - Lobe/Gear	15

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Table 3-2. Typical Life of Assets by Equipment Type			
Equipment Type	Typical Life (years)	Equipment Type	Typical Life (years)
Pump – Metering	12	Transmitter - Flow level	12
Pump - Portable with trailer	15	Transmitter - Pressure	12
Pump - Progressive Cavity	20	Turbidity Meter	12
Pump - Sump, 5 hp or Less	20	Uninterruptable Power Supply	12
Pump - Sump, greater than 5 hp	25	Valves – 4-inch and smaller	25
Pump - Vertical Turbine	25	Valves – 4-inch and larger	20
Remote Terminal Unit	10	Variable Frequency Drive	12
Samplers	15	Vibration Monitor	10
Transformers	25		

Source: Water Environment Research Foundation, "Design Life Table," Remaining Effective Life Tool, 2011, http://simple.werf.org/simple/media/relt/howTo.html (January 2019).
hp = horsepower
mgd = million gallons per day

3.3.2 Condition

The "condition" criterion considers known defects and/or issues such as performance issues, capacity limitations, historical corrective and reactive maintenance, and/or historical failures. Condition information was gathered based on discussions with City staff during the Level 2 visual inspections. Assets that were no longer in service or in of replacement were scored a high condition score of 5, while assets that were new or in like-new condition were scored the lowest condition score of 1. Assets in need of minor repair or rebuilding were identified as being in fair condition and scored a 3. A weighting factor of 0.3 was selected for condition since visual observations were considered a reliable data source and provided a higher level of confidence than other LoF criteria, such as remaining useful life.

3.3.3 Redundancy

The "redundancy" criterion considers the redundancy of an asset or structure under specific operating conditions. For example, if the asset or structure has redundancy under peak operation and service conditions, a redundancy of 1 would be scored. If no redundancy is provided, a redundancy of 5 would be scored. A weighting factor of 0.2 was selected, equivalent to the remaining useful life criterion. While not always feasible, redundancy can provide reassurance that an asset or system will not fail by allowing interchangeable operation between assets, which is often required during routine maintenance activities.

3.3.4 Visual Observation

The "visual observation" criterion considers specific assessment criteria only available to BC's condition assessment team during the Level 2 Visual Observations. Observation forms were developed to standardize scoring for each mechanical, electrical, and structural assessor. Observation criteria varied for each discipline and included standard equipment evaluation criteria, such as equipment vibration, temperature, noise, corrosion, leakage, odor, and visible damage to assets and structures. Example visual observation forms are provided in Tables 3-3, 3-4, and 3-5. Similar to the "condition" criterion, an overall weighting factor of 0.3 was selected for visual observations.

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Table 3-3. Process Mechanical Observation Form

Criteria	Evaluation	Weight	Observation Score		
			1 = Excellent	3 = Fair	5 = Very Poor
Vibration	Vibration of equipment	0.2	No or normal vibration	Some vibration, no apparent damage	Excessive vibration, visible damage
Abnormal temperature	Observed overheating of equipment	0.1	No	--	Yes
Noise (including cavitation, belt, coupling)	Noise level while operating	0.2	Normal	Moderate noise level	Severe noise level
Corrosion	Surface and structural loss	0.1	<10% Surface only	10% to 50% Evaluate for recoating	>50% Asset is compromised
Leakage	Gaskets/Connections/Holes	0.2	None, historic	Drip Only	Stream
Smell	Chemical, burning, etc.	0.2	Normal	--	Abnormal

Table 3-4. Electrical Observation Form

Criteria	Evaluation	Weight	Observation Score		
			1 = Excellent	3 = Fair	5 = Very Poor
Corrosion (boxes, panels, structure)	Surface and structural loss	0.2	<10%, none or surface only	10% to 50%, significant but not compromising asset	>50%, asset is compromised
Covers, panel doors	Damage, missing	0.1	Good	Moderate Damage	Missing, major damage
Leakage	Dielectric fluid	0.2	None, historic	-	Leaks, puddles
Visible damage	Evidence of high heat	0.2	None	-	Visual or smell of arc flash or burns
Loose/unsupported conduit	Signs of improperly secured conduit	0.1	No		Yes
Exposed conductors	Signs of exposure, e.g., cut, frayed, cracked, split, uncovered, etc.	0.2	No	-	Yes

Table 3-5. Structural Observation Form

Criteria	Evaluation	Weight	Observation Score				
			1 = Excellent	2 = Good	3 = Fair	4 = Poor	5 = Very Poor
Corrosion, steel	Surface and structural	0.2	None or minor spot corrosion only (no section loss)	<10% Surface corrosion (no section loss)	10% to 25%, Moderate corrosion with minimal impact to structural capacity (<2% section loss)	>25% Heavy corrosion with impact to structural capacity (2% to 10% section loss)	Significant corrosion affecting structural capacity (>10% section loss)
Spalling, concrete	Exposed aggregate, pitting, delamination, freeze/thaw damage (surface area)	0.2	None or minor	<10%	10% to 25%	>25% to 50%	>50%
Cracking	Cracking (width of crack)	0.2	None or hairline	Minor cracking with cracks < 1/16 inch	Moderate cracking with cracks <1/16 inch	Significant cracking with cracks >1/16 – 3/8 inch	Extensive cracking with some cracks >3/8 inch
Leakage	Cracks/joints/penetrations	0.2	None or historic	Dampness	Drip only	Running leak	Significant loss of contents
Exposed rebar	Exposed reinforcement, surface	0.2	None	Minimal (<2%)	2% to 10%	>10% to 20%	>20%

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3.3.5 LoF Scoring Example

The following example shows how LoF criteria, scores, and weights were applied to an asset following the LoF scoring approach outlined above. For this example, the City's biogas flare installed in 2010 was evaluated. For scoring purposes, the following assumptions and rationale are provided for each criterion:

- **Remaining Useful Life** – the biogas flare was installed in 1990 and has a typical useful life of 30 years. The remaining useful life would be calculated as follows: $Remaining\ useful\ life = 30 - (2023 - 1990) = -3\ years$. Based on this information, the biogas flare is assigned a score of 5 for this criterion because it is past its typical life remaining.
- **Condition** – the biogas flare requires minimal maintenance; however, some corrosion of the biogas flare is apparent. Based on this information, the biogas flare is in fair condition and assigned a score of 3.
- **Redundancy** – there is no redundancy in the biogas flare system, as this is the only flare available when digester gas cannot be sent to the City's cogeneration system. Given that this single biogas flare must always be available, a redundancy score of 5 is assigned.
- **Visual Observation** – the biogas flare was observed by a mechanical inspector, and thus inspection criteria for process mechanical assets was used. Given the flares' observed vibration, temperature, noise, corrosion, leakage, smell, and safety were all fair, the mechanical inspector assigned a score of 3.

As shown in Table 3-6, the individual scores for each criterion are multiplied by its respective weighting factor. The sum of the individual weighted LoF scores is the assigned LoF score for this chemical storage tank example.

Table 3-6. LoF Scoring Example

LoF Criteria	Criteria Score	Weight	LoF Score
Remaining Useful Life	3	0.2	0.6
Condition	3	0.3	0.9
Redundancy	5	0.2	1.0
Visual Observation	3	0.3	0.9
		Total LoF Score	**3.4**

3.4 Consequence of Failure

Individual assets play varying roles across the LTP, each having their own level of importance in providing a safe, regulatory and permit-compliant, and well-operating plant. The consequence of an asset's failure varies based on numerous factors. Standardized CoF criteria provide a methodology to identify critical assets and were used to help prioritize R&R projects and maintenance programs. The CoF criteria used for this assessment included the risk to public and employee safety, the risk of environmental and/or regulatory non-compliance, and the effect an asset would have on a unit process area if it failed. A summary of CoF criteria scoring descriptions and weighting factors is defined in Table 3-7.

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The steps followed to determine an asset's CoF included:

1. Identifying the asset that will be evaluated from the asset inventory.
2. Reviewing each scoring criterion and reviewing the criterion description to determine what best describes the situation for that specific asset.
3. Assigning a score (1 to 5 with 1 = best and 5 = worst) to each criterion. For this assessment, CoF criteria were scored with City staff during the Level 2 Visual Observations.
4. Confirming each criterion's weighting factor with the City.
5. Multiplying each CoF criterion score by its corresponding weighting factor.
6. Calculating the sum of the individual weighted CoF scores to obtain the final overall CoF score for that asset, which will range from 1 to 5.

Table 3-7. CoF Scoring Criteria and Weighting Factors

Criteria	Weight	Criteria Score				
		1	2	3	4	5
Public and Employee Safety	0.4	No injury	--	Minor injury	--	Serious injury or death
Regulatory Compliance	0.3	No violation	--	Potential violation	--	Violation(s)
System Disruption	0.3	Single process or treatment system disruption	--	Adjacent process or treatment system disruption	--	Facility wide disruption

3.4.1 Public and Employee Safety

The "public and employee safety" criterion considers failures that may result in injury to the community, staff, visitors, and/or contractors. Assets whose failure can lead to injuries or fatalities are considered to have a high consequence of failure. A weighting factor of 0.4 was selected since providing a safe and healthy workplace is extremely important and therefore given the highest weight.

3.4.2 Regulatory Compliance

The "regulatory compliance" criterion considers failures that may result in violation of regulatory and/or discharge permitting requirements. Assets whose failure can lead to reportable violations, enforcement actions, fines, and/or legal action are considered to have a high CoF. A weighting factor of 0.3 was selected since meeting regulatory and permit requirements is extremely important.

3.4.3 System Disruption

The "system disruption" criterion considers failures that may result in impacts at other levels of the asset hierarchy. Impacts may be localized (i.e., single asset or system) or widespread (i.e., plant, City). Assets whose failure impacts other assets, systems, and/or facilities are considered to have a higher CoF. A weighting factor of 0.3 was selected since reliability criteria address the City's ability to reliably treat wastewater.

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3.4.4 CoF Scoring Example

The following example shows how CoF criteria, scores, and weights were applied to an asset at the LTP. For this example, the City's existing biogas flare system was evaluated. For scoring purposes, the following assumptions and rationale are provided for each criterion:

- **Workplace and Public Safety** – While not anticipated, a failure of LTP's biogas flare could potentially cause injury requiring hospitalization if operators, visitors, or contractors were exposed to extreme heat or gas caused by a gas leak or explosion. Based on this information, the biogas flare is assigned a score of 5 for this criterion.
- **Regulatory Compliance** – A failure of the biogas flare would violate the City's air permit with a potential enforcement action. Based on this information, the biogas flare is assigned a score of 5 for this criterion.
- **System Disruption** – A failure of the biogas flare would impact adjacent treatment processes, including the City's anaerobic digesters. Based on this information, the biogas flare is assigned a score of 3 for this criterion.

As shown in Table 3-8, the individual scores are each multiplied by the weighting factors for each criterion. The sum of the individual weighted CoF scores is the final overall CoF score assigned to the biogas flare system. All assets associated with this system are then assigned the same CoF score.

Table 3-8. CoF Scoring Example

CoF Criteria	Criteria Score	Weight	CoF Score
Public and Employee Safety	5	0.4	2.0
Regulatory Compliance	5	0.3	1.5
System Disruption	3	0.3	0.9
		Total CoF Score	**4.4**

3.5 Asset Risk

Each asset's risk score was defined as the "likelihood" that an asset or structure was unable to provide the function for which it was installed, combined with the "consequence" resulting from that asset's failure.

3.5.1 Risk Score

An asset's risk score is the product of an asset's LoF and CoF scores, both scored on a 1 to 5 scale, for a max (high risk) score of 25. The risk score for our biogas flare example would thus be 3.4 multiplied by 4.4, which results in a risk score of 14.96. Because of the high LoF score and a high CoF score, our biogas flare example falls in Risk Zone 4, with a recommendation of rehab/replacement planning, as shown in Table 3-9 and in the example risk matrix in Figure 3-1.

Table 3-9. Risk Score Example

Asset Name	LoF Score	CoF Score	Risk Score	Risk Zone	Recommendation
Biogas flare	3.4	4.4	14.96	4 – Critical High Risk	Rehab/Replacement Planning, routine inspection, continue condition monitoring

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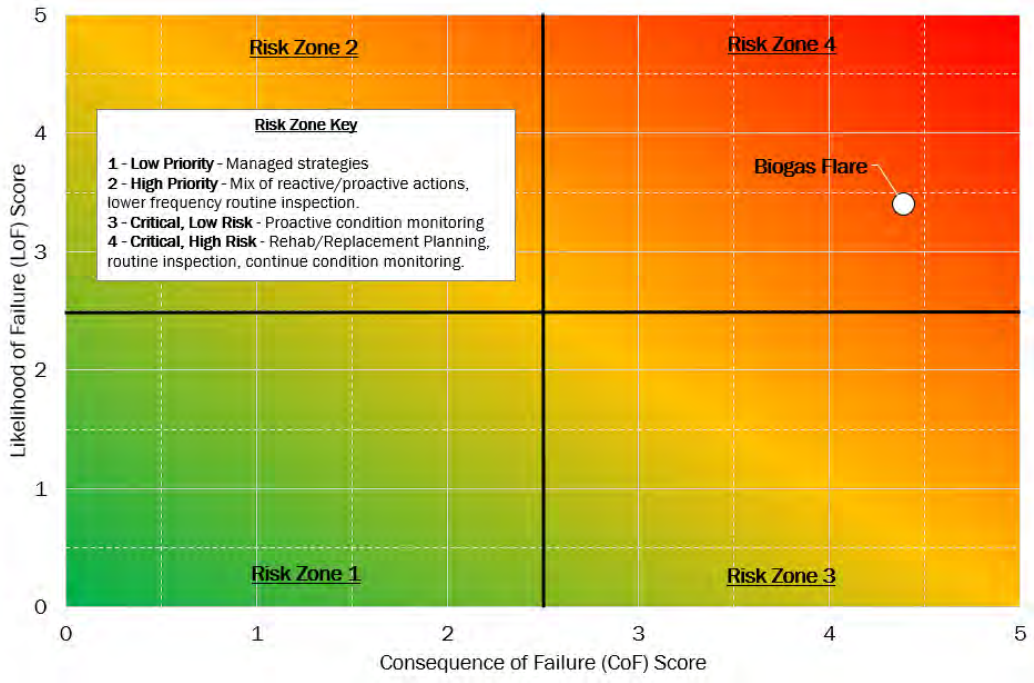


Figure 3-1. Example risk matrix

Section 4: Visual Observations

This section details BC's visual observation findings, photos, and recommendations for each unit process area observed. Visual observations were performed during BC's site visit on January 18, 2023, with support from City staff. Observations were conducted by BC's multi-disciplinary condition assessment team (mechanical, electrical, structural) from accessible locations (e.g., walkways, stairways, and platforms) with assets and process systems in their operational state. Observations did not require confined-space entry, physical testing, or sampling. Visual observations provided an opportunity for the City to describe maintenance activities, issues, and concerns, and to discuss an asset's installation year, rehabilitation history, condition, and remaining useful life. Information gathered was used to help calculate the asset's LoF and CoF score and to identify projects for R&R. Visual observation photos, findings, and recommendations are documented for each unit process area by each discipline and are included in the following subsections.

A list of the unit process areas included in this condition assessment is provided in Table 4-1.

Table 4-1. Unit Process Area included in Visual Observations

HSW receiving facility	WAS pumps	Cake pumps and storage	Compost facility
Septage receiving station	Anaerobic digesters	Gas conditioning system and piping	
Ferric chloride	Gravity belt thickeners	Cogeneration (CHP engines)	
Primary sludge pumps	Belt presses	Biogas flare	

A site map/aerial image of the LTP that highlights each unit process area and the location from which assets were collected is included in Figure 4-1. Each red dot in the figure represents where an asset record was created during visual observation.

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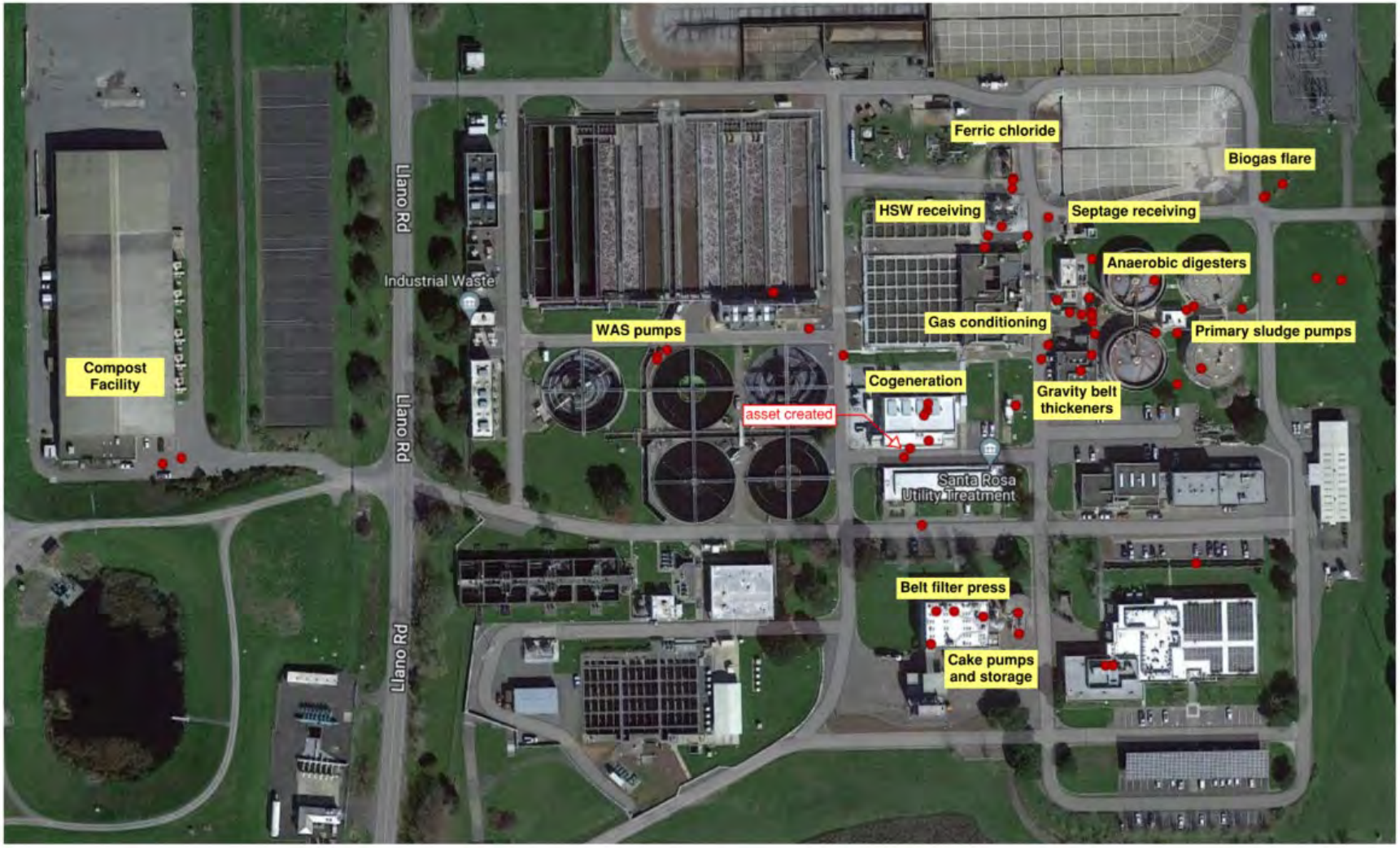


Figure 4-1. LTP aerial image showing location of biosolids asset records created during visual observations

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4.1 HSW Receiving Facility

BC designed the HSW receiving facility, which was constructed in 2015. The system was installed to receive HSW from local restaurants and food processors to increase digester gas production and cogeneration potential at the LTP. The system includes two 4-inch truck connections, two rock traps and fill and recirculation pumps, and four stainless steel (SS) tanks with a volume of 12,000 gallons (gal) each. The system also includes a foul air system, including a single odor control fan and vessel. Photographs of the HSW storage tanks are included in Figure 4-2.



Figure 4-2. HSW receiving facility

4.1.1 Mechanical

The HSW tanks and equipment were observed to be in good condition. Tank capacity may be limiting in the future if trucked waste is to increase at the plant. Most of the exposed SS piping was also observed to be in good condition. City staff did note, however, there have been some issues with clogging when taking in some HSW. The HSW foul air system is underperforming, and a secondary odor scrubber vessel and fan is recommended to be installed in-series to meet future foul air capacity requirements.

4.1.2 Electrical

Motor control center (MCC) MCC 3C-U powers the HSW area equipment. The MCC is an Eaton Freedom 2100 Series that was installed in 2016 and is in good condition. The remote input/output cabinet contains a Siemens Simatic ET 200M modular input/output system. City staff noted that this was recently replaced in 2023 and believed the original installation from 2016 failed due to corrosion.

4.1.3 Structural

The HSW area was noted as being in good condition with no structural deficiencies identified.

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4.1.4 Recommendations

HSW odor scrubber improvements will be needed to meet future foul air capacity requirements. Capacity of HSW tanks should be further evaluated in the BMSP Alternatives Evaluation.

4.2 Septage Receiving

The septage receiving station is located across the street from the HSW system and includes a hopper, bar screen, and dumpster within a concrete containment area, with piping delivering septage from septage truck deliveries to the plant's headworks. A photograph of the septage receiving station is shown in Figure 4-3.



Figure 4-3. Septage receiving station

4.2.1 Mechanical

The hopper, bar screen, and piping at the septage receiving station all have corrosion and are in good to poor working condition, given their location/environment. The dumpster appears to be in poor condition and should be replaced soon. Equipment should continue to be monitored and inspected in the future if operational or maintenance issues increase.

4.2.2 Electrical

There is no electrical equipment in this area.

4.2.3 Structural

There were cracks noted in the slab and the walls around septage receiving and were observed to be wide enough to allow water to penetrate. Water entering the cracks will eventually cause corrosion of the reinforcement and shorten the lifespan of the structure, which is mostly concrete.

4.2.4 Recommendations

BC recommends continued monitoring of the hopper, bar screen, and piping equipment. Cracks in the slab and walls should be sealed.

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4.3 Primary Sludge Pumps

There are eight primary sludge pumps, all progressive cavity, that pump sludge from the LTP's eight primary clarifiers to the anaerobic digesters. All eight primary sludge pumps are installed adjacent to one another within the same gallery in route to the digester control building galleries. Figure 4-4 presents photos of the primary sludge pumps.

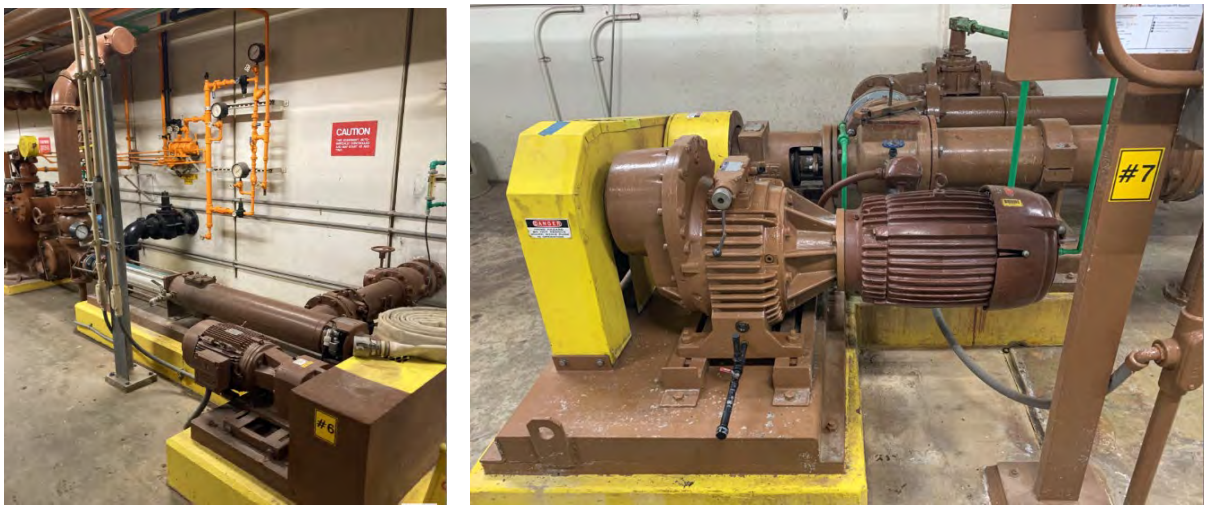


Figure 4-4. Primary sludge pumps 6 and 7

4.3.1 Mechanical

All pumps appear to be in good condition with minor coating defects. Primary sludge pumps 1 through 6 were installed in 2012 and are older than primary sludge pumps 7 and 8.

4.3.2 Electrical

The primary sludge pumps are powered from motor control centers MCC-2B and MCC-2G. Both MCCs are Square D – Model 6 and were installed in 2011. Plant staff had modified the variable-frequency drive (VFD) buckets for each pump to add custom air filters. Both MCCs are in good condition and have at least 10 to 15 years of useful remaining life. A Westinghouse dry-type lighting transformer feeds the Square D NQOD type lighting panel C. Both are in fair condition; however, they are past their estimated useful life, as they were installed in 1998.

The primary programmable logic control (PLC) cabinet (PLC-5) contains a Siemens Simatic S7-300 PLC which was installed in 2011. Plant staff advised that this model will be discontinued this year but that spare parts will be available until 2033.

4.3.3 Structural

No structural concerns were noted with pump pads or supports. There were some structural issues observed with the digester gallery walls within the tunnel. This issue will be noted as a separate structural observation under the digester unit process area.

4.3.4 Recommendations

There are no general mechanical or structural recommendations for this system. The City should replace panelboard C and lighting transformer C, as they are past their expected useful life.

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4.4 WAS Pumps

The WAS pumping station includes two self-priming centrifugal pumps. Both pumps sit on a pad northwest of secondary clarifier 6C with an intake in the mixed liquor (ML) channel. The pumps send WAS from the ML channel to the gravity belt thickeners (GBT). Figure 4-5 presents photos of the WAS pumping station and PLC.



Figure 4-5. WAS pumps and WAS PLC

4.4.1 Mechanical

The WAS pumps were noted to be in good working condition; however, in their current installation they do not achieve or produce the rated pump capacity. The City would like to identify methods to improve pumping capacity so they can pump more WAS back to the GBTs. The City noted they currently get approximately 420 gallons per minute (gpm) from each WAS pump. One method to increase WAS pumping capacity would be to lower the existing WAS pumps by 3 to 5 feet in the same location. This would lower the suction lift of the pump and should result in improving pumping efficiency and capacity. Additional pumping analysis and review of the existing WAS pump curves is still needed. For this installation, temporary WAS pumps would need to be installed while the existing WAS pumps were removed and reinstalled at the lower elevation, likely in a new WAS dry pit. Another method would be installing submersible non-clog centrifugal pumps off the edge of the ML channel using the existing piping back to the GBTs. The concern with submersible pumps in the ML channel would be additional O&M. Inspection of the WAS piping system was not included in this assessment.

4.4.2 Electrical

Switchboard 3H supplies power to the two WAS pump VFDs and other equipment in this area. The GE Spectra Series Switchboard was installed in 2010 and is in good condition. Both WAS pump VFDs are Allen-Bradley PowerFlex 70 Series that are housed in a cabinet near the primaries. The VFDs are in good condition but are nearing the end of their useful life as they were installed in 2010.

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The WAS pump station PLC (PLC-25) is a Siemens Simatic S7-1200 Series that was installed in 2013. This model is the most current of the Siemens' product line.

4.4.3 Structural

No structural concerns noted with WAS pump pads or supports.

4.4.4 Recommendations

If additional WAS pumping capacity is warranted for further evaluation, the City should consider lowering the existing WAS pumps to a lower elevation in the same location or installing new submersible centrifugal non-clog pumps off the edge of the ML channel.

4.5 Anaerobic Digesters

The LTP has four anaerobic digesters that stabilize solids as part of the overall wastewater treatment process. Each digester receives sludge from the LTP's primary clarifiers, thickened WAS from the GBTs, and HSW from the HSW receiving facility. Digesters 1 and 2 have floating covers and were constructed in the mid-1970's, and digesters 3 and 4 have fixed covers and were constructed in the late 80s/early 90s. Each digester has an approximate storage volume of 1 million gallons. Figure 4-6 presents a photo of digester 3's exterior and cracking within the digester gallery walls.



Figure 4-6. Anerobic digester 3 and cracking of digester gallery walls

4.5.1 Mechanical

Digester gas piping and the pressure release valves on each digester appear to be in good condition. The digester gas mixing system on each digester is past its useful life and replacement should be considered. For digester dewatering, a single 400 gpm rated capacity pump is available; however, the pump is past its useful life and has no redundancy. The dewatering pump is also oversized, which causes it to run inefficiently at its lowest speed. A replacement of the dewatering pump with two equal-sized smaller pumps at half the capacity, with overhead motors, is recommended. Access to replace the dewatering pump in the existing pump room beneath the digester gallery will be challenging due to restricted access and size of the room. The City notes that dewatering pump improvements are a high priority and should be made as soon as possible.

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4.5.2 Electrical

The digester area equipment is powered by motor control centers MCC-12R and MCC-6K. Brown Boveri Co manufactured MCC-12R in 1980, and the model has been discontinued no spare parts are available. MCC-6K is a Westinghouse Series 1200 that was installed in 1991. Both MCCs are in fair condition but are past their useful life. Lighting Transformer H and Panelboard H are both manufactured by Sylvania and were installed in 1976, so both are past their useful life. The transformer is in poor condition as water had been leaking on top, which has rusted. A drip shield was installed above it to better protect it.

The Digester PLC (PLC-18) is a Siemens Simatic S7-300 that was installed in 2010. Plant staff advised that this model will be discontinued this year but that spare parts will be available until 2033.

4.5.3 Structural

Within the digester 1 gallery, expansion joint sealant has failed in many locations and requires replacement. Some cracks are wide enough to require repair. Within the digester 3 gallery, the joint between the digester wall beam and gallery ceiling has staining from groundwater entering through the joint. Expansion joint material was noted as falling out of the joint. The wall in digester 4's gallery has a number of cracks that show signs of previous leakage. Based on discussion with the City, significant leaks were present last time digester 4 was filled with water for cleaning. A strip of membrane coating was installed on the interior of the cracks for minor repair. Leaks not sealed by the membrane coating self-healed or plugged after being filled with sludge according to the City. The area of the sidewalk that surrounds the digesters showed signs of settlement and has pulled farther away from the digester wall. Exterior digester walls had spalling and cracking issues. The City recently removed large portions of the stucco as a safety measure.

It was observed that groundwater was entering the digester gallery area between digesters 3 and 4 through a buried conduit pipe that enters the gallery through the east wall. In the gallery adjacent to digester 3, a separation of the expansion joint and a loss of sealant was visible. Sealant at this expansion joint has pulled away from one side of the joint and is no longer functioning properly.

4.5.4 Recommendations

BC recommends further evaluating replacement of the digester mixing system. We also recommend installing two new dewatering pumps to replace the single over-sized dewatering pump that lacks redundancy. We recommend replacing MCC-12R and MCC-6K, as they are both beyond their useful life. The panelboard and transformer H should also be replaced as they are both beyond recommended useful life.

Structural recommendations include epoxy-injecting the observed cracks in the digester gallery walls. Joints between the ceiling of the digester gallery and below-grade wall should be repaired. Backer rod and sealant should be installed at the joints between the digester walls and concrete slabs outside. Expansion joint sealant should be replaced, and the adjacent cracks should be routed out and injected with epoxy. Further investigation should be made to identify the location of water ingress into the conduit, or to seal the end of the conduit, which is allowing the leaking into the digester gallery.

4.6 Gravity Belt Thickeners

There are three GBT installed in the gravity thickener building for WAS dewatering, each with a rated capacity of 340 gpm. GBT 3 is used for digester recuperative thickening when only three of four digesters are in operation. Figure 4-7 presents photos of one of the GBTs and of a wall beam crack within the GBT building.

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Figure 4-7. GBT and wall beam crack

4.6.1 Mechanical

GBTs 1 and 2 were recently rebuilt by the City with new rollers; GBT 3 still has the same components as when it was originally installed. Installation dates were not confirmed prior to this report.

There is a spare pad for a fourth GBT next to GBTs 1-3. Although the GBTs were observed as being in good condition, the City notes there is a lack of capacity and redundancy, related to digester management. For thickened WAS sludge pumping, there are two thickened WAS sludge pumps in the building that are past their expected useful life and recommended for replacement. The City noted they will be installing new polymer blend units and polymer storage tank soon for WAS thickening.

4.6.2 Electrical

Motor control center MCC-11P provides power to the GBT equipment. The MCC is a Westinghouse Five Star model installed in 1987; it is in fair condition, but the equipment is past its useful expected life. Lighting panelboards and transformers L1 and L2, manufactured by Westinghouse, were installed in 1987. They are in fair condition but also past their useful expected life. The GBT PLC (PLC-20) is a Siemens Simatic S7-300 model installed in 2015. Plant staff advised that this model will be discontinued this year but that spare parts will be available until 2033.

4.6.3 Structural

Hairline cracking was observed in the header beam over the coiling door, the exterior side of the building's wall columns, and floor slab. Cracks were observed in the floor slab, with some having widths sufficient to justify sealing to prevent water intrusion. A vertical crack was also observed through the concrete masonry unit block in the building's south wall. A vertical hairline crack in the wall beam above and slightly offset from the larger wall crack was observed. This is not currently a significant structural concern as the crack widths are hairline; however, if the hairline crack widths increase, a repair or sealant may be required.

4.6.4 Recommendations

The City could consider installing a fourth GBT after confirming future capacity requirements and WAS pumping capacity is increased. The existing thickened WAS pumps should be replaced as they are past their useful life. MCC-11P, lighting panelboards L1 and L2, and lighting transformers L1 and L2 should also be replaced as they are past their useful life. Structural cracks within the building should continue to be monitored and corrective action should be taken if cracks begin to widen. Cracks in the floor slab that have a large-enough width to allow water intrusion should be sealed by the City. A new sealant between the floor and wall joints is also recommended.

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4.7 Belt Press

There are four belt filter presses (BFP) in the Biosolids Dewatering building. These assets are called belt presses (BP) by the City. Each BP is accessible from the second floor of the building, with a designated cake pump installed immediately below it on the first floor. The LTP typically operates only two BPs at a time at 60 to 80 gpm each. Figure 4-8 presents photos of a BP and concrete spalling within the Biosolids Dewatering building.



Figure 4-8. BP and concrete spalling in Biosolids Dewatering building

4.7.1 Mechanical

The BPs were observed to be in good condition with no maintenance issues noted by City staff. City staff indicated that the BP dewatering capacity was greater than the LTP's current dewatering demand and that the BP system was inefficient.

4.7.2 Electrical

MCC-22-T-1 and MCC-22-T-2 provide power to the BP equipment. Both MCCs are Siemens Tiastar model and were installed in 1975. They are both in fair condition, however, they are past their estimated useful life. It was noted that water had been leaking onto MCC-22-T; however, this has seen been resolved by the City through roofing improvements. The BP PLC cabinet (PLC-13) is a Siemens S7-300 that was installed in 2015. The City advised that this model will be discontinued this year, but that spare parts will be available until 2033. There is also a console in the control room nearby that was installed in 1988 and is in fair condition. This still controls some of the equipment in that area. Each BP also has its own control cabinet with Siemens Simatic S7-1200 PLCs and Siemens Simatic HMIs. This model is the most current of the Siemens' product line. The control cabinets appear to be in good condition.

4.7.3 Structural

The Biosolids Dewatering building was observed to be in fair to good condition. One significant area of concern is the spalling in the floor slab of the top floor and the associated crack that extends through the slab and seen from the floor below. The floor joint sealant at the expansion joint and floor slab has deteriorated and is no longer functioning to prevent water from seeping into the joint. Corrosion was visible on the exposed floor slab reinforcement.

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4.7.4 Recommendations

A replacement of MCC-22-T-1 and MCC-22-T-2 and the aging control console is recommended, along with an integration of controls and logic to PLC-13. Structural recommendations include a repair of the damaged concrete and floor slab, and that backer rod and sealant be installed at the building's expansion joints.

4.8 Cake pumps and storage

Progressive cavity cake pumps are paired with each BP, which results in four cake pumps. Each cake pump is installed below the BP on the first floor of the Biosolids Dewatering building. The biosolids hopper is located outside and south of the Biosolids Dewatering building as a separate standalone structure with three shoots for truck loading. Figure 4-9 presents photos of one of the BP cake pumps and storage hopper.



Figure 4-9. Cake pump and storage hopper

4.8.1 Mechanical

Each BP is equipped or paired with a progressive cavity cake pump that sends dried cake from the BP to the biosolids hopper. The existing cake pumps have difficulty handling the solids content and require water to be added through an injection ring so that pumps can operate more efficiently. The addition of water to the dried solids increases the weight of the biosolids hauled, which results in increased hauling costs. BC recommends the City consider replacing the existing cake pumps with Schwing Bioset piston pumps or an alternative that can transport the dried solids more efficiently without adding water. The standalone biosolids hopper system outside the BP building was observed to be in good condition.

4.8.2 Electrical

Lighting panelboards TL-1, TL-2, and TL-3 power the cake pump and storage equipment. Panelboards TL-1 and TL-2 are Siemens I-T-E type that were installed in 1988. The associated lighting transformer (TT-1 and TT-2) are I-T-E Branded and were installed in the same year. Both sets of panelboards are in fair condition but are past their useful expected life. Panelboard TL-3 is a Square D NQOD Series, and its associated Square D branded transformer was installed in 2005. Both are in good condition.

Each cake pump has a local control panel that contains Eaton SVX 9000 VFDs. The control panels were installed in 2005, so the VFDs are nearing the end of their useful life.

4.8.3 Structural

A separate structural assessment of the cake pumps and hopper system was not performed.

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4.8.4 Recommendations

The City consider replacing the cake pumps with Schwing Bioset piston pumps, or an alternative that can transport the dried solids more efficiently without adding water, to reduce biosolids hauling costs.

4.9 Gas Conditioning System and Piping

The LTP's gas conditioning system treats and conveys digester gas from the anaerobic digesters to the City's cogeneration system at the CHP building. The gas conditioning system includes two hydrogen sulfide removal vessels (i.e., iron sponge vessels), digester gas heat exchangers, boosters, blowers, and gas cooling chillers. The system also includes three siloxane removal vessels, particulate filters, and a pressure regulating valve before sending gas to the cogeneration engines at the CHP building. Figure 4-10 presents photos of the digester gas piping between the gas conditioning system and the two iron sponge vessels.



Figure 4-10. Gas conditioning piping and iron sponge vessels

4.9.1 Mechanical

The gas conditioning system capacity treats and conveys digester gas from the digester control buildings to the City's cogeneration system at the CHP building. Gas is conveyed through 8-inch-diameter stainless steel piping above grade and is likely undersized for current and future gas conditioning flows; staff also have expressed operational concerns and questions about the system's capacity For example, it was noted that during high digester gas flow rates, approximately 500 standard cubic feet per minute , a vacuum condition occurs in the gas conditioning piping that limits how much digester gas can be sent through the piping system. Increased digester gas velocities have resulted in the pressure at the CHP engines being lower than at what the City operates the engines. To make up for this, the City adds natural gas to reach optimal operating pressures.

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Regarding the hydrogen sulfide removal system upstream of CHP, the City is unsure of the rated capacity of the iron sponge vessels, which include two stainless steel tanks. The vessels are currently run in a duty/standby configuration and can also operate in parallel, however, piping does not exist to run the tanks in series. The City is unsure which configuration provides the rated capacity of 365 gpm.

The gas conditioning system's digester gas heat exchangers, boosters, blowers, and chillers appear to be in good condition. The siloxane removal vessels, which are operated in series, were also observed to be in good condition with no noted operational issues.

4.9.2 Electrical

MCC-30N powers the gas conditioning system. The MCC is a Siemens model 95, was installed in 1995, and is in fair condition. The gas conditioning system PLC (PLC-19) is a Siemens Simatic S7-300 PLC that was installed in 2013. Plant staff advised that this model will be discontinued this year but that spare parts will be available until 2033.

4.9.3 Structural

The gas conditioning system's structural components appear in good condition; however, there is a fair amount of rust staining on adjacent concrete pads at the Gas Booster building due to rust on the equipment anchor bolts and plates. Slab drainage issues were also noted adjacent to the Gas Booster building, which have created ponding at some pipe supports. The City has installed some grating to prevent the need for staff to walk through rain puddles. The concrete slabs in the surrounding areas show significant signs of settlement.

4.9.4 Recommendations

Further evaluate and model the gas conditioning treatment capacity from the digesters through the iron sponge vessels and piping system to CHP to determine bottlenecks and capacity issues. One recommendation is that the existing 8-inch-diameter low-pressure sludge gas piping be replaced with larger-diameter piping to reduce digester gas velocities and increase pressure.

Structural recommendations include drainage improvements or sloping of the top of the concrete slab with epoxy grout outside the Gas Booster building. Rusted bolts, nuts, and straps with stainless steel should be replaced. The City should consider specifying stainless steel on new pipe supports and anchorage plates.

4.10 CHP Engines and Emission Controls

There are four Cummins cogeneration engines installed in the CHP building. The cogeneration system was constructed in 2010 under the CHP project. Selective catalytic reducers (SCR) are installed on CHP engines 3 and 4 to meet air permit requirements for nitrogen oxides (NOx) removal. CHP engines 1 and 2 do not have SCRs. Figure 4-11 presents photos s of CHP engine 1 and the SCR on CHP engine 4.

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Figure 4-11. CHP engine 1 and SCR on CHP engine 4

4.10.1 Mechanical

Currently, the City only operates two CHP engines at a time. All four engines have exceeded their recommended hours for service, and with difficulty receiving parts from Cummins, the City has had to shut some engines down for extended periods. The City also noted that operating the engines gas sensors is difficult. Although SCRs are not typically run to capacity, City staff did note there was likely a capacity issue at full cogeneration engine capacity. The City indicated CHP engine operation would be much simpler if all four engines had SCRs. Operational improvements were noted as a major goal for City staff.

4.10.2 Electrical

The switchgear for the cogeneration system distributes the power generated by the four cogeneration engines. The switchgear manufactured by Thompson Technology and installed in 2012 is in excellent condition. Two medium-voltage transformers (12.4-kilovolt [kV] to 4.16 kV) connect the facility to the plants nearby medium-voltage distribution equipment. The transformers are Prolec Envirotemp FR3 type and were installed in 2012. Both are in good condition.

MCC-118200 powers the ancillary generator equipment. The MCC, a GE Evolution Series E9000 was installed in 2012, is in good condition. There are five battery chargers, one for each generator battery bank and one for the generator switchgear. The chargers are SENS EnerGenius IQ models installed in 2012; all are in good condition.

PLC-48, PLC-49, and PLC-50 control the CHP switchgear, auxiliary equipment, and gas blending skid, respectively. These are all Siemens Simatic S7-300 PLCs that were installed in 2013. Plant staff advised that this model will be discontinued this year but that spare parts will be available until 2033.

4.10.3 Structural

There are non-galvanized brackets installed on the SCRs on the exterior exhaust platform that have started to rust; if allowed to continue, this will become a minor structural issue. The condensate line from the CHP engines drains directly into joints between the slab and building foundation, which can cause long-term localized settlement concerns.

Within the CHP building there was observed cracking on the floor slab near the re-entrant corners adjacent the generator foundations. Unless these cracks widen, there is no significant structural concern. Also, within the CHP building, grating clips were not installed on all gratings. There were two locations that had uneven supports that allowed the grating to partially tip when the corner was stepped on. This is a minor safety hazard.

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4.10.4 Recommendations

There were no electrical recommendations for R&R. Structural recommendations include routing the engine condensate drainage away from the building joint and/or to seal the joint between the wall and slab. The rusted brackets on the SCR exhaust system should be replaced with a material to match the remainder of the platforms. Grating clips should be added at the locations where grating support is not level. Regarding mechanical/operational improvements, SCRs should be added to CHP engines 1 and 2 to ease operational constraints and simplify the engine control strategy. Updates to the air permit will be required when adding SCRs.

4.11 Biogas Flare

The City's existing biogas flare is a Varec candlestick flare that serves as a backup for digester gas to the City's cogeneration system. BC and the City are currently constructing a second biogas flare, which will be a low-NOx enclosed waste gas burner (WGB) by Varec at a rated capacity of 660 cubic feet per minute. It is intended that the City's existing biogas flare will remain in place after installation of the new WGB to serve as back to the new WGB. Figure 4-12 presents photos of the existing biogas flare.



Figure 4-12. Existing biogas flare

4.11.1 Mechanical

Although the biogas flare is operational, it is past its useful life and would not meet the City's digester gas capacity if cogeneration were not online. Significant corrosion and rust on the biogas flare and above grade piping and controls were observed. The surrounding area of the biogas flare has poor drainage that causes large amounts of water buildup around the biogas flare pad.

4.11.2 Electrical

The biogas flare is controlled by PLC-64, which is a Siemens PLC S7-1200 installed in 2015. This model is the most current of the Siemens' product line.

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4.11.3 Structural

Coating on the biogas flare has failed and surface rust is visible, however no noticeable section loss in steel was identified. Pipe supports and the riser pipe near the biogas flare were flooded during visual observations. It appears that past flooding has caused rust at the base of pipe supports and is a long-term concern for both pipe supports and the riser pipe. Ponding of water at the pipe riser may cause long-term settlement issues that would add stress to the pipe.

4.11.4 Recommendations

BC recommends adding a concrete pad in front of the control panel to avoid stepping in puddles during wet weather events when accessing the control panel. Drainage should also be improved to direct drainage away from pipe supports and the pad. The City should continue with the new WGB's construction and continue to reassess the biogas flare's condition.

4.12 Compost Facility

The compost facility is located across the street from the LTP on Llano Road. It is no longer operational but does include office space for City staff. Figure 4-13 presents photos of the compost facility and the mechanical scraping equipment used during previous composting activities. One of the major questions related to this BMSP is what the City should do should any future operations occur at the compost facility.



Figure 4-13. Compost facility

4.12.1 Mechanical

It is assumed that all mechanical equipment associated with the composting operation will need to be replaced or rehabilitated, including the mechanical scraping and compost conveyance equipment, building roofing, and ventilation system, prior to operating the composting facility.

4.12.2 Electrical

The compost facility is powered by switchboard MET-19000. The switchboard powers MCC-1, MCC-2, and five exhaust fan VFDs. The switchboard is an Allen-Bradley Centerline model and is in good condition. MCC-1 and MCC-2 are the Allen-Bradley Centerline model and are in good condition. The VFDs are near the end of their useful life.

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Lighting panelboards PNL-190010 (Panel A) and PNL-190020 (Panel B) are Siemens S1 type panelboards. They are both in good condition. The associated lighting transformers, Trans-191000 and Trans-191050, are Siemens QL type. Trans-191050 appears to be in fair condition; however, transformer Trans-191000 was exceptionally louder than normal.

The compost facility PLC (PLC-59) is a Siemens Simatic S7-300 PLC installed in 2008. Plant staff advised that this model will be discontinued this year but that spare parts will be available until 2033. Installation dates for the MCCs, VFDs, and lighting panel boards were not confirmed prior to this report.

4.12.3 Structural

The compost facility has significant structural issues that would need to be addressed for the building to be recommissioned. Based on conversations with the City, water has collected inside the roof purlins and may have caused significant corrosion. The water may be entering the beams through the screw penetrations used to attach the metal roofing. BC's visual observations did not include the roof, so we cannot verify if the gasket washers, which are intended to prevent water ingress, were used.

Some wall panels at the covered canopy area appear to be inadvertently receiving a vertical load that is causing them to bow outward from the adjacent columns. Some wall panels had spalled concrete with rebar exposed. This may have been caused by accidental impact loads from equipment. There is some significant cracking on the interior side of the wall panels.

Coating on the building's columns have failed and the columns have begun to rust. It does not appear that the columns have suffered extensive section loss, but if left uncoated will continue to rust and will eventually become a safety hazard.

4.12.4 Recommendations

If the City desires to operate the Compost Facility, rehabilitation of most components of the Compost Facility, including building structural, roofing, and ventilation improvements, as well as mechanical and electrical upgrades, would be required. Further evaluation of Compost Facility alternatives for use and operation will be completed in subsequent tasks in this project.

4.13 Primary Clarifier Scum Pots

The scum pots capture scum from the primary clarifiers in a pressurized tank in the primary clarifier gallery, installed adjacent the primary sludge pumps. When the scum pot becomes full and pressurized, the contents are ejected out of the tank and into the primary sludge pump piping routed to the digester. The O&M requirements of the scum pots are extensive and require consistent maintenance.

4.13.1 Mechanical

The scum pots are likely the same age as the primary clarifier structure and sludge pumps. The scum pots are installed adjacent the primary sludge pumps and require constant or nearly hourly attention to ensure the discharge valve is opening at the correct pressure when the tank becomes full. Other pumping technologies or configurations, such as progressive cavity pumps or hose pumps, may be better suited for this application and result in less O&M effort.

4.13.2 Electrical

No electrical assets associated with the primary clarifier scum pots were inspected; however, any new assets installed in the same location as the scum pots would be in the primary clarifier gallery, which is below grade and susceptible to flooding.

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4.13.3 Structural

The scum pots are located in the primary clarifier gallery, which is below grade and susceptible to flooding. The primary clarifier structure was not inspected as part of this assessment; however, on previous site visits it has been noted that the structure is nearing the end of its useful life and may be replaced and relocated. Structural assessments of the primary sludge pumps may be reviewed in lieu of the scum pots.

4.13.4 Recommendations

Consider replacing the existing scum pots with progressive cavity pumps in the same location in the primary clarifier gallery. Use of the existing sludge pumps suction with a tee upstream of the pump suction is also an option. In either case, new instrumentation and control of the pumps is important to ensure pumps operate within an acceptable operating condition. Scum production and characteristics are highly variable from plant to plant, which makes no-flow detection for scum pumps an issue and challenge. There is often no easy one-size-fits-all answer. Monitoring and controlling pump run time would be recommended. Clamp-on flow meters on pump suctions should also be considered. While new pumps and additional instrumentation would be required for replacement, this alternative results in less O&M effort than scum pots. Hose pumps may also be considered as an alternative but require preventative maintenance and hose replacement. Additional review of the existing scum pot and primary clarifier record drawings is required for further analysis.

Section 5: Results and Recommendations

This section summarizes BC's condition assessment results, including the estimated remaining useful life, LoF and CoF scores, and risk scores. It also includes a list of R&R projects recommended to be included in the BMSP CIP Roadmap.

5.1 Risk Score Results

Risk score results for the assets observed during the Level 2 Visual Observations are included in Attachment A. These results will also be submitted to the City electronically in Microsoft Excel format. Results include each asset's description (i.e., name), process area, estimated remaining useful life, observed condition, notes, and calculated LoF, CoF, and risk score. If the installation year of the asset was provided by the City, the remaining useful life calculation takes into consideration the installation year of the asset as well as the asset's typical useful life. A range of estimated remaining useful life years, for example, 0 to 5 years, 6 to 10 years, 11 to 15 years, was assigned to each asset.

Recommended R&R projects and risk score results for each process area are provided in Attachment B. Visual observation forms and results are included in Attachment C and provide a record of BC's observations, communication with City staff, updated asset remaining useful life, asset condition and maintenance activity, and photos of inspected assets.

Incorporation of results into the LTP asset database may include each asset's installation or rehab year, typical useful life, and remaining useful life. The City may use entries to help track when an asset should be considered for replacement or when an asset's monitoring or maintenance activity should increase. Typical useful life examples may be adjusted by the City based on experience and manufacturer input. The Risk Zone and priority of assets evaluated during the Level 2 Visual Observations may be used by the City to identify high priority or critical assets in need of R&R.

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5.2 Recommended R&R Projects

Twelve projects are recommended for R&R to address the operational, mechanical, electrical or structural deficiencies identified during the Level 2 Visual Observations. The projects identified for R&R are provided in Table 5-1. Recommendations were developed using the Level 2 Visual Observations, recommendations, and corresponding LoF, CoF, and risk score results. The scope of work for each project will be further developed with input from City staff, with actual methods and quantities for R&R projects being further refined for the BMSP CIP.

Table 5-1. Preliminary List of Recommend R&R Projects

ID	Project Name	Scope of Work	LoF Score	CoF Score	Risk Score	Risk Priority
BC-01	HSW Odor Scrubber Improvements	Install a secondary odor scrubber vessel and fan.	1.4	2.8	3.9	Critical, Low Risk
BC-02	Digester Dewatering Pump Replacement	Install two dewatering pumps to replace the single over-sized pump that lacks redundancy.	3.6	3.0	10.9	Critical, High Risk
BC-03	Ferric Chloride Improvements	Replace existing ferric chloride storage tanks.	3.0	3.0	9.1	Critical, High Risk
BC-04	Digester Gas Mixing Improvements	Replace digester gas mixing system on each of the four digesters.	2.9	2.2	6.3	High Priority
BC-05	GBT Sludge Pump Replacement	Replace two existing sludge pumps and add expansion capacity.	3.3	2.4	7.9	High Priority
BC-06	SCR Installation for CHP Engines 1 and 2	Add two SCRs to existing engines.	1.7	2.2	3.7	Low Priority
BC-07	BP Cake Pump Replacement	Replace existing cake pumps with piston pumps or an alternative that does not require dilution water.	3.0	2.4	7.2	High Priority
BC-08	WAS Pump Replacement	Reduce suction lift on existing WAS pumps to generate more WAS pumping capacity, or replace existing WAS pumps with submersible pumps.	2.6	1.6	4.2	High Priority
BC-09	Electrical Site Improvements	Replace five MCC units, five lighting panelboards, five lighting transformers, and one PLC.	3.0	3.0	8.9	Critical, High Risk
BC-10	Compost Facility Improvements	Replace roof, purlins, HVAC and fire suppression system. Most mechanical equipment previously used for compost operation will also need to be replaced.	3.7	1.0	3.7	High Priority
BC-11	Structural Improvements	Crack sealing at SRS, digester galleries, GBT room, and BP room. Joint repair in digester galleries, BP room, and SCR room. Conduit water infiltration repair in the digester galleries. Rust repair at CHPs and flare.	3.0	3.8	11.4	Critical, High Risk
BC-12	Scum Pot Replacement	Replace scum pots with progressive cavity or hose pump.	3.0	1.0	3.0	High Priority

In Figure 5-1, an R&R risk matrix, including each R&R project's risk score, zone and priority, is provided for the projects identified as part of this task. The risk matrix may be used to prioritize projects and to identify if either the project's LoF or CoF score drives the R&R decision, e.g., if an asset is beyond its useful life and should be replaced, or if the decision is driven based on the consequence of that system failing. The R&R project with the highest risk score is the Digester Dewatering Pump Replacement with a risk score of 10.9, falling within the Critical, High-Risk zone. Due to the lack of redundancy and COF of this pump, replacement of the existing digester dewatering pump is recommended. Most projects identified for this assessment fell within Risk Zone 2, which are High Priority; however, they require a mix of reactive and proactive actions by O&M.

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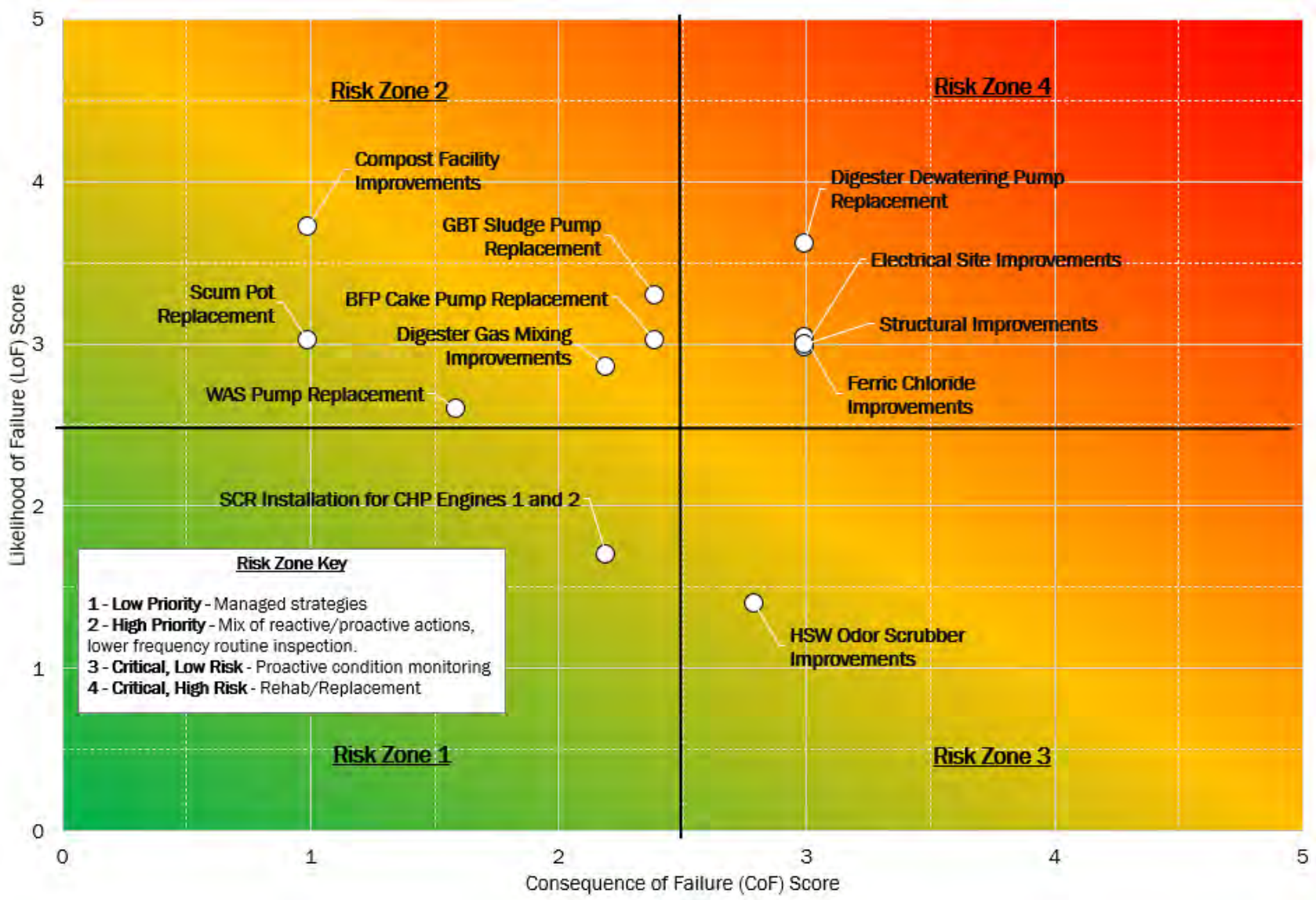


Figure 5-1. R&R project risk matrix

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5.3 Future Investigations

Condition assessment of the LTP's solids handling and treatment assets and unit processes has yielded recommendations to re-evaluate and further investigate certain assets based on the observed conditions and risk. An investigation description and recommended schedule for this work are listed in Table 5-2.

Table 5-2. Future Investigations Recommendation

Process Area	Asset	Concern/Issue	Investigation Description
Compost facility	Compost facility	Decommissioned and structural concerns	Investigate potential alternative uses of compost facility or recommissioning of service.
Gas conditioning	Gas conditioning	Capacity and bottleneck	Investigate two iron sponge vessels for rated capacity and the cause of low-pressure bottlenecks in the system that are causing the City to need natural gas additions in CHP engines.
Anaerobic digestion	Digester mixing system	Past useful life	Investigate alternatives which replace the City's outdated digester mixing system.
HSW receiving	HSW tanks	Future HSW expansion capacity requirements	Investigate capacity configuration of new HSW tanks depending on expansion.

5.4 Next Steps

After completion of the biosolids condition assessment, BC will work with City staff to identify and prioritize the R&R projects to be included in the BMSP CIP for conceptual level cost estimating. These projects will be prioritized to reduce near-term risk to the City and be developed in coordination with other City project priorities, including a new Headworks facility. R&R projects will also be prioritized based on process improvements identified in the BMSP Flows and Loads and Capacity Evaluation (TM 1), and in conjunction with the electrical improvement recommendations provided in the LTP Power Master Plan by Hazen and Sawyer.

BC will develop up to 10 opinion of probable construction cost (OPCC) estimates consistent with the Association for the Advancement of Cost Engineering guidelines for a Class V estimate (minus 50 percent to plus 100 percent accuracy). The OPCCs will be based on the projects' scopes of work, materials, and quantities identified during the condition assessment and confirmed with City staff. Manufacturer quotes obtained for major equipment may also be incorporated into the OPCC. Project costs will include contractor's overhead, profit, mobilization, bonds, insurance, and contingency. An implementation period for each R&R project, including a range of years, will be recommended for scheduling and budgeting of the BMSP CIP, to be completed in the BMSP Biosolids Screening and Alternatives Evaluation task (TM 4).

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Attachment A: Visual Observation Asset List and Results

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Santa Rosa BMSP
Biosolids Condition Assessment
Visual Observation Asset List

ASSET DESCRIPTION	EQUIPMENT TYPE	TYPICAL LIFE (YEARS)	LOCATION	EQUIPMENT NUMBER	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	INSTALL/ REHAB YEAR	VISUAL INSPECTIONS				LIKELIHOOD OF FAILURE (LoF)						CONSEQUENCE OF FAILURE (CoF)						ASSET RISK			
									INSPECTION RECORD				Observation score provided by inspectors during visual inspection 0.3	Number of years an asset has remaining before it no longer provides the required level of service 0.2		Condition observed by O&M and BC staff during visual inspections, ranging from no known issues to out of service. 0.3		Addition of equipment above what is required for optimal performance 0.2		Reduced safety, or potential for serious injury or death caused as a result of asset failure 0.4		Environmental or regulatory compliance violation issued as a result of asset failure 0.3		Impact to a single or multiple process or treatment systems as a result of asset failure 0.3		LoF Criteria Scores x Criteria Weight	CoF Criteria Scores x Criteria Weight	Risk Score = LOF x COF	RISK ZONE	RISK ZONE DESCRIPTION
									PULCRUM ID	INSPECTOR	DISCIPLINE	INSPECTION NOTES	OBSERVATION	REMAINING USEFUL LIFE		CONDITION		REDUNDANCY		PUBLIC/EMPLOYEE SAFETY		ENVIRONMENTAL COMPLIANCE		SYSTEM DISRUPTION		LoF SCORE	CoF SCORE	RISK SCORE	RISK ZONE	RISK ZONE DESCRIPTION
MCC-22T-2	Motor Control Center	30	Belt Filter Presses	MCC-22T-2	Siemens	Tiastar		1996	f9b244b7-9048-45bb-acca-9416c8cd9602	Dane Forsberg	Electrical		1.2	5	Past Useful Life	4	Poor - Replacement or rebuilding is required. Failure is imminent.	4	Some redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	3.4	3.8	12.8	4	Critical, High Risk
Lighting Panelboard C	Panelboard	15	Primary Sludge Pumps	Panel-C	Square D	NQOD	NQOD442L225	1998	cf17be38-7945-4512-8500-83e20fc21fc41	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	3.2	3.8	12.2	4	Critical, High Risk
Lighting Transformer - TT-1	Lighting Transformer	12	Cake Pumps and Storage	TT-1	I-T-E Electrical Products	I-T-E Power Transformar	C9562-487	1988	d0dc7fcf-911e-4dc6-b8aa-545ad55eac41	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	3.2	3.8	12.2	4	Critical, High Risk
Lighting Transformer C	Lighting Transformer	12	Primary Sludge Pumps	T-C	Westinghouse	14BJ2873OD			197daac3-d704-4f2f-af45-437e972e94c6	Dane Forsberg	Electrical	30 kVA- 480V-208Y/120V	1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	3.2	3.8	12.2	4	Critical, High Risk
MCC-11P	Motor Control Center	30	Gravity Belt Thickeners	MCC-11P	Westinghouse	Five Star		1987	9be2c6e8-c964-4f8a-8407-55570a92ae37	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	3.2	3.8	12.2	4	Critical, High Risk
MCC-12R	Motor Control Center	30	Anaerobic Digesters	MCC-12R	BBC Brown Boveri	69BSW012-1		1976	e2a93949-aed0-434a-9540-c4af6851d7b7	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	3.2	3.8	12.2	4	Critical, High Risk
MCC-6K	Motor Control Center	30	Anaerobic Digesters	MCC-6K	Westinghouse	Series 2100	SF27980	1991	91ac3bda-25db-4530-8d1d-a70574ahfa9	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	3.2	3.8	12.2	4	Critical, High Risk
Lighting Transformer H	Transformer	25	Anaerobic Digesters	T-H	Sylvania	HGWT-1	35920.1-2	1976	878720c5-4b5d-4b6d-b5c6-6eab21c3c95c	Dane Forsberg	Electrical	Rain Shield. Rusted On Top. 480V-208Y/120V - 30 kVA	1.8	5	Past Useful Life	4	Poor - Replacement or rebuilding is required. Failure is imminent.	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.7	3.2	11.8	4	Critical, High Risk
MCC-22T-1	Motor Control Center	30	Belt Filter Presses	MCC-22T-1	Siemens	Tiastar		1975	3e777e5d-c4d3-43d9-a6c1-07822be85d42	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	3.0	3.8	11.4	4	Critical, High Risk
Switchboard 3H	Switchboard	25	Waste Activated Sludge Pumps	SWBD-131250	GE	Spectra Series	51094986-5	2010	6ab29496-c87e-493d-b20a-9c3e881a67a4	Dane Forsberg	Electrical	Feeds WAS - Duty / Standby	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	3	Potential violation	5	Facility-wide disruption	2.5	4.4	11.0	4	Critical, High Risk
Dewatering Pump	Pump - Hydraulic	20	Anaerobic Digesters		Wemco				50a56af0-bcdf-4733-b189-fcf869dbf10f	Colin Casey	Mechanical	Single 400 GPM dewatering pump for all 4 anaerobic digesters. Pump is past its useful life and should be replaced. Existing pump is oversized and runs at it's lowest speed on a VFD. There is no bypass or redundancy for the existing pump. BC recommends installing 2 smaller pumps of half the capacity and overhead motors. Access to replace pump in existing pump room beneath digester gallery will be difficult.	2.4	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	3	Minor injury	1	No violation	5	Facility-wide disruption	3.6	3.0	10.9	4	Critical, High Risk
Lighting Transformer TFR-22401	Transformer	25	Anaerobic Digesters	TFR-22401	Sylvania	HGWT-1	35920.3-2		8eeab5f7-7461-4dd9-a3fe-e9c35414dde1	Dane Forsberg	Electrical	480V-208Y/120V - 25 kVA	1.8	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.4	3.2	10.8	4	Critical, High Risk
Lighting Panelboard - Panel H	Panelboard	15	Anaerobic Digesters	Panel H	Sylvania	BG-33605	SO-28966-2		20ae220b-1f0f-4cb1-9b1d-7eaad6440298	Dane Forsberg	Electrical	120/208V -125A Main	1.2	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.3	3.2	10.4	4	Critical, High Risk
Lighting Panelboard - TL-1	Panelboard	15	Cake Pumps and Storage	TT-1 / LVP-166704	Siemens	I-T-E Panelboard	19-11443-02	1988	ca7f0c8c-ba04-4ae2-bd30-e8904c8eb8fa	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
Lighting Panelboard - TL-2	Panelboard	15	Cake Pumps and Storage	TL-2	Siemens	I-T-E Panelboard - CDP-7		1988	95c72f0c-531c-451e-b708-ca85a1516425	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
Lighting Panelboard Panel E	Panelboard	15	Anaerobic Digesters	Panel E	GE	AQF33010B	162-DP56353	1998	e2e65652-0b69-42f2-97d6-abe02b6464a9	Dane Forsberg	Electrical	120/208V - 100A Main, Digester Levels	1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
Lighting Transformer - TT-2	Transformer	25	Cake Pumps and Storage	Transformer TT-2	I-T-E Electrical Products	I-T-E Power Transformar	29-D7743-BBB	1988	1051c8ab-2327-4962-95c4-3fab9845022f	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
MCC-30N	Motor Control Center	30	Gas Conditioning System and Piping	MCC-30N	Siemens	Model 95	33-1420-89527	1995	4a663113-35db-4978-8895-44103a0b0888	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	1	No violation	3	Adjacent process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
Panelboard L1	Panelboard	15	Gravity Belt Thickeners	LVP-167104	Westinghouse			1987	0f486904-fa05-474a-a0cf-678c9a9df552	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
Panelboard L-12R	Panelboard	15	Anaerobic Digesters	Panel L-12R	Servicecenter	9T2151150			c28776b7-db0e-4209-a3ef-9fabbdda4cd1	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
Panelboard L2	Panelboard	15	Gravity Belt Thickeners	LVP-167105	Westinghouse	Y52030	SF28975 IT.8	1987	04aff5ff6-b73f-45d1-84a9-00a6547b6f20	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
Transformer L1	Transformer	25	Gravity Belt Thickeners	LT-167104	Westinghouse	DT-3 Transformar	T87005587	1987	310c0614-4740-423e-94e0-f21d67d7d7be	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
Transformer L2	Transformer	25	Gravity Belt Thickeners	LT-167105	Westinghouse	Type EPT	T-6E982	1987	29f9f00b9-006f-4297-b212-f4807e0f6c49	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.2	3.2	10.2	4	Critical, High Risk
Biogas Flare	Burner - Waste gas	15	Biogas Flare		Varec				9babda80-f6cf-4857-aa54-9243d33bf5c67	Colin Casey	Mechanical	This existing candlestick flare by Varec will soon become backup to the LTP's new ultra-low NOx enclosed waste gas burner (WGB). There is significant corrosion around the flare piping and stack. Flare does not meet capacity requirements and is past its useful life. Obtaining spare parts is difficult and will soon become obsolete. Modifications to this flare are possible, however, major changes will result in requiring the candlestick flare to be replaced with a new enclosed WGB per BAAQMD best available controls technology (BACT) requirements.	1.4	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	3	Minor injury	5	Violation(s)	1	Single process or treatment system disruption	3.3	3.0	10.0	4	Critical, High Risk
Control Console CCP 2	Panel - Local control	15	Belt Filter Presses	CCP1/CCP2/CCP3	Control Manufacturing, Inc			1988	a2c80ebf-a674-4d00-b5c6-732b75e25299	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	3.2	3.0	9.6	4	Critical, High Risk
Digester Dewatering Pump VFD	Variable Frequency Drive	12	Anaerobic Digesters	VFD-164701	Eaton	SVX		1995	13c1d919-34c0-4b35-b0d7-49c215f113c4	Dane Forsberg	Electrical		1.0	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	3.0	3.2	9.6	4	Critical, High Risk
Panelboard 30N	Lighting Panelboard	12	Gas Conditioning System and Piping	LVP-30N	Siemens	S3	53C308L050ETS	1995	800b9b7c-a03e-4872-881b-6d635e3a3f74	Dane Forsberg	Electrical		1.0	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	1	No violation	3	Adjacent process or treatment system disruption	3.0	3.2	9.6	4	Critical, High Risk
WAS Pump 1/2 VFDs	Variable Frequency Drive	12	Waste Activated Sludge Pumps	VSC-135910 / VSC-135920	Allen Bradley	PowerFlex 30		2010	94320c17-6ab4-4376-8860-31c374ae8a77	Dane Forsberg	Electrical		1.0	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	4	Some redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	2.5	3.8	9.5	4	Critical, High Risk
Heat Exchangers	Heat Exchangers	12	Gas Conditioning System and Piping						5f65d98f-6b80-4627-8708-a2f78d84965b	Divj Sharma	Mechanical	City noted that the heat exchangers may need to be replaced in the future.	1.0	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	2	Full redundancy for average operating and service condition	3	Minor injury	5	Violation(s)	5	Facility-wide disruption	2.2	4.2	9.2	3	Critical, Low Risk
Ferric Chloride	Tank - Chemical	25	Ferric Chloride						100fe044-a970-467f-bdbd-fbd22a61545f	Colin Casey	Mechanical	Tanks and piping need to be replaced. Feeds headworks. Chem is expensive -$300k last year.	1.8	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	3.0	3.0	9.1	4	Critical, High Risk
Transformer 191000	Transformer	25	Composting Facility	Trans-191000	Siemens	QL	3F31045F		91f2c2e9-64bf-49e8-8205-1c4dce19dc22	Dane Forsberg	Electrical	Transformer is extremely loud. Recommend immediate action by maintenance staff. (Check torque on connections, loading, etc). Failure of this equipment appears to be imminent.	1.0	5	Past Useful Life	4	Poor - Replacement or rebuilding is required. Failure is imminent.	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	3.5	2.6	9.1	4	Critical, High Risk
Ferric Chloride Structural	Tank - Chemical	25	Ferric Chloride						235b5945-54e4-439e-9d69-d775c8402bd8	Dan Gagne	Structural	Ferric chloride tanks are past their useful life and should be replaced. Significant staining of concrete and equipment from ferric chloride within and surrounding containment area. Some damage to piping insulation and pipe supports. Concrete appears to be in fair condition.	1.8	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	3.0	3.0	9.0	4	Critical, High Risk
MCC-2G	Motor Control Center	30	Primary Sludge Pumps	MCC-2G	Square D	Model 6		2011	8bdc31a3-e07c-461a-83b9-115d8f26eb2c	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	4	Some redundancy	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	2.3	3.8	8.7	3	Critical, Low Risk
Lighting Transformer - TT-3	Transformer	25	Cake Pumps and Storage	Transformer TT-3	Square D	Sorgel General Purpose Transformer - 157.3HEE	32749-17212-084	2005	8200c562-04dc-4scf-b7a8-66a9151b0e000	Dane Forsberg	Electrical		1.0	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	2.7	3.2	8.6	4	Critical, High Risk
Polymer Blend Unit Power Center	Transformer	25	Gravity Belt Thickeners	TRAN-167406	Acme Electric	Panel Tran	PT0611500251S	1998	4949d0fd-f5d0-457b-8429-1f0a698a3bfc	Dane Forsberg	Electrical	480V-240/120V - 25 kVA	1.0	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	2.7	3.2	8.6	4	Critical, High Risk
Gas Conditioning Structural	Concrete	50	Gas Conditioning System and Piping						1e55c591-b244-44f7-9fa6-cc638f43447c	Dan Gagne	Structural	There is rust staining of concrete from rusted bolts and plates within the Gas Conditioning area. Grating is installed at the low point in the structural slab, so observation of concrete at this location was not possible. Corrosion of pipe supports, anchor bolts was also observed. There was visible settlement of concrete at expansion joints, and improper slab drainage. Ground settlement and movement of slab on grade was also observed.	1.8	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.6	3.0	8.5	4	Critical, High Risk
Gravity Belt Thickener Structural	Concrete	50	Gravity Belt Thickeners						85fe28aa-5593-47f0-b681-6945cfaa8601	Dan Gagne	Structural	Vertical cracks observed in walls and on concrete beams. Slab separation from wall also observed, requiring new sealant. There were some hairline cracks in slab; City should monitor and seal if cracks widen/open up. Cracking observed at slab and joint at stairs leading up to GBTs.	1.8	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.6	3.0	8.3	4	Critical, High Risk
Lighting Transformer 30N	Transformer	25	Gas Conditioning System and Piping	LT-30N / TRAN-16115	MGM Transformer CO	297T	95-3-44775-B2		c441a6f1-dd5d-45ac-9256-9baa84009663	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	3.2	2.6	8.3	4	Critical, High Risk
MCC-1	Motor Control Center	30	Compositing Facility	MCC-190020	Allen-Bradley	Centerline			befd022a7-42dd-4104-806f-1854cbce6234	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	3.2	2.6	8.3	4	Critical, High Risk
MCC-2	Motor Control Center	30	Compositing Facility	MCC-190030	Allen-Bradley	Centerline			a6e07fee-3748-4c9b-af31-4367404e6fbb	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	3.2	2.6	8.3	4	Critical, High Risk
Panelboard A	Panelboard	15	Compositing Facility	PNL-190010	Siemens	S1			014b5f22-bb77-410a-be51-0691df0f8f6b	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	3.2	2.6	8.3	4	Critical, High Risk
Panelboard B	Panelboard	15	Compositing Facility	PNL-190020	Siemens	Siemens	S1		6d541446-d926-4af5-bf0e-4fb9566fbbd3	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	3.2	2.6	8.3	4	Critical, High Risk
Switchboard MET-19000	Switchgear	30	Compositing Facility	MET-190000	Siemens	Sentron			cd8d2753-89e4-4241-b80f-e1b6134e5f24	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	3.2	2.6	8.3	4	Critical, High Risk
Transformer 191050	Panelboard	15	Compositing Facility	Trans-191050	Siemens	QL	1D1Y025F		48a7a168-2920-4f92-9514-834e3b1790a4	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	3.2	2.6	8.3	4	Critical, High Risk
Biogas Flare Structural	Concrete	50	Biogas Flare						ef3b30fd-993e-4187-8d0c-b0298aac9f79	Dan Gagne	Structural	Coating on flare failed. Surface rust on flare. No noticeable section loss Pipe supports below flood area. Could lead to corrosion and section loss over time.	1.2	1	30 yrs or more	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	5	Violation(s)	1	Single process or treatment system disruption	2.2	3.8	8.2	3	Critical, Low Risk

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Biosolids Condition Assessment
Visual Observation Asset List

ASSET DESCRIPTION	EQUIPMENT TYPE	TYPICAL LIFE (YEARS)	LOCATION	EQUIPMENT NUMBER	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	INSTALL/ REHAB YEAR	VISUAL INSPECTIONS: INSPECTION RECORD — FULCRUM ID	INSPECTOR	DISCIPLINE	INSPECTION NOTES	LIKELIHOOD OF FAILURE (LoF): Observation score provided by inspectors during visual inspection. 0.2	Number of years an asset has remaining before it no longer provides the required level of service. 0.3	REMAINING USEFUL LIFE	Condition observed by O&M and BC staff during visual inspections, ranging from no known issues to out of service. 0.3	CONDITION	Addition of equipment above what is required for optimal performance. 0.2	REDUNDANCY	CONSEQUENCE OF FAILURE (CoF): Reduced safety, or potential for serious injury or death caused as a result of asset failure. 0.4	PUBLIC/EMPLOYEE SAFETY	Environmental or regulatory compliance violation issued as a result of asset failure. 0.3	ENVIRONMENTAL COMPLIANCE	Impact to a single or multiple process or treatment systems as a result of asset failure. 0.3	SYSTEM DISRUPTION	ASSET RISK: LoF Criteria Scores x Criteria Weight	CoF Criteria Scores x Criteria Weight	Risk Score = LOF x COF	RISK ZONE	Risk Zones and Description 1 = Low Priority 2 = High Priority 3 = Critical, Low Risk 4 = Critical, High Risk: RISK ZONE DESCRIPTION
Lighting Panelboard - TL-3	Panelboard	15	Cake Pumps and Storage	TL-3	Square D	NQOD Panelboard	1.22101E+16		2206fbef-1b8c-46ab-a7ff-02291399b3b0	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	3	Potential violation	1	Single process or treatment system disruption	2.5	3.2	8.0	4	Critical, High Risk
MCC-11B20	Motor Control Center	30	Combined Heat and Power Engines	MCC-11B20	GE	Evolution Series 9000	0CT0N0392L02	2010	3b2d87ea-ee1f-4c0f-b3ad-097a92508884	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	1	No violation	3	Adjacent process or treatment system disruption	2.5	3.2	8.0	4	Critical, High Risk
Neutral Grounding Resistor 1	Neutral Grounding Resistor	30	Combined Heat and Power Engines	NGR-118001	I-Gard Corp		NGR2400-200105	2011	b193840b-561b-4cb9-9bf1-a6a7e9df56b5	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	1	No violation	3	Adjacent process or treatment system disruption	2.5	3.2	8.0	4	Critical, High Risk
Neutral Grounding Resistor 2	Neutral Grounding Resistor	30	Combined Heat and Power Engines	NGR-118001	I-Gard			2011	be4f1908-28f2-4a6b-8542-2b8bc40e2455	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	1	No violation	3	Adjacent process or treatment system disruption	2.5	3.2	8.0	4	Critical, High Risk
MCC-2B	Motor Control Center	30	Primary Sludge Pumps	MCC-2B	Square D	Model 6		2011	aa7dae10-060b-4074-9f11-549a49c210B7	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	Full redundancy for low operating and service condition	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	2.1	3.8	8.0	3	Critical, Low Risk
Thickened Sludge Pumps	Pump - Hydraulic	20	Gravity Belt Thickeners						d1be6668-7aaf-4212-b314-8a92a72e1727	Colin Casey	Mechanical	There are two gravity belt thickener (GBT) sludge pumps for 3 GBTs, which send WAS solids from GBT to digesters. Both pumps are passed their useful life and should be replaced.	2.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	1	No violation	3	Adjacent process or treatment system disruption	3.5	2.4	7.9	2	High Priority
Dewatering Pump Grinder LCP	Panel - Local control	15	Anaerobic Digesters	PFC-164101	Muffin Monster	B100R	4419	1988	30a0d76f-0654-4f03-8706-df5e38cefc84	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	3.2	2.4	7.7	2	High Priority
Field Panel - FP-AD-1	Programmable controller	15	Biogas Flare	FP-AD-1	Siemens	Simatic S7-1200		2015	ecfe2e5a-5926-4dc4-9e17-02d2ee443ff6	Dane Forsberg	Electrical	Flare PLC	1.0	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	5	Violation(s)	3	Adjacent process or treatment system disruption	2.7	2.8	7.6	4	Critical, High Risk
MCC 3C-U	Motor Control Center	30	High Strength Waste Receiving Station	MCC-114300	Eaton	Freedom Series 2100		2016	91d4f926-36ab-4464-82a4-c69ac0a417ac	Dane Forsberg	Electrical	Eaton SVX 9000 - 2	1.0	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	1	No violation	3	Adjacent process or treatment system disruption	2.5	3.2	7.4	3	Critical, Low Risk
Cake Pump	Progressive cavity pump	15	Cake Pumps and Storage						a22d39dc-a632-4197-9cb5-aac043f5469b	Colin Casey	Mechanical	Current cake pumps (progressive cavity) require recently dewatered solids from belt filter press be wetted, so that pumps can pump fir/ahed biosolids to storage hopper. Recommendation to replace existing cake pumps with Schwing Bioset cake pumps, or similar.	2.4	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	3	Full redundancy for low operating and service condition	3	Minor injury	1	No violation	3	Adjacent process or treatment system disruption	3.0	2.4	7.2	2	High Priority
MCC-2B	Motor Control Center	30	Primary Sludge Pumps	MCC-2B	Square D	Model 6		2011	2bf9ed61-1b39-4e96-9cfb-43ab44f66550	Dane Forsberg	Electrical	Allen-Bradley Powerflex 70 VFDs - 3	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	2	Full redundancy for average operating and service condition	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	1.9	3.8	7.2	3	Critical, Low Risk
MCC-2G	Motor Control Center	30	Primary Sludge Pumps	MCC-2G	Square D	Model 6	30006277-002	2012	26033277-f989-4d61-975a-d3dd23f044a7	Dane Forsberg	Electrical	Allen Bradley Powerflex 70 - 3 For Primary Pumps	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	2	Full redundancy for average operating and service condition	5	Serious injury or death	3	Potential violation	3	Adjacent process or treatment system disruption	1.9	3.8	7.2	3	Critical, Low Risk
Digester Dewatering Pump Room	Concrete	50	Anaerobic Digesters						e1530ea8-a767-40d4-a329-ce915d7697a	Dan Gagne	Structural	Cracks were observed in the concrete staircase. Stairs are not sufficiently wide nor full length, which is a risk for tripping. Some delamination of paint and concrete on walls from previous pipe leak.	1.6	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	3.0	2.4	7.2	2	High Priority
Digester 4	Concrete	50	Anaerobic Digesters					1963	b44229bc-73bc-42b0-b2b0-2532c7e4e999	Dan Gagne	Structural	Leaks when filled/in with water. Okay when run with sludge Sidewalk separation from wall Cracks throughout stucco Spalling areas of stucco. Large areas removed to avoid risk of injury Leak at block-out for hatch and horizontal crack aligned near top of hatch block out (or cold joint of added hatch) Swells When water during cleaning is done every 4-8 years they fill with water leaks seen during that time. Healed/plugged with sludge Used 40€™ strip of membrane coating to seal inside of crack.	2.0	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.9	2.4	7.0	2	High Priority
Digester 1 Gallery	Concrete	50	Anaerobic Digesters					1974	0795efacf-82be-4f2d-84a1-fd4b23ab2e93	Dan Gagne	Structural	Wall cracks were observed starting or ending at the jog in expansion joints. Cracks in the roof the slab were also observed. Failed sealant at expansion joints should be replaced. There are signs of settlement at expansion joints, with minor concrete spalling.	2.0	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.9	2.4	7.0	2	High Priority
TWAS Pump 1 - RVSS	Reduced Voltage Soft Starter	25	Gravity Belt Thickeners	SMC-167103	Allen-Bradley	SMC+		1990	c9f28a02-0125-433b-b6ba-a4eb9511bfce	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	3	Full redundancy for low operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.5	2.4	6.7	2	High Priority
TWAS Pump 2 - RVSS	Reduced Voltage Soft Starter	25	Gravity Belt Thickeners	SMC-167103	Allen-Bradley	SMC+		1990	09547f58-2064-4a27-8040-a21f9824b26c	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	3	Full redundancy for low operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.5	2.4	6.7	2	High Priority
Belt Filter Press Building	Concrete	50	Belt Filter Presses						13c36732-b3c6-459e-9500-b4db8f9d9be4	Dan Gagne	Structural		1.4	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	4	Some redundancy	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.2	3.0	6.7	3	Critical, Low Risk
Primary Sludge Pumps Structural	Concrete	50	Primary Sludge Pumps						d4c5613e-bf4a-4f0f-bfc8-54b650fd4f08	Dan Gagne	Structural	Cracking of concrete was observed in several locations, including at the slab aligned with structure's expansion joint, and on the ceiling underneath the stairs landing, aligned with the expansion joint.	1.4	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.7	2.4	6.5	2	High Priority
Panelboard LV-2	Panelboard	15	Combined Heat and Power Engines	LV-2	GE	A-Series II	162DW94487	2010	1a3b4ce9-7504-4359-b8f1-b692a080c115	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	2.5	2.8	6.5	4	Critical, High Risk
Parts Washer XPMR	Transformer	25	Combined Heat and Power Engines		ACME Transformar			2012	4636e86b-22e5-45b1-90ed-a9162e5be6cf	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	2.5	2.8	6.5	4	Critical, High Risk
Transformer LV-2	Transformer	25	Combined Heat and Power Engines	XFMR LV-2	GE	QL	9T83C9872	2010	c7d1c2ff-94e0-49e3-9532-176aaadf04a8	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	2.5	2.8	6.5	4	Critical, High Risk
Cogen Switchgear	Switchgear	30	Combined Heat and Power Engines	SWGR-118200	Thompson Technology			2010	34ce3a00-0d1f-44ab-bb6d-1bbfefa31404	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	4	Some redundancy	5	Serious injury or death	1	No violation	3	Adjacent process or treatment system disruption	2.0	3.2	6.4	3	Critical, Low Risk
Belt Filter Press Blend Tank	Tank - Chemical	25	Belt Filter Presses						979cfdc5-d115-4388-ee57-b044fa24439fd	Dan Gagne	Structural	No structural deficiency's noted.	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	3	Full redundancy for low operating and service condition	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.1	3.0	6.3	3	Critical, Low Risk
CHP Building	Concrete	50	Combined Heat and Power Engines						158562c5-9d4b-4fee-a3db-21facac5c23b	Dan Gagne	Structural	The only risk observed at CHP was on the grating inside the building. Grating clips were not installed on all drain grates. Uneven support on grates is a safety hazard as stepping wrong will cause grating to tilt, with possible injury to staff.	1.0	1	30 yrs or more	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.1	3.0	6.3	3	Critical, Low Risk
Digester 1 Grinder LCP	Panel - Local control	15	Anaerobic Digesters	LCP164414	Muffin Monster	B100R	4748	1989	15d87263-ad4f-4929-8010-3f6bd32ec29b	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.5	2.4	6.2	2	High Priority
Digester 2 Grinder LCP	Panel - Local control	15	Anaerobic Digesters	LCP-164415	Muffin Monster	B100R	4747	1989	3d3fc4c3-c178-45ed-8b9d-6620f3537afd	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.5	2.4	6.2	2	High Priority
Sludge Cake Pump 1 LCP	Panel - Local control	15	Cake Pumps and Storage	CP-166211	Geepex			2005	f92df73c-48b3-441d-b2d5-010a8001b279	Dane Forsberg	Electrical	Eaton SVX 9000 Drives	1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.5	2.4	6.2	2	High Priority
Sludge Cake Pump 2 LCP	Panel - Local control	15	Cake Pumps and Storage	CP-166221				2005	358b9a56-e128-4158-a17e-e24fb8a142bf	Dane Forsberg	Electrical	Eaton SVX 9000 Drives	1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.5	2.4	6.2	2	High Priority
Sludge Cake Pump 3 LCP	Panel - Local control	15	Cake Pumps and Storage	CP-166231				2005	44a79983-7283-4ed1-bfce-95a34546d83a	Dane Forsberg	Electrical	Eaton SVX 9000	1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.5	2.4	6.2	2	High Priority
Sludge Cake Pump 4 LCP	Panel - Local control	15	Cake Pumps and Storage	CP-166241				2005	7857b79c-f848-4237-b09d-fa75c132c260	Dane Forsberg	Electrical		1.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.5	2.4	6.2	2	High Priority
Primary Sludge Pump 6	Pump	15	Primary Sludge Pumps		Netzsch			2012	b375c7b2-b772-4337-85e4-77e1dcfd78d4	Colin Casey	Mechanical	Primary sludge pumps sending settled solids from primary clarifiers to digesters. Pumps 7 and 8 were recently rebuilt. Pumps 1-6 are older and require O&M. City noted pumps run on high pressure and have significant headloss from bends and elbows through digester gallery. City also noted there are no cleanouts in piping within digester gallery. Replacing existing piping in digester gallery would be difficult. Recommend on-going O&M and monitoring of pumps.	1.4	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.5	2.2	5.2	2	High Priority
Natural Gas Blending System	Natural Gas Blending System	30	Combined Heat and Power Engines					2010	213ace9f-5e57-40b8-81b0-4eaa6caccf22	Colin Casey	Mechanical	Natural gas blending system for gas feed to CHP engines. No noted failures or maintenance concerns by City staff.	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	1	Full redundancy for peak operating and service condition	3	Minor injury	5	Violation(s)	3	Adjacent process or treatment system disruption	1.7	3.5	6.1	3	Critical, Low Risk
Compost Facility Structural	Concrete	50	Compost Facility						459e6565-c3a1-4a46-add6-77106ca31cfa	Dan Gagne	Structural	Rainwater has been observed to collect in Purifirs. City should anticipate replacing entire roofing system, Purifirs, and fire sprinklers attached to Purifirs. Mechanical screeners for compost operation were removed when Facility closed.	2.2	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	3	Minor injury	1	No violation	1	Single process or treatment system disruption	3.4	1.8	6.0	2	High Priority
DG Piping	Piping	15	Gas Conditioning System and Piping						62b19e90-732f-475c-beb5-46ec20f396b0	Colin Casey	Mechanical	DG piping on pipe support rack from Digester Control Buildings to Gas Conditioning. Stainless steel piping is in good condition. There was also no noticeable build-up or debris present in piping during the WGB Replacement project assessment in January 2023. Pipe diameter of 8-inch is undersized resulting in too high pressure for CHP engines. City should consider replacing DG piping with 12-inch.	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	3	Minor injury	1	No violation	3	Adjacent process or treatment system disruption	2.5	2.4	6.0	1	Low Priority
SCR Power Center	Transformer	25	Combined Heat and Power Engines		Square D	MP2 Mini Power-Zone	MP2S540F	2018	44de7331-1458-43af-9ac5-6d313a0f87b	Dane Forsberg	Electrical	480V-120/240V - 5 kVA	1.0	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	5	Serious injury or death	1	No violation	1	Single process or treatment system disruption	2.3	2.8	6.0	3	Critical, Low Risk
Field Panel - FP-AD-2	Panel - Local control	15	Anaerobic Digesters	FP-AD-2	Siemens	S7-300		2010	7500cf63-a400-484a-905a-bf48b8ff1b71	Dane Forsberg	Electrical	Siemens S7-300 PLC will be discontinued this year (2023). Spare parts will be available until 2033.	1.0	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.7	2.2	5.9	2	High Priority
Solids Storage LCP	Panel - Local control	15	Cake Pumps and Storage	LCP-166180	Siemens	MP77 HMI			9def4a3f-bc8c-4de6-9823-57bf3a2d165d	Dane Forsberg	Electrical		1.0	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.7	2.2	5.9	2	High Priority
Muffin Monster	Grinder	20	Anaerobic Digesters		Muffin Monster				be586457-e1b1-4cec-a3f0-c8fc4e149d5f5	Colin Casey	Mechanical	Used for grinding and de-bindings solids while dewatering/emptying digesters, sending solids from digesters to gravity belt thickeners.	1.4	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	3	Minor injury	1	No violation	1	Single process or treatment system disruption	3.1	1.8	5.6	2	High Priority
Digester Grinder 4 LCP	Panel - Local control	15	Anaerobic Digesters	LCP-164618	Muffin Monster				afa22c4c-74c6-4bd2-8f93-c1d7b0741802	Dane Forsberg	Electrical		1.0	5	Past Useful Life	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	2.5	2.4	5.5	1	Low Priority
PLC-25	Panel - Local control	15	Waste Activated Sludge Pumps	PLC-25	Siemens	Simatic S7-1200		2013	78aa848c-0e63-46be-9bb5-9e65282e2679	Dane Forsberg	Electrical	WAS PLC.	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.5	2.2	5.5	1	Low Priority

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Primary PLC	Panel - Local control	15	Primary Sludge Pumps	CU-121510	Siemens	S7-300		2011	4fe2802-39d8-4ff1-bb19-5969fdcdf04d	Dane Forsberg	Electrical	Siemens S7-300 PLC will be discontinued this year. Spare parts are available until 2033.	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.6	2.2	5.8	1	Low Priority
Cogen Transformer 1	Transformer	25	Combined Heat and Power Engines	T-118001	Prolec	Envirotemp FR3 Filled	S3213-01-001	2011	dbdbaa26-d7f2-46f1-b448-b91c709cc79c	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	1	Full redundancy for peak operating and service condition	6	Serious injury or death	1	No violation	3	Adjacent process or treatment system disruption	1.7	3.2	5.4	3	Critical, Low Risk
Cogen Transformer 2	Transformer	25	Combined Heat and Power Engines	T-118002	Prolec	Envirotemp FR3 Filled	S3313-01-002	2011	2b720fc3-aec5-4101-8669-e5d506ee1ff8	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	1	Full redundancy for peak operating and service condition	6	Serious injury or death	1	No violation	3	Adjacent process or treatment system disruption	1.7	3.2	5.4	3	Critical, Low Risk
Main Generator Control Panel	Panel - Power distribution	15	Combined Heat and Power Engines	LCP-118200	Siemens	S7-300		2010	429201ef-3975-41ce-ba3a-21208a2489c5	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	5	No redundancy	3	Minor injury	1	No violation	3	Adjacent process or treatment system disruption	2.2	2.4	5.3	1	Low Priority
Dig 1/2 Control Building Equipment	Piping	15	Gas Conditioning System and Piping						a4ba1e4a-06a4-4bad-85ca-c44720c028c8	Colin Casey	Mechanical	Room holding digester gas (DG) piping and compressors for Digesters 1 and 2. DG piping also to existing biogas flare. Piping appears to be in good condition with no noted issues. Insulation on DG piping recently installed. Piping in this room may be undersized for future DG production.	1.0	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	1.7	3.0	5.1	3	Critical, Low Risk
Combined Heat and Power Engines	Engine	20	Combined Heat and Power Engines						ed068f12-5d1a-4634-ad30-7959e7e175e7	Dnji Sharma	Mechanical	According to Director, Engine 1 and 3 are installed such that their exhaust gas may run gas. However, engine 3 and 4 are different do not have a limit to how much gas they can take in. Resulting in the engines being differently programmed. Both Richard and Christian stated Cummins engine parts are hard to get. They had to shut down CHP Engine 4 for around 2 years because they couldn't get the parts. Engines 1 (40k hours) and 3 (40k hours) are still in need of 24,000 hour service. The goal is to bring simplicity back to the room. They don't want the engines to be programmed differently from one another. The operating crew does not know how the gas sensors, operate. Starting on heat recovery make 1	1.4	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	2	Full redundancy for average operating and service condition	1	No injury	5	Violation(s)	3	Adjacent process or treatment system disruption	1.8	3.8	5.1	3	Critical, Low Risk
Digester 4 Gallery	Concrete	50	Anaerobic Digesters						b9f4b281-5065-45b0-a492-88babd3392da	Dan Gagne	Structural	Vertical cracking on walls of Digester 4 gallery	1.0	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	1	No violation	1	Single process or treatment system disruption	2.8	1.8	5.0	2	High Priority
Generator 1 Battery Charger	Battery Charger	25	Combined Heat and Power Engines	BATC-118110	SENS	EnerGenius IQ	318108	2012	ba8ebfcd-4b2e-4df9-8cd1-61545e7c841c	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	2	Full redundancy for average operating and service condition	6	Serious injury or death	1	No violation	1	Single process or treatment system disruption	1.0	2.6	4.0	3	Critical, Low Risk
Gravity Belt Thickener PLC	Panel - Local control	15	Gravity Belt Thickeners	PCP-167430	Siemens	S7-300		2015	96266e7fb-cdd7-4e9f-8d51-bbb03ac4fd2f9	Dane Forsberg	Electrical	Siemens S7-300 PLC will be discontinued this year (2023). Replacement parts will be available until 2033.	1.0	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	1	No injury	3	Potential violation	1	Single process or treatment system disruption	2.8	1.6	4.5	2	High Priority
BFP Sludge Pumps	Pump - Progressive Cavity	20	Belt Filter Presses		Wemco				2ae6049a-2a79-41be-8814-02fd36aa7dd3	Colin Casey	Mechanical	Two sludge feed pumps feed the 4 belt filter presses. Pumps are located in basement of Belt Filter Press (Biosolids Dewatering) Building. Some corrosion identified on pump feed and discharge piping. Pumps are near their end of useful life. No significant operation or maintenance concerns.	1.0	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	3	Full redundancy for low operating and service condition	1	No injury	3	Potential violation	1	Single process or treatment system disruption	2.8	1.6	4.4	2	High Priority
BFP 3	Belt Filter Press	25	Belt Filter Presses						88467a0b-5f9f-4995-934b-57c020b3a20c	Colin Casey	Mechanical	There are four (4) belt filter presses in the BFP (Biosolids Dewatering) building, with two BFPs in-service at a time, typically operating at 60 GPM/each on 24x7 schedule, except for Sundays, when solids hauling is not available. BFP capacity is greater than demand. City needs to add water after BFP operation for successful solids cake pump operation, resulting in wetter biosolids and increased solids hauling costs. BFP 1 and 2 were recently rebuilt. BFP 3 and 4 are older and require rehab soon. BFP drying target is 15% TS	1.0	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	1	Full redundancy for peak operating and service condition	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.0	2.2	4.4	1	Low Priority
Digester 3 Gallery	Concrete	50	Anaerobic Digesters					1983	7360801-98ae-44d4-8942-276b393e8be4	Dan Gagne	Structural	There were no leaks observed like those observed in the Digester 4 Gallery. There was some separation of expansion joint within the gallery.	1.4	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	4	Some redundancy	3	Minor injury	1	No violation	1	Single process or treatment system disruption	2.4	1.8	4.4	1	Low Priority
PLC-13	Panel - Local control	15	Belt Filter Presses	PLC-13	Siemens	S7-300		2015	530f2158-7b6e-4a91-bac6-472527a52333	Dane Forsberg	Electrical		1.0	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	3	Potential violation	1	Single process or treatment system disruption	2.7	1.6	4.3	2	High Priority
PLC-19	Panel - Local control	15	Gas Conditioning System and Piping	PLC-19	Siemens	S7-300		2023	fa838da3-4b90-4e2b-ade4-f808d2041852	Dane Forsberg	Electrical	Siemens S7-300 PLC will be discontinued this year (2023). Spare parts will be available until 2033.	1.0	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	1	No violation	3	Adjacent process or treatment system disruption	2.7	1.6	4.3	2	High Priority
WAS Pump Structural	Concrete	50	Waste Activated Sludge Pumps						a924541c-909d-483d-a9c0-df1f69fa5a22	Dan Gagne	Structural	No structural deficiencies noted.	1.0	1	30 yrs or more	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	4	Some redundancy	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	1.9	2.2	4.2	1	Low Priority
WAS Pumping Station	Pump - Progressive Cavity	20	Waste Activated Sludge Pumps		Gorman Rupp, Super T-Series	T8A3S-B			7577a9fc-5886-40d8-b62d-60295f80acc3	Colin Casey	Mechanical	Current configuration includes two identical self-priming centrifugal pumps by Gorman Rupp, Super T-Series, pulling WAS from ML channel. Pumps have multi-vane impeller for higher head applications, handles up to 3" diameter solids. There may be a benefit to change pump type allowing pumps to be installed in a lower WAS pit, reducing the suction lift while improving purging efficiency. Current condition of WAS pumps is good and does not require significant O&M.	1.0	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	3	Full redundancy for low operating and service condition	1	No injury	1	No violation	3	Adjacent process or treatment system disruption	2.6	1.6	4.2	2	High Priority
Generator 1	Generator	25	Combined Heat and Power Engines	G-118110	Cummins			2012	d7e38a04-a1c0-412f-99a1-5221708a776b	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	6	Serious injury or death	1	No violation	1	Single process or treatment system disruption	1.6	2.6	4.2	3	Critical, Low Risk
Generator 2	Generator	25	Combined Heat and Power Engines	G-118120	Cummins			2012	04ea1641-934c-4106-968b-8897ac0b17d5	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	6	Serious injury or death	1	No violation	1	Single process or treatment system disruption	1.6	2.6	4.2	3	Critical, Low Risk
Generator 3	Generator	25	Combined Heat and Power Engines	G-118140	Cummins			2012	3b8cdde0-3c92-4b0f-a4df-9178307096f2e	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	6	Serious injury or death	1	No violation	1	Single process or treatment system disruption	1.6	2.6	4.2	3	Critical, Low Risk
Generator 4	Generator	25	Combined Heat and Power Engines	G-118140	Cummins			2012	35a26e85-dc8e-4918-a156-82a0ffb271216	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	6	Serious injury or death	1	No violation	1	Single process or treatment system disruption	1.6	2.6	4.2	3	Critical, Low Risk
Lube Oil Pump Panel	Motor Starter Panel	30	Combined Heat and Power Engines	LCP-118151				2012	275bb67e-db72-4898-ad37-fd46df07e78e	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	6	Serious injury or death	1	No violation	1	Single process or treatment system disruption	1.6	2.6	4.2	3	Critical, Low Risk
Gravity Belt Thickener	Gravity Belt Thickener	20	Gravity Belt Thickeners					1996	3034526a-287a-4c41-9409-560e01578e10	Colin Casey	Mechanical	There are 3 GBTs installed with a 4th pad available for additional capacity. GBT #3 is used for digester re-cooperation when only three of four digesters are in operation. The City noted there is a lack of redundancy and capacity in the GBTs. There are 2 thickened sludge pumps for 3 GBTs, which are past their useful life and need replacement. City noted that they will be installing a new polymer blending tank soon. GBTs are rated for 340 gpm. Currently operate at 220 gpm to meet performance requirements.	1.0	5	Past Useful Life	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	3	Full redundancy for low operating and service condition	1	No injury	3	Potential violation	1	Single process or treatment system disruption	2.5	1.6	4.0	1	Low Priority
Cogen Engine 1	Engine	20	Combined Heat and Power Engines					2010	ab92c808-c18f-48a7-b84e-c8d7f7f7806e	Colin Casey	Mechanical	One of four (4) cogeneration engines installed during the 2010 CHP Cogen project. Only 3 or engines typically run at a time. All engines were noted as running past their recommended service for hours in operation. Gas sensors were noted as needing replacement. Getting spare parts from Cummins has been difficult. Cogen Engines 3 and 4 have selective catalytic reducers (SCR) under the LTPs air permit. Cogen Engines 1 and 2 do not have SCRs, yet. This causes some operational issues with the air permit, and the City would prefer that all engines have SCRs. City's goal is to operate this system more simply. No major issues noted or observed.	1.0	2	21 to 30 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	1	No injury	5	Violation(s)	3	Adjacent process or treatment system disruption	1.4	2.8	3.9	3	Critical, Low Risk
Digester Grinder 3 LCP	LCP	15	Anaerobic Digesters	LCP-165611	Muffin Monster	PC2200	13673	2023	0ed7d0da-10a3-415f-b10e-e3bd516c1cf1	Dane Forsberg	Electrical	PLC inside	1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	1	Single process or treatment system disruption	1.0	2.4	3.8	1	Low Priority
GBT HVAC System	HVAC	12	Gravity Belt Thickeners						83d1731f-5814-4504-97af-ba2144ff83aeb	Colin Casey	Mechanical	HVAC system noted by City as being past its useful life and needing replacement.	2.0	5	Past Useful Life	4	Poor - Replacement or rebuilding is required. Failure is imminent.	5	No redundancy	1	No injury	1	No violation	1	Single process or treatment system disruption	3.8	1.0	3.8	2	High Priority
Digester Sludge Pumps	Pump	15	Anaerobic Digesters						7ff0496c2-0dbe-4f20-962f-b0ce665cfa6d	Colin Casey	Mechanical	Four pumps, 1 per digester, to send digested sludge to Belt Filter Press. Heat exchangers in 1 and 2 are smaller than 3 and 4, and City plans to replace these in house.	1.0	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	4	Some redundancy	3	Minor injury	1	No violation	1	Single process or treatment system disruption	2.1	1.8	3.8	1	Low Priority
Iron Sponge	H2S removal	20	Gas Conditioning System and Piping						9d80ba9e-709f-4170-80bb-a820a0911c0b	Colin Casey	Mechanical	Iron sponge for H2S removal at the digester gas going to Gas Conditioning and CHP engines. Includes two stainless steel vessels which cannot be run in series; must be run in parallel, typically 1 at a time. Media is replaced every 4-6 months per vessel. Capacity is pf 365 scfm is sufficient for current gas production, however, may be undersized for future DG production. City would like to be able to run this operation in series. At times, City operates these at 400 scfm.	1.0	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	4	Some redundancy	3	Minor injury	1	No violation	1	Single process or treatment system disruption	2.1	1.8	3.8	1	Low Priority
Selective Catalytic Reducer (SCR)	SCR	25	Combined Heat and Power Engines						eaabb4c5-71df-4d5a-9e4b-676644fc3dc58	Colin Casey	Mechanical	SCRs are only installed on CHP engines 3 and 4. SCRs may have capacity issue at full capacity. SCRs are not typically not run to capacity. Installed after CHP project to meet air permit for NOx removal.	1.0	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	2	Full redundancy for average operating and service condition	1	No injury	5	Violation(s)	1	Single process or treatment system disruption	1.7	2.2	3.7	1	Low Priority
Compost Facility	Concrete	50	Compost Facility					1996	46e46908-ac24-4405-a752-7463615e7178	Colin Casey	Mechanical	The Compost Facility is no longer in service. If the Compost Facility was brought back in to service, several major rehab/replacement projects would be required, including structural improvements to the building, roofing, fire suppression, HVAC, new biofilter media, and improvements to the mechanical and electrical processing equipment. The City noted that the success of the Compost Facility operation is dependant on having knowledgeable and dedicated staff for this process area.	1.4	5	Past Useful Life	5	Out of Service - Asset is longer in service and needs to be replaced	4	Some redundancy	1	No injury	1	No violation	1	Single process or treatment system disruption	3.7	1.0	3.7	2	High Priority
Primary Sludge Pump 7	Pump - Progressive Cavity	20	Primary Sludge Pumps						10a76f79-5c7a-40e6-80b8-332617ee83b5	Dnji Sharma	Mechanical		1.0	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	1	No violation	3	Adjacent process or treatment system disruption	2.5	1.6	3.7	1	Low Priority
HSW Receiving Structural	Concrete	50	High Strength Waste Receiving Station						6ad720f8-c25d-4768-828d-44671dde4c5b7	Dan Gagne	Structural	No structural deficiencies identified.	1.0	1	30 yrs or more	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	1.2	3.0	3.6	3	Critical, Low Risk
Polymer blend pumps	Pump - Chemical	15	Belt Filter Presses						696e4282-d886-4cf9-86fb-0bcfc9d948b7	Colin Casey	Mechanical	Four new polymer blending tanks for 4 BFPs. No significant maintenance or operational issues noted by City staff.	1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	1	Full redundancy for peak operating and service condition	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	1.4	2.2	3.1	1	Low Priority
HSW Receiving	Miscellaneous	25	High Strength Waste Receiving Station						baf8214a-79fc-4dd8-b4f8-d5d79e1c50c4	Colin Casey	Mechanical	WSW volumes have been increasing and City notes that capacity is limited and they could use 2 more tanks in future. Condition of tanks and equipment is good, with no identifiable deterioration. City would like to add a second odor control scrubber to run in series to improve redundancy and avoid breakthrough of gasses during O&M of existing scrubber.	1.0	2	21 to 30 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	1.4	2.2	3.1	1	Low Priority
Scum Ejector 1	Ejector	20	Primary Sludge Pumps						42c14a1d-c41B-49a1-9903-644c13c9c925	Colin Casey	Mechanical	Scum ejectors are located adjacent to primary sludge pumps and require routine O&M effort to avoid spillage and over-pressurizing. Pneumatic ejector pump includes a tank for holding fluid sewage, once the sewage reaches a predetermined level in the tank, the contents are ejected by compressed air. Scum ejectors are past their useful life and are recommended for replacement.	2.4	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	2	Full redundancy for average operating and service condition	1	No injury	1	No violation	1	Single process or treatment system disruption	3.0	1.0	3.0	2	High Priority
Generator 2 Battery Charger	Battery Charger	25	Combined Heat and Power Engines	BATC-118120	SENS	EnerGenius IQ		2012	c3b3ef90-bbd5-405e-9d33-458cfd3970d	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	3	Minor injury	1	No violation	1	Single process or treatment system disruption	1.6	1.8	2.9	1	Low Priority
Generator 3 Battery Charger	Battery Charger	25	Combined Heat and Power Engines	BATC-118130	SENS	EnerGenius IQ	318104	2012	3fb5fd99-1dcf-435c-ba14-ca1e90f9d6cf	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	3	Minor injury	1	No violation	1	Single process or treatment system disruption	1.6	1.8	2.9	1	Low Priority
Generator 4 Battery Charger	Battery Charger	25	Combined Heat and Power Engines	BATC-118140	SENS	EnerGenius IQ	318103	2012	4d6b95b6-c395-431c-9b8d-9e2dfc1c6587	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	3	Minor injury	1	No violation	1	Single process or treatment system disruption	1.6	1.8	2.9	1	Low Priority
Generator Switchgear Battery Charger	Battery Charger	25	Combined Heat and Power Engines	BATC-118201	SENS	EnerGenius IQ		2012	893df77f-fd87-4974-9ce3-cfe00af87de5	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	3	Minor injury	1	No violation	1	Single process or treatment system disruption	1.6	1.8	2.9	1	Low Priority
Waste Oil Pump Panel	Motor Starter Panel	30	Combined Heat and Power Engines	LCP-118153				2012	0a27dd86-83cd-4934-8a55-1bad00013f11	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	3	Minor injury	1	No violation	1	Single process or treatment system disruption	1.6	1.8	2.9	1	Low Priority
Septage Receiving	Barscreen - Bar and Rack	25	Septage Receiving Station						9c22f2dd-41b3-41bd-80db-a30a7d9e8c07	Dnji Sharma	Mechanical	Mechanical screens and hoppers had corrosion but were fine otherwise.	1.2	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	1	No injury	1	No violation	1	Single process or treatment system disruption	2.9	1.0	2.9	2	High Priority
HSW Unloading LCP	LCP/ HMI	15	High Strength Waste Receiving Station	HMI-114300	Siemens	Simatic		2015	21106608-bc78-4f57-adee-10b52a7d929e	Dane Forsberg	Electrical		1.0	4	1 to 10 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	5	No redundancy	1	No injury	1	No violation	1	Single process or treatment system disruption	2.7	1.0	2.7	2	High Priority
Motors, Air Filter	Motor - Greater than 5 HP	25	High Strength Waste Receiving Station						851863 1c-47d9-4a82-86f9-bf0575de0b6	Dnji Sharma	Mechanical	Richard noted a lot of clogging is occurring in the HSW station due to there not being any screen when the HSW is added. Air filtration is a concern, they dont know if its working for how much HSW theyre taking in.	1.0	1	30 yrs or more	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	1.2	2.2	2.6	1	Low Priority
Cake Hoppers	Miscellaneous	25	Cake Pumps and Storage						422b8782-1279-4652-a145-610c076e0d1a	Dnji Sharma	Mechanical	Cake Hoppers were in good condition. Automatic gates to let cake out of the hoppers were working.	0.8	2	21 to 30 yrs	1	Excellent - New or like new condition	1	Full redundancy for peak operating and service condition	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	1.2	2.2	2.6	1	Low Priority

Santa Rosa BMSP
Biosolids Condition Assessment
Visual Observation Asset List

									VISUAL INSPECTIONS				LIKELIHOOD OF FAILURE (LoF)						CONSEQUENCE OF FAILURE (CoF)						ASSET RISK				
									INSPECTION RECORD				Observation score provided by inspectors during visual inspection 0.3	Number of years an asset has remaining before it no longer provides the required level of service 0.2		General condition observed by O&M and BC staff during visual inspections, ranging from no known issues to out of service. 0.3		Addition of equipment above what is required for optimal performance 0.3		Reduced safety, or potential for serious injury or death caused as a result of asset failure 0.4		Environmental or regulatory compliance violation issued as a result of asset failure 0.3		Impact to a single or multiple process or treatment systems as a result of asset failure 0.3		LOF Criteria Scoresx Criteria Weight	COF Criteria Scores x Criteria Weight	Risk Score = LOF x COF	Risk Zones and Description 1 = Low Priority 2 = High Priority 3 = Critical, Low Risk 4 = Critical, High Risk	
ASSET DESCRIPTION	EQUIPMENT TYPE	TYPICAL LIFE (YEARS)	LOCATION	EQUIPMENT NUMBER	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	INSTALL/ RENAS YEAR	FULCRUM ID	INSPECTOR	DISCIPLINE	INSPECTION NOTES	OBSERVATION	REMAINING USEFUL LIFE		CONDITION		REDUNDANCY		PUBLIC/EMPLOYEE SAFETY		ENVIRONMENTAL COMPLIANCE		SYSTEM DISRUPTION		LoF SCORE	CoF SCORE	RISK SCORE	RISK ZONE	RISK ZONE DESCRIPTION
Digestor 1-4 Heat Exchanger LCPs	Programmable controller	15	Anaerobic Digesters		Siemens	Simatic	S7-1200	2016	4430ac04-ee2c-4e3c-8640-baa5f8b989a5	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	1	No injury	3	Potential violation	1	Single process or treatment system disruption	1.0	1.0	2.0	1	Low Priority
RIO Cabinet	Remote IO	25	High Strength Waste Receiving Station	RIO-114300	Siemens	Simatic ET 200M		2016	f974793a-129d-484c-81c2-5ec9e434b958	Dane Forsberg	Electrical	Corroded and Failed. Last week (2023) Controles by PLC 5	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	3	No redundancy	1	No injury	1	No violation	1	Single process or treatment system disruption	2.5	1.0	2.5	1	Low Priority
Strain Press	Filterpress	22	Belt Filter Presses		Huber				940f7392-8c8d-4e45-9b74-691624330ef9	Colin Casey	Mechanical	Single strain press installed upstream of BFP. This system is currently not in use and is scheduled for repair. There is an open spare pad/location for a second strain press.	1.0	3	11 to 20 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	3	No redundancy	1	No injury	1	No violation	1	Single process or treatment system disruption	2.5	1.0	2.5	1	Low Priority
Primary Sludge Pump 8	Pump - Progressive Cavity	20	Primary Sludge Pumps						428a3aa2-117d-4f3c-9943-9a400240f226	Divji Sharma	Mechanical	Pump was in good condition. Pump Tag was completely scratched and hard to read. Primary Sludge Pump 7 was better.	1.0	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	1	Full redundancy for peak operating and service condition	1	No injury	1	No violation	3	Adjacent process or treatment system disruption	1.5	1.6	2.4	1	Low Priority
PLC-48	Programmable controller	15	Combined Heat and Power Engines	PLC-48	Siemens	Simatic S7-300		2010	0ad67855-e202-40d6-9f33-6fd646bf15b9	Dane Forsberg	Electrical		1.0	3	11 to 20 yrs	1	Excellent - New or like new condition	3	No redundancy	1	No injury	1	No violation	1	Single process or treatment system disruption	2.2	1.0	2.2	1	Low Priority

Attachment B: R&R Project List and Results

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Santa Rosa BMSP
Biosolids Condition Assessment
R&R Project List

			VISUAL INSPECTIONS	LIKELIHOOD OF FAILURE (LoF)							CONSEQUENCE OF FAILURE (CoF)						ASSET RISK				
			INSPECTION RECORD	Observation score provided by inspectors during visual inspection		Number of years an asset has remaining before it no longer provides the required level of service		General condition observed by O&M and BC staff during visual inspections, ranging from no known issues to out of service.		Addition of equipment above what is required for optimal performance		Reduced safety, or potential for serious injury or death caused as a result of asset failure		Environmental or regulatory compliance violation issued as a result of asset failure		Impact to a single or mulitiple process or treatment systems as a result of asset failure		LOF Criteria Scores x Criteria Weight	COF Criteria Scores x Criteria Weight	Risk Score = LOF x COF	Risk Zones and Description 1 = Low Priority 2 = High Priority 3 = Critical, Low Risk 4 = Critical, High Risk	
				0.3		0.2		0.3		0.2		0.4		0.3		0.3						
BC ASSET ID	ASSET DESCRIPTION	LOCATION	INSPECTION NOTES	OBSERVATION		REMAINING USEFUL LIFE		CONDITION		REDUNDANCY		PUBLIC/EMPLOYEE SAFETY		ENVIRONMENTAL COMPLIANCE		SYSTEM DISRUPTION		LoF SCORE	CoF SCORE	RISK SCORE	RISK ZONE	RISK ZONE DESCRIPTION
BC-001	HSW Odor Scrubber Improvements	HSW receiving facility	HSW volumes have been increasing and City notes that capacity is limited and they could use 2 more tanks in future. Condition of tanks and equipment is good, with no identifiable deterioration. City would like to add a second odor control scrubber to run in series to improve redundancy and avoid breakthrough of gasses during O&M of existing scrubber. City intends to complete installation of a second odor control scrubber in-house.	1.0	2	21 to 30 yrs	1	Excellent - New or like new condition	2	Full redundancy for average operating and service condition	1	No injury	5	Violation(s)	3	Adjacent process or treatment system disruption	1.4	2.8	3.9	3	Critical, Low Risk
BC-002	Digester Dewatering Pump Replacement	Anaerobic digesters	Single 400 GPM dewatering pump for all 4 anaerobic digesters. Pump is past its useful life and should be replaced. Existing pump is oversized and runs at it's lowest speed on a VFD. There is no bypass or redundancy for the existing pump. BC recommends installing 2 smaller pumps of half the capacity and overhead motors. Access to replace pump in existing pump room beneath digester gallery will be difficult.	2.4	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	5	No redundancy	3	Minor injury	1	No violation	5	Facility-wide disruption	3.6	3.0	10.9	4	Critical, High Risk
BC-003	Ferric Chloride Improvements	Ferric chloride	Tanks and piping need to be replaced. Feeds headworks. Chem is expensive -$300k last year.	1.8	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	3.0	3.0	9.1	4	Critical, High Risk
BC-004	Digester Gas Mixing Improvements	Anaerobic digesters	Replace digester gas mixing system on each of the four digesters.	1.2	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	1	No injury	3	Potential violation	3	Adjacent process or treatment system disruption	2.9	2.2	6.3	2	High Priority
BC-005	GBT Sludge Pump Replacement	Gravity belt thickeners	There are two gravity belt thickener (GBT) sludge pumps for 3 GBTs, which send WAS solids from GBT to digesters. Both pumps are passed their useful life and should be replaced.	2.0	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	1	No violation	3	Adjacent process or treatment system disruption	3.3	2.4	7.9	2	High Priority
BC-006	SCR Installation for CHP Engines 1 and 2	Cogeneration	SCRs are only installed on CHP engines 3 and 4. SCRs may have capacity issue at full capacity. SCRs are not typically not run to capacity. Installed after CHP project to meet air permit for NOx removal.	1.0	2	21 to 30 yrs	2	Good - Cosmetic defects but in good working order, maintenance not anticipated	2	Full redundancy for average operating and service condition	1	No injury	5	Violation(s)	1	Single process or treatment system disruption	1.7	2.2	3.7	1	Low Priority
BC-007	BFP Cake Pump Replacement	Belt filter press	Current cake pumps (progressive cavity) require recently dewatered solids from belt filter press be wetted, so that pumps can pump finished biosolids to storage hopper. Recommendation to replace existing cake pumps with Schwing Bioset cake pumps, or similar.	2.4	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	3	Full redundancy for low operating and service condition	3	Minor injury	1	No violation	3	Adjacent process or treatment system disruption	3.0	2.4	7.2	2	High Priority
BC-008	WAS Pump Replacement	WAS pumps	Current configuration includes two identical self-priming centrifugal pumps by Gorman Rupp, Super T-Series, pulling WAS from ML channel. Pumps have multi-vane impeller for higher head applications, handles up to 3" diameter solids. There may be a benefit to change pump type allowing pumps to be installed in a lower WAS pit, reducing the suction lift while improving pumping efficiency. Current condition of WAS pumps is good and does not require significant O&M.	1.0	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	3	Full redundancy for low operating and service condition	1	No injury	1	No violation	3	Adjacent process or treatment system disruption	2.6	1.6	4.2	2	High Priority
BC-009	Electrical Site Improvements	Multiple areas	Replace five MCC units, five lighting pannelboards, and five lighting transformers and one PLC	1.6	4	1 to 10 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	4	Some redundancy	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	3.0	3.0	8.9	4	Critical, High Risk
BC-010	Compost Facility Improvements	Compost facility	The Compost Facility is no longer in service. If the Compost Facility was brought back in to service, several major rehab/replacement projects would be required, including structural improvements to the building (roofing, fire suppression, HVAC), new biofilter media, and improvements to the mechanical and electrical processing equipment. The City noted that the success of the Compost Facility operation is dependent on having knowledgeable and dedicated staff for this process area.	1.4	5	Past Useful Life	5	Out of Service - Asset is longer in service and needs to be replaced	4	Some redundancy	1	No injury	1	No violation	1	Single process or treatment system disruption	3.7	1.0	3.7	2	High Priority
BC-011	Structural Improvements	Multiple areas	Crack sealing at SRS, Digester galleries, GBT room, and BFP room. Joint repair in Digester galleries, BFP room, and SCR room. Conduit water infiltration repair in the Digester galleries. Rust repair at CHPs and Flare.	3.0	3	11 to 20 yrs	3	Fair - Asset needs or will soon need rebuilding or replacing	3	Full redundancy for low operating and service condition	3	Minor injury	3	Potential violation	3	Adjacent process or treatment system disruption	3.0	3.0	9.0	4	Critical, High Risk
BC-012	Scum Pot Replacement	Primary sludge pumps	Scum ejectors are located adjacent to primary sludge pumps and require routine O&M effort to avoid spillage and over-pressurizing. Pneumatic ejector pump includes a tank for holding fluid sewage, once the sewage reaches a predetermined level in the tank, the contents are ejected by compressed air. Scum ejectors are past their useful life and are recommended for replacement.	2.4	5	Past Useful Life	3	Fair - Asset needs or will soon need rebuilding or replacing	2	Full redundancy for average operating and service condition	1	No injury	1	No violation	1	Single process or treatment system disruption	3.0	1.0	3.0	2	High Priority

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Attachment C: Visual Observation Forms

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Appendix C: Digester 3 Visual Assessment TM

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BMSP Cap Impr Impl Plan Final

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BMSP Cap Impr Impl Plan Final

Brown AND Caldwell

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T: 916.444.0123

Technical Memorandum
FINAL

Prepared for: City of Santa Rosa

Project Title: Biosolids Strategic Master Plan

Project No.: 157568

Technical Memorandum

Subject: Digester 3 Visual Assessment

Date: February 2, 2024

To: Tanya Mokvyts, City of Santa Rosa

From: Colin Casey, Brown and Caldwell

Copy to: Mike Prinz, City of Santa Rosa

Prepared by: _____
Michael Russu, Brown and Caldwell

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Reviewed by: _____
Dan Gagne, P.E., Brown and Caldwell
California License, No. C63095



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Section 1: Introduction

This technical memorandum (TM) documents Brown and Caldwell's (BC) visual assessment of Digester 3 at the City of Santa Rosa's (City) Laguna Wastewater Treatment Plant (LTP). The assessment was completed on December 22, 2022 as part of the City's Biosolids Strategic Master Plan (BSMP). The assessment was completed by Dan Gagne (lead structural engineer), Michael Russo (structural support), and Colin Casey (lead mechanical engineer). The assessment required a confined space entry with visual observation of the interior digester structure and equipment within Digester 3, including the interior digester walls, flooring, columns, pipe supports, piping, and mixing equipment. The purpose of the assessment was to document the current physical condition of the interior of the digester and any immediate rehabilitation or repairs needed.

1.1 Background

The LTP has four anaerobic digesters which stabilize solids as part of the overall wastewater treatment process. Two of these digesters, Digesters 1 and 2, have floating covers and were constructed in the mid-1970's. Re-roofing of Digesters 1 and 2 floating covers was completed with the support of BC in 2019 and 2020, respectively. Digesters 3 and 4 have fixed covers and were constructed in the late 1980's and early 1990's. Digester 3 was constructed in 1986, putting the age of the digester at nearly 40-years. Digester 3 is a 75-foot interior diameter concrete structure with 1-foot 6-inch thick conventionally reinforced concrete sidewalls. The Digester 3 cover is a 10-inch-thick reinforced fixed concrete roof. The height of the digester is approximately 36-feet with approximately 20-feet above surface grade and 16-feet below grade. The floor of the digester slopes inward toward the center of the digester with a center elevation 3-feet below the digester side walls. The mechanical and structural record drawings of Digester 3 are provided in Attachment A.

1.2 Digester Access

Prior to BC's entry, the interior of Digester 3 was cleaned and vented by the City to provide entrants a safe working environment for entry and assessment. Hatches on top of the digester cover were opened before the assessment to ensure no fugitive gasses remained in the digester. All hatches were kept open during the assessment to provide adequate ventilation and lighting for visual observations. Gas monitoring was performed by BC throughout the assessment with no measurable amount of hydrogen sulfide or methane gasses detected. Confined space entry was established by the City through an existing hatch opening on top of the Digester 3 cover with a single-person safety cage, tripod, safety cable, and fitted harness. A photo showing the access point and safety equipment is included Figure 1. Access inside the digester was limited to the digester floor as ladders, scaffolding, and equipment were not available to access the top of the interior digester walls, columns, or the underside of the fixed concrete cover. Piping, mixing equipment, equipment anchorage, and concrete joints within the digester were observed.

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Figure 1. Visual assessment access point on Digester 3 cover

Section 2: Methods and Results

The Digester 3 visual assessment consisted of observations, notes, and photographs of the interior walls, floor, and equipment visible from the floor of the digester. Delamination tests were done on the bottom 5-feet of the wall and support columns using a sounding technique. Physical testing, coating thickness measurements, and sampling of the digester structure and equipment was not performed.

2.1 Delamination Testing

A sounding technique was used by BC to test the interior concrete walls and columns for concrete delamination. Delamination often occurs when corrosion is present on the reinforcing steel and causes the outer layer of concrete to separate from the main body. Knocking a small hammer lightly against a wall and listening for any dull or hollow sounding of concrete is a method to identify delaminated areas. BC observed no evidence of softened or delaminated concrete when performing sounding tests on the Digester 3 walls and support columns. An example of BC's delamination testing on the Digester 3 walls is shown on Figure 2.

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Figure 2. Delamination testing (sounding) of Digester 3 walls

2.2 Visual Observations

The concrete within Digester 3 was observed to be in generally good condition with normal wear and tear consistent with the structure age (approximately 40 years). There were, however, some areas of staining and pealing of the coating on the interior digester walls, which could be addressed through sandblasting and recoating. It was also observed that sections of joint sealant between the concrete floor slabs had partial loss of adhesion from its original substrate. Adhesion loss is a sign of the sealants age and may indicate failure of the joint to maintain a watertight seal. Photos of failed digester wall coatings and joint sealant are provided in Figure 3.

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Figure 3. Coating failure (left) and joint sealant (right)

Despite the coating failure, no cracking, spalling or other signs of concrete deterioration were visible in the bottom half of the digester walls. Unsurprisingly, concrete above the normal waterline within the digester where exposure to higher concentrations of hydrogen sulfide and methane gases occur was observed to be in worse condition. Visibility of the upper half of the digester walls was limited based on the assessment team's sight distance, however, loss of surface concrete and exposed aggregate was visible at the top of the support columns and on the underside of the digester cover adjacent to the walls. Photos documenting the condition of the concrete support column and underside of digester cover are shown in Figure 4.



Figure 4. Digester 3 support column (left) and underside of digester cover (right)

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Pipe supports within the digester appear to be overall in good condition with the exception of the corroded original anchors. It appears a retrofit strategy was used to anchor the pipe straps; however, the retrofit approach does not provide the equivalent capacity of the original anchor. The digester mixing equipment appeared to be in good condition with some staining and peeling of the concrete coating. Photos showing the condition of the Digester 3 mixing equipment and pipe supports are shown in Figure 5.



Figure 5. Digester 3 mixing equipment (left) and pipe strap retrofit (right)

A single location on the digester floor with a pooled rusting spot was observed, as shown in Figure 6. The source of the rust could not be identified, as no exposed rebar or corroded steel was observed in the area. It is assumed the source of the rust was removed from the digester.



Figure 6. Observed rust spot on Digester 3 floor

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Pressure reliefs valves encased in concrete floor blocks appeared to be operable, although the seal of the valve was not checked. Severe rusting and remnant digester sludge was observed on the inside of the pipe when opening the valve flap, as shown in Figure 7.



Figure 7. Inside view of a Digester 3 pressure relief valve

Section 3: Recommendations

Recommendations for Digester 3 were developed based on BC's visual assessment and include the following:

- The coating system that is protecting the interior concrete from degradation has failed. Because of this failure, the concrete surface is more susceptible to deterioration during operation of the digester until it is recoated. While observations indicated that the concrete is generally in good condition, recoating of the interior and underside of the digester's concrete cover is recommended to avoid further degradation. Minor repair of the interior concrete wall surface above the normal waterline should be anticipated.
- A full recoat of the piping and appurtenances within the digester is recommended.
- If recoating is not completed, a follow-up assessment of the digester should be completed within 2-years with a focus on the upper portion of the digester walls and support columns.
- Resealing of concrete slab joints that show signs of failure.
- Cleaning and exercising of all pressure release valves to ensure functional operation with minimal leaking.
- Replacement of corroded anchors on the digester mixing pipe straps.

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Attachment A: Digester 3 Record Drawings

Select drawing sheets from the 1989-0177 record drawing set

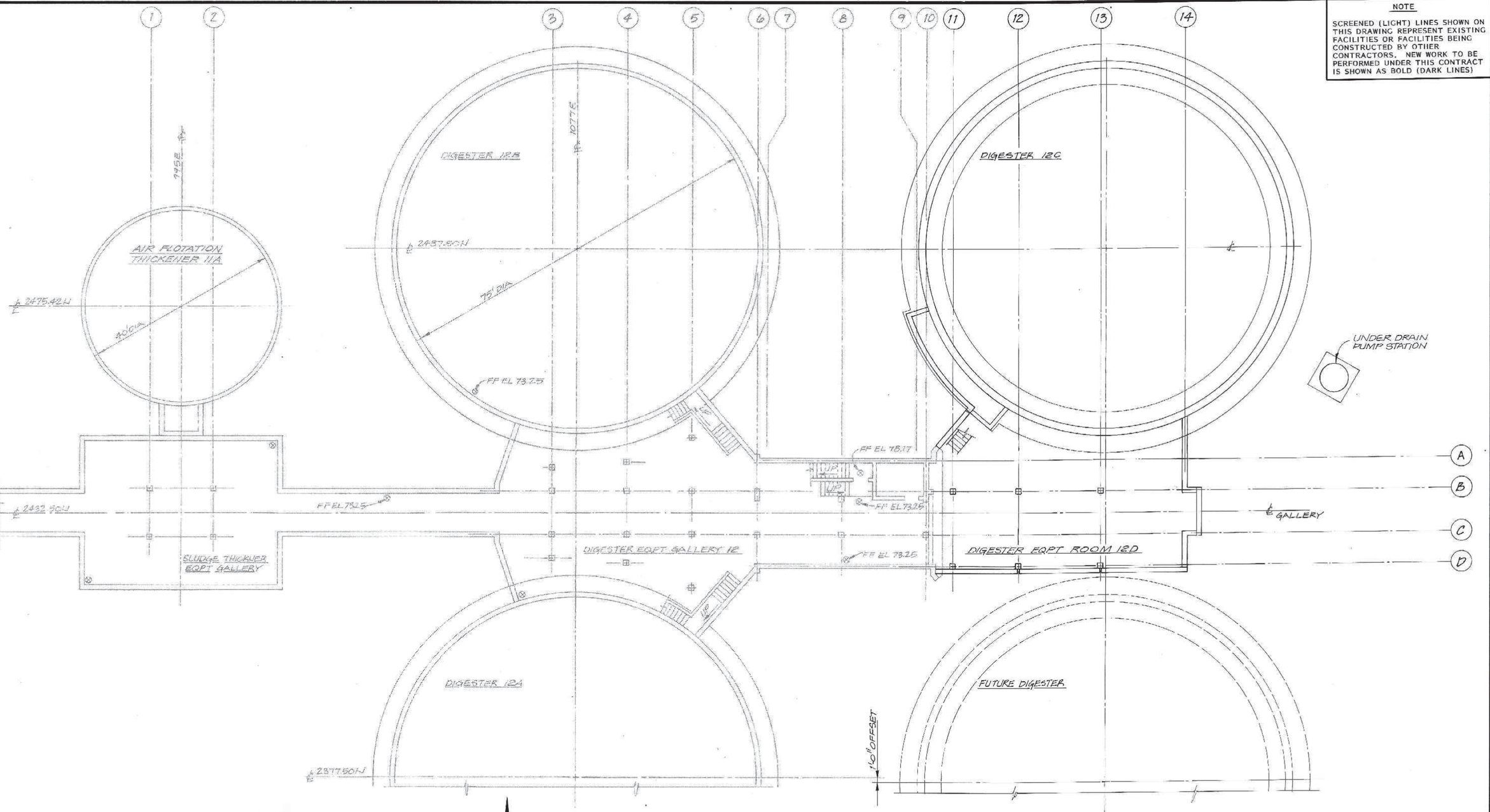
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PLAN - BELOW GRADE

1"=10'

NOTE: THIS DWG IS FOR GENERAL ORIENTATION ONLY

RECORD DRAWINGS

Revisions Drawn by W. Womble Date 8-89

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APPROVED BY: Miles Ferris DATE: 11/24/86
MILES FERRIS, DIRECTOR OF UTILITIES

REGISTERED PROFESSIONAL ENGINEER JEFFREY R. MATHEWS STRUCTURAL STATE OF CALIFORNIA

CH2M HILL

DSGN	S.A. Smith
DR	C.D. MacDonald
CHK	J. Mathews
APVD	A.L. KERNKAMP

NO.	DATE	REVISION	BY	APVD

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WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

SOLIDS DIGESTION FACILITIES
DIGESTER FACILITY PLAN - ABOVE GRADE

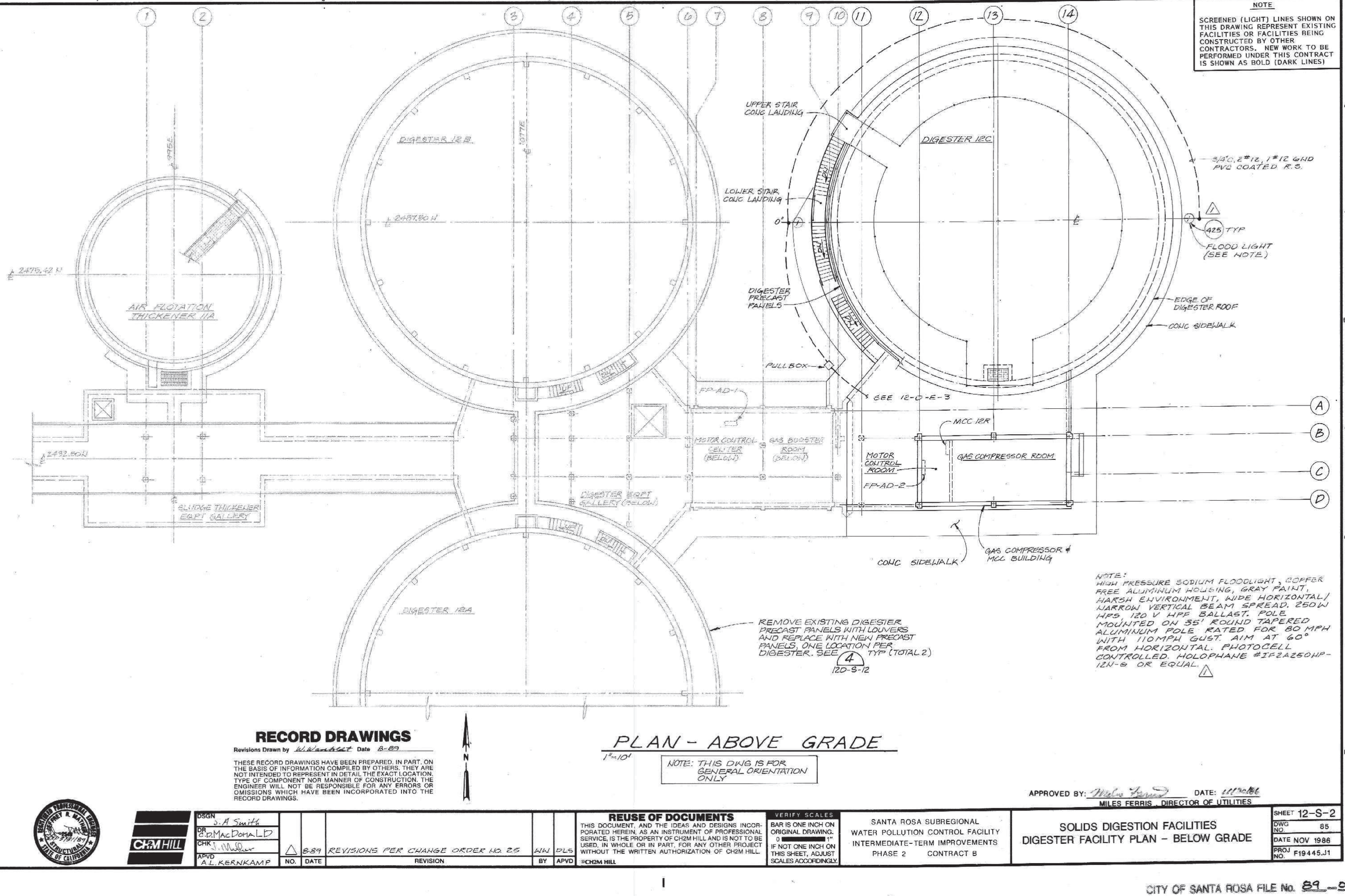
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DWG NO.	84
DATE	NOV 1986
PROJ NO.	F19445.J1

CITY OF SANTA ROSA FILE No. 89-0177

OVERLAY IDENTIFICATION
PROJ NO.
CONTRACT
COMPOSITE 2-S-1
OVERLAY 2-S-1
SCREEN 3
FORMAT E33 MC
FILM KE
PRINTED 84
IC
CHECKED BY
DRAWN BY
DESIGNED BY

NOTE

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NOTE:
HIGH PRESSURE SODIUM FLOODLIGHT, COPPER FREE ALUMINUM HOUSING, GRAY PAINT, HARSH ENVIRONMENT, WIDE HORIZONTAL/ NARROW VERTICAL BEAM SPREAD. 250W HPS, 120 V HPF BALLAST. POLE MOUNTED ON 35' ROUND TAPERED ALUMINUM POLE RATED FOR 80 MPH WITH 110 MPH GUST. AIM AT 60° FROM HORIZONTAL. PHOTOCELL CONTROLLED. HOLOPHANE #IF2A250HP-12N-6 OR EQUAL. 1

RECORD DRAWINGS

Revisions Drawn by W. Wambolt Date 8-89

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PLAN - ABOVE GRADE

1"=10'

NOTE: THIS DWG IS FOR GENERAL ORIENTATION ONLY

APPROVED BY: Miles Ferris DATE: 11/30/86
MILES FERRIS, DIRECTOR OF UTILITIES

REGISTERED PROFESSIONAL ENGINEER — ROBERT R. MAYNARD — EXP 7/31/89 — STRUCTURAL — STATE OF CALIFORNIA

CH2M HILL

DSGN	S.A Smith
DR	C.D.MacDonald
CHK	J. Miller
APVD	A.L. KERNKAMP

NO.	DATE	REVISION	BY	APVD
1	8-89	REVISIONS PER CHANGE ORDER NO. 25	WW	DLS

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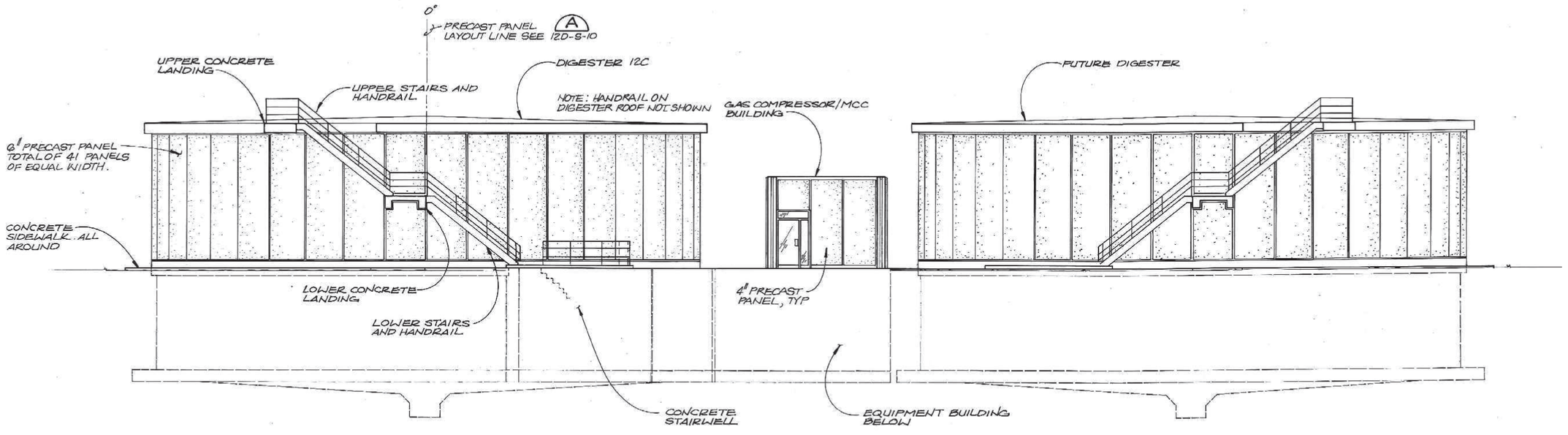
SANTA ROSA SUBREGIONAL
WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

SOLIDS DIGESTION FACILITIES
DIGESTER FACILITY PLAN - BELOW GRADE

SHEET	12-S-2
DWG NO.	85
DATE	NOV 1986
PROJ NO.	F19445.J1

CITY OF SANTA ROSA FILE No. 89-0177

OVERLAY IDENTIFICATION
PROJ NO.
CONTRACT
COMPOSITE
OVERLAY
SCREEN
FILM KS
FORMAT 2-R-2.1 2-R-2.1 S
PRINTED 10 S4
CHECKED BY
DRAWN BY
DESIGNED BY



WEST ELEVATION

1/8" 1'-0"

NOTE:
1. ALL EXPOSED EXTERIOR CONC SURFACES SHALL BE PAINTED WITH PAINT SYSTEM NO 113. COLOR TO MATCH EXISTING EXCEPT THESE SURFACES.
   - A. DIGESTER ROOF (SEE DWG 12C-M-4 FOR LIMITS OF PAINTING.
   - B. CONCEALED ROOF SURFACES BEHIND PARAPET WALL OF GAS COMPRESSOR BUILDING.
   - C. SIDEWALKS & SLABS @ GRADE

APPROVED BY: Miles Ferris DATE: 11/20/86
MILES FERRIS, DIRECTOR OF UTILITIES

JEFFREY R. MACKEY, REGISTERED PROFESSIONAL ENGINEER, STRUCTURAL, STATE OF CALIFORNIA, Exp. 3/31/88

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PHASE 2 CONTRACT B

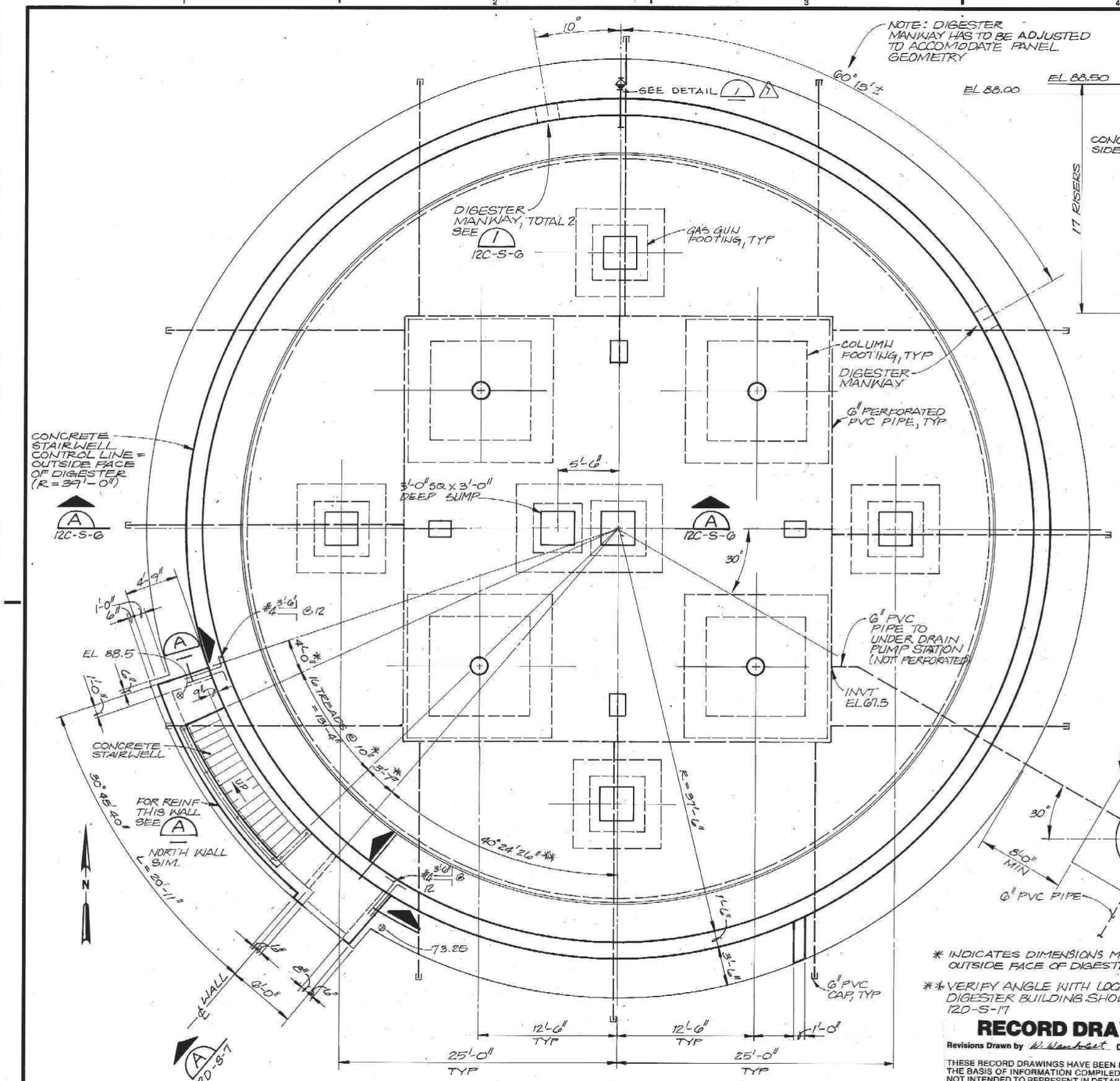
SOLIDS DIGESTION FACILITIES
GAS COMPRESSOR BUILDING
DIGESTER ELEVATION

SHEET 12D-S-3
DWG NO. 86
DATE NOV 1986
PROJ NO. F19445.J1

OVERLAY IDENTIFICATION
PROJ NO.
CONTRACT
COMPOSITE 12D-S-3
OVERLAY 12D-S-3
SCREEN

CHECKED BY
DRAWN BY
DESIGNED BY
FILM KE
FORMAT 2234 DG
FORMAT 36"-2234MG
PRINTED

CITY OF SANTA ROSA FILE No. 89-0177



FOUNDATION PLAN

3/16" = 1'-0"

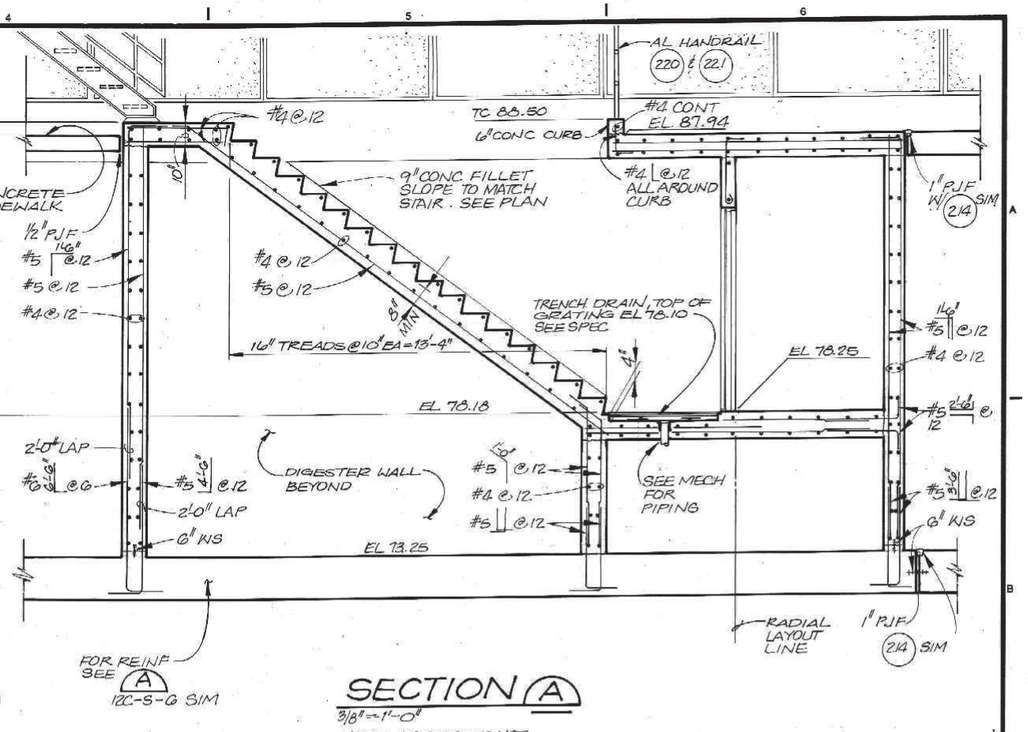
* INDICATES DIMENSIONS MEASURED ALONG OUTSIDE FACE OF DIGESTER (R=39'-0")

** VERIFY ANGLE WITH LOCATION OF EXISTING DIGESTER BUILDING SHOWN ON SHEET 12D-S-17

RECORD DRAWINGS

Revisions Drawn by W. Wambeet Date 8-89

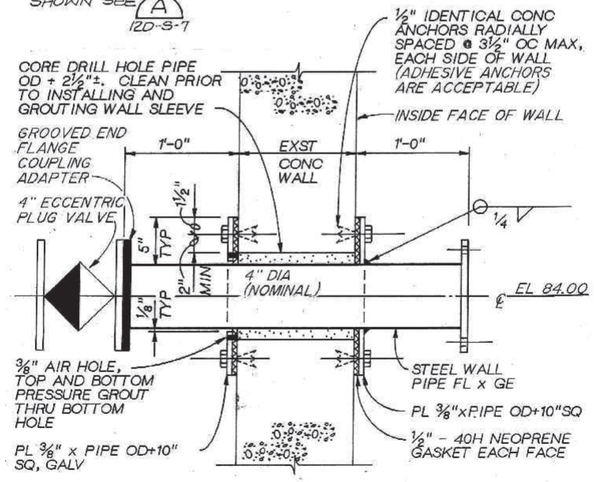
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SECTION A

3/8" = 1'-0"

NOTE: FOR REINF NOT SHOWN SEE A 12D-S-7



NOTE:
HOT DIP GALVANIZE WALL PIPE AFTER FABRICATION. COAT WITH SPECIFIED PAINT SYSTEM PRIOR TO GROUTING.

DETAIL 1

NTS

APPROVED BY: Miles Ferris DATE: 11/20/86
MILES FERRIS, DIRECTOR OF UTILITIES

DSGN G.G. BICKETT						
DR G.D. MACDONALD						
CHK S. MALLEK						
APVD A.L. KERNKAMP	△ NO.	8-89 DATE	REVISION PER CHANGE ORDER NO. 23 REVISION	WW BY	DLS APVD	

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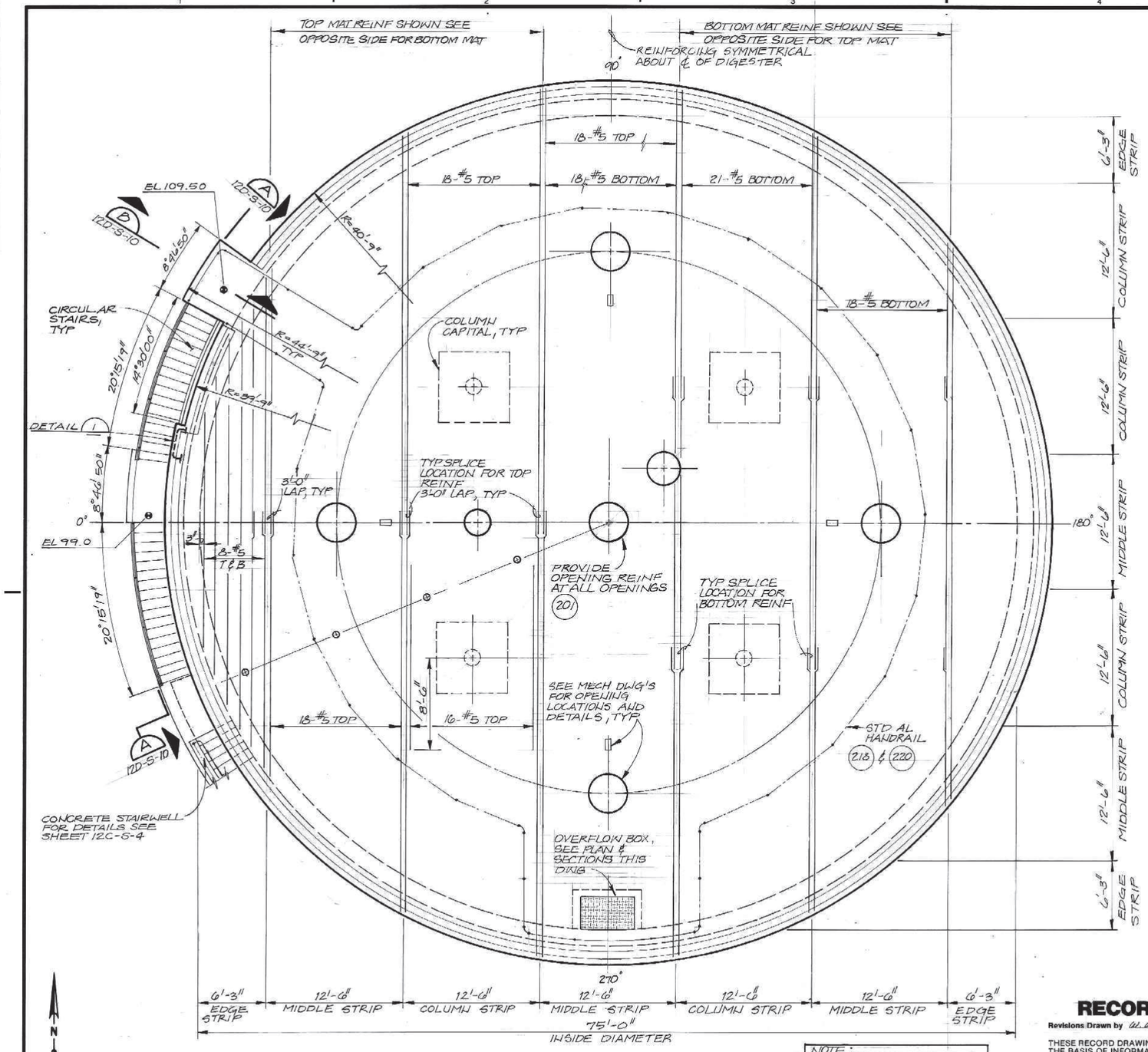
SANTA ROSA SUBREGIONAL WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

SOLIDS DIGESTION FACILITIES
DIGESTER FOUNDATION PLAN AND SECTION

SHEET 12C-S-4
DWG NO. 87
DATE NOV 1986
PROJ NO. F19445.J1

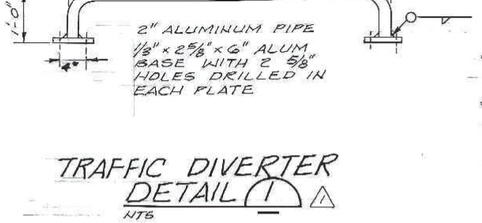
CITY OF SANTA ROSA FILE No. 89-0177

OVERLAY IDENTIFICATION | COMPOSITE 12C-S-4 | OVERLAY 12C-S-4 | SCREEN
PROJ NO. | 12C-R-41 | 12C-R-41
CONTRACT

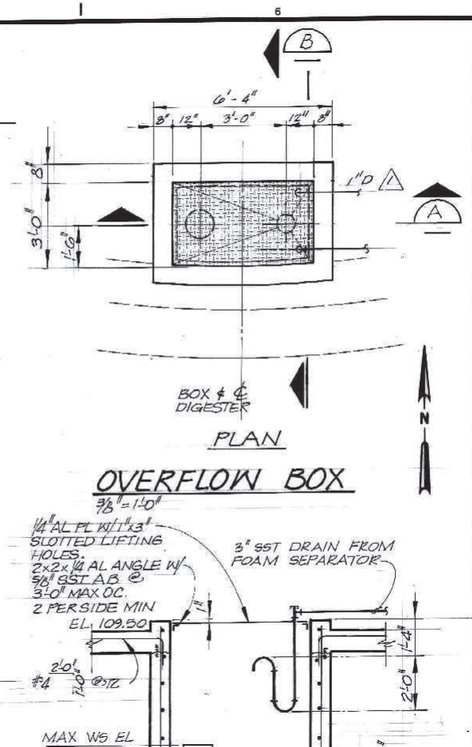


ROOF PLAN
3/16" = 1'-0"

NOTE: REINF RUNNING NORTH & SOUTH IS SHOWN, REINF EAST & WEST IS SIMILAR.

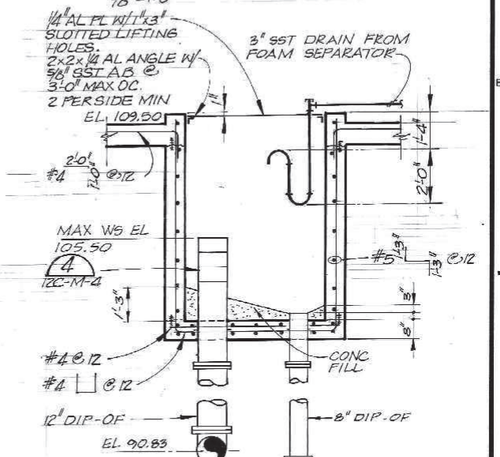


TRAFFIC DIVERTER DETAIL 1 △
NTS

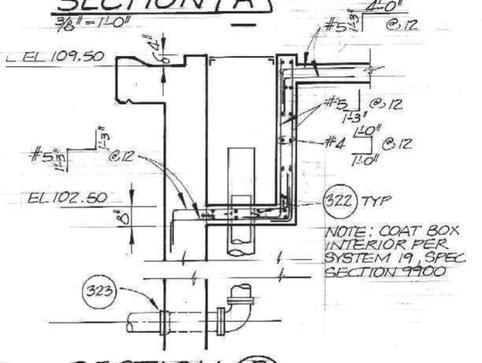


PLAN

OVERFLOW BOX
3/8" = 1'-0"



SECTION A
3/8" = 1'-0"



SECTION B
3/8" = 1'-0"

RECORD DRAWINGS
Revisions Drawn by W. Wambolt Date 8-89

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APPROVED BY: Miles Ferris DATE: 11/20/86
MILES FERRIS, DIRECTOR OF UTILITIES

JEFFREY R. MAYNARD — No. 2138 — Exp. 3/31/89 — REGISTERED PROFESSIONAL ENGINEER — STRUCTURAL — STATE OF CALIFORNIA

CH2M HILL

DSGN	G.G. BICKETT
DR	C.D. MACDONALD
CHK	J. MAFFEO
APVD	A.L. KERNKAMP

NO.	DATE	REVISION	BY	APVD
△	8-89	REVISIONS PER CHANGE ORDER NO. 26	WW	DLS

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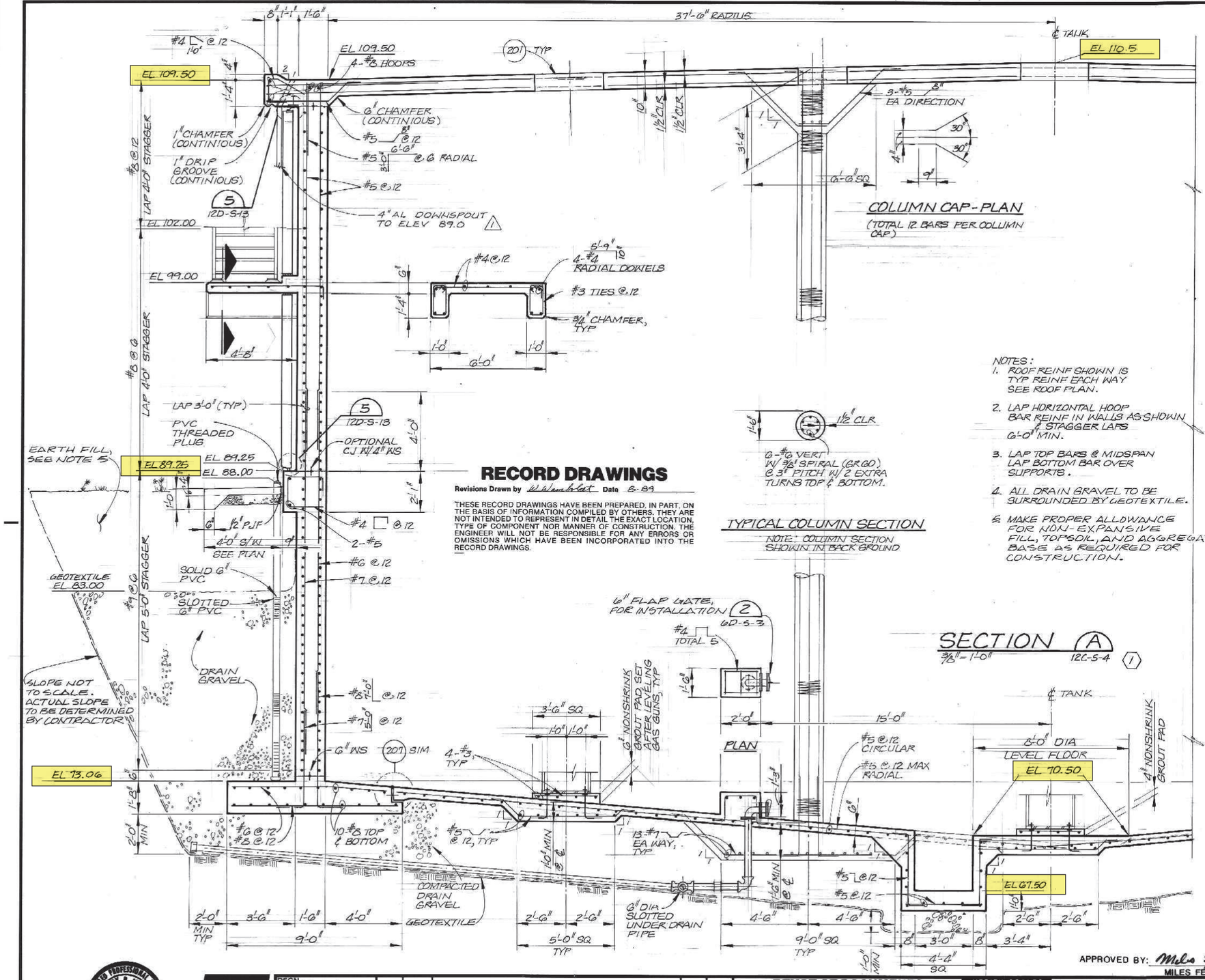
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SANTA ROSA SUBREGIONAL WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

SOLIDS DIGESTION FACILITIES DIGESTER ROOF PLAN, SECTIONS AND DETAILS

SHEET	12C-S-5
DWG NO.	88
DATE	NOV 1986
PROJ NO.	F19445.J1

CITY OF SANTA ROSA FILE No. 89-0177



RECORD DRAWINGS

Revisions Drawn by W. Wambolt Date 6-89

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COLUMN CAP - PLAN

(TOTAL 12 BARS PER COLUMN CAP)

TYPICAL COLUMN SECTION

NOTE: COLUMN SECTION SHOWN IN BACK GROUND

SECTION A

3/8" = 1'-0" 12C-5-4 (1)

NOTES:
1. ROOF REINF SHOWN IS TYP REINF EACH WAY SEE ROOF PLAN.
2. LAP HORIZONTAL HOOP BAR REINF IN WALLS AS SHOWN # STAGGER LAPS 6'-0" MIN.
3. LAP TOP BARS @ MIDSPAN LAP BOTTOM BAR OVER SUPPORTS.
4. ALL DRAIN GRAVEL TO BE SURROUNDED BY GEOTEXTILE.
5. MAKE PROPER ALLOWANCE FOR NON-EXPANSIVE FILL, TOPSOIL, AND AGGREGATE BASE AS REQUIRED FOR CONSTRUCTION.

NOTE:
1. ALL WELDED JOINTS TO BE WATERTIGHT
2. HOT DIP GALV. ENTIRE ASSEMBLY AFTER FABRICATION.
3. 2 REQ'D PER DIGESTER - LOCATE PER SHEET 12C-S-4

NOTE: 2 PER DIGESTER PAINT ANTIQUE WHITE TO MATCH CONC LEDGER.

DIGESTER MANWAY DETAIL (1)

3/4" = 1'-0" 12C-S-4

APPROVED BY: Miles Ferris DATE: 11/20/86
MILES FERRIS, DIRECTOR OF UTILITIES

REGISTERED PROFESSIONAL ENGINEER JEFFREY R. MATHEWS STRUCTURAL STATE OF CALIFORNIA

CH2M HILL

DSGN G.G. Bickett
DR C.D. MacDonald
CHK J. Mathews
APVD A.L. Kernkamp

NO.	DATE	REVISION	BY	APVD
1	8-89	REVISIONS PER CHANGE ORDER NO 27	WN	DLS
0	2-10-87	REVISIONS PER ADDENDUM 2	DLH	JAB

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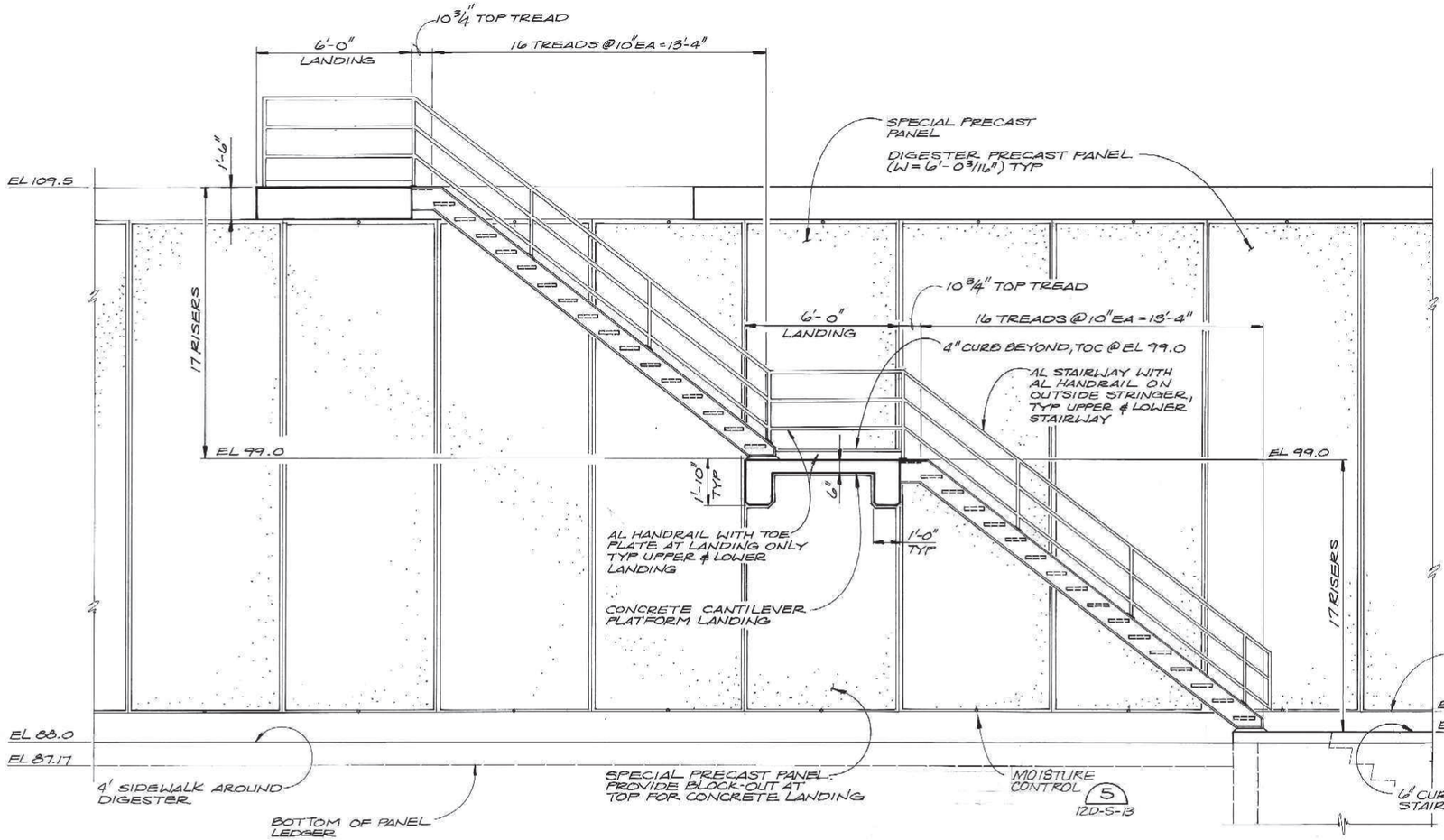
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INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

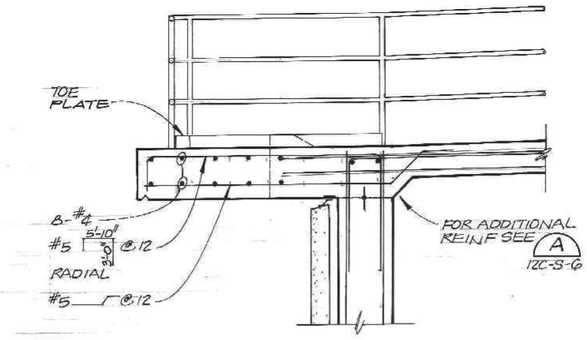
SOLIDS DIGESTION FACILITIES
DIGESTER SECTION

SHEET 12C-S-6
DWG NO. 89
DATE NOV 1986
PROJ NO. F19445.J1

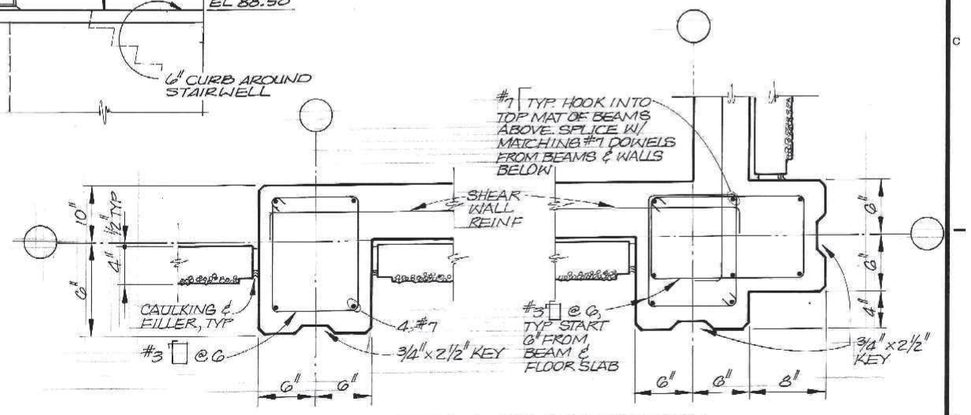
CITY OF SANTA ROSA FILE No. 89-0177



SECTION A
3/8" = 1'-0" 12C-S-5



SECTION B
1/2" = 1'-0" 12C-S-5



TYPICAL COLUMN SECTION
DETAIL 1
1 1/2" = 1'-0" 12D-S-8

RECORD DRAWINGS

Revisions Drawn by W. Wambolt Date 8-89

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APPROVED BY: MILES FERRIS, DIRECTOR OF UTILITIES DATE: 11/20/86

REGISTERED PROFESSIONAL ENGINEER JEFFREY R. MAYNARD Exp 3/31/89 STRUCTURAL STATE OF CALIFORNIA

CH2M HILL

DSGN G.G. BICKETT
DR P. CAMPFIELD
CHK J. Maller
APVD A.L. KERNKAMP

NO.	DATE	REVISION	BY	APVD

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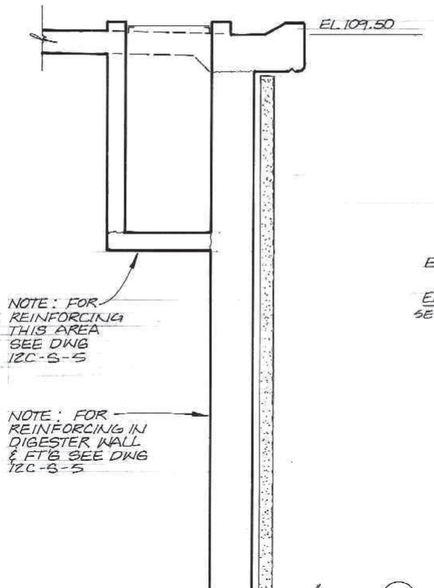
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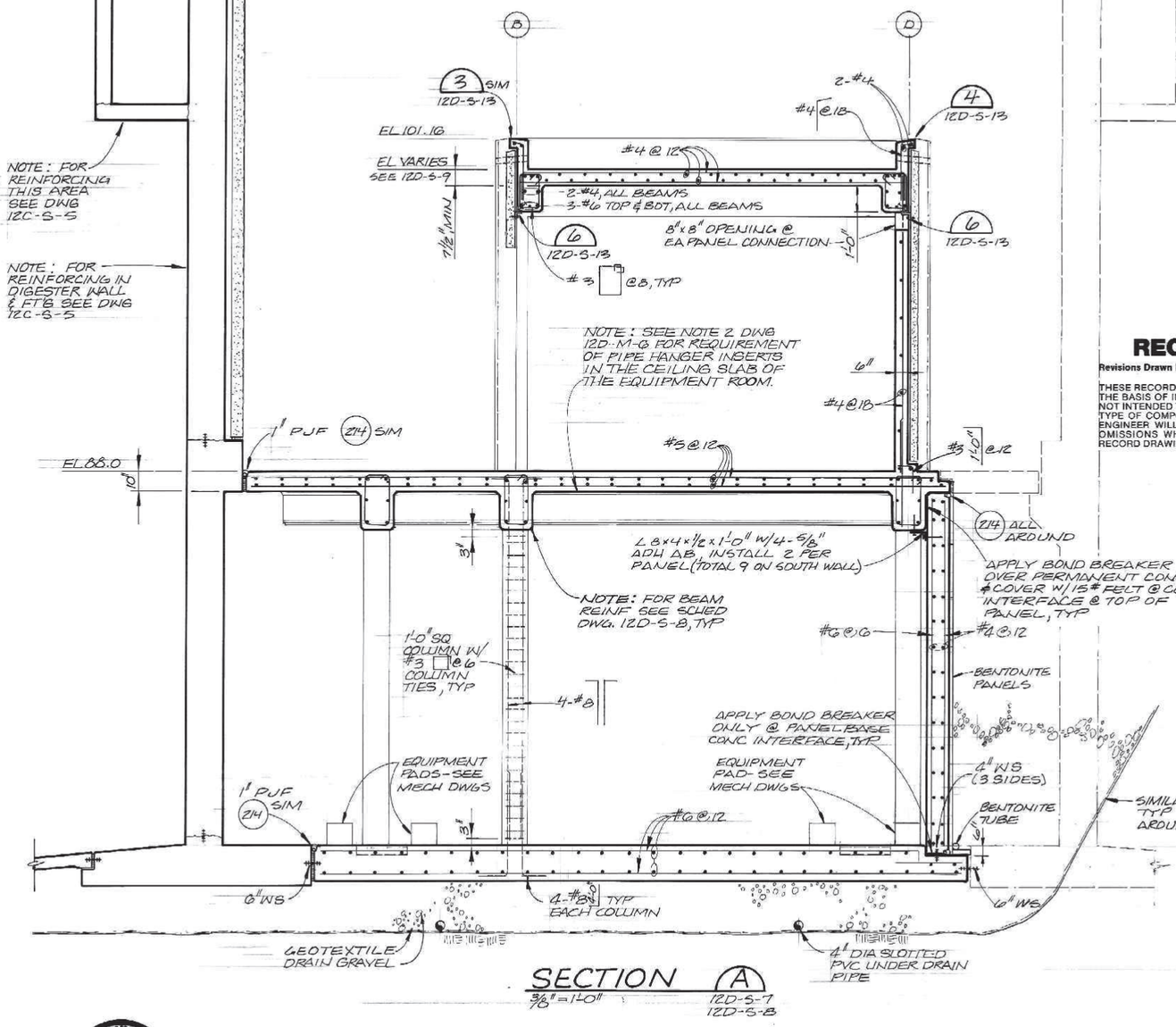
SANTA ROSA SUBREGIONAL
WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

SOLIDS DIGESTION FACILITIES SECTIONS

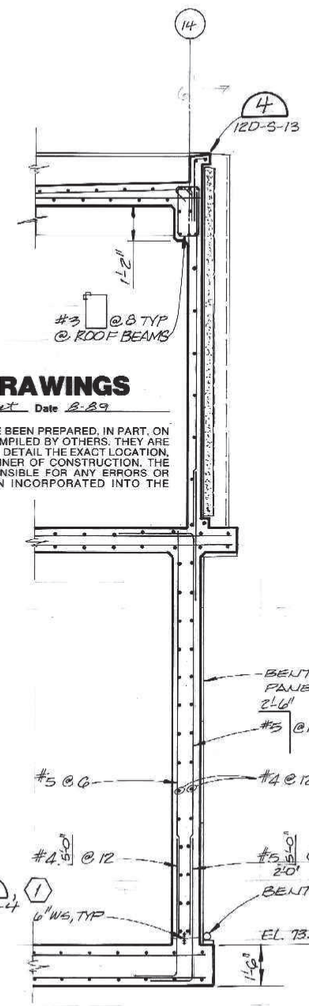
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DWG NO. 93
DATE NOV 1986
PROJ NO. F19445.J1

CITY OF SANTA ROSA FILE No. 89-0177

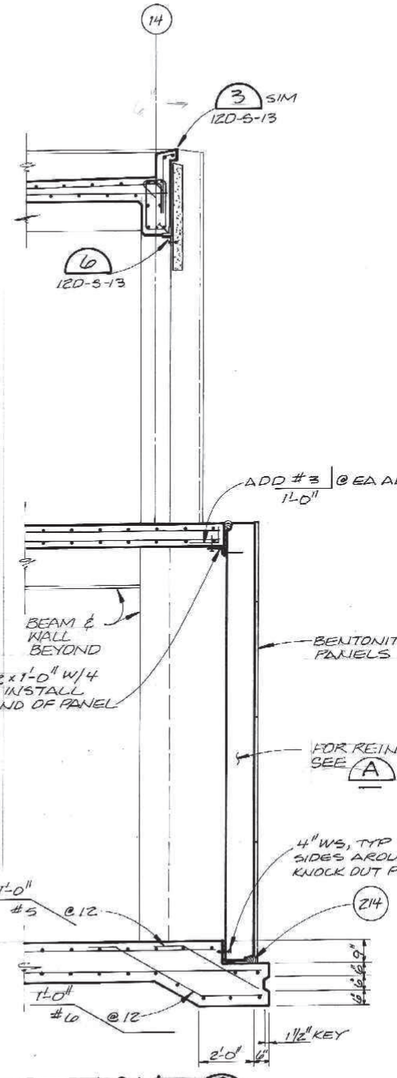




SECTION A
3/8" = 1'-0"
12D-S-7
12D-S-8



SECTION B
3/8" = 1'-0"
12D-S-7
12D-S-8



SECTION C
3/8" = 1'-0"
12D-S-7, 12D-S-8

APPROVED BY: Miles Ferris DATE: 11/20/86
MILES FERRIS, DIRECTOR OF UTILITIES

RECORD DRAWINGS

Revisions Drawn by L. Wentheat Date 8-89

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ERNEST R. MAYER — EXP. 3/31/89 — REGISTERED PROFESSIONAL ENGINEER — STRUCTURAL — STATE OF CALIFORNIA

CH2M HILL

DSGN	G.G. BICKETT
DR	H. KERT
CHK	J. Mather
APVD	A.L. KERNKAMP

NO.	DATE	REVISION	BY	APVD
1	2-10-87	REVISIONS PER ADDENDUM 2	DLH	JAB

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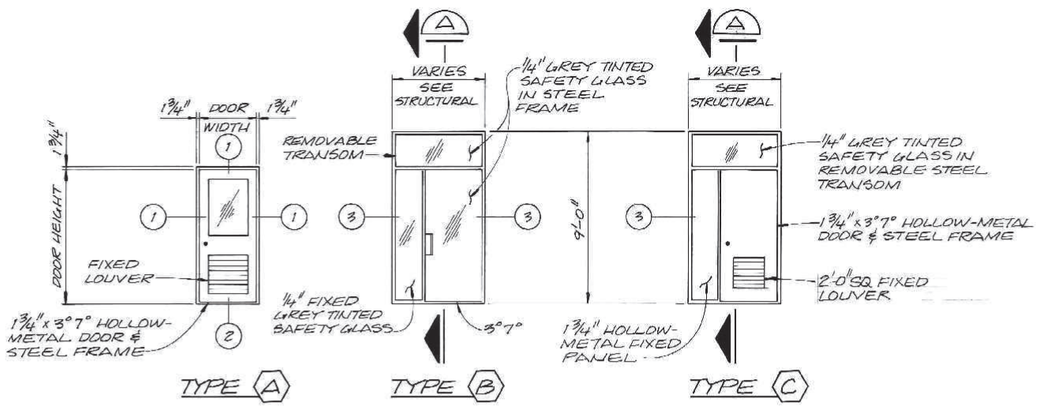
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SANTA ROSA SUBREGIONAL
WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

SOLIDS DIGESTION FACILITIES SECTIONS

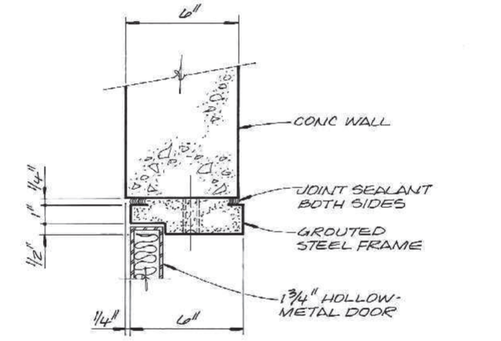
SHEET	12D-S-11
DWG NO.	94
DATE	NOV 1986
PROJ NO.	F19445.J1

CITY OF SANTA ROSA FILE No. 89-0177

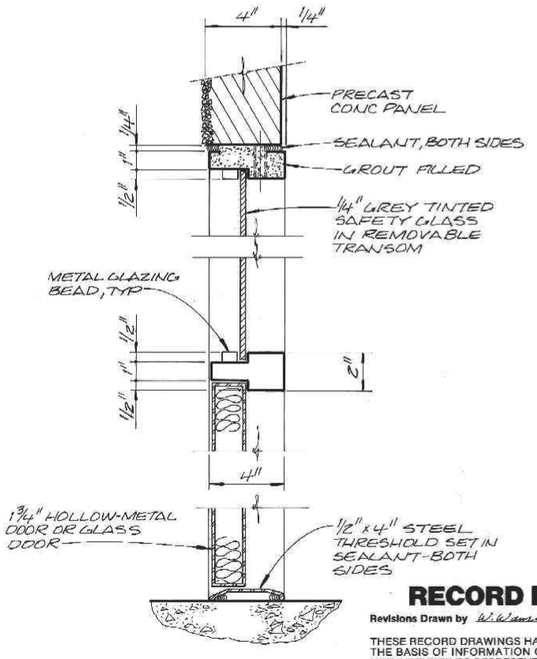


DOOR TYPES
NTS

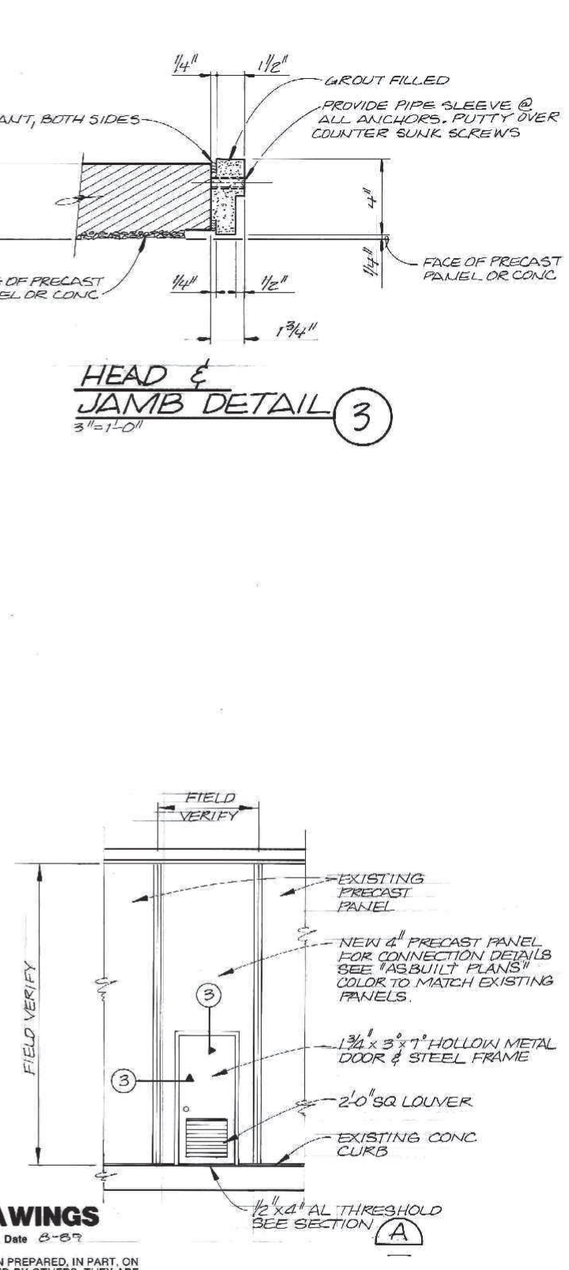
HEAD & JAMB DETAIL 3
3"=1'-0"



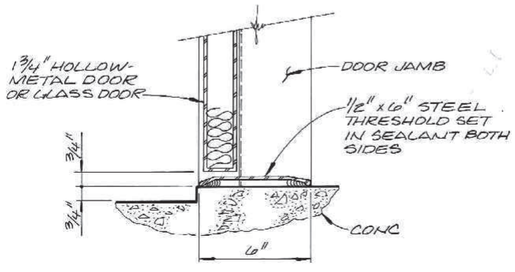
HEAD AND JAMB DETAIL 1
3"=1'-0"



SECTION A
3"=1'-0"



DETAIL 4
NTS 12-3-2



SILL DETAIL 2
3"=1'-0"

RECORD DRAWINGS
Revisions Drawn by W. Wamsteker Date 8-89

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APPROVED BY: Miles Ferris DATE: 11/20/86
MILES FERRIS, DIRECTOR OF UTILITIES

REGISTERED PROFESSIONAL ENGINEER — ERNEST R. KAMP — No. 24 — Exp. 3/31/11/88 — STRUCTURAL — STATE OF CALIFORNIA

CH2M HILL

DSGN	DR	CHK	APVD
G.G. BICKETT	S.MOSS III	J.M. Miller	A.L. KERNKAMP

NO.	DATE	REVISION	BY	APVD

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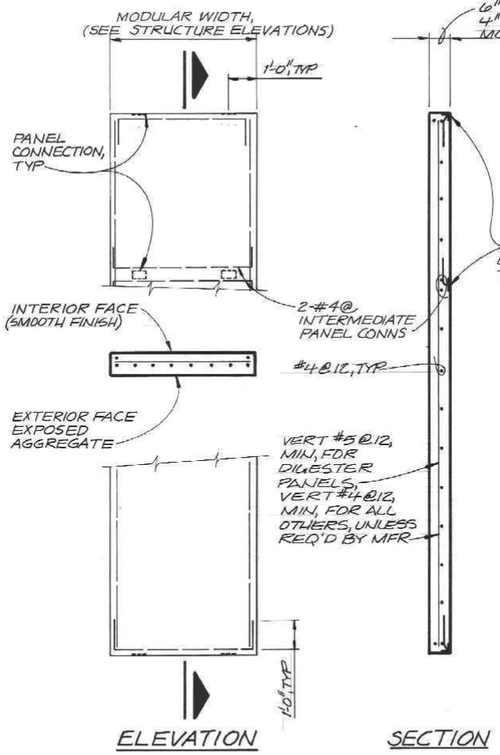
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SANTA ROSA SUBREGIONAL WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

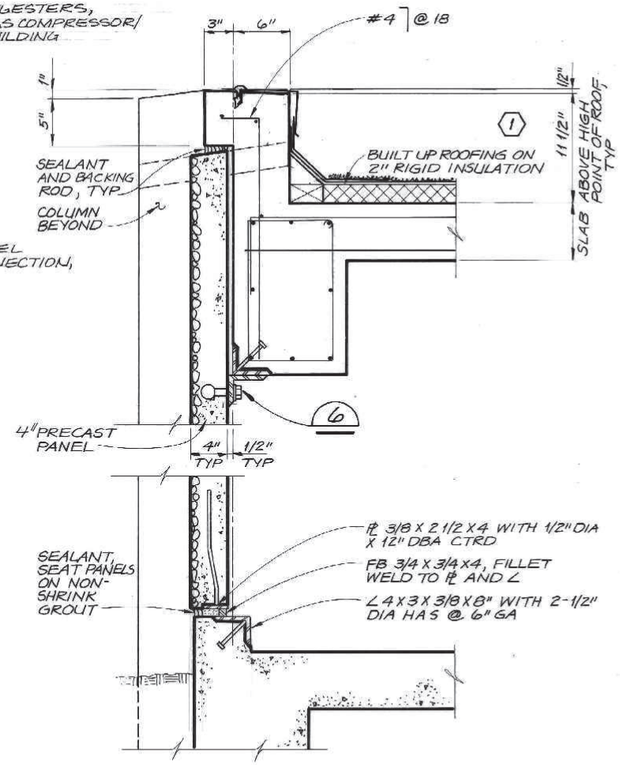
SOLIDS DIGESTION FACILITIES DOOR ELEVATIONS AND DETAILS

SHEET 12D-S-12
DWG NO. 95
DATE NOV 1986
PROJ NO. F19445.J1

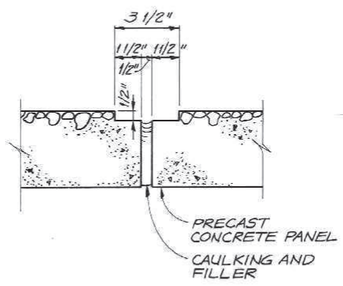
CITY OF SANTA ROSA FILE No. 89-0177



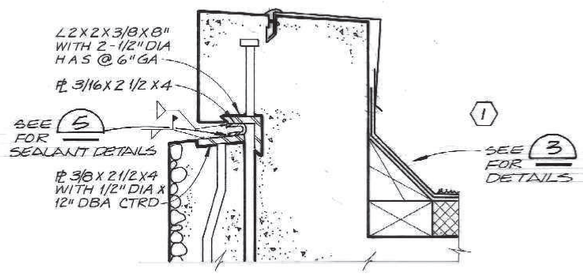
DETAIL (1)
NTS



DETAIL (3)
1 1/2" = 1'-0" 12D-S-11



DETAIL (2)
3" = 1'-0"

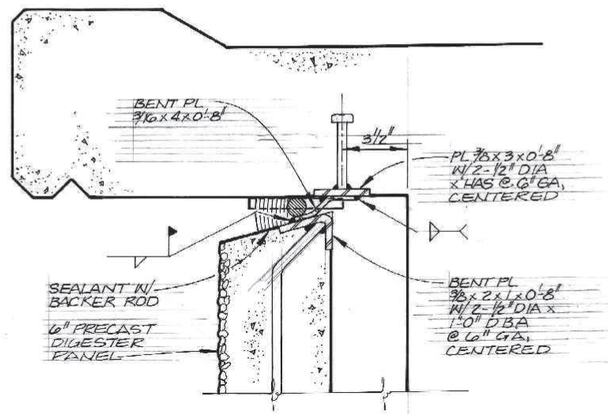


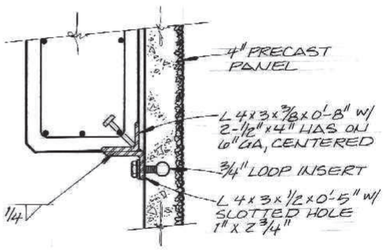
DETAIL (4)
3" = 1'-0" 12D-S-11

RECORD DRAWINGS

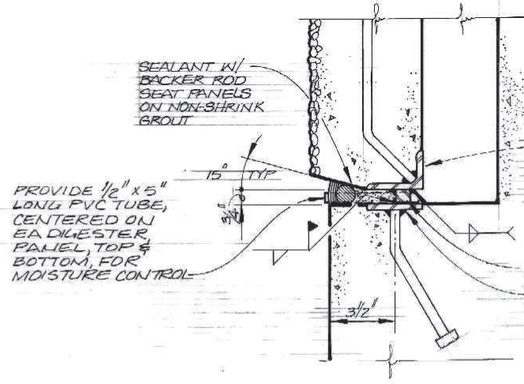
Revisions Drawn by L. Wambolt Date 8-89

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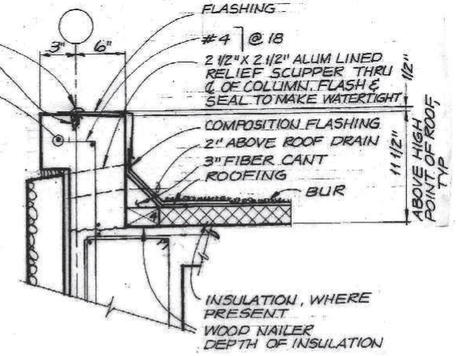




DETAIL (6)
1 1/2" = 1'-0" 12D-S-11



DETAIL (5)
3" = 1'-0" 12D-S-6
(1)



(1) DETAIL (7)
NTS

PRECAST CONCRETE PANEL NOTES

1. ONLY A REPRESENTATIVE PANEL HAS BEEN SHOWN. REFER TO BUILDING ELEVATIONS FOR LOCATIONS OF THESE PANELS.
2. ALL REINFORCING AND CONNECTION DETAILS SHOWN ARE THE MINIMUM REQUIRED FOR SERVICE LOADS ONLY. THE PRECAST CONCRETE SUPPLIER SHALL DESIGN ALL PANELS AND CONNECTIONS AND PROVIDE ALL MILD STEEL REINFORCING AND CONNECTION DETAILS NECESSARY FOR HANDLING, SHIPPING, AND ERECTION LOADS.
3. ALL MISCELLANEOUS METAL SHALL CONFORM TO ASTM A-36. ALL STEEL FABRICATION AND WELDING SHALL CONFORM TO THE 8TH EDITION OF THE MANUAL OF STEEL CONSTRUCTION PUBLISHED BY THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION.
4. ALL STUDS AND DEFORMED BAR ANCHORS SHALL BE MANUFACTURED BY THE NELSON STUD WELDING CO. OR APPROVED. STUDS SHALL BE AUTOMATICALLY END WELDED ON CENTERS AS SHOWN ON THE DRAWINGS. ALL WELDS SHALL DEVELOP THE YIELD STRENGTH OF THE STUD OR BAR ANCHOR AND SHALL BE MADE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.
5. ALL THREADED INSERTS SHALL BE AS MANUFACTURED BY SUPERIOR, BURKE, OR AS APPROVED. LOOP INSERTS SHALL BE THE WELD NUT TYPE.
6. REFER TO BUILDING ELEVATIONS FOR ALL FALSE JOINTS, WINDOW EMBEDMENTS, DOOR LOCATIONS, ETC. (1)
7. REFER TO MECHANICAL DRAWINGS FOR ADDITIONAL PIPE PENETRATIONS, CONNECTIONS, EMBEDMENTS, AND BLOCKOUTS.
8. PANEL ERECTION PROCEDURES AND FIELD INTERFERENCES ARE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

APPROVED BY: Miles Ferris DATE: 11/20/86
MILES FERRIS, DIRECTOR OF UTILITIES

REGISTERED PROFESSIONAL ENGINEER — JEFFREY R. KERN — No. EXP 3/31/89 — STRUCTURAL — STATE OF CALIFORNIA

CH2M HILL

DSGN	G.G. BICKETT		
DR	F. Kerr		
CHK	J. Mahar		
APVD	A.L. KERNKAMP		

NO.	DATE	REVISION	BY	APVD
1	2-11-87	REVISIONS PER ADDENDUM 1	DLH	JAB

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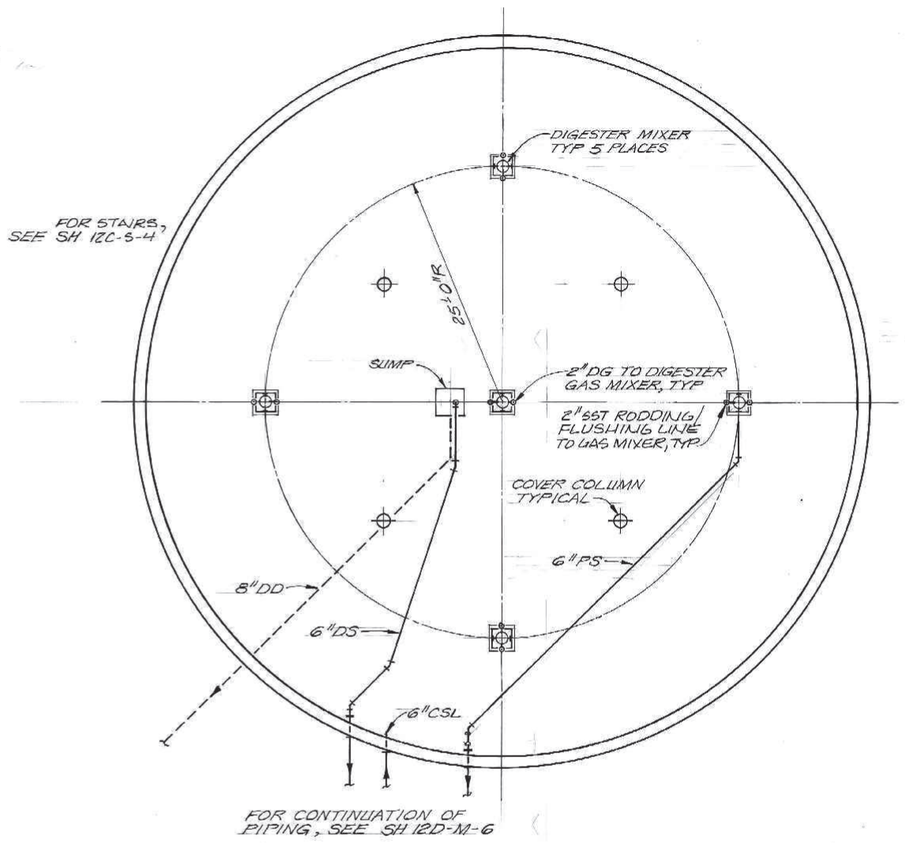
SANTA ROSA SUBREGIONAL
WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

SOLIDS DIGESTION FACILITIES
PRECAST WALL PANELS
SECTIONS AND DETAILS

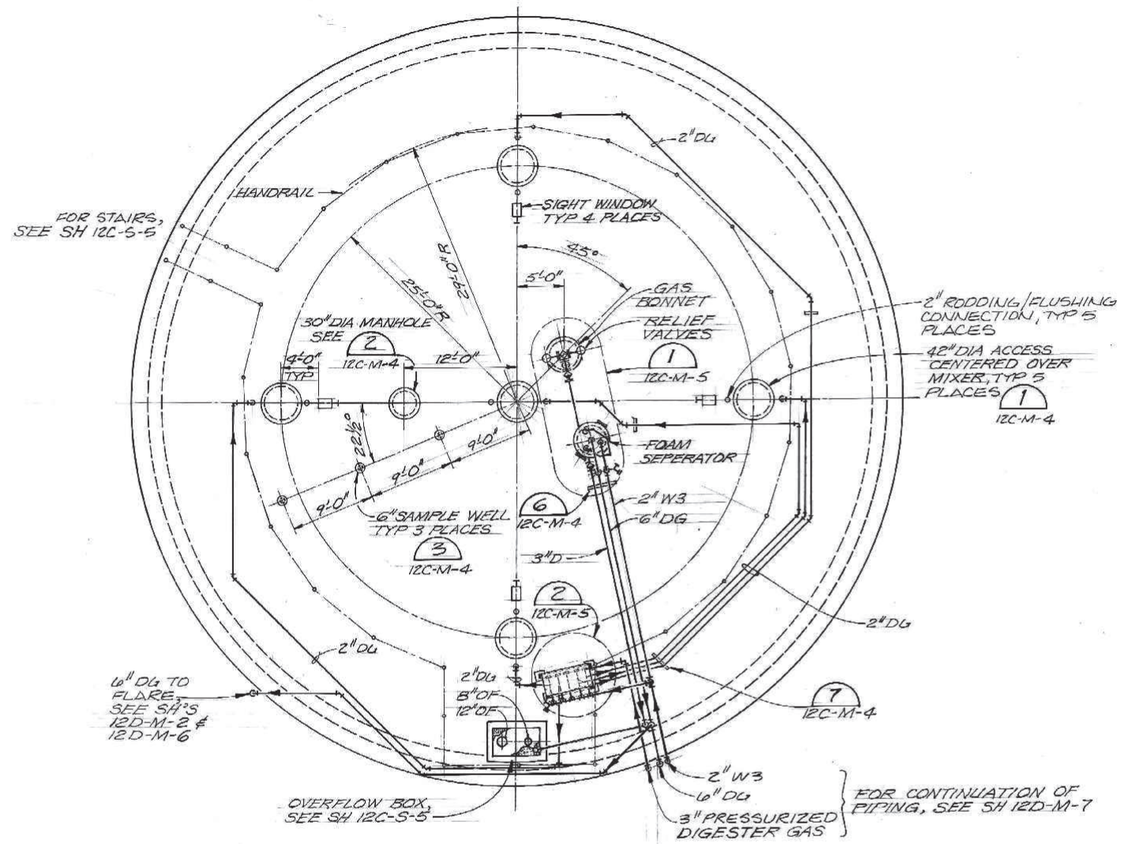
SHEET 12D-S-13
DWG NO. 96
DATE NOV 1986
PROJ NO. F19445.J1

OVERLAY IDENTIFICATION
COMPOSITE 118-S-5
OVERLAY 118-S-5
SCREEN
PROJ NO.
CONTRACT

CITY OF SANTA ROSA FILE No. 89 — 0177



FLOOR PLAN
1/8"=1'0"



ROOF PLAN
1/8"=1'0"

RECORD DRAWINGS

Revisions Drawn by W. Wennerholt Date 8-89

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APPROVED BY: Miles Ferris DATE: 11/30/86
MILES FERRIS, DIRECTOR OF UTILITIES

REGISTERED PROFESSIONAL ENGINEER RODNEY BRAUER No. 23187 Exp. 3-31-87 CIVIL STATE OF CALIFORNIA

CH2M HILL

DSGN R. Brauer
DR J. ZIMMERMAN
CHK MIKE IVERSON
APVD A.L. KERNKAMP

NO.	DATE	REVISION	BY	APVD

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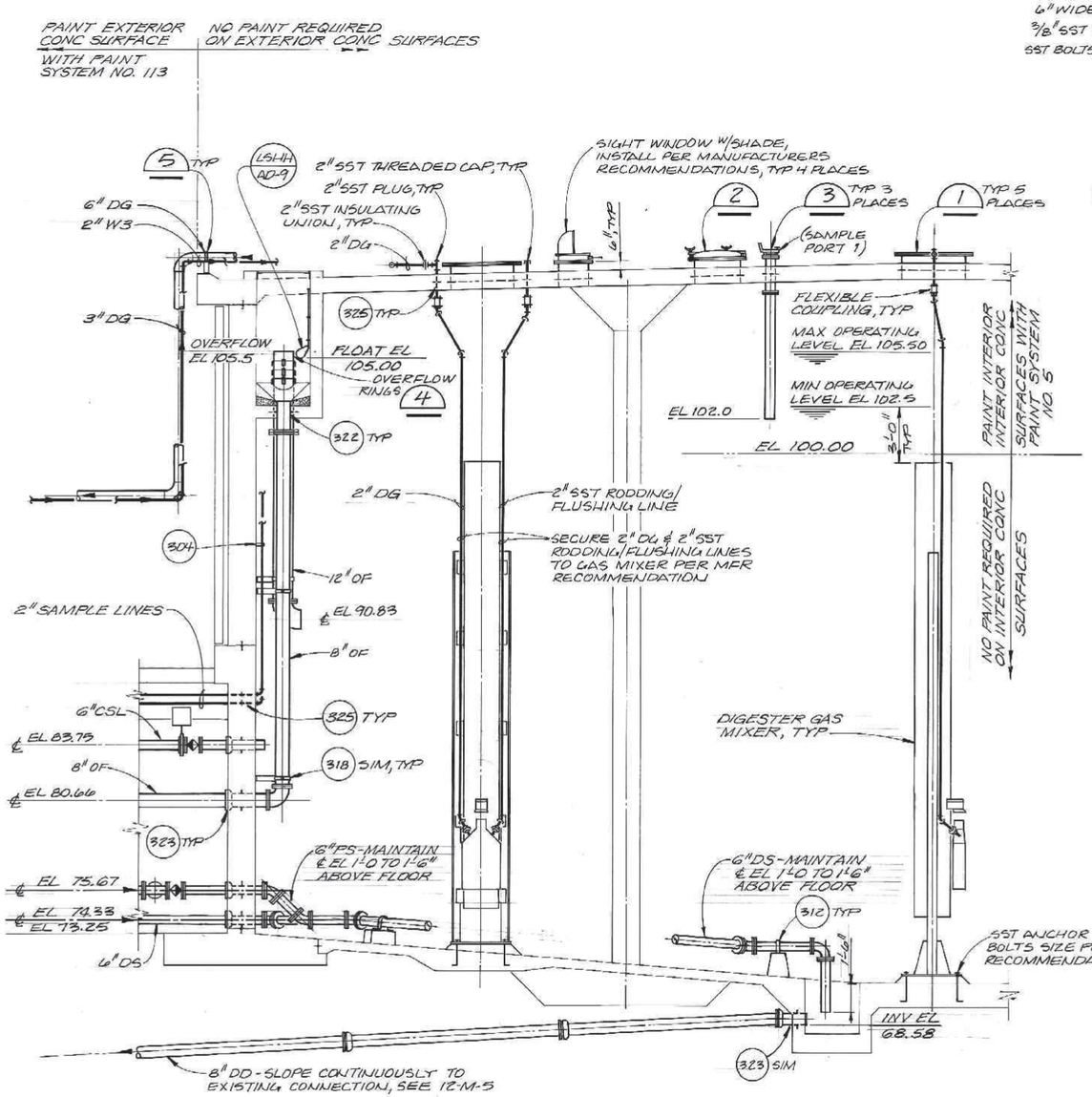
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SANTA ROSA SUBREGIONAL
WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

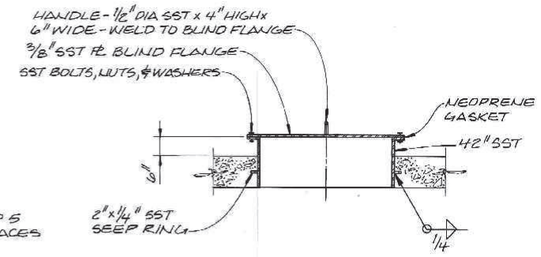
SOLIDS DIGESTION FACILITIES
DIGESTER FLOOR AND ROOF PLANS

SHEET 12C-M-3
DWG NO. 99
DATE NOV 1986
PROJ NO. F19445.J1

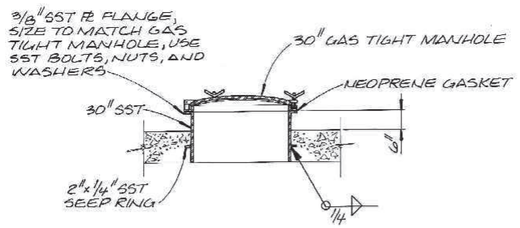
CITY OF SANTA ROSA FILE No. 89-0177



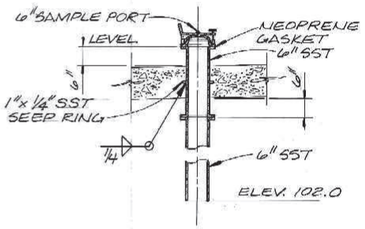
COMPOSITE SECTION
1/4"=1'-0"



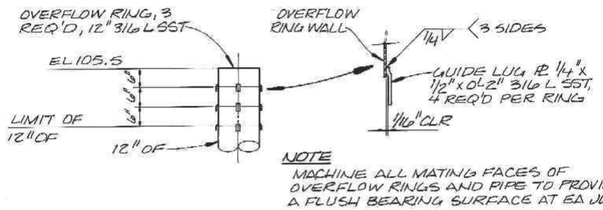
DETAIL 1
1/2"=1'-0" 12C-M-6



DETAIL 2
1/2"=1'-0" 12C-M-6

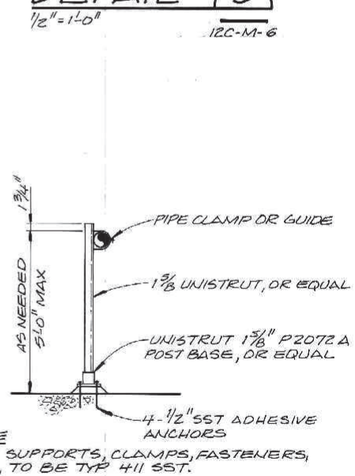


DETAIL 3
1/2"=1'-0" 12C-M-6



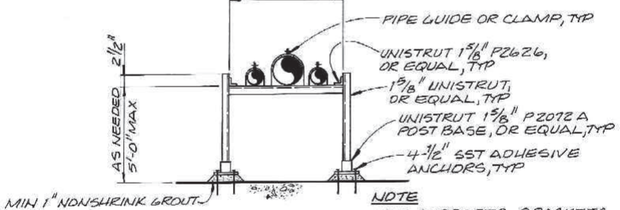
NOTE
MACHINE ALL MATING FACES OF OVERFLOW RINGS AND PIPE TO PROVIDE A FLUSH BEARING SURFACE AT EA JOINT.

DETAIL 4
1/2"=1'-0" 12C-S-5



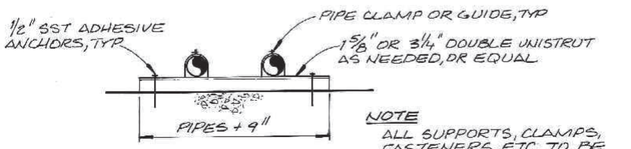
NOTE
ALL SUPPORTS, CLAMPS, FASTENERS, ETC, TO BE TYP 411 SST.

DETAIL 5
3/4"=1'-0" 12C-M-8



NOTE
ALL SUPPORTS, BRACKETS, FASTENERS, CLAMPS, ETC, TO BE TYPE 411 SST.

DETAIL 6
3/4"=1'-0" 12C-M-3 12C-M-5



NOTE
ALL SUPPORTS, CLAMPS, FASTENERS, ETC, TO BE TYPE 411 SST.

DETAIL 7
1 1/8"=1'-0" 12C-M-3 12C-M-5

RECORD DRAWINGS
Revisions Drawn by W. Woodblat Date 8-89

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APPROVED BY: Miles Ferris DATE: 11/20/86
MILES FERRIS, DIRECTOR OF UTILITIES

REGISTERED PROFESSIONAL ENGINEER RODNEY BRAUER No. C041155 Exp. 3-31-87 CIVIL STATE OF CALIFORNIA

CH2M HILL

DSGN R Brauer					
DR J ZIMMERMAN					
CHK MIKE IVERSON					
APVD A.L. KERNKAMP	NO.	DATE	REVISION	BY	APVD

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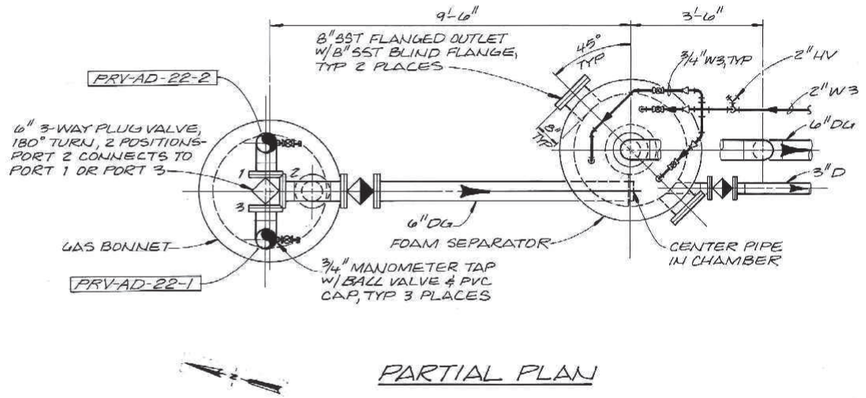
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SANTA ROSA SUBREGIONAL
WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

SOLIDS DIGESTION FACILITIES
DIGESTER SECTION AND DETAILS

SHEET 12C-M-4
DWG NO. 100
DATE NOV 1986
PROJ NO. F19445.J1

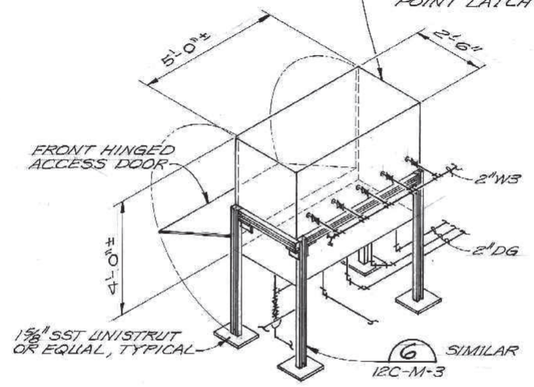
CITY OF SANTA ROSA FILE No. 89-0177



PARTIAL PLAN

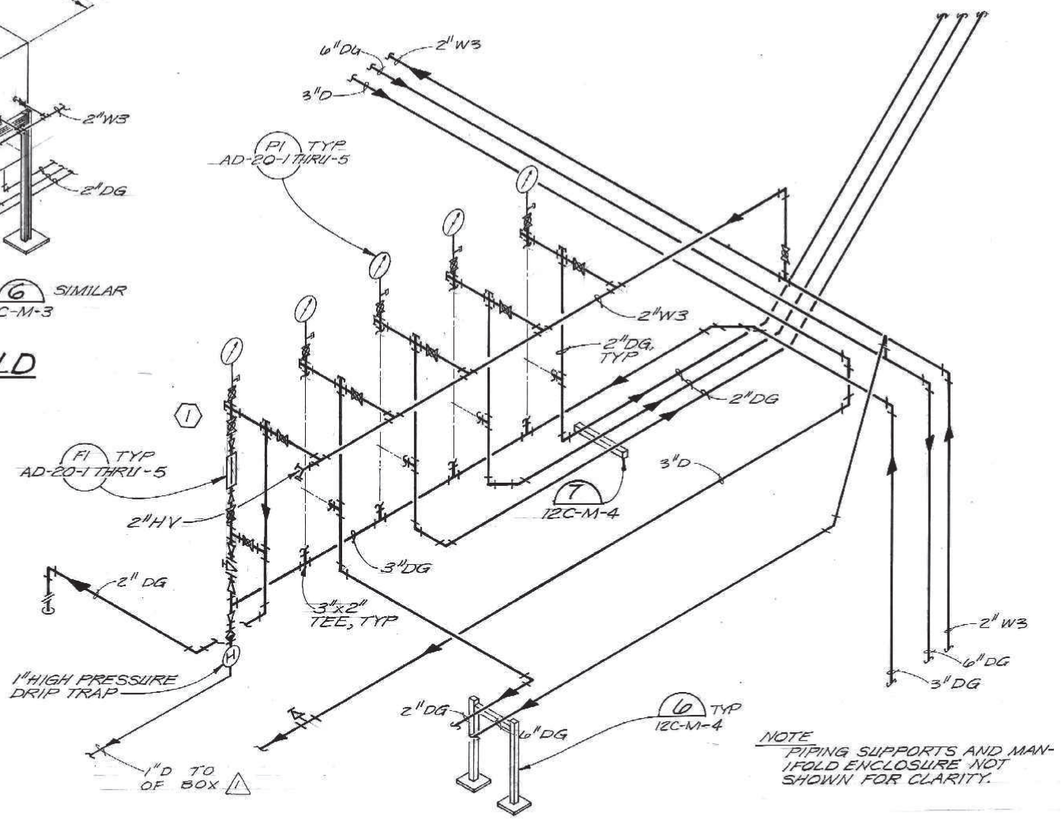
NOTE
ALL SUPPORT MEMBERS, NUTS, BOLTS, AB & WASHERS SHALL BE SST MATERIAL.

DIGESTER GAS MANIFOLD ENCLOSURE: 1/4" FRP PANELS WITH TYPE 304 SST 1"x1"x 1/8" ANGLE FRAME OR 1 5/8" SST UNISTRUT OR EQUAL FRAME, ACCESS DOOR, SST PIANO HINGE AND THREE POINT LATCH.



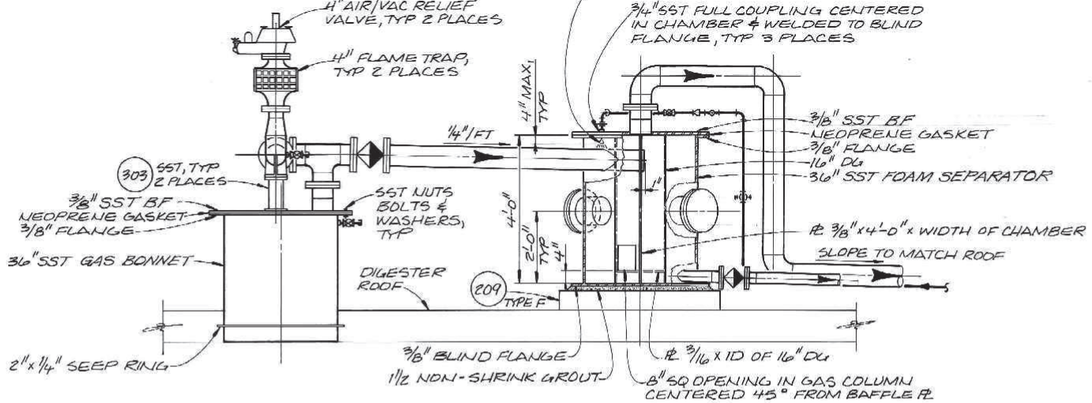
DIGESTER GAS MANIFOLD ENCLOSURE

NTS



NOTE
PIPING SUPPORTS AND MANIFOLD ENCLOSURE NOT SHOWN FOR CLARITY.

DIGESTER GAS MANIFOLD ISOMETRIC



ELEVATION

DETAIL 1

1/2" = 1'-0" 12C-M-3

DETAIL 2

NTS 12C-M-3

RECORD DRAWINGS

Revisions Drawn by LWilson-Forest Date 8-89

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APPROVED BY: Miles Ferris DATE: 11/20/86
MILES FERRIS, DIRECTOR OF UTILITIES

REGISTERED PROFESSIONAL ENGINEER ROONEY BRADLEY No. 17,... Exp. 3-31-87 CIVIL STATE OF CALIFORNIA

CH2M HILL

DSGN R. Brauer
DR S. Moss III
CHK MIKE IVERSON
APVD A.L. KERNKAMP

NO.	DATE	REVISION	BY	APVD
1	8-89	REVISION PER CHANGE ORDER NO. 26	WLL	DLS
0	2-11-87	REVISIONS PER ADDENDUM 1	DLH	JAB

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SANTA ROSA SUBREGIONAL
WATER POLLUTION CONTROL FACILITY
INTERMEDIATE-TERM IMPROVEMENTS
PHASE 2 CONTRACT B

SOLIDS DIGESTION FACILITIES PARTIAL PLAN AND DETAILS

SHEET 12C-M-5
DWG NO. 101
DATE NOV 1986
PROJ NO. F19445.J1

CITY OF SANTA ROSA FILE No. 89-0177

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Attachment B: Digester 3 Visual Assessment Photos

Photos from BC's visual assessment on December 22, 2023.

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Digester 3
Visual Assessment Photos

December 22, 2022





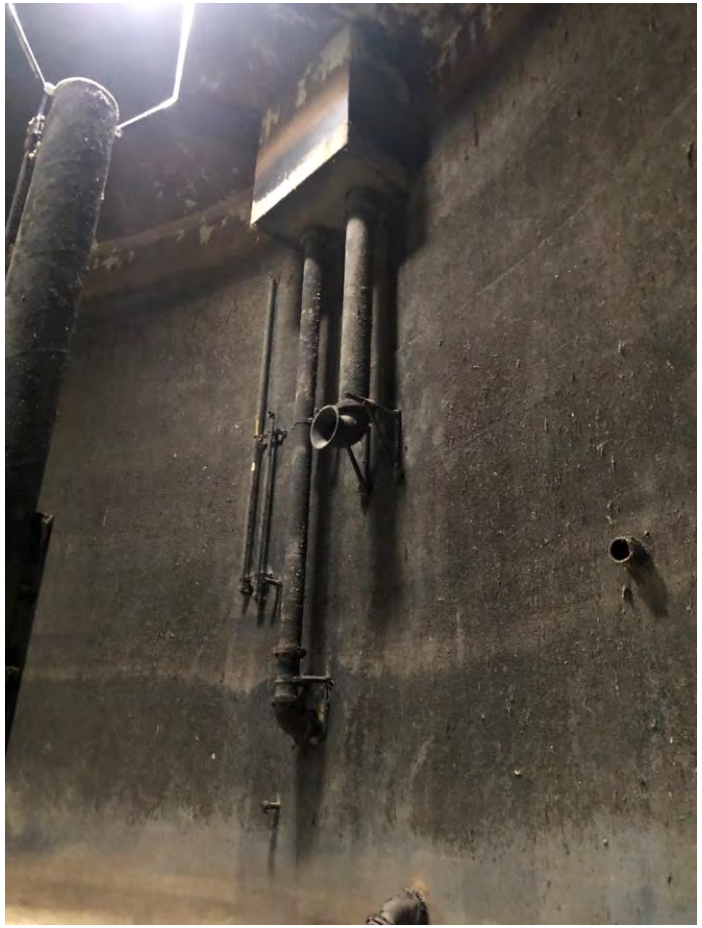


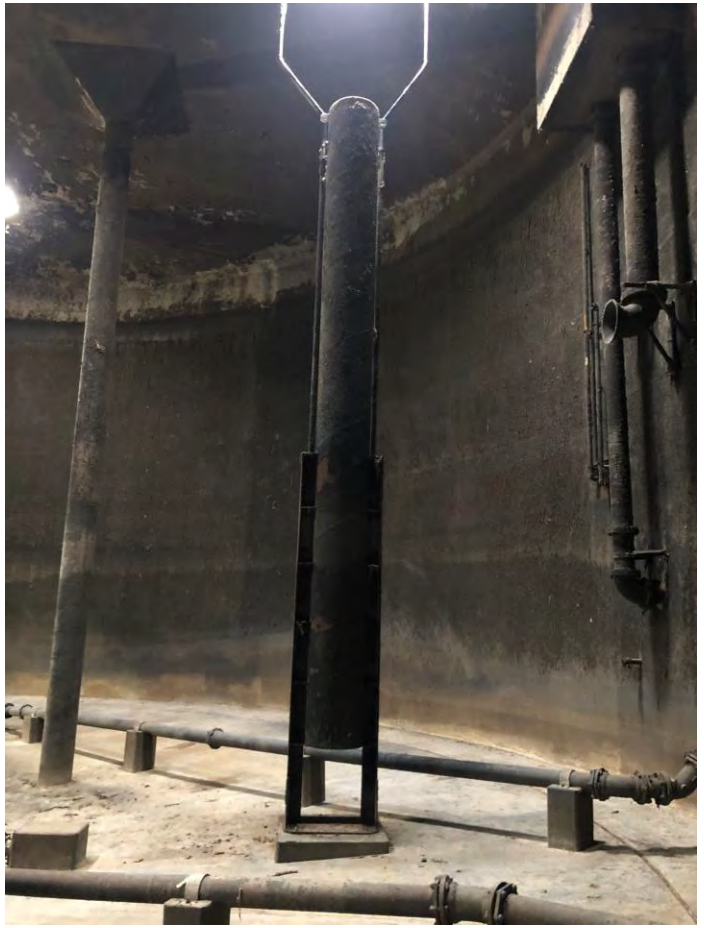


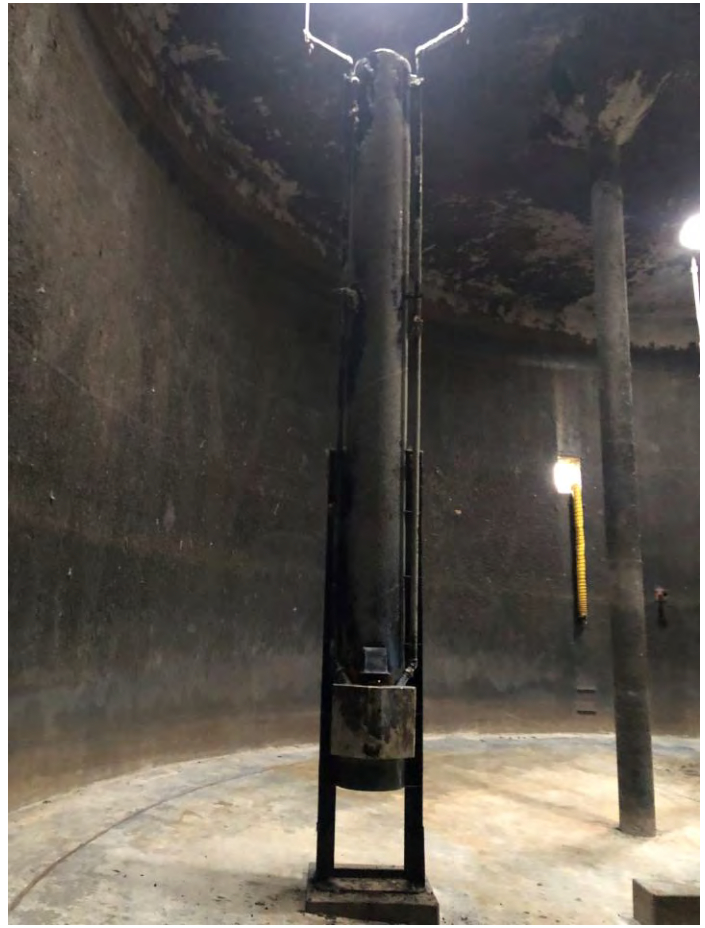




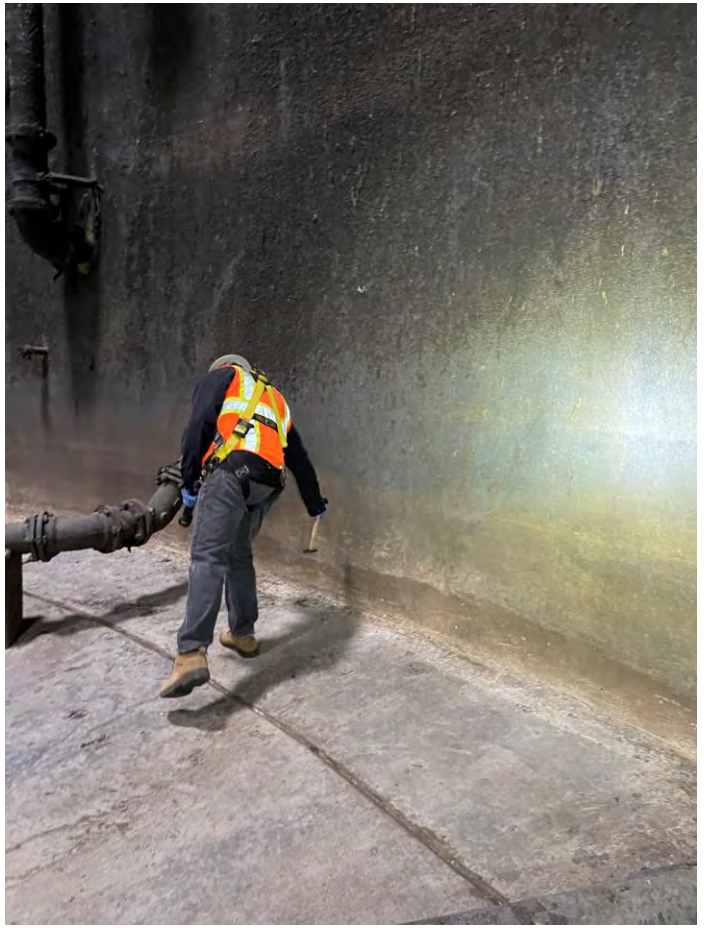


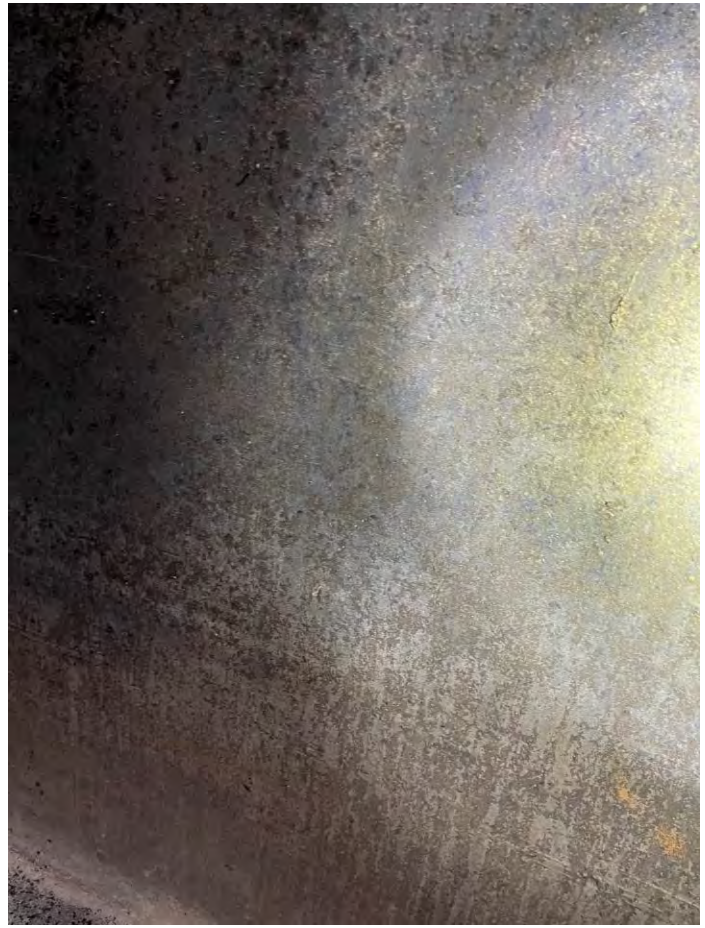






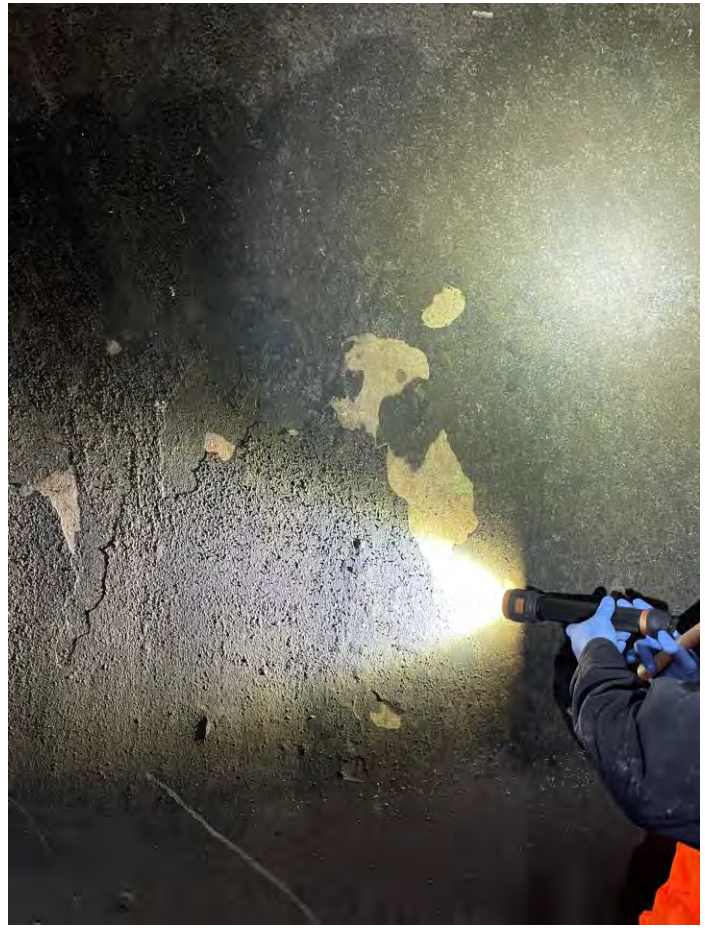


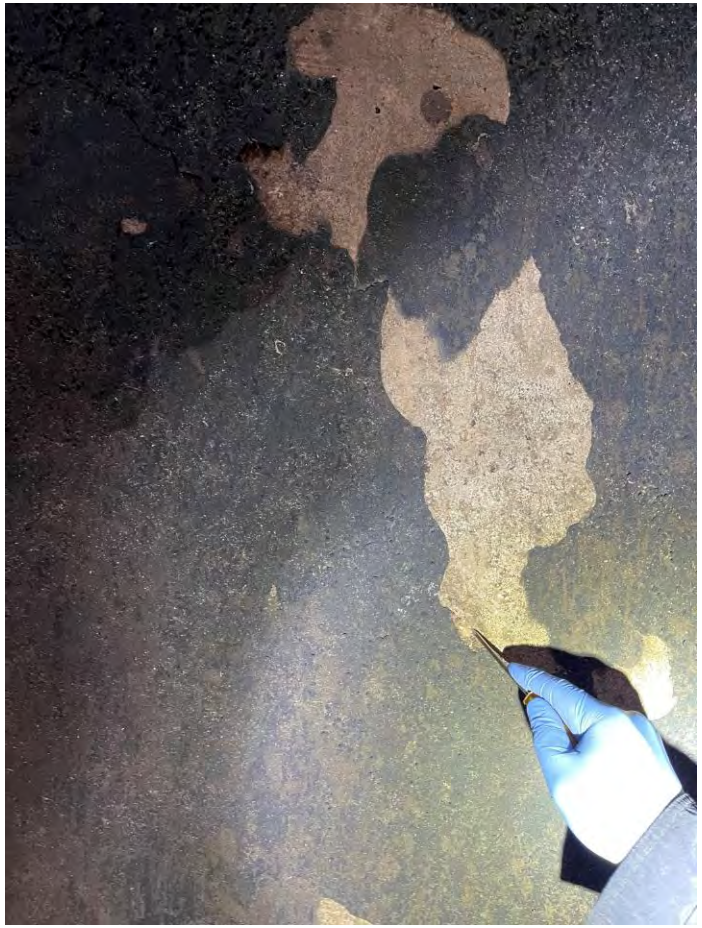




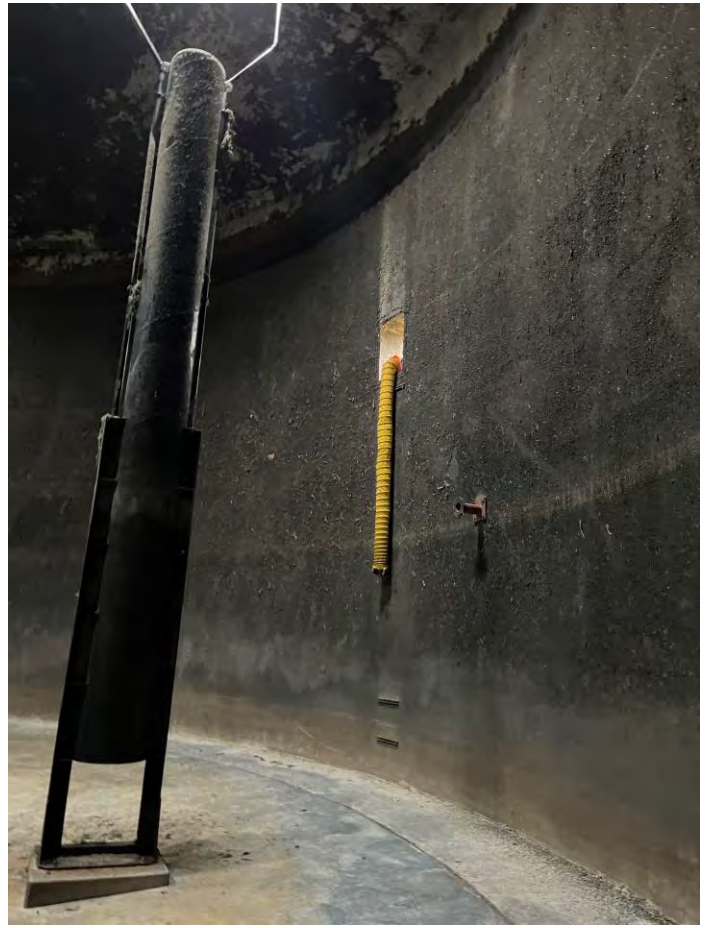


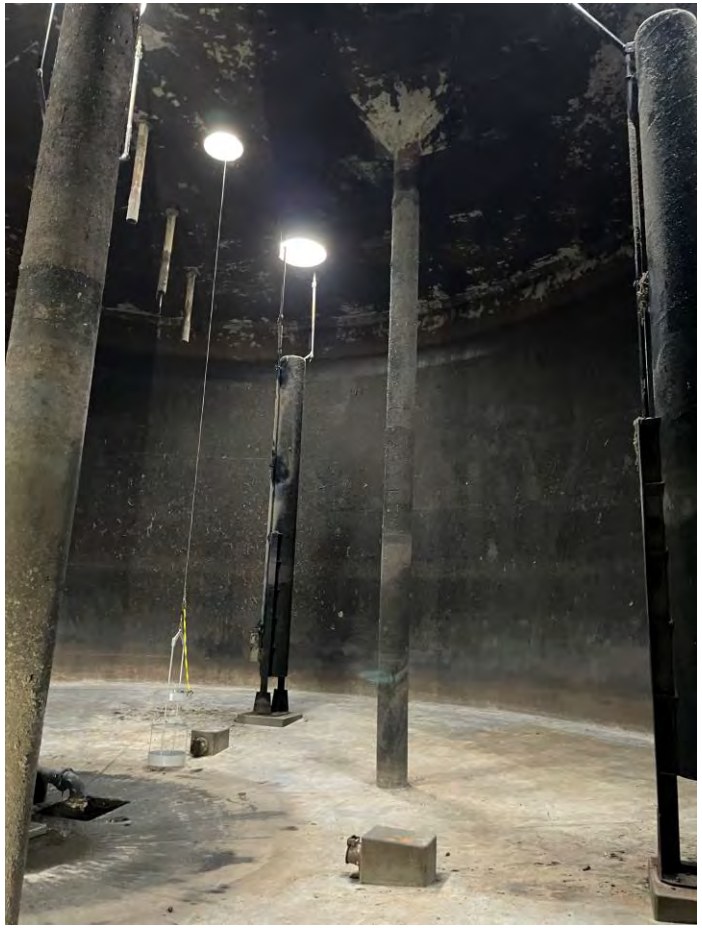




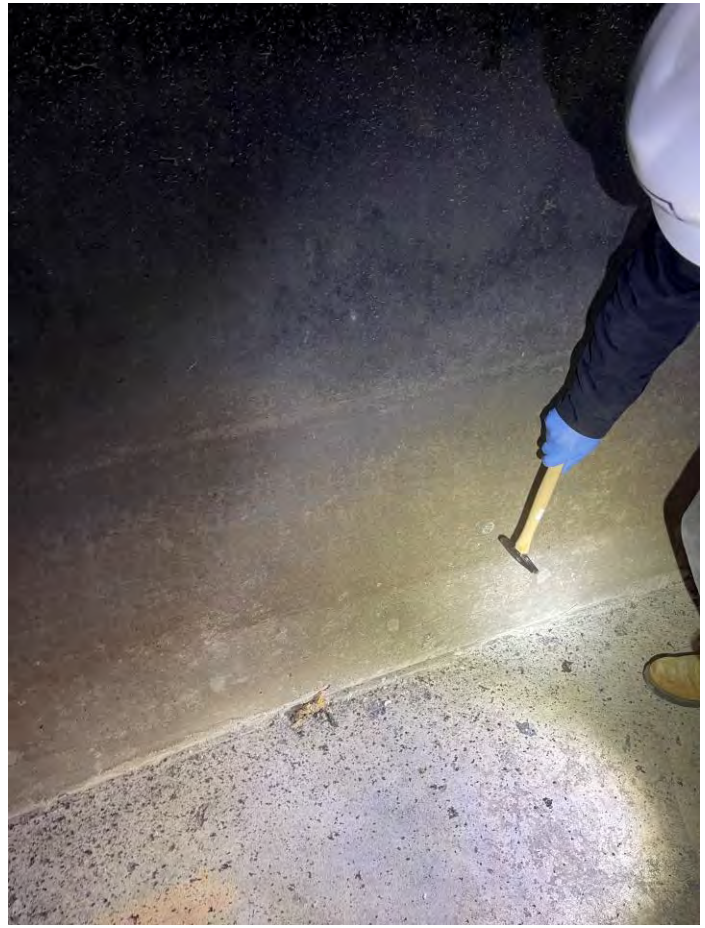






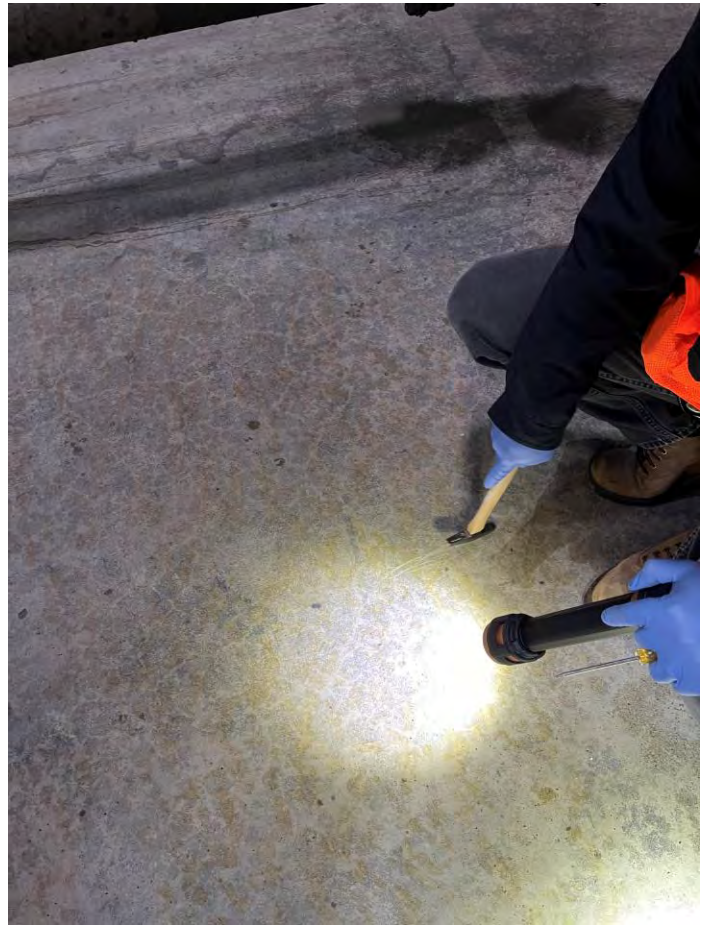


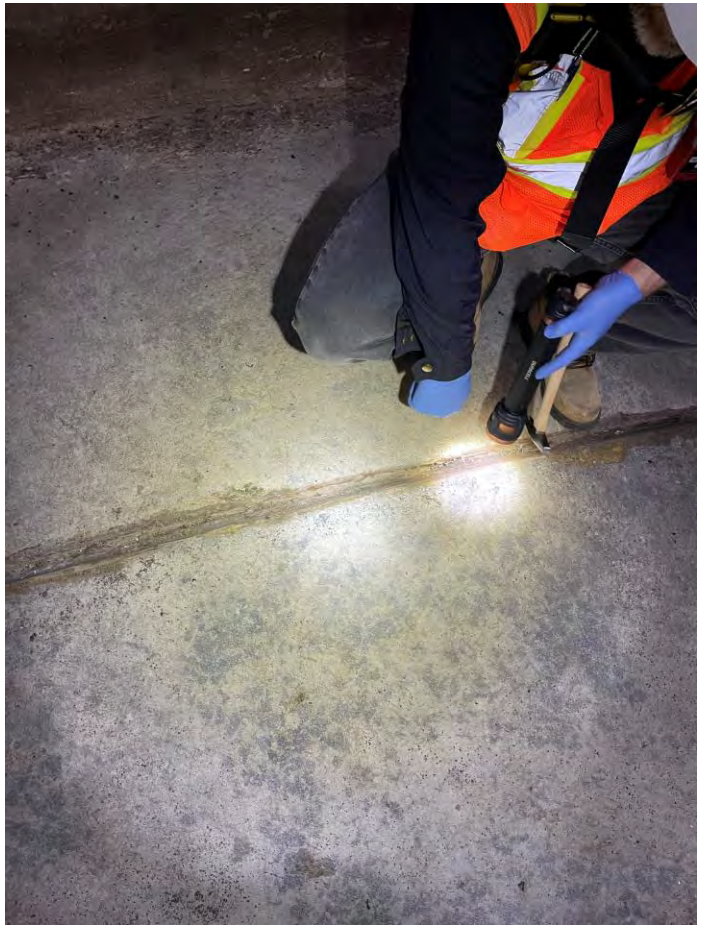
























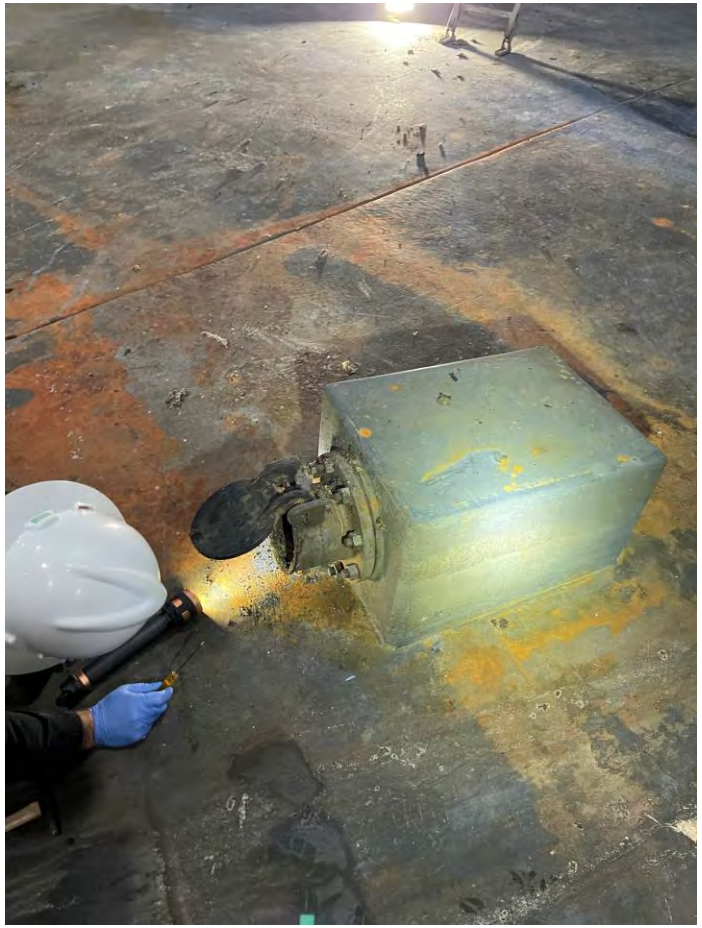




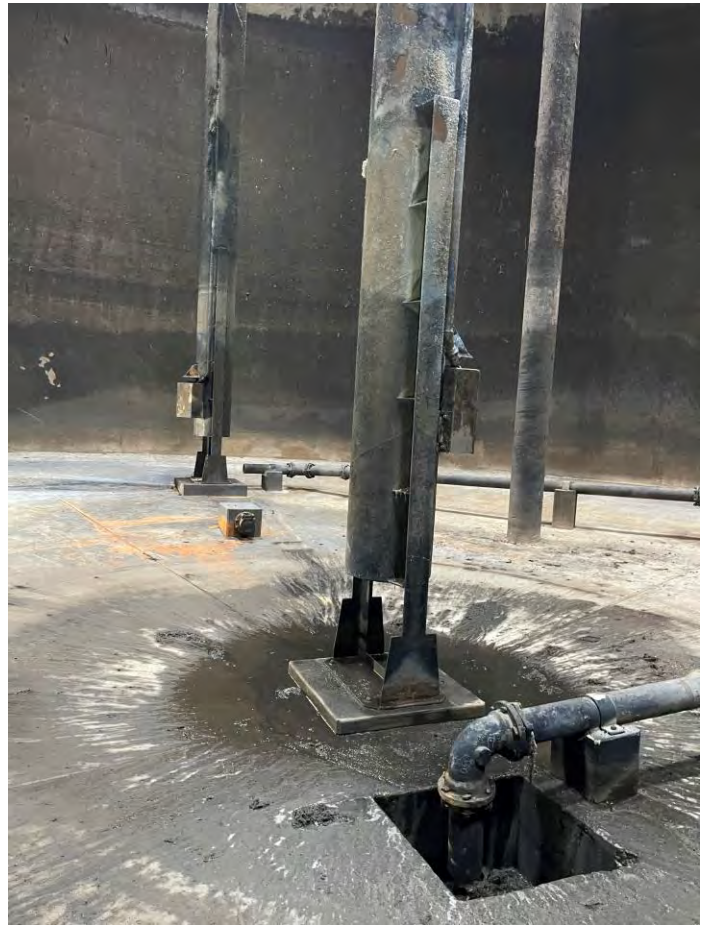






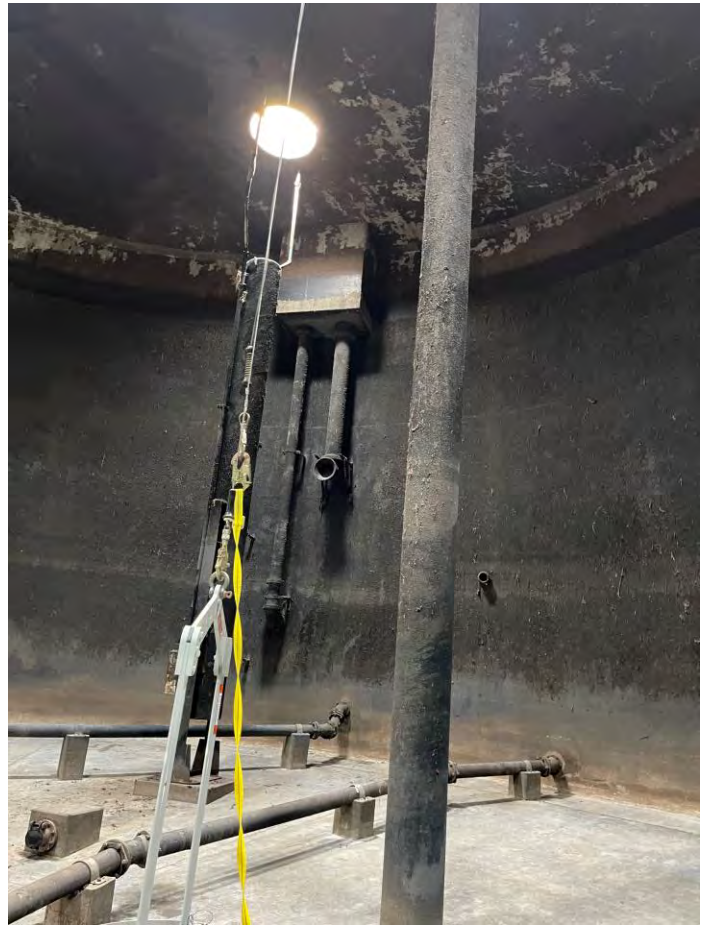


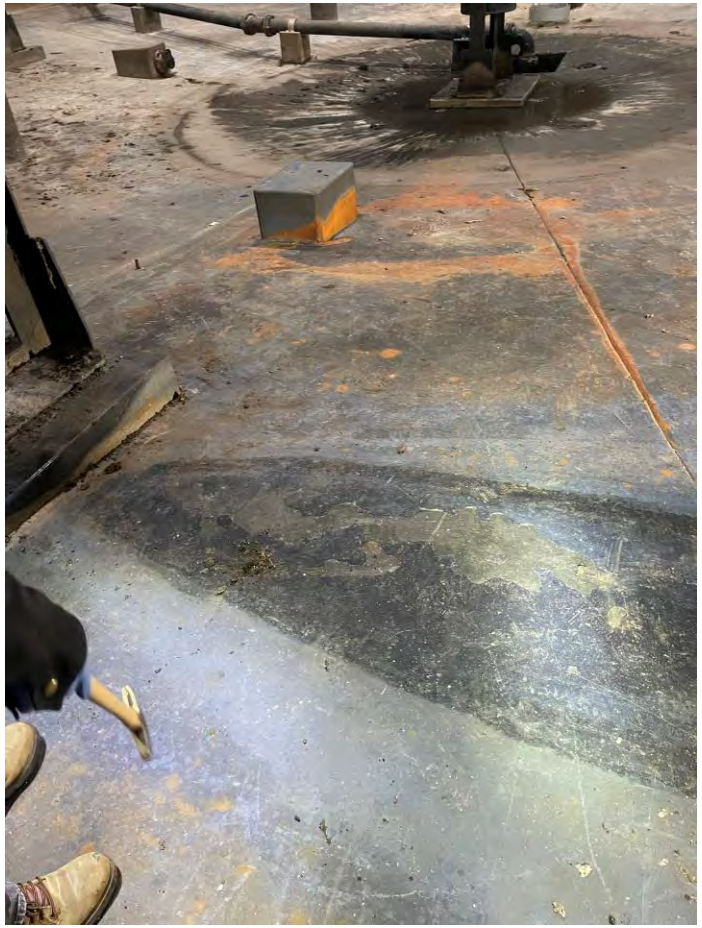




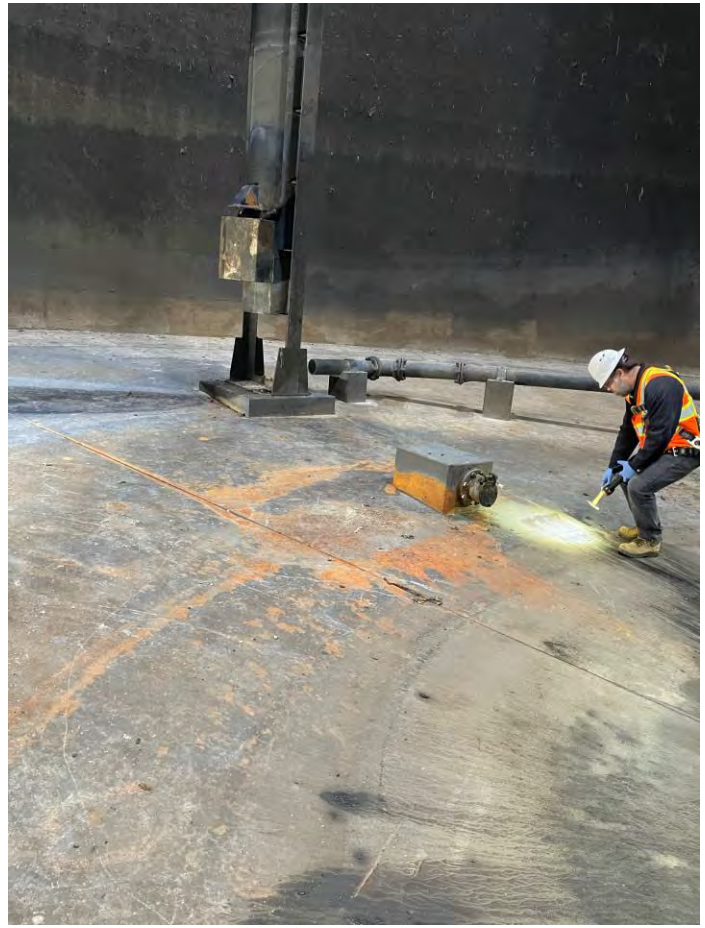






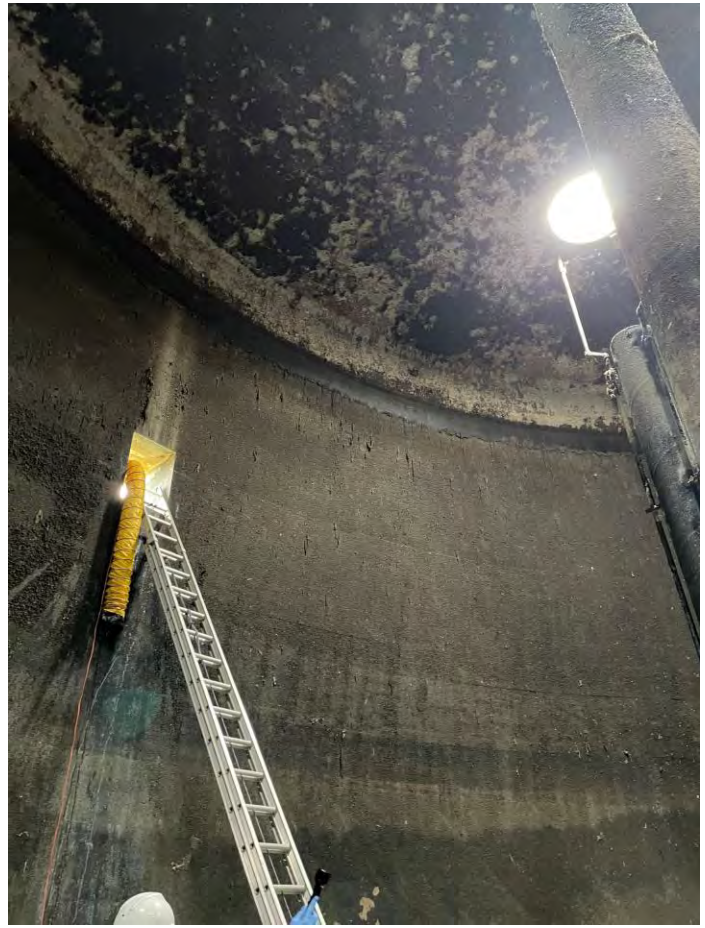













Brown AND
Caldwell

Appendix D: TM3 Regulatory Review and Market Assessment

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BMSP Cap Impr Impl Plan Final

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Technical Memorandum

FINAL

Prepared for: City of Santa Rosa

Project Title: Biosolids Management Strategic Plan

Project No.: 157568.008.003

Technical Memorandum 3

Subject: Regulatory and Market Assessment

Date: June 28, 2023

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Limitations:

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Executive Summary

The City of Santa Rosa (City) engaged Brown and Caldwell (BC) to perform a regulatory and biosolids market assessment to understand the current and future biosolids end-use market. This information can impact the choice of biosolids treatment technology and will be considered and incorporated into the upcoming planning process. BC considered the national, state, and local regulations on biosolids, the California agricultural market, the current commercial soil amendment market, and the impact of regional peer utilities. Ultimately, the market landscape in California can support a wide variety of end-products and markets.

Through the lens of three of the factors we examined, there are viable markets for agricultural land application of biosolids cake, composted biosolids, and a thermally dried pelletized product. There are opportunities to comfortably continue and expand the current biosolids management program while also building resiliency in case of changing local regulations. Alternatively, a composted Class A biosolids product would allow the city to take advantage of numerous regulatory pressures and incentives to support the broader state goal of reducing carbon emissions and open up partnership opportunities. Finally, a thermally dried, pelletized Class A biosolids product would create the most easily marketed and applicable product. Each of these programs have advantages and disadvantages.

Fundamentally, the findings of this assessment indicate a viable market space. Costs to implement these programs will vary depending on the individual product and the necessary technology. Next steps in this biosolids management strategic plan will include exploring economic factors and weighing non-monetary criteria to coalesce on a final strategic plan for the City.

Section 1: Introduction

The City of Santa Rosa (City) is conducting a biosolids management strategic plan (BMSP) for the Laguna Treatment Plant (LTP) to provide short- and long-term options to achieve the City's goals to:

- Reduce operational costs
- Mitigate future regulatory risks
- Provide solutions that best meet the regional community's needs
- Maintain operational flexibility
- Incorporate and align with the City's Climate Action Plan
- Determine the best use of the composting facility

The BMSP will provide recommendations for the solids treatment system, including replacements, optimizations, or improvements. The BMSP will culminate with a capital implementation plan for the City to use as a roadmap for the next 20 years.

The BMSP includes the following tasks and technical memorandums (TM):

- **Flows and Loads and Capacity Evaluation (TM 1)** – evaluates thickening, digestion, dewatering, and combined heat and power (CHP) unit processes for the biosolids screening and alternatives evaluation
- **Condition Assessment and Evaluation (TM 2)** – documents the condition and recommendation for rehabilitation and replacement of biosolids unit processes
- **Regulatory Review and Market Assessment (TM 3)** – conducts regulatory and market study to understand the market potential for biosolids produced at the LTP
- **Biosolids Screening and Alternatives Evaluation (TM 4)** – evaluates and identifies optimal solutions using a 30-year lifecycle cost analysis

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Figure 1-1 shows the BMSP project flow chart. Each task within the BMSP is followed by a workshop with the City and BC to ensure the City's goals are being met within each task's deliverable. This TM describes the methodology and results from the regulatory and market study conducted to understand the market potential for biosolids produced at the LTP.

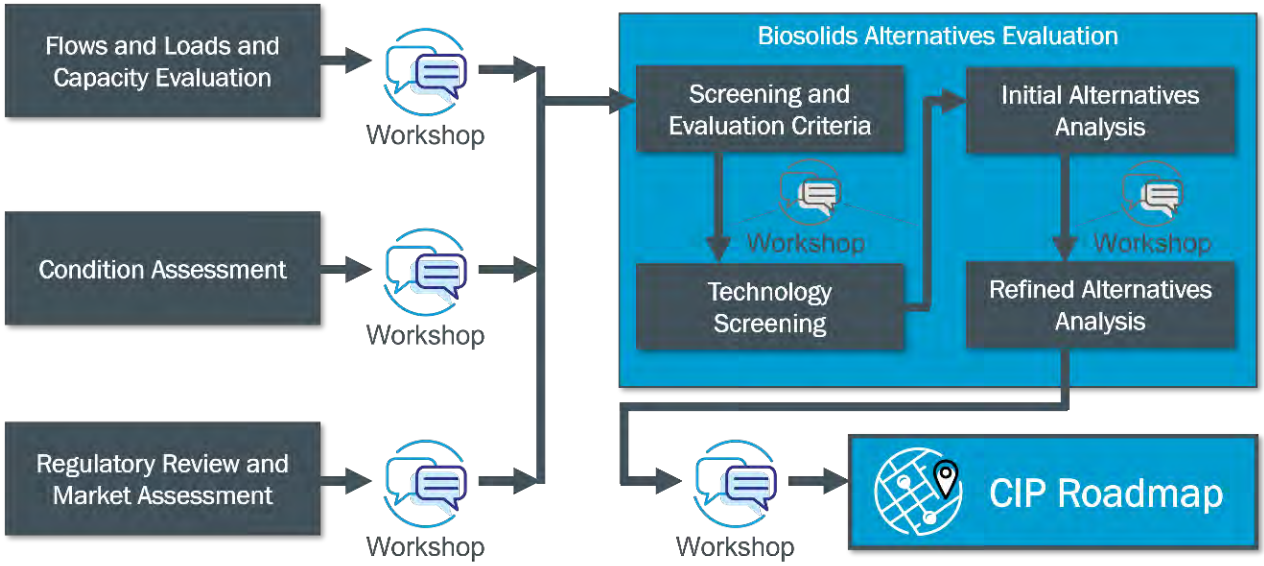


Figure 1-1. Project flow chart

Section 2: Assessment Methodology

As part of this study, BC examined the City's existing biosolids end-use program and four external factors that are major contributors in determining an appropriate biosolids management program. Anchoring the assessment with the existing end-use program allows both the City and BC to reflect on the status quo and understand the overall BSMP's purpose and intent. Analysis of the existing program consisted of outlining strengths, weaknesses, opportunities, and threats, or SWOT. In conjunction with the SWOT analysis, four external factors – the regulatory landscape, agricultural markets, commercial markets, and the competition and/or partnership opportunities with regional utilities – were considered. These factors are outlined below and described in detail in the remainder of this TM (Figure 2-1).

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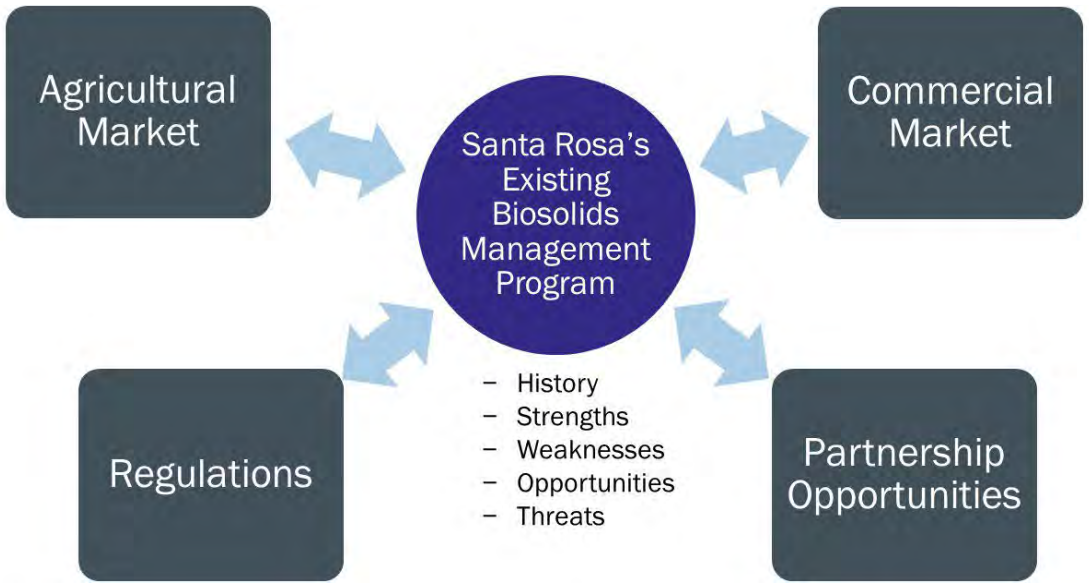


Figure 2-1. Overview of biosolids market assessment

An overlapping network of national, state, and county regulations can influence the City's decisions regarding biosolids product type or end-use. Biosolids from LTP are currently applied in alignment with national and state regulations for biosolids land application. Statewide diversion and compost procurement directives, as well as other sustainability requirements, may incentivize the production of certain biosolids product types over others, e.g., compost versus a thermally dried product. Simultaneously, specific county ordinances can limit the land application of other types of biosolids products in certain regions. Finally, continued national and state investigations on per- and polyfluoroalkyl substances (PFAS), a group of contaminants of emerging concern (CEC), may lead to future regulations or public concern regarding biosolids end-use.

Agricultural land application is fundamental to the City's current biosolids program. While the City has run a successful program for many years, BC sought to broaden the understanding of the current and future agronomic market for biosolids. This included understanding opportunities for expansion within the agricultural market (Class B and Class A cake) and identifying the strengths and vulnerabilities of the current program through conversations with City employees and longtime land application partners. BC also spoke to agricultural extension agents to understand current and future impressions and trends relevant to biosolids land application.

BC explored the commercial demand for a Class A biosolids product within 150 miles of LTP. Phone interviews were conducted with employees at a range of commercial businesses, including soil blenders, landscape suppliers, compost facilities, and biosolids service providers. While the agricultural market forms the foundation of the City's current program, a commercial market could help the city smooth out valleys in biosolids demand throughout the year, expand available land for end-use, and decrease vulnerabilities in its existing Class B program.

Biosolids land application in California is complex and interconnected. Many wastewater utilities exist in the San Francisco Bay area, many of whom also land-apply biosolids. While this can lead to competition for land or end-use markets, the SF Bay area supports a robust coalition of wastewater utilities, which creates opportunities for collaboration and partnership. BC has outlined the regional pressure for land application and the takeaways from our conversations with other regional utilities in Section 7.

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These four components of the biosolids market in California create the context in which the City's biosolids end-use program currently operates. By understanding and communicating these considerations and their interactions, BC hopes to illuminate the external market pressures and current market opportunities to be incorporated into the City's BMSP planning process.

Section 3: Existing Biosolids End-use Program

3.1 Solids Treatment System

The LTP solids treatment system receives influent and high-strength waste (HSW) and uses a combination of thickening, anaerobic digestion, and dewatering to produce Class B biosolids. Currently, LTP produces 4,000 to 5,000 dry tons of biosolids a year in the form of 15 percent total solids Class B cake, which is hauled directly to beneficial use sites or to storage. Production volumes and end-use designation according to the City's National Pollution Discharge Elimination System (NPDES) permits for the last 3 years are presented in Table 3-1.

Table 3-1. Historic Biosolids Production and End-use Designation (in dry tons)

Year	Total Biosolids Produced	Applied at Local Farms	Sent to Lystek	Sent to Redwood Landfill
2020[a]	4,583	3,590	719	346
2021	5,071	3,392	1,519	46
2022	4,337	2,603	1,366	11

a. 315 dry tons were composted in 2020.

The majority of these biosolids are spread on eight or nine farms in Sonoma County at a cost of approximately $40 per wet ton (WT). The city also has a third-party contract that allows up to 150 WT per day and 52,000 WT per year of Class B biosolids to be sent to Lystek's Fairfield facility for a cost of approximately $98/WT. Only a small proportion of biosolids produced are sent to Lystek while an even smaller proportion is sent to the Redwood Landfill in Novato for disposal at the cost of approximately $54/WT during wet weather. Prior to 2021, the City also operated a permitted compost facility where biosolids were composted and sold to the community at $5 per cubic yard.

The City produces Class B biosolids in accordance with the U.S. Environmental Protection Agency's (EPA) regulations governing biosolids land application (described in Section 4). Compliance with Class B requirements and elemental contaminant concentrations are presented in Table 3-2 and Table 3-3. The City has historically and consistently met NPDES requirements for biosolids characteristics and concentrations through careful and active management.

Table 3-2. Historic Class B Compliance Parameters

Year	Temperature (°F)	Days Retained	Volatile Solids Reduction (%)
2020	100	20.0	65
2021	98	18.7	60
2022	98	19.0	60

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Table 3-3. Historic EPA 503 Metals Concentrations (mg per kg)										
Year	As	Cd	Cr	Cu	Pb	Hg	Mo	Ni	Se	Zn
2020	7.3	2.5	28	305	13	0.6	8.8	22	15	780
2021	6.4	3.2	27	289	16	0.6	8.5	30	16	754
2022	6.9	3.2	31	285	9	0.9	8.5	23	17	703
EPA 503 Ceiling Concentrations	75	85	35	4,300	840	57	75	420	100	7,500

As = arsenic; Cd = cadmium; Cr = chromium; Cu = copper; Pb = lead; Hg = mercury; Mo = molybdenum; Ni = nickel; Se = selenium; Zn = zinc

In August 2016, LTP began receiving HSW as part of the plant's trucked waste program. Plant nutrient levels, specifically nitrogen (N), phosphorus (P), and potassium (K), changed minimally due to the addition of HSW. While the average concentration of ammonium, P, and K in 2019–2022 biosolids (post-HSW) was greater than the average in 2015 (pre-HSW), and this increase was statistically significant, the functional increase was minimal and would have no effect on nutrient reporting requirements. The average of total N remained constant before and after HSW receiving began. In TM1, it was estimated that HSW receiving only accounted for 3 percent of biosolids production in the current system, which aligns with the marginal increase in nutrient values. The average nutrient values are presented in Table 3-4.

Table 3-4. Average Biosolids Nutrient Concentrations Before and After the Acceptance of High-strength Waste (%)				
	Ammonia	Total Nitrogen	Total Phosphorus	Total Potassium
Before (2015)	0.8	6.6	2.3	0.14
After (2019–2022)	0.9	6.9	2.5	0.17

3.2 Analysis of Current End-use Program

The City's current biosolids end-use program is well-established and actively managed, which gives space for proactive planning decisions for the next 20 years. To understand opportunities for improvement, BC performed a SWOT analysis of the current program. SWOT analysis provides a framework for understanding the current operating scheme and strategizing for future programmatic growth. Two of the SWOT elements (strengths and opportunities) are positive while two (weaknesses and threats) are vulnerabilities. Additionally, strengths and weaknesses are inherent to the existing program while opportunities and threats are external to the status quo. Following discussion with the City at the Market and Regulatory Assessment Workshop on April 24, 2023, additional elements were added to the analysis. Figure 3-1 depicts the City's final SWOT analysis results. The various features listed in the SWOT analysis are described next, with greater detail provided in the remainder of this TM.

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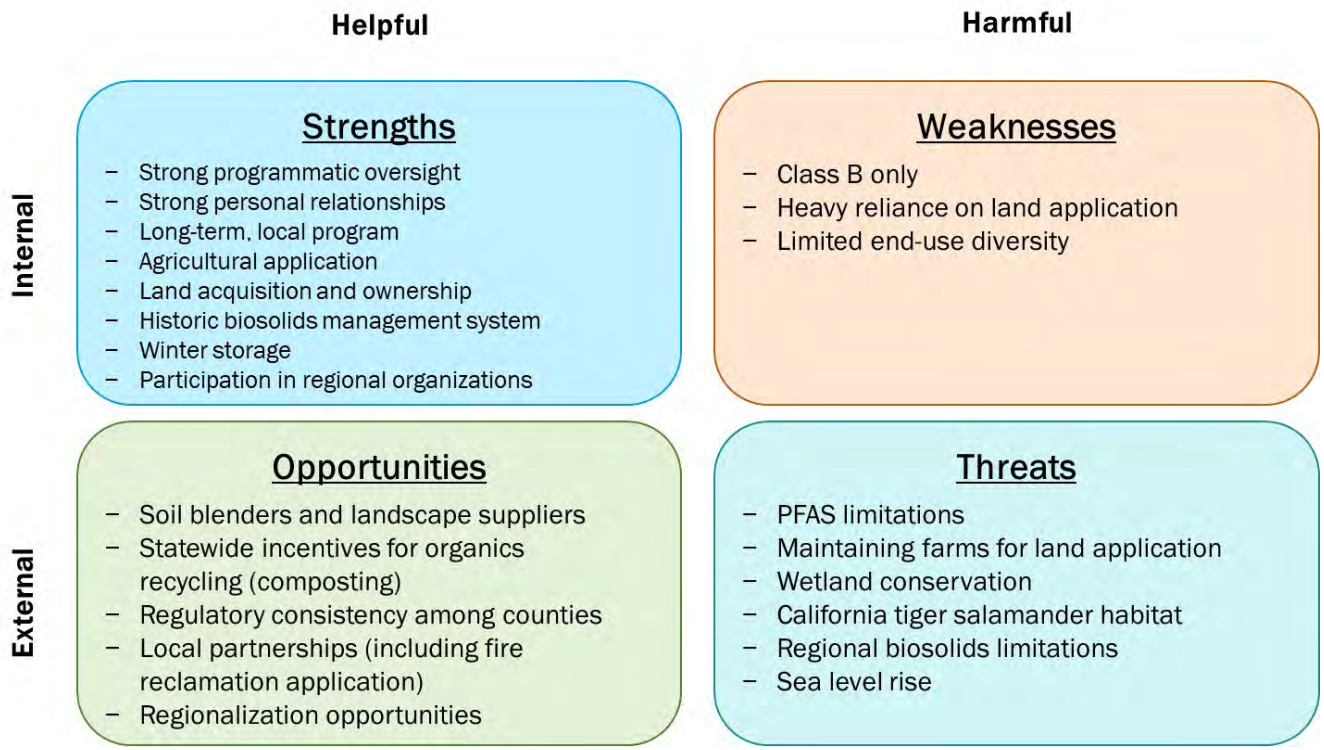


Figure 3-1. SWOT analysis for City's biosolids end-use program

3.2.1 Strengths

The City's biosolids beneficial reuse program has been operating for many years and is actively managed by Zachary Kay, an employee of the City. This experience and attentiveness are unusual and have led to strong, personal relationships between the City and the farms that accept their biosolids. Furthermore, these partnerships are local, and the City has managed to acquire and own some of the farms for beneficial reuse, which further strengthens the City's ability to manage its end-use program. Fundamentally, this foundation allows the current biosolids program to weather risks and threats to biosolids land application. BC spoke with Brian Gilardi of Gilardi and Jacobsen Ag Services, a landowner and farmer who is part of the biosolids reuse program. Brian had previously accepted biosolids from another national biosolids service provider in addition to LTP's biosolids but switched to only accepting the City's product. He credited this change to the City's ability to recognize his needs as a farmer and acknowledged the trustworthy relationship he has with the City. An additional strength of the current program is the variety of winter/wet weather options, namely the storage (Alpha storage) under the City's ownership. This storage provides a rare and valuable buffer during wet-weather months, a period of limited biosolids application which is inherent in an agriculturally dominated end-use program in that region. Finally, the City's participation in regional biosolids and wastewater treatment utility associations have ensured a network of peers who can aid in discussions and actively work toward collaborative and sustainable solutions.

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3.2.2 Weaknesses

The City currently produces Class B solids, which are restricted to application at certain sites and cannot be distributed freely to the public. While the nutrient content and metals restrictions are the same as for a Class A product, the difference in treatment limits distribution and reduces the resiliency of the overall biosolids end-use program. Biosolids have been well documented to be a safe soil amendment with beneficial plant nutrient and soil health properties; however, land application continues to be debated in the public sphere, and existing California county ordinances (described in Section 4.1) indicate that Class B land application is still contested. While the City's current Class B program could be vulnerable due to land application restrictions, the vulnerability is augmented because the majority of its biosolids are currently directed toward agricultural land application.

This pressure was reflected during the Regulatory and Market Assessment Kick-Off meeting on February 9, 2023, when the City expressed concern over finding sufficient land to maintain or expand its existing program. Limited land application locations are also due to the demand for certified-organic goods, a program that does not allow biosolids amendment, or due to protections for endangered species like the California Tiger Salamander. Finally, while the City's land application program is well established, agricultural end-use does entail a seasonal spike in demand for biosolids in the spring/summer and a dearth during the rest of the year. This uneven annual demand can be difficult to manage. Finally, the Redwood Landfill, the City's last-resort disposal option during wet-weather months, may be closing soon, which would leave the City with one less disposal option for its biosolids.

3.2.3 Opportunities

There are several opportunities to expand or strengthen the City's current biosolids end-use program. Due to its proximity to other smaller utilities, the City could partner with local peer wastewater treatment utilities to develop a regional biosolids solution. Solutions could include investing in biosolids processing technology that benefits from economies of scale or leveraging the consortium of utilities to negotiate better end-use options. If the City invested in changing to a Class A system, working with soil blenders and landscape suppliers could help smooth seasonal demand for biosolids. Adding another end-use avenue also increases biosolids distribution outlets, which would diversify the program and reduce risk. These commercial markets are described in greater detail in Section 6.

Changing to a Class A product also provides the City with an opportunity to cultivate local community partnerships and increase public education and outreach (Section 6.7). At the state level, there are many incentives to produce Class A composted biosolids, including Senate Bill (SB) 1383, landscaping ordinances, and California Department of Transportation policies (Section 4.5).

3.2.4 Threats

There are several unresolved but possible threats to the City's current program. The effects of PFAS are currently being studied nationally and at the state level, though explicit regulations on biosolids are currently absent. The details of risk and impact of PFAS in the wastewater treatment stream are still being explored but could have impacts on PFAS land application in the future (Section 4.4). These impacts could either come as formal regulations or as a shift in the way farmers or consumers perceive biosolids land application. Existing biosolids perceptions have led to county-specific ordinances that limit land application. These are being challenged; however, they still currently complicate the broader picture of agricultural land application in California. Additionally, the City has mentioned concerns about sea level rise and wetlands at some of their farms in South County. While levees can be built to strengthen their climate resilience infrastructure, it will require coordination and agreement among their neighbors.

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Section 4: Regulatory Framework

At the federal level, beneficial biosolids use is governed by Chapter 40, Part 503 of the Code of Federal Regulations (CFR 40, Part 503), often referred to as "the 503 Rule." These regulations contain reporting requirements, mandatory management practices, limits on heavy metals, vector attraction reduction requirements, and pathogen reduction requirements.

Regulations and regulatory changes have continued to directly and indirectly affect the demand for and supply of biosolids disposition options in the Bay Area over the last 5 years. Those with the greatest influence over how biosolids are managed in the state include those related to organics diversion targets and local land use ordinances, exerting both positive and negative pressures on biosolids land application, respectively. (See Attachment A for a summary of the overall federal, state, and local regulatory framework influencing biosolids management in California.)

4.1 Land Use Ordinances

States and local jurisdictions may set regulations that are more stringent than the Part 503 Rule, and the impact of such regulations can constrain biosolids use in agriculture or other markets. In California, local county ordinances and permitting requirements have had the impact of restricting their use in certain areas of the state, as illustrated on Figure 4-1.

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Figure 4-1. Current status of county land application ordinances in California

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As a result, many large agricultural counties in California have severe restrictions on biosolids land application, which can increase hauling distances for beneficial use. For example, land application restrictions in Southern California counties force utilities who wish to land apply to ship their biosolids to Arizona for land application. In Northern California, Solano, Sonoma, and Merced counties all place seasonal restrictions on biosolids land application, which in effect prohibit land application during winter months. Solano County's ordinance contains additional restrictions to address environmental concerns, such as land application in the secondary marsh areas, and public concerns associated with odors and traffic generated by land application on weekends.

The California Association of Sanitation Agencies (CASA) recently released data that show the amount of biosolids (excluding compost and dried material) generated in California and the county in which those biosolids were land applied. The impact of county ordinances is evident in these data, with several counties in the area accounting for a significant portion of land application in the state. For Northern California, the primary land application counties are Sacramento, Solano, and Merced. Note that Figure 4-2 shows counties in Arizona, the end destination for much of the biosolids generated in Southern California. Potential exists for tonnage to shift based on cascading impacts from SB 1383, described in the next section.

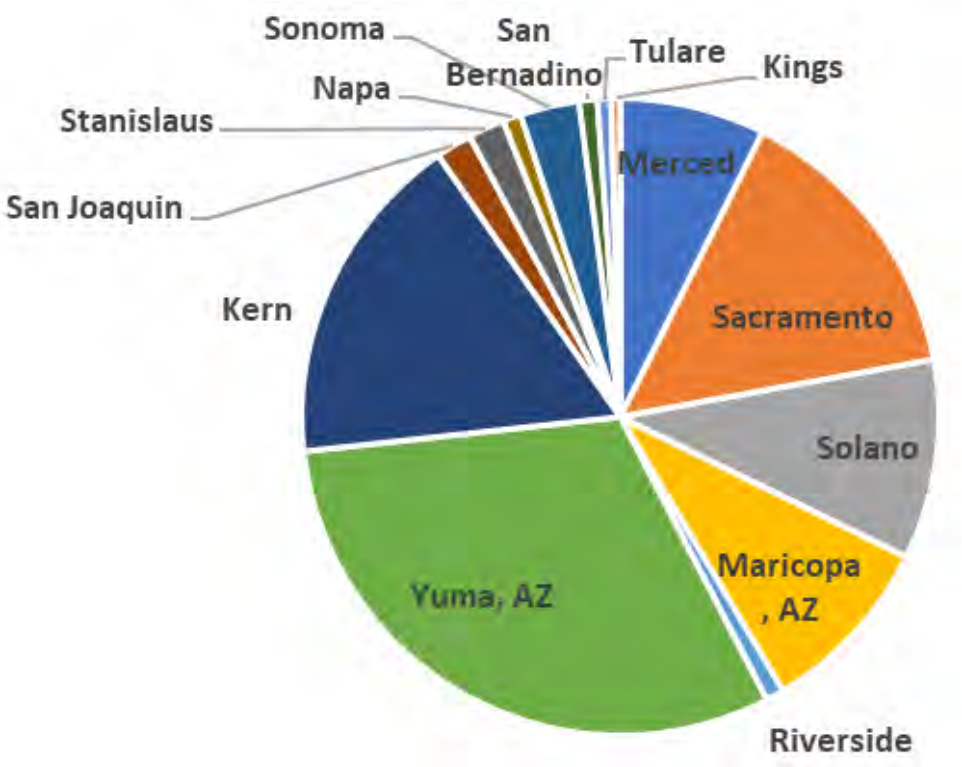


Figure 4-2. 2021 California biosolids land application by county applied, excluding compost and dried material

Source: CASA

The Sacramento Regional Wastewater Treatment Plant (Regional San) is the only facility in Northern California that is currently generating thermally dried material. The drying facility, operated by Synagro, produces around 20 dry tons per day of a 1- to 4-millimeter Class A pellet. According to Synagro, the product is distributed to fertilizer blenders and is land applied at ranches and for row crops. The National Biosolids Data Project (2021) reported that most of the dried material generated at Regional San was land applied to support hay growth.

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4.2 SB 1383

A significant regulatory shift since completion of the last *Biosolids Management Strategic Plan* in 2014 involves efforts aimed at diverting organics from landfills as a means of addressing target reductions in methane emissions set by Assembly Bill (AB) 32.

4.2.1 Organics Diversion Targets

In particular, SB 1383 sets a statewide target related to diversion of organics from landfill disposal to beneficial use. As compared to 2014 levels, SB 1383 sets a target of 50 percent diversion of organics from landfill disposal to beneficial use by 2020 and 75 percent diversion by 2025. Biosolids are included in the State's definition of organics and would comprise part of the total quantity of organics to be diverted, in addition to food waste and green waste. These regulatory efforts impacted the ability of utilities in the Bay Area to use biosolids as alternative daily cover (ADC), which had long been considered a reliable wet weather outlet and a beneficial use. Under SB 1383, ADC is no longer considered a beneficial use, although using biosolids for slope stabilization or erosion control will continue to be considered beneficial.

Solid waste jurisdictions across the state have begun working to explicitly reduce biosolids quantities being sent to landfills. SB 1383 set a compliance date of 2022 for meeting the statewide 50 percent diversion target—a target the California Department of Resources Recycling and Recovery (CalRecycle) has reported has not been met. CalRecycle has the ability to impose penalties on non-compliant jurisdictions (e.g., those that are not making prescribed efforts to divert organics) by 2024. As a result, many jurisdictions have sought to shift their biosolids out of landfills and into beneficial use outlets, increasing both the demand for available biosolids beneficial use options serving the Bay Area and increasing pricing for those options.

While SB 1383 no longer defines landfill ADC as a beneficial use, it does not explicitly ban landfill disposal. Because regulations implementing SB 1383 establish that organics diversion requirements will be enforced at the jurisdictional level, not at local landfills, it is likely that biosolids will continue to be received at landfills but less intensively than in the past and at higher costs. This is primarily because biosolids are generated in bulk and can be more easily diverted than other organics.

4.2.2 Potential Impact on Local Land Use Restrictions

By increasing the demand for other biosolids disposition options, over time SB 1383 also will likely increase the supply of biosolids end products (such as compost) in the market even though the future demand for those products may be uncertain. To help address this, SB 1383 limits local jurisdictions' abilities to restrict organic waste recycling.

CASA, based on its discussions with CalRecycle, has concluded that county ordinances currently restricting biosolids land application, such as San Joaquin County's land application ban, would be overturned by this regulation. Lifting bans and restrictions could unlock land application capacity in Central Valley agricultural counties such as San Joaquin, Stanislaus, and Fresno; however, because this could be subject to litigation, both the timing and outcome are uncertain.

4.2.3 Other Regulatory Efforts to Increase Demand for End Products

SB 1383 attempts to address the need for recycled organics markets by increasing end-product demand by requiring jurisdictions to purchase products generated from organics diversion, currently limited to only compost and renewable natural gas.

Another market-related impact from SB 1383 is that the amount of food and green waste being converted to compost appears to be increasing. However, insufficient infrastructure for processing this material has resulted, in some circumstances, in relatively poor-quality green/food waste compost, which is competing with biosolids compost and being sold at a lower price.

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4.3 Beneficial Use and Nutrient Claims

The California Department of Food and Agriculture (CDFA) has regulatory jurisdiction over any products making nutrient claims, and its corresponding regulations would be used to determine a fertilizer designation. If Santa Rosa were to distribute a thermally dried biosolids product, CDFA regulations, as well as municipal biosolids regulations, would likely need to be met. Product quality requirements from the bulk fertilizer distributors would be in addition to biosolids regulations.

4.4 Emerging Contaminants: Per- and polyfluoroalkyl substances

PFAS are a large group of synthetic chemicals used in various products, including firefighting foams, cookware, food packaging, and stain repellants. Two of the most-studied members of this chemical group are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Scientific studies indicate that these chemicals can accumulate in the body and lead to various adverse health effects in animals and humans. Potential adverse human health effects include increased cholesterol levels, low infant birth weights, immunological effects, cancer, and thyroid hormone disruption. Due to its impacts, EPA are currently performing a risk assessment of PFAS pathways into the human body, including via biosolids land application. Pre-emptively, biosolids land application has been stopped in some locations due to concerns of PFAS.

Although PFOA and PFOS have been voluntarily phased out by most U.S. industries they persist in the environment. In addition, there are thousands of other PFAS still in use for which little information is available regarding environmental occurrence or toxicity. As of this writing, there are approved analytical methods to analyze 29 compounds in drinking water. A draft EPA method (1633) focuses on 40 compounds in non-drinking water media (e.g., groundwater surface water, soil, sediment, biosolids). Otherwise, the EPA database documents upwards of 12,000 individual PFAS compounds.

In the last few years, PFAS have emerged as a top priority for research and regulatory development. PFAS are also actively studied by regulatory agencies, universities, industry, and the Water Research Foundation. Active areas of research include toxicity studies, source identification, date and transport studies, and the development of analytical methods. The EPA and some state regulatory agencies have issued guidance and regulations to protect human health and the environment from PFAS, with more regulations expected.

Examples of regulatory agencies' actions to date include:

- In 2016, the EPA issued health advisories for PFOA and PFOS in drinking water, expressed as a safe lifetime exposure level of 70 nanograms per liter (ng/L). California has proposed drinking water standards for PFOA and PFOS, using even lower values. More recently, on March 14, 2023, the EPA released proposed drinking water maximum contaminant levels (MCL) of 4 parts per trillion (ppt) for PFOA and PFOS, as well as the use of a hazard index calculation for four additional PFAS (GenX, PFBS, PFNA, PFxHS).
- In 2020, the EPA began its risk assessment process to evaluate the need for PFOA and PFOS limits in biosolids under 40 CFR 503 Rule (this would potentially impact both biosolids land application and incineration). The results of this risk assessment are expected to be published in 2024.
- In 2021, the EPA published a single-laboratory-validated method for detecting up to 40 specific PFAS in wastewater and biosolids. The multi-laboratory-validated method (which would then be considered an "approved" method for inclusion in permits) is expected to be published in late 2023.
- The EPA and multiple state regulatory agencies have begun placing PFAS monitoring requirements in NPDES permits for publicly owned treatment works (POTW) and industries.

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Of note, on October 18, 2021, 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. This includes a renewed interest in PFAS source control and identification, which could impact Santa Rosa's pollution prevention program. For example, EPA plans to issue updated effluent limitation guidelines for several key industrial categories (e.g., metal finishing, electroplating, and organic chemicals, plastics, and synthetic fibers [OCPSF]). Proposed rules for OCPSF are expected in late 2023, and metal finishing and electroplating are expected in later 2024. Additional data reviews will be conducted for other industrial categories; this is a dynamic and rapidly evolving area of regulatory oversight.

4.5 Non-regulatory State Initiatives

California has also enacted several programs to require or incentivize environmentally responsible land management practices. These include the Model Water Efficient Landscape Ordinance (MWELO) from the California Department of Water Resources, compost requirements for California Department of Transportation projects, and the Healthy Soils incentive program from CDFA. These programs would accept a composted biosolids product only.

4.5.1 Model Water Efficient Landscape Ordinance

MWELO establishes practices to decrease landscape irrigation and improve water efficiency of urban water use in California. Under MWELO, landscape installations must use compost at a rate of at least 4 cubic yards per 1,000 square feet, unless soils have an organic matter content of greater than 6 percent. Additionally, SB 1383, Article 8 re-states the requirement for jurisdictions to adopt MWELO, de facto pairing the SB 1383 procurement requirements with MWELO compost usage. Ultimately, these ordinances create a market for compost in California like SB 1383 and thus, a composted biosolids product.

4.5.2 California Department of Transportation

For many wastewater treatment utilities, contracting with the local department of transportation can provide a steady distribution outlet for biosolids. The California Department of Transportation (Caltrans) provides guidelines for erosion control techniques in Caltrans projects. These techniques include using compost to promote soil health at a sterile site, improve water holding capacity and vegetative cover, or to improve infiltration and runoff, generally through the application of compost blankets. Compost producers must be approved by the United States Composting Council Seal of Testing Assurance program. The City expressed that previous attempts to work with Caltrans proved to be challenging; however, it may be worth investigating this outlet again if compost is produced.

4.5.3 Healthy Soils Program

The Healthy Soils program, established in 2016, is supported by the Office of Environmental Farming and Innovation within the California Department of Food and Agriculture. It is designed to incentivize sustainable land management practices that improve soil health characteristics while sequestering carbon in the soil and reducing greenhouse gas emissions from farming. The program provides financial assistance to implement a wide variety of sustainable land management practices, including compost application. Compost eligible for the program subsidy must be purchased through a certified facility or produced on site. While biosolids compost was originally eligible when the Healthy Soils Program was first enacted, current guidelines refer to Conservation Practice Standard 808 - Soil Carbon Amendment, from the United State Department of Agriculture's Natural Resource Conservation Service (NRCS), which does not permit biosolids compost. However, biosolids advocacy groups, such as CASA, and biosolids researchers have been

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petitioning the NRCS to allow biosolids compost as a carbon-sequestration practice. These discussions are ongoing.

4.6 Conclusions

The regulatory framework governing beneficial use of biosolids in California is well established. Continued implementation of AB 32 has led to multiple regulations and state initiatives that benefit or encourage the recycling of biosolids to land, most notably SB 1383. The sole potential threat to this trend is EPA's regulation of PFAS; the risk assessment associated with potential regulatory limits will not be complete until next year. In the meantime, a focus on pollution prevention and identifying possible sources of PFAS within the service area would help the City retain a proactive approach toward management of its biosolids program.

Section 5: Agricultural Market

The region surrounding Santa Rosa contains a broad range of agricultural lands that could have interest in using a biosolids product. The City's current program is dominated by agricultural end-use and has been successful for many years; however, changes to biosolids land application regulations and perception can threaten the existing program. A broad summary of the agricultural market, a deeper dive into the North Bay hay market, and other relevant issues to agricultural land application are discussed in this section.

5.1 Agricultural Census

Sonoma County is a highly productive agricultural county with estimated annual crop values of $700 million. Of the more than 400,000 acres reported in the 2019 agricultural census, 312,000 acres were managed as range pasture, 56,800 acres were planted for wine grapes, and 52,500 acres were planted for sileage. Within Sonoma County, 78,000 acres (25 percent total reported acreage) were reported to be implementing certified-organic farming practices, which can be a challenge for finding land for biosolids end use. Due to the region's geography and increased traffic closer to San Francisco, transporting biosolids to other agricultural counties can also be challenging.

Napa and Solano counties are nearby and have large agricultural sectors. Napa County is well known for its 45,200 acres of vineyards but also contains 65,000 acres of range pasture and 4,756 acres of reported organic acreage. Solano County reports a wide range of agricultural and horticultural land uses, including 206,300 acres of pasture, 41,000 acres of hay crops, and 29,000 acres of almonds and walnuts. Solano County did not report any acreage as organic in the 2019 survey; however, this is likely a reporting oversight rather than a reflection of actual land management practices in the county. A summary of agricultural land use by acres is presented on Figure 5-1.

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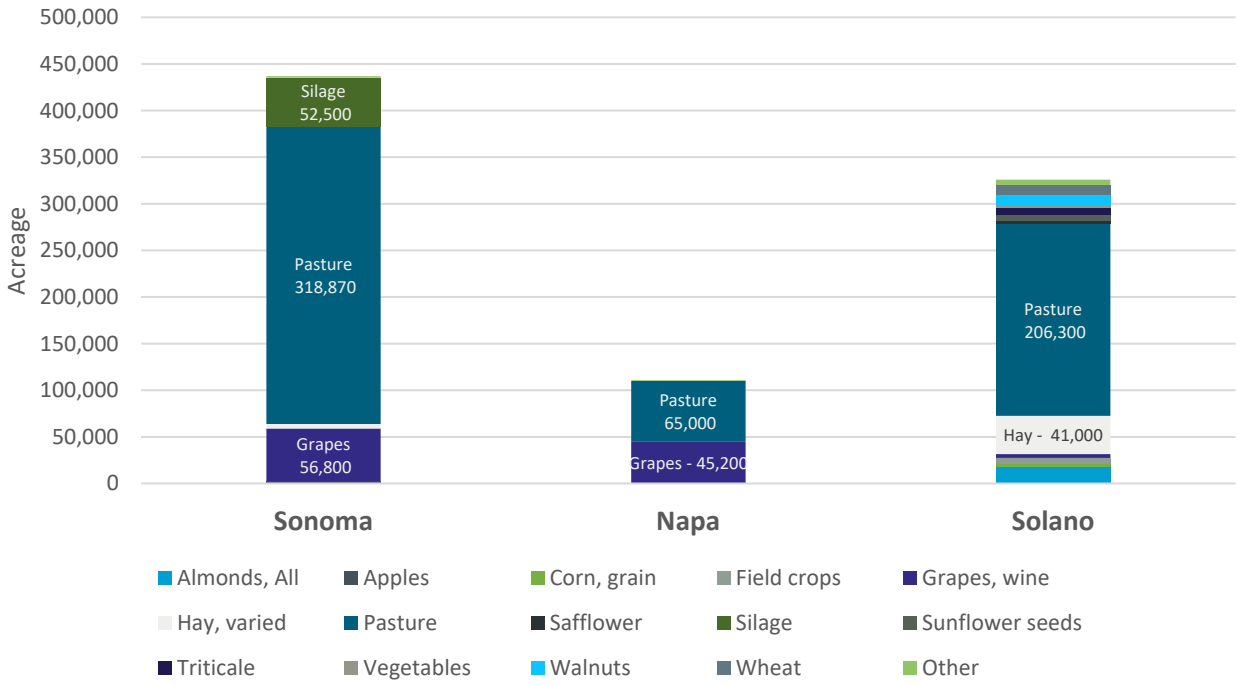


Figure 5-1. Reported acreage by county and crop (2019 California Agricultural Census)

5.2 Agricultural Extension Impressions

BC spoke with six agricultural agents or former agents who represented Sonoma, Napa, and Solano counties. Though two were unfamiliar with biosolids and unwilling to offer an opinion, several agents were familiar with biosolids and its uses. A horticultural agent had worked with biosolids in the past but had found it difficult to convince his contacts to buy into the product. Even with a measured explanation, the taboo of the product overrode any further discussion of its benefits. Two other agents, one in rangeland and one in dairy, were aware of the positive benefits from biosolids land application and believed there would be farmers open to accepting it. However, both mentioned the limitation from certified-organic acreage and concerns about PFAS. If there was research stating minimal impacts from PFAS and no long-term negative consequences, the agents stated their farmers would likely be open to using biosolids. It was noted there is a shortage of compost in the region and that farmers themselves have been severely limited in the amounts they can produce on site. Ultimately, BC's conversations with these keystone community members indicate that there are additional farmers open to accepting biosolids, and that education would be beneficial to supporting those efforts.

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5.3 Hay Market

Currently, the City applies biosolids to land growing conventional hay in Sonoma County and has had success doing so. As part of this market assessment, BC was asked to investigate opportunities to expand capacity for hay farming. Specifically, the City was curious about additional acreage and what the increase in hauling distance would be. The majority of hay grown in California is produced in southern California, with most grown in Imperial County, more than 600 miles away. However, several neighboring counties to Santa Rosa have significant acreage growing hay. Yolo County, Sacramento County, and Glenn County acres are within 150 miles and grow 27,000, 16,000, and 10,000 acres of hay, respectively, according to the 2019 agricultural census. While 19,400 acres of Yolo County practice certified-organic land management, Sacramento and Glenn do not report any amount of dedicated certified-organic land. 150 miles is significantly farther than most locations under the current program; however, it is not unheard of for either California end-use programs or biosolids end-use programs nationally. Closer in, Napa County grows ~600 acres of hay. While this is a small area, it does indicate some capacity to expand into a neighboring county. It is worth noting that Napa Sanitation owns and operates around 900 acres of conventional hay as part of its own biosolids end-use program, but the 600 acres reported in the agricultural census do not appear to include Napa Sanitation's acreage. Since the City has proven quite proficient in developing long-term relationships with its current biosolids receivers, it would not be difficult to apply the same approach to gain additional land for biosolids application by expanding crop/land-use types or to nearby counties.

5.4 Solano County Concerns

In the past few years, Flannery Associates LLC has purchased 30,000 acres of land in Solano County. Many of the transactions have been at real estate development prices, rather than agricultural land prices, and the land has been leased back to the ranchers who originally sold it. Recently, a biosolids permit came up for renewal, and Flannery Associates LLC refused to sign. The impetus for and intention of this company is unknown, along with the company's origins. In spite of the unsigned biosolids permit, current operations have not been significantly impacted, and the implications of these purchases on the broader California biosolids puzzle are yet to be determined.

5.5 Conclusions

The City's current agricultural program is highly successful but does require active relationship and operational management to ensure there is sufficient land for beneficial reuse. Based on the agricultural census and discussions with those in the field, opportunity exists to continue expanding the existing program by developing additional relationships and expanding to additional agricultural markets. Following discussions with the City, which expressed that around 800 acres of land have been lost to California Tiger Salamander habitat, producing Class A cake could also be a solution to re-claiming those acres and mitigating the impact from restrictive county ordinances.

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Section 6: Commercial Market

The region surrounding the City's treatment plant contains a broad range of businesses that could have interest in using a biosolids product. To assess the commercial businesses open to using biosolids, BC performed a biosolids market analysis. This analysis is rooted in guided but open-ended phone interviews with commercial end users to understand interest, volume, seasonal demand, and expected costs. The BC team interviews focused on nurseries, soil blenders, and soil distributors within a reasonable distribution distance for the City (~150 miles). Some entities maintain business addresses outside the geographic area (e.g., Minden, Nevada) but either maintain an active presence around the City or could be options for the City in an emergency. These commercial businesses would accept Class A biosolids products. BC also spoke to biosolids service providers and composters who could receive a Class B product for a service fee. While the City currently produces a Class B product that would be ineligible for distribution to the typical commercial market, producing a Class A product and developing relationships with commercial businesses would diversify the City's current program, protect against potential threats to Class B land application, and provide an opportunity to smooth out seasonal demand for biosolids. Following these conversations, BC found that there is a viable market for Class A biosolids products among commercial businesses or viable options for third-party handoff of Class B biosolids.

6.1 Market Assessment Methodology

A market survey was conducted to identify potential commercial end users for the City's biosolids. The goal was to understand what market type was available for a Class A product, should the City decide to shift from Class B production. A 12-question survey was created and used to guide conversations (Attachment B). A 150-mile radius search for potential end users was performed and included national and regional biosolids service providers. Contact information for end users was obtained using internet searches and built upon other biosolids market assessments done by BC within the past 4 years. Surveys were completed via phone interviews. The survey responses have been compiled, analyzed, and presented in this TM.

Investigation into the commercial market was mainly centered on Sonoma and Sacramento counties. Markets are limited to those that are outside of organic farming, but some organic distributors were contacted to gain a general understanding of the perception of biosolids land application. Additional outreach was undertaken to understand preferences in product type (e.g., compost versus a dried, pelletized product), wet weather capacity, and whether there was an interest in a biochar or ash product.

6.2 Potential End-users Identified

51 businesses were included in this survey. 27 contacts were included from previous biosolids market assessments conducted in Northern California during the past 4 years, and 24 new contacts in and around Santa Rosa were identified and called. Those surveyed consisted of four business types:

- Soil blenders, fertilizer blenders, and landscape suppliers that blend raw materials as their own topsoil and mixes, then sell them to customers (e.g., farmers, contractors, etc.)
- Landscape suppliers who buy pre-mixed blends and sell landscape materials (wholesale or retail)
- Composters who purchase or receive (e.g., for a tip fee) their raw materials from a supplier and blend their own products
- Biosolids management contracting companies who facilitate marketing and sales of biosolids products

Some of the entities contacted had multiple business lines. Figure 6-1 depicts the 31 businesses that were interviewed. Overall, this demonstrates an active horticultural and landscaping industry in the region surrounding Santa Rosa.

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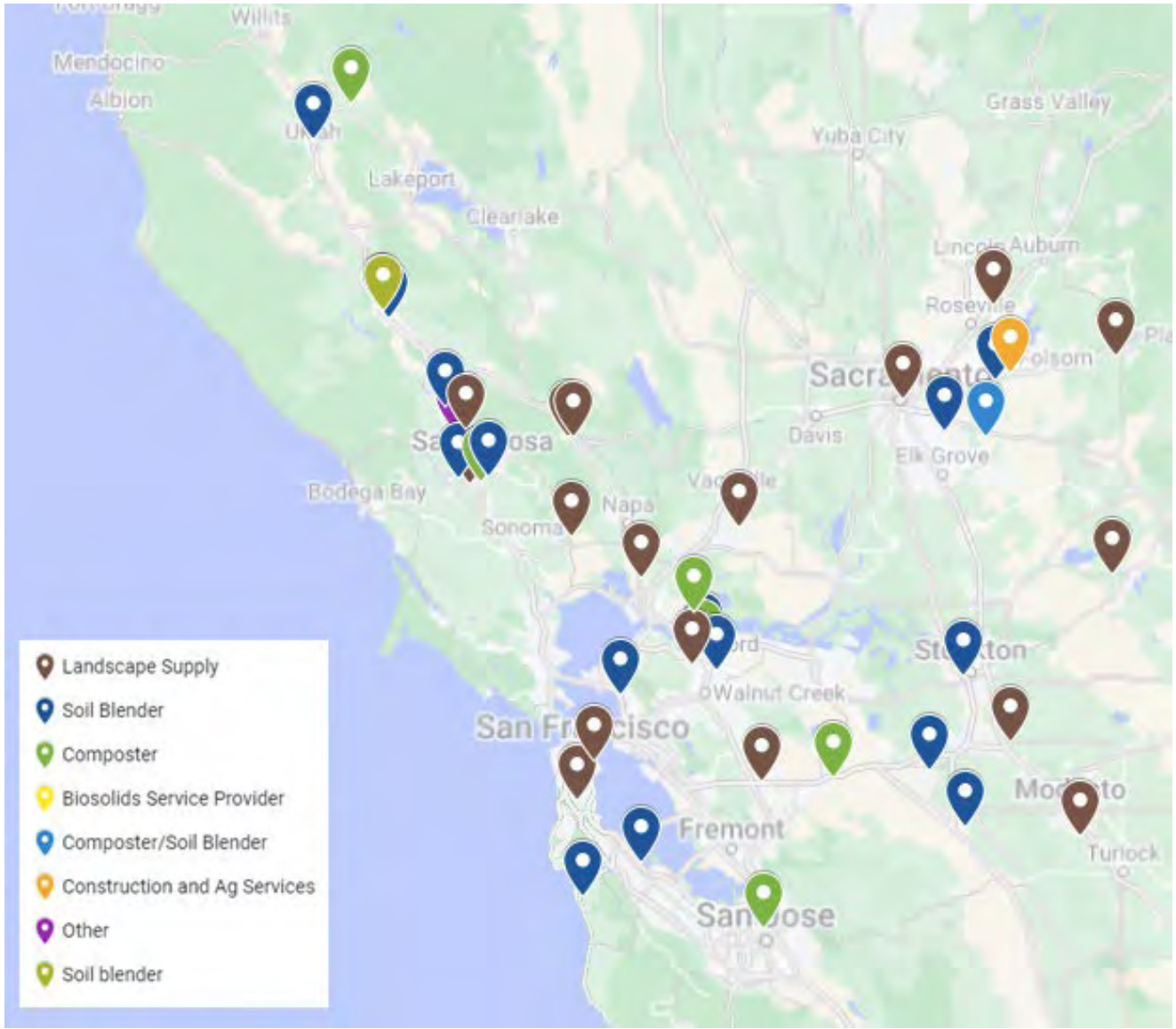


Figure 6-1. Location of businesses contacted for market survey

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6.3 Survey Response Rate

General responses for all end users (i.e., surveyed businesses) called are presented in Table 6-1. From the total general responses 40 entities were reached via phone and nine declined to participate. A total of 31 successful interviews were conducted, with most interviewees within 100 miles of the City.

Table 6-1. General Summary of Commercial Calls

Response	Number of Businesses
No response	11
Declined survey	9
Not interested/Not familiar with biosolids	7
Surveyed contacts	31
Total encounters	51[a]

a. *Some contacts chose to decline participation because they were not interested in discussing biosolids. This could be due to a variety of factors, including their own product line (e.g., organic-certified only), biosolids perception, or time of contact. At the same time, some contacts fully participated though they were still not interested in biosolids. These calls would be registered as both declined/surveyed and "not interested in biosolids," resulting in double-counting.*

6.4 Biosolids Familiarity and Impressions

A rating process was used to categorize participant's impressions of biosolids. Only biosolids service providers, who typically perform Class B land application, were interviewed about Class B cake. All other end users were interviewed regarding Class A products. Four categories were identified:

- A positive (+) rating, where the user is familiar with biosolids and would promote its usage.
- A neutral (+/-) rating, where the end user likes the benefits and/or results from the product but dislikes some aspects, i.e., thought of biosolids from human waste, odors, etc.
- A negative (-) rating, where the end user dislikes the product completely and will not use it
- Not familiar with biosolids; where the end user has not heard of the product or related terminology (e.g., sewage sludge, sludge, etc.) or not interested in biosolids; where the end user expresses they are not interested in biosolids, either providing or not providing a reason

Table 6-2 presents the number of end users surveyed in each category. Overall, 18 out of 31 end-users surveyed had a positive impression of biosolids, eight had a neutral or negative impression, and five did not know what biosolids were or were uninterested. A summary of biosolids impressions from the 31 end-users surveyed is presented in Attachment C with business names, business types, and impressions ratings.

Table 6-2. General Impressions from Surveyed Contacts

Response	Number of Businesses
Positive (+)	18
Neutral (+/-)	6
Not familiar/Not interested in biosolids (?)	5
Negative (-)	2

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6.5 Soil Blenders and Landscape Suppliers: Perceptions and Value

Soil blenders and landscape suppliers represent a former market for the City, as they have relationships with some of these businesses from their previous composting program. Broadly speaking, these customers' exposures to biosolids is likely less than composters and biosolids service providers. Additionally, these commercial customers could only accept Class A biosolids, which would require the City to invest in additional biosolids processing. From survey results, biosolids perceptions for these customers were identified and categorized into three main categories: general feedback, product feedback, and seasonality.

6.5.1 General Feedback

Overall impressions of biosolids were relatively positive among commercial businesses, though many contacts mentioned customer concerns and the need for public education. While businesses we spoke to understand the nutritional and environmental benefits of biosolids, they were concerned that their customers may have concerns about using human waste. Additionally, some contacts mentioned that they probably wouldn't recommend it to consumers for growing food. An in-person visit to discuss these concerns and to provide samples of the product may be beneficial to mitigate these responses. Potential commercial leads are indicated in Attachment C. If the City chose to produce a Class A product, additional opportunities for community outreach (Section 6.7) might also improve commercial biosolids markets with a direct impact on the City's biosolids distribution network.

The demand for organic-certified products or organic materials review institute (OMRI)-certified products, i.e., those that are certified to be used for organic production, was brought up on several occasions, both by the City and by commercial contacts to whom we spoke. Of those surveyed, 25 contacts were asked about organic demand. Two contacts solely produced organic products, though one still had favorable impressions of biosolids. 12 contacts sell a mix of certified organic and non-certified organic products, while 11 contacts do not compete in the organic market. From conversations, homeowners often asked for organic products, while landscapers and other contractors were less interested. Overall, there appears to be enough non-organic businesses to support a commercial biosolids program.

6.5.2 Product Feedback

Only Class A biosolids may be distributed to the public. Beyond that classification there are several forms of product available—cake, compost, and thermally dried/pelletized product. Generally, Class A cake is not a feasible commercial end product and requires additional processing to become commercially viable (e.g., manufactured soil) for the public. While we did not bring up Class A cake in most of our conversations, some soil blenders could be open to accepting biosolids cake to produce manufactured soil; however, this arrangement could change the pricing scheme in that the contract could become a cost center. Thermally dried and pelletized products, on the other hand, are managed as a profit center due to the high commercial quality of the end product and the necessary price point to justify capital investments. These pelletized products are the most versatile biosolids product and could be most widely distributed. Consumers appear to be well educated in the differences between nutrient need and soil carbon need. Thus, composted products are very well marketed in California and are nearly a separate market from the topsoil market.

From the feedback we received, soil blenders and landscape suppliers would be open to thermally dried products and compost. With thermally dried products, a major expressed concern was storage. Like the City, soil blenders and landscape suppliers (bulk and consumer) experience seasonality, but to a lesser degree than in the agricultural market. This concern can be mitigated through appropriate packaging; supersacks or 50-pound sacks on pallets were the most requested style as it allows the most operational flexibility for a variety of business types.

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Product pricing came up in several discussions, especially given high prices for fertilizers currently. While this point is especially relevant for the agricultural market, commercial consumers and their supply chains are also feeling pressure. Several contacts recommended that biosolids products or biosolids compost could successfully enter the market at a lower, competitive price point compared to other products. Specifically, some that we spoke to have the impression that biosolids compost was significantly cheaper than other types of compost.

During the surveys, BC also asked about familiarity with biochar or biosolids-based biochar, specifically. In the majority of conversations, contacts were either unfamiliar with the product or had heard of it but were not sure of its feasibility. However, there were a few customers who were interested in evaluating biochar as a product, though one mentioned that they would be unwilling to pay for it. In this market, biochar remains at the edge of adoption, either as a feedstock or as a standalone product. Some contacts mentioned that the benefits haven't yet been proven to them. Combined with a high price point, biochar is difficult to justify to these buyers at this time.

6.5.3 Seasonality

The City's current program is most active April through October due to its reliance on the California growing season. During wet weather months, finding land application sites can be a challenge. Commercial businesses like soil blenders and landscapers, as well as composters and biosolids contract service providers, can receive biosolids throughout the year and help the City smooth its seasonal demand. These contacts have their own seasonality due to the horticultural portion of their business; however, they also access other markets. Residential landscaping, for instance, is often driven by the housing market. This market is also seasonal but has a longer active period than the agricultural market. By diversifying into these businesses, the City can take advantage of the diversity of end-use markets inherent in a soil blender's network, for instance.

6.6 Biosolids and Composting Service Providers

For this survey, biosolids service providers and composters were grouped as they provide a service to the City, i.e., processing and marketing their biosolids. The fundamental relationship between the City and the providers/composters would be different than with the other commercial businesses we contacted. These services are very active in California, and these providers have extensive experience and appropriate permits to manage biosolids. They can manage all or a portion of the City's biosolids year-round, and services include both trucking and biosolids management. Synagro, Denali, and Lystek are three key service providers and manage Bay Area biosolids at sites throughout Northern California. Land application is the ultimate destination of products managed by these entities, or the use of biosolids as a soil amendment and fertilizer replacement in agricultural practices. More than 60 percent of biosolids generated in the state are managed this way (US EPA Region IX, 2021). Land application onto farmland, for both nutrients and organic matter, provides financial benefit to those using the product, and the service providers reported that recent increases in fertilizer pricing have tended to increase biosolids popularity.

As discussed, some county ordinances restrict biosolids use to certain crops. In Northern California, in addition to restrictions imposed by local ordinances, wet weather constrains the practical ability to land apply from November through April. For example, of the three counties receiving a significant portion of Bay Area biosolids for land application, i.e., Solano, Sacramento, and Merced, two (Solano and Merced) have ordinances prohibiting land application during wet weather months. This has constrained biosolids management capacity in the Bay Area, particularly from December to March, when most available land application acreage is off limits. All three service providers highlighted the fact that management capacity is at a premium during these times. As an example, Lystek's Fairfield facility has available management capacity on an annual basis but nears capacity during these wet weather months. During the dry weather

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season (generally considered to be April through October), all three service providers reported sufficient capacity, noting that more acreage could be permitted if needed. In other words, even though some large agricultural counties in northern California (e.g., San Joaquin and Stanislaus) ban land application, there is still adequate acreage in neighboring counties (particularly Solano and Merced) to support land application by Bay Area utilities.

6.7 Community Outreach

Public education and outreach are key to developing a robust commercial market. While businesses are the City's direct consumers, their customers—the public—ultimately drive the market. The Community Soil Foundation is a non-profit located in Santa Rosa. Their goals are to "raise awareness about practices and methods of regenerative farming and gardening, including the benefits to individual, communal, and ecological health." They support an urban farm and youth education and have participated in fire restoration projects. Their opinion of biosolids is very positive, and their interest in regenerative land management practices is a valuable entryway into biosolids conversations. The City had done significant outreach as part of its biosolids composting program, and they have experience in this area. Additionally, the Master Gardener program through the University of California Cooperative Extension offices is another valuable opportunity to support a commercial end-use program through community outreach.

Section 7: Bay Area Competition and Partnership Opportunities

The Bay Area has a significant number of wastewater treatment utilities of varying sizes. This can lead to both competition for available land for biosolids reuse in the complex California land application market as well as partnership and coordination opportunities. BC spoke to three peer utilities in the region to understand their current situation and their thoughts for collaboration. Fundamentally, there is interest in a regional collaboration among these smaller utilities but orchestrating such a project will require comprehensive organization and higher-level involvement.

7.1 Bay Area Biosolids Capacity

The Bay Area has four utilities that produce around 60 percent of the regions biosolids by dry weight: San José Santa Clara Regional Wastewater Facility (San José), East Bay Municipal Utility District, Central Contra Costa Sanitary District, and the San Francisco Public Utilities Commission (Figure 7-1). Of that 60 percent, nearly half is produced by San José, who have historically disposed their biosolids in a landfill. Since the passing of SB 1383, nearly 180,000 wet tons per year will be diverted into beneficial reuse, causing even more competition for land in the region. Much of this tonnage represents biosolids that were previously managed in landfills during wet weather months, exacerbating the existing issues for utilities in the region. Several utilities, like the City, have contracted with Lystek and Merced County to accept biosolids during wet weather at a higher cost.

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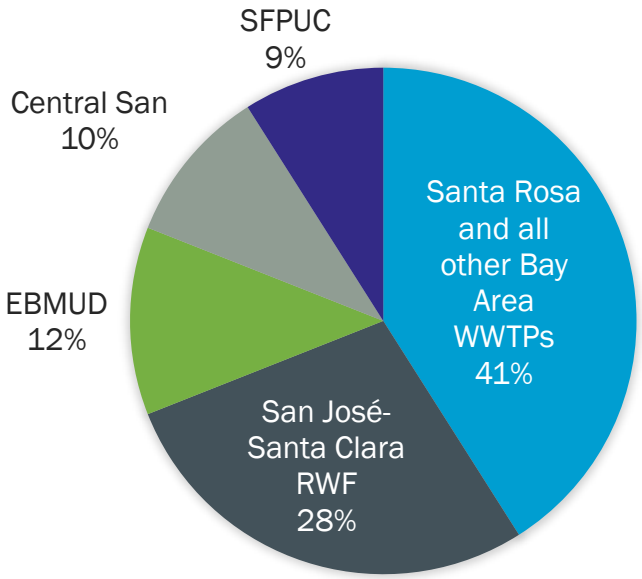


Figure 7-1. Biosolids generation in the Bay Area (dry-ton basis)

7.2 Windsor

The City of Windsor has begun design (currently at 30 percent) for a pyrolysis unit. Their rationale is to take a long-term perspective on technology planning and to get ahead of CECs, including PFAS. Additionally, they have suffered from constantly increasing hauling costs for the past few years and have a desire to reduce their carbon footprint and bring biosolids processing in house. Currently, they have no regional commitments from other utilities but have discussed this idea with several regional associations.

7.3 Las Gallinas

Las Gallinas Valley Sanitary District is currently undertaking a similar biosolids market assessment to understand the opportunities for its biosolids program. GHD is performing the market study, which should be complete in July. In past explorations, Las Gallinas has encountered biosolids land application issues, including farmers struggling to find markets for conventional hay and dairy farmers struggling in general due to the rising interest in alternative (dairy-free) milk products. There is some interest in composting, but Las Gallinas is waiting to see what the market study will illuminate.

7.4 Central Marin Sanitary Agency

Central Marin Sanitary Agency (CMSA) land applies its biosolids during the summer and has a contract with Lystek for wet weather months. They use the Redwood Landfill as a final option but are concerned about the landfill closing. CMSA is interested in a regional solution if economics are favorable.

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Section 8: Conclusions

The regulatory and biosolids market survey identified numerous potential end-use markets for the City that could support a variety of biosolids product types. As such, the City has an opportunity to reflect on its own values and consider the costs of various biosolids management programs in order to decide and plan its ultimate biosolids end-use management program.

California's most recent agricultural census suggests there are significant acres of crop land available that may be suited for biosolids land application. Currently, the City's program benefits from being local, but expanding the distribution radius could increase capacity for land application. A continued and/or expanded agriculture-based biosolids program would build on the City's history and success but would perpetuate some vulnerabilities outlined in the SWOT analysis. Diversifying the program by creating a Class A product would reduce the risk from a solely agriculture-based program with regulatory and perception vulnerabilities. For example, producing a Class A cake could open up additional acreage currently limited by endangered species habitat.

Current California regulations, however, provide a soft push toward a Class A composted product. SB 1383, MWELO, and other carbon-reduction policies encourage the use of compost and provide an opportunity for the City to participate in a collaborative, circular economy for waste products and carbon diversion. Not only could the City work with its solid waste partners to accomplish the requirements of SB 1383, but producing a Class A product also allows the City to participate in the commercial consumer market.

For the commercial consumer market, several soil blenders conveyed their positive impressions of biosolids and a few expressed interest in working with biosolids. The end-user survey responses and analysis suggest there is also a market for a thermally dried, granulated, and homogeneous material for soil blending operations. Dried or composted Class A products are the most readily marketable form of biosolids; however, the production costs will be higher than current operations. Further consideration will be balanced against the cost of contract management for more typical Class B biosolids in the net present value analysis of the alternatives.

The majority of commercial end users interviewed for this study showed general interest in a higher quality, Class A biosolids product, though biosolids service providers and one smaller business was willing to accept a Class A cake product. Note that unlike other markets, the majority of wastewater treatment plants in California pay to beneficially use their biosolids, and in most cases, the assumption will be made that Santa Rosa will pay a tip fee and cover hauling costs to manage their biosolids products. Overall, while there are available markets for biosolids products, the volume of biosolids generated by the City requires advanced planning in order to generate the best value biosolids management solutions.

Ultimately, the City is well positioned to create whatever product and program they deem appropriate. This regulatory and market assessment indicates that there are sufficient markets for a variety of biosolids end products. The next steps in the biosolids management strategic plan will be to help the City determine their goals, evaluate new technology to attain those goals, and compare and, ultimately, select a biosolids management program that matches their values with financial constraints.

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Attachment A: Biosolids Regulatory Framework

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A.1 Introduction

Biosolids are directly and indirectly regulated under a range of federal, state, and local laws, regulations, and ordinances. This regulatory framework establishes rules for biosolids quality and beneficial use, such as land application and composting, but at the local level can also include restrictive ordinances. Local regulations in particular may impact the City depending on the selected disposition locations. In addition, depending on the circumstances, biosolids management can also be governed by regulations that mandate organics diversion (to minimize greenhouse gas emissions), and regulations related to fertilizers and air quality.

A.2 Federal Regulations Governing Beneficial Reuse

The core regulations governing beneficial use of biosolids are contained within the Code of Federal Regulations (CFR), 40 CFR 503, sometimes called "the 503 Rule." These regulations contain reporting requirements, mandatory management practices, limits on heavy metals, vector attraction reduction requirements, and pathogen reduction requirements. California is not considered a delegated state by the United States Environmental Protection Agency (EPA) and does not enforce compliance with the 503 Rule. As a result, EPA Region IX (Region IX) is responsible for the 503 Rule compliance.

The San Francisco Bay Regional Water Quality Control Board (RWQCB) is responsible for the issuance of the National Pollutant Discharge Elimination System (NPDES) permit for the City.

A.3 State and Local Biosolids Regulations

A.3.1 State of California

Technically, utilities are only required to adhere to the 503 Rule when sending biosolids to land application sites. When sending biosolids to landfills for disposal or use as alternative daily cover (ADC), biosolids merely need to be stabilized in some fashion. The 503 Rule serves as the minimum regulation for all states, but individual states may promulgate additional regulations to provide additional environmental protections, such as protections for sensitive waters. In addition, should a utility wish to make beneficial use claims about its biosolids, such as nutrient claims, registry with the California Department of Food and Agriculture (CDFA) is required.

In California, the RWQCBs can adopt the State General Order (Water Quality Order No. 2004-12-DWQ) for land application sites, and it would be considered to be applicable to all sites within that region. This Order is supported by a statewide Programmatic Environmental Impact Report that endorses properly managed land application practices. The Order itself incorporates the standards established by the 503 Rule and adds provisions to require compliance with the California Water Code. Because California does not have a delegated biosolids program, the Order cannot and does not supersede the 503 Rule.

Permitting of land application sites falls under the jurisdiction of the RWQCB in which those sites are situated. In the Bay Area, the San Francisco Bay RWQCB largely has jurisdiction; however, many land application sites fall under the jurisdiction of the Central Valley RWQCB. For example, the Central Valley RWQCB enforces the General Order in portions of Solano County under its jurisdiction. In addition, the RWQCB boundaries do not neatly follow county lines; in addition to the San Francisco Bay RWQCB, the North Coast RWQCB covers portions of Sonoma, Napa and Marin counties.

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A.3.2 Local Regulation

Individual counties and/or cities may regulate biosolids land application via ordinance or conditional use permits (CUP). Of the counties where Bay Area utilities have historically land applied (Solano, Merced, Sacramento, and Sonoma) both Solano and Merced counties have specific land application ordinances, while Sacramento has a CUP process. Sonoma County requires inspection and certification of those tractor trailers hauling biosolids within the county.

Solano County's ordinance is the most stringent of these four counties. Codified in Chapter 25 of the Solano County code, the ordinance puts in place restrictions on the land application of biosolids, including restrictions on the hours of biosolids deliveries, requirements to incorporate biosolids by the end of the day, a ban on weekend land application, and a ban on land application during the winter/rainy season, defined as October 15 through April 15.

Sonoma County has a similar land application season but permits weekend land application.

While in Sonoma and Solano counties biosolids are typically used for grazing crops, in Merced they are used on row crops, and thus must be applied in accordance with farmers' planting schedules. Sacramento is the only county in Northern California with a currently permitted winter land application project (Synagro's Silva Ranch site).

Figure A-1 summarizes the status of county ordinances in California at this time. County ordinances that either prohibit use of all biosolids products (including compost and dried product) in bulk agricultural application, or prohibit Class B land application, remain in effect. In some cases, interpretation of an ordinance or CUP was performed by individual staff members at the relevant local enforcement agency, and an explicit ban within the county code does not actually exist.

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Figure A-1. County ordinances

(Map Courtesy of CASA)

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Sales of bagged biosolids products are exempt from these ordinances. In addition, the ordinances typically apply to bulk land application and not use of biosolids products in smaller landscaping or home applications. Moreover, some contractors have pursued certification of their biosolids products as a fertilizer through the CDFA. Some counties allow such CDFA-certified products to be used without being subject to the county biosolids ordinance. This area of regulatory interpretation is fairly new and continues to evolve. Finally, several of these counties are significantly urbanized and do not contain significant agricultural acreage.

A.4 Organics Diversion

A.4.1 Assembly Bill 341

A significant regulatory shift in California has occurred around organics diversion. Landfill beneficial use, originally defined by Assembly Bill (AB) 939, included the use of biosolids in Alternative Daily Cover (ADC), as well as other practical uses such as slope stabilization within the landfill. When managed as ADC, biosolids are typically mixed with green waste and/or other organics to create a drier mixture suitable for cover. Currently, beneficial use of biosolids as ADC is governed by the California Code of Regulations (CCR), Title 27, Division 2, Chapter 3, Subchapter 4. Organics Diversion.

There has been, however, a large regulatory shift in California around organics diversion that will impact the use of biosolids as ADC. AB 341 sets a statewide organics recycling goal of 75 percent by 2020. This goal is achievable only with significant diversion of organics from disposal.

Supporting this legislative initiative are two other pieces of recent legislation, AB 1826 and AB 1594:

- AB 1826 mandates commercial organics recycling for businesses generating organics and solid waste above certain trigger levels. AB 1826 has a tiered implementation structure, which began in April 2016 for larger businesses and concluded in 2020 for businesses generating two cubic yards per week or more of solid waste.
- AB 1594 requires reporting on diversion of green waste and, since January 1, 2020, green waste is no longer considered landfill diversion when used in ADC. AB 1594 is considered the first step in CalRecycle's implementation of AB 341.

A.4.2 Senate Bill 1383

Senate Bill (SB) 1383, which is aimed at the reduction of short-lived climate pollutants (SLCP), required a 50 percent reduction in organics disposal by 2020 and a 75 percent reduction in organics disposal by 2025. These reductions will be measured on a statewide basis and will be compared against 2014 levels. SB 1383 is considered to support the California Air Resources Board (CARB) efforts to meet statewide greenhouse gas (GHG)-reduction goals, most notably through the SLCP Reduction Strategy. Through the SLCP Reduction Strategy, CARB has indicated that to help meet GHG reduction goals, it intends to pursue 75 percent diversion of organics from landfills by 2025. The SLCP Reduction Strategy is intended to be consistent with the targets set by SB 1383.

The implementing regulation associated with SB 1383 will arguably have the greatest impact to biosolids management in the Bay Area. The final regulation was transmitted to the Office of Administrative Law in October 2020, with the major components (reviewed throughout this planning process) intact. One of these core components is that biosolids are explicitly included within the definition of organic waste, a regulatory area that had previously been unclear. Thus, diversion of biosolids to a beneficial use, such as land application, would aid jurisdictions in meeting the diversion goals. In addition, the draft regulations change ADC from a beneficial use to disposal. Only use as "soil amendment" at landfills (e.g., use in erosion control or slope stabilization) will still be considered beneficial use. The regulations also state that using landfills out of state would still constitute disposal.

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A potential benefit of the regulations implementing SB 1383 is that, as currently written, the regulations limit local ordinances and any other efforts by local jurisdictions that would restrict the recycling of organic waste. In discussions with CalRecycle, California Association of Sanitation Agencies (CASA) has come to understand that this will supersede local ordinances that currently restrict biosolids land application, such as exist in San Joaquin and Kern counties. CASA is actively working with CalRecycle for assistance in working with counties to get the relevant ordinances revised or overturned, as applicable.

Another potential benefit is that the regulations set requirements for jurisdictions to purchase the products generated from diverted organics, currently limited to compost and renewable natural gas. This helps to address one of the biggest problems utilities generally face in generating marketable biosolids products, which is identifying large, viable markets for the products. CASA has provided comments to CalRecycle that the definition of acceptable products should include other Class A biosolids products and intends to continue to work with CalRecycle to document the benefits of these types of beneficial use.

A.5 Nutrient and Fertilizer Regulation

CDFA has oversight over the large agricultural industry in California. It does not regulate bulk soils (e.g., soil blends) but products making nutrient claims would fall under its regulations and enforcement. One of CDFA's six main divisions is the Inspection Services Division, a branch of which is the Feed, Fertilizer, and Livestock Drugs Regulatory Services (FFLDRS). One of the four programs within the FFLDRS is the Fertilizer Inspection Program, whose staff are responsible for regulating the manufacturing, labeling, and use of fertilizing materials. Inspectors in the program conduct routine sampling and inspections and respond to consumer complaints. Oversight also includes conformance with labeling requirements and product claims, such as those associated with nutrient content.

If a utility wishes to market its biosolids and use claims that trigger oversight by CDFA (e.g., "nutrient-rich"), it will need to adhere to CDFA's product labeling standards. Some counties view products with CDFA certification as falling outside of the arena of biosolids regulations, in which case it may be advantageous to pursue certification. The certification process requires submittal of a modest fee (currently $100) and an application; certification is valid for 2 years. In addition, licensing fees are paid quarterly based on sales/ distribution of product, as logged into CDFA's reporting system.

A.6 Composting

CalRecycle has issued a General Order for Composting Operations. This regulation governs composting activities, including food-waste-only digestion, but there is an exemption for organics co-digestion at wastewater treatment plants operating under an NPDES permit. In addition, biosolids compost facilities covered under an existing Waste Discharge Requirement (WDR) are exempt from the General Order, although upon the expiration of the WDR, it is CalRecycle's intent that those facilities be brought under the General Order. For biosolids composters, metals and pathogen monitoring under the 503 Rule can be used for compliance with the General Order. Overall, the CalRecycle's General Order for Composting Operations is equally or less restrictive than existing WDRs for biosolids composting facilities, which tend to include more stringent requirements related to monitoring, stormwater, and other environmental controls.

Related to end use, there has been considerable discussion in the State regarding the use of compost for land reclamation (e.g., abandoned mines, fire ravaged lands) as well as use by Caltrans in highway maintenance activities. While EPA Region IX has been extremely supportive of the use of compost in land reclamation, funding for demonstration projects and research has yet to emerge. Successful examples of biosolids in land reclamation exist elsewhere, particularly in the northeastern United States, but a successful demonstration of this application has only occurred on a limited scale in California.

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With respect to compost use by Caltrans, specifications for all compost use were set nearly a decade ago. Concerns over salinity led to the use of a surrogate marker, i.e., electrical conductivity, as a standard for compost use. Biosolids compost tends to have high electrical conductivity levels, as nutrients in the biosolids compost register as salts in the established testing protocol. This has restricted the use of biosolids compost in a very large market sector. CASA has begun outreach efforts to propose that the electrical conductivity standard be replaced with a salinity standard to better enable use of biosolids compost by Caltrans. The Previous attempts to work with Caltrans proved to be challenging for the City; however, it may be worth investigating this outlet again if compost is produced.

A.7 Air Quality

Statewide, agencies have responded with a broad range of strategies to address the goals of AB 32, which aimed to reduce California's GHG emissions to 1990 levels by 2020. Associated mandates and goals are:

- Reducing carbon dioxide equivalent emissions to 40 percent below 1990 levels
- Providing 50 percent of the State's energy needs from renewable sources
- Reducing carbon intensity of transportation fuel used in the State by 10 percent
- Effectively eliminating organic waste disposal in landfills
- Increasing soil carbon under the Healthy Soils Initiative and Forest Carbon Plan
- Reducing short-lived climate pollutant emissions

AB 32 also requires CARB to adopt regulations to require the reporting and verification of statewide GHG emissions and to monitor and enforce compliance with this program. A benefit of California's efforts to reduce GHG emissions and improve air quality has been the creation of a cap-and-trade program, with funds available for expanding organics infrastructure and use of biomethane.

SB 605 further requires CARB to adopt a strategy to address SLCP. To that end, CARB has established a SLCP Reduction Strategy (Strategy), which proposes a range of options to accelerate reductions in SLCPs, including both regulations and incentives. The Strategy articulates that the wastewater sector is part of the climate solution and notes that wastewater treatment plants are negligible methane emitters, though it does not address biosolids processing facilities, such as compost operations, specifically.

Of note, the Strategy identifies that wastewater treatment plants can accept hauled-in organic waste for co-digestion and sequester carbon in the soil and avoid the use of fossil-fuel-intense inorganic fertilizer while improving soil health through the application of biosolids to agricultural land. Organics diversion under SB 1383, described previously, is part of the Strategy for SLCP reduction.

On a more local level, the Bay Area and the Central Valley air districts are considered non-attainment areas for certain air pollutants and, as a result, have among the most stringent air quality regulations in the nation. These regulations impact biosolids management, such as limiting compost operations in their size and allowable technologies. Utilities and biosolids contractors alike have made significant investments to comply with these regulations, and some facilities have either closed, chosen to limit their capacity, or abandoned projects so as not to trigger more stringent regulations. This seems to have the strongest impact on compost operations, which raises the cost to create Class A compost.

Some air quality management districts have passed regulations that specifically impact biosolids operations. For example, the San Joaquin Valley Air Pollution Control District (SJVAPCD) has jurisdiction over Synagro's Central Valley Compost (CVC) facility and any land application activities that occur in Merced County. The SJVAPCD adopted Rule 4565 in March 2007, which limits emissions from biosolids compost and land application operations. Land-applied biosolids must be incorporated within 3 hours of delivery under this rule. Compost facilities where biosolids are co-composted with other organics are subject to emissions

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mitigation measures. There are three tiers of requirements, depending on the throughput of the co-composting facilities, and Synagro has elected not to expand the CVC facility as a result. Another example is the South Coast Air Quality Management District Rule 1133-1133.3, which similarly limits emissions from biosolids composting, with the most recent Rule 1133.3, for emissions reductions from green-waste composting, being adopted in 2011.

The Bay Area Air Quality Management District (BAAQMD) is developing a new set of rules under Regulation 13. The following rules are part of BAAQMD's steps in implementing its Basin-Wide Methane Strategy as part of the climate protection program and are relevant to the City's operations. Rules 13-2 and 13-3 are no longer being pursued.

- Regulation 13, Rule 1: Significant Methane Releases would be BAAQMD's first rule focused on regulating methane as a powerful GHG. Rule 13-1 would include monitoring and repair provisions whenever a significant methane release is discovered. This rule has been in draft stage for several years and would likely require an additional public comment period prior to implementation.
- Regulation 13, Rule 4: Sewage Treatment and Anaerobic Digestion aims to minimize methane emissions from municipal sewage treatment and anaerobic digester operations. Rule 13-4 may include standards for feedstock and digestate handling, leak detection, fugitive emissions minimization, flaring requirements, and enhanced recordkeeping.

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Attachment B: Commercial End-user Survey

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Name of Contact:

Phone number and/or email:

Associated Company:

Primary Business Sector

(Note: questions below were tailored to specific sectors)

1. What is the nature of your business (i.e., state for the record what you think they do but ask for clarification – if a nursery, do they have a retail center or are they just doing bulk; if a fertilizer blender are they just doing sales or blending on site?)
2. What types of products do you create and/or sell?
3. Approximately what volume of product do you manage (if they won't answer ask for a relative volume or approximate volume)?
4. Is there a seasonal nature to your business?
5. Who are your main types of customers?
6. Is there demand among your customers for OMRI-certified/organic products?
7. Have you ever heard of biosolids or sewage sludge?
    a. If so, have you ever used biosolids historically?
    b. What is your impression of these products?
    c. What would you look for in bringing biosolids to your facility (Metro's is 1-4 mm in size, bulk density of about 45 lb/ft^3 and product is 93-95 percent dry)?
    d. Do you pick up your feedstocks or prefer delivery?
    e. Would you be interested in seeing a sample?
8. How do you typically buy your products (e.g., on contract, as needed through POs)?
9. What type of product would you be looking for – liquid, cake, dried, pellet?
10. Would you be open to biochar made from biosolids?
11. Are you willing to give a price range for feedstocks? (look up sale price range for your products online first if possible, but ask what the range of similar, pelleted fertilizers is for 5-3-0 or 4-3-0)?
12. Based on what we've talked about today, would you be interested in learning more and can I follow up with you?

Other info:

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Attachment C: Commercial Market Survey Impressions

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Table C-1. Impressions from Surveyed Commercial Market Contacts

Surveyed Business	Contact Name	Business Type	Impression of Biosolids
American Soil & Stone Products	Lou	Soil Blender	Neutral (+/-)
California Landscape Services, Inc	James	Landscape Supply	Neutral (+/-)
Cold Creek Compost	Martin	Composter	Not interested (?)
Crown Hill Stone Supply	Jose	Landscape Supply	Neutral (+/-)
Denali	--	Biosolids Service Provider	Positive (+)
DenBeste Yard and Garden	Paul	Soil Blender	Negative (-)
Engel & Gray, Inc.	Bob Engel	Composter	Positive (+)
Ewing Irrigation & Landscape Supply	Kevin	Landscape Supply	Positive (+)
Grab n Grow Soil Products	Johnny	Soil Blender	Positive (+)
Green Waste (formerly Zanker, Z-Waste)	Michael	Composter	Positive (+)
Kobold Landscape Materials (formerly Cochran Landscape Materials)	--	Landscape Supply	Negative (-)
L.H. Voss	Butch Voss	Soil Blender	Not interested (?)
Macalvey's Nursery	--	Landscape Supply	Not familiar (?)
MANNCO	Bradley	Biosolids Service Provider	Positive (+)
Marion Ag	John	Soil Blender	Positive (+)
Nimbus Landscape Materials[a]	Rochelle/John Lambirth	Soil Blender	Positive (+)
NorCal Ag Service[a]	Robert	Construction Supply and Ag Services	Positive (+)
Nutrients Plus (Clarus)	John	Biosolids Service Provider	Positive (+)
Pacific Landscape Supply	George	Soil Blender	Positive (+)
Pleasanton Trucking/PTI Soils	Tom	Composter	Positive (+)
Ralph Hayes & Sons, Inc	Buddy	Soil Blender	Positive (+)
Recology Compost	--	Composter	Positive (+)
Redi-Gro Corporation	Sharon Yon	Soil Blender	Not interested (?)
Rice's Soil Farm	Tom/Bob	Soil Blender	Positive (+)
SBI Materials	Art	Soil Blender	Positive (+)
Sequoia Soil Company	Kevin	Soil Blender	Positive (+)
SF Garden Supply	Brian	Landscape Supply	Neutral (+/-)
Shamrock Materials	--	Landscape Supply	Neutral (+/-)
Synagro	--	Biosolids Service Provider	Positive (+)
United Forest Products, Inc.[b]	--	Landscape Supply	Neutral (+/-)
Wheeler Zamaroni	Jessica	Soil Blender	Not familiar (?)

a. indicates a commercial lead.

b. From the conversation with United Forest Products, Inc., the customer service representative seemed unfamiliar but given past transactions between the City and United Forest Products, Inc. for the City's composted product, this business would likely be a good lead to contact.

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Appendix E: TM4 Biosolids Screening and Alternatives Evaluation

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Technical Memorandum
FINAL

Prepared for: City of Santa Rosa

Project Title: Biosolids Management Strategic Plan

Project No.: 157568.009.005

Technical Memorandum 4

Subject: Biosolids Screening and Alternatives Evaluation

Date: January 23, 2024

To: Tetyana Mokvyts, P.E., Project Manager, City of Santa Rosa

From: Alison Nojima, P.E., Project Manager, Brown and Caldwell

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Limitations:

This document was prepared solely for the City of Santa Rosa in accordance with professional standards at the time the services were performed and in accordance with the contract between the City of Santa Rosa and Brown and Caldwell dated October 6, 2022. This document is governed by the specific scope of work authorized by the City of Santa Rosa; 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 the City of Santa Rosa and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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List of Abbreviations

AACE	American Association of cost Engineering International
Alpha Barn	City's biosolids storage facility
BC	Brown and Caldwell
BC:SWEET	BC's solids-water-energy evaluation tool
BMSP	biosolids management strategic plan
BP	belt press
CHP	combined heat and power
CIP	capital implementation plan
City	City of Santa Rosa
CO_2e	carbon dioxide equivalent
-d	day(s)
EPA	U.S. Environmental Protection Agency
GBT	gravity belt thickener
GHG	greenhouse gas
GHGRF	Greenhouse Gas Reduction Fund
gpd	gallons per day
hr	hour(s)
HRT	hydraulic retention time
HSW	high-strength waste
IRA	Inflation Reduction Act
ITC	Investment Tax Credit
LTP	Laguna Treatment Plant
MAD	mesophilic anaerobic digestion
Mgd	million gallons per day
MMBTU	million British thermal units
NG	natural gas
O&M	operations and maintenance
PS	primary sludge
R&R	repair and replacement
sN	soluble nitrogen
TAD	thermophilic anaerobic digestion
THP	thermal hydrolysis process
TM	technical memorandum
TPAD	temperature-phased anaerobic digestion
TS	total solids
TWAS	thickened waste activated sludge
VS	volatile solids
VSR	volatile solids reduction
WAS	waste activated sludge
WTPY	wet tons per year

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Executive Summary

Introduction

The City of Santa Rosa (City) is developing their Biosolids Management Strategic Plan (BMSP) for the Laguna Treatment Plant (LTP) to provide short- and long-term options that incorporate and align with the City's Climate Action Plan and help the City achieve its goals to:

- Reduce LTP and biosolids management operational costs
- Mitigate risk of non-compliance with future regulatory requirements
- Provide solutions that best meet the needs of the regional community
- Maintain LTP operational flexibility
- Align biosolids management solutions with the City's climate action plan
- Determine the best use of the composting facility

The BMSP will provide recommendations for the solids treatment system, including replacements, optimizations, or improvements. It will culminate with a capital implementation plan (CIP) for the City to use as a roadmap for the next 20 years.

This technical memorandum (TM) documents the methodology and results from the biosolids alternatives analysis. The analysis was conducted in three phases:

1. **Screening of Technologies** – Solids stabilization technologies were screened using criteria developed with the City. A list of initial alternatives were created to evaluate non-economic and lifecycle costs associated with different strategies the City could implement to alleviate capacity constraints and address market and regulatory drivers.
2. **Initial Alternatives Analysis** – Performance predictions and lifecycle cost estimates were reviewed for 19 initial alternatives. Three alternatives were advanced for refinement based on lifecycle costs and biosolids management benefits (i.e., minimalization of wet tons hauled per year, production of Class A biosolids, or potential for PFAS mitigation compatibility).
3. **Refined Alternatives Analysis** – Refined capital and lifecycle cost estimates were prepared. Site layouts, greenhouse gas emission estimates, non-economic scoring, and impacts to upstream and downstream processes were also reviewed. One alternative was recommended. Phasing and implementation options for other alternatives were presented in a BMSP roadmap.

Capital project costs associated with the recommended alternative will be advanced to the CIP roadmap report.

Screening of Technologies

Screening criteria were used to determine which solids stabilization technologies would be carried forward to the initial alternatives analysis. Technologies that passed all screening criteria were used to develop end-to-end alternatives that were considered in the initial alternatives analysis. The pass/fail screening criteria included: plant compatibility, established and mature technology, diversifies the City's biosolids management for beneficial reuse, and program reliability. Sludge stabilization technologies that passed all screening criteria include: thermal hydrolysis, mesophilic and thermophilic anaerobic digestion, recuperative thickening, thermal drying, and Lystek.

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Technologies that passed through screening were considered for the initial alternatives analysis. The initial alternatives were created to provide short- and long-term options to address capacity constraints while advancing the City's goals. These goals include reducing operational costs, mitigating future regulatory risks, providing solutions that best meet the needs of the regional community, maintaining operational flexibility, incorporating and aligning biosolids management solutions with the City's Climate Action Plan, and determining the best use of the composting facility. The list of initial alternatives included:

Alternatives with New Anaerobic Digester Capital Cost:

- Status quo (30,000 gpd HSW)
- Increase HSW to permitted capacity of 46,000 gpd
- Increase HSW to a capacity of 92,000 gpd
- Expand biosolids storage at Alpha Barn
- Add gas storage
- Rehabilitate existing composting facility and compost a portion of biosolids
- Replace cake pumps with conveyors
- Replace belt presses with centrifuges; Replace cake pumps with conveyors
- Replace belt presses with centrifuges and cake pumps with conveyors; Increase HSW to 92,000 gpd
- Thermal dryers for part of biosolids
- Thermal dryers

Alternatives with Anaerobic Digester Cost Deferred:

- Thermal dryers with sub-15-day SRT digestion
- Thermophilic digestion with sub-15-day SRT
- On-site Regional Lystek Facility with sub-15-day SRT
- Recuperative thickening with sub-15-day SRT digestion
- Thermal hydrolysis; Replace cake pumps with conveyors
- Thermal hydrolysis; Replace cake pumps with conveyors; Increase HSW to 46,000 gpd
- Thermal hydrolysis; Replace cake pumps with conveyors; Increase HSW to 92,000 gpd
- Thermal hydrolysis; Replace cake pumps with conveyors and belt presses with centrifuges

Results from the Initial Alternatives Analysis

The initial alternatives analysis included process performance predictions, capital and operating cost estimates, and non-economic scoring. Key results are shown in Figure ES-1 and conclusions listed below:

- There are potential financial benefits from increasing HSW receiving beyond the existing permitted capacity, but this would require near-term capital investments.
- Composting achieved a Class A end product for only the portion of solids processed by the composting facility. The capital and operating costs to startup the City's existing composting facility were higher than the status quo.
- Centrifuges and conveyors would decrease wet solids hauling but would require near-term capital investment and does not have a clear lifecycle cost benefit.
- Thermal dryers would result in even lower wet solids hauling than centrifuges and conveyors, but thermal dryers had the second highest capital and operating cost between options that achieve Class A biosolids. Thermal dryers also require significant natural gas for heating, so this alternative has the highest greenhouse gas emissions.

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- Thermophilic digestion, on-site Lystek, and recuperative thickening have lower lifecycle and capital costs than the status quo. Only on-site Lystek produces a Class A product. Thermophilic digestion and recuperative thickening provided similar lifecycle and capital cost benefits as on-site Lystek, but these options were not advanced because only on-site Lystek would provide a Class A end-use product. Also, none of these alternatives minimalized wet tons produced by the LTP.
- Thermophilic hydrolysis process (THP) had the highest capital and operating cost between the options that achieve Class A biosolids. THP also requires a specialized licensed operator to be onsite for the steam system.

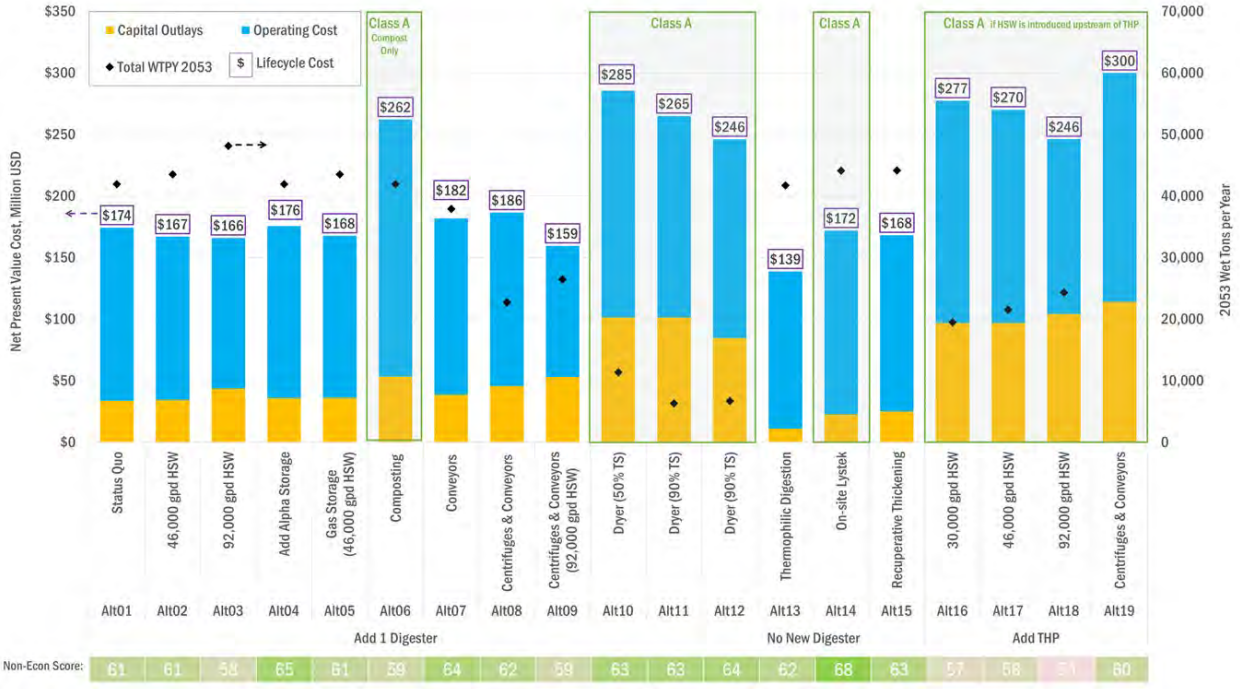


Figure ES-1. Initial alternatives analysis lifecycle costs and biosolids production

Based on results from the initial alternatives analysis, three options were carried forward for comparison with the status quo. Performance predictions and lifecycle costs for the initial alternatives were presented to the City during an initial alternatives workshop. The City provided feedback on analysis methodology and identified three preferred options to refined: centrifuges and conveyors (Alt 08), thermal dryers (Alt 12), and on-site Lystek (Alt 14). These options were refined by based on City feedback regarding assumptions and methodology used to calculate operating costs, and based on feedback from vendor correspondence on process performance and capital costs.

Results from Refined Alternatives Analysis

The refined alternatives analysis included development of site layouts, refined capital costs, greenhouse gas emission estimates, refined non-economic scoring, and refined lifecycle costs. Correspondence with the City and vendors during the refined alternatives analysis was used to develop site layouts and costs. Refined alternatives included:

- Status Quo (Alt 01)
- Centrifuges and Conveyors (Alt 08)

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- Thermal Dryers (Alt 12)
- On-site Lystek (Alt 14)

The status quo and centrifuges and conveyors alternatives would require a digester to be constructed in the near term to alleviate digestion capacity constraints when one digester is offline for cleaning. Thermal dryers or on-site Lystek incorporate processes that achieve Class A biosolids and would allow the City to defer constructing a new digester. A sensitivity analysis was performed to evaluate the impact of Lystek contract pricing. Table ES-1 presents refined alternatives results for comparison. The status quo alternative (Alt 01) had the lowest lifecycle cost, thermal drying (Alt 12) had the highest GHG emissions estimate, and on-site Lystek had the highest non-economic score (Alt 14). On-site Lystek's lifecycle cost was $172 million if contract pricing increases at the normal rate of escalation, and if contract pricing were to increase at double the rate of general escalation then a lifecycle cost of $223 million was calculated. This demonstrates financial potential risk of contracting all biosolids to Lystek (Alt 14).

Table ES-1. Refined Alternatives Comparison

Alt. No.	Alternative Description	30-year NPV Capital Cost ($ million)	30-year Lifecycle Cost ($ millions)	Non-Econ. Score	GHG Emissions (metric tons CO_2e/d)
01	Status quo dewatering and end use (Class B) Design and build one new anaerobic digester now	Lower $29	Lowest $167	Lowest (61 of 100)	Low (4.0)
08	Replace dewatering equipment with centrifuges and conveyors (Class B) Design and build one new anaerobic digester now	Higher $46	Higher $187	Lowest (61 of 100)	Lowest (3.0)
12	Build new thermal dryer facility, including centrifuge before drying (Class A) Design and build one new anaerobic digester in 2043	Highest $87	Highest $237	Middle (64 of 100)	Highest (13.5)
14	Build on-site regional Lystek facility; All biosolids end use to Lystek (Class A) Design and build one new anaerobic digester in 2043	Lowest $23	Higher $172-$223	Highest (68 of 100)	Low (4.1)

Recommendation

The analysis demonstrates that building centrifuges and conveyors (Alt 08) or thermal dryers (Alt 12) now will not provide lifecycle cost benefits to the City relative to the status quo (Alt 01), and both alternatives would incur higher near-term capital costs. On-site Lystek (Alt 14) had a similar lifecycle cost to the status quo, but was not recommended due to the financial risk associated with Lystek contract pricing for all biosolids at full scale. **Based on lifecycle costs, BC recommends the continued operation of current dewatering technology (belt presses) and construction of a new anaerobic digester (to alleviate capacity constraints).** The status quo provides the greatest flexibility and lowest risk to the City because onramps to achieve lower hauling costs (e.g., centrifuges), Class A biosolids (e.g., thermal dryers), or PFAS mitigation (e.g., pyrolysis) are left open for the City to consider as future drivers emerge and are better defined (Figure ES-2). If future market conditions significantly impact hauling costs, a dewatering process designed to achieve drier cake could be considered. If regulatory triggers require Class A biosolids or PFAS mitigation, then new processes downstream of dewatering could be considered (Lystek or thermal dryers and pyrolysis, respectively).

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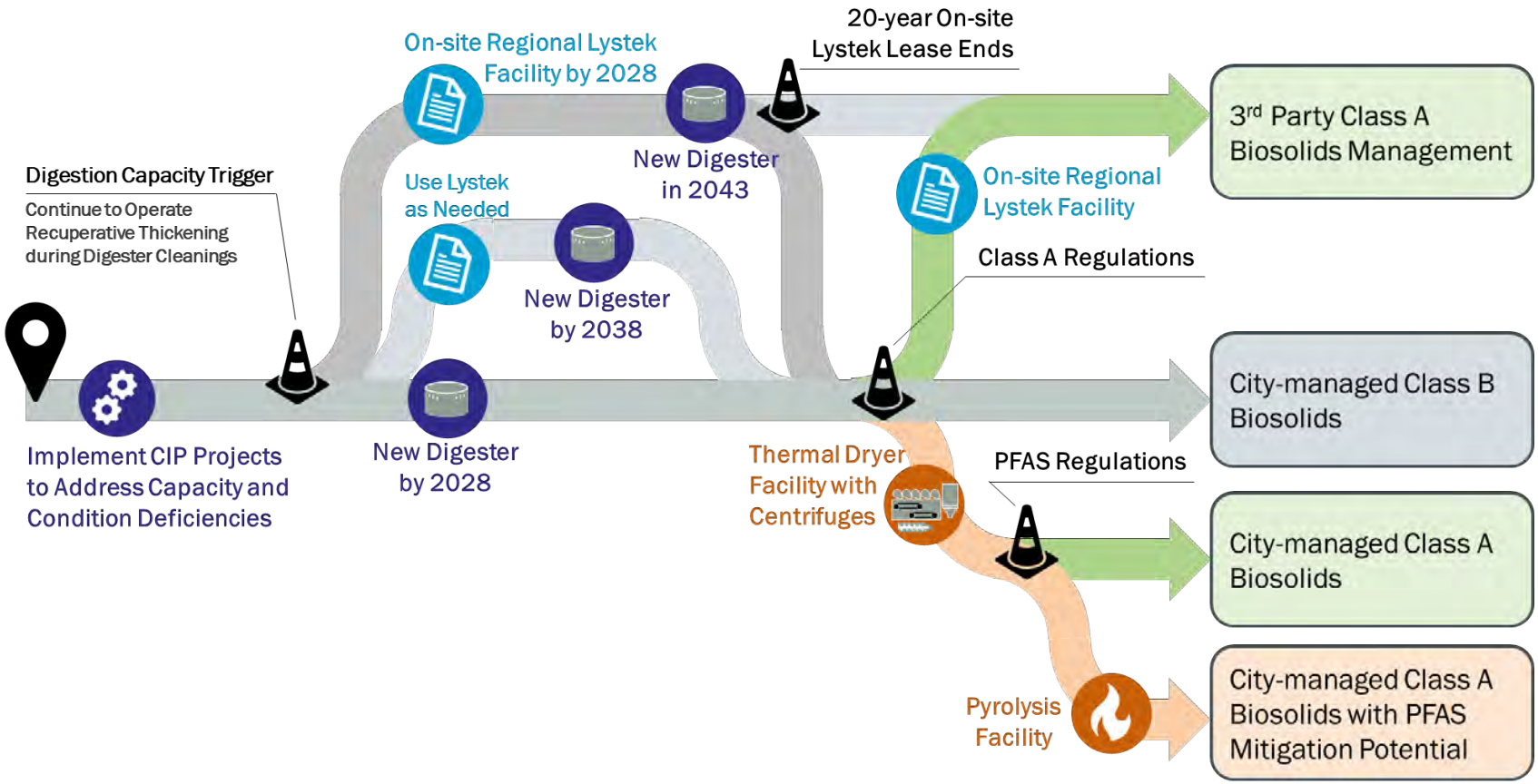


Figure ES-2. Biosolids management strategic plan implementation roadmap '

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A new anaerobic digester is needed to alleviate capacity constraints when one digester is out of service. The City performs routine cleaning on each digester every other year; Each digester is cleaned once every 8 years. As shown in Figure ES-2, the City could elect to strategically use Lystek when one digester is offline to defer construction of a new anaerobic digester by about 10 years. Until a new digester is constructed, the City should continue to operated digestion in a recuperative thickening mode while one digester is offline. The City should also secure Lystek as an end-use for any non-Class B biosolids during recuperative thickening operations in the event that peak flow and loadings coincide with high volumes of trucked waste.

Next Steps

The capacity evaluation (TM1) and condition assessment (TM2) had identified projects required to address capacity constraints and condition deficiencies. Cost estimates were prepared for these projects in tandem with cost estimates that were prepared for projects associated with the refined alternatives. The status quo was recommended as the preferred biosolids management strategy for the CIP roadmap. Capital costs for a new digester will be deferred by using recuperative thickening and Lystek, as needed, during digester cleanings. Projects that address capacity constraints and condition deficiencies will be prioritized in the CIP roadmap.

Section 1: Introduction

The City of Santa Rosa (City) is developing their Biosolids Management Strategic Plan (BMSP) for the Laguna Treatment Plant (LTP) to provide short- and long-term options that incorporate and align with the City's Climate Action Plan and help the City achieve its goals to:

- Reduce LTP and biosolids management operational costs
- Mitigate risk of non-compliance with future regulatory requirements
- Provide solutions that best meet the needs of the regional community
- Maintain LTP operational flexibility
- Determine the best use of the composting facility

The BMSP will provide recommendations for the solids treatment system, including replacements, optimizations, or improvements. It will culminate with a capital implementation plan (CIP) for the City to use as a roadmap for the next 20 years.

The BMSP includes the following tasks and technical memorandums (TM):

- **Flows and Loads and Capacity Evaluation (TM1)** – project flows and loads and evaluate capacity
- **Condition Assessment and Evaluation (TM2)** – provide recommendations based on visual observations
- **Regulatory Review and Market Assessment (TM3)** – evaluate market conditions for regional biosolids management solutions
- **Biosolids Screening and Alternatives Evaluation (TM4)** – evaluate and identify optimal solutions using a 30-year lifecycle cost analysis

1.1 Evaluation Process

Figure 1-1 shows the project flow chart for the BMSP. Each task within the BMSP is followed by a workshop with the City and Brown and Caldwell (BC) to ensure the City's goals are being met within each task's deliverable.

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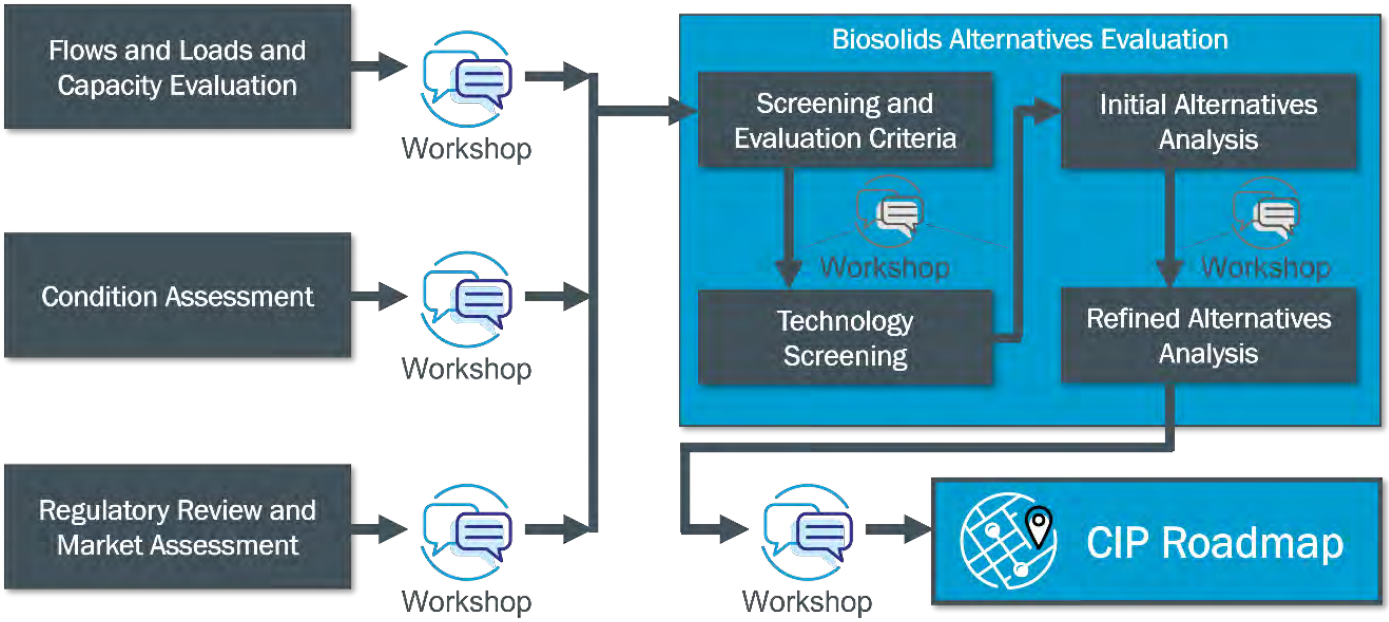


Figure 1-1. Project flow chart

The BMSP team (BC and the City) participated in the following screening and alternatives analysis workshops to confirm decisions before advancing to the next phase in the biosolids alternatives evaluation:

- **Screening Criteria Workshop** – a review of criteria that would be used to screen technologies and factors that would be used to score alternatives based on non-economic considerations was conducted on April 24, 2023. Screening criteria and weighting factors for the non-economic evaluation were proposed by BC. The City provided feedback to refine the criteria and factors. Meeting notes documented the final decisions.
- **Screening Workshop** – a review of screened technologies and developed alternatives for the initial alternatives analysis was conducted on May 25, 2023. The list of initial alternatives was refined and confirmed.
- **Initial Alternatives Analysis Workshop** – a review of the results from the initial alternatives analysis was conducted on July 6, 2023. Refinements to methodology were documented and a shortlist of alternatives for the refined alternatives analysis was confirmed.
- **Refined Alternatives Analysis Workshop** – a review of the results from the refined alternatives analysis was conducted on October 12, 2023. Refinements to this TM were made based on notes captured from the workshop, but overall conclusions and recommendations did not change..

1.2 Laguna Treatment Plant

The LTP solids treatment system uses a combination of thickening, anerobic digestion, and dewatering to produce a Class B cake product. Additionally, biogas is sent to either the biogas conditioning system and combined heat and power (CHP) engines for beneficial reuse, or to a flare. Figure 1-2 shows a process flow diagram with the LTP's major components. The City also has a third-party contract that allows up to 150 wet tons per day and 11,200 wet tons per year (WTPY) of biosolids to be sent to Lystek's Fairfield facility.

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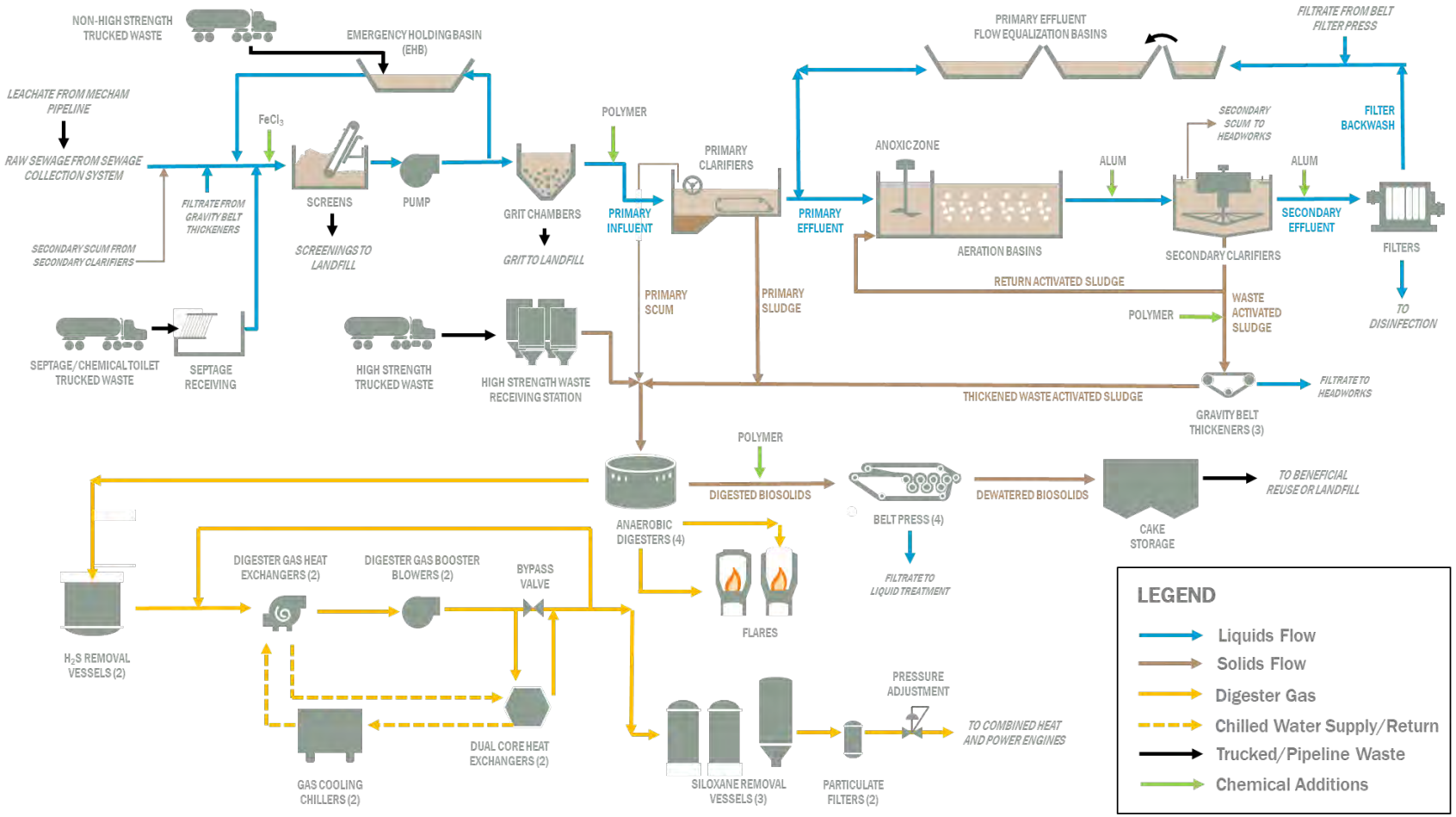


Figure 1-2. LTP process flow diagram

Waste activated sludge (WAS) is thickened using gravity belt thickeners (GBT) to produce thickened waste activated sludge (TWAS). TWAS is sent to the anaerobic digesters in addition to primary sludge (PS), high-strength waste (HSW), and primary scum. Waste haulers trucks deliver HSW to the LTP about 5 to 6 days per week. The HSW receiving station was brought online in August 2016. After anaerobic digestion, digested sludge is dewatered using belt presses (BP). Dewatered cake is pumped to cake storage hoppers. Class B biosolids are hauled directly to beneficial-use sites.

1.3 Biosolids End Use Overview

Biosolids end use is managed by the City. Figure 1-3 shows historical end use for LTP biosolids. Historically, the City owned and operated a composting facility, and the Redwood Landfill was used to dispose a portion of biosolids. In recent years, the City has contracted with Lystek for biosolids disposal during wet weather winter months. Biosolids are sent to Lystek if the City's biosolids storage facility (Alpha Barn) is at capacity. Attachment A provides supplemental data and analyses, including the biosolids data and analysis.

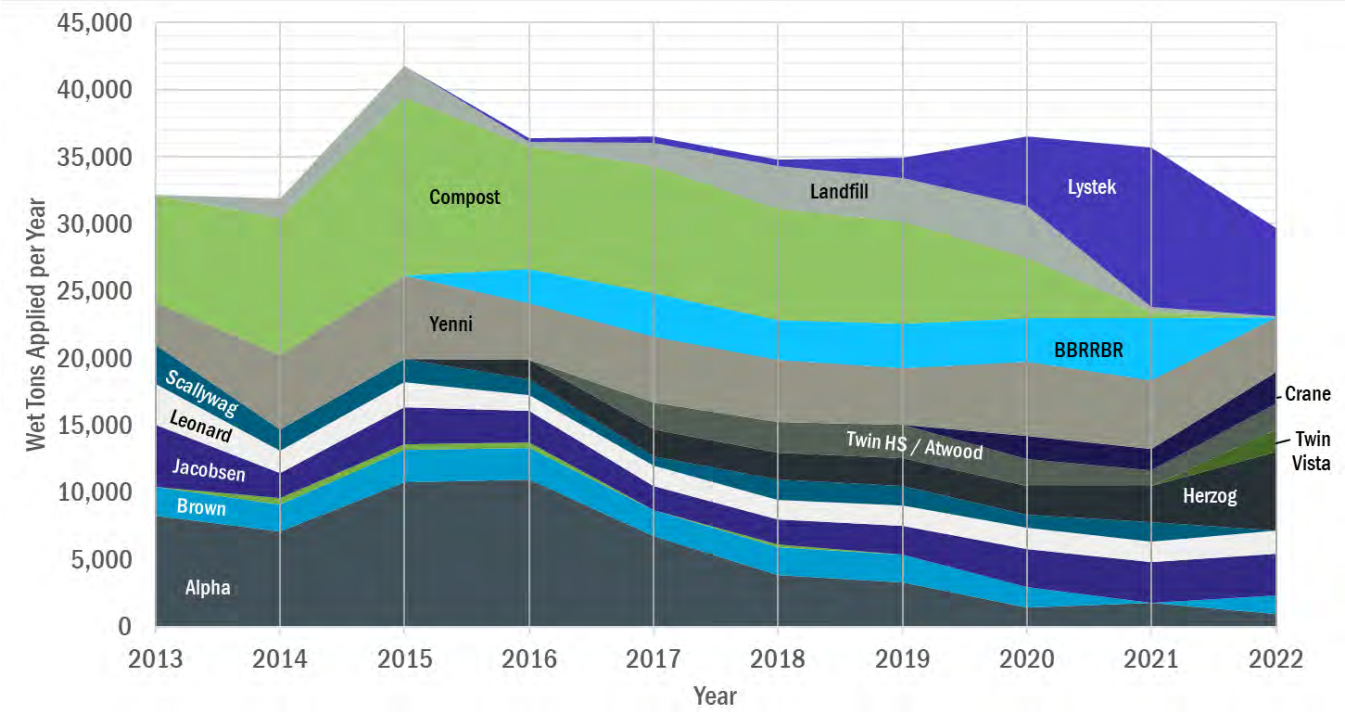


Figure 1-3. Total annual biosolids production and end use from 2013 through 2022

Categories for end use represents names of sites where the City land applies biosolids except for landfill and Lystek

Figure 1-4 shows the use of Lystek for between 15 and 30 percent of the City's biosolids in the past 3 years, and biosolids end use to compost or landfill have stopped.

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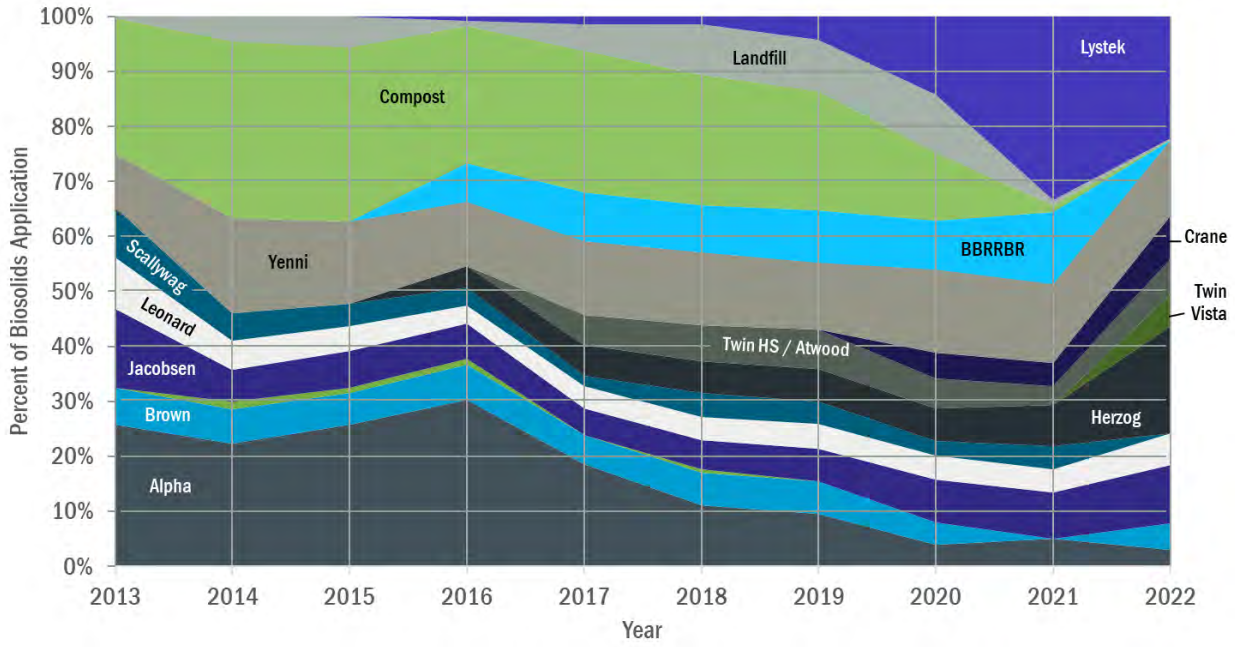


Figure 1-4. Percent of annual biosolids end use from 2013 through 2022

The City's biosolids land application sites are divided between sites in north and south Sonoma County. Each site is divided into fields, and the City tracks and manages biosolids application on each field. A review of the City's historical biosolids management data suggested the following operations between 2020 and 2022:

- 90 percent of all biosolids that are land applied by the City are applied in South County.
- 10 percent of all biosolids that are land applied by the City are applied in North County.
- Land application trends toward 10 wet tons per acre for sites with long-term biosolids application.
- Biosolids were about 15 percent total solids or more from 2013 through 2021.
- Biosolids percent solids have decreased since 2021 to about 12 percent total solids.
- About 12 percent of the City's existing land application acreage (Class B only) is restricted due to setbacks.

1.4 Solids-Water-Energy Evaluation Tool

The alternatives analysis uses BC's solids-water-energy evaluation tool (BC:SWEET). BC:SWEET conducts a mass balance around the solids treatment process and tracks the following parameters for use in a lifecycle cost evaluation:

- Total solids (TS), volatile solids (VS), and water
- Power and heat required for unit processes
- Energy and heat production from unit processes
- Energy and heat recovery (e.g., recovery from CHP engines)

BC:SWEET allows the evaluation of multiple feedstocks, including PS, WAS, and HSW. The carbon footprint and lifecycle cost of each alternative can be determined using process predictions from BC:SWEET. A business case evaluation based on lifecycle costs is conducted based on capital costs and annual costs (e.g., chemical costs, operations and maintenance [O&M] cost, repair and replacement [R&R] costs, etc.) associated with each alternative.

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The BC:SWEET was used in this evaluation for two rounds of analysis. An initial alternatives analysis was conducted for 20 alternatives to investigate biosolids production, natural gas (NG) requirement, energy and heat recovery potential, and lifecycle cost differences among the solids treatment alternatives. The results from the initial alternatives analysis were used to inform a second round in the evaluation: a refined alternative analysis. The refined alternatives analysis focused on three main alternatives. Sensitivity was layered onto each main alternative to create sub-alternatives that were useful for evaluating phasing opportunities in the CIP roadmap.

Section 2: Screening and Non-economic Evaluation Criteria

This section presents the screening and non-economic evaluation criteria that are applied to screen technologies and score alternatives, respectively. Fatal flaw (pass/fail) screening criteria and non-economic criteria weighting factors were developed with input from the City. The application of screening criteria is presented in Section 3 (Technology Screening and Initial Alternatives Development), and non-economic evaluation results are presented in Sections 5.3 (Non-economic Evaluation Results) and 6.5 (Refined Non-economic Evaluation Results).

2.1 Screening Criteria

Screening criteria were used to determine which solids stabilization technologies would be carried forward to the initial alternatives analysis. Technologies that passed all screening criteria were advanced. The pass/fail screening criteria included:

- **Plant Compatibility** – Technology and process train are compatible with existing operating scheme and staffing levels. This criterion reflects the compatibility with existing processes (including liquid stream) and City resources (e.g., staffing).
- **Established and Mature Technology** – This criterion reflects the extent to which a given technology/method has been proven at full scale. The technology must have a minimum of five installations currently operating, with at least two of the five in North America, with a successful operation history of at least 5 years. One installation must have 5 year or more of consecutive operation. The reference facilities must treat at least 70 percent municipal wastewater solids and handle a minimum of 10 million gallons per day (mgd) influent flow.
- **Diversifies Santa Rosa's Biosolids Management for Beneficial Reuse –** This criterion reflects whether a technology/method creates beneficial use opportunities in support of statewide organics diversion from landfill via multiple pathways.
- **Program Reliability** – This criterion reflects whether a technology/method will be compatible with existing and future regulatory/market conditions (e.g., emerging contaminants regulations, trucker shortages, rising end-use costs, competition from other diverted organics, etc.).

2.2 Non-economic Evaluation Criteria

Non-economic scoring criteria were used to further evaluate and rank alternatives. Non-economic criteria allow for alternatives to be evaluated based on the City's safety goals, values, and operational practices. The non-economic scoring criteria are summarized in Table 2-1. Each criterion was assigned a weight based on importance to the City. Criteria with higher weight values were more important to the City and had a greater impact on the overall non-economic scoring. Table 2-1 also describes scoring guidelines for each criterion.

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Table 2-1. Non-economic Scoring Criteria		
Criteria	Weight	Scoring Guidelines
End-use Market Compatibility	30	• A high-scoring alternative will produce a desirable biosolids product and is easily paired with additional processing technologies. • A low-scoring alternative does not produce a desirable product and cannot adapt to produce a desired biosolids product.
O&M Impacts	20	• A high-scoring alternative will reduce O&M staff time, require simple operation, be reliable with minimal downtime, and introduce no new chemicals or hazards to staff. • A low-scoring alternative will increase O&M staff time and overall operational complexity.
Existing Site and Process Compatibility	25	• A high-scoring alternative will include available footprint for new facilities, maintain space for future facilities, easily integrate into existing plant processes, and be compatible with the trucked waste program. • A low-scoring alternative will significantly reduce space for future facilities, be difficult to integrate, and impact upstream and downstream equipment and facilities.
Environmental and Community Impacts	5	• A high-scoring alternative will have low greenhouse gas emissions, minimal sidestream generation or impacts, and nuisance factors that can be mitigated. • A low-scoring alternative will have high greenhouse gas emission, difficult to treat sidestreams, and increased nuisance factors that are difficult to mitigate.
Permitting and Regulatory Risk	10	• A high-scoring alternative will have minimal air permit impacts and the technology will provide flexibility to meet future or current regulations. • A low-scoring alternative will require new or more stringent air permits and the technology cannot meet future or current regulations.
Safety Impacts	10	• A high-scoring alternative will have minimal impacts to plant staff and contractor safety, and minimal or no emergency procedures required. • A low-scoring alternative will have an unknown safety or reliability record and several required emergency procedures.

Section 3: Technology Screening and Initial Alternatives Development

This section details various biosolids stabilization technologies considered for the initial alternatives analysis and the results of the technology screening evaluation. Technologies that passed the screening evaluation were used to develop a list of initial alternatives for further analysis using BC:SWEET. Biosolids management technology options considered in the screening evaluation are detailed in Attachment B.

3.1 Biosolids Stabilization Technology Screening

This section provides an overview of biosolids stabilization technologies that were evaluated. Figure 3-1 shows the universe of biosolids stabilization technologies considered for screening. Technologies are grouped into eight categories. These technologies and categories are described in more detail in Attachment B.

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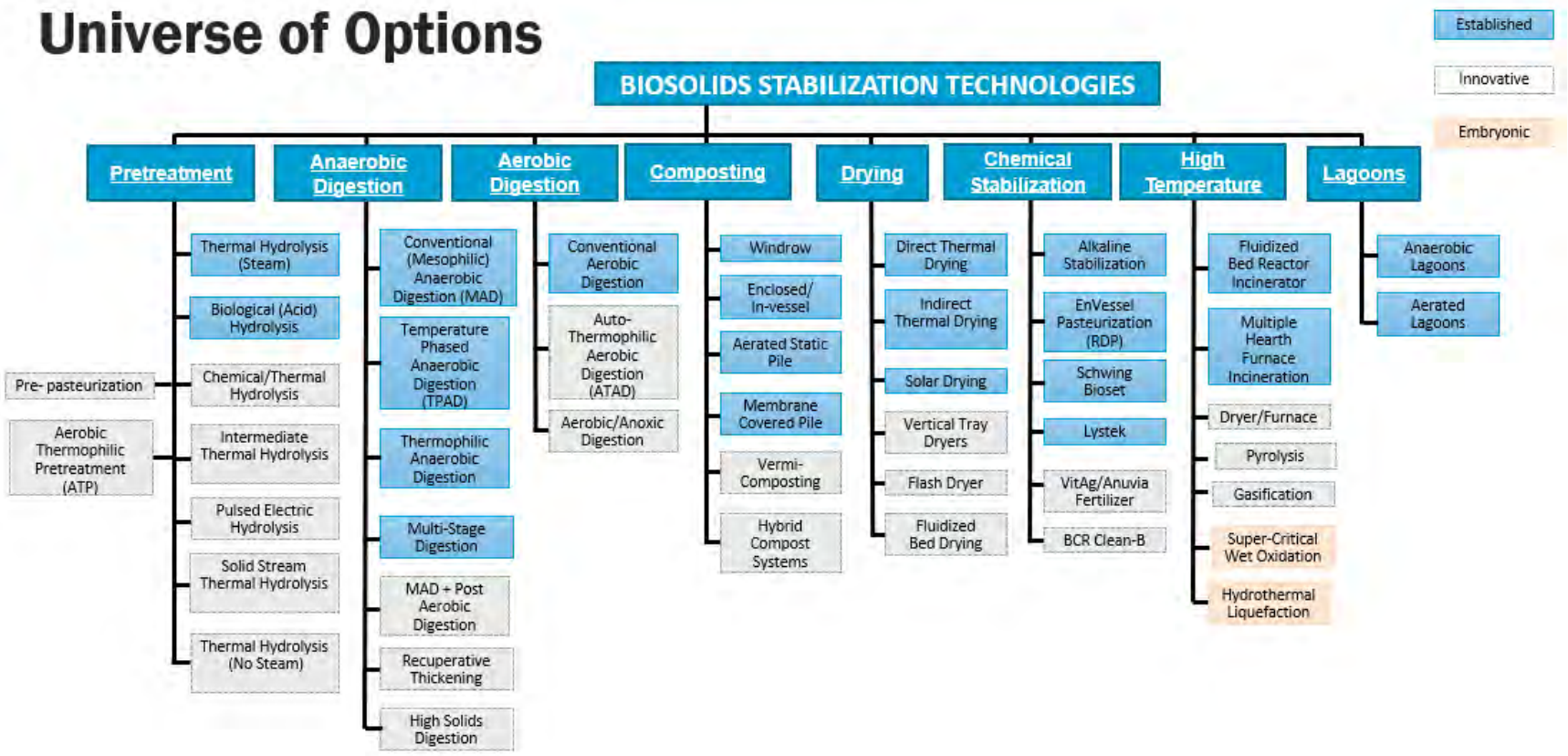


Figure 3-1. Universe of biosolids stabilization technology options

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3.1.1 Pretreatment

All pretreatment technologies passed the plant compatibility criteria; however, thermal hydrolysis (steam), biological (acid) hydrolysis, and chemical/thermal hydrolysis were the only pretreatment technologies that passed all screening criteria. All other pretreatment technologies did not pass the "established and mature" criteria and were eliminated.

Thermal hydrolysis (steam), biological (acid) hydrolysis, and chemical/thermal hydrolysis are proven methods of a thermal hydrolysis process (THP) and would help the City achieve a diversified biosolids product for beneficial reuse by producing a Class A product. Additionally, THP would address existing capacity limitations in the digesters when one digester is offline for maintenance. It was determined that thermal hydrolysis (steam) would act as the representative pretreatment technology to be incorporated into the initial alternatives.

3.1.2 Anaerobic Digestion

Temperature-phased anaerobic digestion (TPAD) and multi-stage digestion did not pass the plant compatibility criteria because there is limited site footprint for additional digesters. High solids digestion did not pass plant compatibility criteria because it is not compatible with existing digestion technology. Conventional (mesophilic) anaerobic digestion (MAD) followed by post aerobic digestion (MAD + post aerobic digestion) did not pass the established criteria as it is considered an innovative technology. Recuperative thickening is also considered an innovative technology; however, the City currently uses recuperative thickening to address capacity limitations when one digester is offline for maintenance.

Recuperative thickening, an established technology already used by the City periodically, passed all screening criteria. Conventional MAD is currently the City's digestion strategy and therefore passed all screening criteria. Thermophilic anaerobic digestion (TAD) is compatible with the existing infrastructure and was not evaluated to limit the existing biosolids management strategy; therefore, TAD passed all screening criteria.

TAD would easily integrate into the existing process and would alleviate digestion capacity limitations documented in TM1 (Flows and Loads and Capacity Evaluation) by allowing the City to operate its digesters at a sub-15-day hydraulic retention time (HRT) and still have the potential to produce a Class B biosolids product. For this alternative, Class B equivalency would need to be demonstrated and approved by the U.S. Environmental Protection Agency (EPA). This process has been completed successfully by other agencies in the Bay Area (e.g., East Bay Municipal Utilities District), making it a feasible alternative for consideration in the biosolids alternatives evaluation.

3.1.3 Aerobic Digestion

All aerobic digestion technologies did not pass the plant compatibility criteria because each technology would require additional infrastructure and could not be easily incorporated into the existing process.

3.1.4 Composting

Most composting technologies did not pass the plant compatibility criteria. Enclosed/In-vessel composting was carried forward because the City already owns and had operated this composting technology.

3.1.5 Drying

Solar drying did not pass initial plant compatibility criteria due to its large footprint requirements. Vertical tray dryers, fluidized bed drying, and bio dryers did not pass the established and mature technology criteria because these technologies are considered innovative.

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Direct thermal drying and indirect thermal drying are both well-established technologies that would be compatible with the City's current process. Both technologies passed additional screening criteria because thermal drying produces a Class A biosolids product, which helps diversify the City's biosolids management strategy and increase program reliability.

Indirect drying technologies produce a dustier product than direct thermal drying. As a dustier product is typically less desirable and may be more challenging for beneficial reuse in the area, direct thermal drying was identified as the representative drying technology for the biosolids alternatives evaluation.

3.1.6 Chemical Stabilization

Only Lystek passed the initial plant compatibility screening for chemical stabilization, and as the City currently uses Lystek during winter when biosolids production exceeds the City's storage capacity, Lystek was carried forwarded and incorporated into the biosolids alternatives evaluation.

3.1.7 High Temperature

Fluidized bed reactor incinerator, multiple-hearth furnace incineration, and dryer/furnace technologies failed the plant compatibility criteria. Incineration in lieu of anaerobic digestion is not compatible with the City's current biogas utilization, and incineration technologies are not compatible with the City's current air permit. Other high-temperature technologies (pyrolysis, gasification, super-critical wet oxidation, and hydrothermal liquefaction) failed the established and mature criteria.

3.1.8 Lagoons

All lagoon technologies failed the plant compatibility criteria due to footprint limitations.

3.2 Technology Screening Results

The pass/fail screening criteria (Section 2.1) was used to evaluate the universe of solids stabilization technologies. The technologies outlined previously in Figure 3-1 were passed through screening criteria sequentially. Each technology was screened in the following order:

1. Plant compatibility
2. Established and mature
3. Diversifies biosolids management
4. Program reliability

Technology that failed to meet a criterion was eliminated and was not evaluated against further screening criteria. Technology that passed all four criteria was considered for the biosolids alternatives evaluation. Table 3-1 presents the screening results.

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Table 3-1. Technology Screening Results				
Technology	Plant Compatibility	Established and Mature	Diversifies Biosolids Management	Program Reliability
Pretreatment				
Thermal Hydrolysis (Steam)	Pass	Pass	Pass	Pass
Biological (Acid) Hydrolysis	Pass	Pass	Pass	Pass
Chemical/Thermal Hydrolysis	Pass	Pass	Pass	Pass
Pre-pasteurization	Pass	Fail		
Aerobic Thermophilic Pretreatment	Pass	Fail		
Intermediate Thermal Hydrolysis	Pass	Fail		
Pulsed Electric Hydrolysis	Pass	Fail		
Solid Stream Thermal Hydrolysis	Pass	Fail		
Thermal Hydrolysis (No Steam)	Pass	Fail		
Anaerobic Digestion				
Conventional (Mesophilic) Anaerobic Digestion (MAD)	Pass	Pass	Pass	Pass
Temperature-phased Anaerobic Digestion	Fail			
Thermophilic Anaerobic Digestion	Pass	Pass	Pass	Pass
Multi-Stage Digestion	Fail			
MAD + Post Aerobic Digestion	Pass	Fail		
Recuperative Thickening	Pass	Pass	Pass	Pass
High Solids Digestion	Fail			
Aerobic Digestion				
Conventional Aerobic Digestion	Fail			
Auto-Thermophilic Aerobic Digestion	Fail			
Aerobic/Anoxic Digestion	Fail			
Composting				
Windrow	Fail			
Enclosed/In-vessel	Pass	Pass	Pass	Pass
Aerated Static Pile	Fail			
Membrane-covered Pile	Fail			
Verni-Composting	Fail			
Hybrid Compost Systems	Fail			
Drying				
Direct Thermal Drying	Pass	Pass	Pass	Pass
Indirect Thermal Drying	Pass	Pass	Pass	Pass
Solar Drying	Fail			
Vertical Tray Dryers	Pass	Fail		
Flash Dryer	Pass	Fail		
Fluidized Bed Drying	Pass	Fail		
Bio Dryer	Pass	Fail		

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Table 3-1. Technology Screening Results				
Technology	Plant Compatibility	Established and Mature	Diversifies Biosolids Management	Program Reliability
Chemical Stabilization				
Alkaline Stabilization	Fail			
EnVessel Pasteurization	Fail			
Schwing Bioset	Fail			
Lystek	Pass	Pass	Pass	Pass
VitAg/Anuvia Fertilizer	Fail			
BCR Clean-B	Fail			
High Temperature				
Fluidized Bed Reactor Incinerator	Fail			
Multiple Hearth Furnace Incineration	Fail			
Dryer/Furnace	Fail			
Pyrolysis	Pass	Fail		
Gasification	Pass	Fail		
Super-Critical Wet Oxidation	Pass	Fail		
Hydrothermal Liquefaction	Pass	Fail		
Lagoons				
Anaerobic Lagoons	Fail			
Aerated Lagoons	Fail			

3.3 Initial Alternatives for Evaluation

Technologies that passed through screening were considered for the initial alternatives analysis. The initial alternatives were created to provide short- and long-term options to address capacity constraints while advancing the City's goals, as introduced in Section 1. These goals include *reducing operational costs, mitigating future regulatory risks, providing solutions that best meet the needs of the regional community, maintaining operational flexibility, incorporating and aligning biosolids management solutions with the City's Climate Action Plan, and determining the best use of the composting facility.*

The City's Climate Action Plan is committed to reducing greenhouse gas (GHG) emissions. The LTP contributes to Climate Action Plan goals by accepting HSW for co-digestion. HSW co-digestion produces additional biogas, which the City uses for cogeneration of heat and energy. Energy generated from the HSW program offsets energy purchases and fossil fuel reliance; therefore, all alternatives were assumed to incorporate the baseline HSW. Some alternatives considered additional HSW to evaluate whether acceptance of additional HSW provides an economic benefit for the City.

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Table 3-2 lists the initial alternatives to be evaluated using BC:SWEET.

Table 3-2. Initial Alternatives Descriptions

Alternative Number	Alternative Description[a]
New digester required[b]	
01	• Status quo mesophilic digestion • 30,000 gallons per day (gpd) HSW • Existing BP
02	• Status quo mesophilic digestion • Permitted HSW capacity at 46,000 gpd • Existing BP
03	• Status quo mesophilic digestion • Double current HSW capacity to 92,000 gpd • Existing BP
04	• Status quo mesophilic digestion • 30,000 gpd HSW • Existing BP • Includes expanding Alpha Barn storage
05	• Status quo mesophilic digestion • 30,000 gpd HSW • Existing BP • Includes new gas storage
06	• Status quo mesophilic digestion • 30,000 gpd HSW • Existing BP • Assumes existing composting facility is rehabbed and a percent of biosolids composted rather than land applied • Composted solids achieve Class A
07	• Status quo mesophilic digestion • 30,000 gpd HSW • Existing BP • Conveyors installed to replace existing cake pumps
08	• Status quo mesophilic digestion • 30,000 gpd HSW • Centrifuges installed to provide a dryer end-use product • Conveyors installed to replace existing cake pumps
09	• Status quo mesophilic digestion • 92,000 gpd HSW • Centrifuges installed to provide a dryer end-use product • Conveyors installed to replace existing cake pumps
10	• Status quo mesophilic digestion • 30,000 gpd HSW • Thermal drying installed to create dryer end-use product at 50 percent TS[c]
11	• Status quo mesophilic digestion • 30,000 gpd HSW • Thermal drying installed to create dryer end-use product at 90 percent TS • Achieves Class A

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Table 3-2. Initial Alternatives Descriptions

Alternative Number	Alternative Description[a]
Assumes no new digester required[d]	
12	• Sub-15-day solids retention time (SRT) mesophilic digestion • 30,000 gpd HSW • Thermal drying installed to create dryer end-use product at 90% TS • Achieves Class A
13	• Sub-15-day SRT thermophilic digestion • 30,000 gpd HSW • Existing BP • Testing to certify Class B at sub-15-day SRT
14	• Status quo mesophilic digestion • 30,000 gpd HSW • All biosolid sent to regional Lystek facility located on site • Achieves Class A
15	• Status quo mesophilic digestion • 30,000 gpd HSW • Recuperative thickening
Pretreatment (thermal hydrolysis)[e]	
16	• Status quo mesophilic digestion • 30,000 gpd HSW • Existing BP • Conveyors installed to replace existing cake pumps
17	• Status quo mesophilic digestion • 46,000 gpd HSW • Existing BP • Conveyors installed to replace existing cake pumps
18	• Status quo mesophilic digestion • 92,000 gpd HSW • Existing BP • Conveyors installed to replace existing cake pumps
19	• Status quo mesophilic digestion • 30,000 gpd HSW • New centrifuges for dewatering • Conveyors installed to replace existing cake pumps

a. All alternatives assume new GBTs to address current capacity constraints

b. A new digester is required to address capacity limitations when one digester is offline for maintenance. The alternatives that do not address this capacity limitation are assumed to include the cost of constructing a new digester.

c.. Biosolids stored at 50 percent TS have increased fire risk. In actuality, this alternative would likely have half of biosolids dried to 90 percent TS and the remaining biosolids not treated with a thermal dryer.

d. Alternatives that addressed capacity limitation do not include the cost of constructing a new digester.

e. All THP alternatives address capacity limitations and do not include the cost of constructing a new digester.

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Section 4: Analysis Assumptions and Methodology

Alternatives analyses were based on process performance predictions, capital and annual cost estimates, non-economic scoring, GHG emissions estimates, and impacts to upstream and downstream processes. This section documents the assumptions and methodology used in the initial and refined alternatives analyses.

4.1 Key Process Assumptions

The technologies and options evaluated for each major unit process, along with corresponding process assumptions, are described in this section. Key assumptions for unit processes are detailed below, and a complete list of assumptions and inputs used in BC:SWEET are documented in Attachment C.

4.1.1 Feedstock Assumptions

Feedstocks assumed for all status quo conditions in the evaluation are shown in Table 4-1. Feedstocks included PS, TWAS, and HSW. The values shown in Table 4-1 are based on the mass balance detailed in TM1; the HSW status quo was updated to reflect a value of 30,000 gallons per day (gpd) to HSW receiving. BC:SWEET calculates feedstock flows based on percent TS and VS, and calculates volatile solids reduction (VSR) across anaerobic digestion based on an assumed VSR input associated with each feedstock.

Table 4-1. Summary of Feedstocks

Feedstock	Dry Mass Flow (lb-TS/d)	TS (%)	VS (%)	VSR (%)
PS				
2023	36,300	4.5	86	65
2053	48,000	4.5	86	65
TWAS				
2023	20,000	4.7	83	32
2053	26,300	4.7	83	32
HSW				
2023	15,760	6.3	92	90
2053	15,760	6.3	82	90

lb-TS/d = pounds total solids per day

4.1.2 Thermal Hydrolysis Process Assumptions

THP alternatives (initial alternatives 16, 17, 18, and 19) assumed that THP would be incorporated into the City's current solids treatment train before digestion. The BC:SWEET model for THP alternatives assumed only PS and TWAS would be fed to the THP system. It was assumed that HSW would bypass the THP system and be fed directly to the digester because there is no significant benefit to pretreating HSW with THP. Operating a THP system in this manner would not produce Class A biosolids; however, if future regulations require Class A biosolids, HSW could be fed to the THP system. Modeling the THP alternatives with HSW fed to the THP system is not expected to have a significant impact on model results; therefore, all THP alternatives were assumed to provide a Class A product.

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4.1.3 Anaerobic Digestion Process Assumptions

The City currently operates anaerobic digesters at mesophilic conditions with an SRT above 15 days (-d) to achieve Class B biosolids. In TM1, the mesophilic digester performance was calibrated using a mass balance approach. Table 4-2 summarizes the assumed digester performance parameters for mesophilic digestion and other digestion alternatives considered in the analyses.

Table 4-2. Digestion Process Assumptions

Parameter	Unit	Mesophilic	Thermophilic	Sub 15-d SRT Mesophilic	Recuperative Thickening	THP + Mesophilic
Operation Temperature	°F	98	130	98	98	100
PS VSR	-	65%	65%	60%	65%	65%
WAS VSR	-	32%	33%	30%	32%	60%
Gas Production	ft^3/lb VS removed	15.9	17	15.9	15.9	15.9
Energy Consumption[a]	hp	310	400	310	330	636 (THP) + 330 (Meso)
Shell Heat Loss	-	15%	10%	15%	15%	10% (THP) + 15% (Meso)

a. Motor horsepower input into model; does not include thermal energy. A 90 percent motor efficiency was assumed.
ft^3/lb VS = cubic feet per pound of volatile solids

Alternatives with thermophilic digestion were assumed to have a slight increase in WAS digestibility. Alternatives with digestion below 15-d SRT (and above 12-d SRT) were developed to evaluate options to defer anaerobic digestion construction. These alternatives were assumed to have a decrease in PS and WAS digestibility. THP alternatives were assumed to have a significant increase in WAS digestibility due to hydrolysis of feed streams.

4.1.4 Dewatering Assumptions

Dewatering is included in all alternative models. Two dewatering technologies were considered in the initial alternatives analysis. Alternatives with the existing BP (status quo) were assumed to achieve 15 percent TS prior to addition of any dilution water associated with biosolids pumping. BP dewatering was assumed to achieve 25 percent TS if THP system was installed due to improved dewaterability. BP dewatering performance assumptions are shown in Table 4-3.

Table 4-3. Belt Press Dewatering Process Assumptions

Parameter	Unit	Alts 0 -15	Alts 16-19
Stream Dewatered	-	Digestion	THP + Digestion
Solids Capture	-	96%	96%
Dewatered Biosolids TS	-	15%	25%
Process Energy Consumption	horsepower	100	100

New centrifuges were assumed for to evaluate costs and benefits from improved mechanical dewatering performance. Centrifuge cake solids were assumed as 25 percent TS for both mesophilic digestion and THP system alternatives. Cake solids for THP are likely higher but would need to be confirmed if this alternative is advanced to pre-design. Centrifuge dewatering performance assumptions are shown in Table 4-4.

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Table 4-4. Centrifuge Dewatering Process Assumptions			
Parameter	Unit	Alts 0-7 and 9-18	Alts 8 and 19
Stream Dewatered	-	Digestion	THP + Digestion
Solids Capture	-	96%	96%
Dewatered Biosolids TS	-	25%	25%
Process Energy Consumption	horsepower	245	245

4.1.5 Thermal Drying Assumptions

Thermal belt dryers were considered as the representative technology for thermal drying alternatives. It was assumed the thermal driers could achieve a range of 50 to 90 percent TS. Thermal drying to 50 percent TS would produce Class B biosolids, and 90 percent TS would achieve Class A biosolids. The thermal dryer heat demand in BC:SWEET models was met using NG. Recycling heat captured from CHP engines would require process piping to connect the heating system to the thermal drying facility (higher capital cost) but would reduce NG requirements (lower GHG emissions and annual operating costs).

4.1.6 End Use and Storage Assumptions

The City land applies biosolids during the summer season, and stores biosolid during the winter season at the Alpha Barn. Biosolids stored during winter are land applied the following summer. When the Alpha Barn storage capacity is met, any remaining solids produced in the winter season are diverted to Lystek. This biosolid management strategy was assumed for all alternatives evaluated in this analysis. Table 4-5 summarizes the Alpha Barn storage capacity.

Table 4-5. Biosolids Land Application and Storage Assumptions			
Parameter	Unit	Class B	Class A
Alpha Barn Storage	Wet Tons	7,000	
Max Allowable Wet Tons per Acre Land Applied[a]	Wet Tons/Acre/Year	10	
Total Land Available for Application[b]	Acres	2,662	3,462
Nitrogen Land Application Limit Based on 15 percent TS[c]	Tons Nitrogen/Acre/Year	0.104	
Biosolids Nitrogen Content[d]	%	6.9%	
Nitrogen Loss from Thermal Drying	%	0%	10%
Annual Allowable Nitrogen for Land Application[e]	Tons Nitrogen/Year	276	358

a. *Key assumption provided by City staff.*
b. *Calculated based on 800 more acres of land currently eligible for land application of Class A biosolids per numbers provided by City staff.*
c. *Limit was determined based on an average biosolids %TS concentration of 15 percent, the max allowable wet tons per acre land applied, and the assumed biosolids nitrogen content from TM3.*
d. *Assumed biosolids nitrogen content determined from TM3.*
e. *Allowable nitrogen is calculated by multiplying the "Nitrogen Land Application Limit" by (1 minus "Nitrogen Loss from Thermal Drying") by the "Total Land Available for Application."*

The City's ability to land apply during summer is limited by available acreage. An estimated land-application threshold of 10 wet tons per acre per year was determined based on review of historical data (Attachment A). The land-application threshold is driven by annual nitrogen loading limitations. Table 4-5 also summarizes the total land availability for biosolids application during summer and the maximum limit of wet tons and nitrogen that can be applied per year.

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The annual allowable biosolids application rate was determined for both Class A and Class B biosolids alternatives. The allowable application rate was quantified in terms of nitrogen applied per acre. Based on biosolids management documentation from the City, the current biosolids application rate is limited to about 10 wet tons per acre per year. At a 6.9 percent nitrogen content, 0.104 tons of nitrogen per acre per year was estimated as the limiting application rate.

If Class A biosolids are produced, 800 more acres of land would be eligible for land application. This land is currently restricted to Class A use only due to California Tiger Salamander habitat. This land is also currently used to grown organic crops and would likely require advanced coordination before biosolids could be applied.

It was assumed that the City would purchase more land in cases where the BC:SWEET predicts solids production that exceeds the land application limits. The cost to procure more land is captured as capital costs, as needed, to reflect the economic risk of running out of summer-season land for application. This cost assumption is shown in Attachment B.

4.2 Cost Assumptions

The following section describes the capital, operating, and lifecycle assumptions made on capital and operating costs for the BC:SWEET lifecycle cost analysis.

4.2.1 Capital Costs for Initial Alternatives Analysis

Total project capital cost (including design, construction management, and engineering services during construction) for each initial alternative option were estimated based on recent project experience and vendor quotes. Capital cost from recent project experience were inflated to reflect present day costs and scaled based on plant loads to match the predicted equipment sizing. A 30 percent contingency factor was applied to the capital costs. Total project capital costs developed for the initial alternatives analysis were considered American Association of Cost Engineering (AACE) International Class 5 estimates with an accuracy range of +100 to -50 percent.

4.2.2 Capital Costs for Refined Alternatives Analysis

Capital costs for the refined alternatives analyses were developed based on vendor budgetary cost proposals for equipment sized to the projected 2053 flows and loadings. Refined capital costs were used to update the initial capital costs for all projects included in the refined alternatives.

Capital cost estimates for demolition, and structural, civil, and mechanical components, were estimated based on quantity estimates from facility layout drawings using unit costs from RS Means. Electrical and instrumentation costs were estimated by applying a cost factor relative to installation cost of other components. Markups for contractor profit, taxes, shipping, and handling were applied to estimate the total construction cost. An estimation contingency was also applied. The total project capital cost was calculated by applying markups for design and construction services. Total project capital costs developed for the refined alternatives analysis are considered AACE Class 5 estimates with an accuracy range of +100 to -50 percent. Attachment D shows detailed capital cost estimation sheets with all estimate line items, markups, and assumptions. The list below highlights typical quantities assumed for refined capital cost estimates:

- Sales tax was included at 9.25 percent.
- An 8 percent per year escalation rate was assumed through the midpoint of construction.
- A 25-month construction length was assumed for most projects.
- A 50 percent construction cost estimation contingency was included to cover unforeseen conditions and area economic factors. Contingency will decrease at later stages of design.

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4.2.3 Capital Costs for Projects Addressing Capacity Constrains and Condition Deficiencies

The capacity evaluation (TM1) and condition assessment (TM2) had identified projects required to address capacity constraints and condition deficiencies. Cost estimates were prepared for these projects in tandem with cost estimates that were prepared for projects associated with the refined alternatives. The cost estimating methodology for these projects aligned with the approach, markups, sales tax, escalation, and contingency presented in Section 4.2.2 – Capital Costs for Refined Alternatives Analysis. A 12-month construction length was assumed for most projects.

All capital cost estimates are shown in Attachment D and are presented as AACE Class 5 estimates with an accuracy range of +100 to -50 percent.

4.2.4 Annual Costs and Benefits

Annual costs and benefits (i.e., cost savings) were calculated based on process performance predictions. Unit costs for chemicals, energy, NG, and biosolids management were developed and presented to the City. Unit costs were applied to annual use or production rates predicted by calculations using the BC:SWEET. The R&R costs were applied to the analysis as an annual cost equaling 2.5 percent of the equipment costs. Table 4-6 presents unit cost assumptions.

Table 4-6. Unit Cost Assumptions

Item	Unit	Unit Cost
Natural Gas Cost	$/therm	0.5
Unblended Electricity Cost[a]	$/kWh	0.16
Max Demand Charge (summer and winter)[a]	$/kW	29.78
Peak Demand Charge (summer and winter)[a]	$/kW	12.7
Reservation Charges[a]	$/kW	10.58

a. Base on Pacific Gas & Electric's Rate S

4.2.5 Lifecycle Cost Assumptions

Table 4-7 shows lifecycle cost assumptions for all alternatives under the initial and refined alternatives analyses. The "Lystek Sensitivity Escalation" value was used in the refined alternatives analysis to capture the change in overall lifecycle cost if Lystek contract pricing were to increase at a rate two times greater than general escalation. This assumption quantifies potential "risk" of Lystek prices increasing if regulations impact end-use costs for Lystek.

Table 4-7. NPV Assumptions

Item	Value
Lifecycle Term, years	30
Discount Rate, annual percentage	4%
General Escalation, annual percentage	2.8%
Lystek Sensitivity Escalation, annual percentage	5.6%

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4.3 Non-economic Evaluation Assumptions and Approach

Non-economic scoring was determined from the six identified criteria detailed in Section 2.2 (Non-economic Evaluation Criteria). Technologies and end-use scenarios were scored individually to avoid bias, and the scoring for all technologies and scenarios in each alternative were averaged to determine the alternative score. Digestion technologies and end uses were weighted more heavily compared to thickening or dewatering technologies because the alternatives were developed primarily to address digestion capacity constraints and end-use options. Attachment A provides a more detailed overview and shows scores assessed for each technology and the detailed non-economic scoring for each alternative.

4.4 Greenhouse Gas Assumptions and Approach

GHG emissions were estimated based on Scope 1 and Scope 2 emission sources, as defined by the Greenhouse Gas Protocol by the World Business Council for Sustainable Development and the World Resources Institute. All emissions were quantified in terms of annual average carbon dioxide equivalent (CO_2e) mass loading per day. Assumed emission factors and sources are documented in Attachment A. The list below outlines sources accounted for in the Scope 1 and Scope 2 emissions. Scope 3 emissions (chemical production, fertilizer offset from land application) were omitted because these sources are outside of the City's property limits and are included in GHG accounting from third parties.

Scope 1 GHG emissions originate from sources owned and managed by the City and include CO_2e emissions from:

- Natural gas used
- Fugitive methane
- Incomplete combustion after flaring
- Methane (CH_4) and nitrous oxide (N_2O) released from stored biosolids
- On-site composting

Scope 2 GHG emissions are indirect emissions stemming from offsite electricity generation. Electricity generation by the City reduces the need to purchase off-site electricity, which reduces Scope 2 emissions. Scope 2 emissions include CO_2e emissions from:

- Off-site electricity generation

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Section 5: Initial Alternatives Analysis

This section compares the process performance predictions, lifecycle costs, and non-economic evaluation scoring among the 19 initial alternatives. The alternatives shortlisted for the refined alternatives analysis are presented at the end of this section.

5.1 Process Performance Predictions

Process performance predictions, determined for each alternative, include:

- Annual wet tons produced
- Land application limitations
- Winter biosolid storage
- Total gas production and electricity generation
- Natural gas demand
- Energy demand

5.1.1 Annual Wet Tons Produced

The total wet tons produced is anticipated to increase from 2023 to 2053, as shown in Figure 5-1. The total WTPY will increase as HSW receiving is increased. The alternatives where a drier end-use product is achieved (Alts 08-12 and Alts 16-19) will produce significantly less WTPY when compared to the other alternatives. It should be noted that THP will enhance biosolids dewaterability, meaning that a drier end-use product can be produced using the existing BPs. Overall, the thermal drying alternatives produce the driest end-use product and least WTPY.

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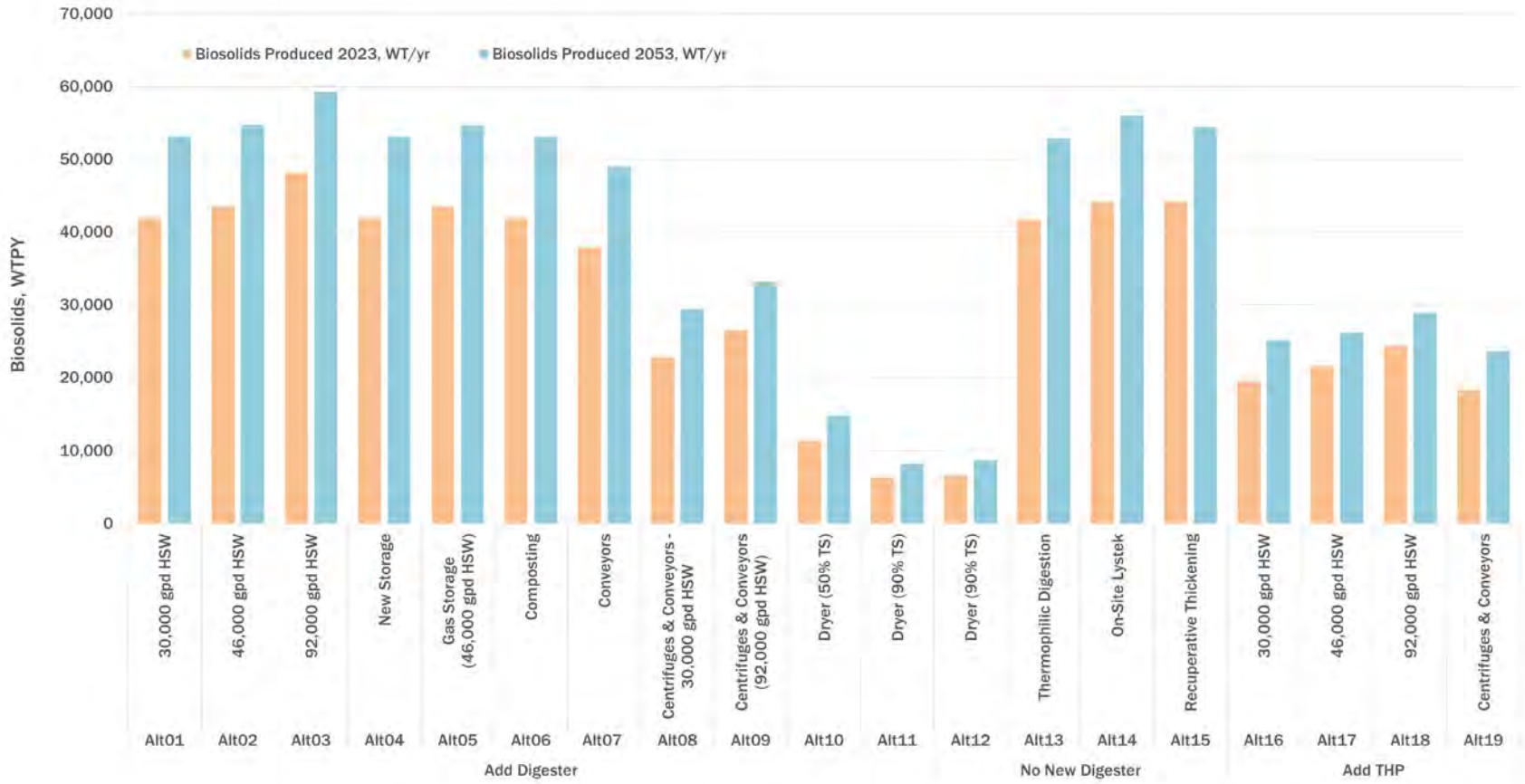


Figure 5-1. Annual predicted biosolids production 2023 and 2053

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5.1.2 Land Application Limitations

Using the land application assumptions outlined in Section 4.1.6, the future limitations of biosolids land application were predicted based on the total dry tons of nitrogen in the biosolids and the current City-owned acreage. The land application limitations vary depending on the total land available for biosolids application. Biosolids application is limited by State Water Resource Control Board and Sonoma County restrictions, under which Class A biosolids are less restricted than Class B biosolids as mentioned previously in Section 4.1. The total land application limitation based on Class B and Class A are outlined in Figure 5-2.

As outline in Figure 5-2, in 2053, the centrifuge and conveyor alternatives (Alts 08 and 09), recuperative thickening (Alt 15), and thermal dryer 50 percent TS alternative (Alt 10) will exceed the allowable land application nitrogen limits for Class B, meaning the City will be required to either purchase more land or use a different end-use outlet, such as Lystek. Additionally, in 2053, the 90 percent thermal drying (Alt 11) and sub-15-day SRT digestion + 90 percent drying (Alt 12) alternatives will exceed the Class A land application capacity under the current assumptions. It is anticipated that all other alternatives will remain within the current Class A and Class B land application limitations.

It should be noted that for this evaluation, THP was assumed to not pretreat HSW, meaning the biosolid are classified as Class B and are subject to Class B limitations. However, as outline in Figure 5-2, the THP alternatives are predicted to remain below the Class B limitations. This means unless there are regulatory drivers to produce Class A biosolids, producing a Class B product is sufficient in terms of land application limitations.

5.1.3 Winter Storage Summary

As the City is unable to land apply biosolids during the winter season it must store biosolids during this period; any biosolids that exceed storage limitations are hauled to Lystek for further processing. Figure 5-3 and Figure 5-4 outline the predicted 2023 and 2053 winter biosolids stored and hauled to Lystek, respectively.

As outlined on Figure 5-3 and Figure 5-4, the amount of biosolids directed to Lystek is anticipated to increase between 2023 and 2053. The addition of new storage in Alt 04 allows an additional 1,000 WT to be stored at the Alpha Barn but would still require the City to direct biosolids to Lystek during the winter. The thermal dryer alternatives (Alts 10, 11, and 12) are the only alternatives that eliminate the need to direct any biosolids to Lystek through 2053.

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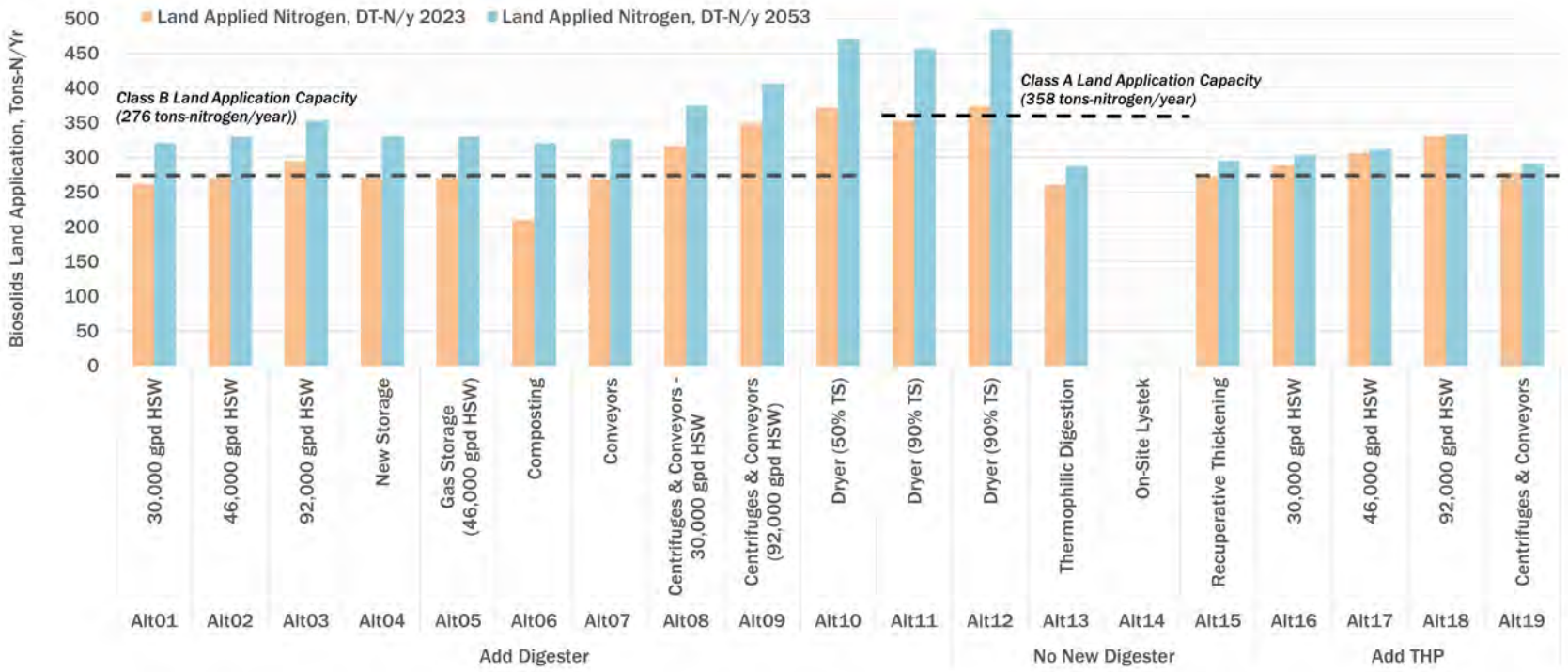


Figure 5-2. Land application limitations based on predicted total dry tons of nitrogen produced

Biosolids land application nitrogen (dry tons-nitrogen/yr) does not include nitrogen loading from biosolids sent to Lystek. Centrifuges and conveyor and dryer alternatives assume less to Lystek, and therefore show more nitrogen loading to land application managed by the City.

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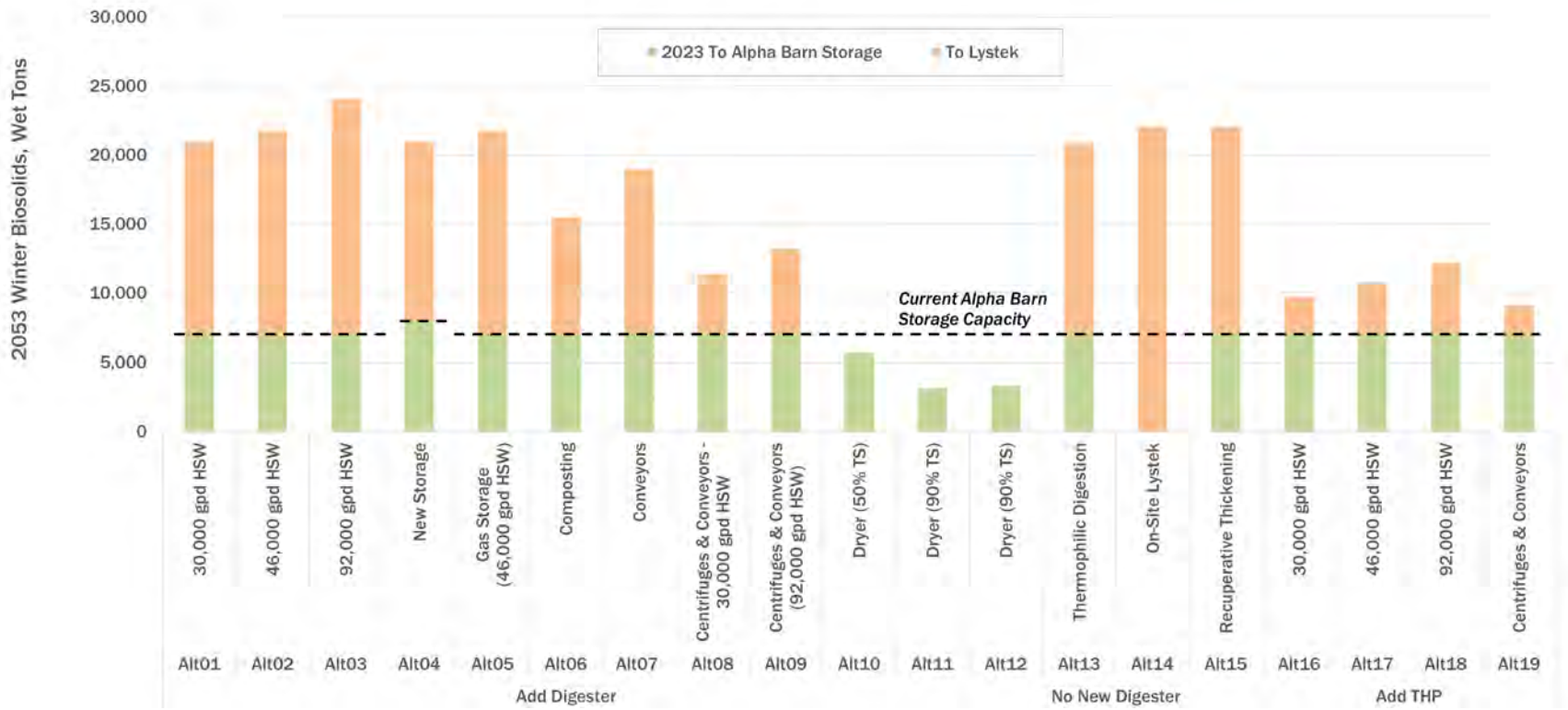


Figure 5-3. 2023 biosolids storage and 2023 biosolids diverted to Lystek

Composting (Alt 06) was assumed to divert a fraction of biosolids to the composting facility, which is not shown in this figure.

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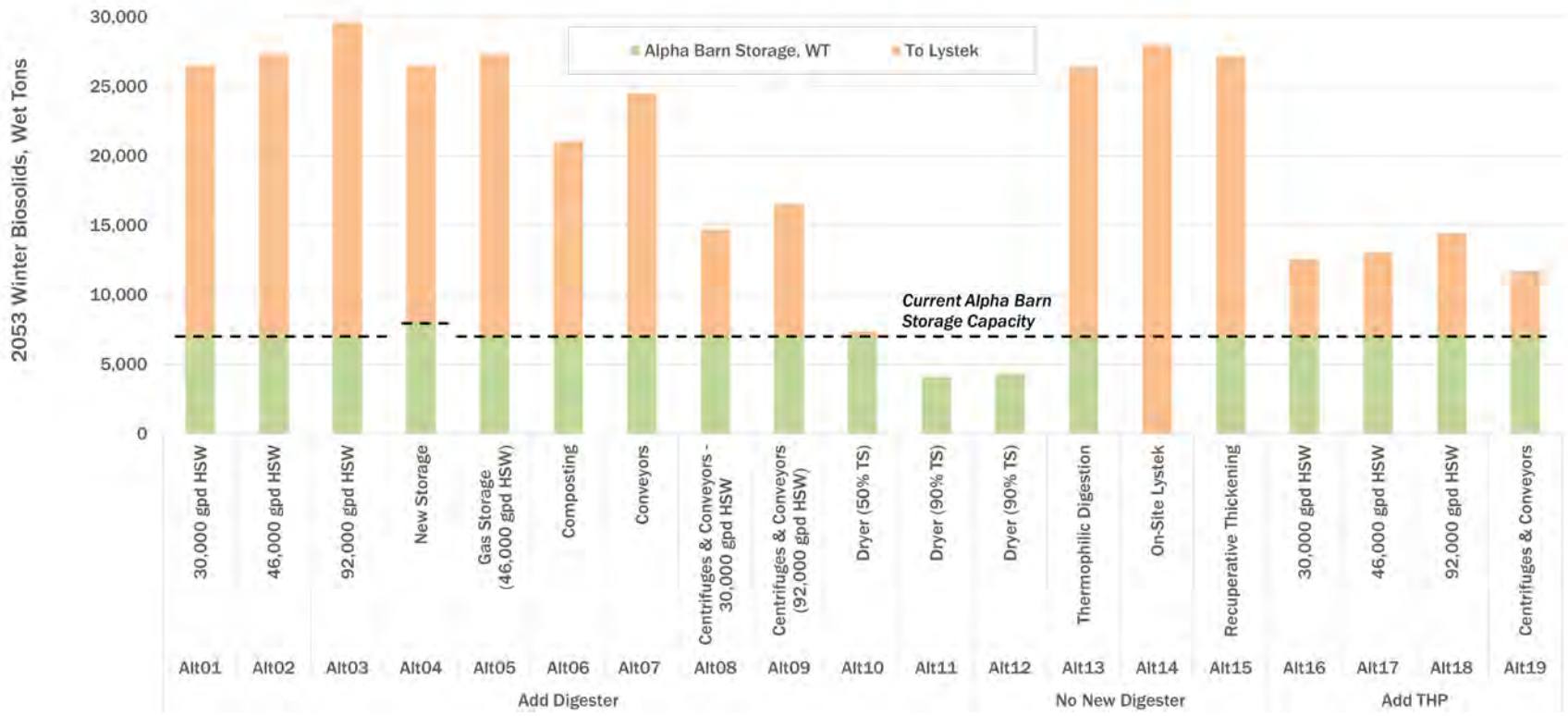


Figure 5-4. 2053 biosolids storage and 2053 biosolids diverted to Lystek

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5.1.4 Digester Gas and Electricity Production

The total digester gas produced for each alternative is shown in Figure 5-5. As shown, the alternatives that receive 92,000 gpd of HSW (Alts 03, 09, and 18) produce the largest rate of digester gas. However, it should be noted that the digester gas treatment system's existing capacity is currently exceeded in all alternatives.

In terms of electricity production and engine capacity, the City will have sufficient engine capacity through 2053, as shown in Figure 5-6. Electricity production was determine based on biogas use in the engine without NG blending.

5.1.5 Natural Gas Usage

The NG required for each alternative is shown in Figure 5-7. It should be noted that NG blending was not considered in the cogeneration engines, and digester heating demand was met using recycling heat from CHP. The greatest NG demand is seen in the thermal dryer options (Alts 10, 11, and 12). As noted previously, the heat demand of the thermal dryers does not include recycling of heat from CHP but assumes NG as the auxiliary fuel for operation. The NG demand shown in the THP alternatives represents the NG demand in the steam boilers for producing steam required for THP. The NG demand of these alternatives will significantly impact GHG emissions at the plant and is discussed in more detail in Section 6 (Refined Alternatives Analysis). About 3.2 million British thermal units per hour (MMBTU/hr) of heat generation from CHP engines was modeled as leftover heat. If used for thermal dryers or THP, the NG demands shown in Figure 5-7 would be lower.

5.2 Capital, Annual, and Lifecycle Cost Results

Capital, annual, and lifecycle costs were estimated for each alternative. Capital and annual costs were estimated in accordance with methodology discussed in Sections 4.2.1 and 4.2.3. The lifecycle costs were evaluated based on methodology discussed in Section 4.4.4 and included a 30-year analysis period.

5.2.1 Capital Cost Estimates

Capital project cost estimates are considered AACE Class 5 estimates (-50 percent, +100 percent). As such, capital cost estimates in this document should be used for planning-level cost scope or to evaluate alternatives in design conditions.

It should be noted that all initial alternatives include new gravity belt thickeners to address current capacity limitations. Additionally, Alts 01–11 include the construction of a new digester to address current capacity limitations. In the scenario where land application is limited in the future based on biosolids production, the cost to acquire additional acreage for land application is included in capital cost. The alternatives where this cost is applied is detailed in Section 4.3. Capital costs associated with Lystek (Alt 14) assumes new infrastructure required to pump biosolids from LTP to the new Lystek facility. The capital cost estimates for the initial alternatives are outlined in Figure 5-8.

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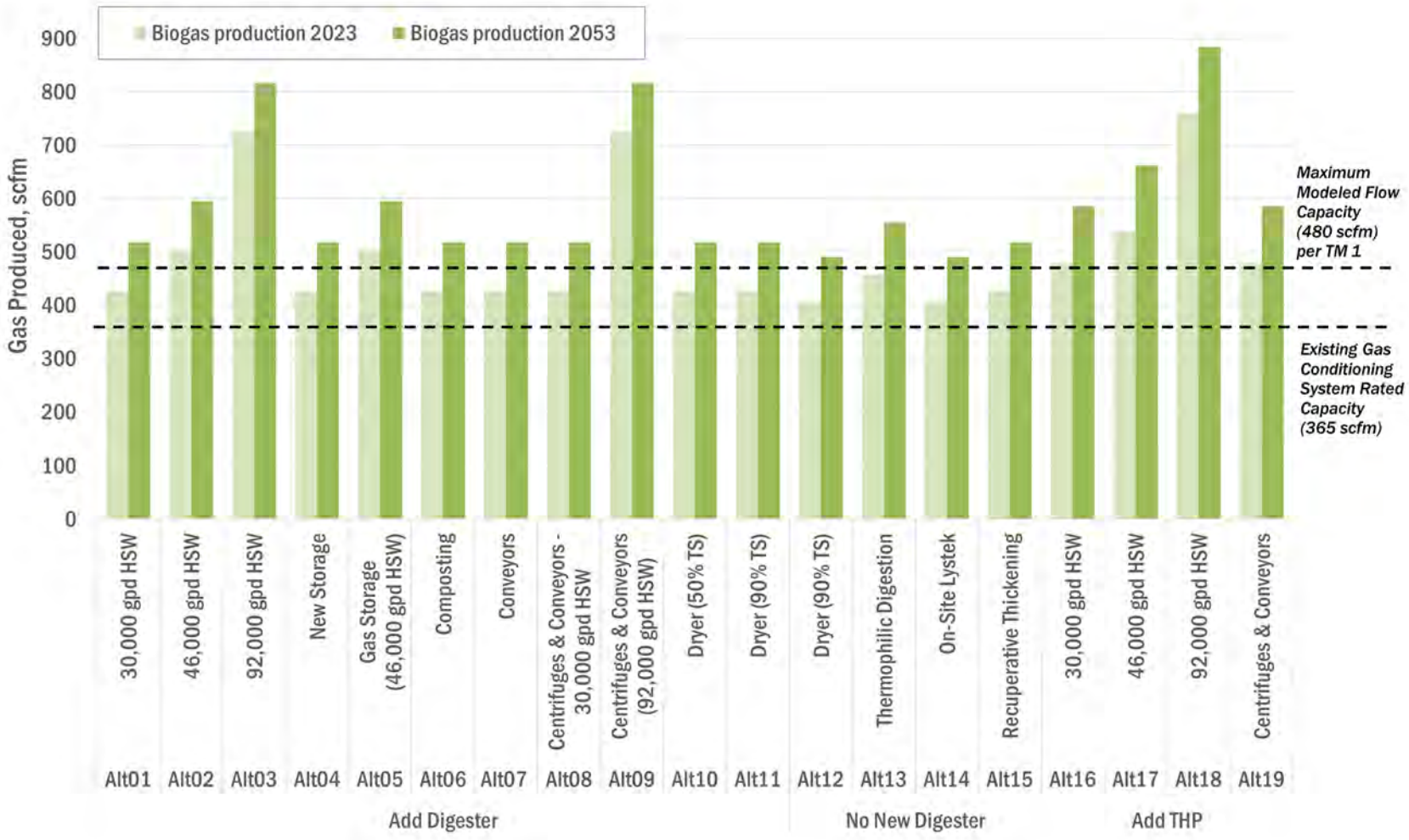


Figure 5-5. Biogas production predictions for initial alternatives

scfm = standard cubic feet per minute

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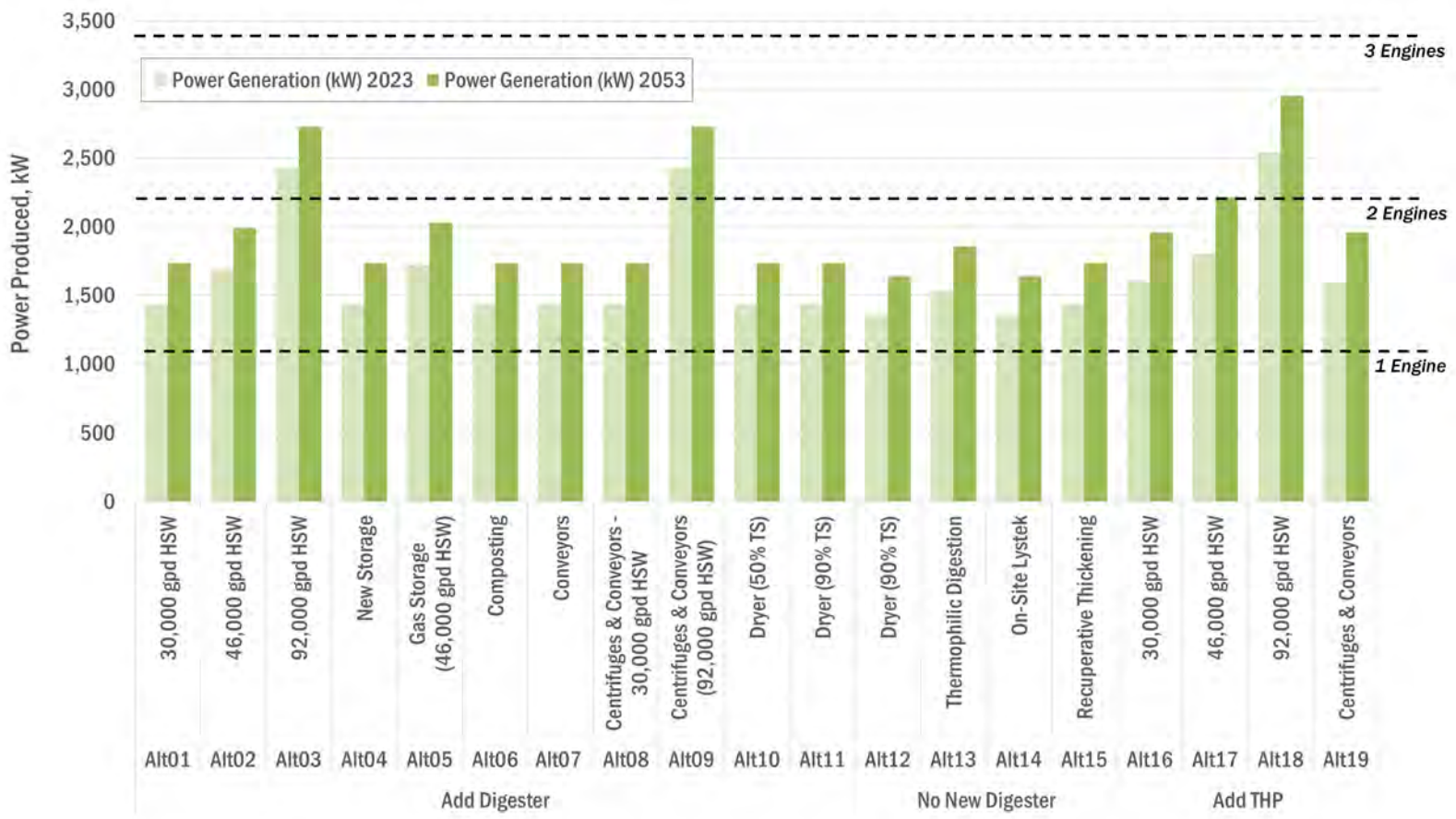


Figure 5-6. Power generation predictions for initial alternatives

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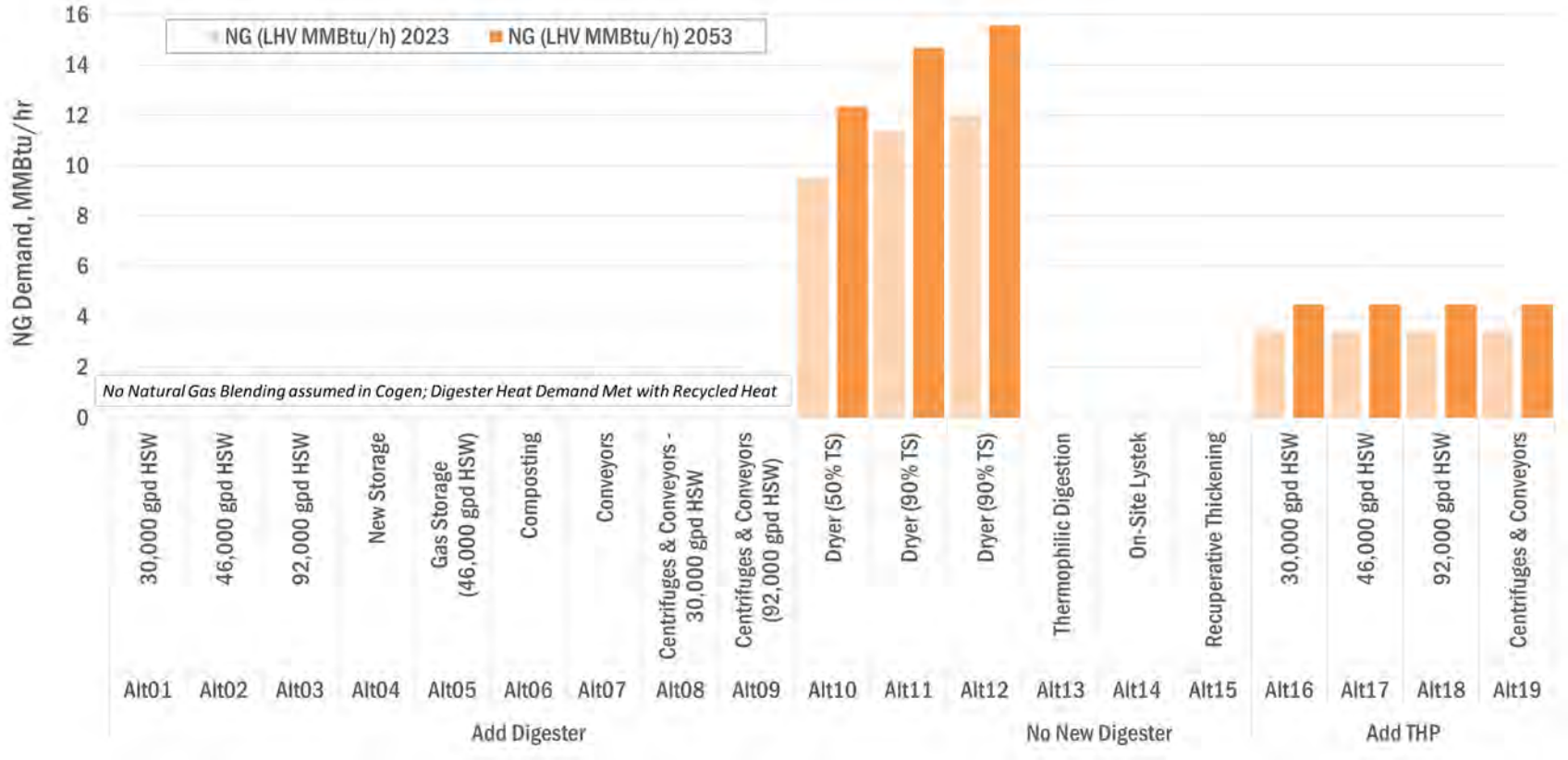


Figure 5-7. Natural gas demand for initial alternatives

Initial alternatives analysis assumes CHP engine heat can be used for thermophilic digestion.

LHV = Lower Heating Value

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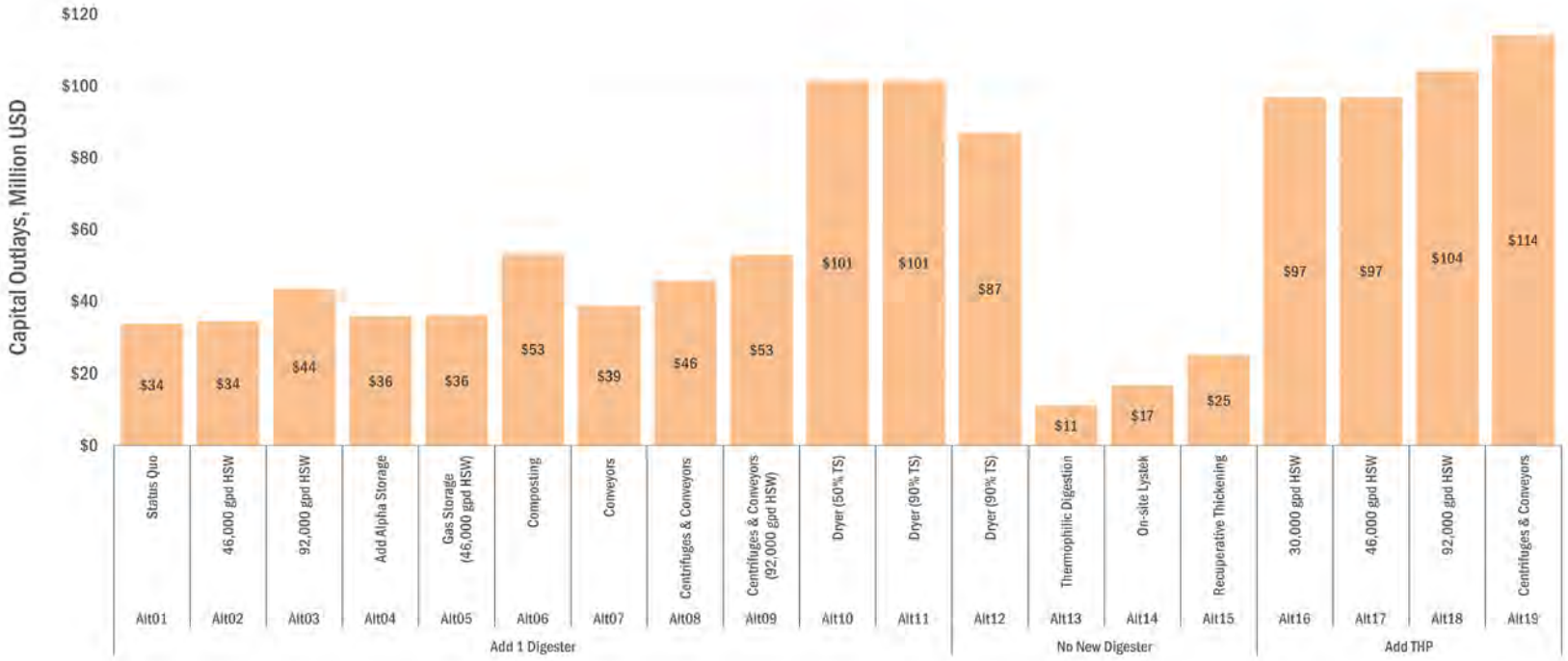


Figure 5-8. Capital cost breakdown for initial alternatives

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5.2.2 Annual Costs and Benefits

Where possible, LTP operating cost estimates are based on actual operating parameters and unit costs. Cost information was received from the City on staffing and labor rates, NG, electricity, chemical (polymer/lime), and biosolids trucking/disposition costs. Unit cost for these assumptions are tabulated in Attachment C. Figure 5-9 outlines the operating cost, benefits, and R&R cost over the 30-year lifecycle.

Benefits for each alternative include electricity demand charge offset from the cogeneration engines, electricity offset from cogeneration, and tipping fee revenues from HSW receiving. Additional revenue is included for the sale of composted product in the composting alternative (Alt 06). Annual O&M costs are a summation of operation costs, which include electricity, NG, biosolid management and hauling, chemicals, labor cost, and Lystek cost. R&R costs are based off an assumed 3 percent of total capital cost.

As outlined in Figure 5-9, alternatives that include receiving 92,000 gpd of HSW (Alts 03, 09, and 18) have the largest benefit due to the increase gas production and tipping fee revenue. Annual O&M costs are comparable among all alternatives; however, alternatives that produce a drier end-use product (Alt 08 through Alt 12) have lower annual O&M costs due to the reduction in annual biosolids management and hauling costs and the cost for biosolids diverted to Lystek. The composting alternative (Alt 06) has the highest annual O&M cost.

5.2.3 30-year Lifecycle Costs

The initial alternatives analysis results are presented in the form of bar charts that show the stacking of capital costs, operational costs, and the overall lifecycle costs, as seen in Figure 5-10. The operational costs include all O&M costs, repair and replacement costs, and any associated benefits. The stacked bars add up to the lifecycle costs over the 30-year planning period for each alternative. Table 5-1 quantifies the operating costs (including operations plus R&R costs minus cogeneration benefits), capital costs, and lifecycle costs for all alternatives for comparison.

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Figure 5-9. Operating cost and benefit breakdown over 30-year lifecycle analysis

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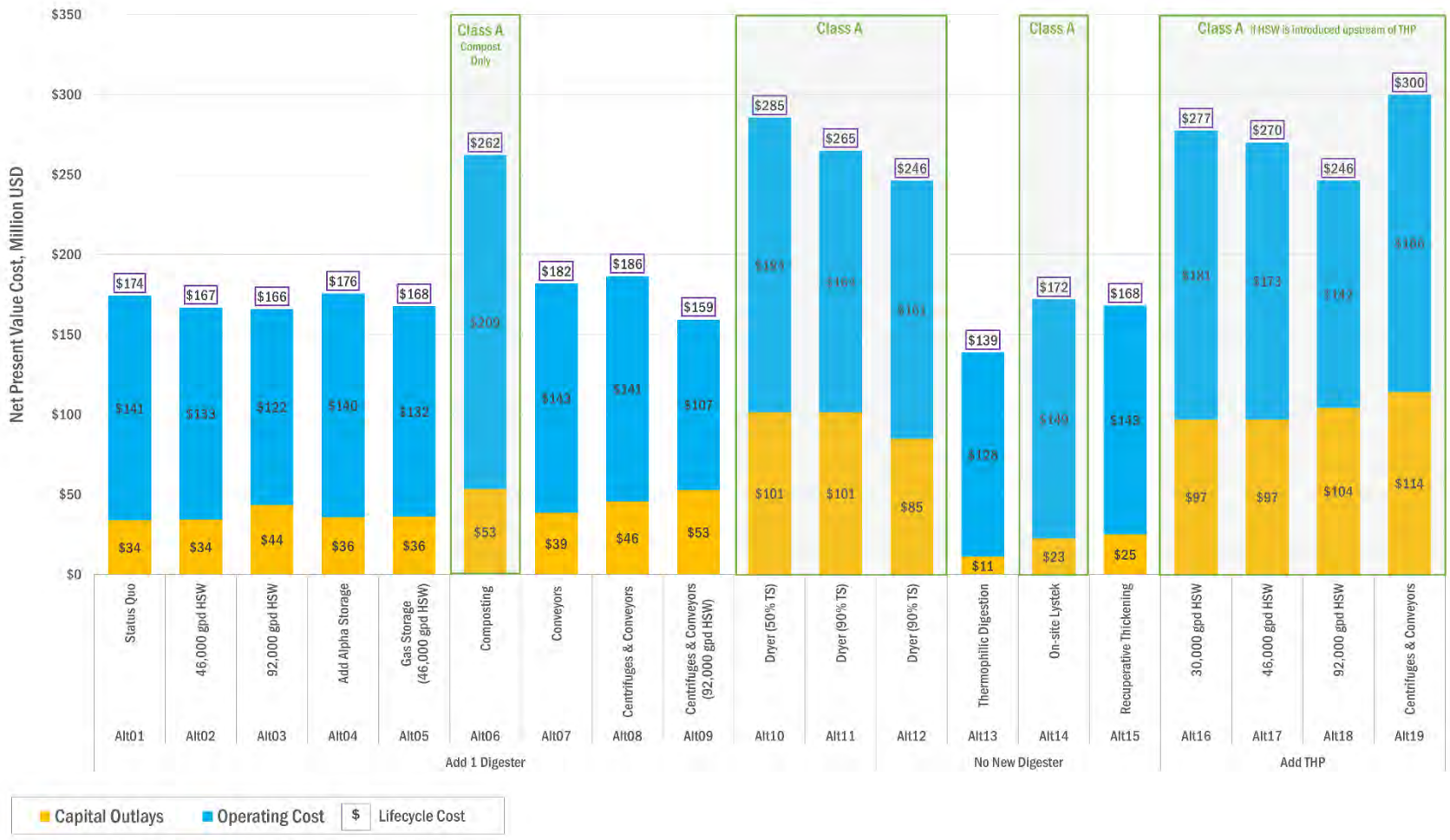


Figure 5-10. Summary of lifecycle cost analysis, including capital and operating lifecycle costs

Initial alternatives analysis included common capital cost items, including new GBT, Selective Catalytic Reduction, and upgraded biogas conditioning system.

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Table 5-1. Net Present Cost 30-year Lifecycle Breakdown ($ millions)				
Alt Number	Alternative Description	NPV Operating Cost[a]	NPV Capital Outlays[a]	Lifecycle Cost[a]
Alt01	Status Quo	$141	$34	$174
Alt02	46,000 gpd HSW	$133	$34	$167
Alt03	92,000 gpd HSW	$122	$44	$166
Alt04	Add Alpha Storage	$140	$36	$176
Alt05	Gas Storage	$132	$36	$168
Alt06	Composting	$209	$53	$262
Alt07	Conveyors	$143	$39	$182
Alt08	Centrifuges & Conveyors	$141	$46	$186
Alt09	Centrifuges & Conveyors (92,000 gpd HSW)	$107	$53	$159
Alt10	Dryer (50% TS)	$184	$101	$285
Alt11	Dryer (90% TS)	$164	$101	$265
Alt12	Dryer (90% TS)	$162	$87	$249
Alt13	Thermophilic Digestion	$128	$11	$139
Alt14	On-site Lystek	$145	$17	$162
Alt15	Recuperative Thickening	$143	$25	$168
Alt16	THP 30,000 gpd HSW	$181	$97	$277
Alt17	THP 46,000 gpd HSW	$173	$97	$270
Alt18	THP 92,000 gpd HSW	$142	$104	$246
Alt19	THP Centrifuges & Conveyors	$186	$114	$300

a. Negative values reflect savings; Positive values reflect costs.

5.3 Non-economic Evaluation Results

As seen in Figure 5-11 the non-economic scoring distribution is relatively small; however, some alternatives stand out. On-Site Lystek (Alt 14) received the highest non-economic score of 66 due to high compatibility with the end-use market, low impacts to current O&M operations, and its plant compatibility, assuming Lystek's facility is located across the street at the existing composting site. It should be noted that any risk in contracting with a third party such as Lystek is not captured in this evaluation.

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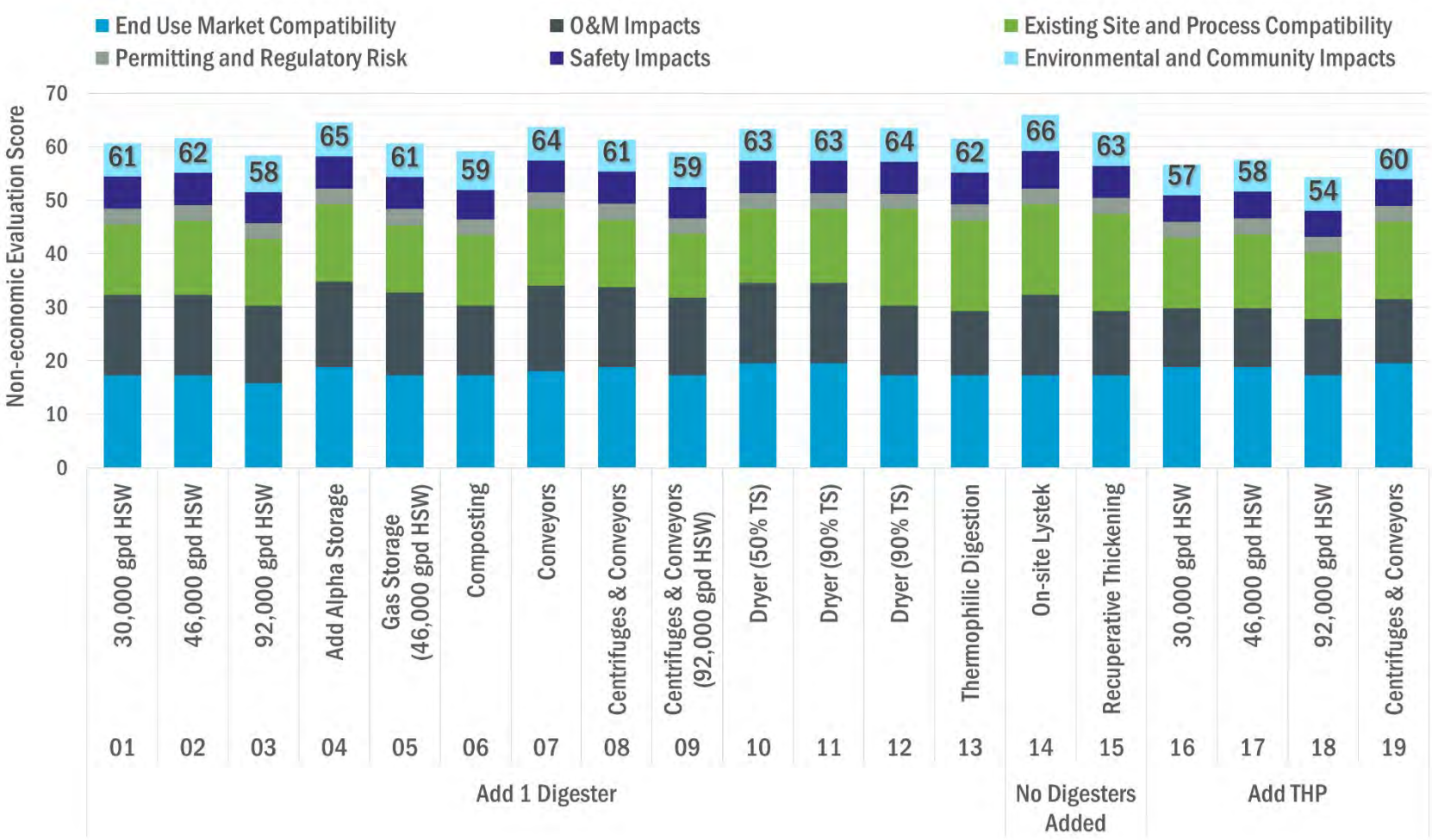


Figure 5-11. Non-economic scoring for initial alternatives

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Adding Alpha Barn storage (Alt 04) received the second highest score of 65, followed by the conveyors alternative (Alt 07) and thermal dryers alternative (Alt 12) with scores of 64. The lowest scoring alternative is the THP + 92,000 gpd of HSW (Alt 18).

5.4 Shortlisted Alternatives for Refined Analysis

By combing the process predictions and the economic and non-economic scoring results, certain alternatives were eliminated and more refined alternatives were developed for further analysis. Figure 5-12 summarizes the overall lifecycle costs, non-economic criteria scoring, 2053 wet tons produced annually, and which alternatives produce a Class A biosolids product.

Three alternatives were selected to carry forward into the refined alternatives analysis for comparison against the status quo. These alternatives are:

- **Centrifuges & Conveyors (Alt 08)** – Selected because it reduces biosolids hauling costs due to a drier end-use product. This alternative is limited to producing a Class B biosolids product.
- **Thermal Drying (Alt 12)** – Thermal drying with a sub-15-d SRT mesophilic digestion process was selected as a Class A biosolids-producing alternative that defers new digester construction. Thermal drying alternatives have higher non-economic scores than THP alternatives and has simpler operational requirements than THP. This alternative meets the City's goals of establishing a flexible biosolids management program and is compatible with pyrolysis, which is a newer technology with the potential for PFAS mitigation; however, thermal drying would be required upstream of pyrolysis.
- **On-Site Lystek (Alt 14)** – Selected because it had the highest non-economic score and would provide a Class A biosolids outlet for the City.

The three shortlisted alternatives were refined into various sub alternatives that would be evaluated in the refined analysis.

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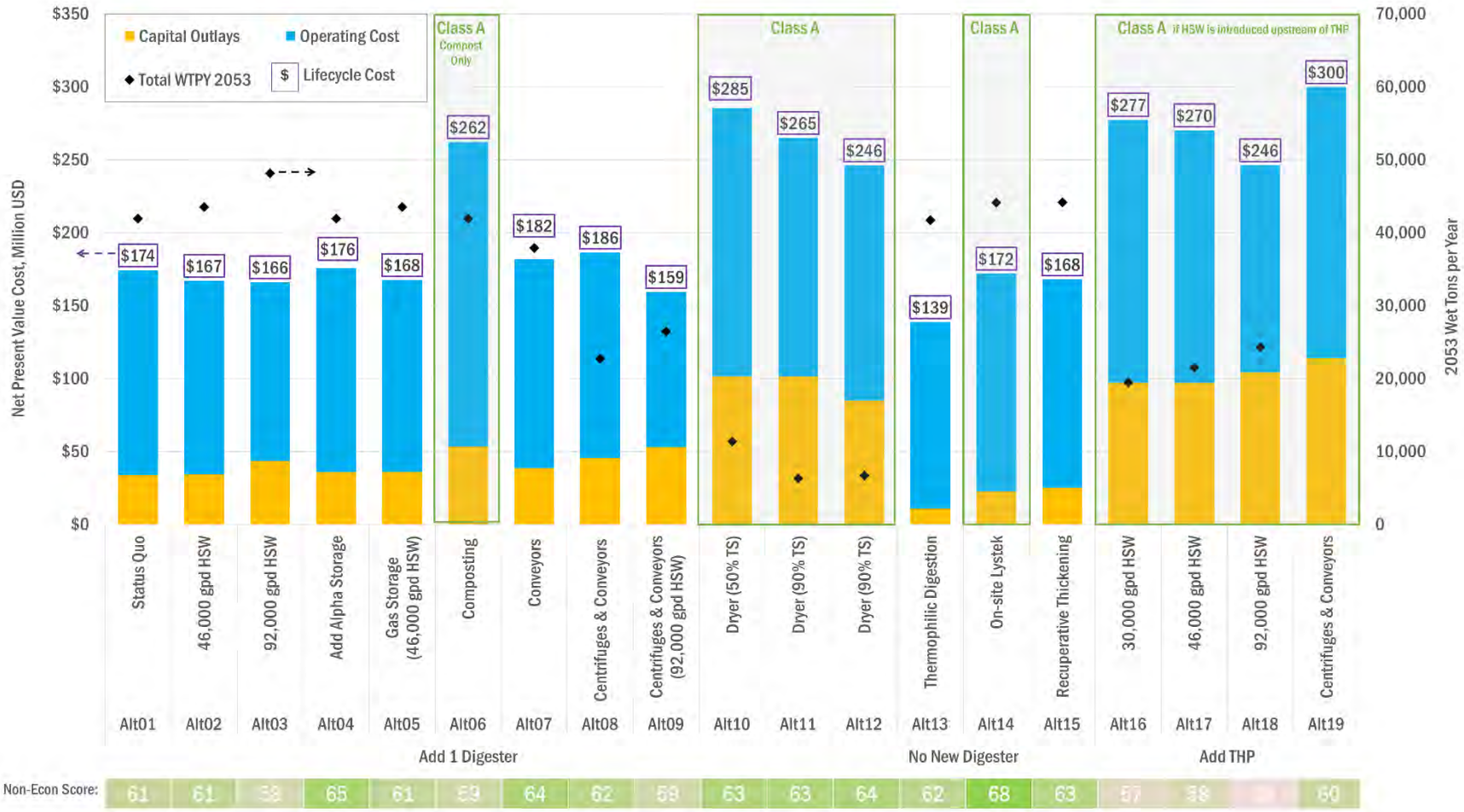


Figure 5-12. Summary of initial alternatives' lifecycle costs, biosolids production, and non-economic scoring

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Section 6: Refined Alternatives Analysis

After the initial round of alternatives analysis, the City identified three shortlisted options to progress to the refined alternatives analysis. This section describes the process used to refine these three options for a more accurate evaluation of facility site layout requirements, lifecycle costs, and non-economic scoring. Funding opportunities, GHG emission estimates, phasing and implementation options, and impacts on upstream and downstream processes were also evaluated for the refined alternatives.

6.1 Refined Alternatives Overview

Three alternatives were identified to progress to the refined alternatives analysis. These alternatives were compared against the City's status quo. Sub-alternatives were identified to investigate process performance and lifecycle cost sensitivity to changes in HSW receiving (Alts 08a-08d) and dryer facility costs with improved dewatering performance (Alts 12a-12b). Alternatives 08c and 08d were evaluated to answer whether additional HSW or addition of food waste have an economic benefit for the City. Each refined alternative addresses existing capacity limitations, includes processes that logically integrate with the LTP, and provides flexible solutions for current and future management of the City's biosolids.

A key differentiator between alternatives is their impact on digestion capacity limitations. Alternatives 01, 08a, 08b, 08c, and 08d require a new digester to be constructed to address capacity limitations identified in TM1. Alternatives 12a, 12b, and 14 provide technologies downstream of digestion that would achieve a Class A product regardless of the anaerobic digester SRT, which defers the need to design and build a new digester to approximately 2043. The refined alternatives are summarized in Table 6-1 and shown in Figure 6-1.

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Table 6-1. Refined Alternatives Descriptions	
Alternative Number	**Alternative Description[a]**
New Digester Required	
08a	• Status quo mesophilic digestion • No HSW • Centrifuges installed to provide a dryer end-use product • Conveyors installed to replace existing cake pumps
08b	• Status quo mesophilic digestion • 30,000 gpd HSW • Centrifuges installed to provide a dryer end-use product • Conveyors installed to replace existing cake pumps
08c	• Status quo mesophilic digestion • 92,000 gpd HSW • Centrifuges installed to provide a dryer end-use product • Conveyors installed to replace existing cake pumps
08d	• Status quo mesophilic digestion • 30,000 gpd HSW and 30,000 gpd food waste • Centrifuges installed to provide a dryer end-use product • Conveyors installed to replace existing cake pumps
New Digester Deferred to 2043	
12a	• Sub-15-day SRT mesophilic digestion • 30,000 gpd HSW • Thermal drying installed to create dryer end-use product at 90 percent TS • Achieves Class A
12b	• Sub-15-day SRT mesophilic digestion • 30,000 gpd HSW • Centrifuges installed to provide dewatering before drying and to reduce dryer sizing (25 percent TS instead of 15 percent TS to dryer) • Thermal drying installed to create dryer end-use product at 90 percent TS • Achieves Class A
14	• Sub-15-day SRT mesophilic digestion • 30,000 gpd HSW • All biosolid sent to regional Lystek facility located on site • Achieves Class A

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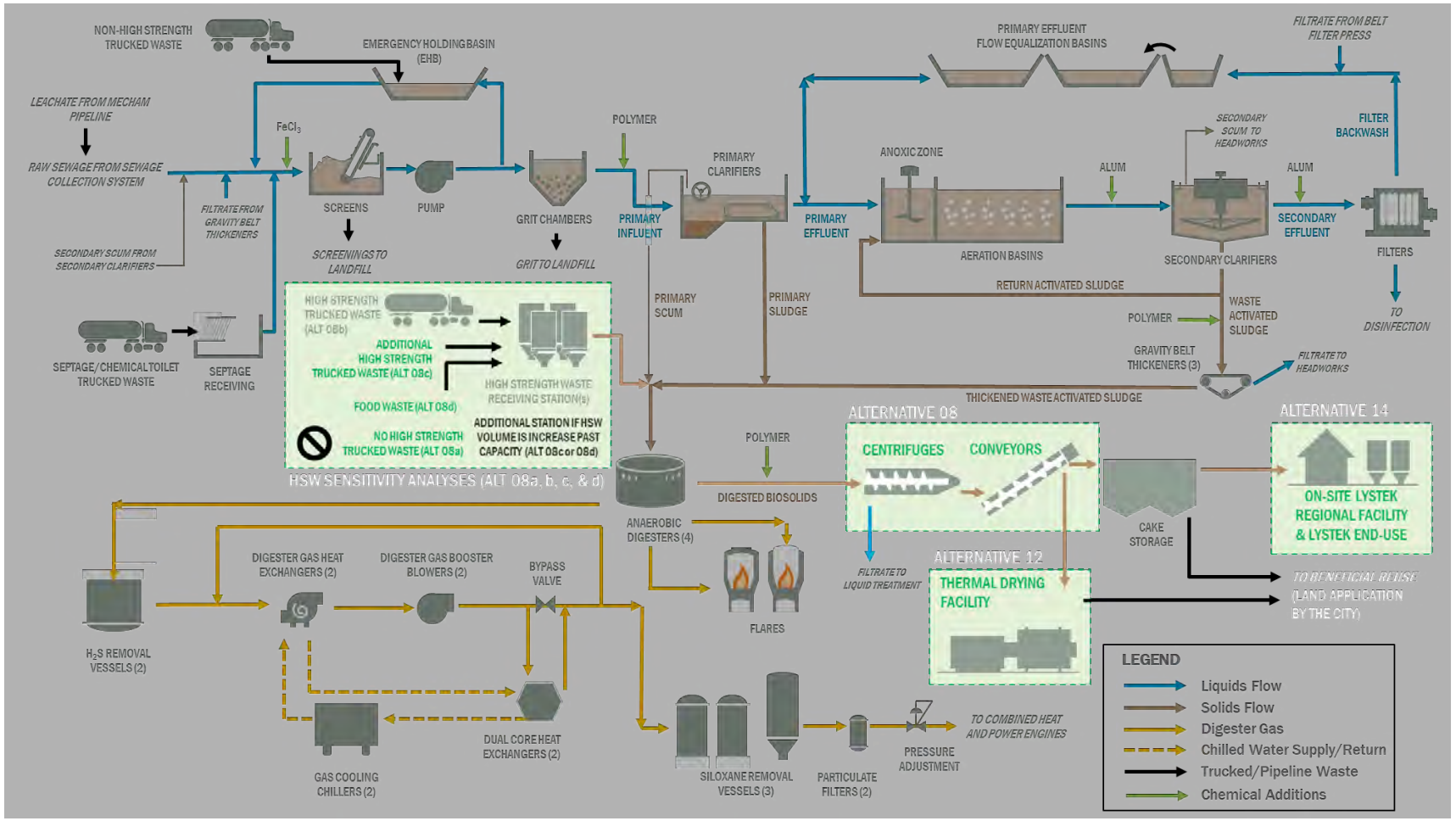


Figure 6-1. LTP process flow diagram with refined alternatives highlighted

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6.2 Facility Layout Requirements

Facility layouts for each alternative are shown in Figure 6-2. These projects include demolition of existing BPs and progressive cavity pumps in order to install centrifuges and conveyors, construct a new anaerobic digester and extend the existing digester gallery, and construct a new thermal drying facility.

Requirements and assumptions for facility layouts shown in Figure 6-2 are described below:

- **New Anaerobic Digester and Gallery (Alts 01, 08, 12, 14)** – This project assumes a new anaerobic digester is built adjacent to the existing digesters and the existing below-grade gallery is extended. Process piping to convey digester feed sludge, digested sludge, and biogas would be constructed. A new electrical room would be installed adjacent to the new digester and above the new gallery. The existing road would require demolition and repaving, and a new pipeline installed as part of the tertiary improvements project would be needed to avoid or accommodate the below-grade gallery construction. The gallery would also be constructed to accommodate the option for future digestion capacity expansion by adding the sixth digester.
- **New Centrifuges & Conveyors (Alt 08)** – This project assumes existing BPs are demolished and replaced with centrifuges to achieve a dryer biosolid product (about 25 percent TS is assumed in this analysis). Progressive cavity pumps would be demolished and replaced with conveyors to transport biosolids to the storage hoppers. The existing dewatering structural supports, process piping, electrical and instrumentation controls, and biosolids chute would need to be modified to accommodate new centrifuges. Drier biosolids would not be compatible with the existing progressive cavity pumping system and piping. Conveyors would be installed and supported. A more robust support structure would be required to configure conveyors so that biosolids are dropped into the top of the existing hoppers, and equipment should be considered to mitigate bridging. Alternative technologies could be considered in lieu of centrifuges or conveyors and may have comparable lifecycle costs, assuming biosolids dryness is around 25 percent TS. For example, installing piston pumps could be considered in lieu of conveyors.
- **New Thermal Dryer Facility (Alt 12)** – This project assumes a new thermal dryer facility will be constructed that includes biosolids storage, thermal belt dryers, dried product pelletizer and storage, odor control, an electrical room, and a boiler room. The facility would enclose all major process equipment except biosolids storage, dried pellet storage, and the biofilter. The facility footprint shown in Figure 6-2 is based on two trains of Huber's belt dryer, which would be necessary for biosolids with about 15 percent TS. The current configuration of the new thermal dryer facility may conflict with flood protection dikes that are planned for construction in 2024 through 2025; The thermal dryer facility site plan would need to be refined or potentially relocated depending on the dryness of biosolids sent to thermal drying and the technology that is selected. The dryer alternatives assumed more dry tons of biosolids can be stored at the Alpha Barn due to a drier final product. Cost to waterproof and install fire suppression was included, but the approach to managing dried biosolids pellets should be refined if the thermal dryer alternative is advanced. Dried biosolids pellets can ignite if wetted.
- **New On-site Regional Lystek Facility (Alt 14)** – This project assumes the entire composting site is leased to Lystek for a 20-year period. Lystek would use the site footprint and add their process equipment, biosolids storage, and Lystek product storage, as necessary. The site would require access for haulers delivering biosolids from other facilities. The City would be contracted to send a minimum biosolids quantity to Lystek and pay Lystek the price for treatment. Lystek would provide a small amount of profit-sharing to the City, but for the purposes of this analysis the revenue from Lystek is assumed as negligible. This analysis assumes process piping would be constructed to transport biosolids to the Lystek facility. This requires a new pumping station to convey biosolids at 15 percent TS. Biosolids storage would be Lystek's responsibility. Alternatively, the City could transport biosolids to Lystek via truck, which is similar to how biosolids were conveyed to the composting facility.

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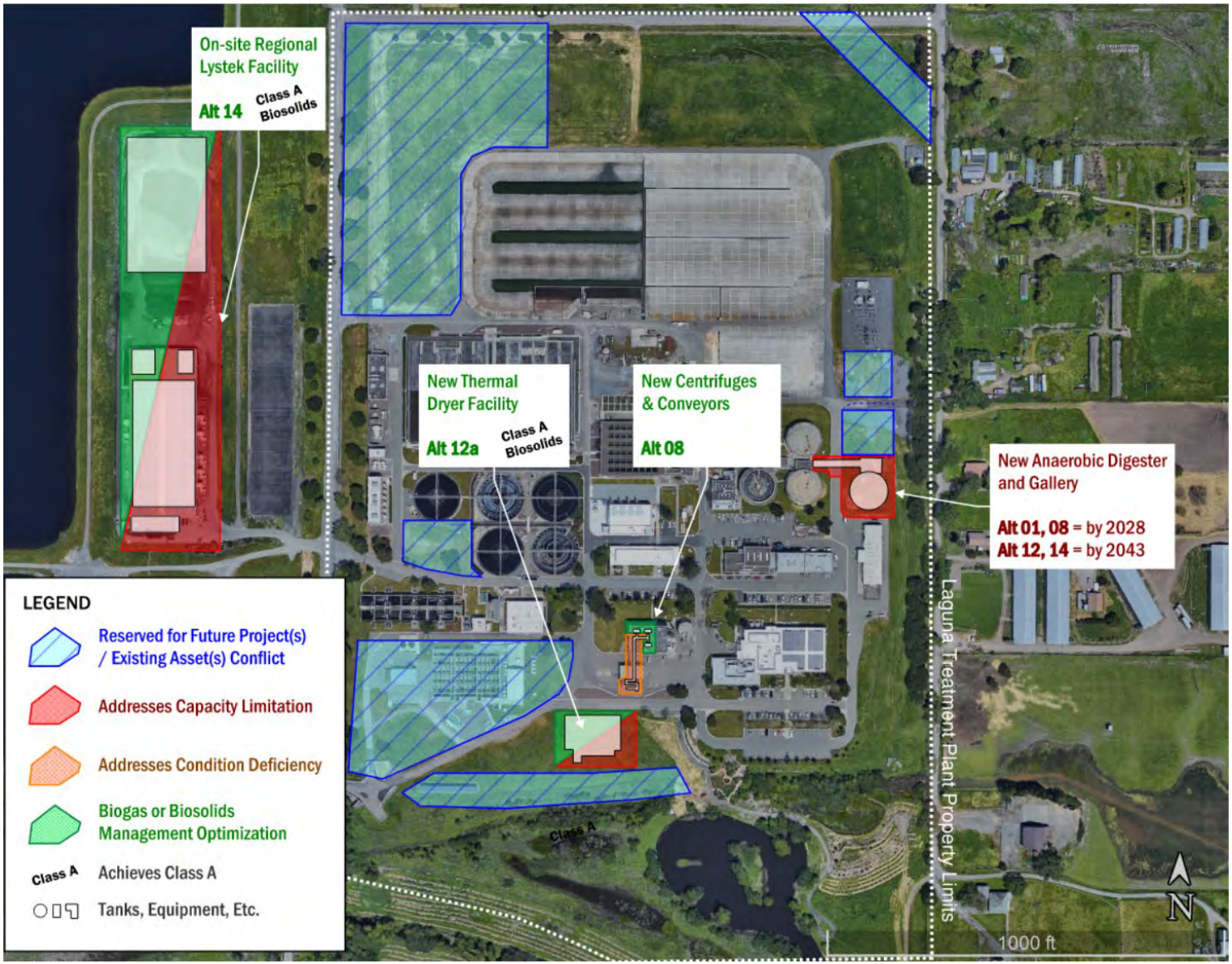


Figure 6-2. Facility layouts for improvements included in refined alternatives analysis

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6.3 Refined Process Performance Predictions

Process performance predictions for each of the refined alternatives were calculated and are summarized in the follow sections.

6.3.1 Annual Wet Tons Produced

Figure 6-3 shows annual wet tons produced by the LTP. The WTPY will increase as HSW receiving is increased, as shown in the Centrifuge & Conveyors alternatives (Alts 08a-08d). As anticipated, the thermal drying alternatives (Alts 12a and 12b) produce the driest end-use product and therefore produce the lowest WTPY.

6.3.2 Land Application Limitations

As outline in Figure 6-4, by expanding the HSW receiving facility for the Centrifuge & Conveyor Alts 08c and 08d, the biosolids allowed for land application will exceed the Class B limitations in 2023. In 2053, all alternatives will exceed the allowable land application nitrogen limits for Class B, meaning the City will be required to either purchase more land or use a different end-use outlet, such as Lystek. Additionally, in 2053 the 90 percent thermal drying alternatives (Alt 12a and Alt 12b) will exceed the Class A land application limitation under the current assumptions. The on-site Lystek alternative (Alt 14) produces biosolids that are land applied; however, this quantity is not shown in Figure 6-4 since end-use would be the responsibility of Lystek.

6.3.3 Winter Storage Summary

The City is unable to land apply biosolids during the winter season; therefore, it must store biosolids during this period. Any biosolids that exceed storage limitations are hauled to Lystek for further processing. Figure 6-5 and Figure 6-6 outline the predicted 2023 and 2053 winter biosolids stored and hauled to Lystek.

As outlined in Figure 6-5 and Figure 6-6, the biosolids that exceed the existing Alpha Barn storage capacity will be directed to Lystek for the Centrifuge & Conveyors Alternatives (08a-08d) starting in 2023; however, the drier biosolids product produced from Alts 08a-08d will reduce the amount of biosolids directed to Lystek compared to the status quo, where approximately 10,300 WTPY are currently sent to Lystek. Additionally, the amount of biosolids directed to Lystek is anticipated to increase between 2023 and 2053. The thermal dryer alternatives (Alts 12a and 12b) are the only alternatives that eliminate the need to direct any biosolids to Lystek through 2053.

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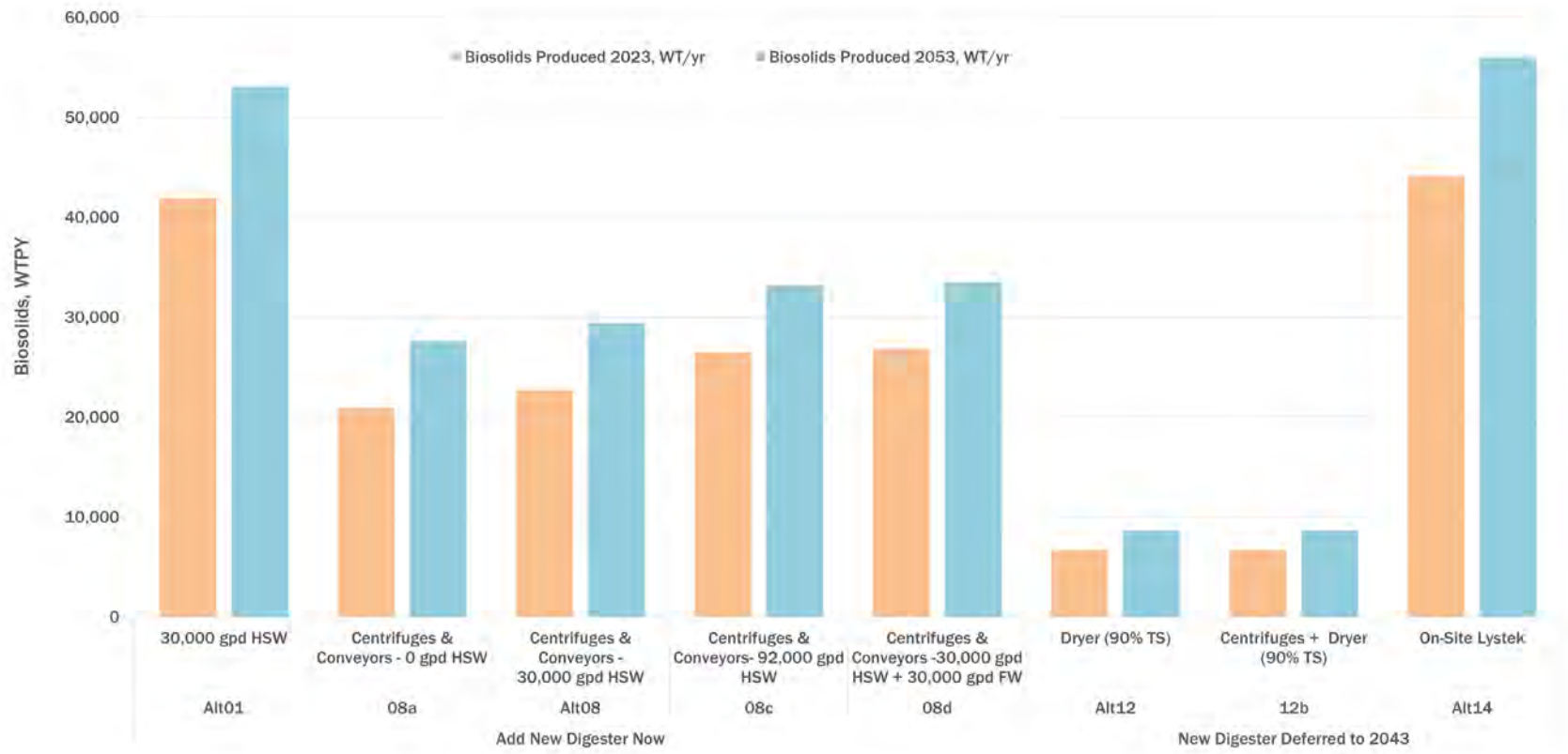


Figure 6-3. Annual biosolids production predictions for refined alternatives

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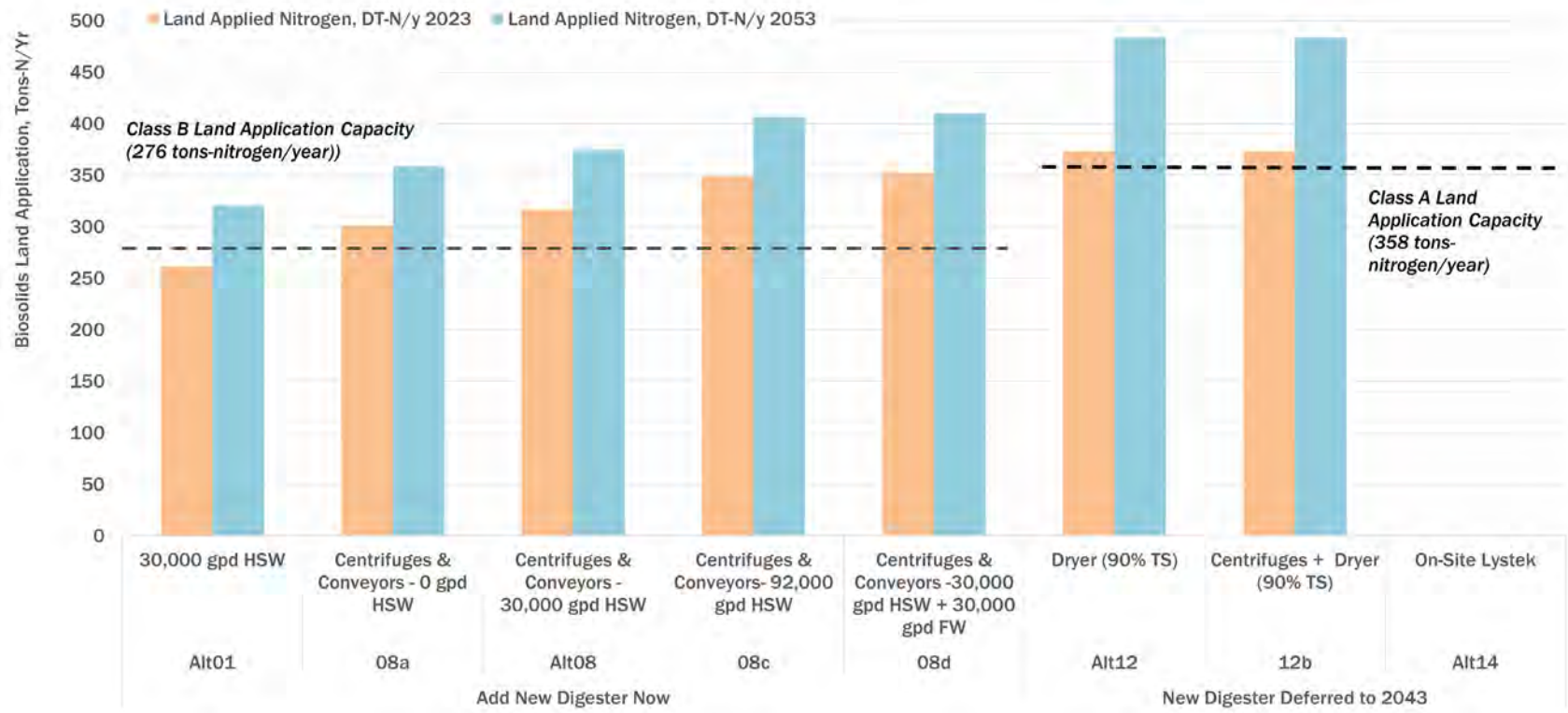


Figure 6-4. Biosolids land application predictions and limitations for refined alternatives

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Figure 6-5. 2023 winter biosolids production predictions for refined alternatives

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Figure 6-6. 2053 winter biosolids production predictions for refined alternatives

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6.3.4 Digester Gas and Electricity Production

The total digester gas produced for each alternative is shown in Figure 6-7. As outlined in the figure, the alternatives that receive higher volumes of HSW produce the largest rate of digester gas. However, it should be noted that the existing capacity of the digester gas treatment system is currently exceeded in all alternatives, and expansion of the digester gas treatment system is assumed for all alternatives.

In terms of electricity production and engine capacity, the City will have sufficient engine capacity through 2053, as outline in Figure 6-8. Electricity production was determine based on biogas use in the engine without NG blending.

6.3.5 Natural Gas Demand

The NG required for each alternative is shown in Figure 6-9. As mentioned, NG blending was not considered in the cogeneration engines, and digester heating demand was met using recycling heat from CHP. The thermal dryer options (Alts 12a and 12b) are the only alternatives that required NG. The NG demand of Alt 12b is lower than Alt 12a due to the addition of the centrifuges upstream of the dryers. By dewatering the solids to 25 percent TS before thermally drying, the amount of energy needed to thermally dry the solids is significantly decreased, also as shown in Figure 6-9.

As noted previously, the heat demand of the thermal dryers does not include recycle of heat from CHP but assumes NG as the auxiliary fuel for operation. The NG demand of these alternatives will significantly impact GHG emissions at LTP and is discussed in more detail in Section 6.7.

6.4 Refined Non-economic Evaluation

The non-economic evaluation was updated to compare refined alternatives (Figure 6-10). Alternatives demonstrating the impact of accepting additional HSW, accepting food waste, or adding centrifuges upstream of thermal dryers were added to the refined alternatives. Addition of food waste was evaluated to have a score similar to the status quo. Acceptance of food waste negatively affected safety and O&M impacts due to greater truck traffic and regulatory compliance associated with a new waste type being accepted; however, acceptance of food waste has a positive environmental and community impact.

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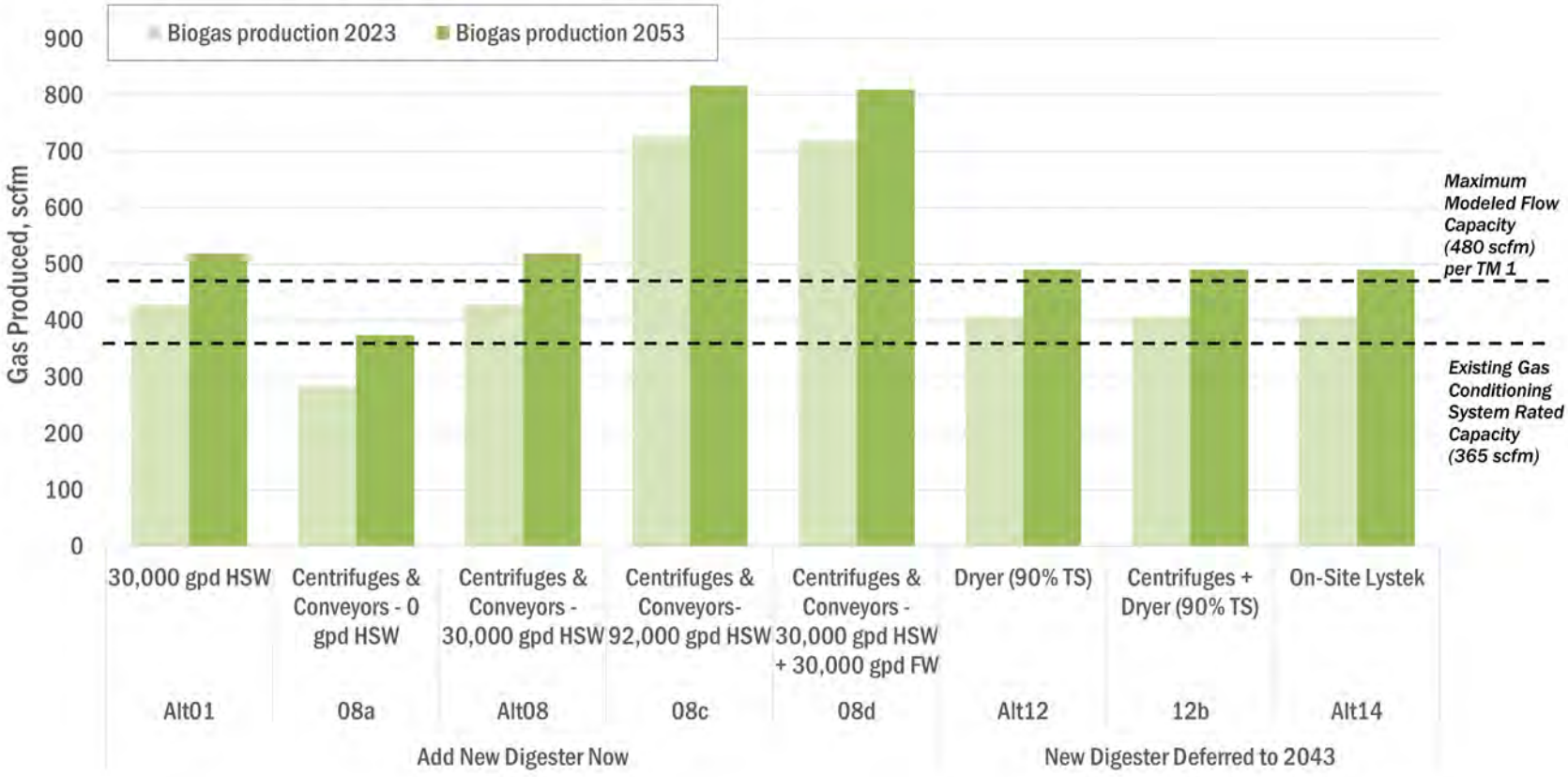


Figure 6-7. Biogas production predictions for refined alternatives

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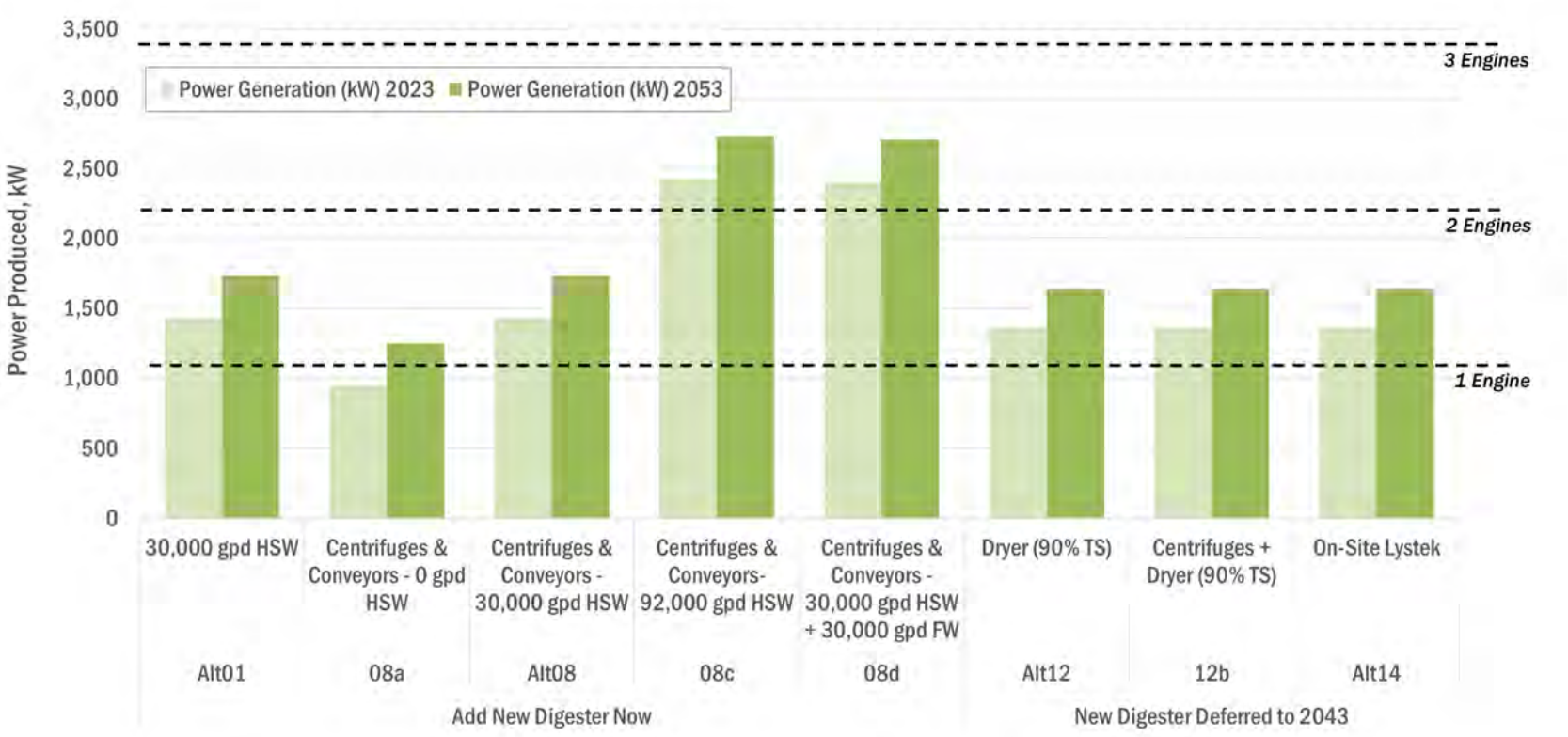


Figure 6-8. Power generation predictions for refined alternatives

Kw = kilowatt

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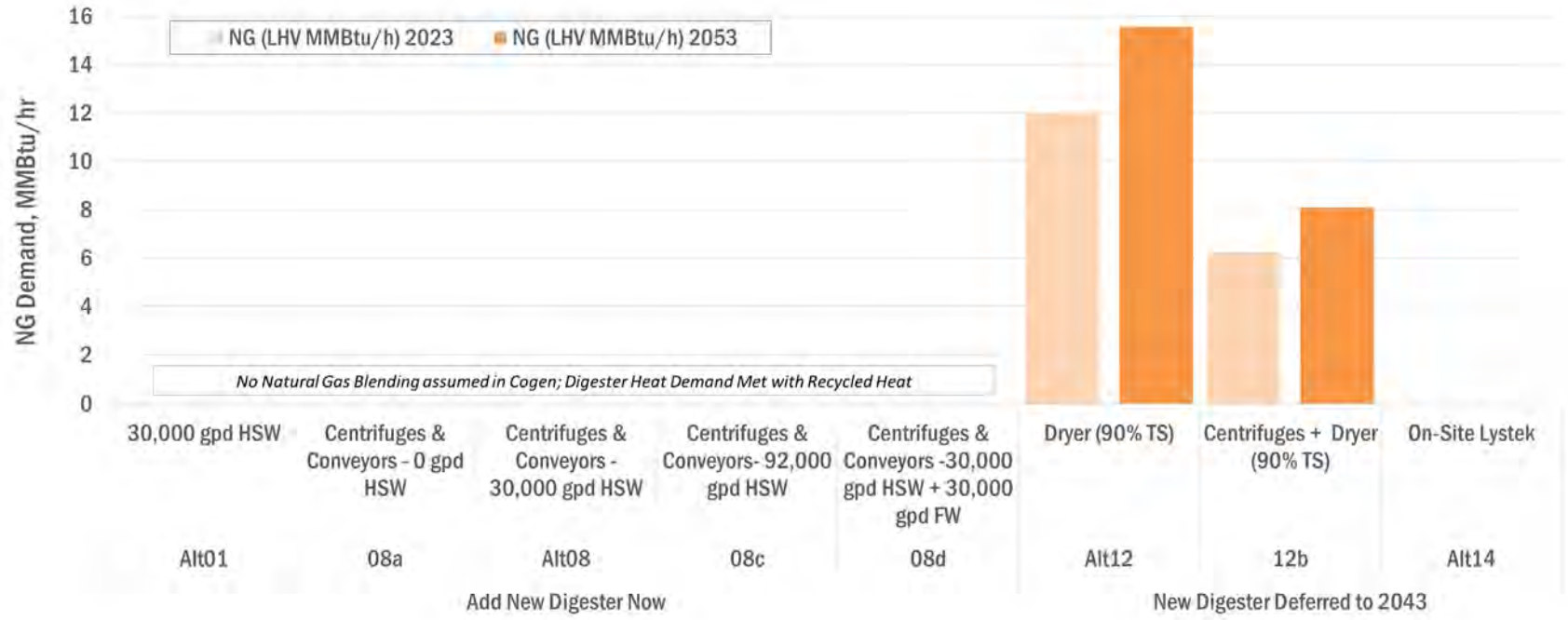


Figure 6-9. Natural gas demand predictions for refined alternatives

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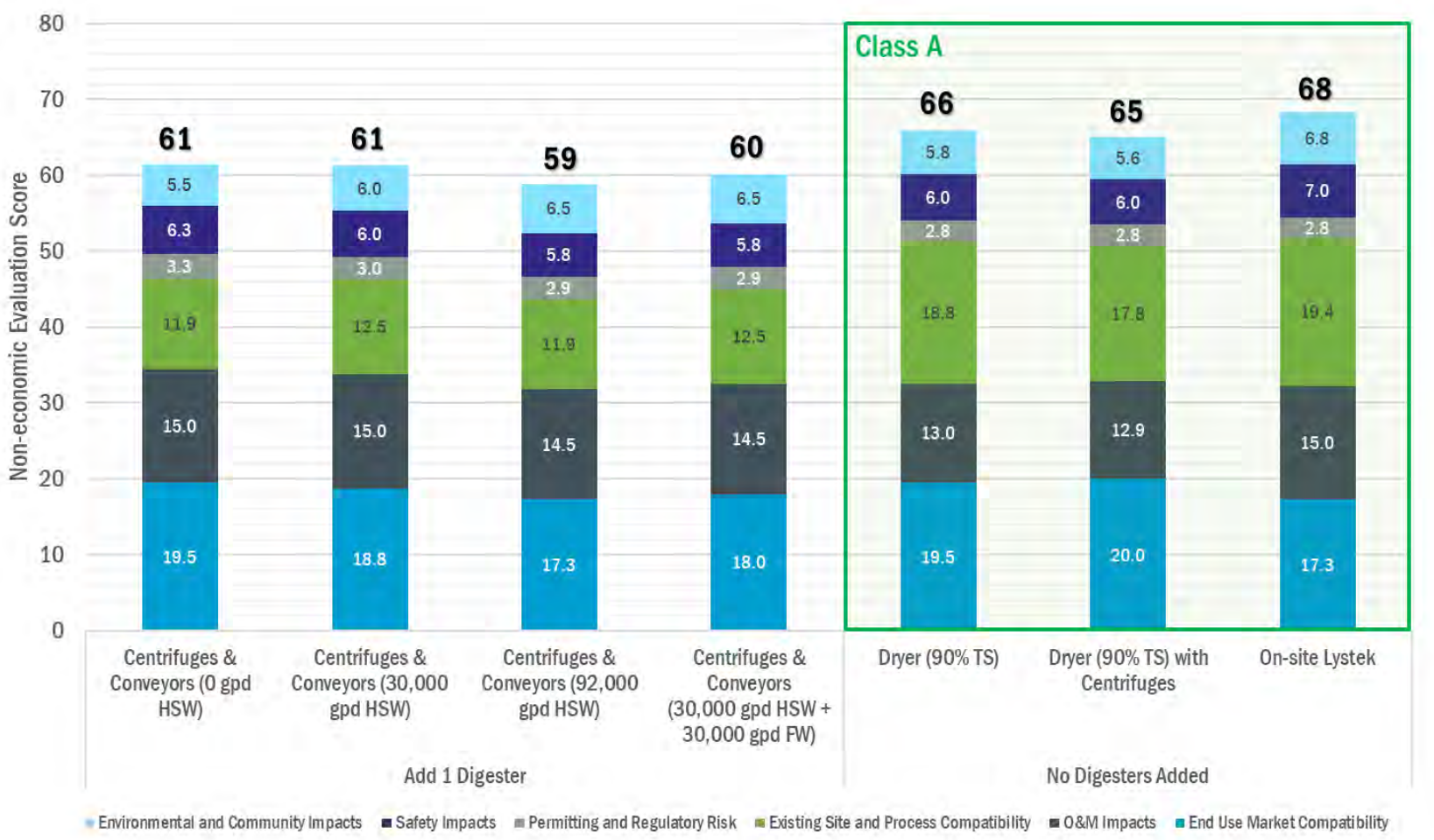


Figure 6-10. Non-economic scoring for refined alternatives

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The non-economic scoring of the dryer alternative with a centrifuge was rated similarly to the scoring of the dryer alternative without a centrifuge. Negative environmental impacts from GHG emissions affected the environmental and community impact score, but end-use market compatibility and existing site and process compatibility were rated high due to the potential of this alternative to mitigate heavy reliance on Lystek during winter months.

The option with centrifugation has a lower score due to negative O&M impacts and a lower environmental score, i.e., more energy to operate centrifuges.

The On-site Lystek alternative has the highest non-economic score because of the positive effects on safety, existing site and process compatibility, O&M impacts, and environmental and community impacts. Diverting biosolids to Lystek minimizes City staff requirements to transport and store biosolids, which decreases City staff's use of machinery. The potential monetary risk associated with Lystek is not captured in the non-economic evaluation.

6.5 Refined Capital, Annual, and Lifecycle Cost Results

Capital, annual, and lifecycle cost estimates were updated for the refined alternatives analysis. Capital cost estimates previously completed based on parametric estimates leveraging recent project experience and budgetary quotes were updated based on vendor budgetary proposals for refined alternatives equipment. Annual costs were updated based on performance predictions from refined alternatives, and the lifecycle costs were updated based on the refined capital cost and annual cost estimates.

6.5.1 Refined Capital Cost Estimates

Refined capital costs estimates were further developed using unit and equipment costs from RS Means, quantity take-offs from planning-level facility drawings, and budgetary proposals for this project as described in Section 4.2.1 and shown in Attachment D. Table 6-2 shows construction and project cost estimates for projects included the refined alternatives analysis. Cost estimates for projects that were not included in the refined alternatives analysis but that address capacity constraints or condition deficiencies are shown in Attachment D.

Table 6-2. Total Construction and Project Cost Estimates (-50%/+100%)

Project	Total Construction Cost (million $)	Total Project Cost (million $)
New Anaerobic Digester and Gallery	$ 17.9	$ 23.7
Replace BPs with Centrifuges	$ 10.1	$ 13.7
Replace Dewatering Progressive Cavity Pumps with Conveyors	$ 6.0	$ 8.4
New HSW Receiving (identical to current receiving station)	$ 2.4	$ 4.0
On-Site Regional Lystek Facility (70,000 WT/yr)	$ 8.4	$ 11.3
Thermal Dryer (15 percent cake) – two units with pre-engineered building	$ 66.2	$ 86.1
Thermal Dryer (25 percent cake) – one unit with pre-engineered building	$ 43.4	$ 56.4
Water Proofing to Alpha Barn	$ 4.4	$ 5.5

Note: All costs presented in 2023 dollars, rounded to nearest $1,000.

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Total construction cost includes markups for contractor profit and overhead and represents the City's cost at end of construction. Total project costs include costs for design and construction services. Total construction and project capital costs developed for the refined alternatives analysis are considered AACE Class 5 estimates with an accuracy range of -50 percent to +100 percent.

Total project cost estimates shown in Table 6-2 were summed to calculate the capital cost associated with each alternative listed in Table 6-3. Table 6-3 outlines the project costs included in the overall capital outlays for each alternative.

Table 6-3. Description of Projects included in Refined Alternatives Capital Outlays

	New Digester Required Now					New Digester Deferred to 2043		
Project Description	01	08a	08b	08c	08d	12a	12b	14
New Anaerobic Digester and Gallery Now	✓	✓	✓	✓	✓			
New Anaerobic Digester and Gallery in 2043						✓	✓	✓
Replace BPs with Centrifuges		✓	✓	✓	✓		✓	
Switch Dewatering Progressive Cavity Pumps to Conveyors		✓	✓	✓	✓			
Construct New HSW Receiving Facility				✓	✓			
Install Thermal Dryer (15 percent cake) – two units						✓		
Install Thermal Dryer (25 percent cake) – one unit							✓	
Water Proofing to Alpha Barn						✓	✓	
Develop On-Site Lystek Facility (70,000 WT/yr capacity)								✓
Additional Land Acquisition Anticipated in Next 30 Years	✓	✓	✓	✓	✓			

Figure 6-11 shows the total present cost outlay assumed for each refined alternative. The Lystek alternative has the lowest lifecycle cost, followed by the status quo. Centrifuges and conveyors increase capital costs, and thermal dryers increase capital costs significantly.

6.5.2 Refined Annual Costs and Benefits

The refined results are presented in the form of bar charts that show the stacking of operational cost, R&R cost, and benefits, as seen on Figure 6-12. The operational costs include all O&M costs, R&R costs, and any associated benefits.

Benefits for each alternative include electricity demand charge offset from the cogeneration engines, electricity offset from cogeneration, and tipping fee revenues from HSW receiving. Annual O&M cost are a summation of operation costs, which include electricity, NG, biosolid management and hauling, chemicals, labor cost, and Lystek cost. R&R costs are based off an assumed 3 percent of total capital cost.

As outlined in Figure 6-12, the centrifuge and conveyors (Alt 08b) alternative has similar operating costs and benefits to the status quo (Alt 01). Additional HSW or food waste receiving (Alts 08c and 08d, respectively) provide the largest benefit due to the increase gas production and tipping fee revenue. These alternatives also increase treatment and hauling costs. The dryer alternatives (Alt 12a and Alt 12b) have higher overall operating costs relative to either status quo (Alt 01) or centrifuges and conveyors (Alt 08b). The annual O&M costs associated with on-site Lystek have the lowest R&R costs but relatively high biosolids management due to the assumed contract pricing with Lystek.

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6.5.3 Refined 30-year Lifecycle Costs

The refined alternatives' lifecycle costs are shown on Figure 6-13 and quantified in Table 6-4. The results from the refined alternatives analysis suggests that the status quo has the lowest lifecycle cost. Lystek has a similar lifecycle cost, but was quantified as 3 percent higher. The centrifuge and conveyors (Alt 08b) lifecycle cost was 12 percent higher than status quo, and the thermal dryers (Alt 12a and 12b) alternatives were at least 42 percent higher than status quo.

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Figure 6-11. Capital project costs for refined alternatives

Capital costs are presented as net present value

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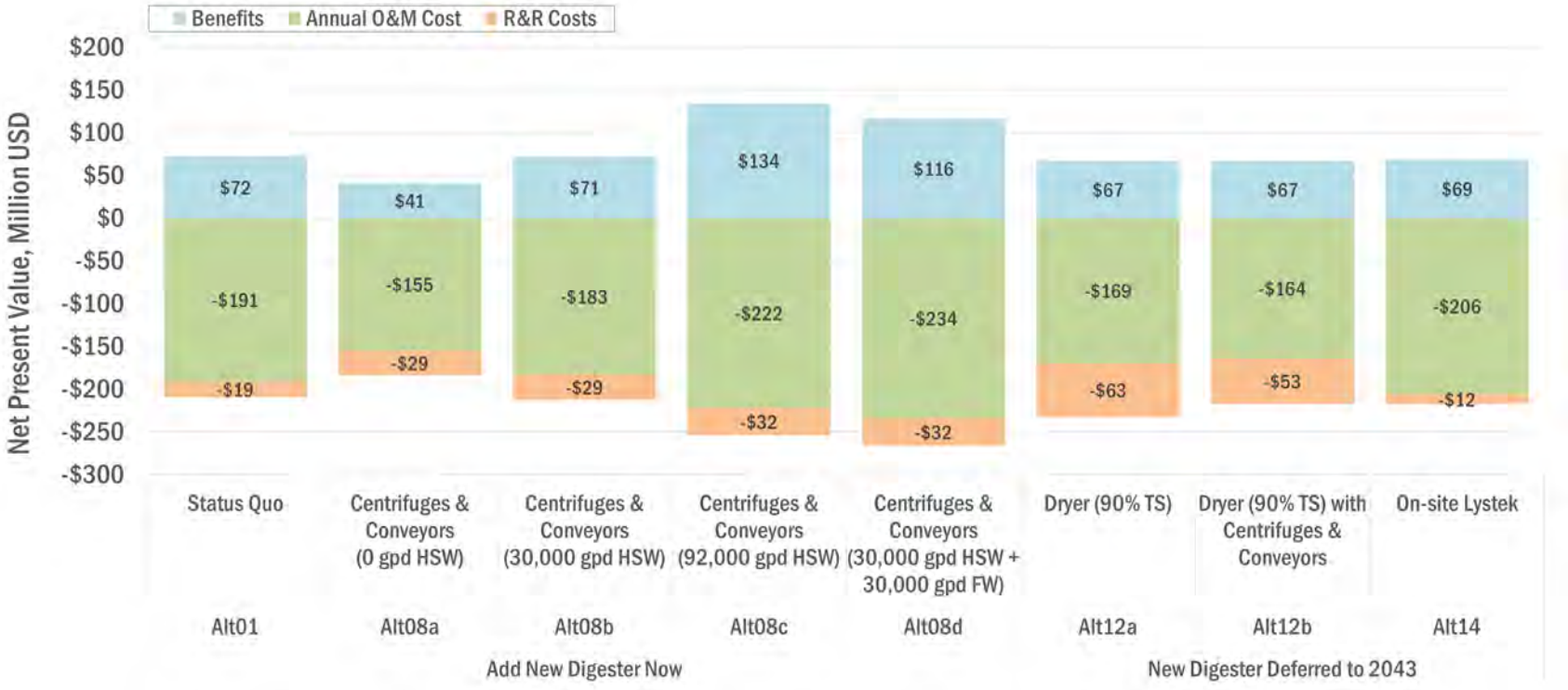


Figure 6-12. 30-year net present value annual cost breakdown

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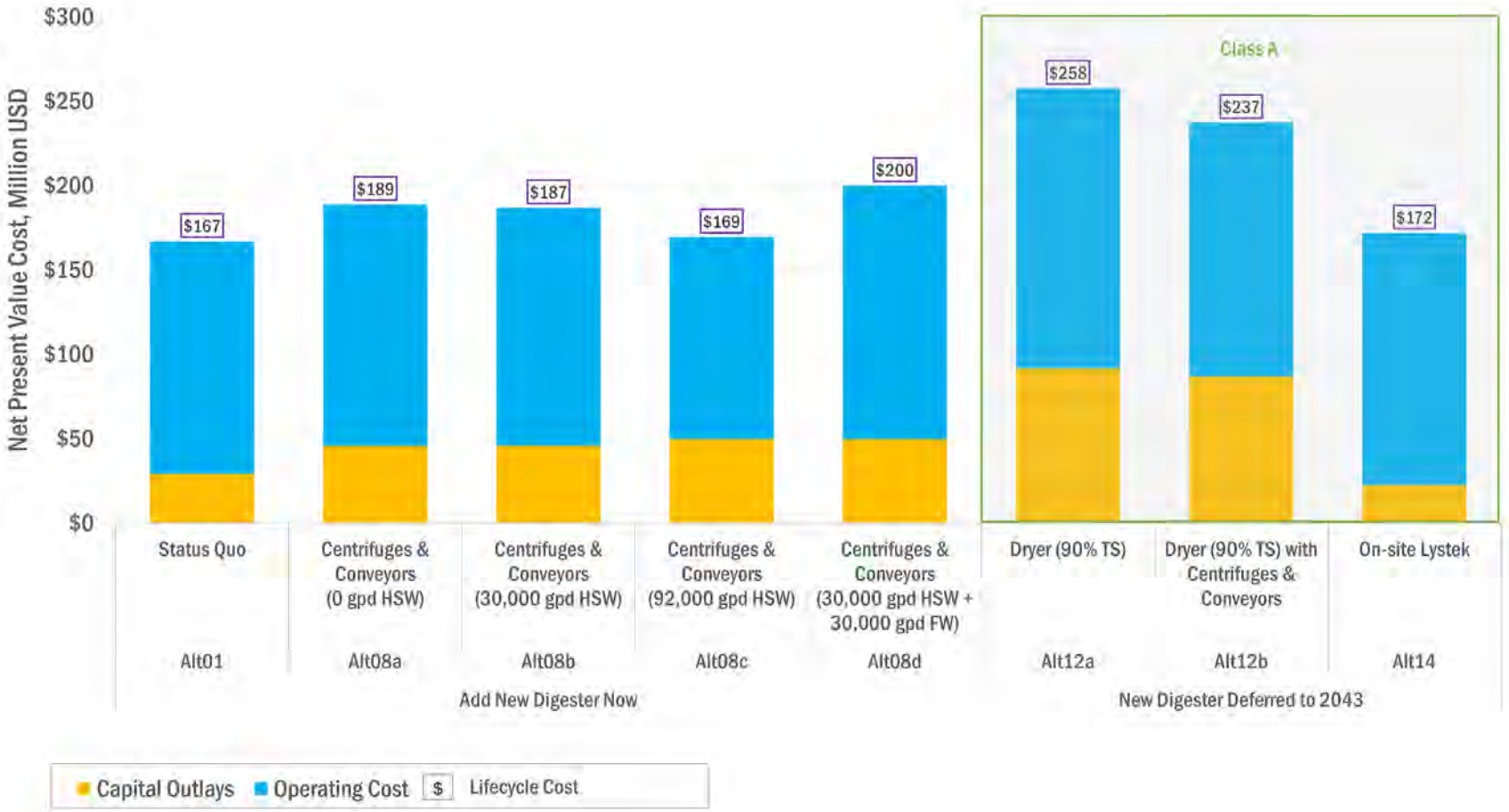


Figure 6-13. 30-year NPV capital, operating, and lifecycle costs

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Table 6-4. Net Present Cost 30-year Lifecycle Breakdown ($ million)				
Alt Number	Alternative Description	NPV Operating Cost	NPV Capital Outlays	Lifecycle Costs
Alt01	Status Quo	$138	$29	$167 (--)
Alt08	Centrifuges & Conveyors – 0 gpd HSW	$143	$46	$189 (+13%)
Alt08	Centrifuges & Conveyors – 30,000 gpd HSW	$141	$46	$187 (+12%)
Alt08	Centrifuges & Conveyors – 92,000 gpd HSW	$120	$50	$169 (+2%)
Alt08	Centrifuges & Conveyors – 30,000 gpd HSW and 30,000 gpd FW	$150	$50	$200 (+20%)
Alt12	Thermal Dryers (90 percent TS) – 30,000 gpd HSW	$166	$92	$258 (+54%)
Alt12	Centrifuges and Thermal Dryers (90 percent TS) – 30,000 gpd HSW	$150	$87	$237 (+42%)
Alt14	Lystek – 30,000 gpd HSW	$149[a]	$23[b]	$172 (+3%)[c]

a. *If Lystek contract pricing increases at twice the rate of general escalation, then NPV operating cost would be $200 million.*
b. *If the City elects to truck biosolids to the Lystek facility, then NPV capital costs would be $11.2 million.*
c. *Sensitivity analyses suggest NPV lifecycle costs could range between $153 and $223 million, depending on Lystek contract pricing and whether a dedicated biosolids pumping system is constructed. Lifecycle costs do not account for potential revenue the City could receive from liquidating City-owned land in South County and cost savings from terminating contracts with farmers.*

The considerations below should be evaluated with lifecycle costs and non-economic results from the refined alternatives analysis:

- **Digestion capacity increase, thermal dryers, or on-site Lystek is required to address anaerobic digestion capacity constraints when one digester if offline** – Anaerobic digestion was evaluated to be at capacity when one digester is taken offline for routine cleaning and maintenance. The City cleans one digester every other year. Considering this cleaning schedule, the City will need to continue recuperative thickening operations or utilize Lystek to address capacity constraints until a new digester is installed. A new digester is required for the LTP to maintain a minimum 15-day SRT and Class B biosolids compliance without reliance on recuperative thickening. Alternatively, adding a thermal dryer or on-site Lystek could be implemented to achieve Class A biosolids and allow digesters to be operated below a 15-day SRT (e.g., SRT between 12 and 15 days).
- **Installing centrifuges and conveyors now decreases hauling costs and decreases thermal drying facility costs if thermal dryers are installed at a later date** – Installing centrifuges and conveyors in the short term is estimated to provide lifecycle cost benefits to the City due to decreased hauling costs from a drier biosolids product. A sensitivity analysis was completed to compare capital and lifecycle costs between 15 percent and 25 percent TS biosolids being sent to the drying facility. This comparison demonstrated that achieving a drier biosolids from mechanical dewatering results in an overall lower capital cost.
- **If thermal dryers or on-site Lystek are implemented to defer new digester construction, then centrifuges and conveyors are not cost efficient to install at a later date** – If a thermal dryer or on-site Lystek is implemented, then anaerobic digesters could be operated at an SRT at or above 12-day, which is estimated to extend digestion capacity through about 2044 when one digester is offline. This digestion capacity increase is based on projected PS and TWAS loading increases and does not account for HSW, which could still trigger the need for occasional recuperative thickening when one digester is offline for cleaning. Adding a thermal dryer or on-site Lystek does not prohibit addition of a thermal dryer, but implementing either of these alternatives first negates capital and/or annual operating cost savings that would otherwise be provided by installing centrifuges and conveyors for a drier biosolids product.

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- **The On-site Lystek alternative (Alt 14) is sensitive to contract pricing** – Based on previous experience and discussions with Lystek, the contract pricing for biosolids handling at the Lystek facility could change depending on various factors that were not included in this analysis. Due to these unknowns, a sensitivity analysis regarding on-site Lystek contract price was conducted to capture the risks associated with future Lystek pricing and contracting. The sensitivity analysis assumed that Lystek contract pricing escalation would be twice the rate of general escalation. In this scenario, the lifecycle cost increased from $172 million to $223 million. Another sensitivity analysis considered lifecycle costs if infrastructure to pump biosolids to the Lystek facility (assumed to be located on the site of the existing composting facility) were omitted, representing a scenario where the City elects to truck biosolids daily to Lystek's on-site facility. In this scenario, the lifecycle cost decreased from $172 million to $153 million.
- **The HSW sensitivity demonstrates that maximizing HSW provides economic value to the LTP** – The lifecycle cost comparison between Alts 08a through 08c demonstrate lower lifecycle costs when HSW receiving is maximized. However, food waste addition (Alt 08d) does not have a clear positive impact on the lifecycle costs due to lower digestibility from food waste compared to the City's current HSW feedstocks.

6.6 Potential Funding Opportunities

Funding opportunities compatible with potential projects were investigated. Grant opportunities and tax credits can reduce overall project costs and mitigate risk. The Inflation Reduction Act (IRA) and Greenhouse Gas Reduction Fund (GHGRF) are two mechanisms by which the City could receive financing for capital projects.

6.6.1 Inflation Reduction Act Investment Tax Credit

The IRA is the most significant climate legislation in U.S. history and promotes investments in domestic energy production and clean energy in the form of grants, tax credits, rebates, and loans. The IRA covers new and reinstated tax laws that are expanded to include tax-exempt organizations, such as municipalities and water authorities/utilities like the City. There are opportunities to take advantage of the pre-existing Investment Tax Credit (ITC), which was previously only available to tax-paying entities. Additionally, the IRA introduced new energy property categories, one of which is "qualified biogas property." This addition allows ITC funds to be claimed for projects that convert biomass into a gas that is captured for sale or productive use; applicable projects are those for which construction starts on or before December 31, 2024.

The IRA and related guidance suggest that installing new anaerobic digesters and gas conditioning systems are likely eligible for an ITC; however, retrofit projects such as installing a new digester gas storage cover would require further investigation by a licensed tax professional to determine eligibility. Credit values range from 6 percent to 50 percent of eligible project costs based on the following:

- 6 percent base credit rate
- 2 percent base credit bonus for projects meeting domestic content requirements
- 2 percent base credit bonus for projects located in an "energy community" (based on IRS guidance, the City is not in an energy community)
- 5x base credit bonus for projects that meet prevailing wage and apprenticeship requirements

For tax-exempt agencies to receive a direct payment, the domestic content requirements must be met, otherwise the credit is subject to an "applicable percentage," which would reduce the total credit value by 10 percent, assuming construction starts in 2024. Domestic content requires using steel and iron made in the U.S. for all structural components, and 40 percent of manufactured products on a total cost basis.

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Tax credits through the IRA are subject to federal review and approval. BC's input related to whether the project is eligible does not include a legal or tax review and should not be interpreted as legal or financial advice. The City should independently review the IRA opportunity, along with the rules and limitations, with its procurement, legal, and accounting departments. BC does not have control over, nor can it guarantee, acceptability or likelihood of success in securing tax credits or ultimate payout from the Internal Revenue Service. BC is working with a tax advisor to understand the nuances and intricacies of the IRA but recommends the City work with an independent tax advisor if pursuing the ITC.

6.6.2 Greenhouse Gas Reduction Fund

The GHGRF allocates $27 billion to EPA to award competitive grants to mobilize financing and leverage private capital for clean energy and climate projects that reduce GHG emissions. A portion of the GHGRF ($7 billion) must be used to provide financial and technical assistance to low-income and disadvantaged communities to deploy or benefit from zero-emission technologies. The remaining $20 billion of the fund is to be used to provide financial and technical assistance for qualified projects that reduce or avoid GHG emissions and other forms of air pollution, with $8 billion of it to be used specifically for low-income/disadvantaged communities. Grants under the $20 billion "General and Low-income Assistance Competition" can be awarded to any project, activity, or technology that:

- Reduces or avoids GHG emissions and other forms of air pollution in partnership with, and by leveraging investment from, the private sector; or
- Assists communities in the efforts of those communities to reduce or avoid GHG emissions and other forms of air pollution.

The GHGRF is a potential financial assistance opportunity for the City to track specifically for expanding the HSW program infrastructure that would reduce organic waste and process organic waste into new value-added products. These grants are competitive, and while additional EPA guidance is awaited, it is anticipated that the GHGRF will be administered as loans at the project level.

6.7 Greenhouse Gas Emission Estimates

GHGs affect the climate and ecosystems. This section documents GHG emission estimates between the refined alternatives. These estimates quantify environmental impacts from each alternative and may be used to guide decision making. The City and Sonoma County are dedicated to reducing GHG emissions. The City's Climate Action Plan sets the goal of reducing emissions to less than 50 percent of 2007 levels by 2035 and 83 percent below 2007 levels by 2050. Similarly, Sonoma County's 2020 GHG reduction targets aim for an 80 percent reduction below 1990 levels by 2050, and focusing on lowering fertilizer emissions and improving carbon sequestration.

The GHG emission calculations were performed based on BC:SWEET model outputs. The emissions were calculated based on Scope 1 and Scope 2 emissions. The assumptions used in calculations, including items accounted for in each scope, are documented in Section 4.4.

Figure 6-14 presents results from the GHG emission calculations for refined alternatives. The contribution from individual components are shown in Attachment A. Results shown in Figure 6-14 demonstrate that Dryer alternatives contribute the most GHG emissions and could impact the City's and Sonoma County's GHG emission reduction goals. This difference in GHG emissions among the alternatives is mainly affected by NG usage required for thermal dryer operations. Biogas utilization could be considered to offset NG usage for thermal dryer operations, which would lower the GHG emissions estimated for Dryer alternatives. The evaluation assumed biogas is used in CHP engines to maximize electrical savings via energy production with biogas, but this assumption could be refined if Dryer alternatives are advanced to a preliminary design.

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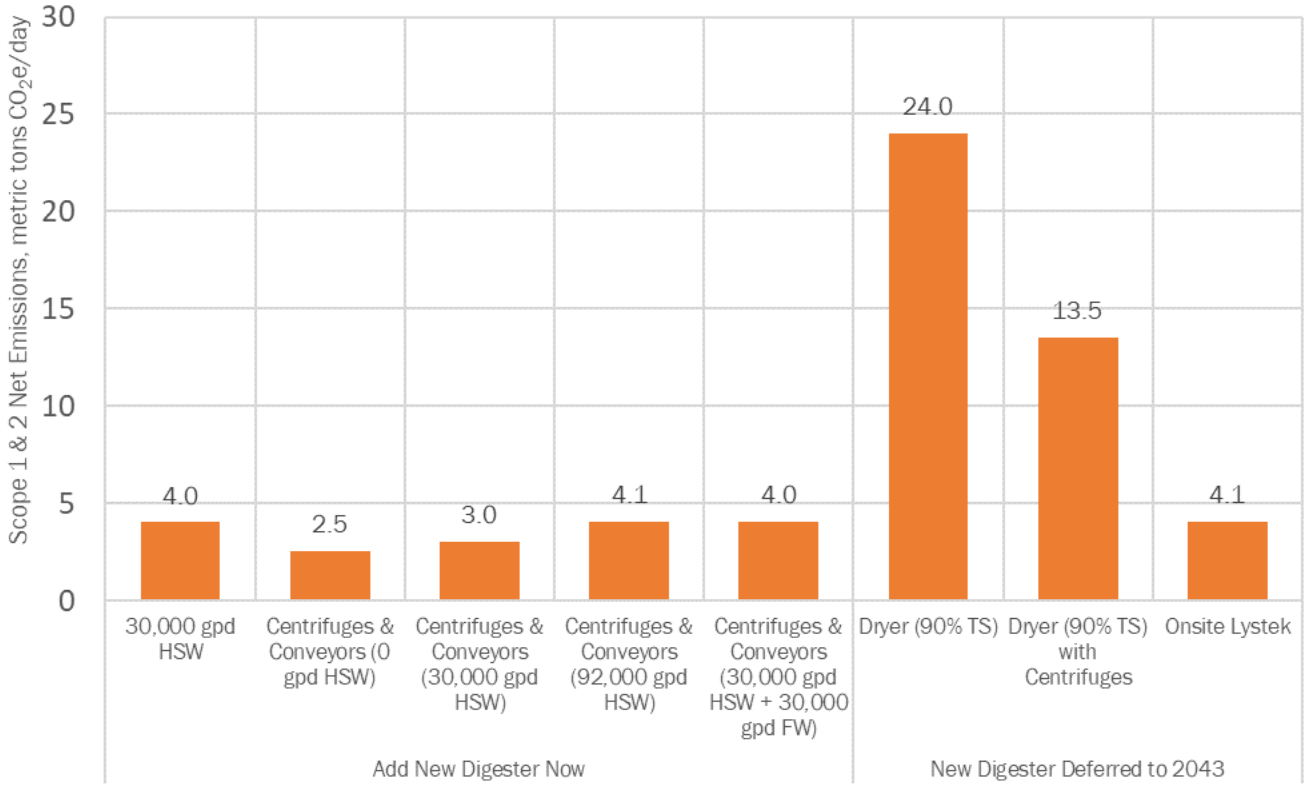


Figure 6-14. Refined alternatives GHG emissions (Scope 1 and 2)

Emissions shown are based on 2053 performance predictions and for relative comparison.

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6.8 Impacts on Upstream and Downstream Processes

Changes to the solids treatment process may have impacts to other LTP processes. Table 6-5 summarizes return stream flow and loadings associated with each refined alternative. This table demonstrates a negligible impact on return stream loading between Alternatives 01, 08b, 12a, and 14, where the amount of HSW is maintained but changes to the solids treatment process are implemented. Adding a thermal dryer is estimated to increase the nitrogen loading to the liquid treatment process by about 10 percent.

Table 6-5. Return Stream Summary

Alternative	Flow (mgd)		TSS[a] (lb/d)		sN[b] (lb-N/d)		sP[b] (lb-P/d)	
	2023	2053	2023	2053	2023	2053	2023	2053
Alt 01 – Status Quo **(30,000 gpd HSW)**	**0.50**	**0.70**	**3,520**	**4,600**	**1,290**	**1,570**	**350**	**420**
Alt 08a – Centrifuge & Conveyors (0 gpd HSW)	0.48	0.69	3,410	4,490	930	1,230	210	280
Alt 08b – Centrifuge & Conveyors **(30,000 gpd HSW)**	**0.51**	**0.72**	**3,520**	**4,600**	**1,370**	**1,680**	**380**	**440**
Alt 08c – Centrifuge & Conveyors (92,000 gpd HSW)	0.57	0.78	3,730	4,810	2,240	2,560	720	790
Alt 08d – Centrifuge & Conveyors (30,000 gpd HSW + 30,000 gpd FW)	0.54	0.74	3,750	4,830	3,240	3,550	590	660
Alt 12a – Dryer **(30,000 gpd HSW)**	**0.67**	**0.92**	**3,590**	**4,700**	**1,400**	**1,700**	**330**	**390**
Alt 12b – Dryer with Centrifuge & Conveyors (30,000 gpd HSW)	0.68	0.93	3,590	4,700	1,400	1,700	360	420
Alt 14 – On-Site Lystek **(30,000 gpd HSW)**	**0.50**	**0.71**	**3,590**	**4,700**	**1,220**	**1,490**	**330**	**390**

a. *Assumes TS is approximately equal to total suspended solids.*
b. *sN and soluble phosphorus (sP) are intended to represent the approximate total return loading for ammonia and ortho-phosphate based on mass balance assumptions for particulate N and P associated with sludge volatile suspended solids and ammonia and ortho-phosphate concentrations measured in the liquid treatment process.*

Increasing the amount of HSW received by LTP is predicted to have a significant impact on return stream nutrient loading. Increasing HSW receiving in 2023 from 30,000 gpd to 92,000 gpd (addition of 62,000 gpd of HSW; a 207 percent increase) is predicted to increase the soluble nitrogen (sN) loading by about 60 percent. Adding 30,000 gpd of food waste was predicted to increase sN loading by about 135 percent. All alternatives were predicted to have similar total suspended solids return stream loading to the liquid treatment process. The calculation methodology is described in Attachment A.

Increased nitrogen loading in return streams is expected to increase aeration demand and effluent nitrogen concentration and loading in the liquid treatment process. Sidestream treatment is one strategy that can mitigate these impacts by removing nitrogen between the dewatering and mainstream liquid treatment process. Before significantly expanding HSW receiving, the impact of increased nitrogen loading on the liquid treatment process should be considered. The actual impact on return stream nutrient loading will be dependent on the type of HSW that is received, and specific wastewater characterization on waste haulers is recommended to refine the return stream loading predictions before using values to inform design criteria.

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6.9 Phasing and Implementation Options

The three refined alternatives offer an opportunity for phased implementation, and certain alternatives could be used as on-ramps if changes to regulations or market pricing impact the results of this analysis. For example, installing centrifuges and conveyors in the short term does not prohibit the City from installing thermal dryers or executing a contract for a regional on-site Lystek facility in the long term.

Although phasing and implementation between all three refined alternatives is feasible, the order of implementation would impact the estimated capital and life-cycle costs. For example, installing centrifuges and conveyors would increase the unit cost of Lystek, which has a higher unit cost per wet ton for drier solids. On the other hand, a drier biosolids product due to implementation of centrifuges would decrease the thermal dryer facility cost and footprint, as demonstrated by comparing alternatives 12a and 12b.

Thermal dryers also could be seen as a first step toward pyrolysis, and pyrolysis has the potential for PFAS destruction (EPA, 2021). Phasing thermal dryers into the City's CIP could be a potential on-ramp if PFAS regulations start to impact land application.

Regarding the City's trucked waste program, the refined alternatives analysis demonstrated that accepting additional HSW provides comparable or lower lifecycle cost to the City. Accepting food waste resulted in a higher lifecycle cost. This makes expansion of HSW feasible based on the economic evaluation, assuming feedstocks are of similar quality as the existing HSW that is currently received. The impacts of additional HSW on the liquid treatment process require evaluation before accepting additional HSW. Section 6.8 (Impacts on Upstream and Downstream Processes) demonstrates a significant increase in nitrogen and phosphorus loading in return streams to the liquid treatment process if additional HSW or food waste is accepted. Section 6.9.1 (High Strength Waste Capacity) demonstrates the City's existing and future solids treatment capacity for additional HSW.

The City has a variety of implementation and phasing options, as shown in Figure 6-15. The refined alternatives analysis suggests the City's current biosolids management strategy (status quo) has the lowest lifecycle costs, but a new digester is required to address capacity constraints when one digester is offline for cleaning. The On-site Lystek alternative (Alt 14) could defer the need for a new digester but requires a 20-year contract. This places the City's end-use management onto Lystek, but results from the sensitivity analysis demonstrate a risk of higher end-use costs if Lystek pricing increases at a faster rate than the City's traditional biosolids management operating costs. An intermediate option would be for the City to secure Lystek as an outlet during digester cleanings to defer new digester design and construction to 2043.

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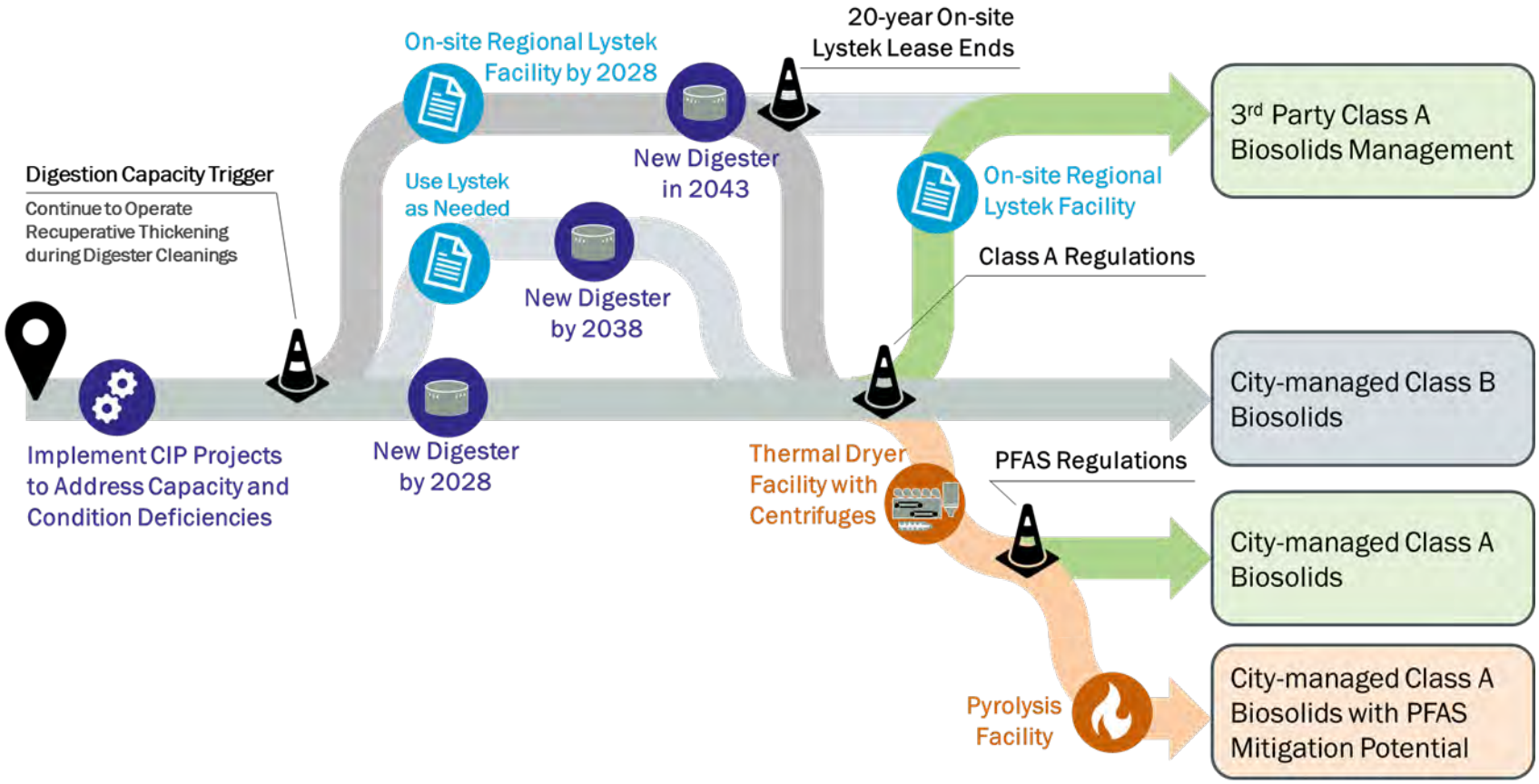


Figure 6-15. Implementation and phasing options

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Maintaining the status quo in lieu of committing to an On-site Lystek facility also provides the option for the City to take on-ramps to achieve Class A biosolids or PFAS mitigation if regulatory or market conditions change. One such on-ramp may be installation of a thermal dryer to achieve Class A biosolids. Thermal dryer product could be compatible with pyrolysis depending on the dryer technology that is selected. This flexibility may be seen as a benefit if the City prefers to continue managing biosolids end-use.

6.9.1 High-strength Waste Capacity

The City's trucked waste program brings in significant revenue. The program provides a benefit to the community, and co-digestion of HSW for clean energy production is aligned with the City's and Sonoma County's climate action plans. A recent report estimated more than $2 million of revenue and about $440,000 in net profit per year (Brown and Caldwell, 2022). The ability to receive and maximize economic and environmental benefits from HSW is limited by capacity constraints in the solids and biogas utilization unit processes (Brown and Caldwell, 2023). This section presents the impact of project phasing on the City's ability to receive HSW and use all biogas produced by HSW.

Figure 6-16 presents the HSW receiving capacity for the status quo. This assumes the biogas conditioning system and digester biogas piping are improved per recommendations from TM1 and TM2 (Condition Assessment and Evaluation), and that a new digester is added in 2028 to address anaerobic digestion capacity constraints during routine cleaning. The figure demonstrates the additional capacity added by building a new digester. The HSW capacity during average annual digester loading conditions is shown based on capacity with one digester out of service. The HSW capacity during peak 14-d loading conditions is shown based on the capacity with all digesters online.

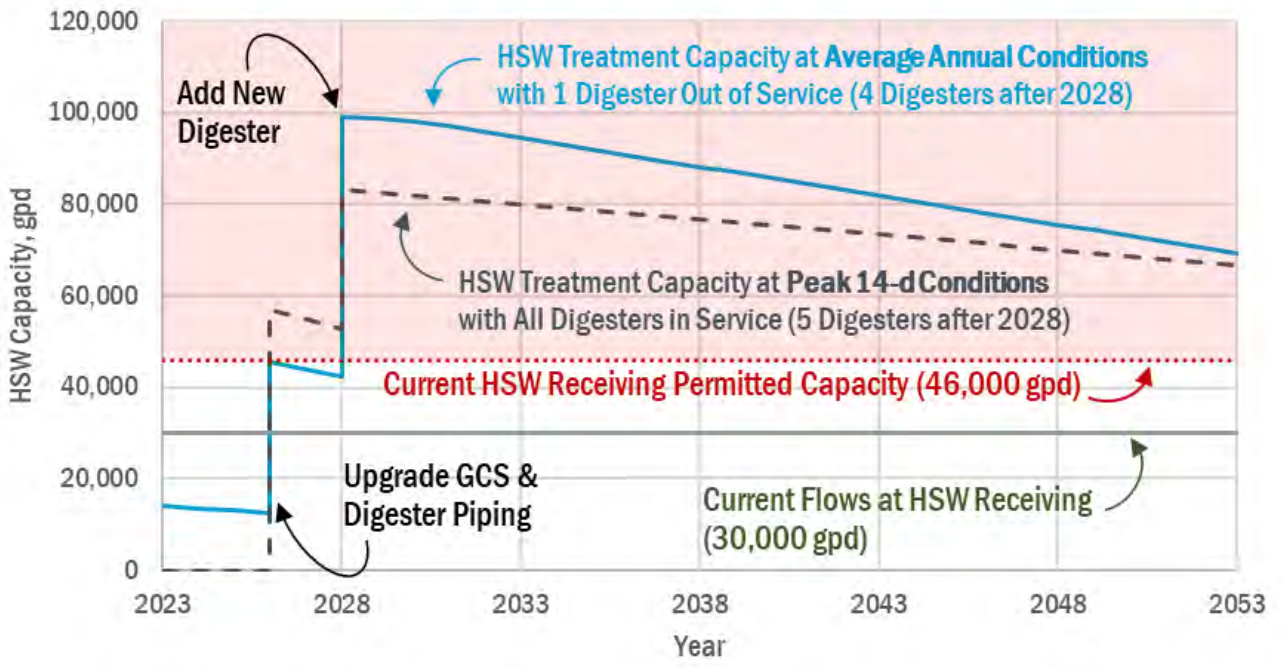


Figure 6-16. HSW capacity projections for phasing of Status Quo or Alternative 08 (Centrifuges & Conveyors)

HSW capacity shown in the figure assumes all anaerobic digesters are online for peak 14-d loading.

Negligible impact from HSW on dewatering and thickening capacity assumed based on results from capacity assessment (TM1).

GCS = biogas conditioning system

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Section 7: Conclusions and Next Steps

This section summarizes results from the initial and refined alternatives analyses and discusses next steps to incorporate the results from this TM into the City's CIP roadmap.

7.1 Summary of Initial Alternatives Results

The initial alternatives evaluation suggested the following trends:

- **Thermal Dyer, Composting, and THP alternatives resulted in the highest lifecycle costs, but thermal drying was advanced due to biosolids management benefits (decreases wet tons produced and achieves Class A compliance).** Composting was not advanced because only a fraction of biosolids would achieve Class A compliance; therefore, composting does not provide any solids treatment capacity benefits. THP alternatives were not advanced, in part due to the requirement for additional, certified staffing and relatively high operating and capital costs. Retention of skilled, certified operators is a potential risk associated with this alternative.
- **Adding storage capacity at Alpha Barn or gas storage at LTP did not significantly increase or decrease lifecycle costs.** These alternatives were advanced for refined capital cost estimation and could be added to any alternative selected for the CIP roadmap.
- **Centrifuges & Conveyors had a similar lifecycle cost compared to Status Quo but decreased the wet tons produced from the LTP.** The Centrifuges & Conveyors alternatives were advanced for refined evaluation of capital and lifecycle costs.
- **On-site Lystek achieved Class A compliance and had a beneficial lifecycle cost.** The alternative was advanced to the refined alternatives analysis.

7.2 Summary of Refined Alternatives Results

The refined alternatives evaluation suggested the following trends:

- **Thermal Dryer** (Alt 12) resulted in the highest capital costs, lifecycle cost, and GHG emissions. Thermal dryers are required upstream of pyrolysis, which is a relatively new technology that has potential for PFAS mitigation in biosolids. Therefore, thermal dryers may be considered as an on-ramp to pyrolysis depending on future regulations.
- **On-site Lystek** (Alt 14) resulted in the lowest capital cost and highest non-economic benefit.; however, the lifecycle cost sensitivity analysis captured economic risk associated with this option from contract pricing escalation. This option would require the City to send all biosolids to Lystek for about a 20-year period, which would be the duration the City would lease out the composting facility to Lystek. Lystek would cover the capital expenses to convert the existing composting facility into a regional Lystek facility.
- The **Status Quo** (Alt 01) resulted in a lower capital and lifecycle cost compared to Centrifuges & Conveyors (Alt 08). The refined capital and operating costs demonstrated that higher capital costs to install centrifuges and conveyors were not offset by lower hauling costs; however, the status quo alternative results in the highest wet tons produced per year. If hauling costs continue to increase, then centrifuges and conveyors may prove to be more valuable, and overall lifecycle costs are comparable considering the level of accuracy of the Class 5 capital cost estimates. Additionally, centrifuges and conveyors are recommended as part of a future thermal dryer facility.

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7.3 Recommendations

Table 7-1 compares refined alternatives. The analysis suggests building centrifuges and conveyors (Alt 08) and thermal dryers (Alt 12) do not provide lifecycle cost benefits to the City, and both alternatives would incur higher near-term capital costs. Based on 30-year lifecycle costs, maintaining the status quo is the recommended biosolids management strategy for the City:

- **Recommendation: Status Quo (Alt 01)** – continue operation of current dewatering technology (belt presses) and build a new anaerobic digester to alleviate capacity constraints. This option provides the greatest flexibility and lowest risk to the City because onramps to achieve lower hauling costs (e.g., centrifuges), Class A biosolids (e.g., thermal dryers), or PFAS mitigation (e.g., pyrolysis) are left open for the City to consider if future regulatory triggers require new processes.
- Consider future installation of centrifuges and conveyors. Improved dewatering will reduce hauling costs and facilitates future solids processing technologies like thermal drying. If hauling or management costs increase in the future, centrifuge dewatering and conveyors could be considered as an opportunity to reduce costs. In the near-term, the City could replace the existing cake pumps with a technology that does not require water addition downstream of dewatering.
- Reserve footprint for future Class A biosolids process technologies. Class A technologies such as thermal dryers provide opportunities to reduce solids mass and access new, Class A markets. Class A processes should be considered if management costs and/or California regulations improve the economics of this alternative. Additionally, thermal drying may be an avenue to advance PFAS destruction though pyrolysis.

Table 7-1. Refined Alternatives Comparison

Alt. No.	Alternative Description	30-year Lifecycle Cost ($ millions)	Non-Econ. Score	GHG Emissions (metric tons CO_2e/d)
01	Status quo dewatering and end use (Class B) Design and build one new anaerobic digester now	Low $167	Lowest (61 of 100)	Low (4.0)
08	Replace dewatering equipment with centrifuges and conveyors (Class B) Design and build one new anaerobic digester now	Higher $187	Lowest (61 of 100)	Lowest (3.0)
12	Build new thermal dryer facility, including centrifuge before drying (Class A) Design and build one new anaerobic digester in 2043	Highest $237	Middle (64 of 100)	Highest (13.5)
14	Build on-site regional Lystek facility; Contract all biosolids end use to Lystek (Class A) Design and build one new anaerobic digester in 2043	Higher $172[a]	Highest (68 of 100)	Low (4.1)

a. *Sensitivity analyses suggest NPV lifecycle costs could range between $153 and $223 million, depending on Lystek contract pricing and whether a dedicated biosolids pumping system is constructed. Lifecycle costs do not account for potential revenue the City could receive from liquidating City-owned land in South County and cost savings from terminating contracts with farmers.*

The status quo still requires a new digester to be built before the next digester cleaning to address capacity constraints. An on-site regional Lystek facility could defer costs for a new digester by 20 years because the City would no longer be required to meet a 15-day HRT since Lystek's technology achieves Class A biosolids regardless. This option leases the existing composting facility to Lystek and contract all biosolids end-use management to Lystek. This option is not recommended over the status quo because of operating cost risks. Any changes to the cost of operation for Lystek may be passed onto the City, including if improvements are required from Lystek to achieve PFAS mitigation. Maintaining the status quo keeps on-ramps available for either Class A or PFAS mitigation open in the future, as shown in Figure 6-15.

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The construction of a new digester can be deferred if recuperative thickening and Lystek are used in the near-term whenever one digester is taken offline for cleaning. Mass balance calculations suggest that the GBT and digesters have sufficient capacity to operate in recuperative thickening mode until 2039 based on average annual flow and loading projects for PS and TWAS, and assuming 46,000 gpd of HSW are received. During peak 14-day flow and loading conditions, the GBT and digesters do not have sufficient capacity to operate recuperative thickening mode if the current levels of HSW are received. There is sufficient GBT and digester capacity to handle peak 14-day flow and loading conditions through 2032 if only PS and TWAS are fed to digesters, based on GBT solids loading capacity assumptions from the capacity evaluation (TM1). These estimates assume one GBT is dedicated to recuperative thickening mode, which may impact WAS thickening capacity.

Therefore, the City should be ready to use Lystek as an end-use during digester cleanings in the near-term; Sending biosolids to Lystek may be required if peak loading conditions occur when there are three digesters in operation.

7.4 Next Steps

This TM documents results from the biosolids alternatives evaluation. The results predict that the City's status quo biosolids management strategy will result in the lowest lifecycle cost. The capacity evaluation (TM1) and condition assessment (TM2) had identified projects required to address capacity constraints and condition deficiencies. Cost estimates were prepared for these projects in tandem with cost estimates that were prepared for projects associated with the refined alternatives. The status quo was recommended as the preferred biosolids management strategy for the CIP roadmap. Capital costs for a new digester will be deferred by using recuperative thickening and Lystek, as needed, during digester cleanings. Projects that address capacity constraints and condition deficiencies will be prioritized in the CIP roadmap.

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References

Brown and Caldwell, *Trucked Waste Program Evaluation Report*, City of Santa Rosa, August 2022

Brown and Caldwell, *Technical Memorandum 1: Flows and Loads and Capacity Evaluation*, City of Santa Rosa, June 2023

United States Environmental Protection Agency, *Research Brief: Potential PFAS Destruction Technology: Pyrolysis and Gasification,* January 2021, https://www.epa.gov/sites/default/files/2021-01/documents/pitt_research_brief_pyrolysis_final_jan_25_2021_508.pdf

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Attachment A: Supplemental Data and Analyses

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A.1 Supplemental Data and Data Analysis

This section presents supplemental data for biosolids management. The data in this section was summarized based on information provided by the City. Data analysis was completed to inform inputs and assumptions in BC:SWEET (see Attachment C).

A.1.1 Biosolids Data

Biosolids data is presented in Section 1.3 – Biosolids End Use Overview. This section provides a table of data summarized in the TM. The biosolids data demonstrates a trend toward 10 wet tons per year of biosolids land applied as shown in Table A-1. Per conversations with the City, this number is impacted by the amount of nitrogen that can be applied to farmland per year.

Table A-1. Biosolids Land Application Data (wet tons per acre)

Year	Alpha (North)	Brown (North)	Stone (North)	North Total	Jacob (South)	Leonard (South)	SW (South)	Herzog (South)	Twin Vista (South)	Twin HS/Atwood (South)	Crane (South)	Yenni (South)	BBRRBR (South)	South Total	All Sites Average
2013	175.8	19.4	0.0	58.2	17.7	19.9	18.9	0.0	0.0	0.0	0.0	4.9	0.0	5.5	**31.9**
2014	151.4	18.1	20.0	53.3	7.1	11.0	10.4	0.0	0.0	0.0	0.0	8.6	0.0	4.3	**28.8**
2015	229.1	21.4	20.1	75.8	10.7	12.1	11.2	0.0	0.0	0.0	0.0	9.7	0.0	5.1	**40.4**
2016	233.7	21.1	18.4	76.6	8.9	8.1	7.5	3.5	0.0	0.0	0.0	6.6	13.6	5.2	**40.9**
2017	144.1	17.4	0.0	48.7	6.7	10.1	4.4	4.9	0.0	9.8	0.0	7.7	17.4	6.5	**27.6**
2018	82.2	18.5	10.1	34.2	7.0	9.9	9.7	4.9	0.0	11.4	0.0	7.2	16.1	6.7	**20.5**
2019	70.3	18.6	0.0	30.0	8.0	10.2	9.4	5.0	0.0	12.6	0.0	6.6	18.0	6.9	**18.5**
2020	30.2	13.6	0.0	16.3	10.8	10.4	6.3	5.3	0.0	10.0	5.6	8.6	17.2	8.1	**12.2**
2021	37.6	0.0	0.0	9.9	11.5	10.1	9.7	6.4	0.0	6.0	5.1	8.0	25.1	8.5	**9.2**
2022	19.2	12.6	0.0	12.9	11.9	11.5	0.0	14.0	10.1	9.8	7.6	6.3	0.0	8.3	**10.6**

A.2 Non-Economic Analysis Calculations and Detailed Results

This section presents non-economic analysis scoring and calculations.

A.2.1 Non-economic scoring

To conduct an impartial scoring of all biosolids alternatives, the individual technologies were scored on a scale of 1 to 5, where 1 is the lowest score and 5 is the highest score (greatest benefit to City). Table A-2 shows scoring results from this exercise.

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Table A-2. Non-economic Scoring						
Technology/Scenario	End Use Market Compatibility	O&M Impacts	Existing Site and Process Compatibility	Permitting and Regulatory Risk	Safety Impacts	Environmental and Community Impacts
Scenarios						
No HSW	4	3	2	5	4	1
Status Quo HSW (30,000 gpd)	3	3	3	3	3	3
Mid HSW (46,000 gpd)	3	3	3	3	3	4
High HSW (92,000 gpd)	1	2	2	2	2	5
30,000 gpd HSW + 30,000 gpd Food Waste	2	2	3	2	2	5
Digestion Alternatives						
Status Quo (no change)	3	3	3	3	3	3
Add Meso Digester	3	5	1	3	3	3
Thermo Digester	3	2	4	3	3	3
Operate <15d SRT (no new digester)	3	3	5	2	3	3
Add Recuperative Thickening	3	2	5	3	3	3
Add THP	4	1	1	3	1	2
Biogas Storage						
Status Quo (no change)	3	3	3	3	3	3
Add Biogas Storage	3	4	2	3	3	3
Biogas Utilization						
Status Quo (no change)	3	3	3	3	3	3
Add 2 SCRs	3	5	4	3	3	4
Dewatering Alternatives						
Status Quo (no change)	2	3	3	3	3	3
Add Conveyors	3	5	5	3	3	3
Add Centrifuges & Conveyors	4	3	2	3	3	2
Add Thermal Dryers	5	3	4	3	3	1
End Use Alternatives						
Status Quo (Class B)	3	3	3	3	3	3
Add Composting	3	1	3	3	2	5
Add Lystek Facility On Site	3	5	4	3	5	4
Add Biosolids Storage at Alpha Barn	4	4	4	3	3	3

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A.2.2 Alternative Scoring

Alternative scoring was based on a summation of technology scores times weight factors divided by 5. This is demonstrated by the example calculation below. The alternative score for each category was based on the average of scoring for each technology/scenario in Table A-1. After initial review of alternatives scoring, a greater weight was given to digestion technologies and end-use scenarios to differentiate alternative scores.

End Use Market Compatibility Scoring for Alternative = 3

End Use Market Compatibility Weight = 30 points

End Use Market Compatibility Weighted Score for Alternative = 3 x (30/5) = 18 points of 30 possible points

Figures A-1 through A-5 present non-economic evaluation scores for the 20 initial alternatives and 4 added refined sub-alternatives (08a, 08c, 08d, and 12b). Alternatives 08b and 12a represent the initial alternatives 08 and 12, respectively.

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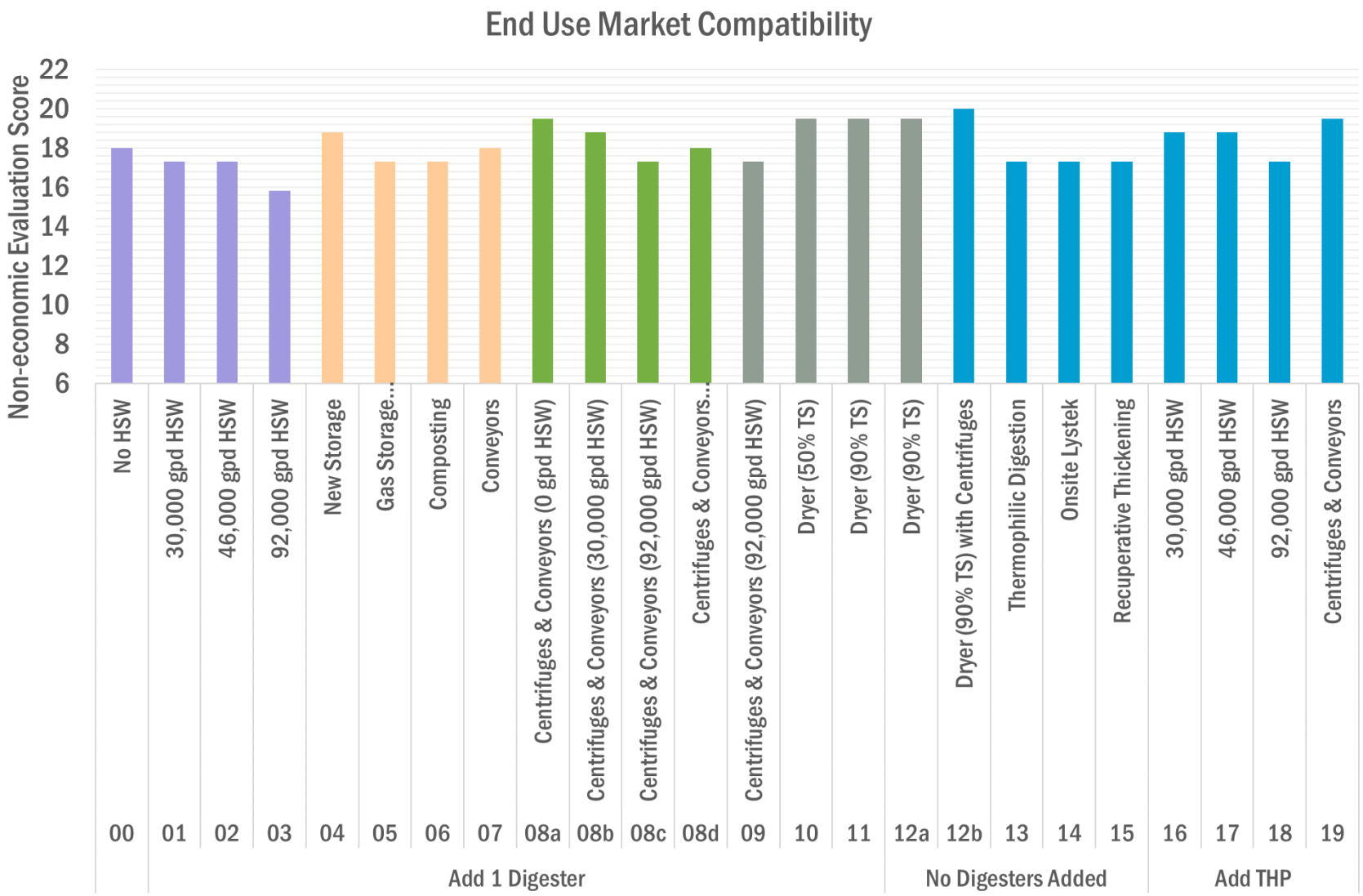


Figure A-1. Non-economic end-use compatibility scoring

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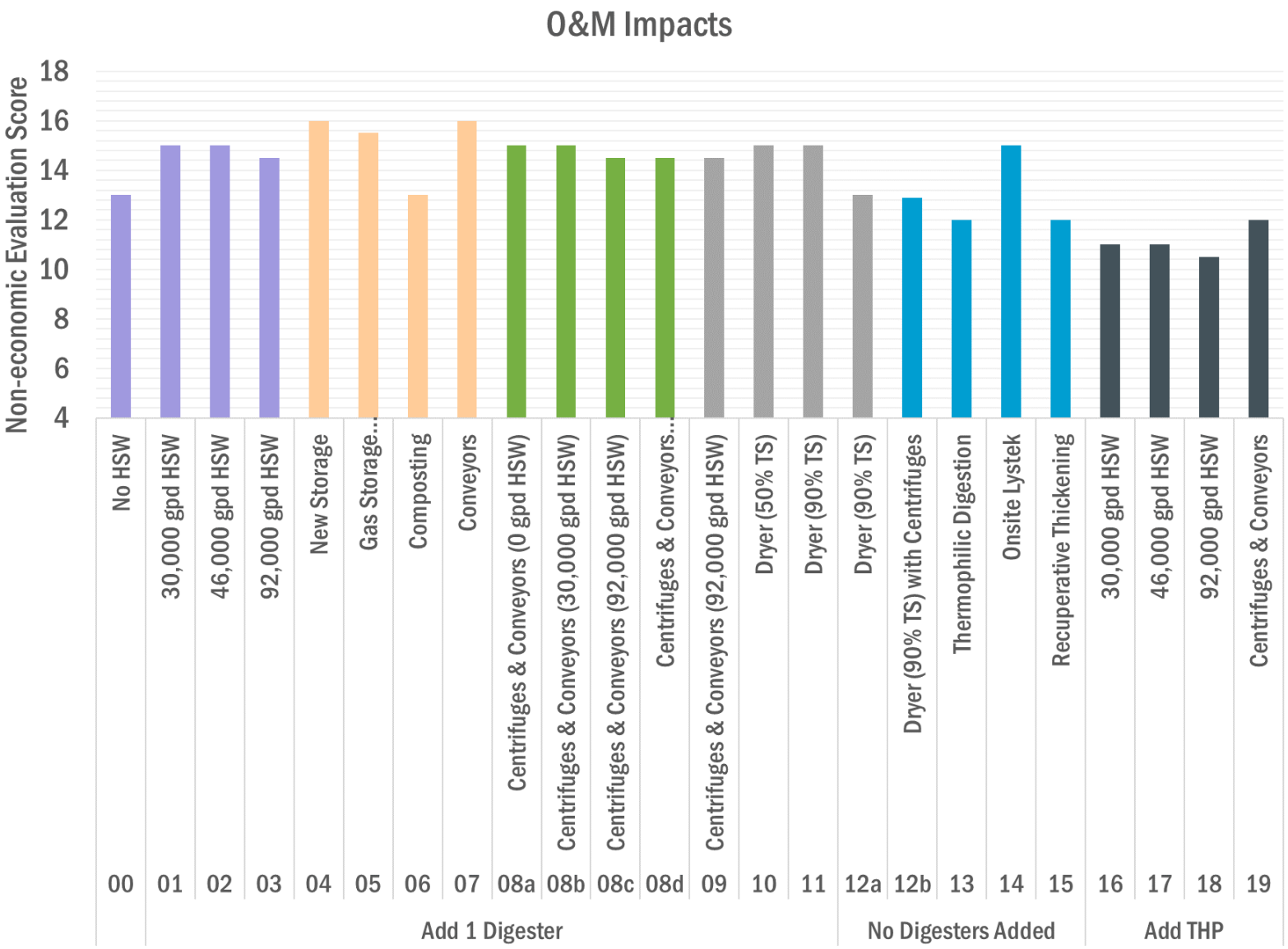


Figure A-2. Non-economic O&M impacts scoring

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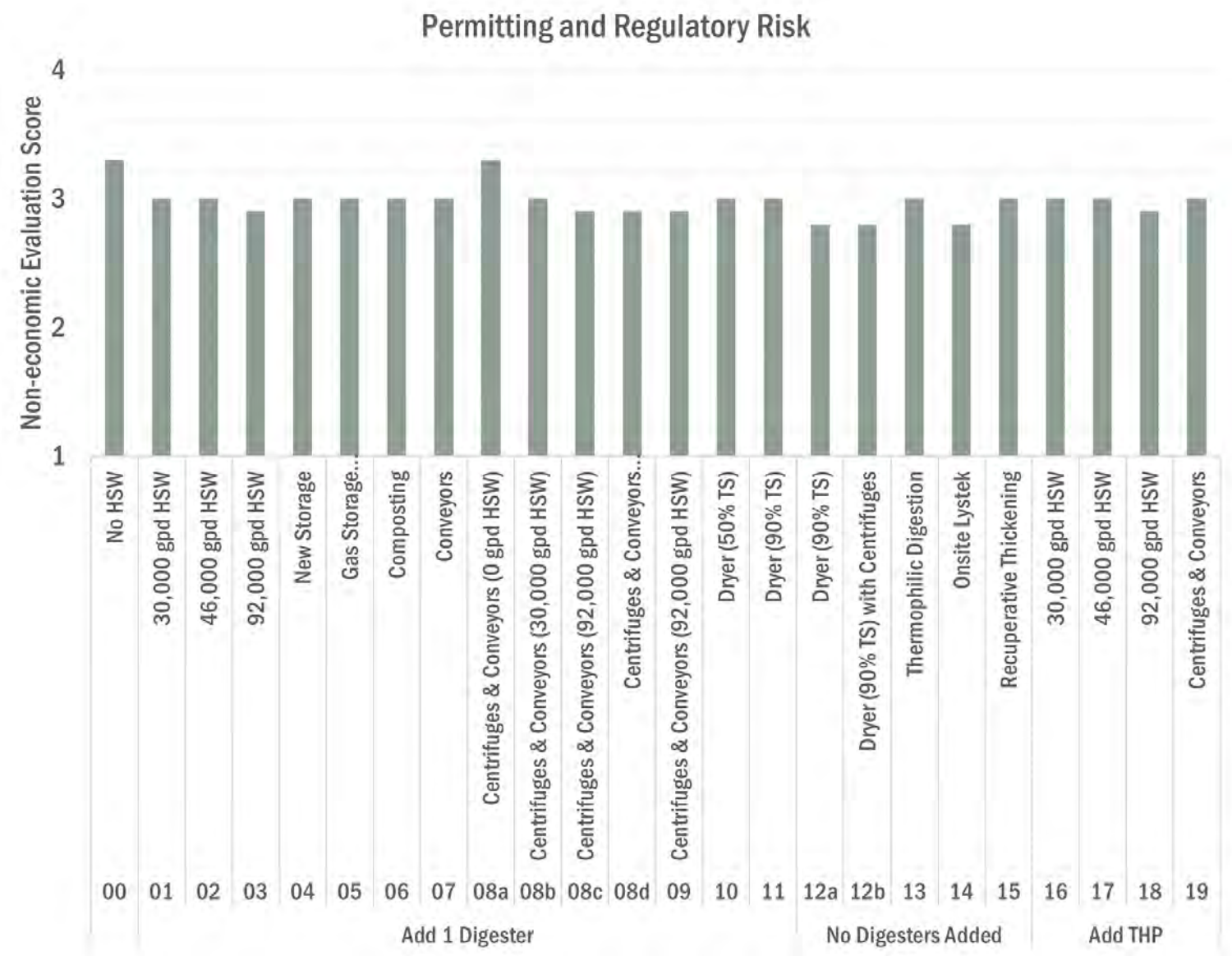


Figure A-3. Non-economic permitting and regulatory risk scoring

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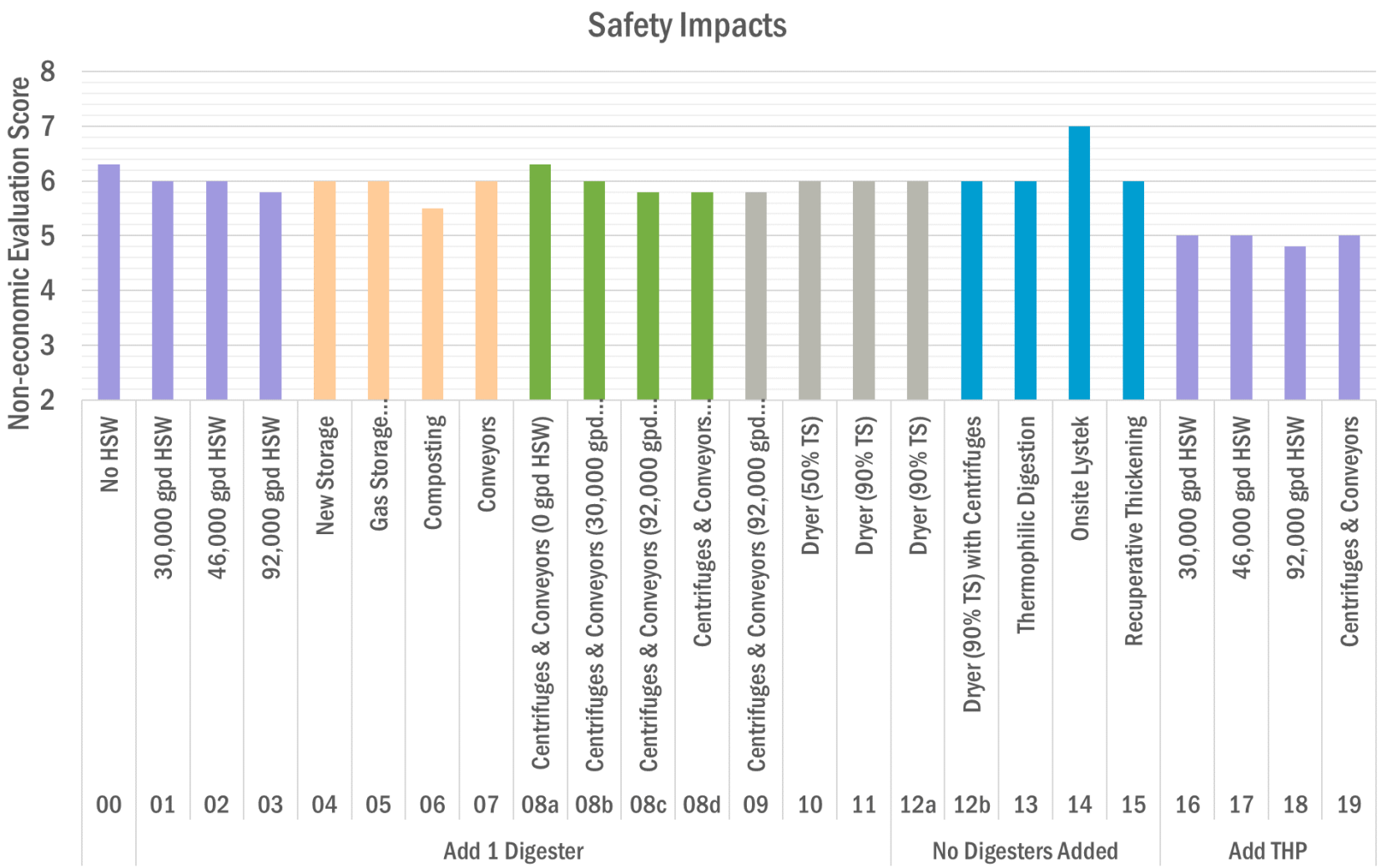


Figure A-4. Non-economic safety scoring

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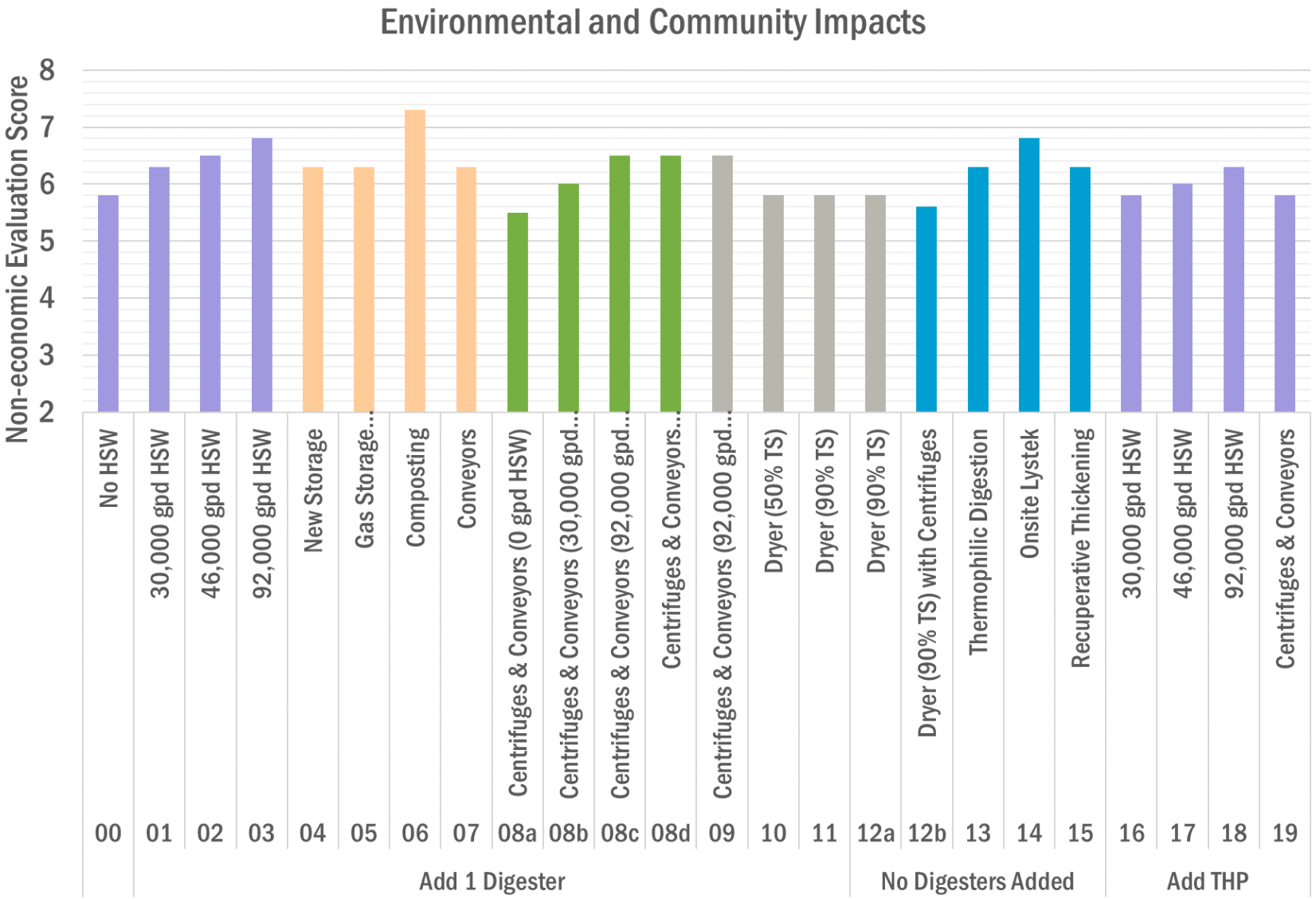


Figure A-5. Non-economic environmental and community impact scoring

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A.3 Return Stream Loading Estimates

Return stream total suspended solids (TSS), soluble nitrogen (sN), and soluble phosphorus (sP) loads were estimated based on mass balance calculations. Particulate nitrogen and phosphorus was assumed to be associated with volatile solids, and the fraction of volatile solids destroyed in digestion was assumed to equal the fraction of particulate nitrogen and phosphorus loading transformed during digestion to soluble nitrogen and phosphorus. Return loading was calculated as a sum of soluble loads in return stream flows plus the particulate loads associated with total suspended solids not captured in thickening or dewatering. The following inputs were assumed for waste types:

- Primary sludge:
  - sN = 37 mg/L-N, based on influent ammonia data
  - pTKN/VSS = 0.03 g/g, based Metcalf and Eddy (2.5 percent N of TS)
  - sP = 4.8 mg/L-P, based on influent total phosphorus data assuming 50 percent is orthophosphate
  - pP/VSS = 0.005 g/g, based on Metcalf and Eddy (1.6 percent P_2O_5 of TS)
- Waste activated sludge:
  - sN = 14.1 mg/L-N, based on effluent total nitrogen data
  - pTKN/VSS = 0.05 g/g, based on Metcalf and Eddy (0.07 g-N/g-COD and 1.42 g-COD/g-VSS)
  - sP = 1.7 mg/L-P, based on effluent total phosphorus data assuming 50 percent is orthophosphate
  - pP/VSS = 0.015 g/g, (0.022 g-P/g-COD and 1.42 g-COD/g-VSS)

Assumes for high strength waste and food waste nutrients were based on fats, oils, and grease and liquid organic waste characteristics from previous co-digestion project experience, and based on the 2017 Water Research Foundation report: Impacts of Co-digestion:

- High strength waste:
  - sN = 600 mg/L-N
  - pTKN/VSS = 0.02 g/g
  - sP = 200 mg/L-P
  - pP/VSS = 0.01 g/g
- Food waste:
  - sN = 5,000 mg/L-N
  - pTKN/VSS = 0.03 g/g
  - sP = 300 mg/L-P
  - pP/VSS = 0.005 g/g

A.4 Greenhouse Gas Emission Calculations and Detailed Results

This section presents GHG emission calculation methodology, assumptions, and results. The GHG emission calculations were performed based on the BC:SWEET model outputs. The emissions were calculated in terms of Scope 1, Scope 2, and Scope 3 emissions, as defined by the GHG protocol by the World Business Council for Sustainable Development and World Resources Institute (WRI). This classification of emissions helps identify and categorize greenhouse gas emissions, enabling their addressing at various levels.

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A.4.1 Scope 1, 2, and 3 Emissions Included in Calculation

Scope 1 GHG emissions refer to emissions directly produced by the City. These emissions originate from sources owned and managed by the City. Scope 1 emissions include CO2e emissions from:

- Natural gas used
- Fugitive methane
- Incomplete combustion after flaring
- CH4 and N2O released from stored biosolids
- On-site composting

Scope 2 GHG emissions are indirect emissions stemming from offsite electricity generation. Electricity generation by the City reduces the need to purchase offsite electricity, reducing Scope 2 emissions. Scope 2 emissions include CO2e emissions from:

- CO2e emissions from offsite electricity generation

Scope 3 GHG emissions refer to the indirect emissions associated with sources not owned by the treatment facility. These emissions result from activities related to the treatment plant but are produced externally. Scope 3 emissions include CO2e emissions from:

- Polymer and ferric production
- Cake hauling and from equipment used for spreading during biosolids land application
- Carbon sequestration (CO2e emissions credit) from biosolids land application
- Credit for avoided inorganic fertilizer production due to nutrients applied via biosolids land application

The Scope 3 GHG emissions were calculated but are not included in the final comparison of alternatives, as it is a common practice to only account for Scope 1 and Scope 2 emissions.

A.4.2 GHG Assumptions

To facilitate the calculations, assumptions were made based on technical research papers and available supporting data. The list of key assumptions can be found in Table A-3.

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Table A-3. List of GHG Calculation Assumptions			
Factor	**Units**	**Value**	**Sources**
Land application factors			
Months in winter	months	6	Assumed months with rain (requires storage)
Months in summer	months	6	Assumed months without rain
Avg storage duration of biosolids produced during summer	days	3	Assumed time between dewatering and land application during summer months
Avg storage duration of biosolids produced during winter	days	92.3	Assumed average storage duration during winter months
Avg days biosolids are stored	days	47.6	Calculated based on avg. storage and months in summer and winter
Carbon sequestration from biosolids or composting	Mg CO_2/ dry Mg-biosolids	0.15	Badzmierowski, 2022, in BEAM, 2022
N_2O emissions during storage of biosolids at the plant prior to land application	kg/m^3-day	0.0004	Clemens et al., 2006, in BEAM, 2022
CH_4 emissions from biosolids storage prior to land application	kg/m^3-day	0.01	Clemens et al., 2006, in BEAM, 2022
Total nitrogen	%-dry wt. (g-N/g-TS)	6.9%	Per the BMSP- TM 3
Total phosphorus	%-dry wt. (g-P/g-TS)	2.5%	Per the BMSP- TM 3
Credit for nitrogen (avoided emissions from the production of inorganic fertilizer)	kg CO_2e/kg-N	4.00	Based on BEAM (2022) assumptions for Credit for Nitrogen
Credit for phosphorus	kg CO_2e/kg-P	2.00	Based on BEAM (2022) assumptions for Credit for Phosphorus
Misc. Assumptions			
Emissions from polymer manufacture	Mg CO_2e/Mg-polymer	2.06	EPA WARM v. 15 documentation (2019)
Density, dewatered sludge	kg/m^3	1,000	Per the BMSP- TM 1
Percentage of assumed fugitive emissions from the total methane content.	percent	0.3%	Based on BEAM (2022) assumptions for flared fugitive emissions
Percentage of methane emitted directly to the atmosphere when biogas is burned or flared - normal efficient combustion	percent	0.3%	Smith et al, 2000; Foley & Lant, 2007, in BEAM, 2022
density of methane gas- at standard temp. and pressure	kg/m^3	0.71	EPA 2006, Solid Waste Management and GHG Emissions
Methane content	percent	60.0%	Per the BMSP- TM 1
Energy & Fuel Factors			
Electricity, PG&E	kg CO_2e/MWh	40	PG&E Climate Strategy Report (June 2022), value calculated assuming average of 0% renewable in 2023 and 100% renewable in 2053
Natural Gas	kg CO_2e/MMBtu	53.13	EPA, 2021 Emissions Factors for GHG Inventories- Table 1

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Table A-3. List of GHG Calculation Assumptions

Factor	Units	Value	Sources
Transportation factors			
Diesel Fuel	kg CO_2e/gallon	10.21	EPA, 2021 Emissions Factors for GHG Inventories- Table 2
Fuel consumption	miles/gallon	5.82	From GeoTab data gathered from 31,170 trucks 2016-2017, in BEAM, 2022
Truck load capacity (wet)	tons/load	22	Assumed based on provided information and typical load sizes to meet CADOT weight limits
Distance to North County	miles round trip	12	Rough estimate using aerial maps
Distance to South County	miles round trip	60	Rough estimate using aerial maps
Percent biosolids to North County	percent	10%	Based on biosolids data from previous years
Percent biosolids to South County	percent	90%	Based on biosolids data from previous years
Cake spreaders factors			
Load size	cubic meter per load	13	Based on Nebraska tractor test lab, in BEAM, 2022
Time to apply	loads per hour	3	Based on Nebraska tractor test lab, in BEAM, 2022
Spread fuel consumption (diesel)	liters per hour	25	Based on Nebraska tractor test lab, in BEAM, 2022
Conversion Factors			
N_2O Global Warming Potential	grams/grams	273	From IPCC AR4
N to N_2O	grams/grams	1.57	Typical values per BEAM, 2022
CH4 Global Warming Potential	grams/grams	28.5	From IPCC AR4
LHV to HHV	LHV = 1.1HHV	1.10	Typical values per BEAM
CH4 to CO_2 (Not Equivalent, CO_2 emissions during combustion process)	grams/grams	2.75	Calculated using stoichiometry
$FeCl_3$ production emission factor	0.954 kg CO2e/gal FeCl3(40%)	0.95	WSTP South End Plant Process Selection Report, 2012- Appendix H (winnipeg.ca)
Compost Assumptions			
Percent of Biosolids to composting (2023)	percent	26.5%	Referred from SWEET model for the BMSP
Percent of Biosolids to composting (2053)	percent	21%	Referred from SWEET model for the BMSP
CH4 emissions from composting	%-wet weight	0.000623	Amlinger et al 2008, in BEAM, 2023
N2O emissions from composting	%-wet weight	0.000137	Amlinger et al 2008, in BEAM, 2023

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A.4.3 GHG Emissions Results

Figure A-6 indicates that Scope 1 contributes the most to GHG emissions, as commonly observed. Figure A-7 shows that in scenarios where natural gas is used, it contributes the most to Scope 1 emissions, followed by fugitive emissions as the second most significant factor. Negative emission values indicate a net decrease in GHG emissions due to its reduction or removal. CO2 emissions from electricity (Scope 2) were negative because the system boundary for the calculations was the solids treatment process, and the energy produced was greater than the energy required within the defined system boundary. The Scope 3 emissions for the Dryer and Centrifuges & Conveyors alternatives are negative because they generate a larger credit for nitrogen, phosphorous, and carbon sequestration relative to the carbon emissions from hauling as compared to other Scope 3 emissions.

Figure A-8 illustrates that the Dryer alternative, followed by the THP alternative, is associated with the highest GHG emissions. This is due to their substantial natural gas requirements necessary for operations like running the boiler during the treatment process. The Centrifuges and Conveyors alternative results in the least GHG emissions as emissions from hauling are reduced.

A.4.4 GHG Emissions Discussion

The City of Santa Rosa (City) and the County of Sonoma are dedicated to reducing GHG emissions. The City's Climate Action Plan sets the goal of reducing emissions to less than 50 percent of 2007 levels by 2035 and 83 percent below by 2050 (City of Santa Rosa, 2023). Similarly, Sonoma County's 2020 Greenhouse Gas Reduction Targets aim for an 80 percent reduction below 1990 levels by 2050, focusing on lowering fertilizer emissions and improving carbon sequestration. Figure A-9 shows almost identical fertilizer emissions and carbon sequestration credits for all alternatives, and there is no significant GHG emission reduction between the Centrifuges and Conveyors versus the Dryer alternatives. Fertilizer emissions and sequestration credits are similar because all biosolids are land applied and alternative end-uses, such as landfilling, are not considered. However, Figure A-8 illustrates that the Dryer alternative (with or without an added digester) contributes the most to GHG emissions and could impede the achievement of the City and County's GHG emission reduction goals. This difference in GHG emissions among the alternatives is mainly affected by natural gas usage, as observed in Dryer and THP alternatives, which contribute the most to the scope 1 emissions.

References

City of Santa Rosa, *Climate Action Planning in Santa Rosa,* Accessed August 2023. https://www.srcity.org/1634/Climate-Action-Planning

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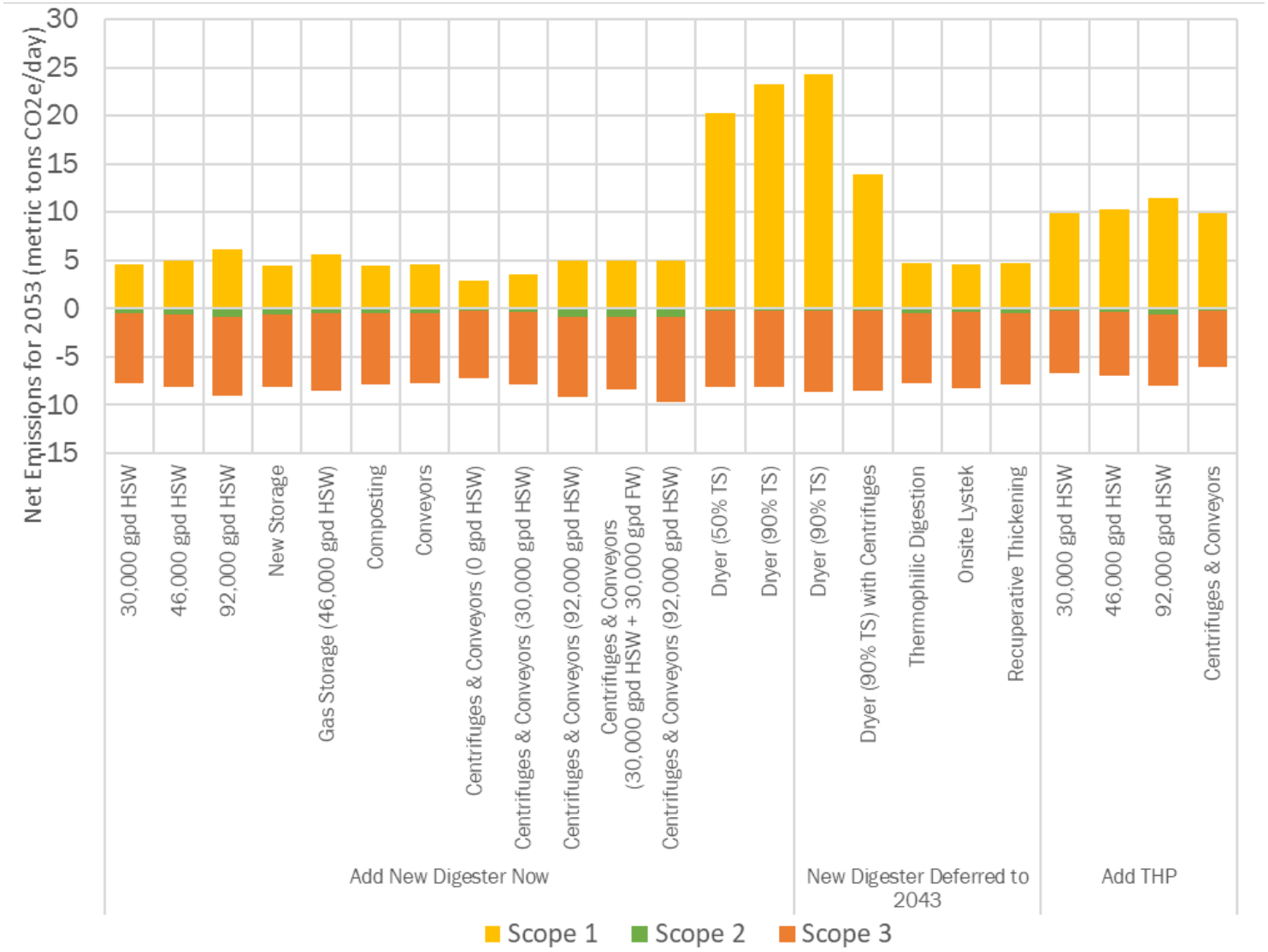


Figure A-6. GHG emissions for Scope 1, 2, and 3

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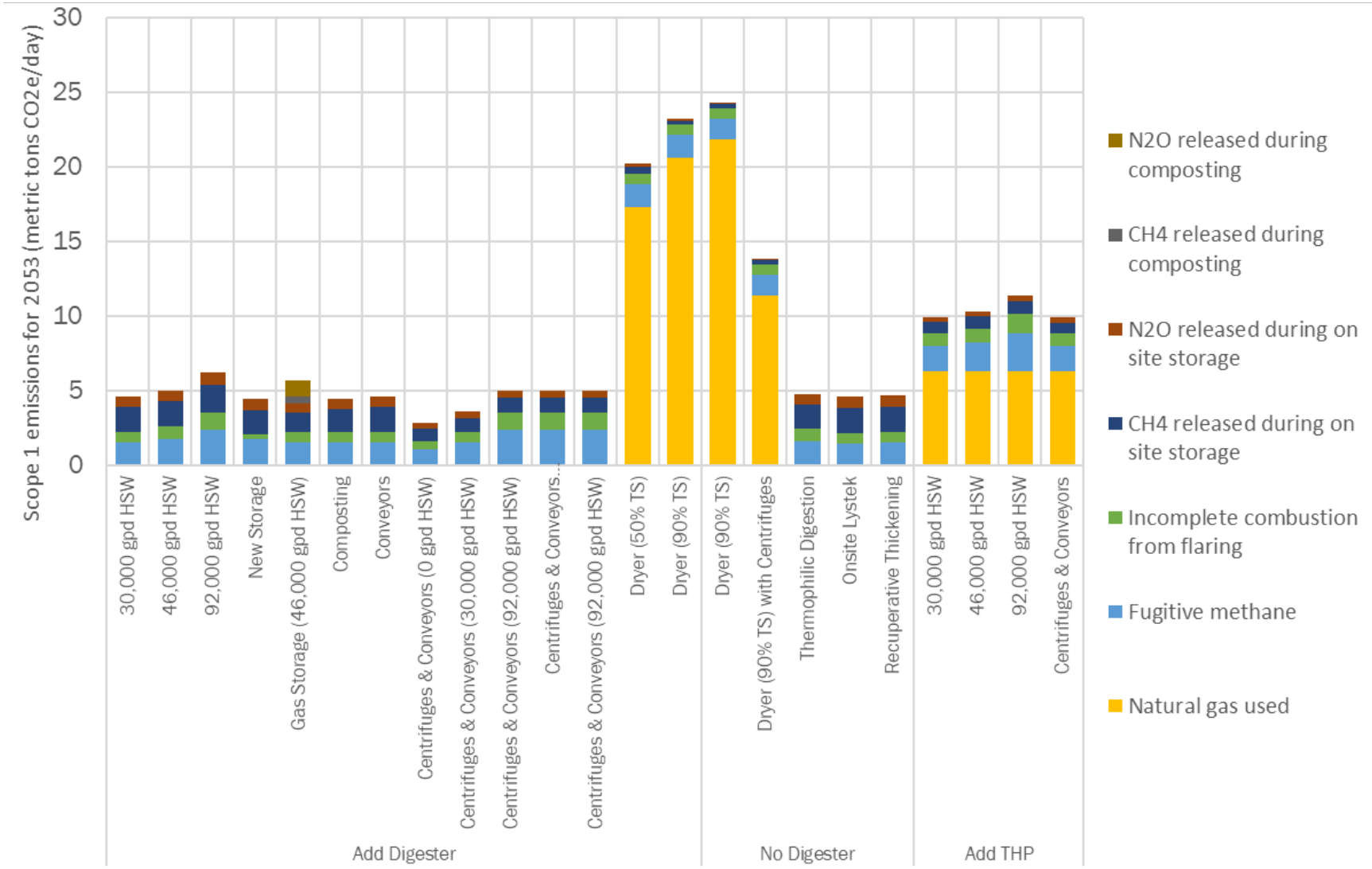


Figure A-7. Emissions contributing towards Scope 1 emissions (2053) for each alternative

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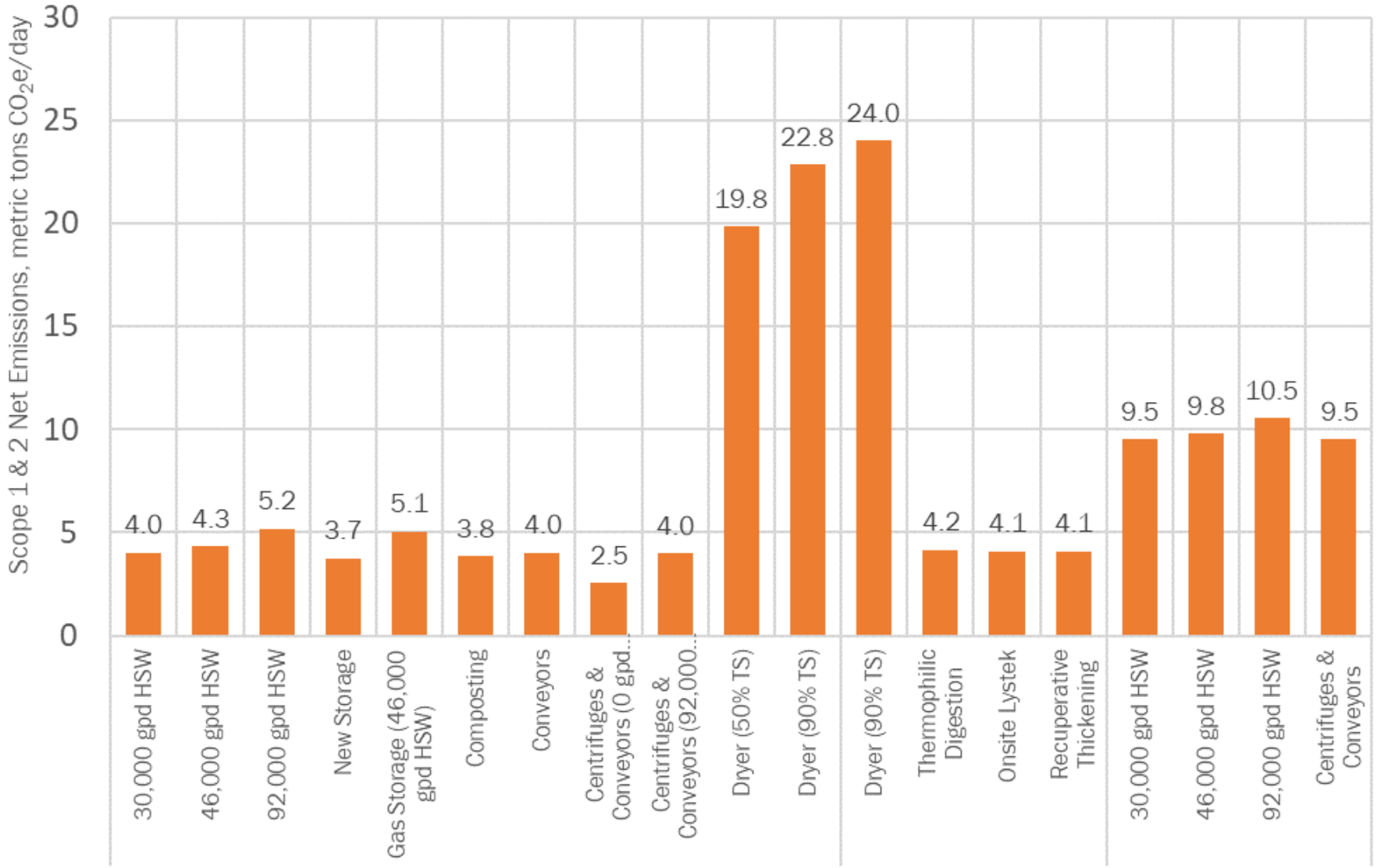


Figure A-8. Net emissions (2053; Scope 1 and 2) for each alternative

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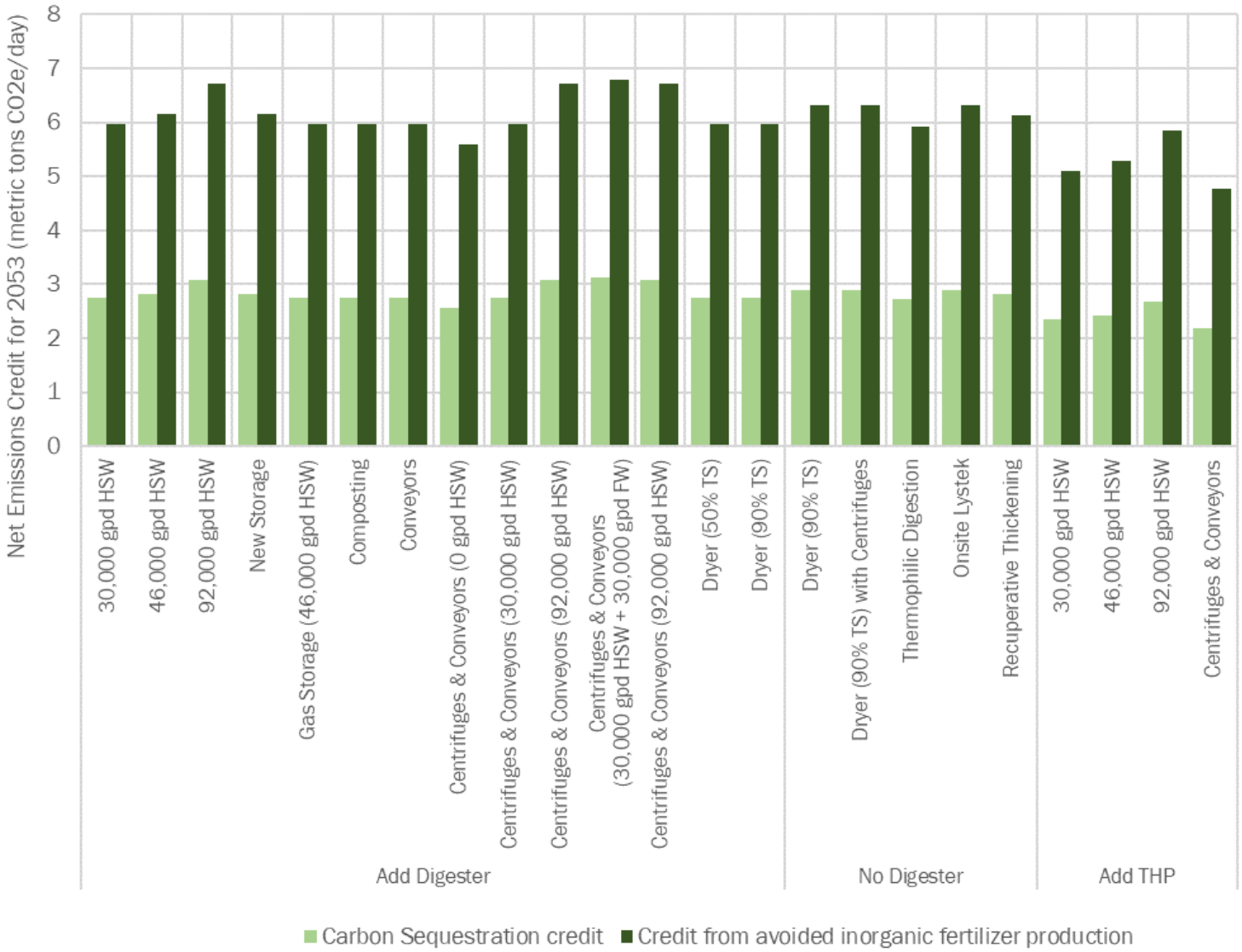


Figure A-9. Net carbon sequestration and fertilizer offset credits (2053)

Fertilizer offset credits are from avoided inorganic nitrogen and phosphorus production for different alternatives

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Attachment B: Biosolids Management Technology Options

Descriptions for all biosolids management technologies considered in the screening evaluation.

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B.1 Descriptions of Biosolids Stabilization Technologies and Categories

This attachment describes biosolids stabilization technologies to provide a brief overview of each technology. Descriptions are intended to be introductory and do not provide comprehensive information on all process and operational considerations or requirements.

B.2 Pretreatment

Pretreatment assists with downstream digestion by allowing a higher hydraulic and solids loading rate to anaerobic digestion. This can extend or increase digestion capacity. Pretreatment may also have dewatering benefits. The pretreatment technologies considered in this evaluation include: thermal hydrolysis (steam), biological (acid) hydrolysis, chemical/thermal hydrolysis, intermediate thermal hydrolysis, pulsed electric hydrolysis, solid stream thermal hydrolysis, and thermal hydrolysis (no steam). Many of these technologies are considered innovative and were no compatible with the established and mature criterion applied in the screening process. This section focuses on describing established full-scale thermal hydrolysis technologies.

B.2.1 Thermal Hydrolysis Process

Thermal hydrolysis process (THP) is considered an anaerobic digestion pretreatment system that results in more efficient wastewater solids stabilization and energy production, results in a drier dewatered cake and, in certain configurations, achieves Class A biosolids. Several types of THP systems are available, were screened/reviewed in this evaluation work. These included Class A and Class B configurations.

Class A THP (as well as most THP configurations) are considered mature technology options around the globe (with over 70 THP systems in operation world-wide).The first installation in the United States and world's largest (at DC Water) has been operating since 2014. Since then three more US facilities are operational, and 4 additional US starting up or planning to start in 2023. Several more are in the works for startup prior to 2030. To date, all of the US THP facilities provide Class A biosolids product, and all involve Cambi THP technology. With Cambi's purchase of the Veolia THP line (in 2022), Cambi has the majority of world-wide THP capacity and installations.

Most THP systems use medium-pressure steam to create elevated temperature and pressure conditions within the reactors, which lyse bacterial cells and promote the release and solubilization of particulate organic material, making the digestion feed solids more amenable to degradation. Figure B-1 depicts a typical process flow of the Cambi Class A THP system. THP can also be used in a waste activated sludge (WAS)-only configuration, generating Class B biosolids. While THP systems normally reduce digester volume required, the ancillary systems required for a total project significantly impact total project cost, complexity, and footprint. Several of the Class B THP plants around the world incinerate the final dewatered Class B biosolids.

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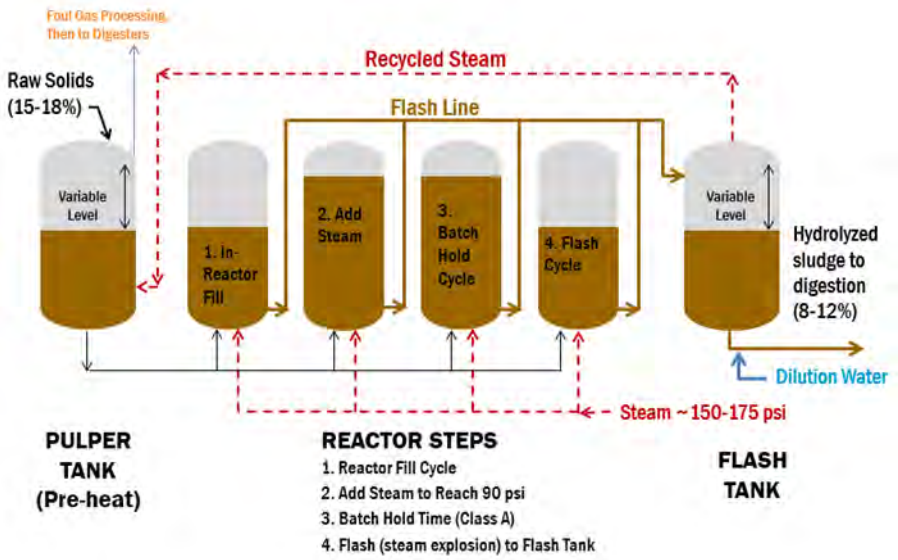


Figure B-1. Typical process flow diagram for the Cambi Class A THP system

B.3 Anaerobic Digestion

Digestion is a core stabilization technology used in the wastewater industry for the purpose of reducing pathogens, reducing vector attraction, and producing a biosolids product capable of meeting regulatory requirements associated with beneficial use. Individual digestion technologies identified for consideration are described below. Only anaerobic digestion technologies that produce a beneficially useable biogas were considered in order to align the City's resiliency and resource recovery goals.

B.3.1 Conventional Mesophilic Anaerobic Digestion (MAD)

Mesophilic anaerobic digestion (MAD) is a conventional sludge stabilization process. MAD typically employs operating temperatures between 95 and 102 °F and solids are digested under anaerobic conditions. Typically, MAD systems are operated at a minimum hydraulic retention time (HRT) of 15 days, which, when requirements for vector attraction reduction are met, guarantees Class B pathogen status for beneficial use. This stabilization process has the longest operational history of the processes under consideration.

Although this alternative provides the benefits of operational simplicity and a long history of operation, the process has its disadvantages when compared to newer, more aggressive technologies. While MAD operates efficiently, the degradation rates are relatively low when compared with other advanced digestion processes. This lower biological degradation rate results in lower VS destruction, lower gas production, more tankage volume required, and additional mass of solids for disposal relative to the advanced digestion processes evaluated. In addition, use of MAD allows for less available capacity for co-digestion substrates because of the inherently lower organic loading rate (OLR) associated with the process.

B.3.2 Temperature Phased Anaerobic Digestion (TPAD)

A temperature-phased anaerobic digestion (TPAD) system operates in two distinct temperature phases, digesting sludge in different tanks arranged in series. The first phase is the thermophilic phase, which typically operates at an HRT between 5 and 10 days. This is followed by a mesophilic phase typically operated between 6 and 15 days HRT. If Class B biosolids are desired, the TPAD system would be designed such that the combined retention time meets the 15-day HRT requirement. As with the TAD system, the OLR is approximately double MAD, at 0.4 lb-VS/ft3-d, applied to the first-stage thermophilic digester. This high

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loading rate can allow for smaller digesters, reducing footprint relative to the overall system capacity, if the relevant criterion for total system HRT is met.

By phasing the digestion process through the thermophilic phase to the mesophilic phase, the advantages of thermophilic digestion are gained but carry an additional benefit of allowing the mesophilic phase to "polish" the volatile acid concentrations, improve VSR, and reduce product odors. The thermophilic digestion phase is typically characterized by high biogas production rates, high VS destruction (60 to 65 percent), and enhanced pathogen kill. Most of the stabilization occurs in the thermophilic phase. Due to the higher OLR and temperature in the thermophilic phase, there are higher volatile acid and ammonia concentrations. When cooled and allowed to enter the mesophilic phase, these concentrations are polished, decreasing volatilized ammonia and other odorous compounds. Like TAD, TPAD can be configured to generate Class A biosolids.

B.3.3 Thermophilic Anaerobic Digestion

Thermophilic anaerobic digestion (TAD) is a means of enhancing digestion capacity through anaerobic digestion at thermophilic temperatures, typically ranging from 122 to 132°F. The high-temperature operation increases reaction rates and increases gas production, solids destruction, and pathogen inactivation. TAD can accommodate approximately double the OLR of MAD, up to 0.4-pound VS per cubic foot per day (lb-VS/ft3-d).

Thermophilic digestion can be configured to generate Class A biosolids. This can be accomplished with batch tanks, for example, where the sludge is held for 24 hours at thermophilic temperatures (131°F or greater) to meet EPA requirements for Class A. Some wastewater treatment facilities, like the City of Los Angeles, have produced Class A biosolids using thermophilic digestion with limited-size batch tanks, which results in somewhat less time and temperature stipulated by the Class A criteria; however, additional sampling and testing of the biosolids is required to demonstrate Class A compliance in such instances.

B.3.4 Multi-Stage Digestion

Multi-stage digestion refers to two distinct operations for digesters. One example of two-stage digestion configuration is acid-phase and gas-phase anaerobic digestion. In this configuration, the first stage operates at a low SRT and primarily serves to form acids. The second stage primarily serves to produce methane and further destroy volatile solids. As the names suggest, acid-phase digestion has low pH and a high concentration of volatile fatty acids (VFAs). The gas from acid-phase digesters have low energy value and high hydrogen sulfide (H_2S) concentration. The potential process benefits of this system and improved kinetics relative to conventional mesophilic anaerobic digestion. Facilities with acid-phase gas-phase digestion need to consider management of two separate digester gas piping systems and proper safety protocols around the acid-phase digester, which has high H_2S concentrations.

B.3.5 Mesophilic Anaerobic Digestion + Post Aerobic Digestion

Anaerobic and post aerobic digestion can be phased in an attempt to optimize VS destruction. This configuration is less common than single stage digestion (e.g., mesophilic anaerobic digestion), but has been studied to evaluate potential process benefits. Nitrogen removal and potential improvements to mechanical dewatering are some of the benefits suggested by studies with a post aerobic digester (Water Environment Federation [WEF], 2023). Digesters in this configuration can be operated at either mesophilic or thermophilic temperatures.

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B.3.6 Recuperative Thickening

Recuperative thickening decouples the SRT and HRT in the anerobic digestion process. Solids are captured and returned to the digester and a separate return stream with low solids concentration and loading is returned to the liquid treatment process. This operation increases the digester TS concentration and allows for higher flows to be processed by the digestion process. This configuration requires dedicated thickening equipment and piping to perform the recuperative thickening process.

B.3.7 High Solids Digestion

High solids digestion is defined here as solids above concentrations that are conventionally pumpable and mixable within a conventional anaerobic digester (e.g., TS above 20 percent). Due to sludge rheology at high concentrations, high solids digestion processes are typically operated differently than conventional mixed systems. High solids digestion may be operated as batch or continuous processes, and for mixed systems the mixing approaches differs from more conventional digestion processes (Akinbomi et al., 2022).

B.4 Aerobic Digestion

Aerobic digestion is an alternative stabilization approach with benefits and disadvantages when compared to anaerobic digestion. Aerobic digestion can designed for batch or continuous operation. Reactors are provided with oxygen for VS destruction and sludge stabilization. This process does not produce biogas for beneficial reuse, but the aerobic conditions minimalize odors and also limit safety risks associated with anaerobic digesters. Aerobic digestion is usually more advantageous for smaller facilities due to relative operational simplicity and lower costs compared to anaerobic digestion (WEF, 2023).

B.4.1 Conventional Aerobic Digestion

Conventional aerobic digestion requires reactors for digestion, blowers and diffusers for air and oxygen transfer, pumps for sludge transfer. Mixing can typically be achieved using the process air that also provides oxygen.

B.4.2 Auto-thermophilic Aerobic Digestion (ATAD)

The auto-thermophilic aerobic digestion (ATAD) process has a target solids concentration above 5 percent so that heat from biological reactions can be used to raise the digester temperature (WEF, 2023). The process can be operated in a single or multi-stage configuration, and can be operated continuously or in batches. This process has additional design and operational considerations and complexities compared to conventional aerobic digestion, but process benefits may include less oxygen (and energy) required for digestion and the potential for improved dewaterability. This process can produce Class A biosolids.

B.4.3 Aerobic/Anoxic Digestion

Aerobic/anoxic digestion operates in alternating modes. The anoxic phase, similar to liquid treatment processes, allows for denitrification to occur. During aeration, ammonia is converted to nitrite and nitrate. In the absence of oxygen (anoxic) organism convert nitrite and nitrate to di-nitrogen gas (N2) using organic carbon, and this process recovers alkalinity. The aerobic/anoxic digestion therefore can result in energy and cost savings because of lower oxygen and chemical requirements.

B.5 Composting

Composting produces a more stable end-use product and is compatible downstream of other sludge stabilization configurations. Composting product can improve soil properties and act as a fertilizer. Composting is an aerobic process that generates heat as organic matter is decomposed.

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B.5.1 Windrow

Windrow composting consists of compost piles formed in windrows, which are long rows of product allowing for drying and ease of access to mix the piles. Windrows are mixed periodically to cool material, provide air, and release moisture. Windrow composting can be outside or covered. Windrow composting requires a large footprint due to the configuration of windrow piles.

B.5.2 Enclosed/In-Vessel

Enclosed/in-vessel composting systems include agitated bay systems, like the existing system previously operated by the City. Agitated bay systems can be installed indoors. Bays are organized in long rows, similar to windrows, but less space is required because the mixing is completed via an overhead agitator. New feed is loaded on one end of the bay, and the agitator mixes and moves the material down the row. Air is supplied via fans to each pile. Figure B-2 shows the City's existing enclose composting system.

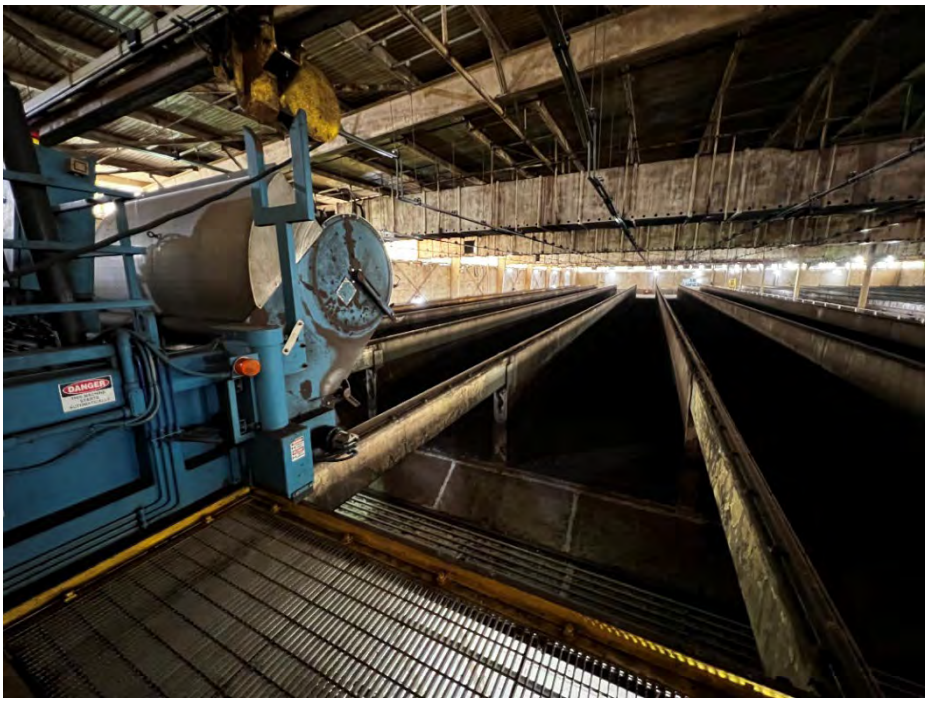


Figure B-2. Inside the City of Santa Rosa Composting Facility

B.5.3 Aerated Static Pile

Aerated static pile composting consists of piles on top of an aerated floor. Blowers are designed to provide air through the floor. After sufficient composting time (about 21 to 28 days) the material is screened and cured (WEF, 2023), and curing is typically 30 days. Aerated static pile composting can be done under cover or in an enclosed facility.

B.5.4 Membrane Covered Pile

Membrane covered pile composting is more sophisticated than aerated static pile and is relatively newer. In this configuration, piles are covered with a membrane that traps moisture and odors but allows oxygen and carbon dioxide transfer. Aeration is provided via an aerated floor, and sensors are used to control aeration. There is a 28-day initial composting period followed by 14-day secondary composting period, both covered. The process is finished with a final 14-day period of aerated composting without a cover (WEF, 2023). This process claims reduced odors compared to other methods.

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B.5.5 Vermi-Composting

Vermi-composting uses worms to digest and decompose material. This approach has relatively low operational cost but is more novel than other biosolids composting approaches.

B.6 Drying

B.6.1 Direct Thermal Drying

Direct Drum dryers is a direct drying process that mixes heated air with biosolids. The heated air comes in contact with the biosolids in a rotating drum, evaporates water from the biosolids, and produces a granule. Drying begins when dewatered sludge is mixed with the recycled solids to control the moisture content of the mixture and minimize sticking to the inner surface of the drum and to allow the wetter sludge to absorb the finer solids coming from the crusher. Air heated to between 850°F and 950°F is introduced in the drum while the sludge mixture tumbles through and exits the other end. From the dryer, the dried solids are fed to a separator to separate the hot air from the solids. The solids are then screened; particles of the appropriate size are conveyed to storage silos while other solids are sent to a crusher. Crushed biosolids are blended with fresh dewatered sludge as described previously. Air emission and odor control systems consist of polycyclones, impingement trays, condensers/sub-coolers, venturi scrubbers, and regenerative thermal oxidizers for the process of off-gas emission control. Up to 75 percent of exhaust gas recirculation is applied to increase the efficiency of the drying system and reduce total dryer system air emissions and odor potential.

B.6.2 Indirect Thermal Drying

Indirect thermal drying uses a separate material to transfer heat to biosolids instead of heated air. Indirect thermal drying processes include fluidized bed dryers, paddle dryers, and tray dryers.

B.6.3 Solar Drying

Solar drying uses radiant and convective heat transfer methods in a greenhouse system to dry the solids. The greenhouse system is typically constructed with multiple large bays that allow for isolating a bay once it is fully loaded or allows for continuous throughput through multiple bays. Dewatered solids are spread within a drying chamber, and various types of mixing systems are used to expose wetter material to the greenhouse atmosphere and move the material from one end of the bay to the other end. A microprocessor controls vents and fans to optimize the humidity level within the chamber to promote drying. Foul air/odor control is used for installations that are located close to sensitive development. Solar drying is typically used to dry to between 40 and 90 percent total solids (TS). The relatively higher TS concentrations require more time in the drying chamber and can create sufficient dust for safety concerns. Demonstrating compliance of solar drying with Class A criteria has been difficult and typically only occurs if the biosolids reach around 90 percent or more TS. The primary advantage of solar drying is the low energy needed to create a partially dried or largely dried biosolids product. The primary disadvantages of solar drying are that it requires significant site space and usually results in a large range of particle sizes which make product marketing and/or land application more challenging.

B.7 Chemical Stabilization

Chemical stabilization can produce Class A products but require chemicals, and therefore operational costs are typically increases relative to facilities without downstream chemical stabilization.

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B.7.1 Alkaline Stabilization

Alkaline stabilization can be used on untreated biosolids to stabilize sludge. Sufficient chemical dose and type, contact time, temperature, pH, and mixing should be considered to verify compliant biosolids product. Alkaline stabilization requires storage and potentially on-site processing equipment for alkaline chemicals. Chemicals need to be mixed with biosolids and held for a sufficient time at a target pH (greater than 12 for 2 hours). The pH must remain elevated (above 10.5) to ensure biosolids are stable (WEF, 2023).

B.7.2 Lystek

Lystek is a Canadian company with several full-scale installations in Canada and one full-scale installation in the United States. Lystek uses a process that thermally hydrolyzes the solids after dewatering. This process can be performed on digested or raw sludge, but most typically on digested sludge. The result is a Class A fertilizer product. Additionally, Lystek claims that the solid material that has undergone its process can be fed back into the digester to provide more biogas production and higher VSR. It can also be used as a carbon source for biological nutrient removal. Lystek opened its first U.S. installation in Fairfield, California, in 2016. This is a regional facility treating solids from several Bay area treatment plants, roughly equivalent to the solids production from a 150 mgd treatment plant. There are concerns whether the product meets vector attraction reduction requirements.

B.8 High Temperature

High temperature processes include thermal oxidation (i.e., incineration), pyrolysis, and gasification.

B.8.1 Incineration

Fluidized bed reactor and multiple hearth furnace incinerators provide maximum destruction of organic matter using combustion. Fluidized bed reactor incinerators use sand as the fluidized medium. Air is distributed to the sand and biosolids are added into the reactor for incineration. Design of subsystems are required to control air, sludge, sand, auxiliary fuel, preheating, water, temperature, oxygen, and exhaust gas. Multiple hearth furnace incinerators feed sludge to the system at the top and sludge stabilized then cooled through the multiple stages. This process differs from fluidized bed reactors, but has similar permitting considerations with respect to exhaust gas and air quality.

B.8.2 Pyrolysis

Pyrolysis is a thermochemical conversion process that is performed in the absence of oxygen. Pyrolysis systems tested to date with biosolids require drying of the solids prior to being introduced into the pyrolysis unit. The process converts the biosolids to biochar and syngas. Pyrolysis occurs at a range of high temperature typically between 570°F to 1,560°F. The syngas is a low-grade energy source with a heat value that ranges usually between 350 and 600 Btu per standard cubic foot and is composed of a mixture of primarily CH_4, CO_2, and hydrogen, along with other gases. The biochar has the capability to be sold as a slow-release fertilizer. However, the market is currently not well established.

Pyrolysis of biosolids is an emerging technology in the United States, with one full-scale facility in operation at Silicon Valley Clean Water in the San Francisco Bay Area (3 biodryers and one pyrolysis unit). Another full-scale facility is current under construction in Rialto, CA. The Rialto Bioenergy Facility was commissioned by Anergia and will process up to 300 tons-per-day of dewatered biosolids through pyrolysis and produce up to 30 tons-per-day of fertilizer. Additionally, a system supplier, KORE Infrastructure, conducted a 6-year pilot test at Los Angeles County Sanitation District that concluded in 2015. KORE is planning for a full-scale system in San Bernardino County with a capacity of reportedly 150 dtpd.

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B.9 Lagoons

Lagoon systems provide potential benefits for facilities with available footprint and desiring simple operations and low costs.

References

Akinbomi, J.G., Patinvoh, R.J., Taherzadeh, M.J., *Current challenges of high-solid anaerobic digestion and possible measures for its effective application: a review*, Biotechnology for Biofuels and Bioproducts, 2022.

Water Environment Federation, *Solids Process Design and Management, 2nd Edition,* 2023.

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Attachment C: BC:SWEET Assumptions and Inputs

Detailed and complete information used in BC:SWEET (Solids Water Energy Evaluation Tool)

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C.1 BC:SWEET Assumptions and Inputs

Table C-1 presents all assumptions used in BC:SWEET. Assumptions impact process performance predictions and annual operating costs and benefits. The refined capital cost estimates are presented in Attachment D.

C.2 BC:SWEET Baseline Model

A BC:SWEET baseline model was built using the calibrated mass balance information detailed in TM 1. The results of the mass balance were captured in BC:SWEET in a baseline model to validate model predictions. The status quo alternative was built to mimic the baseline model, and this alternative (Alternative 01) served as a basis for comparison between all initial and refined alternatives.

Each input stream and solids treatment unit process are captured in BC:SWEET using a module. Each model requires process and energy inputs (See Table C-1) and the model performs solids and power calculations on an annual average basis. The baseline model was built using 2-year average waste activated sludge (WAS) and primary sludge (PS) projections. WAS thickening was modeled using gravity belt thickeners (GBT) to produce thickened waste activated sludge (TWAS). HSW was input and the combined PS, TWAS, and HSW sludge was modeled through anaerobic digestion. The model included belt presses (BP) to predict dewatered Class B cake production. Model inputs for combined heat and power (CHP) engines and dilution water were used to predict energy and heat production and Class B cake percent solids, respectively.

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	Units	Value	Comments/Source
Solids Loading 2023			
PS TS loading	lb-TS/day	36,300	Biosolids Management Strategic Plan (BMSP) TM 1
PS VS Loading	lb-VS/day	31,200	BMSP TM 1
PS %TS	%TS	4.5%	BMSP TM 1
PS %VS	%VS	86.0%	BMSP TM 1
WAS TS Loading	lb-TS/day	22,200	BMSP TM 1
WAS %TS	%TS	0.66%	BMSP TM 1
WAS %VS	%VS	83.00%	BMSP TM 1
TWAS TS Loading	lb-TS/day	20,000	BMSP TM 1
TWAS Solids VS Loading	lb-VS/day	16,600	BMSP TM 1
TWAS %TS	%TS	4.7%	BMSP TM 1
TWAS %VS	%VS	83%	BMSP TM 1
HSW TS Loading	lbs-TS/day	15,763	BMSP TM 1
HSW TS Loading Mid (Permitted)	lbs-TS/day	24,169	BMSP TM 1
HSW TS Loading HIGH	lbs-TS/day	48,339	BMSP TM 1
High Strength Waste%TS	%TS	6.3%	BMSP TM 1
High Strength Waste %VS	%VS	92%	BMSP TM 1
HSW Nitrogen Content	%N	7%	Quality of Biogas Derived from Wastewater, Solids and Co-digested Organic Wastes – A Characterization Study (Water Research ,)
Food Waste TS Loading	lbs-TS/day	32,526	Based on 30,000 gpd of Food Waste
Food Wate %TS	%TS	13%	Trucked Waste Program Evaluation - TM 2 Process and Physical Enhancements
Food Waste % VS	%VS	90%	Trucked Waste Program Evaluation - TM 2 Process and Physical Enhancements

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	Units	Value	Comments/Source
Solids Loading 2053			
Primary Solids TS loading	lb-TS/day	48,000	BMSP TM 1
Primary Solids VS Loading	lb-VS/day	41,200	BMSP TM 1
Primary Solids %TS	%TS	4.5%	BMSP TM 1
Primary Solids %VS	%VS	85.8%	BMSP TM 1
WAS TS Loading	lb-TS/day	29,193	BMSP TM 1
WAS %TS	%TS	0.60%	BMSP TM 1
TWAS TS Loading	lb-TS/day	26,300	BMSP TM 1
TWAS Solids VS Loading	lb-VS/day	21,900	BMSP TM 1
TWAS %TS	%TS	4.7%	BMSP TM 1
TWAS %VS	%VS	83%	BMSP TM 1
High Strength Waste %TS	%TS	6.3%	Biosolids Management Strategic Plan – TM 1
High Strength Waste %VS	%VS	92%	Biosolids Management Strategic Plan – TM 1
VSR Parameters			
Primary Solids Meso Digestion VSR	% VSR	65.0%	From recommendations per mass balance in BMSP TM 1
Primary Solids THP+Meso Digestion VSR	% VSR	65.0%	Per Brown and Caldwell (BC) Subject Matter Expert
Primary Solids Thermo (12 Day HRT) Digestion VSR	% VSR	65.0%	Per BC Subject Matter Expert
Primary Solids Meso (12 Day HRT) VSR	%VSR	60.0%	Per BC Subject Matter Expert
Primary Solids High Solids Digestion VSR	%VSR	65.0%	Per BC Subject Matter Expert
TWAS Solids Meso Digestion VSR	% VSR	32.0%	From recommendations per mass balance in BMSP TM 1
TWAS Solids THP+Meso Digestion VSR	% VSR	60.0%	Per BC Subject Matter Expert
TWAS Solids Thermo Digestion VSR	% VSR	33.0%	Per BC Subject Matter Expert (assumes 12 Day SRT)
TWAS Solids Meso (12 Day HRT) VSR	% VSR	30.0%	Per BC Subject Matter Expert
TWAS High Solids Digestion VSR	% VSR	32.0%	Per BC Subject Matter Expert
HSW VSR	% VSR	90.0%	From recommendations per mass balance in BMSP TM 1
FW VSR	%VSR	90.0%	Per BC Subject Matter Expert. Refine to lower VSR if specific FW feed stock is identified or alternative is advanced.

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	Units	Value	Comments/Source
End Use Assumptions			
Months Lystek Utilized	Months	6.00	From Lystek Contract, months include November 1 through April 30
Storage at Alpha Barn	WT	7000	per June 1, 2023 check-in meeting correspondence with Zach and Donald
Additional Storage	WT	1000	per correspondence with Zach and Donald
Land Acquisition Cost	$/Acre	8000	per email correspondence with Zach and the City of Santa Rosa
Land Application Wet Tons per Acre	WT/Acre	10	Per July 6, 2023 Initial Alternatives Workshop meeting minutes
Total Land Available for App, Class B	Acres	2662	Total Acres as provided by the City. Both this value and the WT Per Acre value include acres with setback restrictions.
Percent of Land Available for App, Class B with Setback Restrictions	Acre/Acre	0.12	Per land app analysis; Not used in analysis
Total Land Available for App, Class A	Acres	800	Per July 6, 2023 Initial Alternatives Workshop meeting minutes
Biosolids Nitrogen Content	%	6.9%	From historical data, per BMSP TM 3
Historical End Use Target % TS	%	15%	Based on review of historical data, approximate and used to calculate planning level nitrogen land application limit.
Compost Max WT Allowed	WT/d	30	Per correspondence with City based on historical operation experience
Winter Months (Biosolids Storage Required)	Months	6	Assumed per typical rain pattern, presented in July 6, 2023 workshop
To Compost 2023	%	31.6%	Calculated based on 30 WT/d assumption and predicted final WT/d produced
To Compost 2053	%	24.9%	Calculated based on 30 WT/d assumption and predicted final WT/d produced
Chemical Loading			
GBT Polymer Dose	lb/dry ton	3.72	Per data shown in BMSP TM1
GBt Polymer Dose - Metric Units	g/kg	1.86	For recuperative thickening alternative in SWEET
Belt Press Polymer Dose	lb/dry ton	16.1	Per data shown in BMSP TM1
Centrifuge Polymer Dose	lb/dry ton	25.0	Assumed based on EPA publication (https://www3.epa.gov/npdes/pubs/centrifuge_thickening.pdf)
Ferric Dosage	gal/scfm produced	0.6	Per ferric dose data provided by City

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	Units	Value	Comments/Source
Dewatering			
GBTs Performance (Capture)	% TS Removed	90.0%	Per mass balance in BMSP TM 1
GBT Cake Concentration Raw WAS	% TS	4.7%	Per mass balance in BMSP TM 1
Digestion			
Meso Digestion Sludge Inlet Temp	F	68	Typical for Meso Digestion
Meso Digestion Operation Temp	F	98	Typical for Meso Digestion
Meso Shell Losses	%	15%	Typical for Meso Digestion
Thermo Digestion Sludge Inlet Temp	F	68.0	Typical for Thermo Digestion
Thermo Digestion Operation Temp	F	130	Typical for Thermo Digestion
Thermo + HSW Digestion cellulosic conversion	scf/lb-VSd	17	Includes HSW
Thermo Shell Losses	%	10%	Typical for Thermo Digestion
Calorific Value of Sludge	btu/lbvs	10,000	Typical for Digestion/Sludge
THP Sludge Inlet temp	F	98	Typical for Thermo Digestion
Inert Solids Assumptions	%	10%	Per mass balance in BMSP TM 1
Thickening			
Existing Belt Press Performance	%TS Captured	96.0%	Per mass balance in BMSP TM 1
Meso Digestion Belt Press %TS	%TS	15.0%	Per mass balance in BMSP TM 1
Existing Dilution Water	lb/day	22,100	Calculated to achieve dilution down to %TS measured at the City's biosolids hoppers
Thermo Digestion Belt Press %TS	% TS	15.0%	Per BC Subject Matter Expert
THP + Meso Digestion Belt Press % TS	% TS	25.0%	Per BC Subject Matter Expert
Centrifuge Performance	%TS Captured	96.0%	Assumed to Match BP for SWEET mass balance
Meso Digestion Centrifuge %TS	%TS	25.0%	Per BC Subject Matter Expert
THP + Meso Digestion Centrifuge % TS	%TS	25.0%	Per BC Subject Matter Expert
Thermo Digestion Centrifuge %TS	%TS	21.0%	Per BC Subject Matter Expert

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	Units	Value	Comments/Source
Thermal Drying Parameters			
Thermal - Belt Dryer			
90% Thermal Dryer Solids Content	%	90%	Typical for Thermal Dryers (90 to 92% TS)
50% Thermal Dryer Solids Content	%	50%	Assumed to model scenario with drying of part of dewatered biosolids; Drying to 50% TS not recommended due to ignition risk
Thermal Drying Heat Consumed-High	BTU/lb	1,500	Per BC Subject Matter Expert
Thermal Drying Shell Heat Loss	%	5%	Per BC Subject Matter Expert
Thermal Dryer Inlet Temp	F	60	Typical for Thermal Dryers
Thermal Dryer Outlet Temp	F	220	Typical for Thermal Dryers
Nitrogen Removal from Thermal Drying	%	10.00%	Percent based on volume reduced - Paper states 10% of nitrogen in dewatered sludge or 5 g-N/kg TS vaporized during drying
Thermal Hydrolysis			
Pre-dewatering Capture - PS + WAS	%	100%	Assumed as 100% capture to account for recycle that would come back to solids stream
Pre-dewatering Solids Content Goal- PS + WAS	%TS	18%	Typical for THP
Steam Demand	lb steam/lb TS	1.1	Typical for THP
Sludge Inlet Temp	F	122	Typical for THP
Sludge Operation Temp	F	320	Typical for THP
Boiler Efficiency for THP	%	80%	Typical for THP
Boiler Feedwater Temperature	F	110.00	Typical for THP
Heat required for steam generation (Btu/lb steam)	BTU/lb steam	1,196.37	Calculated
Dilution Water Before THP	lb/day	38,730.00	Calculated with Goal seek to determine water required to meet desired %TS
Dilution Water After THP	lb/day	400,000.00	Calculated with Goal seek to determine water required to meet desired %TS, Desired %TS calculated to ensure ammonia toxicity would not occur, see THP HSW Tabs
Dilution Water After THP - MID HSW	lb/day	525,000	Calculated with Goal seek to determine water required to meet desired %TS
Dilution Water After THP - High HSW	lb/day	800,000	Calculated with Goal seek to determine water required to meet desired %TS
2053 Dilution Water Before THP	lb/day	52,215	Calculated with Goal seek to determine water required to meet desired %TS

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	**Units**	**Value**	**Comments/Source**
2053 Dilution Water After THP	lb/day	23,345	Calculated with Goal seek to determine water required to meet desired %TS
Dilution Water After THP Low	lb/day	510,000	Calculated with Goal seek to determine water required to meet desired %TS, Desired %TS calculated to ensure ammonia toity would not occur, see THP HSW Tabs
Dilution Water After THP - MID HSW	lb/day	600,000	Calculated with Goal seek to determine water required to meet desired %TS
Dilution Water After THP - High HSW	lb/day	1,293,260.66	Calculated with Goal seek to determine water required to meet desired %TS
Steam Pressure	PSI	149.7	Per BC Subject Matter Expert
Cogeneration			
Thermal Efficiency	%	38%	Per City's historical and engine data, typical source for cogeneration assumptions
Electrical Efficiency	%	35%	
Number of Engines running at once	No.	3	Average Number of Engines running at once
Max Electrical Output	kW	2867	
Average Electrical Output	kW	1700	
Max Electrical Output MMBTU/hr	MMBtu/hr	28	Calculated
Engine Uptime	%	90%	
Biogas Utilized in Cogen	%	97%	
NG Utilized in Cogen Status Quo	scfh	3003	
Boilers			
Thermal Efficiency	%	85.0%	Typical assumption for SWEET
Lower Heating Values (LHV)			
Natural Gas Volumetric Heat Capacity, LHV	BTU/scf	950.0	Typical assumption for SWEET
Digester Gas Volumetric Heat Capacity, LHV	BTU/scf	560.0	Typical assumption for SWEET
Sidestream Assumptions			
TWAS Soluble Nitrogen	mg/L	14.10	Assumed per review of City's effluent total nitrogen data
TWAS particulate TKN/VSS ratio	g/g	0.05	Metcalf and Eddy Biomass 0.07 g-N/g-COD/1.42 g-COD/g-VSS
TWAS Soluble Phosphorous	mg/L	1.70	Assumed per review of City's effluent total phosphorus data
TWAS particulate P/VSS ratio	g/g	0.015	Metcalf and Eddy .022 g-P/g-COD/1.42 g-COD/g-VSS
Primary Solids Soluble Nitrogen	mg/L	37.00	Assumed per review of City's influent ammonia data

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	Units	Value	Comments/Source
Primary Solids particulate TKN/VSS ratio	g/g	0.03	Assumed per Metcalf and Eddy typical nitrogen content in untreated primary sludge
Primary Solids Soluble Phosphorous	mg/L	4.80	Assumed per review of City's total phosphorus data
Primary Solids particulate P/VSS ratio	g/g	0.0052	Assumed per Metcalf and Eddy phosphorus content in untreated primary sludge
HSW Soluble Nitrogen	mg/L	600	based on project experience HSW wastewater characterization data
HSW particulate TKN/VSS ratio	g/g	0.020	based on WRF Understanding Impacts of Co-Digesiton Final Report (2017)
HSW Soluble Phosphorous	mg/L	200	based on project experience HSW wastewater characterization data
HSW particulate P/VSS ratio	g/g	0.010	based on WE&RF Understanding Impacts of Co-Digesiton Final Report (2017)
Food Waste Soluble Nitrogen	mg/L	5000	based on WE&RF Understanding Impacts of Co-Digesiton Final Report (2017)
Food Waste particulate TKN/VSS ratio	g/g	0.03	based on WE&RF Understanding Impacts of Co-Digesiton Final Report (2017)
Food Waste Soluble Phosphorous	mg/L	300.00	based on project experience HSW wastewater characterization data
Food Waste particulate P/VSS ratio	g/g	0.01	based on WE&RF Understanding Impacts of Co-Digesiton Final Report (2017)
Energy Consumption			
GBTs Energy	hp	42.0	2 units*(1 hp hydraulic power unit+5 hp wash water booster pump+15 hp TEFC motor in TWAS progressive cavity pump)
GBTs Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
Meso Digestion Energy	hp	310.0	Typical based on BC SWEET planning level calculation experience
Meso Digestion Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
Belt Press Energy	hp	100.0	Typical based on BC SWEET planning level calculation experience
Belt Press Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
Cogen Energy	%-kw produced	8%	Typical based on BC SWEET planning level calculation experience
Cogen Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
Boilers Energy	hp	30.0	Typical based on BC SWEET planning level calculation experience
Boilers Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
Thermo Digestion Energy	hp	400.0	Typical based on BC SWEET planning level calculation experience
thermo Digestion Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
THP Energy	hp	400.0	Typical based on BC SWEET planning level calculation experience

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	Units	Value	Comments/Source
THP Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
THP-Predewatering	HP	200.0	Typical based on BC SWEET planning level calculation experience
THO Predewatering Eff	%	0.9	Typical based on BC SWEET planning level calculation experience
Dilution Water HP	HP	3.0	Typical based on BC SWEET planning level calculation experience
Dilution Water Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
Centrifuges Energy	hp	245.0	1* (125 hp main motor + 40 hp back drive motor) + 2*40 hp cake pumps
Centrifuges Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
Thermal Dryers Energy	hp	500.0	Typical based on BC SWEET planning level calculation experience
Thermal Dryers Efficiency	%	0.9	Typical based on BC SWEET planning level calculation experience
Conveyance Energy Efficiency	hp	40.5	4*3 hp motor conveyor+ 5 hp + 5 hp+7.5 hp+5hp+2*3 hp motors for conveyors
Conveyance Efficiency	%	90%	Typical based on BC SWEET planning level calculation experience
Average Plant Demand	MW	4	Typical based on BC SWEET planning level calculation experience
Recuperative Thickening	HP	20	Typical based on BC SWEET planning level calculation experience
Recuperative Thickening	Eff	90%	Typical based on BC SWEET planning level calculation experience
Economic Assumptions - Rates and Costs			
Gas and Electricity Cost			
Natural Gas Cost	$/therm	0.5	Based on 2021 data
Unblended Electricity Cost	$/kWh	0.16	Assumed Secondary Voltage
Max Demand Charge (summer and winter)	$/kW	29.78	
Peak Demand Charge (Summer and Winter)	$/kW	12.7	Weighted average of summer and winter peak demand charge
Reservation Charges	$/kW	10.58	
Total Engine Reservation	kW	3400	Reservation applies to 85% of reservation capacity, assumed 4MW of installed engine capacity and 85% reserved

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	Units	Value	Comments/Source
Labor Cost			
Maintenance & operations cost	$/hr	175	
THP Labor	FTE 2080 hr/yr	2	
Anaerobic Digestion (Mesophilic) Labor	FTE 2080 hr/yr	2	
Anaerobic Digestion (Thermophilic) Labor	FTE 2080 hr/yr	2	
GBTs	FTE 2080 hr/yr	1	
Class B Hauling Labor	FTE 2080 hr/yr	2	
Belt Press Labor	FTE 2080 hr/yr	1	
Centrifuge Labor	FTE 2080 hr/yr	1	
Thermal Dryer Labor	FTE 2080 hr/yr	2	per 06-01-23 check-in meeting with Zach and Donald
Cogeneration Engine Labor	FTE 2080 hr/yr	1	
Compost FTEs	FTE 2080 hr/yr	8	per 06-01-23 check-in meeting with Zach and Donald
HSW Labor - Offloading	FTE 2080 hr/yr	1.3	Per Trucked Waste Program Evaluation TM 1
Operation and Maintenance			
Cogen O&M	$/yr	$620,000	Per Trucked Waste Program Evaluation Report (Brown and Caldwell, 2023)
Cogen O&M	$/kWh	$0.041	Per Trucked Waste Program Evaluation Report (Brown and Caldwell, 2023)
HSW	$/yr	$40,000	Per Trucked Waste Program Evaluation Report (Brown and Caldwell, 2023)
Nitrogen	$/lb-N	1.37	Per Trucked Waste Program Evaluation Report (Brown and Caldwell, 2023)
Cost to Treat HSW	$/1000 gal	9.68	Per Trucked Waste Program Evaluation Report (Brown and Caldwell, 2023)
Chemical Cost			
GBT Polymer Unit Cost	$/lb	0.35	Per pricing provided by Christian Williams via email (May 23, 2023)
BP Unit Cost	$/lb	1.75	Per pricing provided by Christian Williams via email (May 23, 2023)
Centrifuge Polymer Cost	$/lb	2.65	Per EPA guidance (https://www3.epa.gov/npdes/pubs/centrifuge_thickening.pdf)
Ferric Sulfate	$/gal	3.44	
Sales Tax	%	9%	Per pricing provided by Christian Williams via email (May 23, 2023)

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Table C-1. BC:SWEET Assumptions and Model Inputs			
Parameter	Units	Value	Comments/Source
Hauling Cost & Tip Fees			
Biosolids Class A Management-Hauling/Tip Fee (Combined)	$/WT	40	Assumes Class A program management is same as Class B
Lystek Tip Fee 13%	$/WT	65	Calculated per pricing information suggested by James (Jim) Dunbar, Lystek
Lystek Tip Fee 15%	$/WT	84	Calculated per pricing information suggested by James (Jim) Dunbar, Lystek
Lystek Tip Fee 25% TS	$/WT	179	Calculated per pricing information suggested by James (Jim) Dunbar, Lystek
Lystek On Site Fee 15% - includes onsite discount	$/WT	80	Contract Price for On-site Lystek (not including hauling)
Lystek Hauling Fee	$/WT	24	Assuming 60 miles/truck x 2 (round trip) x $0.10/mile x 2 (two trucks a day)
Biosolids Class B Management- Hauling	$/WT	40	Per TM 3 - Reg and Market Assessment
Cost to Compost/ Management	$/WT	129	FW Revised Biosolids Options Analysis_Update.msg
Compost Revenue	$/WT	8.05	Per TM3 workshop meeting minutes. Compost revenue converted to WT using Compost weight charts (approximate) assuming an average of 60 %TS.
HSW Tipping Fee Revenue	$/kgal	40.00	HSW tipping fee revenue per the City's posted tipping fees
FW Tipping Fee Revenue	$/kgal	20.00	Assumed as half the HSW tipping fee; to be verified with a food waste provider
Economics			
Discount Rate	%	4.0%	Typical BC assumption for NPV analyses in Summer 2023
Escalation Rate	%	2.8%	Typical BC assumption for NPV analyses in Summer 2023
Start Year	Year	2024	Based on time of evaluation; next calendar year
NPV Analysis Duration	year	30	30-year lifecycle per project scope
R&R	%	2.5%	Typical BC assumption for NPV analyses in Summer 2023
Lystek Escalation Sensitivity	%	5.6%	Parameter for sensitivity analysis; twice the general escalation rate

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References

Higgins, M., Rajagopalan, G., *Understanding Impacts of Co-Digestion: Digester Chemistry, Gas Production, Dewaterability, Solids Production, Cake Quality, and Economics*, Water Environment & Reuse Foundation, 2017.

Tchobanoglous, G., Stensel, H. D., Tsuchihashi, R., Burton, F., *Wastewater Engineering Treatment and Resource Recovery, Fifth Edition*, Metcalf and Eddy, AECOM, 2014.

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Attachment D: Capital Cost Estimation Sheets

Capital cost estimates used in the refined alternatives analysis

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[TM2-BC-01] HSW Odor Scrubber Improvements (Class V Cost Estimate)			
Item	Unit Cost / Allowance	Item Cost	Notes
(1) Odor Control System, including: (1) Drum Scrubber (1) Full charge of absorb media (1) 1000cfm blower	$ 25,725 $/System	$ 26,000	vendor provided package
(1) Electronic media bed monitor	$ 6,500 $/System	$ 7,000	Monitor not required
A - Subtotal Construction Materials and Equipment Cost		$ 33,000	
Demolition	25% of "A"	$ 8,000	
Structural	15% of "A"	$ 5,000	
Process Piping	20% of "A"	$ 6,000	
Electrical	20% of "A"	$ 6,000	
Instrumentation and Controls	25% of "A"	$ 8,000	
Excavated Soil Disposal	5% of "A"	$ 2,000	
B - Total Construction Materials and Equipment Costs		$ 68,000	
Startup and Construction Sequencing	5% of "B"	$ 3,000	
General Conditions	10% of "B"	$ 7,000	
Contractor Overhead and Profit	15% of "B"	$ 10,000	
Sales Tax	9.25% 1/2 of "B"	$ 3,000	
C - Subtotal Construction Costs		$ 91,000	
Escalation to Midpoint	8.00% of "C"	$ 7,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		$ 98,000	
Construction Contingency	50% of "D"	$ 49,000	
E - Total Construction Costs		$ 147,000	
Planning and Permitting	5% of "E"	$ 7,000	
Engineering	0% of "E"	$ -	City managing project in house
Construction Management + ESDC	0% of "E"	$ -	City managing project in house
Total Project Cost		$ 150,000	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

[TM2 -BC-02] Digester Sludge to Dewatering Pump (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) Progressive Cavity Pump Units	$ 31,541 $/EA	$ 63,000	vendor provided package
A - Subtotal Construction Materials and Equipment Cost		**$ 63,000**	
Demolition	15% of "A"	$ 9,000	
Structural	10% of "A"	$ 6,000	
Process Piping	15% of "A"	$ 9,000	
Electrical	25% of "A"	$ 16,000	
Instrumentation and Controls	20% of "A"	$ 13,000	
B - Total Construction Materials and Equipment Costs		**$ 116,000**	
Startup and Construction Sequencing	5% of "B"	$ 6,000	
General Conditions	10% of "B"	$ 12,000	
Contractor Overhead and Profit	15% of "B"	$ 18,000	
Sales Tax	9.25% 1/2 of "B"	$ 5,000	
C - Subtotal Construction Costs		**$ 160,000**	
Escalation to Midpoint	8% of "C"	$ 13,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 173,000**	
Construction Contingency	50% of "D"	$ 85,000	
E - Total Construction Costs		**$ 258,000**	
Planning and Permitting	5% of "E"	$ 13,000	
Engineering	40% of "E"	$ 102,000	Lower engineering & ESDC
Construction Management + ESDC	40% of "E"	$ 102,000	if combined with other work
Total Project Cost		**$ 480,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

[TM2-BC-03] Ferric Chloride Tank Improvements (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(1) Ferric Chloride Tank System, including: (2) Primary Tank (2) Tank Base (2) Manway (2) Fittings including Dome, Dome Flat, IMFO, & Sidewalls (2) Venting (2) Nameplate (2) Restraint System (2) Expansion Joint	$ 75,000 $/System	$ 75,000	vendor provided inclusive package 8,100 Gallon IMFO D: 11'-"11 H:11'-10" Manway size 24"
A - Subtotal Construction Materials and Equipment Cost		**$ 75,000**	
Demolition	30% of "A"	$ 23,000	Demo existing Ferric Chloride Tanks
Shoring and Dewatering	5% of "A"	$ 4,000	
Civil	10% of "A"	$ 8,000	
Structural	10% of "A"	$ 8,000	
Process Piping	20% of "A"	$ 15,000	
Electrical	20% of "A"	$ 15,000	
Instrumentation and Controls	25% of "A"	$ 19,000	
Excavated Soil Disposal	5% of "A"	$ 4,000	
B - Total Construction Materials and Equipment Costs		**$ 171,000**	
Startup and Construction Sequencing	5% of "B"	$ 8,000	
General Conditions	10% of "B"	$ 17,000	
Contractor Overhead and Profit	15% of "B"	$ 25,000	
Sales Tax	9% 1/2 of "B"	$ 8,000	
C - Subtotal Construction Costs		**$ 230,000**	
Escalation to Midpoint	8% of "C"	$ 18,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 248,000**	
Construction Contingency	50% of "D"	$ 123,000	
E - Total Construction Costs		**$ 371,000**	
Planning and Permitting	5% of "E"	$ 18,000	
Engineering	28% of "E"	$ 103,000	Lower engineering & ESDC
Construction Management + ESDC	28% of "E"	$ 103,000	if combined with other work
Total Project Cost		**$ 600,000**	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

[TM02-BC-04] Digester Mixing Improvements (Class V Cost Estimate)			
Item	Unit Cost / Allowance	Item Cost	Notes
(2) Digester Cleaning	$ 200,000 $/digester	$ 400,000	
(2) Internal Sludge Mixer Model SMI11 including control pan	$ 1,581,800 $/2 Mixers	$ 1,582,000	For Fixed Covered Digesters
A - Subtotal Construction Materials and Equipment Cost		**$ 1,982,000**	
Demolition	10% of "A"	$ 198,000	
Temporary Construction	5% of "A"	$ 99,000	
Structural	5% of "A"	$ 99,000	
Process Piping	10% of "A"	$ 198,000	
Electrical	20% of "A"	$ 396,000	
Instrumentation and Controls	15% of "A"	$ 297,000	
B - Total Construction Materials and Equipment Costs		**$ 3,269,000**	
Startup and Construction Sequencing	10% of "B"	$ 327,000	
General Conditions	10% of "B"	$ 327,000	
Contractor Overhead and Profit	15% of "B"	$ 490,000	
Sales Tax	9.25% 1/2 of "B"	$ 151,000	
C - Subtotal Construction Costs		**$ 4,560,000**	
Escalation to Midpoint	16% of "C"	$ 731,000	Assumed 24 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 5,291,000**	
Construction Contingency	50% of "D"	$ 2,648,000	
E - Total Construction Costs		**$ 7,939,000**	
Planning and Permitting	5% of "E"	$ 397,000	
Engineering	12% of "E"	$ 953,000	
Construction Management + ESDC	15% of "E"	$ 1,192,000	
Total Project Cost		**$ 10,500,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

[TM2-BC-05] GBT Sludge Pump Replacement (Class V Cost Estimate)			
Item	Unit Cost / Allowance	Item Cost	Notes
(2) Progressive Cavity Pump Units	$ 15,007 $/EA	$ 30,000	vendor provided package
A - Subtotal Construction Materials and Equipment Cost		$ 30,000	
Demolition	15% of "A"	$ 5,000	
Structural	10% of "A"	$ 3,000	
Process Piping	15% of "A"	$ 5,000	
Electrical	25% of "A"	$ 8,000	
Instrumentation and Controls	20% of "A"	$ 6,000	
B - Total Construction Materials and Equipment Costs		$ 57,000	
Startup and Construction Sequencing	5% of "B"	$ 3,000	
General Conditions	10% of "B"	$ 6,000	
Contractor Overhead and Profit	15% of "B"	$ 8,000	
Sales Tax	9.25% 1/2 of "B"	$ 3,000	
C - Subtotal Construction Costs		$ 80,000	
Escalation to Midpoint	8% of "C"	$ 6,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		$ 86,000	
Construction Contingency	50% of "D"	$ 40,000	
E - Total Construction Costs		$ 126,000	
Planning and Permitting	5% of "E"	$ 6,000	
Engineering	83% of "E"	$ 101,000	Lower engineering & ESDC
Construction Management + ESDC	83% of "E"	$ 101,000	if combined with other work
Total Project Cost		$ 330,000	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

[TM2-BC-06] Selective Catalytic Reduction Units (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) SCR/Oxidation System, including: SCR Housing Oxidation Housing & Catalyst Mixing Sections SCR Control System Dual Ply Bellow (1) Reactant Tank	$177,939 $/system	$ 356,000	vendor provided package 1000 gal tank for both units
A - Subtotal Construction Materials and Equipment Cost		**$ 356,000**	
Demolition	5% of "A"	$ 18,000	
Structural	15% of "A"	$ 53,000	
Process Piping	10% of "A"	$ 36,000	
Electrical	5% of "A"	$ 18,000	
Instrumentation and Controls	5% of "A"	$ 18,000	
B - Total Construction Materials and Equipment Costs		**$ 499,000**	
Startup and Construction Sequencing	5% of "B"	$ 25,000	
General Conditions	10% of "B"	$ 50,000	
Contractor Overhead and Profit	15% of "B"	$ 75,000	
Sales Tax	9% 1/2 of "B"	$ 23,000	
C - Subtotal Construction Costs		**$ 670,000**	
Escalation to Midpoint	8% of "C"	$ 54,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 724,000**	
Construction Contingency	50% of "D"	$ 362,000	
E - Total Construction Costs		**$ 1,086,000**	
Planning and Permitting	5% of "E"	$ 54,000	
Engineering	15% of "E"	$ 163,000	
Construction Management + ESDC	15% of "E"	$ 163,000	
Total Project Cost		**$ 1,470,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

[TM2-BC-07] BFP Cake Pump Replacement (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(4) Bioset Piston Pump System (4) Screw Feeder (4) Hydraulic Power Unit (4) Control Panel Lubrication System, Tools, Spare Parts	$ 1,677,500 $/system	$ 1,678,000	vendor provided package based on 16% TS Cake
A - Subtotal Construction Materials and Equipment Cost		**$ 1,678,000**	
Demolition	10% of "A"	$ 168,000	
Structural	10% of "A"	$ 168,000	
Process Piping	35% of "A"	$ 587,000	
Electrical	15% of "A"	$ 252,000	
Instrumentation and Controls	15% of "A"	$ 252,000	
B - Total Construction Materials and Equipment Costs		**$ 3,105,000**	
Startup and Construction Sequencing	5% of "B"	$ 155,000	
General Conditions	10% of "B"	$ 310,000	
Contractor Overhead and Profit	15% of "B"	$ 466,000	
Sales Tax	9% 1/2 of "B"	$ 144,000	
C - Subtotal Construction Costs		**$ 4,180,000**	
Escalation to Midpoint	8% of "C"	$ 334,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 4,514,000**	
Construction Contingency	50% of "D"	$ 2,256,000	
E - Total Construction Costs		**$ 6,770,000**	
Planning and Permitting	5% of "E"	$ 338,000	
Engineering	15% of "E"	$ 1,015,000	
Construction Management + ESDC	15% of "E"	$ 1,015,000	
Total Project Cost		**$ 9,140,000**	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

[TM2-BC-08] WAS Pump Replacement (Class V Cost Estimate)			
Item	Unit Cost / Allowance	Item Cost	Notes
(1) WAS Pump (same as existing)	$ 30,000 $/unit	$ 30,000	Cost of new T8A3S-B WAS Pump
electric motor	$ 8,000 $/unit	$ 8,000	
A - Subtotal Construction Materials and Equipment Cost		$ 38,000	
Demolition	15% of "A"	$ 6,000	
Structural	20% of "A"	$ 8,000	
Process Piping	15% of "A"	$ 6,000	
Electrical	25% of "A"	$ 10,000	
Instrumentation and Controls	20% of "A"	$ 8,000	
B - Total Construction Materials and Equipment Costs		$ 76,000	
Startup and Construction Sequencing	5% of "B"	$ 4,000	
General Conditions	10% of "B"	$ 7,000	
Contractor Overhead and Profit	15% of "B"	$ 11,000	
Sales Tax	9% 1/2 of "B"	$ 3,000	
C - Subtotal Construction Costs		$ 100,000	
Escalation to Midpoint	8% of "C"	$ 8,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		$ 108,000	
Construction Contingency	50% of "D"	$ 54,000	
E - Total Construction Costs		$ 162,000	
Planning and Permitting	5% of "E"	$ 8,000	
Engineering	62% of "E"	$ 100,000	Lower engineering & ESDC
Construction Management + ESDC	62% of "E"	$ 100,000	if combined with other work
Total Project Cost		$ 370,000	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

[TM2-BC-09] Electrical Site Improvements (Class V Cost Estimate)			
Item	Unit Cost / Allowance	Item Cost	Notes
(2) Lighting Panel Board 42 circuit	$ 1,200 $/unit	$ 2,000	
Lighting Panel Board 30 circuit	$ 1,200 $/unit	$ 1,000	
Lighting Panel Transformer 45kVA	$ 8,500 $/unit	$ 9,000	
Lighting Panel Transformer 30kVA	$ 6,600 $/unit	$ 7,000	
Lighting Panel Transformer 15kVA	$ 3,800 $/unit	$ 4,000	
MCC 12R	$ 55,000 $/unit	$ 55,000	
MCC 33 T 1	$ 20,000 $/unit	$ 20,000	
MCC 33 T 2	$ 40,000 $/unit	$ 40,000	
MCC 6K	$111,000 $/unit	$ 111,000	
MCC 11P	$ 50,000 $/unit	$ 50,000	
PLC 13 Replacement	$ 9,000 $/system	$ 9,000	
Control Console Replacement	$ 50,000 $/system	$ 50,000	
A - Subtotal Construction Materials and Equipment Cost		$ 358,000	
Demolition	15% of "A"	$ 54,000	
Electrical	25% of "A"	$ 89,000	
Instrumentation and Controls	20% of "A"	$ 72,000	
B - Total Construction Materials and Equipment Costs		$ 573,000	
Startup and Construction Sequencing	5% of "B"	$ 29,000	
General Conditions	10% of "B"	$ 57,000	
Contractor Overhead and Profit	15% of "B"	$ 86,000	
Sales Tax	9.25% 1/2 of "B"	$ 26,000	
C - Subtotal Construction Costs		$ 770,000	
Market Factor	10% of "C"	$ 77,000	Market Factor for escalation of elec.
Escalation to Midpoint	8% of "C"	$ 62,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		$ 909,000	
Construction Contingency	50% of "D"	$ 454,000	
E - Total Construction Costs		$ 1,363,000	
Planning and Permitting	5% of "E"	$ 68,000	
Engineering	15% of "E"	$ 204,000	
Construction Management	15% of "E"	$ 204,000	
F - Project Costs without Estimating Contingency		$ 1,840,000	
Total Project Cost		$ 1,840,000	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

[TM2-BC-11] Structural Site Improvements (Class V Cost Estimate)			
Item	Unit Cost / Allowance	Item Cost	Notes
Digester Gallery Repair, including: (expansion joint & crack repair, water infiltration repair)	$ 50,000	$ 50,000	
Rust Repair/Recoat misc.	$ 100 $/Linear foot	$ 2,000	
Flare Recoat	$ 5,000	$ 5,000	
Flare concrete pad and drainage	$ 10,000	$ 10,000	
Epoxy sealing in at GBTs, Digesters, misc.	$ 50 $/Linear foot	$ 38,000	
A - Subtotal Construction Materials and Equipment Cost		$ 105,000	
Demolition	5% of "A"	$ 5,000	
B - Total Construction Materials and Equipment Costs		$ 110,000	
Startup and Construction Sequencing	5% of "B"	$ 5,000	
General Conditions	10% of "B"	$ 11,000	
Contractor Overhead and Profit	15% of "B"	$ 16,000	
Sales Tax	9% 1/2 of "B"	$ 5,000	
C - Subtotal Construction Costs		$ 150,000	
Escalation to Midpoint	8% of "C"	$ 12,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		$ 162,000	
Construction Contingency	50% of "D"	$ 80,000	
E - Total Construction Costs		$ 242,000	
Planning and Permitting	5% of "E"	$ 12,000	
Engineering	42% of "E"	$ 101,000	Lower engineering & ESDC
Construction Management + ESDC	42% of "E"	$ 101,000	if combined with other work
Total Project Cost		$ 460,000	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

[TM2-BC-12] Scum Pot Replacement (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(8) Progressive Cavity Pump Units	$ 10,108 $/EA	$ 81,000	vendor provided package
A - Subtotal Construction Materials and Equipment Cost		**$ 81,000**	
Demolition	50% of "A"	$ 40,000	
Civil	10% of "A"	$ 8,000	
Process Piping	30% of "A"	$ 24,000	
Electrical	25% of "A"	$ 20,000	
Instrumentation and Controls	30% of "A"	$ 24,000	
B - Total Construction Materials and Equipment Costs		**$ 197,000**	
Startup and Construction Sequencing	20% of "B"	$ 40,000	
Construction Easements	0% of "B"	$ -	
General Conditions	10% of "B"	$ 20,000	
Contractor Overhead and Profit	15% of "B"	$ 30,000	
Sales Tax	9.25% 1/2 of "B"	$ 9,000	
C - Subtotal Construction Costs		**$ 300,000**	
Escalation to Midpoint	8% of "C"	$ 24,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 324,000**	
Construction Contingency	50% of "D"	$ 160,000	
E - Total Construction Costs		**$ 484,000**	
Planning and Permitting	5% of "E"	$ 24,000	
Engineering	21% of "E"	$ 101,000	Lower engineering & ESDC
Construction Management + ESDC	21% of "E"	$ 101,000	if combined with other work
Total Project Cost		**$ 700,000**	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

Digesters 1 & 2 Cover and Mixer Replacement (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) Digester Coating	$ 500,000 $/digester	$ 1,000,000	
(2) Digester Cleaning	$ 200,000 $/digester	$ 400,000	
(2) Digester Membrane Covers with New Mixing System	$ 2,320,000 $/total	$ 2,320,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 3,720,000**	
Demolition	10% of "A"	$ 372,000	
Structural	15% of "A"	$ 558,000	
Electrical and Instrumentation	20% of "A"	$ 744,000	
B - Total Construction Materials and Equipment Costs		**$ 5,394,000**	
Startup and Construction Sequencing	5% of "B"	$ 270,000	
General Conditions	10% of "B"	$ 539,000	
Contractor Overhead and Profit	15% of "B"	$ 809,000	
Sales Tax	9.25% 1/2 of "B"	$ 249,000	
C - Subtotal Construction Costs		**$ 7,300,000**	
Escalation to Midpoint	8.00% of "C"	$ 581,000	Assumed 12 month construction
D - Subtotal Construction Costs with Market Factor		**$ 7,881,000**	
Construction Contingency	50% of "D"	$ 3,921,000	
E - Total Construction Costs		**$ 11,802,000**	
Planning and Permitting	5% of "E"	$ 588,000	
Engineering	10% of "E"	$ 1,176,000	
Construction Management + ESDC	15% of "E"	$ 1,765,000	
Total Project Cost		**$ 15,330,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Add 1 GBT to existing thickening building (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(1) Gravity Belt Thickener (2m), including: Control Panel hydraulic power unit water booster pump discharge hopper discharge hopper	$326,500 $/total	$ 327,000	vendor provided package
Polymer System	$ 50,000 $/total	$ 50,000	
Flow Meter	$ 5,500 $/total	$ 6,000	
Thickened sludge pump & VFD	$ 45,000 $/total	$ 45,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 428,000**	
Demolition	10% of "A"	$ 43,000	
Structural	10% of "A"	$ 43,000	
Process Piping	15% of "A"	$ 64,000	
Electrical	25% of "A"	$ 107,000	
Instrumentation and Controls	20% of "A"	$ 85,000	
B - Total Construction Materials and Equipment Costs		**$ 770,000**	
Startup and Construction Sequencing	5% of "B"	$ 38,000	
General Conditions	10% of "B"	$ 77,000	
Contractor Overhead and Profit	15% of "B"	$ 115,000	
Sales Tax	9.25% 1/2 of "B"	$ 36,000	
C - Subtotal Construction Costs		**$ 1,040,000**	
Escalation to Midpoint	8.00% of "C"	$ 83,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 1,123,000**	
Construction Contingency	50% of "D"	$ 559,000	
E - Total Construction Costs		**$ 1,682,000**	
Planning and Permitting	5% of "E"	$ 84,000	
Engineering	15% of "E"	$ 251,000	
Construction Management + ESDC	15% of "E"	$ 251,000	
Total Project Cost		**$ 2,270,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Gas Conditioning System (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
Hydrogen Sulfide Removal System	$ 1,246,875 LS	$ 1,247,000	
Compression/Moisture Removal System	$ 1,837,500 LS	$ 1,838,000	
Siloxane Removal System	$ 689,063 LS	$ 689,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 3,774,000**	
Demolition	2.5% of "A"	$ 94,000	
Shoring and Dewatering	0% of "A"	$ -	
Temporary Construction	0% of "A"	$ -	
Civil	5% of "A"	$ 189,000	
Yard Piping	0% of "A"	$ -	
Structural	2.5% of "A"	$ 94,000	
Process Piping	10% of "A"	$ 377,000	Includes digester piping upsizing
Electrical	15% of "A"	$ 566,000	
Instrumentation and Controls	5% of "A"	$ 189,000	Some controls provided by vendor
Excavated Soil Disposal	0% of "A"	$ -	
B - Total Construction Materials and Equipment Costs		**$ 5,283,000**	
Startup and Construction Sequencing	12% of "B"	$ 634,000	
Construction Easements	0% of "B"	$ -	
General Conditions	10% of "B"	$ 528,000	
Contractor Overhead and Profit	15% of "B"	$ 792,000	
Sales Tax	9.25% 1/2 of "B"	$ 244,000	
C - Subtotal Construction Costs		**$ 7,500,000**	
Escalation to Midpoint	8.00% of "C"	$ 599,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 8,099,000**	
Construction Contingency	30% of "D"	$ 2,424,000	
E - Total Construction Costs		**$ 10,523,000**	
Planning and Permitting	5% of "E"	$ 525,000	
Engineering	10% of "E"	$ 1,050,000	
Construction Management + ESDC	10% of "E"	$ 1,050,000	
Total Project Cost		**$ 13,100,000**	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

New Anaerobic Digester and Gallery (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(1) 75' Inner Diameter Digester, including:			
Structural	$ 161,387 $/total	$ 161,000	
Dewatering System	$ 101,659 $/total	$ 102,000	
Excavation and Backfill	$ 615,278 $/total	$ 615,000	
Yard Piping	$ 97,608 $/total	$ 98,000	
Sludge mixer	$ 1,237,445 $/total	$ 1,237,000	
Electrical	$ 1,054,600 $/total	$ 1,055,000	
Instrumentation	$ 602,600 $/total	$ 603,000	
Digester Gallery, including:			
Structural	$ 1,050,251 $/total	$ 1,050,000	
Electrical	$ 774,900 $/total	$ 775,000	
Instrumentation	$ 442,800 $/total	$ 443,000	
Dewatering System	$ 135,266 $/total	$ 135,000	
Excavation and Backfill	$ 506,576 $/total	$ 507,000	
Process Equipment	$ 50,027 $/total	$ 50,000	
Process Piping	$ 443,000 $/total	$ 443,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 7,274,000**	
B - Total Construction Materials and Equipment Costs		**$ 7,274,000**	
Startup and Construction Sequencing	12% of "B"	$ 873,000	
General Conditions	10% of "B"	$ 727,000	
Contractor Overhead and Profit	15% of "B"	$ 1,091,000	
Sales Tax	9.25% 1/2 of "B"	$ 336,000	
C - Subtotal Construction Costs		**$ 10,300,000**	
Escalation to Midpoint	16.13% of "C"	$ 1,662,000	Assumed 25 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 11,962,000**	
Construction Contingency	50% of "D"	$ 5,981,000	
E - Total Construction Costs		**$ 17,943,000**	
Planning and Permitting	5% of "E"	$ 897,000	
Engineering	12% of "E"	$ 2,153,000	
Construction Management + ESDC	15% of "E"	$ 2,692,000	
Total Project Cost		**$ 23,690,000**	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

New High Strength Waste Receiving (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
High-Strength Waste Receiving Facility	$ 1,491,000 LS	$ 1,491,000	
		$ -	
A - Subtotal Construction Materials and Equipment Cost		**$ 1,491,000**	
B - Total Construction Materials and Equipment Costs		**$ 1,491,000**	
Startup and Construction Sequencing	12% of "B"	$ 179,000	
Construction Easements	0% of "B"	$ -	
General Conditions	10% of "B"	$ 149,000	
Contractor Overhead and Profit	15% of "B"	$ 224,000	
Sales Tax	9.25% 1/2 of "B"	$ 69,000	
C - Subtotal Construction Costs		**$ 2,100,000**	
Escalation to Midpoint	16.13% of "C"	$ 341,000	Assumed 25 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 2,441,000**	
Construction Contingency	0% of "D"	$ -	
E - Total Construction Costs		**$ 2,441,000**	
Planning and Permitting	5% of "E"	$ 123,000	
Engineering	10% of "E"	$ 245,000	
Construction Management + ESDC	10% of "E"	$ 245,000	
F - Project Costs without Estimating Contingency		**$ 3,100,000**	
Estimating Contingency	30% of "F"	$ 920,000	
Total Project Cost		**$ 4,020,000**	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

Replace Belt Presses with Centrifuges (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
Centrifuge Replacements, including:			
Demolition	$ 391,158 $/total	$ 391,000	
Structural	$ 100,000 $/total	$ 100,000	
Electrical	$ 980,000 $/total	$ 980,000	
Instrumentation	$ 560,000 $/total	$ 560,000	
Process equipment	$ 1,749,350 $/total	$ 1,749,000	
Process Piping	$ 560,000 $/total	$ 560,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 4,340,000**	
B - Total Construction Materials and Equipment Costs		**$ 4,340,000**	
Startup and Construction Sequencing	5% of "B"	$ 217,000	
General Conditions	10% of "B"	$ 434,000	
Contractor Overhead and Profit	15% of "B"	$ 651,000	
Sales Tax	9.25% 1/2 of "B"	$ 201,000	
C - Subtotal Construction Costs		**$ 5,800,000**	
Escalation to Midpoint	16.13% of "C"	$ 943,000	Assumed 25 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 6,743,000**	
Construction Contigency	50% of "D"	$ 3,393,000	
E - Total Construction Costs		**$ 10,136,000**	
Planning and Permitting	5% of "E"	$ 509,000	
Engineering	15% of "E"	$ 1,527,000	
Construction Management + ESDC	15% of "E"	$ 1,527,000	
Total Project Cost		**$ 13,700,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Replace Dewatering PC pumps with Conveyors (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
Conveyor Replacement, including:			
Demolition	$ 82,809 $/total	$ 83,000	
Structural	$ 400,000 $/total	$ 400,000	
Electrical	$ 577,000 $/total	$ 577,000	
Instrumentation	$ 330,000 $/total	$ 330,000	
Process equipment	$ 1,165,350 $/total	$ 1,165,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 2,555,000**	
B - Total Construction Materials and Equipment Costs		**$ 2,555,000**	
Startup and Construction Sequencing	5% of "B"	$ 128,000	
General Conditions	10% of "B"	$ 256,000	
Contractor Overhead and Profit	15% of "B"	$ 383,000	
Sales Tax	9% 1/2 of "B"	$ 118,000	
C - Subtotal Construction Costs		**$ 3,400,000**	
Escalation to Midpoint	16.13% of "C"	$ 555,000	Assumed 25 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 3,955,000**	
Construction Contingency	50% of "D"	$ 1,997,000	
E - Total Construction Costs		**$ 5,952,000**	
Planning and Permitting	5% of "E"	$ 300,000	
Engineering	20% of "E"	$ 1,198,000	
Construction Management + ESDC	15% of "E"	$ 899,000	
Total Project Cost		**$ 8,350,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Thermal Dryer Option 1 (15% Cake, two units with pre-engineered building) (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) BT18 Thermal Dryers, including: Boiler Cake Pumps Odor Control Dry Product Silo Hopper	$ 16,840,000 $/total	$ 16,840,000	Vendor Provided Quote
Process Piping	$ 2,830,000 $/total	$ 2,830,000	
Pre-engineered building	$ 62 $/sqft	$ 760,000	
Slab on Grade	$ 475 $/cy	$ 200,000	
Equipment Pads (Dryer,condeser, hopper, silo, & scrubber)	$ 1,700 $/cy	$ 471,000	
Misc. (Walls, doors, panels, hardware)	$ 83,022 $/total	$ 83,000	
Fire sprinklers	$ 29 $/sqft	$ 352,000	
HVAC	$ 20 $/sqft	$ 243,000	
Electrical	$ 4,949,700 $/total	$ 4,950,000	
Instrumentation	$ 2,828,400 $/total	$ 2,828,000	
Escavation	$ 18 $/cy	$ 63,000	
Paving	$ 47,020 $/total	$ 47,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 29,667,000**	
B - Total Construction Materials and Equipment Costs		**$ 29,667,000**	
Startup and Construction Sequencing	12% of "B"	$ 3,560,000	
General Conditions	10% of "B"	$ 2,967,000	
Contractor Overhead and Profit	15% of "B"	$ 4,450,000	
Sales Tax	9.25% 1/2 of "B"	$ 1,372,000	
C - Subtotal Construction Costs		**$ 42,020,000**	
Escalation to Midpoint	16.13% of "C"	$ 6,777,000	Assumed 25 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 48,797,000**	
Construction Contigency	50% of "D"	$ 24,397,000	
E - Total Construction Costs		**$ 73,194,000**	
Planning and Permitting	5% of "E"	$ 3,660,000	
Engineering	10% of "E"	$ 7,319,000	
Construction Management + ESDC	15% of "E"	$ 10,979,000	
Total Project Cost		**$ 95,200,000**	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

Thermal Dryer Option 2 (25% Cake, one unit with pre-engineered building) (Class V Cost Estimate)			
Item	Unit Cost / Allowance	Item Cost	Notes
(1) BT18 Thermal Dryers, including: Boiler Cake Pumps Odor Control Dry Product Silo Hopper	$ 8,240,000 $/total	$ 8,240,000	Vendor Provided Quote
Process Piping	$ 2,830,000 $/total	$ 2,830,000	
Pre-engineered building	$ 62 $/sqft	$ 444,000	
Slab on Grade	$ 475 $/cy	$ 200,000	
Equipment Pads (Dryer,condeser, hopper, silo, & scrubber)	$ 1,700 $/cy	$ 376,000	
Misc. (Walls, doors, panels, hardware)	$ 83,022 $/total	$ 83,000	
Fire sprinklers	$ 29 $/sqft	$ 205,000	
HVAC	$ 20 $/sqft	$ 142,000	
Electrical	$ 4,949,700 $/total	$ 4,950,000	
Instrumentation	$ 2,828,400 $/total	$ 2,828,000	
Excavation	$ 18 $/cy	$ 63,000	
Paving	$ 47,020 $/total	$ 47,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 20,408,000**	
B - Total Construction Materials and Equipment Costs		**$ 20,408,000**	
Startup and Construction Sequencing	12% of "B"	$ 2,449,000	
General Conditions	10% of "B"	$ 2,041,000	
Contractor Overhead and Profit	15% of "B"	$ 3,061,000	
Sales Tax	9.25% 1/2 of "B"	$ 944,000	
C - Subtotal Construction Costs		**$ 28,900,000**	
Escalation to Midpoint	16.13% of "C"	$ 4,662,000	Assumed 25 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 33,562,000**	
Construction Contigency	50% of "D"	$ 16,783,000	
E - Total Construction Costs		**$ 50,345,000**	
Planning and Permitting	5% of "E"	$ 2,517,000	
Engineering	10% of "E"	$ 5,035,000	
Construction Management + ESDC	15% of "E"	$ 7,552,000	
Total Project Cost		**$ 65,400,000**	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

Waterproofing Alpha Barn (Class V Cost Estimate)			
Item	Unit Cost / Allowance	Item Cost	Notes
Alpha Bar Waterproofing, including:			
Demolition	$ 164,017 $/total	$ 164,000	
Structural	$ 1,024,001 $/total	$ 1,024,000	
Sprinklers	$ 352,559 $/total	$ 353,000	
Electrical	$ 208,500 $/total	$ 209,000	
Instrumentation	$ 208,500 $/total	$ 209,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 1,959,000**	
B - Total Construction Materials and Equipment Costs		**$ 1,959,000**	
Startup and Construction Sequencing	5% of "B"	$ 98,000	
General Conditions	10% of "B"	$ 196,000	
Contractor Overhead and Profit	15% of "B"	$ 294,000	
Sales Tax	9.25% 1/2 of "B"	$ 91,000	
C - Subtotal Construction Costs		**$ 2,600,000**	
Escalation to Midpoint	4.00% of "C"	$ 105,000	Assumed 6 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 2,705,000**	
Construction Contingency	50% of "D"	$ 1,370,000	
E - Total Construction Costs		**$ 4,075,000**	
Planning and Permitting	5% of "E"	$ 206,000	
Engineering	10% of "E"	$ 411,000	
Construction Management + ESDC	10% of "E"	$ 411,000	
Total Project Cost		**$ 5,100,000**	

Notes:
- All costs presented in 2023 dollars
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Infrastructure to Pump Cake to On-site Lystek (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
Infrastructure from LTP Dewatering to Lystek, including:			
Trench for Utilities	$ 204 $/lf-total	$ 347,000	
Thickened Sludge Pipe	$ 314 $/lf-total	$ 534,000	
Sludge Piston Pump Pumps	$ 1,342,000 $/total	$ 1,342,000	Equipment cost for (4) piston pumps
A - Subtotal Construction Materials and Equipment Cost		**$ 2,223,000**	
Demolition	5% of "A"	$ 111,000	
Shoring and Dewatering	5% of "A"	$ 111,000	
Electrical	20% of "A"	$ 445,000	
Instrumentation and Controls	20% of "A"	$ 445,000	
Excavated Soil Disposal	5% of "A"	$ 111,000	
B - Total Construction Materials and Equipment Costs		**$ 3,446,000**	
Startup and Construction Sequencing	5% of "B"	$ 172,000	
Construction Easements	5% of "B"	$ 172,000	
General Conditions	10% of "B"	$ 345,000	
Contractor Overhead and Profit	15% of "B"	$ 517,000	
Sales Tax	9.25% 1/2 of "B"	$ 159,000	
C - Subtotal Construction Costs		**$ 4,800,000**	
Market Factor	0.00% of "C"	$ -	
Escalation to Midpoint	16.13% of "C"	$ 776,000	Assumed 25 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 5,576,000**	
Construction Contigency	50% of "D"	$ 2,793,000	
E - Total Construction Costs		**$ 8,369,000**	
Planning and Permitting	5% of "E"	$ 419,000	
Engineering	15% of "E"	$ 1,257,000	
Construction Management + ESDC	15% of "E"	$ 1,257,000	
Total Project Cost		**$ 11,300,000**	

Notes:

- All costs presented in 2023 dollars
- All costs are rounded

Appendix F: Estimate of Greenhouse Gas Emissions from Fugitive Methane TM

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Brown AND Caldwell

201 North Civic Drive, Suite 300
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T: 925.937.9010

Technical Memorandum
FINAL

Prepared for: City of Santa Rosa

Project Title: Biosolids Management Strategic Plan

Project No.: 157568

Technical Memorandum

Subject: Estimate of Greenhouse Gas Emissions from Fugitive Methane

Date: August 14, 2024

To: Tanya Mokvyts, City of Santa Rosa

From: Maxwell Armenta, Brown and Caldwell

Copy to: Mike Prinz, City of Santa Rosa

Prepared by: _____
Maxwell Armenta, P.E., Brown and Caldwell
California License, No. C95432

Reviewed by: _____
Trung Le, P.E.*, Brown and Caldwell
*Licensed in Another State

Stamp to be added after confirmation from City that Final Report is ready for print.

Limitations:

This document was prepared solely for the City of Santa Rosa in accordance with professional standards at the time the services were performed and in accordance with the contract between the City of Santa Rosa and Brown and Caldwell dated October 6, 2021. This document is governed by the specific scope of work authorized by the City of Santa Rosa; 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 the City of Santa Rosa and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Section 1: Introduction

This technical memorandum (TM) documents Brown and Caldwell's (BC) estimate of greenhouse gas (GHG) emissions due to fugitive methane from the City of Santa Rosa's (City) floating cover digesters. Fugitive methane is unintended release or leak of methane. The City's Laguna Wastewater Treatment Plant (LTP) completed a condition assessment and alternatives analyses as part of the City's Biosolids Management Strategic Plan (BMSP). The condition assessment identified floating digester covers as a priority project, and replacement of the floating covers was recommended for the City to address in its capital improvement plan (CIP).

BC had recently performed a quantification of fugitive methane being emitted from sources at the Southerly wastewater treatment plant (WWTP) located in Columbus, Ohio. This facility has both fixed and floating covers for digesters, and each digester had a dedicated biogas flow meter. This provided an ideal situation for quantifying fugitive methane emissions, which allowed BC to quantify biogas leakage from floating covers. Biogas estimates were confirmed at the Southerly WWTP using a specialized drone and an optical gas imaging camera, as shown in Figure 1. BC's project experience, and GHG emission factors from the Intergovernmental Panel on Climate Change, are used in this TM to estimate GHG mitigation potential from replacing floating covers.



Figure 1. Typical camera (top) and optical gas imaging camera showing methane leakage (bottom) from Columbus.

Fugitive methane captured with optical gas imaging is circled in red for clarity. Images from Southerly WWTP (Columbus, OH).

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This TM documents BC's estimation of fugitive methane from digesters with floating covers. Quantifying GHG emissions provides the City with a number to compare with other projects, which will help the City identify the most cost-effective way to address climate action plan (CAP) goals.

Section 2: Greenhouse Gas Emission Estimates

BC performed calculations to quantify the fugitive methane emitted from floating digester covers (Attachment A), and estimated GHG impacts. Results suggest that GHG emissions that can be reduced if the two floating covers (Digesters 1 and 2) are replaced with fixed covers; however, the degree of reduction requires verification since floating cover leakage rates are highly dependent on digester design and operation (e.g., mixing type, annular space, withdrawal type, feed location, etc.).

2.1 Approach

GHG emissions are estimated based on the biogas flow rate (427 standard cubic feet per minute [scfm]) and methane fraction (60 percent) used in the BMSP alternatives analysis to represent baseline conditions. The approach assumes each digester produces an identical amount of biogas since they have identical process volume (i.e., 25 percent of total biogas comes from each digester). Fugitive methane is assumed to occur from floating covers and decrease measured biogas rates relative to production. The percentage of fugitive methane from floating digesters is based on engineering judgment using relevant BC project experience documented in the September 2023 issue of Water, Environment, and Technology (Water Environment Federation, 2023); Lower and higher values are estimated based on short-term drone measurements and analysis from long-term process data at the Southerly WWTP, respectively.

Attachment A lists assumptions used to quantify current fugitive methane emissions in terms of carbon dioxide equivalent (CO_2e) global warming potential and shows calculations.

2.2 Results

Results include methane emission estimates quantified in three ways to allow the City to compare the magnitude of GHG impacts from floating covers between other projects. Based on calculations documented in Attachment A of this TM, floating covers contribute a significant amount of GHG emissions. Table 1 summarizes results.

c			
Parameter	Units	Lower Estimate	Higher Estimate
Biogas Loss from Floating Digester Covers	% of production	5%	20%
Methane Leakage	kg CH_4/hr	8	34
Global Warming Potential	mt CO_{2e}/yr	2,000	8,600
Impact in Terms of Vehicles Removed from Road per Year	cars/year	430	1,900

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Section 3: Conclusions and Next Steps

These calculations suggest that replacing floating covers would result in potentially significant GHG emission reduction: 2,000 to 8,600 metric tons of CO_2e per year from fugitive methane. Additionally, the actual GHG emissions from the LTP is likely higher due to contributions from other processes. The GHG emissions from dewatering, biosolids storage, foul air treatment, gas conditioning, and digestion pressure relief valves are not included in this calculation, but are expected to also contribute to fugitive methane emissions.

The City can elect to directly measure GHG emissions at the LTP using a drone. Optical gas imaging cameras can also be used for source identification to confirm locations of methane leaks at the LTP and potentially identify additional areas of fugitive methane, such as leaks from digester pressure reducing valves, digester hatches, dewatering, or biosolids storage.

BC recommends using an optical gas imaging camera to identify further leaks before conducting direct measurements to validate and refine the estimates from this desktop calculation. These GHG estimates are quantified to provide the City with numbers that can be compared to other projects or baseline emissions when identifying the best way to address CAP goals.

Replacing digester floating covers would reduce GHG emissions and address a CIP project for the LTP.

3.1 Comparison to Other Greenhouse Gas Emission Reduction Actions

The City has developed a zero-emission bus rollout plan to reduce GHG emissions, meet California's Innovative Clean Transit regulation, and meet the Federal Transit Administration's amended requirement for agencies seeking federal grants (City, 2023). Table 2 compares the zero-emission bus rollout plan with a project to replace floating digester covers. The comparison suggests that digester cover replacement reduces significantly more GHG emissions per dollar spent. Compared to the zero-emission bus rollout plan, replacing digester covers is estimated to have two to 10 times greater GHG reduction per dollar spent.

Table 2. Fugitive Methane Desktop Calculation Results for LTP Floating Digester Covers

Parameter	Units	Zero-Emission Bus Rollout Plan	Replace Floating Digester Covers
Estimated Potential GHG Emissions Reduction	mt CO_2e/yr	1,800[a]	2,000 to 8,600
Estimated Capital Cost	$ million	$33[b]	$15[c]
Estimated GHG Emissions Reduction per Dollar Spent (i.e., "Bang for the Buck")	mt CO_2e/yr per million dollars spent	55	130 - 560

Notes

a. *Calculated based on City's current fleet fuel consumption per the City of Santa Rosa Zero-Emission Bus Rollout Plan (June 2023) and using 8,887 g CO_2 per gallon gasoline fuel and 10,180 g CO_2 per gallon diesel fuel per the Federal Register Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards (May 2010).*

b. *Per estimated costs presented in the City of Santa Rosa Zero-Emission Bus Rollout Plan (June 2023).*

c. *Per estimated project costs presented in the Biosolids Screening and Alternatives Evaluation, page D-13 (January 2024).*

All values are rounded to two significant figures.

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References

Brown and Caldwell (January 2024). Biosolids Screening and Alternatives Evaluation. Attachment D: Capital Cost Estimation Sheets; page D-13. City of Santa Rosa.

City of Santa Rosa (June 2023). City of Santa Rosa Zero-Emission Bus Rollout Plan. City of Santa Rosa City Council.

Environmental Protection Agency (June 2023). Tailpipe Greenhouse Gas Emissions from a Typical Passenger Vehicle. Environmental Protection Agency. Office of Transportation and Air Quality. <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1017FP5.pdf>

Federal Register (May 2010). Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, page 25, 330.

Water Environment Federation (September 2023). Escape Artist. Water, Environment, & Technology. <https://www.waterenvironmenttechnology-digital.com/waterenvironmenttechnology/september_2023 >

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Attachment A: Calculations

Calculations performed to estimate fugitive methane emissions.

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A.1 Calculation Assumptions

Assuming all four digesters are in operation and are operated identically, the actual biogas production per digester is represented by Equations A-1 and A-2.

$$BG_1 = BG_2 = BG_3 = BG_4 = BG_{each} \quad \text{(A-1)}$$

$$BG_{total} = BG_1 + BG_2 + BG_3 + BG_4 = 4 \times BG_{each} \quad \text{(A-2)}$$

Assuming Digesters 1 and 2 have equal fugitive methane losses (relative to Digesters 3 and 4), and that fugitive methane losses in Digesters 3 and 4 are negligible to simplify the comparative calculations, then Equation A-3 represents fugitive methane relative to actual biogas production per digester.

$$BG_{fugitive} = 2 \times BG_{each} \times F \quad \text{(A-3)}$$

Where, $F = \text{fugitive methane loss in Digester 1 and 2}$

Equation A-4 is used to estimate actual biogas production based on the measured total biogas flow and the estimated fugitive methane losses in Digesters 1 and 2.

$$BG_{measured} = BG_{total} - BG_{fugitive} \quad \text{(A-4)}$$

Substituting Equation A-2 and Equation A-3 into Equation A-4 and simplifying results in Equation A-5.

$$BG_{total} = \frac{4 \times BG_{measured}}{(4 - [2 \times F])} \quad \text{(A-5)}$$

A.2 Calculations

The difference between calculated actual biogas (BG_{total}) and measured biogas ($BG_{measured}$) provides an estimate of fugitive biogas. Multiplying this value by 60 percent methane (the average methane fraction at the LTP per BMSP TM1) and converting to metric units provides the estimated fugitive methane rate.

A rate of 28.5 g CO_2/g CH_4 for the methane global warming potential is used to calculate the carbon dioxide equivalent (CO_{2e}) global warming potential, as documented in Attachment A of TM4 (based on the Intergovernmental Panel on Climate Change Sixth Assessment Report [AR6]). A rate of 4.6 metric tons CO_{2e} per car is used to calculate the equivalent number of cars representing the global warming potential impact of fugitive methane based on tailpipe GHG emissions from a typical passenger vehicle (EPA, 2023).

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A.2.1 Assuming 20 percent Loss in Digesters 1 and 2

$$4 \times \frac{427 \text{ scfm}}{(4 - [2 \times 20\%])} = 475 \frac{\text{std. ft}^3}{\text{min}} \text{ actual biogas production}$$

$$475 \frac{\text{std. ft}^3}{\text{min}} - 427 \frac{\text{std. ft}^3}{\text{min}} = 47 \frac{\text{std. ft}^3}{\text{min}} \text{ fugitive biogas}$$

$$47 \frac{\text{std. ft}^3}{\text{min}} \times 60\% \text{ methane} \times \frac{1 \text{ m}^3}{35.3 \text{ ft}^3} \times 0.71 \frac{\text{kg}}{\text{std. m}^3} \times 60 \frac{\text{min}}{\text{hr}} = \mathbf{34 \frac{kg}{hr}} \textbf{ fugitive methane}$$

$$34 \frac{\text{kg CH}_4}{\text{hr}} \times \frac{28.5 \text{ kg CO}_2}{1 \text{ kg CH}_4} \times \frac{1 \text{ mt}}{1{,}000 \text{ kg}} \times 24 \frac{\text{hr}}{\text{d}} \times 365 \frac{\text{d}}{\text{yr}} = \mathbf{8{,}582 \frac{mt}{yr}} \textbf{ carbon dioxide equivalent}$$

$$8{,}582 \frac{\text{mt CO}_2}{\text{yr}} \times \frac{1 \text{ car}}{4.6 \frac{\text{mt CO2}}{\text{yr}}} = \mathbf{1{,}866 \frac{cars}{yr}} \textbf{ removed from the road}$$

A.2.1 Assuming 5 percent Loss in Digesters 1 and 2

$$4 \times \frac{427 \text{ scfm}}{(4 - [2 \times 5\%])} = 438 \frac{\text{std. ft}^3}{\text{min}} \text{ actual biogas production}$$

$$438 \frac{\text{std. ft}^3}{\text{min}} - 427 \frac{\text{std. ft}^3}{\text{min}} = 11 \frac{\text{std. ft}^3}{\text{min}} \text{ fugitive biogas}$$

$$11 \frac{\text{std. ft}^3}{\text{min}} \times 60\% \text{ methane} \times \frac{1 \text{ m}^3}{35.3 \text{ ft}^3} \times 0.71 \frac{\text{kg}}{\text{std. m}^3} \times 60 \frac{\text{min}}{\text{hr}} = \mathbf{8 \frac{kg}{hr}} \textbf{ fugitive methane}$$

$$8 \frac{\text{kg CH}_4}{\text{hr}} \times \frac{28.5 \text{ kg CO}_2}{1 \text{ kg CH}_4} \times \frac{1 \text{ mt}}{1{,}000 \text{ kg}} \times 24 \frac{\text{hr}}{\text{d}} \times 365 \frac{\text{d}}{\text{yr}} = \mathbf{1{,}981 \frac{mt}{yr}} \textbf{ carbon dioxide equivalent}$$

$$1{,}981 \frac{\text{mt CO}_2}{\text{yr}} \times \frac{1 \text{ car}}{4.6 \frac{\text{mt CO2}}{\text{yr}}} = \mathbf{431 \frac{cars}{yr}} \textbf{ removed from the road}$$

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Appendix G: Meeting Minutes and Workshop Materials

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BMSP Cap Impr Impl Plan Final

FINAL Meeting Minutes

201 North Civic Drive, Suite 300
Walnut Creek, CA 94596

T: 925.937.9010

Prepared for: City of Santa Rosa (Santa Rosa)
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose of Meeting: Santa Rosa BMSP Kickoff Meeting
Date: November 3, 2022
Meeting Location: Microsoft Teams (Virtual) **Time:** 8:30 a.m. – 10:00 a.m.
Minutes Prepared by: Divij Sharma, Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
Christian Williams, Santa Rosa
Adam Ross, BC
Alison Nojima, BC
Tanya Mokvyts, Santa Rosa
Zach Kay, Santa Rosa
Divij Sharma, BC
Maxwell Armenta, BC

Summary

This document captures notes from the Kickoff Meeting for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. Notes are organized according to the PowerPoint outline, highlighting presentation takeaways.

Action items are underlined. **Key decisions/notes are in bold.** Notes from BC's presentation are in black font. Questions, answers, and comments from the workshop are in blue font.

1. Agenda was reviewed for the meeting
2. Goals and Objectives were reviewed. City was asked two questions: 1) What would you like to see, and 2) what is your biggest concern on this project?
   a. Zach
      i. Goal: convert Santa Rosa's current Class B biosolids into Class A so the City can more easily manage biosolids with fewer restrictions. A dried product would be ideal to lower hauling costs and reduce trucking loads. A dried Class A biosolid product could make a profit instead of biosolids being given away or instead of paying farmers to take it.
      ii. Concern: time and money to go to Class A.
         1. Other notes:
            a. $130/WT to compost
            b. Fear of paying high fees to Lystek or being without an outlet if Santa Rosa can no longer go to land application. Concerned about a scenario where Santa Rosa needs to make a rushed decision.

b. Tanya
   i. **Goal**: same as Zach's, Class A biosolids onsite.
   ii. **Concern**: funding for initial capital cost to achieve Class A.
c. Christian
   i. **Goal:** have a plan that Santa Rosa does not outgrow itself in 5 years; make sure to size facilities adequately if there is future expansion such as adding food waste.
   ii. **Concern:** financial preparation to implement desires, such as cost to receive food waste.
d. Mike
   i. **Goal:** a solution that is resilient, adaptable, and scalable, and which does not limit options in the future. No irony in the solutions that are applied.
   ii. **Concern:** building something and regretting it because the previous technology worked better. Cautious to go the Class A route unless it solves a problem; exhaust all options for Class B.
      1. **Other notes:**
         a. The BMSP should capture the problems that we (Santa Rosa) want to solve
         b. Design solutions and reserve footprint for next phases
e. Discussion
   i. Zach is looking for means to reduce biosolids volume so it is more manageable. The storage facility could be converted to store more product on site and reduce the risk of high seasonal costs.
   ii. Mike noted that existing infrastructure needs attention first, such as digesters and headworks.
   iii. Zach is concerned that if HSW is expanded, more biosolids will be generated and Santa Rosa could exceed land application capacity.
   iv. Adam noted items that are unique and done well by Santa Rosa:
      1. Compost facility – could be re-started
      2. Farms – storage and land application

3. BMSP: Then and Now
   a. Then: Kern County had banned Class B, HSW facility was partnership with local business community and went over really well, continued composting was evaluated and there was an emphasis to save money
      i. Mike noted cost is a factor but not the only factor. Okay with something that is not the cheapest if there are benefits that are not quantified in costs.
   b. Now: PFAS regulatory uncertainty, SB 1383 has limited disposal options and there may be desire for regional solutions, and review costs/benefits of resumed composting
      i. Santa Rosa is currently involved in PFAS research in land application of biosolids. The findings may impact Santa Rosa's biosolids decision(s), but the research will not be completed by the end of the BMSP. **The BMSP should save room for potential outcomes of the PFAS research.**
      ii. Mike mentioned that Windsor is at a 30 percent design phase for a Class A project and plans to take solids from other plants. **BMSP needs to make sure nearby facilities are not all working toward regional solutions independently.**
      iii. Zach noted there are farms in North County area that would take biosolids, but they need to be Class A because lands are designated as California Tiger Salamander (CTS) habitat.

1. Mike questioned whether CTS habitat requiring Class A could be revised to Class B instead of changing treatment process. Zach noted California Association of Sanitation Agencies (CASA) has been hesitant to pursue this route because it could re-open the general order and there is risk of stricter regulations being imposed.

iv. Mike noted that any composting facility lease should have a good termination clause due to regulatory uncertainty.

4. Project Tasks
   a. Flow & loads, capacity evaluation, condition assessment, and regulatory/market assessment
      i. **Incorporate upstream components that could be at risk of failure in condition assessment.** Consider adding recommendation that the plant can look at replacements upstream if it solves capacity/condition problems.
5. Biosolids Alternatives Analysis
   a. 30-year life cycle mentioned in presentation.
   b. Mike suggested the CIP roadmap should extend to 15 years; 30 years may be too long of a planning horizon. This will be discussed during the screening and evaluation phase.
   c. Flag solutions as adjustable, scalable, or phase-able – as applicable
6. CIP
   a. Need information before January to incorporate into CIP for FY24
      i. Dewatering evaluation recommendations that could be incorporated would need to be received sooner than the January workshops to incorporate into the budget.
7. Project Schedule
   a. Receiving data request information and planning condition assessment site visit in November
   b. Next workshops in late January 2023
   c. Santa Rosa has a Master Plan schedule running in parallel to the BMSP project.
8. Next Steps
   a. City to provide data request materials for assessments/evaluations to start
   b. Start flow and loads and capacity evaluation
   c. Schedule site visit and interviews for condition assessment
9. Discussion
   a. Zach highlighted trends from land application of biosolids. Based on Jacobs Ranch history, first application of biosolids onto fields was about 20 tons per acre. Crops grew too fast, and the application was reduced to 10 tons per acre.

      Newer facilities need organics but within less than 10 years the land application rate will likely be reduced.

Action Required

The following are a list of actions required as a result of the meeting discussion:

1. Santa Rosa to respond to BC's data request.
   Assigned Person(s): Tanya Mokvyts; **Response Required:** November 17, 2022
2. BC to schedule site visit and interviews with Santa Rosa for condition assessment.
   Assigned Person(s): Maxwell Armenta; Alison Nojima; **Response Required:** November 17, 2022

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. Goals:
   a. Greater biosolids application flexibility (e.g., lower volumes, Class A if it addresses end use drivers)
   b. No regrets, no irony solution (i.e., no recommendations that the plant outgrows within 5 years)
   c. Resilient, adaptable, scalable, and phase-able solutions
2. Concerns
   a. Funding, capitals costs for projects/improvements
   b. Expensive solutions (e.g., Class A) that don't optimally address challenges/risks (e.g., PFAS)
3. BMSP should save footprint to consider outcomes from ongoing PFAS research
4. BMSP should connect with nearby facilities to confirm other regional solutions are not being developed independently
5. BMSP should note whether improvements upstream could potentially solve any capacity/condition issues (e.g., consider if a new headworks facility impact solids treatment recommendations)
6. BMSP should focus on a 15-year CIP roadmap

Brown AND Caldwell

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FINAL Meeting Minutes

Prepared for: City of Santa Rosa (Santa Rosa)
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose of Meeting: Regulatory and Market Assessment Kickoff Meeting
Date: February 9, 2023
Meeting Location: Microsoft Teams (Virtual) **Time:** 2:30 p.m. – 3:30 p.m.
Minutes Prepared by: Maxwell Armenta, Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
Tanya Mokvyts, Santa Rosa
Persephone Ma, BC
Alison Nojima, BC
Zach Kay, Santa Rosa
Natalie Sierra, BC
Maxwell Armenta, BC

Summary

This document captures notes from a BMSP meeting to kickoff the regulatory and market assessment task. BC requested and reviewed information form the City, and started performing work under this task. This meeting was used to verify the path forward for completing the market assessment.

Action items are underlined. **Key decisions/notes are in bold.** Notes from BC's presentation are in black font. Questions, answers, and comments from the workshop are in blue font.

Zach and Mike were asked to share their goals and concerns for this task.

Zach

- Goals:
  - Biosolids land app is always a concern about the land. Whether or not the owners will change their minds.
    - For example, one farm (Leonard Farm) is about 150 acres and is currently looking at stopping biosolids application from Santa Rosa in a couple years.
    - Another example is another property that occasionally is being put up for sale, and that same property has a change in ownership – thankfully for Santa Rosa's biosolids management, the new farmer wants to continue with current farming practices and not organic.

- Concern:
  - Levy stability protecting City-owned lands; potential risk.
  - Unknowns that might blindside the City and their biosolids management practices.
  - Answering whether going to Class A biosolids is what the City really wants to achieve? Is it worth going to Class A?
    - Zach knows that going to Class A unlocks more land application opportunities in the north with biosolids (i.e., unlocking California tiger salamander (CTS) habitat lands for application)
  - Potential new regulations being imposed on City's biosolids (e.g., on farms in the north); City is not sure what new regulations will be imposed.
    - "What we're going to get hit with next is always a concern"

Mike

- Goals/concerns/beliefs:
  - Do we improve and remediate levies for what might not present a huge amount of land application capacity?
  - Believes Class B (and non-potable) are still viable options
  - City owns a composting (Class A) facility on City grounds. Mike is not sold on eliminating composting as an option for the City; does not believe capital improvement costs are necessarily cost prohibitive for this option and has "a residue of discontent" with the past decision to shut down the facility
  - The director of Santa Rosa Water is interested in a Class A facility
  - Mike believes that composting rehabilitation costs were inflated in past work or not inclusive of the full picture
    - Composting can also be used to manage green waste. This goes into the benefits of a circular economy. **Mike would like to have the topic of circular economy brought up and discussed in deliverables.** Believes the future of the world may depend on or require going this route.
  - Mike wants to reserve room for uncertainties and different outcomes; looking for "on-ramps" in the roadmap

Natalie Sierra facilitated the remaining discussion with discussion from Zach, Mike, and Tanya.

<u>Aging Farmer Population</u>

- Natalie identified aging farmer population seen as a risk for Santa Rosa's area
  - Zach has heard this as well, but there are examples of other farmers willing to take over land from aging farmers.

<u>General</u>

- Santa Rosa wants an adaptable plan; value in having multiple channels to take material.
- **Mike would like to see funding opportunities that are generally applicable to biosolids or to Santa Rosa's situation**
  - E.g., money to put into compost because of the GHG emissions associated with it.

Composting

- **Mike wants composting facility findings articulated in a manner that doesn't make the previous decision to shut down composting look erroneous**
  - Zach and Natalie saw an email today regarding funding opportunities for composting
    - **If BC needs justification for another composting facility site visit, the City can make this happen**
  - Natalie asked, "what is the City's strategy with respect to SB 1383?" One challenge that is seen is that there is now more competition in the composting space.
    - Mike noted that Joey Hejnowicz (jhejnowicz@srcity.org; 707-543-3023) is the City's solids waste coordinator
    - Natalie suggested that BC can facilitate a conversation with Joey
      - BC to reach out and facilitate the conversation (Mike would like to sit in on meeting, but fine if he cannot). According to Mike, "no strategy on our part would be complete if we don't coordinate with him."
      - Zach believes Joey may be involved with Sonoma County Zero Waste. **Zach suggests linking with Sonoma County Zero Waste will also be important if composting is investigated.**
      - Tanya noted that grant funding piece should be discussed when considering cost.
  - Zach was disappointed when composting was lost because he lost one of his options available for biosolids management. It is also a wet weather option.
  - Mike asked whether composting could be used as a covered, aerated static pile storage facility?
  - Zach is curious for storage for compost during wet weather. Zach noted that they've always made it through winter for storage capacity, but if compost was significantly increased they may need more storage capacity.
  - Mike is interested in how we quantify benefits of triple bottom line and not just bottom line when it comes to composting managing green waste.

Land Application Acreage

- **Natalie and Zach agree that land application acreage is "stable but you never know."**

Landfill

- Zach noted Redwood Landfill is still a viable option at this point, but never know when Waste Management will make the option no longer viable. Redwood Landfill is used by Santa Rosa as an emergency, but they are only guaranteed one load a day with no questions asked. There is a potential to send more if they call and confirm.
  - Zach noted landfill is a cheaper option than going to Lystek.

Lystek

- **Mike noted that Lystek can be seen as a risk:**
  - What if Lystek has a problem?
  - What happens when there is not enough capacity and a lot of competition for Lystek's capacity?

- Natalie asked whether Lystek has given Santa Rosa grief over use during only winter
  - Zach noted that Lystek has not given the City grief, but they have reminded the City that the option to go there is available (at a slightly lower cost).

PFAS

- **City is NOT currently hearing any concerns about PFAS from farmers.** They know it's everywhere, but are of the opinion of "what will we be able to do about it." Farmers believe the City will figure out how to deal with PFAS in biosolids.

Regional Solutions

- Natalie asked whether there are other facilities that BC should talk to making sure there are no other regional plans
  - Mike is not aware of what is going on in Marin County. **Marin County is an unknown to the City; but not sure this warrants much outreach.**
    - Mike thinks Las Galinas may be trying to support other nearby sanitary districts, but their plans will not have enough capacity for all sanitary districts (e.g., CMSA could use all the capacity that Las Galinas would build).
    - Mike believes Novato may have been talking to Lystek
- Windsor already have decided that they want to go with biochar and have their mind set on the solution. They're currently contracting with Synagro. Mike believes they could contract with Santa Rosa and pay less than Synagro. Windsor understands that it would be best to go in for grant fundings.
  - **Mike would like BC to try and tamp down Windsor's enthusiasm, although they're already in 30 percent design.** Windsor produces about 10 percent of the biosolids produced by Santa Rosa.
  - BioForce tech is being investigated for 30 percent design.
  - (Natalie is curious whether BC should talk with Vallejo as well as other non-BACWA utilities)
- **Natalie summarized that BC should be documenting the out-of-the-box strategies and reaching out to Novato and Las Galinas.**
- Sonoma County is stuck on "certified organic," and the biosolids are hindered by this certification. This is why the City was stuck at the $5/cy cost, otherwise there were no outlets. This price allowed for people to "overlook" the biosolids component
  - Zach noted that a lot of compost was given away to schools and community gardens, and they received a benefit for their fields.
  - Zach tried to use biosolids for Caltrans. They used it once for roadside and engineer got in a dispute believing that the compost was "biosolids."
- Mike believes people just don't understand what compost is and the process it takes to create it (high temperature and curing)
- CTS = California tiger salamander, and Class B cannot be used on CTS land.

Summary of Regulatory and Market Assessment Investigations

- Natalie asked what investigations are most valuable to City?
  - **Mike wants to know what market looks like for conventional hay versus organically certified hay. Where are the conventional hay markets and is transportation a deal-breaker to get access to conventional markets.**

- Mike noted that shutdown of compost has made those customers go to other sources. How difficult will it be to re-procure the green waste feedstock that was previously received by Santa Rosa's compost.
- Mike is not aware of what Sonoma County is doing with green waste.
  - Zach believe Joey can answer this question.
  - Zach noted Renewable Sonoma didn't want to take City's compost land and have to separate an organic side (biosolids) and a non-organic side (green waste).
- Zach noted so much farming is organic. Zach wants to understand whether decreasing water content will allow for a greater trucking distance. Does a change in %TS lead to a greater access to conventional farming land for Santa Rosa's biosolids?
- Zach noted in the past composting was not making money. The idea was a weather independent facility and to reduce what was going to landfill.
  - Natalie suggest a more granular understanding of seasonality of the product. What are some strategy suggestions for managing product. Natalie suggests looking into end-users that "shorten" the "wet weather" season may also be helpful.
    - Zach agreed
- Zach re-iterated that the City wants to understand their "blind spots"
- Mike wants a guidance on how markets might change in 5 years
  - Zach noted that he can connect Natalie with Ryan Gilardi (Farmer). Zach would facilitate the conversation and inform the farmer why Natalie/Persephone is calling.
- Mike asked whether they could identify how much of the compost could be made available to residential customer base?
  - Zach noted that Santa Rosa had tried to market to residential market through word of mouth and Earth Day booth.

Action Required

The following are a list of actions required as a result of the meeting discussion:

1. BC to facilitate conversation with Joey from the City. Invite Mike and Zach to the meeting. **Assigned Person(s):** Persephone Ma/Natalie Sierra; **Response Required:** March 2023
2. City to facilitate connection between BC and an biosolids end-user (farmer), Ryan Gilardi. Zach to facilitate the conversation and inform the farmer why Natalie and Persephone are calling. **Assigned Person(s):** Zach Kay; **Response Required:** March 2023

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. Status of land application acreage is "stable, but you never know"
2. City is not currently hearing concerns about PFSA generated from farmers that receive their biosolids for land application
3. Investigations requested by the City (Zach and Mike):
   a. Funding opportunities applicable to biosolids or Santa Rosa LTP
   b. Answer whether composting can be used as a covered, aerated static pile storage facility
   c. Reach out to other facilities to confirm what other facilities have regional plans, including:
      i. Marin County (Las Galinas, Novato)
      ii. Windsor – currently at 30 percent design for pyrolysis regional facility
   d. Document "out-of-the-box" strategies for LTP and regional biosolids management
   e. Confirm what the market looks like for conventional hay versus organically certified hay (where are conventional hay markets and is transportation a deal-breaker to get access to the conventional markets)
   f. Evaluate the difficulty/feasibility of re-procuring green waste feedstock customers that previously used Santa Rosa's composting facility. Confirm other sources/competition for these customers.
   g. Confirm what Sonoma County (Renewable Sonoma) is doing with green waste by reaching out to Joey Hejnowicz, City of Santa Rosa Solids Waste Coordinator (jhejnowicz@srcity.org; 707-543-3023). Inquire about SB 1383 and grant funding when coordinating with Renewable Sonoma
   h. Answer whether a change in %TS will lead to greater hauling range for LTP biosolids and provide greater access to conventional farming lands
   i. Find end-users that shorten the wet weather season (end-users that can accept biosolids over greater range of months)
   j. Document potential "blind spots" for City's biosolids management strategy/program
   k. Provide guidance on how markets might change in the next 5 years
   l. Identify how much compost could be made available to residential customer base
4. Requests for deliverables:
   a. Introduce and discuss topic of circular economy (Mike)
   b. Present compost facility findings in a matter that doesn't make previous decision to shut down composting look erroneous (Mike)
   c. Quantify triple bottom line and not just bottom line (Mike)
   d. Include "on ramps" accounting for uncertainty in the CIP Roadmap (Mike)

FINAL Meeting Minutes

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Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose: Flows and Loads, Capacity Evaluation, and Condition Assessment
Date: March 6, 2023
Location: Laguna Treatment Plant **Time:** 9:30 a.m. - 11:00 a.m.
12:30 p.m. - 2:00 p.m.
Prepared by: Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
Christian Williams, Santa Rosa
Sean McNeil, Santa Rosa
Alison Nojima, BC
Adam Ross, BC
Tanya Mokvyts, Santa Rosa
Zach Kay, Santa Rosa
Richard Giordanella, Santa Rosa
Maxwell Armenta, BC
Colin Casey, BC

Summary

This document captures the meeting minutes from the Flow and Loads, Capacity Evaluation, and Condition Meeting for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. Notes are organized according to the PowerPoint outline, highlighting presentation takeaways. The meeting included a summary of BC's analysis and results of its flows and loads, capacity evaluation, and condition assessment draft technical memorandums. Questions and recommendations by the City will be addressed in each task's final technical memorandum. The meeting was concluded with a general discussion of each task's findings and BMSP recommendations. Notes from BC's presentation are in black font.

Action items are underlined. **Key decisions/notes are in bold.** Action items and key decisions/notes are summarized at the end of this document.

Meeting Minutes

Flows and Loads

1. **Zach**: Do flows and loads represent other agencies biosolids projections?
   a. Dependent on where in the process they are injecting biosolids and level of treatment others are providing to their biosolids.
2. For taking in other plants' biosolids, Bioforcetech (BFT) is similar to Lystek and manages end use/land application.
3. BC will get in touch with Windsor to understand timeline, capacity, and how they are taking solids from other plants (related to regionalization alternatives).

4. **Mike**: A lot of planned development – Tanya Mokvyts to check with water supply analysis to confirm population growth assumptions.
   a. City to confirm 25% population growth over timespan align with water-side projections.

Capacity Evaluation

1. Digester 3 has been cleaned and was recently put back into service.
2. The Belt Filter Press (BFP) shuts down every Sunday when solids are not hauled, or else storage capacity in the hoppers is exceeded.
   a. City's current hauling contract does not include hauling on Sunday. This could be amended in a future or amended hauling contract.
   b. **Adam**: Better dewatering from the BFP will result in freeing up more hopper storage.
   c. **Mike**: Is interested in switching back to a conveyor system instead of using cake pumps and piping to hopper structure. Cake inlet is at bottom of the hoppers.
3. **Mike**: The existing storage hoppers at the LTP were recently built.
4. **Zach**: Fear that an increased Total Solids (TS) % will cause issues with getting solids out of the hoppers (bridging).
5. Christian: The CHP capacity presented in the workshop is misleading. CHP engines' limitations should reflect SCR and NG blending; SCR on all units would alleviate the problem.
   a. Air permit limits NG blending on engines 1 and 2 without SCR.
   b. BC will revise CHP capacity to reflect utilizing digester gas in engines 1 and 2.
6. **Christian**: Waste Activated Sludge (WAS) pumps can only generate 220 gpm/each to GBT.
   a. Feed flow meters are not working well and will be replaced.

Condition Assessment

1. **Zack**: The Alpha Storage Barn facility helps with biosolids management, particularly during the wet season in preparation for land application through the dry season.
   a. Biosolids alternatives including land application of biosolids would need to consider the condition of the Alpha Storage Barn. Condition assessment of the Alpha Storage Barn was not included in BC's scope of work. Team should consider performing a condition assessment of the Alpha Storage Barn. This will be revisited after the market assessment.
   b. **Zack**: The Alpha Storage Barn is generally full by May.
   c. **Zack**: Santa Rosa owns the land for storage and land application.
   d. **Zack**: **The Alpha Storage Barn's side walls and paneling are open to allow air in for ventilation and appear to be in poor condition. The roof of the barn is in decent condition, with some leaks during wet weather.**
   e. **Zack**: Biosolids storage for the City is easier if biosolids have a lower TS, because the biosolids tend to flatten out and slough due to their weight, rather than pile high, which happens with drier biosolids.
2. **Sean**: HSW facility is susceptible to shutdown due to rag clogging. This is often a weekly occurrence that requires maintenance to shut down HSW. This should be scored more critically than currently shown and be addressed in a rehab project.
   a. Richard: Would like to see a grinder installed at HSW receiving.
3. Drains at the septage receiving station often get clogged, resulting in increased maintenance activity.

4. **Mike**: Concerned about the electrical equipment plantwide being below the hydraulic grade line. A structural failure could result in flooding and loss of electrical equipment, having a significant impact to plant operations. Location of electrical equipment below the HGL should be scored as high risk in condition assessment.
   a. Mike's primary concern for electrical equipment below the HGL are the primary sludge pumps. The LTPs Headworks and Primary Treatment structure is very old and would likely fail in a seismic event. **City has been discussing a new Headworks structure.**
   b. **If electrical equipment is replaced, it should be above the HGL.**
5. City to provide the digester lighting transformer H and panelboard H installation dates.
6. Currently, there is only one oversized digester dewatering pump for all four digesters, resulting in a single point of failure. This pump is used for transferring sludge between digesters, to dewatering, emptying the digester and recuperative thickening.
   a. BC recommends installing two smaller pumps that are more appropriately sized to avoid single point failure. The existing dewatering pump is also beyond its useful life.
7. City to confirm GBT 3 installation date.
8. BC to verify the installation date of 1975 date on BFP MCCs. City noted this was unlikely since BFP building was not built until 1990s.
9. BC should confirm that condition assessment recommendations align with electrical master plan recommendations by Hazen and Sawyer.
10. BC to send Christian information on TMWRF's Schwing Bioset cake pumps.
11. Auger that feeds sludge to the cake pump stator may have issues. The City is currently replacing existing one.
12. Axtrap on the H2S removal vessels worked for a week but got breakthrough because the plant was running the vessels in series.
13. **Christian**: Can't store iron sponge media without degradation and get the removal performance. BC will check with Unison on media alternatives. City currently must replace media approximately every 6-months.
14. **Zach**: Compost facility fire suppression system, HVAC, and roofing need replacement. Most of the compost facility structural/coating failures occur from the inside out.
15. **Mike**: City will soon be completing a business risk vulnerability assessment for the Geysers pumping system and would be interested in doing a similar assessment for the LTP.

Discussion (12:30 – 2:00 PM)

1. Priority and/or "exciting" projects:
   a. **Christian: SCRs for CHP engines 1 and 2.**
   b. **Mike: Electrical improvements plantwide and relocate electrical equipment above the HGL.**
   c. **Mike: Digester dewatering pump replacement.**
   d. **Sean: HSW odor control scrubber – project driver is permit compliance.**
   e. **Zach: Composting and Class A product.**
2. **Sean**: PFAS is three times higher than statewide average that are likely cause by leachate.
   a. Santa Rosa will be performing a study. City knows PFAS levels in Central pipeline leachate, but not trucked waste haulers. Study may potentially lead to local limits.
   b. Sean to send a graph on PFAS data.

3. Colin will follow up with James Jetton (BC) on scum ejectors PS pumps. Recommendations will be included in Final Condition Assessment TM.
4. **Mike**: Two digesters have fixed covers and the other two have floating covers.
5. Lystek allows for sub-Class B biosolids.
6. Christian wants all CHP engines to operate at the same time to make them easier to tune while providing redundancy.
7. City commented that O&M has discussed purchasing and storing a 5th CHP Engine onsite and available to be moved into the CHP building when one of the CHP engines is out of service for maintenance would mitigate having to operate CHP with one of their engines. This would be costly and only considered if SCRs could not be added to CHP engines 1 and 2.
8. Colin will send Christian information for new ferric chloride tanks. City communicated they anticipate self-installing ferric chloride tanks. Existing tanks are bulging and the City is concerned of failure.
9. Digester mixing improvements, from current gas mixing system to mechanical mixing, would include digester cover replacement. The City's digester cover replacement is Year 5 on the CIP.
10. Adam suggested the biosolids alternatives analysis look at solution synergies, using THP (Cambi) as an example of a method to increase thickening capacity, digester capacity, and product Class A product. This was noted as a recommendation in the previously BMSP; however, the previous drive was Class A and the current driver appears to be capacity.

Action Items

The following are a list of actions items as a result of the meeting discussion:

Santa Rosa

1. **Santa Rosa** to check water supply analysis growth projections and confirm BMSP growth assumption (currently 0.75 percent/year).
   Assigned Person(s): Tanya Mokvyts; **Response Required:** 3/20/2023
2. **Santa Rosa** to confirm GBT 3 installation date.
   Assigned Person(s): Tanya Mokvyts; **Response Required:** 3/20/2023
3. **Santa Rosa** to provide the digester lighting transformer H and panelboard H installation date.
   Assigned Person(s): Tanya Mokvyts; **Response Required:** 3/20/2023
4. **Santa Rosa** to provide PFAS data.
   Assigned Person(s): Sean McNeil; **Response Required:** 3/20/2023

Brown and Caldwell

1. **BC** to get in touch with Windsor to understand timeline, capacity, and how they are taking solids from other plants for future pyrolysis system.
   Assigned Person(s): Max Armenta/Persephone Ma; **Response Required:** 3/27/2023
2. **BC** to revise CHP calculations, including air permit limitations from engines without SCRs
   Assigned Person(s): Max Armenta; **Response Required:** 3/23/2023
3. **BC and Santa Rosa** to consider a condition assessment for the alpha barn facility.
   Assigned Person(s): Max Armenta/Tanya Mokvyts; **Response Required:** 3/27/2023
4. **BC** to consider feedback regarding HSW rag clogging; Include in condition assessment as appropriate. Consider grinder installation as recommendation at HSW receiving.
   Assigned Person(s): Colin Casey; **Response Required:** 3/27/2023
5. **BC** to confirm installation date of 1975 for BFP MCCs.
   Assigned Person(s): Dane Forsberg; **Response Required:** 3/27/2023
6. **BC** to confirm electrical master plan recommendations align with condition assessment. Reach out to Tanya to request electrical master plan Excel file.
   Assigned Person(s): Colin Casey; **Response Required:** 3/27/2023
7. **BC** to send City information on TMWRF's Schwing Bioset cake pumps.
   Assigned Person(s): Colin Casey; **Response Required:** 3/20/2023
8. **BC** to check with Unison about iron sponge media alternatives for gas conditioning system
   Assigned Person(s): Alison Nojima; **Response Required:** 3/20/2023
9. **BC** to follow up with James Jetton on scum injectors PS pumps.
   Assigned Person(s): Colin Casey; **Response Required:** 3/20/2023
10. **BC** to send ferric chloride tank information to Santa Rosa.
    Assigned Person(s): Colin Casey; **Response Required:** 3/20/2023

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. Capacity Evaluation
   a. CHP engines limitations should reflect SCR and NG blending; SCR on all units would alleviate the problem. Revise CHP engine calculation; acknowledge air permit limitations.
2. Condition Assessment
   a. Alpha storage barn's side walls and paneling are in poor condition; Site not evaluated by BC.
   b. HSW receiving experiences clogging weekly due to rags in equipment.
   c. City has been discussing a new headworks structure.
   d. Any electrical equipment recommended for replacement should be considered above the HGL.
3. Discussion
   a. Priority condition assessment projects include:
      i. SCRs for CHP engines 1 and 2.
      ii. Electrical improvements and relocation of electrical equipment above the HGL.
      iii. Replace single digester dewatering pump with two pumps.
      iv. HSW odor control scrubber.
      v. Composting.

FINAL Meeting Minutes

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Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose: Regulatory/Market Assessment and Screening/Evaluation Criteria Workshops
Date: April 24, 2023
Location: Laguna Treatment Plant **Time:** 9:30 a.m. - 12:00 p.m.
Prepared by: Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
Christian Williams, Santa Rosa
Sean McNeil, Santa Rosa
Alison Nojima, BC (Virtual)
Adam Ross, BC
Tanya Mokvyts, Santa Rosa (Virtual)
Zach Kay, Santa Rosa
Natalie Sierra, BC (Virtual)
Maxwell Armenta, BC
Persephone Ma, BC (Virtual)

Summary

This document captures the meeting minutes from the Regulatory/Market Assessment and Screening/Evaluation Criteria Workshops for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. Notes are organized according to the PowerPoint outline, highlighting presentation takeaways and discussion.

Action items are underlined. **Key decisions/notes are in bold.** Action items and key decisions/notes are summarized at the end of this document.

Meeting Minutes

Regulatory/Market Assessment – S.W.O.T. Analysis & Discussion

1. Biosolids quality information presented before/after HSW. Group agreed that nutrient content after HSW receiving was implemented has not changed significantly; does not impact nutrient guarantee to end users.
2. Strengths Weaknesses Opportunities Threats (SWOT) Analysis presented.
   a. Zach suggested:
      i. Document City's ability to purchase land in South Sonoma County as a strength. (This was taken as a threat by Sonoma County Land Trust. City mitigated concern with a white paper in past, but large purchases may be met with resistance – potential external threat to land purchases.)
      ii. Document owning Alpha farm as a strength.

iii. Add sea-level rise as a threat. (A threat to City-owned South County properties and farms. The City could take action but that doesn't mitigate risk to non-City-owned lands.)

b. Mike suggested:

i. Add California tiger salamander (CTS) habitat as a threat. (over 800 acres lost due to CTS habitat. This could be seen as a motivator for a Class A product [i.e., compost] to unlock some of City owned land for biosolids application.)

ii. Add composting as an opportunity. Could footnote this under Class B only weakness.

c. Natalie noted:

i. BC should add City's participation in regional organizations as a strength.

ii. BC should add City's control over program, and ability to be nimble, as a strength.

d. Zach agreed programmatic oversight has been a strength; a lack of oversight (e.g., facilities only sending biosolids to Arizona) has become a threat for facilities without direct oversight and has caused some utilities to scramble.

e. Zach noted the City would not be opposed to purchasing more land in the future.

f. Zach mentioned some facilities use tubes to store biosolids. There may be uncertainty regarding whether this adds per- and polyfluoroalkyl substances (PFAS) from plastic sent to landfill.

g. Tanya asked if there is a timeline for when sea level rise will require action.

i. Zach noted that it depends on the model; there is no hard-and-fast answer.

ii. Natalie added that recent climate events add to uncertainty. In some cases, threats are happening sooner than models predict.

iii. City already had an overtopping of one levy at their properties from past storms.

Regulatory/Market Assessment – Regulatory Review

1. California Agency of Sanitation Agencies (CASA) is optimistic that some land bans may be overturned in California due to organic diversion bill (Senate Bill [SB] 1383).
2. About 2 years out from EPA's decision on if/how PFOS and PFOA will be regulated.
3. EPA's commentary communicates that they do not intend to ban biosolids. EPA likes the Michigan pre-treatment route, which may suggest limits set for industrial dischargers.
4. EPA change drinking water maximum contaminant level (MCL) from 70 to 4 parts per trillion
5. Caltrans requires US Composting Council (USCC) certification.
   a. Zach confirmed this was required. The City worked with Caltrans in the past, but their requirements were difficult. **Working with Caltrans is not as beneficial as the City would hope for biosolids management purposes.**
   b. Zach noted that he was starting to break into grape vineyard market with compost product.

Regulatory/Mark Assessment – Agricultural Market Review

1. **Zach noted that silage is required to be organic when cows reach certain age. Organic market is a threat/limitation to silage and hay acreage.**
2. Persephone noted the exact quantities of organic versus non-organic hay was not investigated, but a deeper dive can be made if required/beneficial.
   a. Zach acknowledged this (organic hay) may be more of an issue for Sonoma County

Regulatory/Mark Assessment – Commercial Market Review

1. Zach noted golf courses wanted a finer compost product than the City produced. The City found sports field welcoming to compost application.
2. Class A versus compost may have differences in end use costs. Some of the end users surveyed noted that they would want product in super sacks.
3. The impression from end users on biochar was "I would try it, but I wouldn't pay for it."
4. Zach noted that landscapers and soil blenders were the largest compost consumers.
   a. **$5/cubic yard was the magic number. Above this price, und users would stop using compost.**
5. Zach shared community gardener experience: the community garden was unsure if they would use product. After using the product, 2 weeks later they returned and asked for much more to apply to the garden.
6. Lystek had attempted to market storage on farms as a solution to farmers, but farmers did not want to participate if they had to pay for storage.
7. **Zach noted that Lystek is preferred in lieu of Synagro based on experience with both.**
8. **Zach noted preference for City to manage biosolids in lieu of contracting out. This minimizes "surprises" on end use changes.**

Regulatory/Mark Assessment – Regional Considerations

1. Windsor is open to and encouraging a regional facility.
   a. **Mike noted uncertainty about being committed to end user with emerging technology risk (Windsor's pyrolysis)**
   b. Mike asked which consultant supported the design. Natalie noted it was Hazen.
      i. Mike wants to reach out to Windsor or Hazen to learn the screening criteria or decision making process that led to pyrolysis selection for Windsor.
   c. Natalie suggested that BC can place City in contact with Alexandre Miot from Silicon Valley Clean Water to better understand the performance of the BioForceTech unit there.
2. Zach noted that he wants to add 1 or 2 more options to the City's current biosolids portfolio
3. Zach and Mike noted a threat of farmer relationship changeover. For example, if Brian (a farmer applying biosolids to their land) were replaced, would biosolids application still continue?
4. Vallejo was not included in slides, but has options similar to the City for their biosolids. Vallejo has 1400 acres of land.
   a. **Zach suggested that Vallejo's lime-stabilized biosolids may be a good fit for City farms, and whether a swap of biosolids applications (i.e., City biosolids to Vallejo farms in exchange) would be mutually beneficial.**
      i. Mike noted that there was a positive interaction with Vallejo during interactions with the Regional Board. They have demonstrated good partnership potential and Mike was going to reach out to Jennifer Harrington at Vallejo for further discussion.
5. 30,000 acres of agricultural land bought in Solano county at real estate pricing by an LLC.

Screening & Evaluation Criteria

1. Screening criteria presented.
   a. Zach noted that flow and ton criteria are lower than City's sizing. Max suggested criteria is to ensure full-scale sizing, but not necessarily intended to ensure an installation at a facility the size of Laguna Treatment Plant or larger.
   b. **Mike suggested proceeding with the proposed criteria in the slides and the City can review screening results at the next workshop.**
2. Evaluation criteria presented.
   a. Sean suggested:
      i. **Decrease permitting/reg risks to a 5 instead of 10, and**
      ii. **Increase environmental/community impacts to a 10 instead of 5.** Mike agreed.
   b. Mike suggested:
      i. **Increase end use to 30 instead of 25, and**
      ii. **Decrease O&M impacts to 20 instead of 20**
   c. Adam noted that O&M impacts are also quantified in alternatives analysis through operating costs from additional FTE or increased maintenance.
3. Biosolids end use diversification noted as important.

Action Items

The following are a list of actions items as a result of the meeting discussion:

Santa Rosa

1. **Santa Rosa** to contact Hazen and/or Windsor to ask how pyrolysis was identified for design. (what were the screening criteria? what was the decision-making process?)
   Assigned Person(s): Mike Prinz; **Response Required:** 5/31/2023

Brown and Caldwell

1. **BC** to add items to SWOT analysis results in TM, including:
   - Document City's ability to purchase land in South Sonoma County as a strength.
   - Document owning Alpha farm as a strength
   - Add sea-level rise as a threat.
   - Add California tiger salamander (CTS) habitat as a threat.
   - Add composting as an opportunity.
   - Add City's participation in regional organizations as a strength.
   - Add City's control over program as a strength.
   - Add farmer turnover/change as a threat.

   Assigned Person(s): Persephone Ma/Natalie Sierra; **Response Required:** 5/1/2023

2. **BC** to perform screening exercise with updated criteria (see Key Decisions and Notes)
   Assigned Person(s): Max Armenta/Alison Nojima; **Response Required:** 5/17/2023

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. Regulatory/Market Assessment
   a. Working with Caltrans is not as beneficial as the City would hope for biosolids management purposes.
   b. Organic market is a threat/limitation to silage and hay acreage.
   c. $5/cubic yard was the magic number. Above this price, und users would stop using compost.
   d. Working with Synagro is not preferred.
   e. Committing to Windsor's "regional" biosolids solution is not preferred.
   f. Contracting out biosolids is not preferred.
   g. Zach suggested that Vallejo's lime-stabilized biosolids may be a good fit for City farms, and whether a swap of biosolids applications (i.e., City biosolids to Vallejo farms in exchange) would be mutually beneficial.
2. Screening/Evaluation Criteria
   a. Screening Criteria includes the following:
      Technology is scored against each criterion based on a pass/fail score.
      i. **Plant compatibility** – is the technology compatible with existing processes and City resources (e.g., staffing)?
      ii. **Established/mature** – does the technology have sufficient full-scale installations with proven operation history?
         1. Screening guidelines:
            a. 5 reference installations minimum
            b. 1 installation with 5 years or more of operation
            c. 2 installations operating in North America
            d. 1 vendor with 3 or more installation references in North America
            e. References for facility similar to Santa Rosa (e.g., 70 percent municipal wastewater solids facility with 10 mgd influent or 5 dry tons TS/d)
      iii. **Diversify Santa Rosa's biosolids management toward beneficial use** – does the technology contribute, or not deter, from the City's goal to have multiple pathways for organics diversion from landfill?
      iv. **Program reliability** – is the technology compatible with existing/future regulatory/market conditions?
   b. Non-Economic Criteria includes the following:
      Alternatives will be scored out of total points, where higher scores are more favorable.
      i. End Use Market Compatibility – 30 total points
      ii. Existing Site and Process Compatibility – 25 total points
      iii. O&M Impacts – 20 total points
      iv. Environmental and Community Impacts – 10 total points
      v. Safety Impacts – 10 total points
      vi. Permitting and Regulatory Risks – 5 total points

FINAL Meeting Minutes

201 North Civic Drive, Suite 300
Walnut Creek, CA 94596

T: 925.937.9010

Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose: Screening Workshop
Date: May 25, 2023
Location: Laguna Treatment Plant **Time:** 2:10 p.m. - 3:45 p.m.
Prepared by: Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
Christian Williams, Santa Rosa
Sean McNeil, Santa Rosa
Alison Nojima, BC
Adam Ross, BC (Virtual)
Tanya Mokvyts, Santa Rosa
Zach Kay, Santa Rosa
Donald Marlatt, Santa Rosa
Maxwell Armenta, BC
Alexis Valenti, BC

Summary

This document captures the meeting minutes from the Screening Workshop for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. Notes are organized according to the PowerPoint outline, highlighting presentation takeaways and discussion.

Action items are underlined. **Key decisions/notes are in bold.** Action items and key decisions/notes are summarized at the end of this document.

Meeting Minutes

Introduction, Technology Screening Intro, Technology Overview

1. Workshop part of biosolids alternatives evaluation. Purpose is to confirm end-to-end alternatives for the initial alternatives analysis. The initial alternatives analysis workshop is scheduled for late June.
2. Santa Rosa's project drivers decided at the previous workshop were reviewed. Screening importance and process reviewed.
3. An example of the screening exercise was presented. It was noted that some technologies were driven by capacity constraints, but may also provide a Class A product as well.
4. Cake pumping was noted as an issue currently (adds water to biosolids).
5. Thermal hydrolysis process (THP) is a sludge pre-treatment prior to digestion increases the biodegradability of wastewater solids, thereby increasing digester loading rates and requiring half

the tank volume than with conventional mesophilic digestion. However, THP would require more equipment and steam boiler is required.

a. Mike noted that steam-related staffing seems like a pain point
b. Zach asked if belt press (BP) will have higher total solids (TS) or reduce biosolids produced if THP is implemented
c. Zach noted the ability to ramp up/down a technology to achieve either Class A or Class B is a benefit because it adds flexibility
    i. Zach noted that with THP you only get a Class A product (no ability to ramp up or down)

Preliminary Screening Results

1. Preliminary screening results and rationale were presented. List of alternatives from preliminary screening results shown on a slide and in handouts.

Preliminary Alternatives Review

1. Preliminary alternatives presented.
2. Max noted that biosolids conveyance should be added to compare against cake pumping
3. Zach cited calculations on current and potential future truck loads:
    a. 1,472 trucks/year currently based on wet tons produced
    b. 190 trucks/year based on dry tons
        i. Big difference in carbon footprint related to transportation
        ii. Lowering biosolids nitrogen content would increase the agronomic rate
4. City asked how adding food waste compares with other high-strength waste (HSW) feedstock alternatives
    a. Max noted that adding food waste would assume different volatile solids reduction performance and percent TS concentration than HSW currently received.
5. HSW increased from Foster Farms deliveries (2x 6,500 gal trucks per weekday)
    a. Mike noted that Foster Farms offered to build new HSW tanks for their waste if the City receives the waste
    b. Christian is currently required to turn away trucks
        i. 30-day average flow is 28,000 gpd
        ii. Recent maximum day is 41,000 gpd
        iii. A "crust" forms inside HSW tanks that can cause clogging. This effectively requires 13,000-17,000 gallons (15,000 gallons average) to be storage in tanks to mitigate pulling "crust" into digester feed piping.
        iv. Sacrificial cone bottom is also not pumped
            1. Cleaned once per year
    c. Mike noted that gas storage will fit into the analysis
    d. Zach noted that additional digester gas could be used for thermal drying
    e. BC to update status quo HSW quantity (more than 16,900 gpd currently)
    f. BC to add sub alternatives for 46,000 gpd (permitted capacity), 92,000 gpd (double capacity), and an intermediate HSW loading scenario.
6. Zach would want thermal drying instead of electrolysis; Does not want nitrogen coming back to the Laguna Treatment Plant (LTP)

7. Zach noted that Lystek option leads to a storage capacity question. Drying beds would be assumed, and could perhaps be located at the compost site.
   a. Sean noted that the board of public utilities (BPU) was told that Lystek is being considered.
   b. **Dedicated Lystek storage on-site is not desirable, but can be explored in the alternatives analysis.**
   c. Zach noted that the City has a 5-year contract with Lystek with a 4-year extension option
8. Sean noted that the BPU had concerns about the vehicle miles traveled
9. Zach noted that California tiger salamander (CTS) habitat is still organic crop, so Class A biosolids will not unlock more land application capacity on CTS habitat in north county.
10. **Zach noted that storage capacity (Alpha Barn) has been exceeded. A dryer product could be stacked higher and biosolids volume reduction is important.**
    a. **Alpha Barn storage capacity estimated at 7,000 wet tons.**
    b. **Water-tight barn required to protect a drier biosolids product during wet weather storage**
11. Mike suggested building storage in south county.
    a. Zach and Donald noted that runoff from storage would be an issue.
    b. Mike suggested runoff storage could be constructed and intermittently hauled.
    c. Zach noted that storage at south county is also at risk of sea level rise.
12. City is not sold on the centrifuge option. Christian is agnostic. Zach is concerned about odor.
13. **Christian would rather have additional biogas go to combined heat and power (CHP) engines instead of a dryer**
14. **Christian needs to expand gas conditioning so that biogas (and additional biogas) can go to engines.**
    a. Mike noted that gas storage could be used and allow the City more flexibility.
    b. Noji noted gas storage only provides a storage on the order of minutes and generally has a large footprint.
15. Zach asked if gas- or electric-powered dryers would be best
    a. Sean noted that greenhouse gas (GHG) emissions are not completely tracked by City or County, but Sonoma Clean Power is supposed to be 100% renewable energy.
    b. **BPU would be interested if added technology impacts GHG emissions. City plans to be carbon free by 2030.**
16. City asked how SB 1383 change the requirement to take compost
    a. Noji noted that 50% diversion is required relative to benchmark year
17. Zach noted that getting yard waste now would be challenging. Previously, Ukiah had food waste and provided food feedstock to the City for free. Now, new permit may be required and feed stocks would need to be acquired. Certain feed stocks killed the temperatures in composting.

Action Items

The following are a list of actions items as a result of the meeting discussion:

Santa Rosa

1. **Santa Rosa** to work with BC to coordinate Initial Alternatives Analysis workshop/meeting for late June.
   Assigned Person(s): Tanya Mokvyts; **Response Required:** 6/9/2023

Brown and Caldwell

1. **BC** to update alternatives analysis
   - use recent number (to be confirmed with Christian) to represent new status quo.
   - add intermediate HSW number for evaluation between permitted capacity and 2x permitted capacity (69,000 gpd).
   - quantify added food waste volume in alternative list
   - add gas storage alternative
   - add additional storage alternative(s)
   Assigned Person(s): Lexi Valenti; **Response Required:** 6/1/2023
   a. ***Post meeting response:*** *The initial alternatives analysis will assume low, mid, and high HSW quantities to bracket the net present values focused on the main solids treatment processes. This is recommended in lieu of intermediate HSW number and using FW assumptions for initial analysis, and sensitivity analyses with HSW quantities will be evaluated during the refined alternatives analysis.*
2. **BC** to answer Zach's question THP impact on TS and biosolids production.
   Assigned Person(s): Alison Nojima; **Response Required:** 6/1/2023
   a. ***Post meeting response:*** *In general, yes, a slight increase in VSR results in a reduction in biosolids produced.*
   b. ***Post meeting response:*** *THP improves the dewaterability of biosolids, so a higher %TS can be achieved in the BP's. This would need to be paired with a cake conveyance belt project.*
3. **BC** to perform initial alternatives analysis and present results at next workshop
   Assigned Person(s): Lexi Valenti/Alison Nojima; **Response Required:** 7/6/2023

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. Updated Alternatives Analysis
   a. The table below documents updated alternatives based on discussion during the workshop

Alternative Number	HSW[1]	PreTreatment	Digestion[2]	Dewatering[3] Belt Press assumed unless otherwise stated	Drying[4]	Conveyance Cake Pumping unless otherwise stated	Product[5]	Gas Storage
01	30,000 gpd	-	Meso		-		B	
02	46,000 gpd	-	Meso		-		B	
03	92,000 gpd	-	Meso		-		B	
04	30,000 gpd	-	Meso		-	Conveyors	B	
05	30,000 gpd	-	Meso		-		B + New Storage	
06	46,000 gpd	-	Meso		-		B	Gas Storage
07	30,000 gpd	-	Meso		-		B + Compost	
08	30,000 gpd	-	Meso	Centrifuges 25% TS	-	Conveyors	B	
09	92,000 gpd	-	Meso	Centrifuges 25% TS	-	Conveyors	B	
10	30,000 gpd	-	Meso		ThrDry 50% TS		B	
11	30,000 gpd	-	Meso		ThrDry 90% TS		A	
12	30,000 gpd	-	Meso		-		A/Lystek	
13	30,000 gpd	-	Thermo (12d SRT)		-		B	
14	30,000 gpd	-	Meso (12d SRT)		ThrDry 90% TS		A	
15	30,000 gpd	Recup Thk	High Solids Meso		-		B	
16	30,000 gpd	THP	Meso		-	Conveyors	A	
17	46,000 gpd	THP	Meso		-	Conveyors	A	
18	92,000 gpd	THP	Meso		-	Conveyors	A	
19	30,000 gpd	THP	Meso	Centrifuges 25% TS	-	Conveyors	A	

2. Biosolids Alternatives Assumptions
   a. Assumptions from the workshop include:
      i. 7,000 wet tons of storage capacity in Alpha Barn
      ii. Water-tight barn required to protect a drier biosolids product during wet weather storage
      iii. Biogas conditioning requires expansion

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FINAL Meeting Minutes

201 North Civic Drive, Suite 300
Walnut Creek, CA 94596

T: 925.937.9010

Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose: Initial Alternatives Evaluation Workshop
Date: July 6, 2023
Location: Laguna Treatment Plant **Time:** 10:05 a.m. – 12:32 p.m.
Prepared by: Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
Christian Williams, Santa Rosa
Heather Johnson, Santa Rosa
Alison Nojima, BC
Adam Ross, BC
Tanya Mokvyts, Santa Rosa
Zach Kay, Santa Rosa
Richard Giordanella, Santa Rosa (Virtual)
Taylor Scobey,BC
Alexis Valenti, BC
Maxwell Armenta, BC (Virtual)

Summary

This document captures the meeting minutes from the Initial Alternatives Evaluation Workshop for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. Notes are organized according to the PowerPoint outline, highlighting presentation takeaways and discussion.

Action items are underlined. **Key decisions/notes are in bold.** Action items and key decisions/notes are summarized at the end of this document.

Meeting Minutes

Introduction

1. Initial alternatives analysis preliminary results are being presented today.
2. Goal: Identify 3 refined alternatives in today's workshop. Next steps include: completing detailed layouts, GHG emissions, and develop CIP plan.

Review of Alternatives

3. Goals for groups of alternative are presented:
   a. Alt 0 to 3 = expand HSW program from status quo
   b. Alt 4 to 7 = optimize status quo
   c. Alt 8 to 9 = produce drier cake product (assuming centrifuges; 25 percent TS)

d. Alt 10 to 11 = produce significantly drier cake product (assuming dryers; 50 to 90 percent TS)
e. Alt 12 to 15 = address digester capacity with lower than 15-day HRT options
   i. These options provide a Class A backstop to avoid needing to meet Class B solids retention time regulation requirements in digesters.
f. Alt 16 to 19 = address digester capacity with THP
   i. This method does not achieve Class A if HSW is added after THP
   ii. These alternatives assume only PS and TWAS are affected by THP

4. Zach has a concern regarding getting cake out of hoppers if the cake product is drier.
   a. **Adam agreed that a conveyor project would require a bridge breaker to ensure a dryer product is compatible with the existing cake storage hopper.**
   (NOTE: this is a potential revision to currently assumed conveyor capital cost)

Initial Alternatives Evaluation – Approach

1. BC's solids water energy evaluation tool (BC:SWEET) methodology and outputs are explained.

Initial Alternatives Evaluation – Process Results

Biosolids summary

1. Conveyor and thermal drying options produce drier product and less overall wet tons per day
2. THP also produces less overall wet tons per day

Biosolids land application summary (Winter)

1. Analysis assumes 10 wet tons can be applied per acre. This assumption factors into the economics in the evaluation.
2. Zach noted that ammonia will limit the land application. (NOTE: ammonia-based limits are not currently accounted for in the BC:SWEET model and should be refined in the refined alternatives analysis. A dry ton or nutrient loading basis could be considered in SWEET model.)
3. Zach noted 8-10,000 wet tons annually
4. Zach noted that by having drier product the cost to haul is reduced significantly and help maintain storage capacity.
   a. Unlocking Class A would allow about 11 percent more acreage of land application.
   b. There is a reduced cost for product to be applied in North County compared to South County. North County land is currently organic, but Zach and Mike noted that this may be driven by the farmers knowing biosolids cannot be applied. However, this could be changed. **Refined alternatives analysis can assume that additional land in North County (about 800 acre) could be available for Class A biosolids application and a lower cost per wet ton due to lower hauling costs in North County.**

Biosolids storage summary (Winter)

1. Mike noted that 35,000 wet tons is current production and that this looks approximately similar to status quo.
2. Lexi noted that 6 months of winter and 6 months of summer were assumed in the BC:SWEET model
   a. Zach noted that this sounds about right
3. Zach noted 8,200 wet tons have been storage at (and outside) Alpha this past year

4. Mike noted that Santa Rosa is currently collecting HSW revenue to maintain lower rate increases but Mike believes revenue should be diverted to CIP projects at laguna treatment plant (LTP).
5. Adam, Mike, and Zach noted that if new HSW capacity is created, it would require more storage if there are no additional biosolids outlets.
6. Thermal dryer biosolids are below the storage line and composting requires less biosolids to be sent to Lystek per BC:SWEET model results.

Biogas and power generation

1. Christian noted that all graphs appear to suggest THP alternatives look good.
2. The biogas production status quo exceeds the current biogas conditioning capacity.
3. Mike noted that THP would require a steam plant (steam required for THP). Adds new systems and O&M staff.
   a. Adam noted that a special operator/engineer certification is required on-site 24/7.
   b. Mike noted that TM can noted that addition to staff assumed Santa Rosa can continue to attract and retain staff.

Natural gas demand

1. Thermal drying and THP require natural gas (more cost).
2. Mike asked if plants with similar size to LTP have THP installed?
   a. The Washington Suburban Sanitary Commission (WSSC) is installing THP but not currently running it.
   b. San Francisco Public Utilities Commission (SFPUC) is a marque installation that was faced with building big digesters or using THP and installing half as many digesters.
3. Mike expressed concern about hiring and retaining enough certified staff to be able to operate THP reliably
4. Adam noted that thermal drying requires a significant amount of natural gas.
   a. Adam noted that thermal drying has significant fossil fuel demand.
   b. Mike noted thermal drying could go against Santa Rosa's climate goals
   c. **Mike suggested this should be highlighted in the report**
   d. Zach asked if there is a biological drying unit that's less carbon intensive
      i. BioForceTech is an installation, but is relatively new and was screened
      ii. Zach noted that WEF RBC showcased an electric-based technology which could be an alternative
5. Lexi and Noji noted that two thermal dryers were assumed to be installed in the composting facility area.
   a. Mike expressed concern about thermal dryer and THP cost risks.
6. Heather noted that air permitting is a risk for drying.
7. Adam suggested drying could be implemented as a phased approach in the roadmap *if* either regulations require a drying alternative OR if the pyrolysis technology becomes more developed.
8. Lexi/Adam noted that natural gas for THP is optional. The biogas could be used in boilers instead of natural gas (i.e., the calculations could be updated).
   a. Mike noted that THP could also be a heat sink for the LTP's current waste heat

Initial Alternatives Evaluation – Capital and Annual Cost Results

Capital Costs

1. Capital, operating, and net present value costs were presented.
2. The On-site Lystek option assumes capital investment in pipe used to pump sludge across the street near the composting area. **Lexi noted the risk of contracting with Lystek is not captured in these numbers.**
   a. Composting was assumed as about $15 million
   b. Mike asked if it is difficult for BC to be objective. Adam does not believe so since it is a new team "plugging in the numbers"; An independent team is performing the current analysis.
3. Mike noted that capital required from headworks and electrical upgrades that are competing for money with digestion upgrades.
4. Adam noted that dryer and THP are one big multi-million dollar investment compared to other alternatives which are a group of smaller million dollar projects.

Operating Costs

1. Composting assumed 8 FTE
2. Lystek includes contract cost (City pays tipping fee to Lystek)

Net Present Value Cost

3. Composting, dryers, and THP are highest cost
4. Centrifuges and conveyors present the lowest net present value (NPV) cost. Mike noted that if the City go for centrifuges and conveyors, they could continue to expand HSW and an expanded HSW should reduce the NPV.
5. **Mike is looking at how to create chunks out of alternatives for a phased CIP plan**
6. Mike noted that the actual availability of HSW should be considered. Noji noted that the high HSW alternative likely would assume food waste is a significant portion ofz new HSW.

Non-economic Scoring

1. Approach was reviewed.
2. Dryers and THP alternatives have the highest scores end use scores
3. <15-d SRT and THP alternatives have lowest O&M scores (more complexity and/or staffing burden)
   a. Mike noted that the material presented today suggest that Class B treatment process makes a lot of sense; Class A for the sake of it does not appear to be beneficial.
4. On-site Lystek has highest score (created 100% class A); THP alternatives have lowest scores (impacted by danger of steam)
5. Composting has the highest environmental and community impacts.
6. Adam noted that we can drop compost as only a small portion of biosolids will become class A. Zach noted that compost is a tough sell.
7. Highest scoring alternatives were:
   a. Lystek – note: the risk of contracting with Lystek is not captured
   b. Composting
   c. Add Alpha Storage
   d. Dryers

e. Recuperative thickening

8. Mike noted that if PFAS levels are high, then an on-ramp is needed to address this potential regulatory trigger.

Discussion and Sensitivity

1. Mike asked to look at cost savings relative to the most expensive option and layer on the non-economic score more clearly.
   a. Zach noted that there is sufficient land for application now, but that could change if a single farmer decides to no longer use biosolids in the future.
2. **Mike noted that we need at least one Class A option for the refined alternatives.**
3. Zach noted that getting rid of biosolids compost will be hard to bring back. Only a small portion of biosolids would be Class A with composting.
4. Mike asked the City which alternatives they liked most.
   a. **Heather** liked:
      i. Composting,
      ii. Centrifuge and Conveyors, and
      iii. THP
   b. **Christian** would like to see updated graphs before determining preferred alternatives.
      i. Christian asked to couple the NPV cost graphic with biosolids production.
   c. **Zach** liked:
      i. Centrifuges and Conveyors (top)
      ii. Perhaps Lystek if there was area for storage, and
      iii. THP if it creates Class A.
   d. **Mike** notes:
      i. Class A is important to keep as an alternative
      ii. Recuperative thickening gives flexibility
      iii. On-site Lystek is perhaps the best Class A alternative but has risk associated with it
      iv. Cannot currently identify top three alternatives
5. **Tanya summarized revised graphics to support City's decision making:**
   a. **Use an identifier to denote Class A vs Class B options**
   b. **Update to incorporate biosolids production in visual**
   c. **Update how non-economic evaluation is layered into the results**
   d. **Remove HSW alternatives – fair to say increasing HSW only benefits situation**
6. Adam noted optimized status quo, Lystek, and dryer appear to be three beneficial alternatives. The question is whether THP will provide a product that the market wants, and it appears it may not.
7. **Mike noted that an alternative does not need to be constructed all at once. The ability to construct a project in chunks will add a lot of value.**
8. Adam noted dual membrane cover as a win-win. Mike noted they would likely go this direction.
   a. Adam noted new digester covers would help with fugitive methane emissions.
9. Lexi noted that gas storage was assumed to have better up time and more gas utilization and Noji noted that gas storage is significantly large footprint relative to the gas

Next Steps

1. BC to send the City revised figures to support decision making for three refined alternatives.
2. BC and the City to finalize the alternatives via meeting minutes and email correspondence.
   a. Adam summarized the refined alternatives based on feedback from the City (see Figure 1):

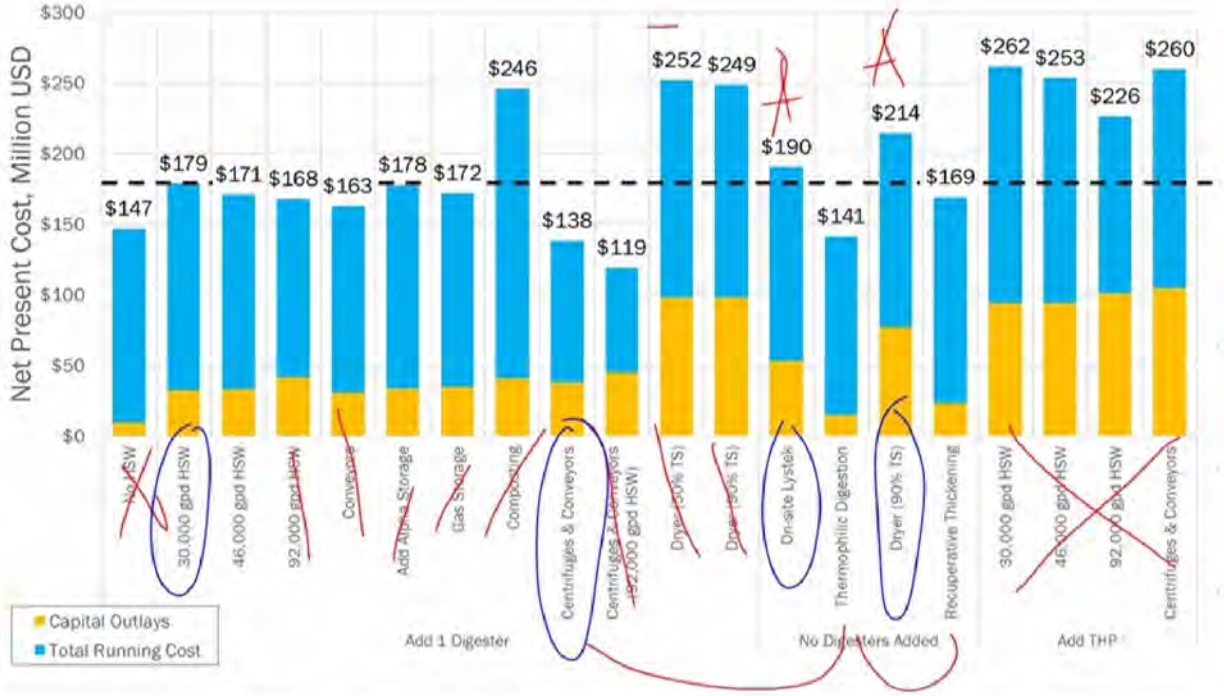


Figure 1. Documented Live Selection of Alternatives during Workshop

Updated Net Present Cost Figures based on City Feedback from Workshop

Figure 2 and 3 were created after the Workshop and are documented in these meeting minutes for the City's review and feedback.

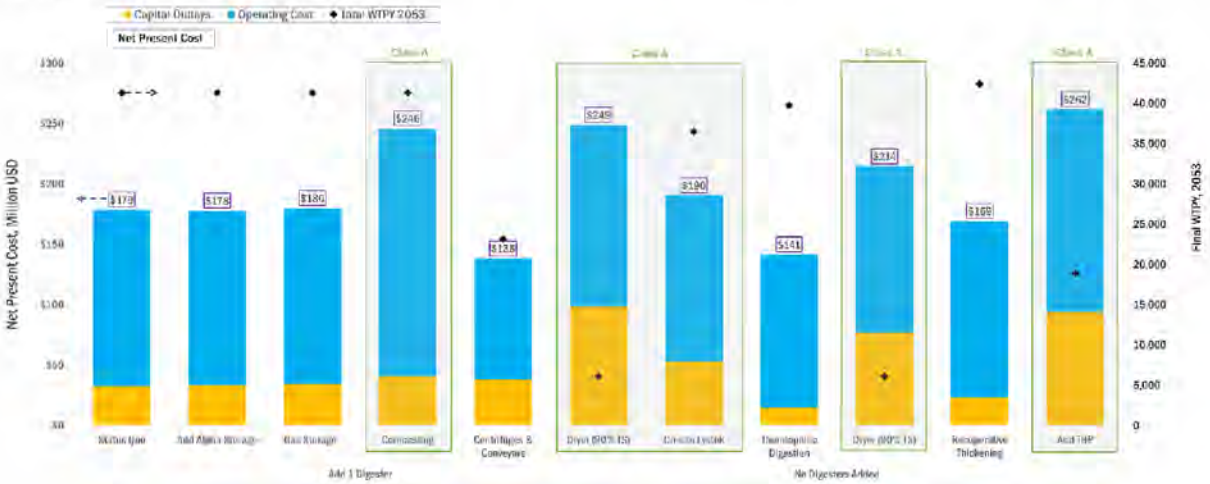


Figure 2. Updated Net Present Cost Summary and Biosolids Production

NOTE: Selected Main Alternatives for Refined Alternative Analysis are:
Alt 1) Centrifuges and Conveyors + 1 Digester,
Alt 2) Dryer (90%TS) + 1 Digester,
Alt 3) On-site Lystek

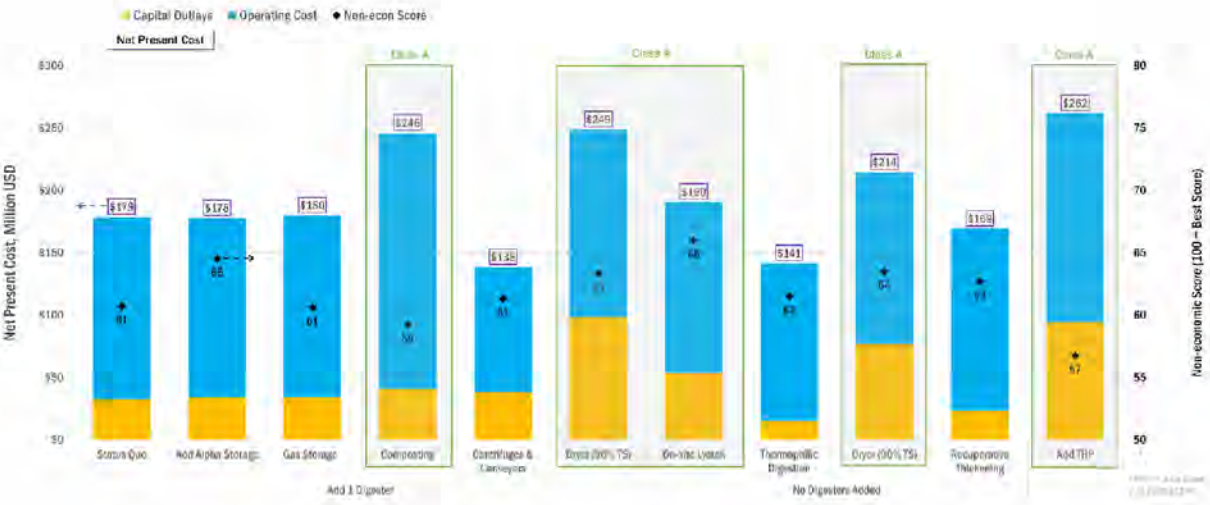


Figure 3. Updated Net Present Cost Summary and Non-economic Score

Action Items

The following are a list of actions items as a result of the meeting discussion:

Santa Rosa

1. **Santa Rosa** to confirm refined alternatives via email correspondence. Refined alternatives will be documented in the draft and final meeting minutes.
   Assigned Person(s): Tanya Mokvyts; **Response Required:** 7/19/2023

Brown and Caldwell

1. **BC** to document the preliminary decision on three refined alternatives to support decision making. BC to attach updated figures including biosolids production, consolidating alternatives (removing HSW variation), denoting Class A vs Class B, and including non-economic scoring to support City's decision making.
   Assigned Person(s): Alison Nojima/Max Armenta; **Response Required:** 7/13/2023

2. BC to incorporate workshop feedback into refined alternatives analysis, including:
   a. 800-acre additional land available for Class A biosolids application in north county and a lower cost per wet ton due to lower hauling costs in the region to be assumed in the revised alternatives analysis.
   b. Bridge breaker cost to be added to the conveyor project to ensure that a drier cake produce is compatible with existing cake storage hopper (i.e., to prevent bridging).
   c. Consider ammonia-based limits in the refined BC:SWEET model for the refined alternatives analysis.

   Assigned Person(s): Lexi Valenti/Max Armenta; **Response Required:** 9/8/2023

3. BC to document in TM 4 that Higher fossil fuel demands for thermal drying and the potential conflict with Santa Rosa's climate goals to be highlighted in the report. BC to document in TM 4 that alternatives do not need to be constructed all at once. The ability to construct a project in chunks will add a lot of value. BC to document in TM that additional City staff assumptions also assumes that Santa Rosa can continue to attract and retain staff (i.e., acknowledge challenge to attract and retain staff as a potential risk for alternatives requiring high staffing).
   Assigned Person(s): Max Armenta; **Response Required:** 9/8/2023

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. Three main refined alternatives finalized in this meeting include:
    a. Centrifuges and Conveyors,
    b. On-site Lystek, and
    c. Dryer (90% TS)
2. NOTE: Optimizations/sub-alternatives – such as gas storage, adding Alpha Storage, and increasing HSW – will be carried into refined alternatives analysis.
3. The Lystek option involves a capital investment to pipe sludge across the street to the composting area. It is to be noted that the risks associated with contracting with Lystek are not accounted for in these numbers.
4. At least (1) Class A option is necessary for the refined alternatives.

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FINAL Meeting Minutes

201 North Civic Drive, Suite 300
Walnut Creek, CA 94596

T: 925.937.9010

Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose: Refined Alternatives Evaluation Workshop
Date: October 12, 2023
Location: Laguna Treatment Plant **Time:** 1:00 p.m. – 3:00 p.m.
Prepared by: Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
James Austin, Santa Rosa
Sean McNeil, Santa Rosa
Alison Nojima, BC
Adam Ross, BC
Tanya Mokvyts, Santa Rosa
Zach Kay, Santa Rosa
Richard Giordanella, Santa Rosa
Alexis Valenti, BC
Maxwell Armenta, BC

Summary

This document captures the meeting minutes from the Refined Alternatives Evaluation Workshop for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. Notes are organized according to the PowerPoint outline, highlighting presentation takeaways and discussion.

Action items are underlined. **Key decisions/notes are in bold.** Action items and key decisions/notes are summarized at the end of this document.

Meeting Minutes

Introductions

1. Donald and Heather were not in attendance. BC provided introductions for James Austin.

Refined Alternatives Analysis Discussions

Pyrolysis

1. Sean noted the City toured the Silicon Valley Clean Water dryer and pyrolysis units. The tour was organized by Windsor. Zach and Sean noted the following regarding pyrolysis and Bioforcetech:
   a. Zach believes there may be new emissions-related legislation on pyrolysis that could impact implementation considerations. Zach can forward this to the BC team.
   b. Zach liked the 10:1 reduction claimed in total volume (biochar vs. City's current Class B cake)

c. Multiple pyrolysis units would be needed for Santa Rosa; Technology is not scaled up
d. Sean and Zach were thinking an option could be to send only a fraction of the City's biosolids to pyrolysis (management diversification)
e. Sean is considering sending PFAS-rich wastes received at LTP (e.g., landfill waste) to pyrolysis so other biosolids are not contaminated

2. Noji and Lexi agreed that pyrolysis is not a mature or proven technology at scale. Pyrolysis was screened in the City's BMSP for this reason.

Site Layouts

1. Mike noted that a berm on south-side of the LTP may conflict with the thermal dryer facility as shown. Max confirmed that Tanya had shared that the levee improvements project may come close to the thermal dryer layout, and that the **dryer facility layout would require refinement if advanced.** Thermal dryer facility was intentionally sited near current cake hoppers and dewatering.
2. BC confirmed that the site layout presented in the slides was cropped, but includes Lystek storage and is shown in the TM.

On-Site Lystek Alternative

1. City asked whether more Lystek product could be applied per acre compared to current Class B cake
   a. Zach believes it will be about the same
   b. Zach noted Class A Lystek would open more field for application in North County
   c. Zach noted Lystek has the potential for land application in Winter months
   d. Different machinery is used since the liquid product requires subsurface injection.
2. Adam noted that Lystek would handle all end-use; Management would be Lystek's issue
3. Tanya noted that Lystek could save the City cost on levee maintenance
   a. **Mike added that they could liquidate Southy County land, but the savings would be minimal compared to lifecycle costs ($3-5 million on capital savings/benefit)**
   b. Mike requested BC to footnotes that the Lystek option would allow the City to liquidate South County land and the Jacobsen contract could be terminated.
4. Full Lystek would decrease City's end-use options/diversity, but eliminates City's hauling cost
5. Mike suggested a cost saving measure to negotiate a lower Lystek tipping fee negotiated that would allow Lystek to use City land/farms for land application.
6. BC noted that Lystek's ideal facility capacity is two times the volume of Santa Rosa's biosolids.

Thermal Dryer Alternative

1. Richard asked whether digester gas could be used to lower GHG emissions calculated for thermal dryer option.
   a. Adam said cogeneration is typically a higher value for biogas utilization, and natural gas use for thermal dryers was assumed for this reason. Dryers can use lower grade heat but this would increase the facility footprint.

Centrifuges and Conveyors Alternative

1. Conveyors were assumed as placeholder technology, but piston pumps may also be acceptable alternative to mitigate current practice of adding water that dilutes biosolids
2. James likes conveyors more than piston pumps

3. Richard noted that going back to conveyors could look bad since that was the previous technology before upgrading to progressive cavity pumps.
4. Richard noted that procurement of parts is important for any technology selection

High Strength Waste Sensitivity

1. Impact on nutrients returned in sidestream was highlighted as a key finding if high strength waste is increased or food waste is added.
   a. Sean noted that effluent phosphorus and nitrogen has increased after accepting chicken blood waste

Roadmap and Recommendations

1. **Status quo was recommended.** Options to contract with Lystek if digester SRT drops below 15 days, or to proceed with an on-site Lystek facility contract could defer capital costs to build a new digester. The assumed dates shown in the roadmap were based on assuming a 10-year cleaning cycle.
   a. **James said the cleaning cycle was about once every 8 years.** Christian had told James that one digester is typically cleaned every other year.

Addressing Anaerobic Digester Capacity

1. **Zach suggested cleaning could be done during Winter when biosolids are already typically sent to Lystek.**
2. **Mike noted there is not enough budget for a new digester.**
   a. **Sean suggested an opportunity to secure grant funding or partner with a landfill if unpackaged food waste is accepted**
      i. BC will calculate whether additional food waste would trigger downstream capacity issues using typical assumptions for food waste characteristics and projected loading.
      ii. Zach noted that addition of food waste would increase biosolids production and would require additional land for biosolids application. Already nervous about land application capacity and potentially losing acreage for 5,000 wet tons per year application capacity.
      iii. Max noted we could estimate biosolids increase if we had information on food waste production. One refined alternative demonstrates potential biosolids production impact from food waste (FW) slurry (Alt 08d: 30,000 gpd HSW + 30,000 gpd FW slurry)
         1. Sean was talking with Zero Waste Sonoma regarding potential food waste partnership; No current contact with landfill / solids waste management directly
      iv. Adam said there are two types of project approaches for FW co-digestion: 1) City pays for digester and receives tip fee from landfill, or 2) landfill helps pay for digester and "purchases" digestion capacity for a certain amount of flow and loading.
         1. Adam noted that BC can look at FW tip fee revenue versus additional hauling and biosolids management cost.

CIP Projects Discussion

1. Mike requested that BC footnote projects that the City (Richard) could complete without a contractor
   a. Max noted that BC can follow-up with Richard to identify the list of projects
2. Sean would like to see BMSP projects for SCR and gas conditioning folded into the rate structure for the trucked waste program
   a. Demonstrate the tipping fees needed to support new infrastructure

3. Mike requested that capital cost values associated with each project are included in the roadmap figure in TM 4
4. Tanya requested that older master planning and trucked waste program cost estimates are folded into the CIP report. BC to connect with Tanya via Teams to coordinate on report before sending the draft.

Next Steps

1. BC will update TM 4 based on feedback from City in this workshop. City will confirm whether there are any additional comments for the TM before BC finalizes the TM.

Action Items

The following are a list of actions items as a result of the meeting discussion:

Santa Rosa

1. **Santa Rosa** to send TM 4 comments to BC.
   Assigned Person(s): Tanya Mokvyts; **Response Required:** 10/23/2023

Brown and Caldwell

1. **BC** to follow-up with Zach on pyrolysis emissions legislation.
   Assigned Person(s): Alison Nojima/Max Armenta; **Response Required:** 10/19/2023

2. **BC** to incorporate workshop feedback into refined alternatives analysis, including:
   a. Footnote additional benefits of Lystek option for the City, including the ability to liquidate South County land and terminate the Jacobsen contract. Highlight that this could result in a few million dollars of savings but does not significantly impact results from the lifecycle cost analysis.
   b. Update digester cleaning cycle assumption.
   c. Add capital costs to the roadmap figure.

   Assigned Person(s): Lexi Valenti/Max Armenta; **Response Required:** 10/26/2023

3. **BC** to estimate tipping fee, biosolids production, and digestion capacity impacts if Food Waste is accepted. Quantify and tie these results into the CIP roadmap. Incorporate BMSP projects associated with the trucked waste program into the tipping fee structure.
   Assigned Person(s): Max Armenta; **Response Required:** 10/26/2023

4. **BC** to footnote the CIP projects that can be completed in-house by the City. BC to connect with Richard to confirm the projects that can be self-performed.
   Assigned Person(s): Max Armenta; **Response Required:** 10/26/2023

5. **BC** to coordinate with the City to confirm all previous master planning and CIP projects are included in the BMSP CIP report. BC to connect with Tanya and confirm project scoping in report aligns with City's format for project scopes.
   Assigned Person(s): Max Armenta; **Response Required:** 10/26/2023

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. The status quo alternative was recommended. Using recuperative thickening and/or Lystek to manage biosolids that are not Class B is the preferred strategy to defer a digester project. This strategy would be needed during digester cleanings when 1 digester is taken offline.
    a. Digester cleaning during the winter season was recommended to synergize with existing Lystek utilization period.
    b. The is insufficient budget in the CIP to construct a new digester before 2028.
2. Each digester is cleaned every 8 years. A digester is cleaned every other year.
3. Lystek was estimated to have potential revenue of $3 million to $5 million dollars from liquidating South County land and terminating contracts with farmers.
4. The dryer facility layout may require refinement if advanced to avoid the levee/berm on the south side of the LTP.
5. Grant funding may be available for a new digester project if Food Waste is accepted. This requires closer investigation at FW load and revenue vs capacity and costs.

Brown AND Caldwell

201 North Civic Drive, Suite 300
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DRAFT Meeting Minutes

Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose: Capital Improvements Implementation Plan Workshop
Date: January 11, 2024
Location: Laguna Treatment Plant **Time:** 1:00 p.m. – 3:00 p.m.
Prepared by: Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
James Austin, Santa Rosa
Sean McNeil, Santa Rosa
Alison Nojima, BC
Adam Ross, BC
Maxwell Armenta, BC
Tanya Mokvyts, Santa Rosa
Zach Kay, Santa Rosa
Richard Giordanella, Santa Rosa
Heather Johnson, Santa Rosa
John Walker, Santa Rosa
Jerry Winterlin, Santa Rosa
Donald Marlatt, Santa Rosa

Summary

This document captures the meeting minutes from the Capital Improvements Implementation Plan Workshop for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. Notes are organized according to the PowerPoint outline, highlighting presentation takeaways and discussion.

Action items are underlined. Key decisions/notes are in bold. Action items and key decisions/notes are summarized at the end of this document.

Meeting Minutes

Introductions

1. Jerry and John were new attendees. BC and Santa Rosa completed a round of introductions.

20-Year Capital Improvements Implementation Plan

Roadmap

2. Max provided a more detailed summary of results from the previous workshop. The roadmap was presented and results from the BC:SWEET analyses were discussed. Findings from capacity and condition assessments, completed previously in the project, were communicated.

BMSP CIP Roadmap

3. CIP roadmap assumes the capital cost for an anaerobic digester is deferred by operating in recuperative thickening mode and sending solids to Lystek if the 15-day SRT criteria is not met.
   a. Max noted that the capacity assessment had identified anaerobic is out of capacity when 1 digester is offline, which is why recuperative thickening operation would be necessary
   b. **Zach did an analysis of found hauling costs are about 77 percent higher per wet ton if forced to go to Lystek.** Off-spec (non Class B) solids would need to be stored by Santa Rosa and transferred to Lystek.
4. Sean wants to stay no "lower line" and go after grant funding to build a new anaerobic digester sooner and take on more high strength waste with more biogas potential.
   a. Sean asked whether the digester project can be brought forward with grants
   b. Sean wants an evaluation of how much revenue food waste would bring in to pay for investment (partnership with landfill). BC to email/call Sean to discuss details/assumptions of this type of analysis.
   c. Zach noted that if we assume more food waste or high strength waste is accepted, then we need to consider the higher cost for end use.
5. Adam and Noji noted that the inflation reduction act (IRA) would require pre-purchasing of key equipment and Santa Rosa would need to continue working on the project to secure funds. The IRA could apply to biogas projects, including the gravity thickener equipment based on recent advising from tax partners. BC could help with this but would need to get contract in place.
   a. Sean and Mike noted that the schedule is too fast for Santa Rosa. Grant funding from state or federal sources are preferred over IRA. Safer approach to secure funding for projects.
   b. Sean noted Santa Rosa could also find the means to collaborate with the landfills.
6. Adam recommended that a grant funding approach should typically prepare 30 percent design materials, including a cost estimate, private commitments, and a business case.
7. Grant funding package would be used to cover multiple projects (not just a new digester)

Trucked Waste Program Recommendations

8. Sean noted that BC's slides incorrectly stated that revenue does not go to Laguna Treatment Plant (LTP). Mike and Sean clarified that **revenue goes to the LTP but helps to smooth rates and is not allocated into capital improvement projects.**

Next Steps

9. BC will add one more meeting to follow-up on details not covered in today's meeting
   a. BC to add Jason Roberts to next meeting. Next meeting to be scheduled via Teams.
10. BC to identify funding opportunities and cost/benefit analysis to inform business plan
   a. These items were requested by Sean and Jerry.

11. BC to follow-up with Richard and John regarding list of projects that Santa Rosa may elect to complete in-house.

Action Items

The following are a list of actions items as a result of the meeting discussion:

Brown and Caldwell

1. **BC** to follow-up with Sean on cost/benefit analysis assumptions/details.
   Assigned Person(s): Alison Nojima/Max Armenta; **Response Required:** 1/25/2024

2. **BC** to schedule follow-up CIP workshop with group and add Jason Roberts.
   Assigned Person(s): Max Armenta; **Response Required:** 1/15/2024

3. **BC** to add funding opportunities and cost/benefit analysis to CIP report.
   Assigned Person(s): Alison Nojima/Max Armenta; **Response Required:** 1/29/2024

4. **BC** to follow-up with Richard and John regarding projects that can be done in-house.
   Assigned Person(s): Alison Nojima/Max Armenta; **Response Required:** 1/25/2024

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. Zach calculated that Lystek hauling costs are about 77 percent higher than Santa Rosa's status quo biosolids end use.
2. Revenue from trucked waste program goes to LTP but is not necessarily allocated to capital improvement projects.

Brown AND Caldwell

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DRAFT Meeting Minutes

Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose: Capital Improvements Implementation Plan Workshop #2
Date: January 29, 2024
Location: Microsoft Teams (Virtual) **Time:** 10:00 a.m. – 11:45 a.m.
Prepared by: Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
Jerry Winterlin, Santa Rosa
Lexi Valenti, BC
Alison Nojima, BC
Adam Ross, BC
Tanya Mokvyts, Santa Rosa
Zach Kay, Santa Rosa
John Walker, Santa Rosa
Candace Michael, Santa Rosa
Maxwell Armenta, BC
Richard Giordanella, Santa Rosa (11 am departure)
James Austin, Santa Rosa (11 am arrival)

Summary

This document captures the meeting minutes from the Capital Improvements Implementation Plan Workshop (Part 2) for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. The purpose of this workshop was to present results from a business case evaluation on implementation timeline for capital improvement projects.

Action items are underlined. Key decisions/notes are in bold. Action items and key decisions/notes are summarized at the end of this document.

Meeting Minutes

1. Adam provided drivers for analysis
    a. Digesters out of capacity – BMSP identified 15 projects over next 5 years
    b. Deferring project will incur higher O&M cost and more risk
        i. If unable to meet 15-day compliance during digester cleaning or under regular operation, the City will risk increased cost for handling solids via Lystek
    c. Deferring projects -> curtails HSW -> eliminates profitable program -> falls out of sync with funding opportunities
        i. Current funding incentivizes projects that reduce greenhouse gas emissions or produce renewable power. Deferring construction of new digester deviates from these goals.

d. Is there a way to increase capacity, streamline delivery, and align with funding opportunities?
    i. BC modeled various scenarios [Slide 7] to evaluate the net present cost (NPC) of building a new digester now versus deferring 10 years. Evaluated how different financing mechanisms and interest rates would affect the NPC of these alternatives.
    ii. Alternatives where new digester is built now and financed with State Revolving Fund (SRF) loan have the lowest NPC.
        1. Mike asked if there is double the HSW for digestion available on the market?
            a. BC noted that this is uncertain, but even the scenario where HSW does not increase has a lower NPC than deferring the construction of a new digester.
        2. Jerry asked if HSW haulers are leaving the area; can we assume they will be around long term?
            a. Adam provided an example of a prior situation where local brewers planned on leaving the area due to high direct connection costs to sewer, but the City's HSW program provided local businesses with an outlet that retained them in the area. This same concept could apply to dairy wastes, etc. if more capacity is needed for them in the future.
    iii. BC noted sensitivity was completed to identify that a fixed loan with 3.7 to 4% interest is better than deferring digester construction. Loans below this interest rate are cost effective.
    iv. Mike asked which projects are included in capital costs shown in the analysis?
        1. New digester, Digesters 1 & 2 covers/mixing/coating, Digesters 3 & 4 mixing/coating, two SCRs, gas piping upsizing, new H2S vessels, BP cake pump replacement, and new GBT are included in capital costs.

2. Recommendations
    a. The City should progress towards a 30% design to become funding ready.
        i. SRF application will require a 30% design, along with CEQA, site plans, a refined scope, and cost estimate.
    b. Zack asked whether the 30% design has to include all 15 projects or can the City take a look at the most critical?
        i. Adam noted that there are two approaches:
            1. Economies of scale: including everything is easier from a project management perspective and based on economics
            2. Prioritize critical projects: projects that cannot wait for 3 to 4 years can be pulled out and done in-house. An example is the HSW odor scrubber, which the City is already working on replacing in house.
    c. Mike noted the City would not have the bandwidth pull together funding application and would need help.
        i. Adam noted that this is something BC or another consultant could do.
    d. Noji noted that if you install a new digester now – improvements to the other digesters (mixing, covers, coating) would be less complicated since it would alleviate the City capacity constraint when one digester is offline. <u>BC will add risk costs to the evaluation for the deferred digester option.</u>
3. Funding and CIP
    a. Adam noted that the projects that are getting grants or funding are projects that are addressing GHG emissions and producing renewable energy

i. Some project examples are projects that address fugitive methane by replacing floating covers with fixed covers. Projects like electrical replacement would not be eligible for this funding.

b. Adam reviewed the funding opportunities BC identified
   i. SRF
      1. A lot of the stimulus funding is being allocated through the SRF program but the projects need to be semi-developed to apply and get approval (e.g., 30% design completion)
   ii. Bond Sale
      1. Mike stated a bond sale requires coordination and would take time
   iii. Infrastructure and Economic Development Bank (IBank)
      1. Mike note that obtaining this load was not difficult; Mike worked to obtain this type of loan for Las Galinas in the past
   iv. CalRecycle
      1. Competitive loan and would most likely require partnership with solid waste group

c. CIP Funds
   i. CIP funds increase by 1 million annually.
      1. Adam noted that with inflation this is not necessarily increasing the budget. This could be seen as keeping up with inflation, or be at risk of not keeping up with inflation in the future.

4. Closing Conversation
   a. BC and the City discussed the local HSW available in the area with local breweries
      i. Jerry requested a list of HSW providers. Max noted that BC can send the list that was received as part of the trucked waste program evaluation.
   b. Adam noted that the City is the only WWTP in his California experience that relies on recuperative thickening to meet permit requirement
      i. Mike asked for BC to send any more feedback on where the City's operations are below or at risk of falling out of line with industry average.
   c. BC and the City discussed increased loading to the plant
      i. Max noted that population growth was included in the lifecycle cost and capacity analysis
      ii. Zach noted since 2010 the City's biosolids increased by 10,000 wet tons (to 37,000 wet tons per year currently) despite decreasing influent flows
   d. Adam noted that the City has two subsidies:
      i. Current biosolids management is diversified and lower cost than the NorCal average
      ii. HSW program also subsidizing overall solids handling cost
      iii. City needs to maintain the current infrastructure or budget for the systems to be gone and result in higher operating costs (hauling biosolids to Lystek and higher costs for electricity)

5. Next Steps
   a. BC requested direction on how the City would like the CIP projects refined and presented in the report
      i. Mike stated that he would like projects separated into "Tier 1" and "Tier 2"
         1. Tier 1: Critical needs, smaller projects, and projects that could be done in-house/sooner. This includes the solids expansion 30% design project that would be used to go after funding.
      ii. Mike requested a $500,000 line item be added for the 30% design project used to go after funding.
   b. BC to send slides to City by 2/2/24.

c. Mike would like a list of painful realities and/or undeniable risks for the LTP
d. Mike is going to meet with other City individuals to discuss results and determine how to catalyze project needs recommended by BC
e. BC to put together a consolidated list of HSW haulers

Action Items

The following are a list of actions items as a result of the meeting discussion:

Brown and Caldwell

1. **BC** to send a copy of the slides to workshop attendees.
   Assigned Person(s): Max Armenta; **Response Required:** 1/30/2024

2. **BC** to send list of LTP deficiencies and/or risks compared to other WWTPs to Mike.
   Assigned Person(s): Adam Ross; **Response Required:** 2/2/2024

3. **BC** to revise the list of CIP projects by:

   Adding a $500,000 line item to cover up to 30% design package, which could be used to pursue funding, and

   Categorizing projects into Tier 1 and Tier 2 based on priority and timing.

   Assigned Person(s): Max Armenta; **Response Required:** 2/2/2024

4. **BC** to follow-up with Tanya, Richard, and John regarding projects that can be done in-house and add to the report.
   Assigned Person(s): Max Armenta; **Response Required:** 2/2/2024

5. **BC** to send Jerry a consolidated list of the HSW types and haulers.
   Assigned Person(s): Max Armenta; **Response Required:** 2/2/2024

6. **BC** will add risk costs to the evaluation for the deferred digester option.
   Assigned Person(s): Max Armenta; **Response Required:** 2/2/2024

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. Revisions to CIP roadmap and report will incorporate action items and notes from meeting minutes.

FINAL Meeting Minutes

201 North Civic Drive, Suite 300
Walnut Creek, CA 94596

T: 925.937.9010

Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose: Capital Improvements Implementation Plan Workshop
Date: January 11, 2024
Location: Laguna Treatment Plant **Time:** 1:00 p.m. – 3:00 p.m.
Prepared by: Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
James Austin, Santa Rosa
Sean McNeil, Santa Rosa
Alison Nojima, BC
Adam Ross, BC
Maxwell Armenta, BC
Tanya Mokvyts, Santa Rosa
Zach Kay, Santa Rosa
Richard Giordanella, Santa Rosa
Heather Johnson, Santa Rosa
John Walker, Santa Rosa
Jerry Winterlin, Santa Rosa
Donald Marlatt, Santa Rosa

Summary

This document captures the meeting minutes from the Capital Improvements Implementation Plan Workshop for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. Notes are organized according to the PowerPoint outline, highlighting presentation takeaways and discussion.

Action items are underlined. **Key decisions/notes are in bold.** Action items and key decisions/notes are summarized at the end of this document.

Meeting Minutes

Introductions

1. Jerry and John were new attendees. BC and Santa Rosa completed a round of introductions.

20-Year Capital Improvements Implementation Plan

Roadmap

2. Max provided a more detailed summary of results from the previous workshop. The roadmap was presented and results from the BC:SWEET analyses were discussed. Findings from capacity and condition assessments, completed previously in the project, were communicated.

BMSP CIP Roadmap

3. CIP roadmap assumes the capital cost for an anaerobic digester is deferred by operating in recuperative thickening mode and sending solids to Lystek if the 15-day SRT criteria is not met.
   a. Max noted that the capacity assessment had identified anaerobic is out of capacity when 1 digester is offline, which is why recuperative thickening operation would be necessary
   b. **Zach did an analysis of found hauling costs are about 77 percent higher per wet ton if forced to go to Lystek.** Off-spec (non Class B) solids would need to be stored by Santa Rosa and transferred to Lystek.
4. Sean wants to stay no "lower line" and go after grant funding to build a new anaerobic digester sooner and take on more high strength waste with more biogas potential.
   a. Sean asked whether the digester project can be brought forward with grants
   b. Sean wants an evaluation of how much revenue food waste would bring in to pay for investment (partnership with landfill). BC to email/call Sean to discuss details/assumptions of this type of analysis.
   c. Zach noted that if we assume more food waste or high strength waste is accepted, then we need to consider the higher cost for end use.
5. Adam and Noji noted that the inflation reduction act (IRA) would require pre-purchasing of key equipment and Santa Rosa would need to continue working on the project to secure funds. The IRA could apply to biogas projects, including the gravity thickener equipment based on recent advising from tax partners. BC could help with this but would need to get contract in place.
   a. Sean and Mike noted that the schedule is too fast for Santa Rosa. Grant funding from state or federal sources are preferred over IRA. Safer approach to secure funding for projects.
   b. Sean noted Santa Rosa could also find the means to collaborate with the landfills.
6. Adam recommended that a grant funding approach should typically prepare 30 percent design materials, including a cost estimate, private commitments, and a business case.
7. Grant funding package would be used to cover multiple projects (not just a new digester)

Trucked Waste Program Recommendations

8. Sean noted that BC's slides incorrectly stated that revenue does not go to Laguna Treatment Plant (LTP). Mike and Sean clarified that **revenue goes to the LTP but helps to smooth rates and is not allocated into capital improvement projects.**

Next Steps

9. BC will add one more meeting to follow-up on details not covered in today's meeting
   a. BC to add Jason Roberts to next meeting. Next meeting to be scheduled via Teams.
10. BC to identify funding opportunities and cost/benefit analysis to inform business plan
   a. These items were requested by Sean and Jerry.

11. BC to follow-up with Richard and John regarding list of projects that Santa Rosa may elect to complete in-house.

Action Items

The following are a list of actions items as a result of the meeting discussion:

Brown and Caldwell

1. **BC** to follow-up with Sean on cost/benefit analysis assumptions/details.
   Assigned Person(s): Alison Nojima/Max Armenta; **Response Required:** 1/25/2024

2. **BC** to schedule follow-up CIP workshop with group and add Jason Roberts.
   Assigned Person(s): Max Armenta; **Response Required:** 1/15/2024

3. **BC** to add funding opportunities and cost/benefit analysis to CIP report.
   Assigned Person(s): Alison Nojima/Max Armenta; **Response Required:** 1/29/2024

4. **BC** to follow-up with Richard and John regarding projects that can be done in-house.
   Assigned Person(s): Alison Nojima/Max Armenta; **Response Required:** 1/25/2024

Key Decisions and Notes

The following are a list of key decisions and notes from the meeting discussion:

1. Zach calculated that Lystek hauling costs are about 77 percent higher than Santa Rosa's status quo biosolids end use.
2. Revenue from trucked waste program goes to LTP but is not necessarily allocated to capital improvement projects.

Final Meeting Minutes

201 North Civic Drive, Suite 300
Walnut Creek, CA 94596

T: 925.937.9010

Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan (BMSP)
Project No.: 157568

Purpose: Capital Improvements Implementation Plan Workshop #2
Date: January 29, 2024
Location: Microsoft Teams (Virtual) **Time:** 10:00 a.m. – 11:45 a.m.
Prepared by: Brown and Caldwell (BC)

Attendees:
Mike Prinz, Santa Rosa
Jerry Winterlin, Santa Rosa
Lexi Valenti, BC
Alison Nojima, BC
Adam Ross, BC
Tanya Mokvyts, Santa Rosa
Zach Kay, Santa Rosa
John Walker, Santa Rosa
Candace Michael, Santa Rosa
Maxwell Armenta, BC
Richard Giordanella, Santa Rosa (11 am departure)
James Austin, Santa Rosa (11 am arrival)

Summary

This document captures the meeting minutes from the Capital Improvements Implementation Plan Workshop (Part 2) for the BMSP. The BMSP is an amendment to the Santa Rosa Trucked Waste Program Evaluation project. The purpose of this workshop was to present results from a business case evaluation on implementation timeline for capital improvement projects.

Action items are underlined. **Key decisions/notes are in bold.** Action items and key decisions/notes are summarized at the end of this document.

Meeting Minutes

1. Adam provided drivers for analysis
    a. Digesters out of capacity – BMSP identified 15 projects over next 5 years
    b. Deferring project will incur higher O&M cost and more risk
        i. If unable to meet 15-day compliance during digester cleaning or under regular operation, the City will risk increased cost for handling solids via Lystek
    c. Deferring projects -> curtails HSW -> eliminates profitable program -> falls out of sync with funding opportunities
        i. Current funding incentivizes projects that reduce greenhouse gas emissions or produce renewable power. Deferring construction of new digester deviates from these goals.

d. Is there a way to increase capacity, streamline delivery, and align with funding opportunities?
    i. BC modeled various scenarios [Slide 7] to evaluate the net present cost (NPC) of building a new digester now versus deferring 10 years. Evaluated how different financing mechanisms and interest rates would affect the NPC of these alternatives.
    ii. Alternatives where new digester is built now and financed with State Revolving Fund (SRF) loan have the lowest NPC.
        1. Mike asked if there is double the HSW for digestion available on the market?
            a. BC noted that this is uncertain, but even the scenario where HSW does not increase has a lower NPC than deferring the construction of a new digester.
        2. Jerry asked if HSW haulers are leaving the area; can we assume they will be around long term?
            a. Adam provided an example of a prior situation where local brewers planned on leaving the area due to high direct connection costs to sewer, but the City's HSW program provided local businesses with an outlet that retained them in the area. This same concept could apply to dairy wastes, etc. if more capacity is needed for them in the future.
    iii. BC noted sensitivity was completed to identify that a fixed loan with 3.7 to 4% interest is better than deferring digester construction. Loans below this interest rate are cost effective.
    iv. Mike asked which projects are included in capital costs shown in the analysis?
        1. New digester, Digesters 1 & 2 covers/mixing/coating, Digesters 3 & 4 mixing/coating, two SCRs, gas piping upsizing, new H2S vessels, BP cake pump replacement, and new GBT are included in capital costs.

2. Recommendations
    a. The City should progress towards a 30% design to become funding ready.
        i. SRF application will require a 30% design, along with CEQA, site plans, a refined scope, and cost estimate.
    b. Zack asked whether the 30% design has to include all 15 projects or can the City take a look at the most critical?
        i. Adam noted that there are two approaches:
            1. Economies of scale: including everything is easier from a project management perspective and based on economics
            2. Prioritize critical projects: projects that cannot wait for 3 to 4 years can be pulled out and done in-house. An example is the HSW odor scrubber, which the City is already working on replacing in house.
    c. Mike noted the City would not have the bandwidth pull together funding application and would need help.
        i. Adam noted that this is something BC or another consultant could do.
    d. Noji noted that if you install a new digester now – improvements to the other digesters (mixing, covers, coating) would be less complicated since it would alleviate the City capacity constraint when one digester is offline. <u>BC will add risk costs to the evaluation for the deferred digester option.</u>
3. Funding and CIP
    a. Adam noted that the projects that are getting grants or funding are projects that are addressing GHG emissions and producing renewable energy

i. Some project examples are projects that address fugitive methane by replacing floating covers with fixed covers. Projects like electrical replacement would not be eligible for this funding.

b. Adam reviewed the funding opportunities BC identified
   i. SRF
      1. A lot of the stimulus funding is being allocated through the SRF program but the projects need to be semi-developed to apply and get approval (e.g., 30% design completion)
   ii. Bond Sale
      1. Mike stated a bond sale requires coordination and would take time
   iii. Infrastructure and Economic Development Bank (IBank)
      1. Mike note that obtaining this load was not difficult; Mike worked to obtain this type of loan for Las Galinas in the past
   iv. CalRecycle
      1. Competitive loan and would most likely require partnership with solid waste group

c. CIP Funds
   i. CIP funds increase by 1 million annually.
      1. Adam noted that with inflation this is not necessarily increasing the budget. This could be seen as keeping up with inflation, or be at risk of not keeping up with inflation in the future.

4. Closing Conversation
   a. BC and the City discussed the local HSW available in the area with local breweries
      i. Jerry requested a list of HSW providers. Max noted that BC can send the list that was received as part of the trucked waste program evaluation.
   b. Adam noted that the City is the only WWTP in his California experience that relies on recuperative thickening to meet permit requirement
      i. Mike asked for BC to send any more feedback on where the City's operations are below or at risk of falling out of line with industry average.
   c. BC and the City discussed increased loading to the plant
      i. Max noted that population growth was included in the lifecycle cost and capacity analysis
      ii. Zach noted since 2010 the City's biosolids increased by 10,000 wet tons (to 37,000 wet tons per year currently) despite decreasing influent flows
   d. Adam noted that the City has two subsidies:
      i. Current biosolids management is diversified and lower cost than the NorCal average
      ii. HSW program also subsidizing overall solids handling cost
      iii. City needs to maintain the current infrastructure or budget for the systems to be gone and result in higher operating costs (hauling biosolids to Lystek and higher costs for electricity)

5. Next Steps
   a. BC requested direction on how the City would like the CIP projects refined and presented in the report
      i. Mike stated that he would like projects separated into "Tier 1" and "Tier 2"
         1. Tier 1: Critical needs, smaller projects, and projects that could be done in-house/sooner. This includes the solids expansion 30% design project that would be used to go after funding.
      ii. Mike requested a $500,000 line item be added for the 30% design project used to go after funding.
   b. BC to send slides to City by 2/2/24.

c. Mike would like a list of painful realities and/or undeniable risks for the LTP
d. Mike is going to meet with other City individuals to discuss results and determine how to catalyze project needs recommended by BC
e. BC to put together a consolidated list of HSW haulers

Action Items

The following are a list of actions items as a result of the meeting discussion:

Brown and Caldwell

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1. Revisions to CIP roadmap and report will incorporate action items and notes from meeting minutes.



Biosolids Management Strategic Plan

Kickoff Meeting

November 3, 2022

Agenda

1. Introductions
2. Project goals and objectives
3. Task overview and schedule
4. Next steps

Introductions

Brown AND Caldwell

Project Goals and Objectives

- What is the most important outcome you would like to see from this project?
- What is your biggest concern on this project?

Brown AND Caldwell

The BMSP: Then and Now

BMSP 2014

- Regulatory uncertainty about Class B land app (driving Class A solutions): Recommended thermal hydrolysis
- Evaluated whether codigestion was a worthwhile opportunity: Recommended a HSW facility
- Cost/benefit of continued composting?

BMSP 2023

- Regulatory uncertainty about PFAS (driving high temperature, Class A solutions)
- SB 1383 has limited disposal options for all biosolids in CA (driving regional solutions)
- Cost/benefit of resumed composting?

Address any potential threats to land application

Motivation

- Privately owned lands/farms in south county are used for land application of biosolids
- Regulatory and/or public scrutiny, changing farming practices, or changing ownership could be seen as potential risks

Direction

- Expanding north county land application could provide greater flexibility and certainty
- Move to Class A
  - Would require treatment process to accomplish Class A

Decide plan for the composting facility

Motivation

- Space is currently unused
- Risk of leasing space if it is needed in the future
- A comprehensive evaluation to provide greater certainty on any decision regarding this space

Direction

- Leverage BC:SWEET and biosolids alternatives analysis to determine best path forward
- Do the right projects: if it makes sense to use the space, use it!

Coordination with regional partners

Motivation

- What are other utilities doing with biosolids handing and end use?
- Is a regional solution for the North Bay economically and politically viable?

Direction

- Larger contracts with multiple agencies could be more attractive to hauling and disposal companies: more competitive in the market.
- Leverage storage and treatment capabilities between all partners

PFAS

Motivation

- If regulations ban biosolids end use due to PFAS, this could be a risk for the LTP

Direction

- Incorporate flexibility within CIP Roadmap with off-ramps that allow the City to pivot based on future regulations

Project Tasks and Schedule

Brown AND Caldwell

Overview of Tasks

- Flow and Loads
- Capacity Evaluation
- Condition Assessment
- Regulatory Review and Market Assessment
- Biosolids Alternatives Evaluation
- Capital Improvements Implementation Plan

Flows and Loads



- Review historical flow, loads, and population
- Develop per capita basis for flow and loads
- Project future growth and solids for use in BC:Solids-Water-Energy-Evaluation-Tool (SWEET) and capacity evaluation

Capacity Evaluation



- Determine if or when additional capacity is needed based on flow and load projections
- Includes solids treatment units, HSW receiving facility, and digester gas processes (CHP facility, gas conditioning system, flares)
- Review and incorporate air permit limitations

Condition Assessment



- One-day site visit by process mechanical, structural, and electrical/instrumentation engineers
- Evaluate solids treatment, solids pumping, HSW receiving, gas, and storage processes
- *Permitted confined space entry not provided*
- *Seismic and coating evaluations not included*



Regulatory Review & Market Assessment

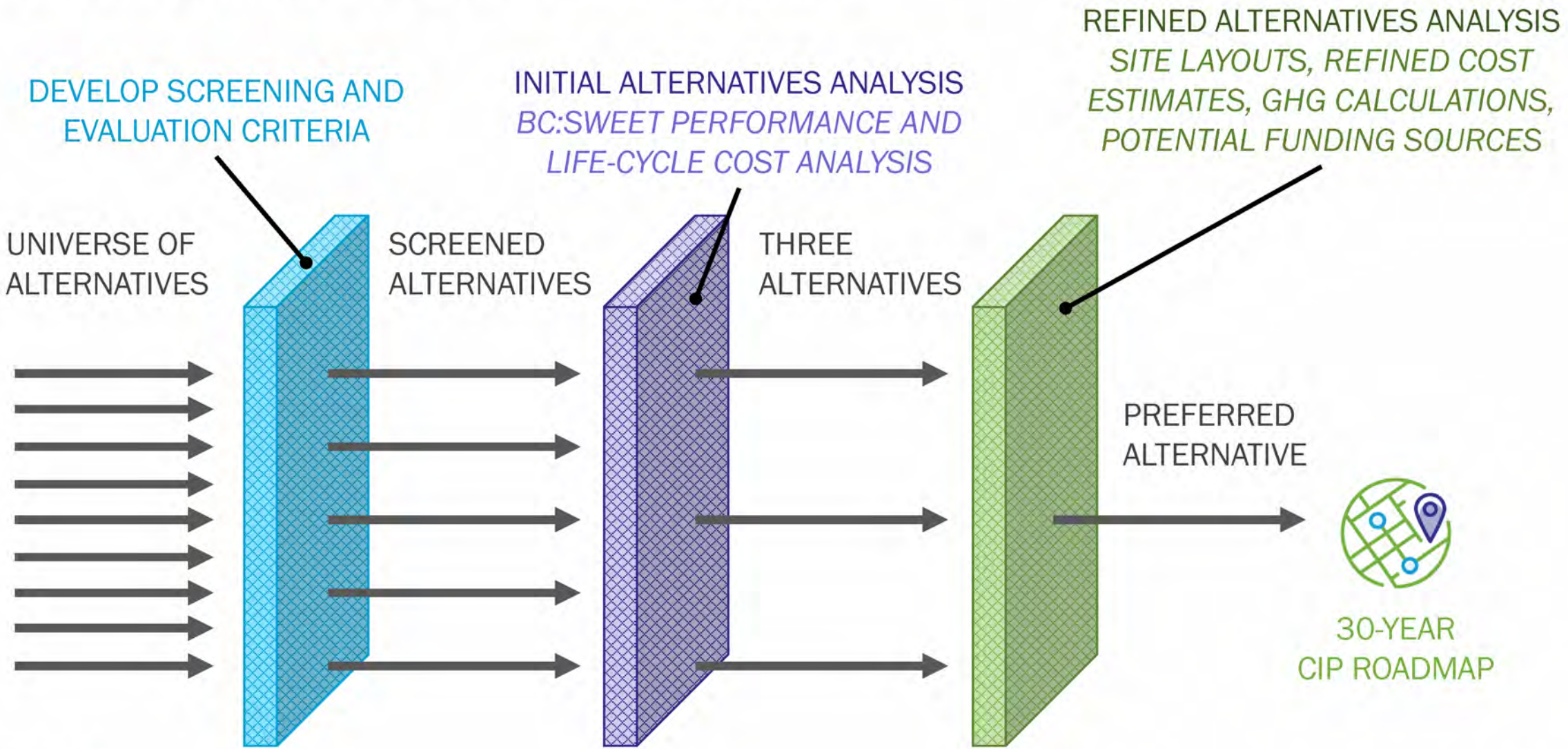
- Review regulations applicable to end uses for biosolids and regulatory trends (e.g., SB 1383 and PFAS), include key dates
- State of end use market assessment in the region for biosolids products
- Evaluate potential participation in regional biosolids projects and subregional solution
- Review technologies and vendors that provide packaged solutions for biosolids ownership

Biosolids Alternatives Analysis

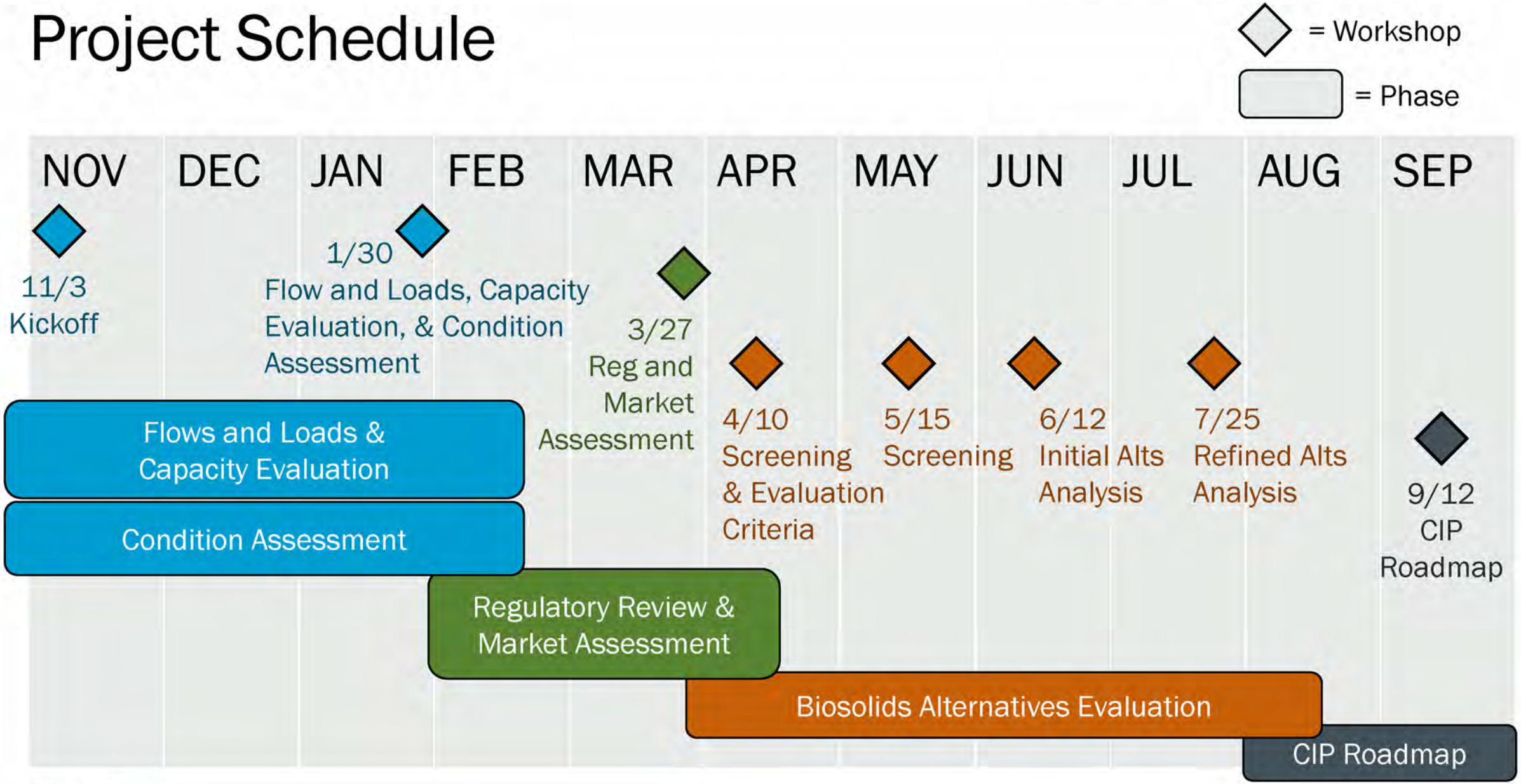
- Develop screening criteria (fatal flaw criteria) and non-economic criteria
- Perform technology screening
- Initial and refined alternatives analysis



Biosolids Alternatives Analysis

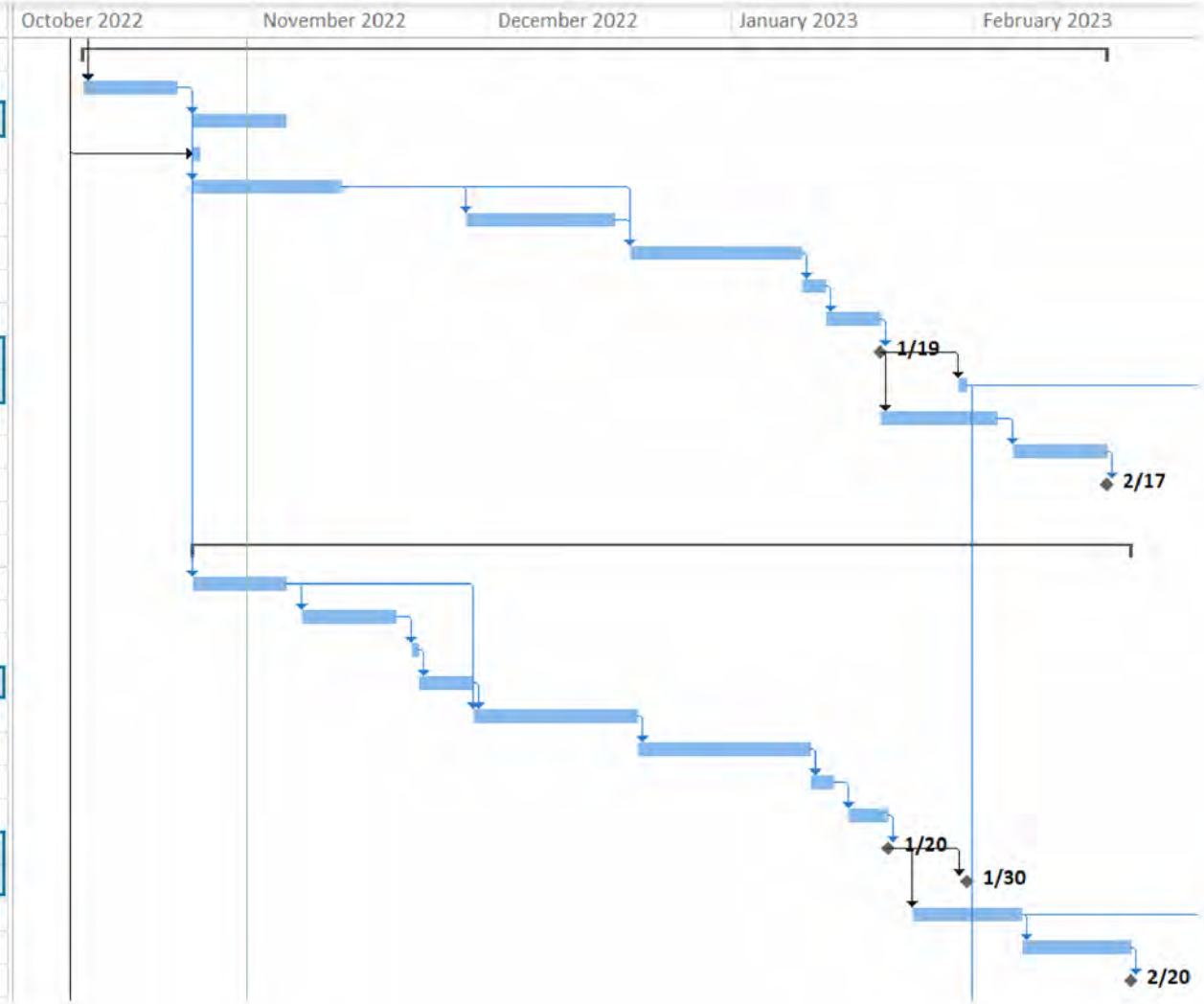


Project Schedule



Three Month Lookahead

	Task Name	Finish	Duration
	Phase 006: Flows and Loads and Capacity Evaluation	**Fri 2/17/23**	**88 days**
	Info request - BC	Fri 10/21/22	2 wks
NOV	Info request - City	Fri 11/4/22	2 wks
	Kickoff workshop	Mon 10/24/22	1 day
	Flow and load projections	Fri 11/11/22	3 wks
	Capacity evaluation	Fri 12/16/22	3 wks
	Draft TM development	Mon 1/9/23	2 wks
	Internal QC	Thu 1/12/23	3 days
	Incorporate QC comments	Thu 1/19/23	1 wk
JAN	Draft Flows and Loads and Capacity Eval TM to City	Thu 1/19/23	0 days
	Flows and Loads and Capacity Eval Workshop	Mon 1/30/23	1 day
	City Review TM	Fri 2/3/23	2 wks
	Finalize TM	Fri 2/17/23	2 wks
	Final Flows and Loads and Capacity Eval TM to City	Fri 2/17/23	0 days
	Phase 007: Condition Assessment	**Mon 2/20/23**	**79 days**
	Review existing info	Fri 11/4/22	2 wks
	Develop plan	Fri 11/18/22	2 wks
	Review plan with City	Mon 11/21/22	1 day
NOV	Site visit / staff interviews	Mon 11/28/22	1 wk
	Evaluation	Mon 12/19/22	3 wks
	Condition Assessment TM Draft	Tue 1/10/23	2 wks
	Internal QC	Fri 1/13/23	3 days
	Incorporate QC comments	Fri 1/20/23	1 wk
JAN	Draft TM to City	Fri 1/20/23	0 days
	Condition Assessment Workshop	Mon 1/30/23	0 days
	City Review	Mon 2/6/23	2 wks
	Finalize TM	Mon 2/20/23	2 wks
	Final TM to City	Mon 2/20/23	0 days



Next Steps

Brown AND Caldwell

Next Steps

- Flow and Loads and Capacity Evaluation
  - Use data request information for flow and loads projections
  - Complete capacity evaluation
- Condition Assessment
  - Review data request and develop site visit plan
  - Schedule site visit and staff interviews
- Regulatory Review and Market Assessment
  - Start 1/31

Discussion

Brown AND Caldwell



Biosolids Management Strategic Plan

Flows and Loads, Capacity Evaluation, & Condition Assessment

March 6, 2023

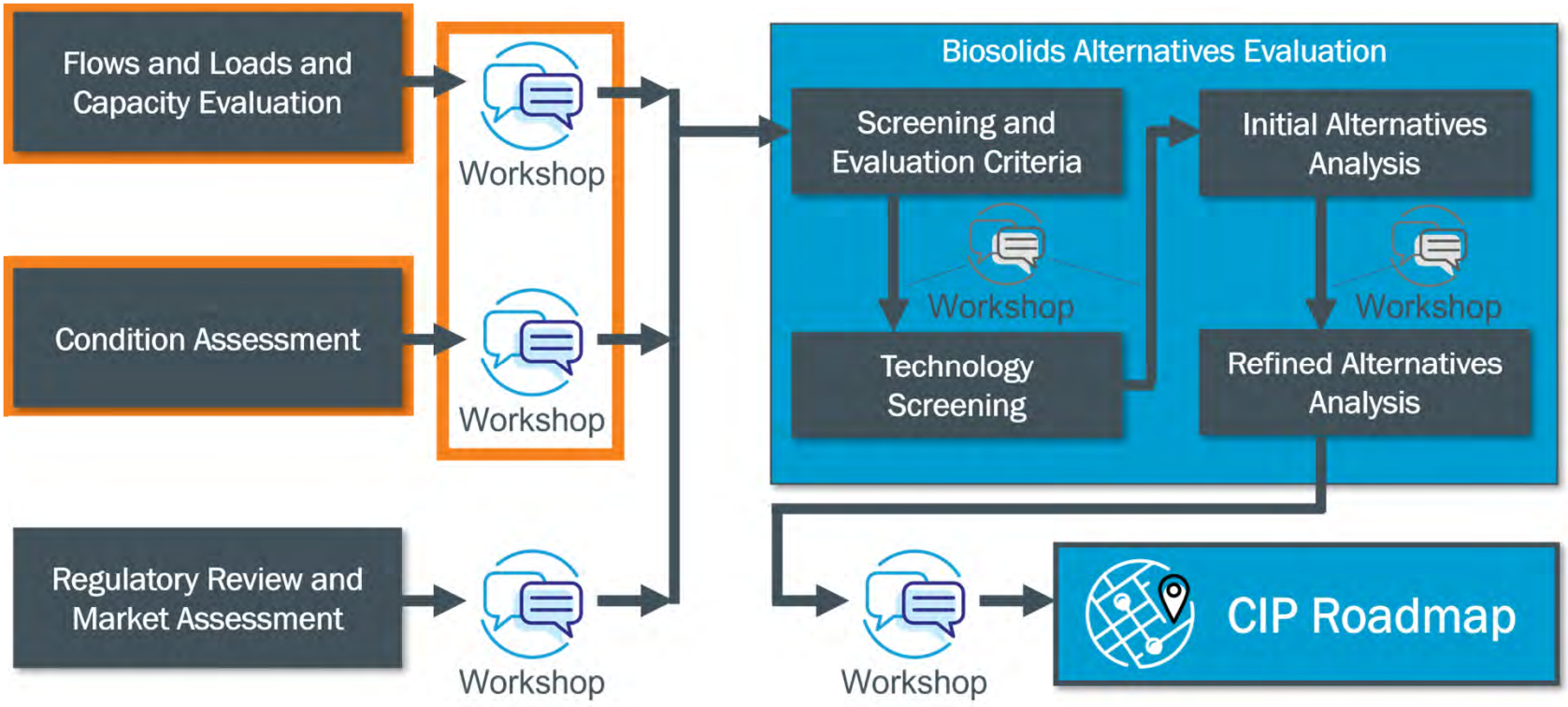
Agenda

1. Introductions
2. Project goals and task objectives
3. Flows and Loads
4. Capacity Evaluation
5. Condition Assessment
6. Discussion & Next Steps

Introductions

Brown AND Caldwell

Biosolids Management Strategic Plan



Flows and Loads

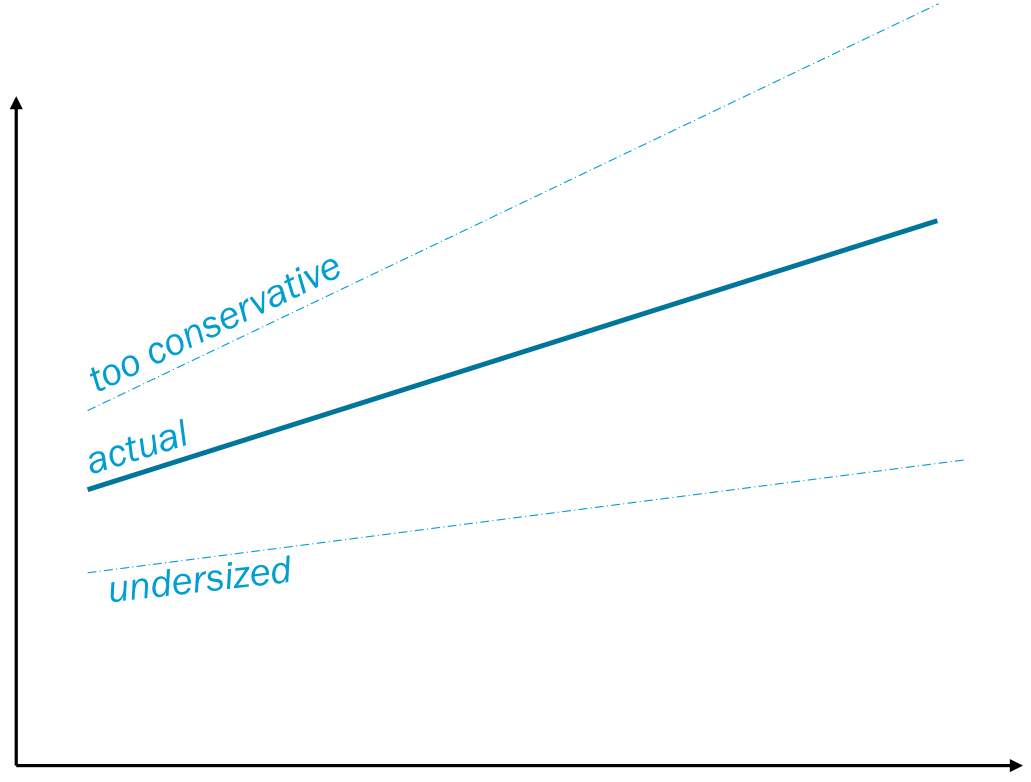
Brown AND Caldwell

Flows and Loads Methodology

What are the goals?

1. Not too conservative
   too large of a facility and higher cost

2. Not undersized
   premature treatment capacity limitation

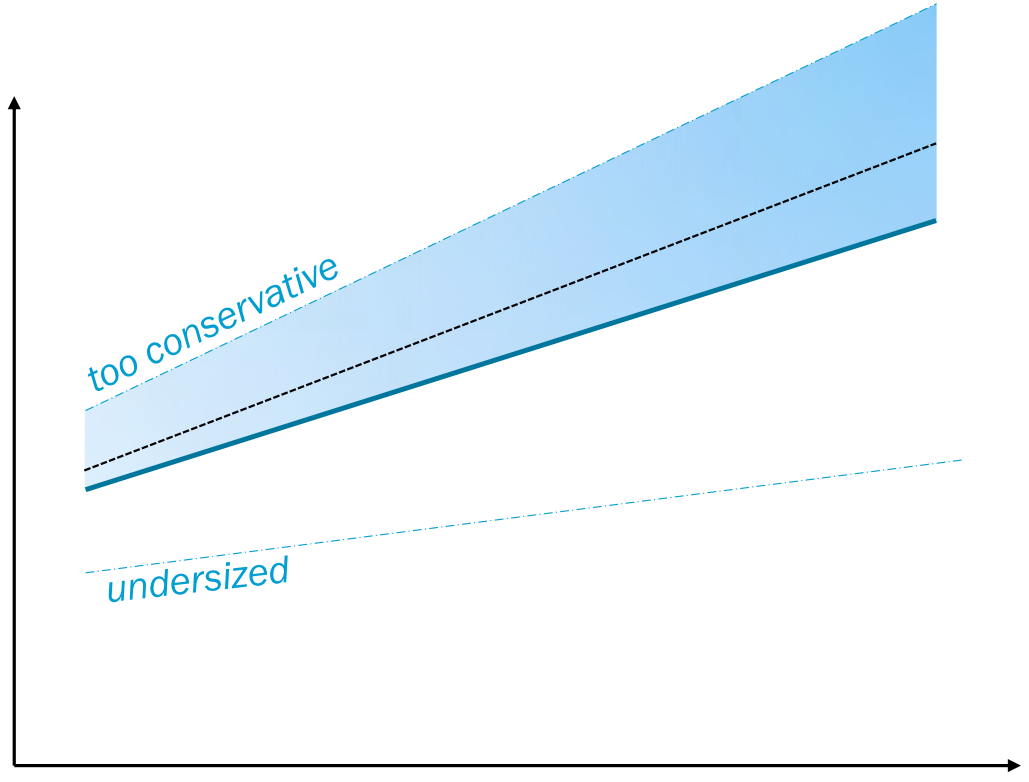


Flows and Loads Methodology

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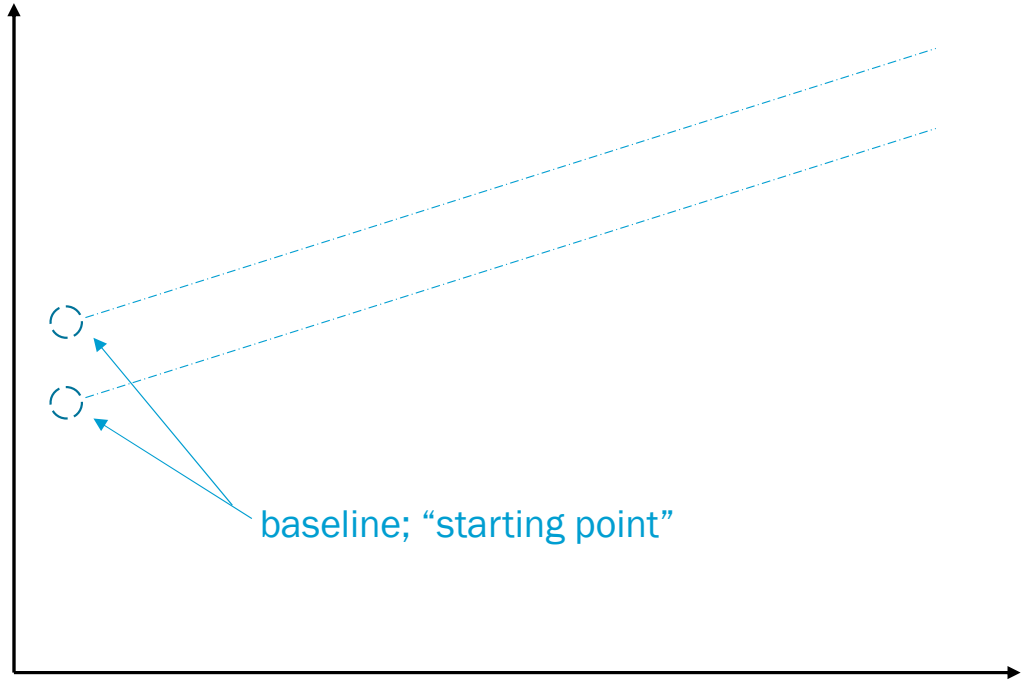
2. Not undersized
   premature treatment capacity limitation



Flows and Loads Methodology

What impacts our goals?

1. Starting point based on review of historical data *(baseline flows and loads and peaking factors)*

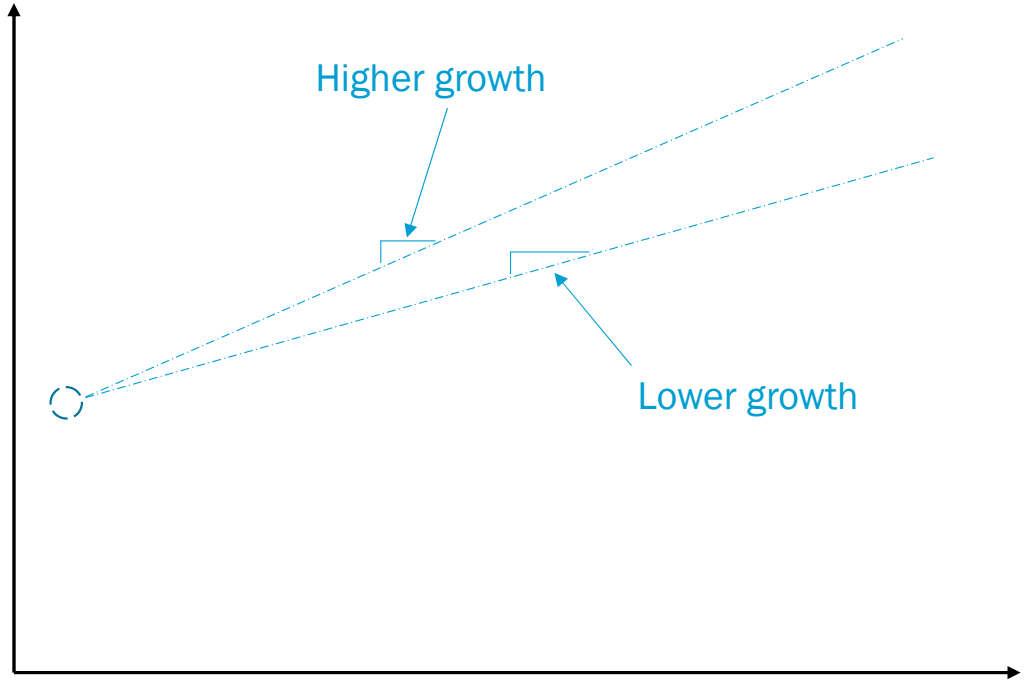


Flows and Loads Methodology

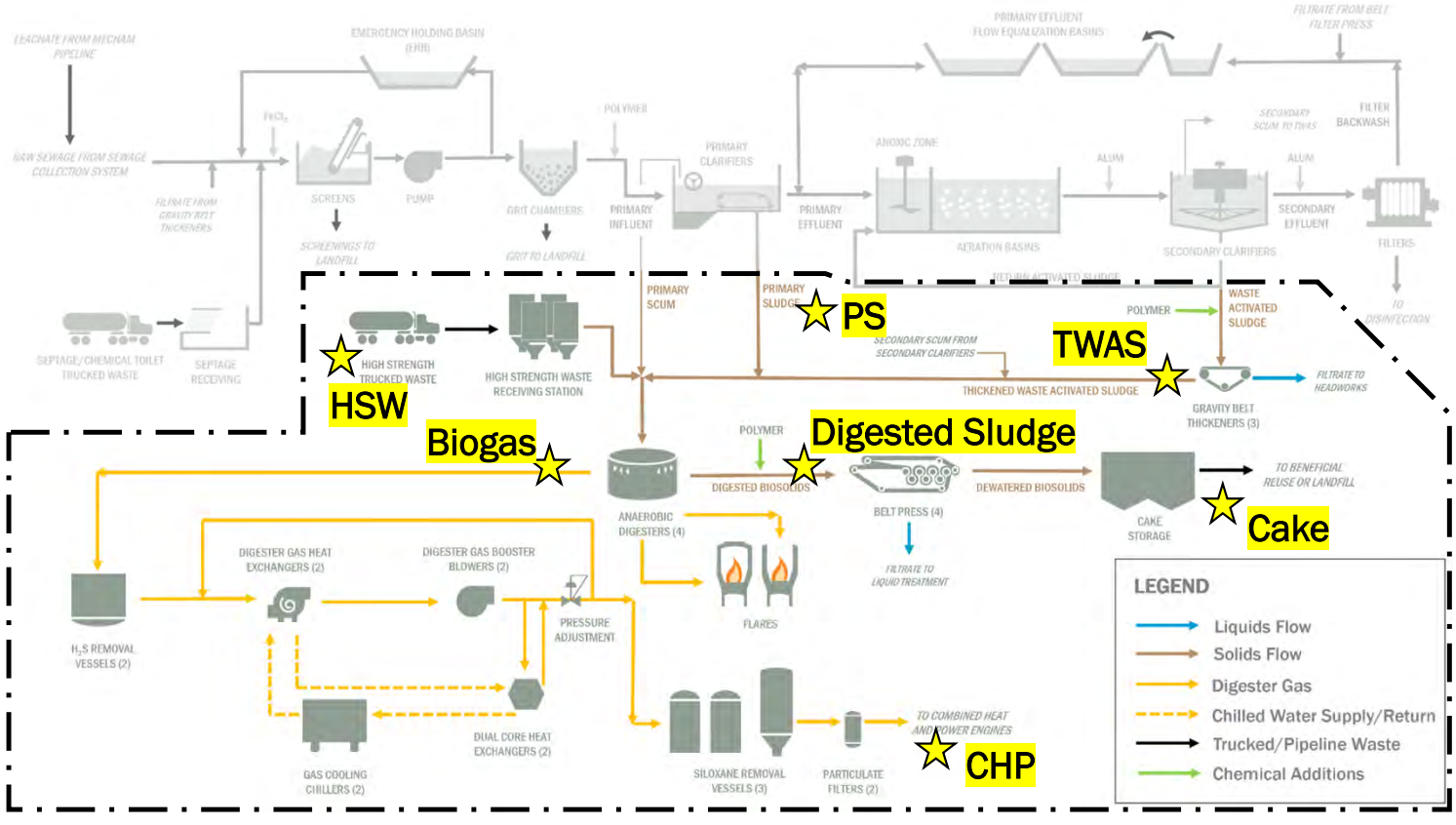
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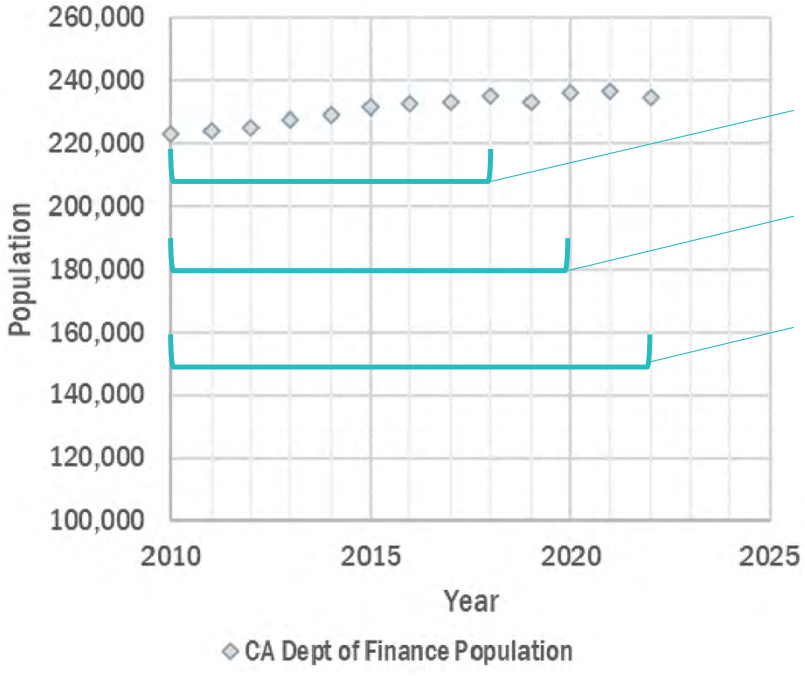
2. Estimated growth rate



Flows and Loads Methodology: Baseline Calibration



Flows and Loads Methodology: Population Growth



0.68 percent/year before decrease in 2019

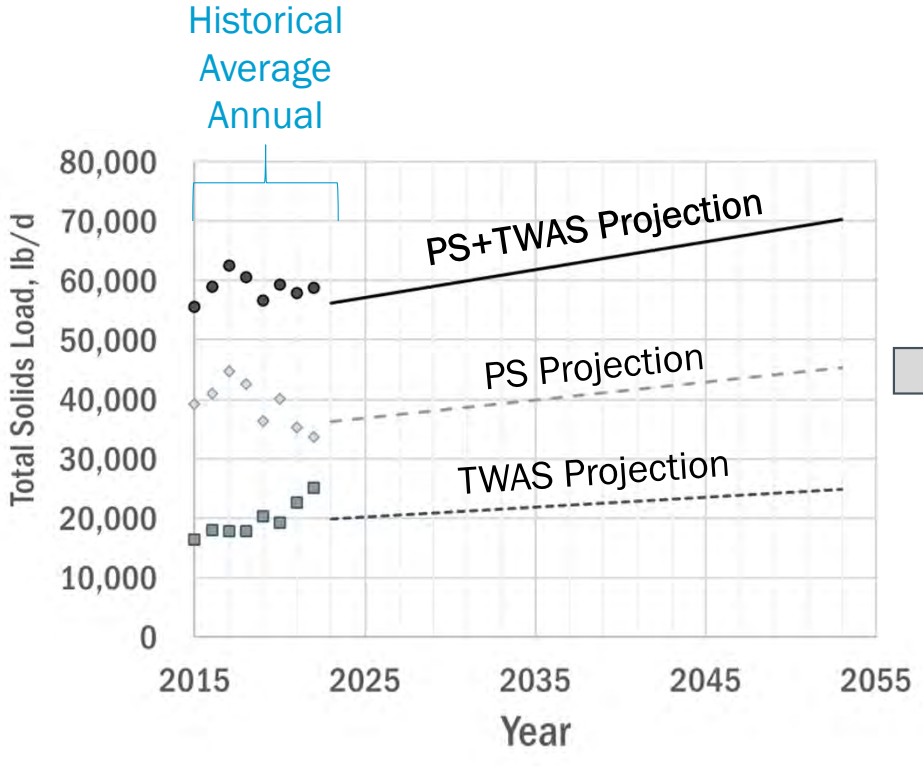
0.57 percent/year before 2020 pandemic

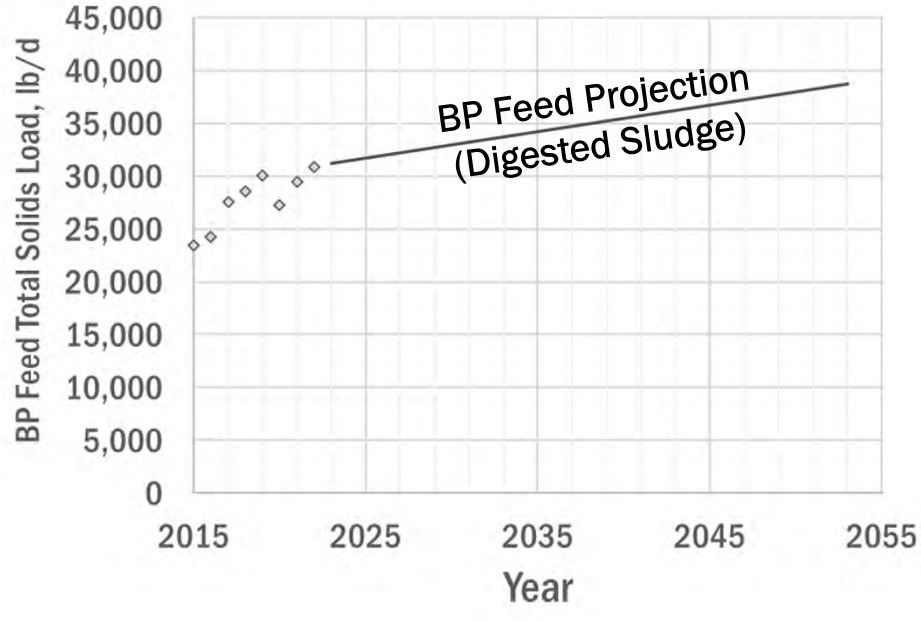
0.49 percent/year since 2010 census

Suggest **0.75 percent/year** as planning assumption

Results in a **25 percent growth** over a **30-year** projection period

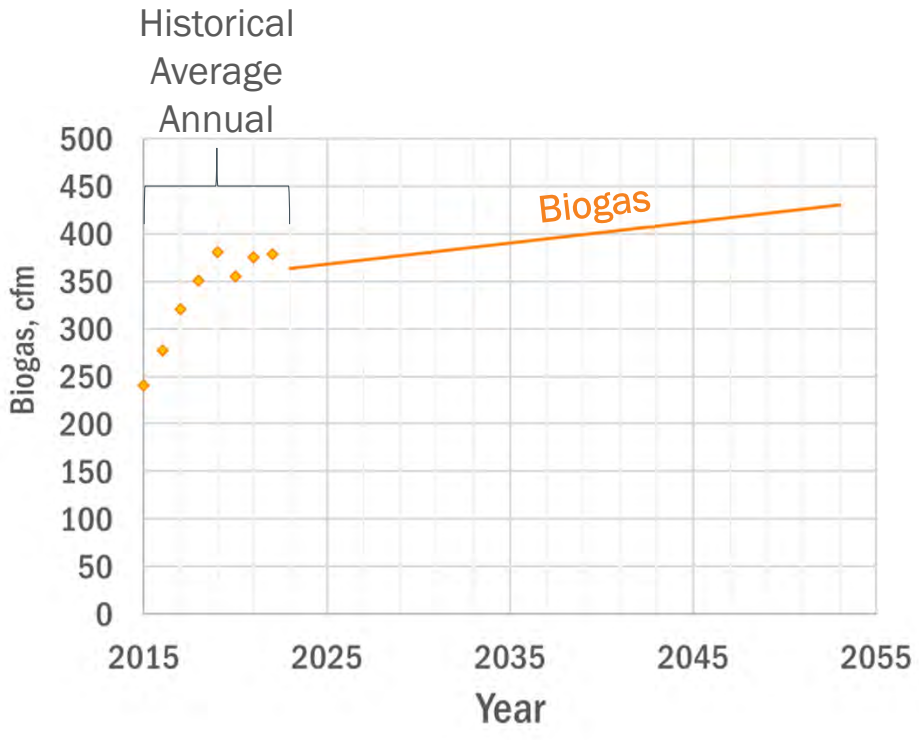
Projected Sludge Flows and Loads

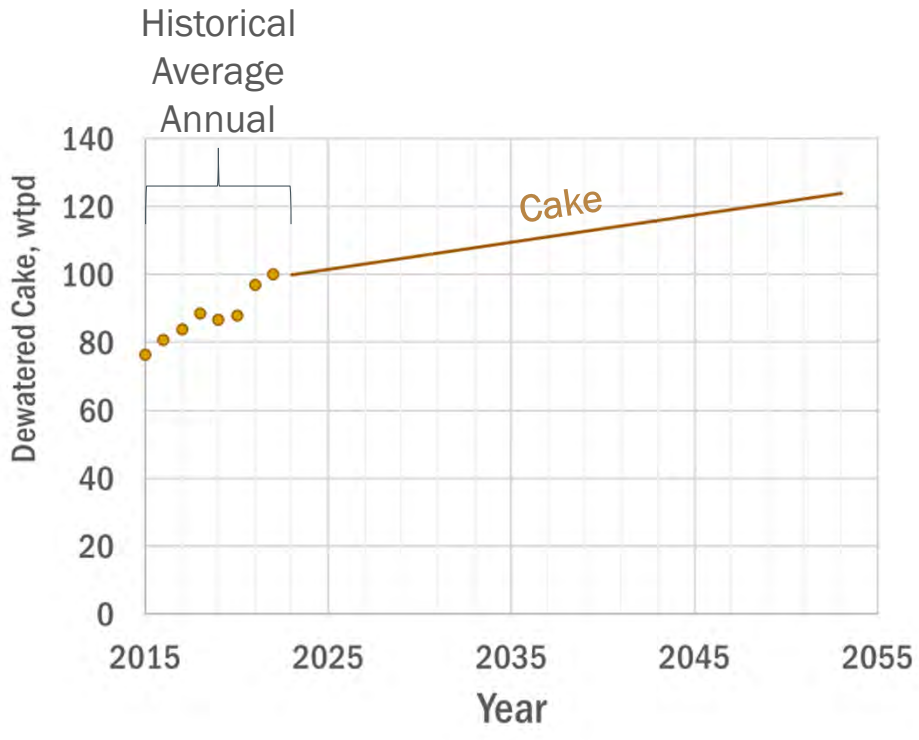




NOTE: 16,900 gal/d HSW assumed as “baseline” condition based on past three years of operation

Projected Biogas and Biosolids





NOTE: Projections shown assume 16,900 gpd HSW

Projections for Biosolids Alternatives Analysis & Capacity Evaluation

Table 9. Flow and Load Projections

Parameter[a]	Units	2019-21 Average	2023			2053		
			PS+TWAS	with 16,900 gpd HSW	with 46,000 gpd HSW	PS+TWAS	with 16,900 gpd HSW	with 46,000 gpd HSW
Primary Sludge Flows and Loads								
PS Flow	gpd	99,400	96,600	96,600	96,600	120,900	120,900	120,900
PS TS Loading	lb/d	36,500	36,300	36,300	36,300	45,400	45,400	45,400
PS TVS Loading	lb/d	31,300	31,200	31,200	31,200	39,000	39,000	39,000
Thickened Waste Activated Sludge Flows and Loads								
TWAS Flow	gpd	58,300	50,800	50,800	50,800	63,600	63,600	63,600
TWAS TS Loading	lb/d	22,400	19,900	19,900	19,900	24,900	24,900	24,900
TWAS TVS Loading	lb/d	18,200	16,500	16,500	16,500	20,700	20,700	20,700
Combined Digester Feed Sludge Flows and Loads								
Digester Feed Flow[b]	gpd	174,600	147,500	164,400	193,500	184,500	201,400	230,500
Digester Feed TS Loading	lb/d	64,200	56,200	65,100	80,400	70,300	79,200	94,500
Digester Feed TVS Loading	lb/d	54,500	47,700	55,900	70,000	59,700	67,900	82,000
Digester Feed TS Concentration[c]	%TS	N/A	4.6	4.7	5.0	4.6	4.7	4.9

a. Loading calculated based on measured flow rates and sludge concentrations.
b. Digester feed flow is a sum of annual average measured PS and TWAS flows.
c. Digester feed TS concentration not directly measured.
TVS = total volatile solids

Projections for 2023 (now) through 2053:
A 30-year planning horizon

Projections for:

- PS+TWAS only
- PS+TWAS with 16,900 gpd HSW (baseline; current operations)
- PS+TWAS with 46,000 gpd HSW (HSW receiving station air permit capacity)

Capacity Evaluation

Brown AND Caldwell

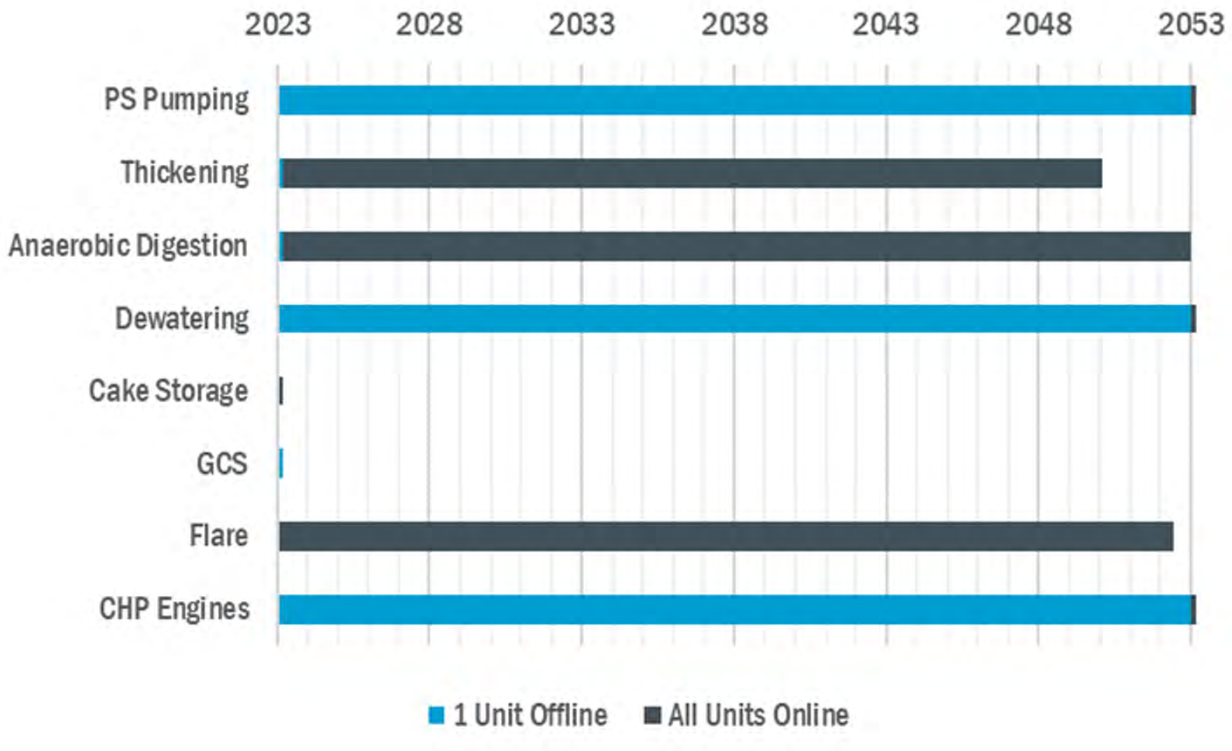
Capacity Evaluation Methodology

1. Redundancy – evaluation performed with **all units online and** with **one unit offline**

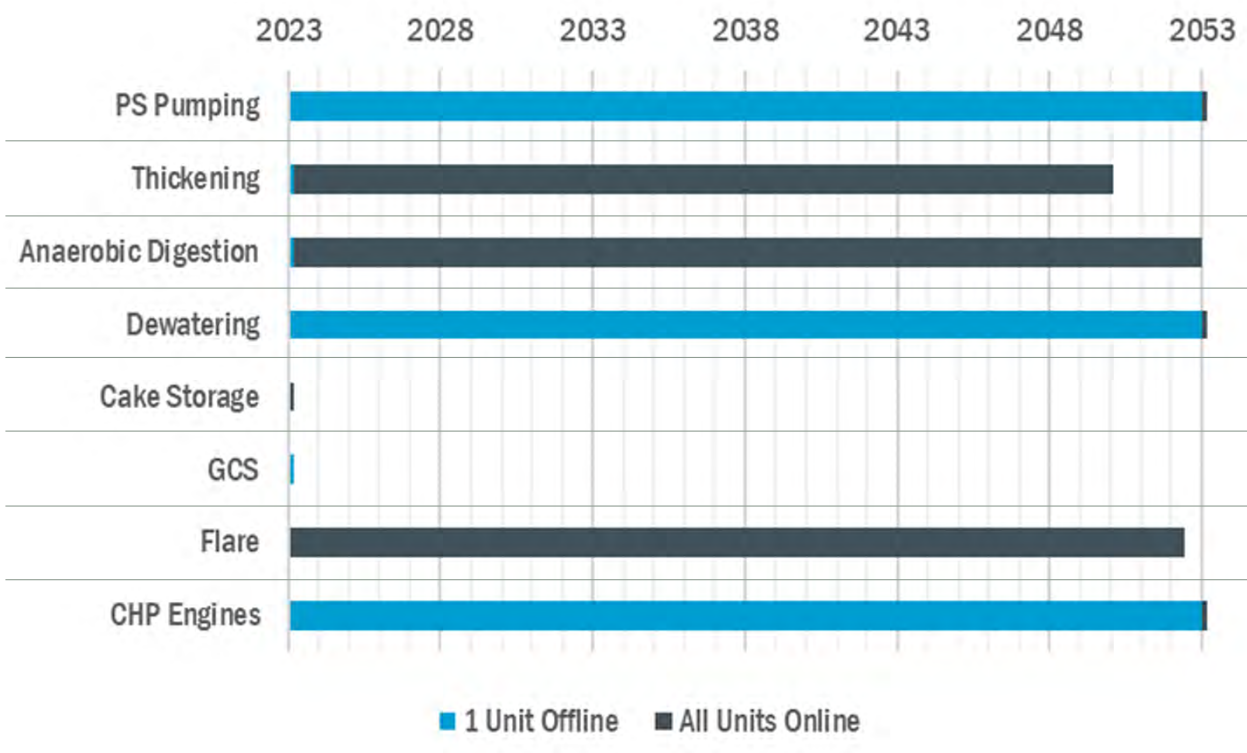
2. Sludge & HSW – evaluation based on **PS+TWAS flows and loads only**. Results calculate additional HSW capacity in 2023-2053, if available.

3. Maximum Flows and Loads – evaluation based on maximum flows and loads to each unit process or equipment, as appropriate. For example, maximum 14-day flows and loads were considered for digestion capacity and maximum 1-hour biogas flow rates for flare capacity.

Capacity Evaluation



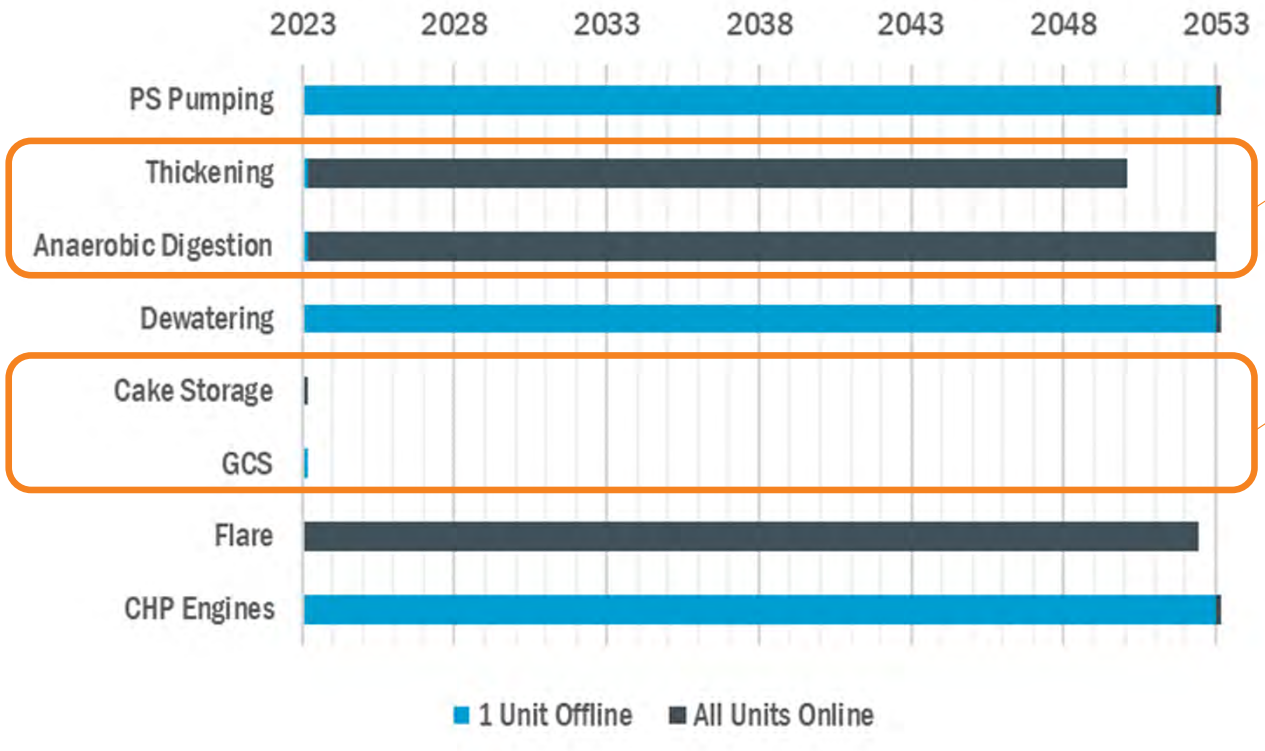
Capacity Evaluation



Capacity based on PS+TWAS
Max 1-day flow rate
Max 7-day HLR and SLR
Min 14-d HRT and max 14-d OLR
Max 1-d HLR and SLR
Max 1-d loading
Max 1-d biogas flow rate
Max 1-hr biogas flow rate
Max 1-d biogas flow rate

d = day
HLR = hydraulic loading rate
SLR = solids loading rate
HRT = hydraulic residence time
OLR = organic loading rate

Capacity Evaluation



No capacity when one unit is offline

No capacity with all units online

Next Steps

Brown AND Caldwell

Opportunities to Alleviate Capacity Constraints

Address capacity limitations by considering biosolids alternatives for life cycle costs analysis.

- Limitations include thickening, digestion, cake storage, and GCS
- Opportunities include:
  - **Upstream of thickening** → improved primary clarification would decrease loading to secondary treatment system and WAS loading to thickening.
  - **Upstream of digestion** → thermal hydrolysis process (THP) could be considered to alleviate thickening capacity and digestion capacity constraints.
  - **Downstream of digestion** → biosolids treatment process downstream of digestion (e.g., Lystek or composting) could alleviate digestion HRT capacity constraints, cake storage hopper constraints, and provide additional biosolids management alternative.
  - **Biogas Utilization** → increasing size of biogas collection piping could lower pressure loss and provide additional capacity by alleviating vacuum in piping upstream of blowers.

Next Steps

1. Address workshop Action Items
2. Address City comments on draft TM
3. Prepare Final Flows and Loads and Capacity Evaluation TM

4. Incorporate alternatives to alleviate capacity constraints into biosolids alternatives analysis

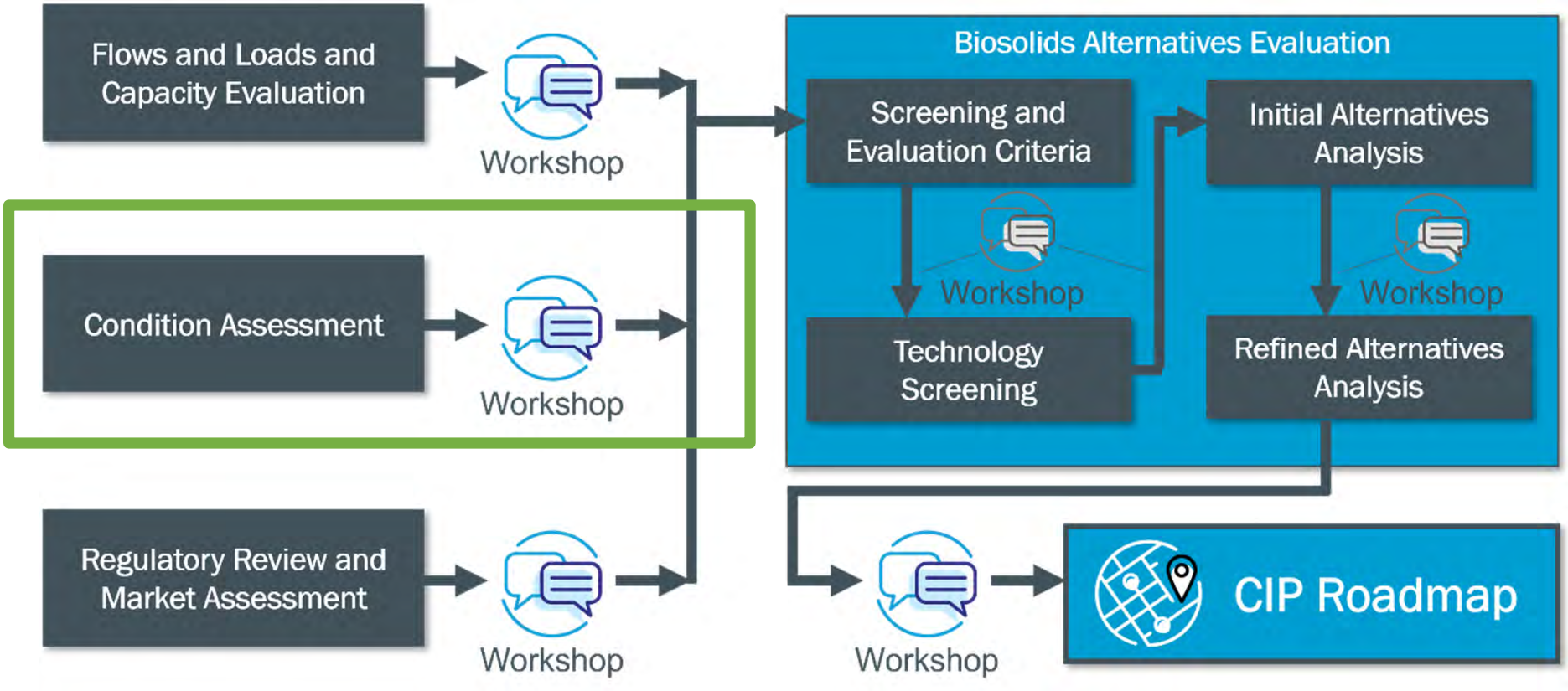
Condition Assessment

Brown AND Caldwell

Meeting Agenda

- Workshop Goals
- Approach
- Visual Observations
- R&R Project List
- Next Steps

BMSP CIP Roadmap



Condition Assessment Team

BC Staff	Role
Colin Casey, P.E.	Mechanical Lead
Divij Sharma, E.I.T.	Mechanical Support
Dan Gagne, P.E.	Structural Lead
Dane Forsberg, P.E.	Electrical Lead
James Jetton, P.E.	Technical Advisor

Thank you to City staff for their time and input!

Today's Goals

1. Understand condition assessment scope and approach
2. Discuss visual observations
3. Discuss preliminary list of rehabilitation and replacement (R&R) projects
4. Agree on next steps



Condition Assessment Scope – Task 001

Phase 007 – Condition Assessment and Evaluation

Brown and Caldwell (BC) shall conduct a review of the existing solids handling and treatment processes based on available as-built drawings, historical data, report, and observations. Solids processes to be evaluated include thickening, digestion/solids stabilization, and dewatering. Condition assessment results and recommended improvements will be documented in a TM.

Task 001 – Condition Assessment and Site Visit

BC will submit a request for information via email, requesting at a minimum items highlighted under Phase 006. BC will review provided record drawings, reports, and historical data prior to a site visit. BC shall prepare forms to conduct a condition assessment of existing assets during a one-day site visit. The site visit shall include three BC staff including one process mechanical, one structural, and one electrical engineer.

Unit processes to be evaluated include:

- High strength waste receiving station
- Septage receiving station
- Primary sludge pumps
- Waste activated sludge pumps
- Gravity belt thickeners (thickening process)
- Anaerobic digesters
- Gas conditioning system and piping
- Combined heat and power engines and emissions control systems
- Biogas flare
- Belt filter presses (dewatering processes)
- Cake pumps and storage

Added Ferric Chloride and Compost Facility

Assumptions

- Seismic and coating evaluations are not included in the assessment.
- Field data collection will use Fulcrum
- City will provide data on age of all equipment to be assessed
- City will provide maintenance history for all equipment to be assessed
- Permitted confined space entry is not provided.
- The City shall accompany BC during the site visit and be available for questions to assist with the assessment. City staff shall include the project manager and at least one operator familiar with the unit processes identified.
- Condition assessment of existing assets will be based on visual observation of the portions of the assets that can be viewed without removal of it or other equipment and does not require confined space entry. Condition assessment will be based on the viewed portions only.

Condition Assessment Scope – Task 002

Task 002 – Condition Assessment Technical Memorandum and Workshop

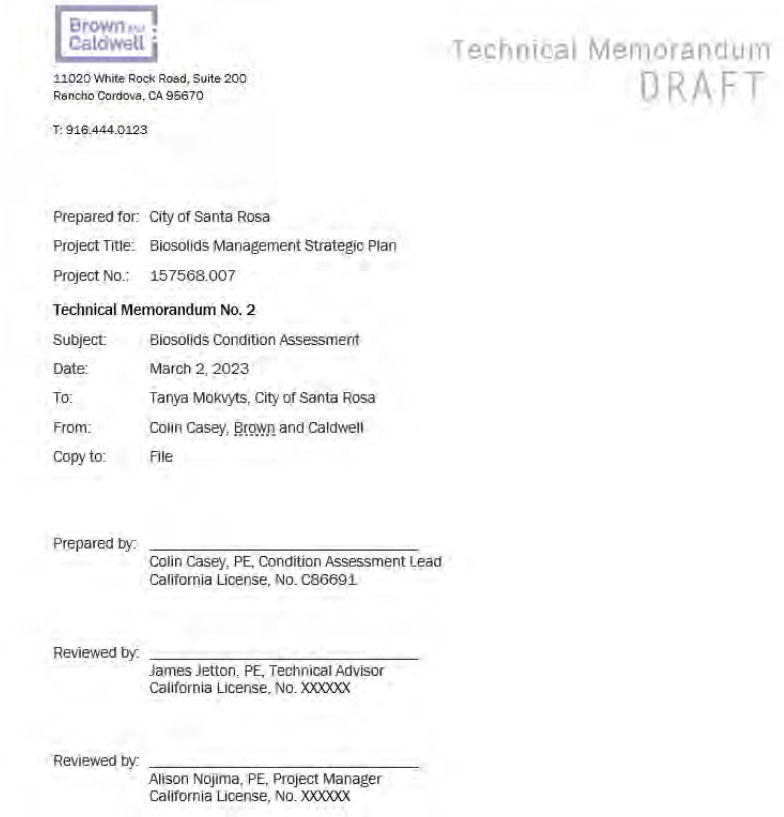
A TM shall be prepared to document observations and recommendations from the site visit and condition assessment. A workshop shall be conducted to review preliminary results and recommended improvements, and the City shall provide feedback. Evaluation and criticality criteria will be established during the workshop to provide a basis for recommendations. BC will incorporate feedback from the City and provide a final TM.

Deliverables

- Condition Assessment Workshop agenda
- Condition Assessment Workshop PowerPoint slides PDF and minutes
- Draft Condition Assessment TM
- Final Condition Assessment TM

Assumptions

- BC will organize and lead the workshop. Meetings will be attended in person.
- BC workshop attendees shall include one project manager, one technical expert, and up to two project engineers.
- City PM will be responsible for inviting the City staff attendees including the project manager, plant management, operations, maintenance, biosolids operations and public works engineering representatives.
- The condition assessment TM will be based on a desktop evaluation from visual observations during the site visit. Additional testing can be added to this scope.
- Draft and final TM will be submitted electronically in PDF format.
- City will provide a consolidated set of comments 10 business days after submittal of the draft TM for review.



Brown and Caldwell

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Rancho Cordova, CA 95670

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Technical Memorandum
DRAFT

Prepared for: City of Santa Rosa
Project Title: Biosolids Management Strategic Plan
Project No.: 157568.007

Technical Memorandum No. 2

Subject: Biosolids Condition Assessment
Date: March 2, 2023
To: Tanya Mokvyts, City of Santa Rosa
From: Colin Casey, Brown and Caldwell
Copy to: File

Prepared by: _____
Colin Casey, PE, Condition Assessment Lead
California License, No. C86691

Reviewed by: _____
James Jetton, PE, Technical Advisor
California License, No. XXXXXX

Reviewed by: _____
Alison Nojima, PE, Project Manager
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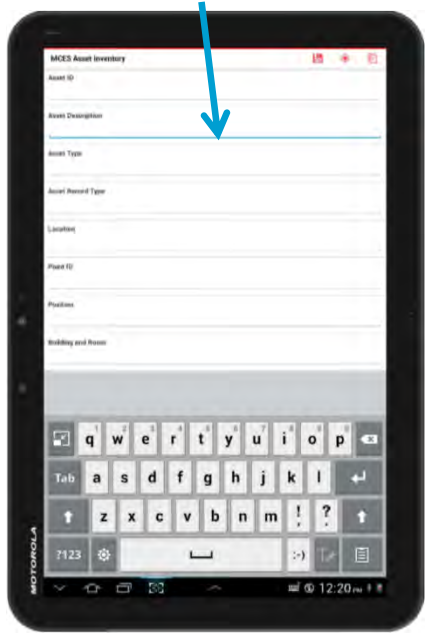
Mobile Application

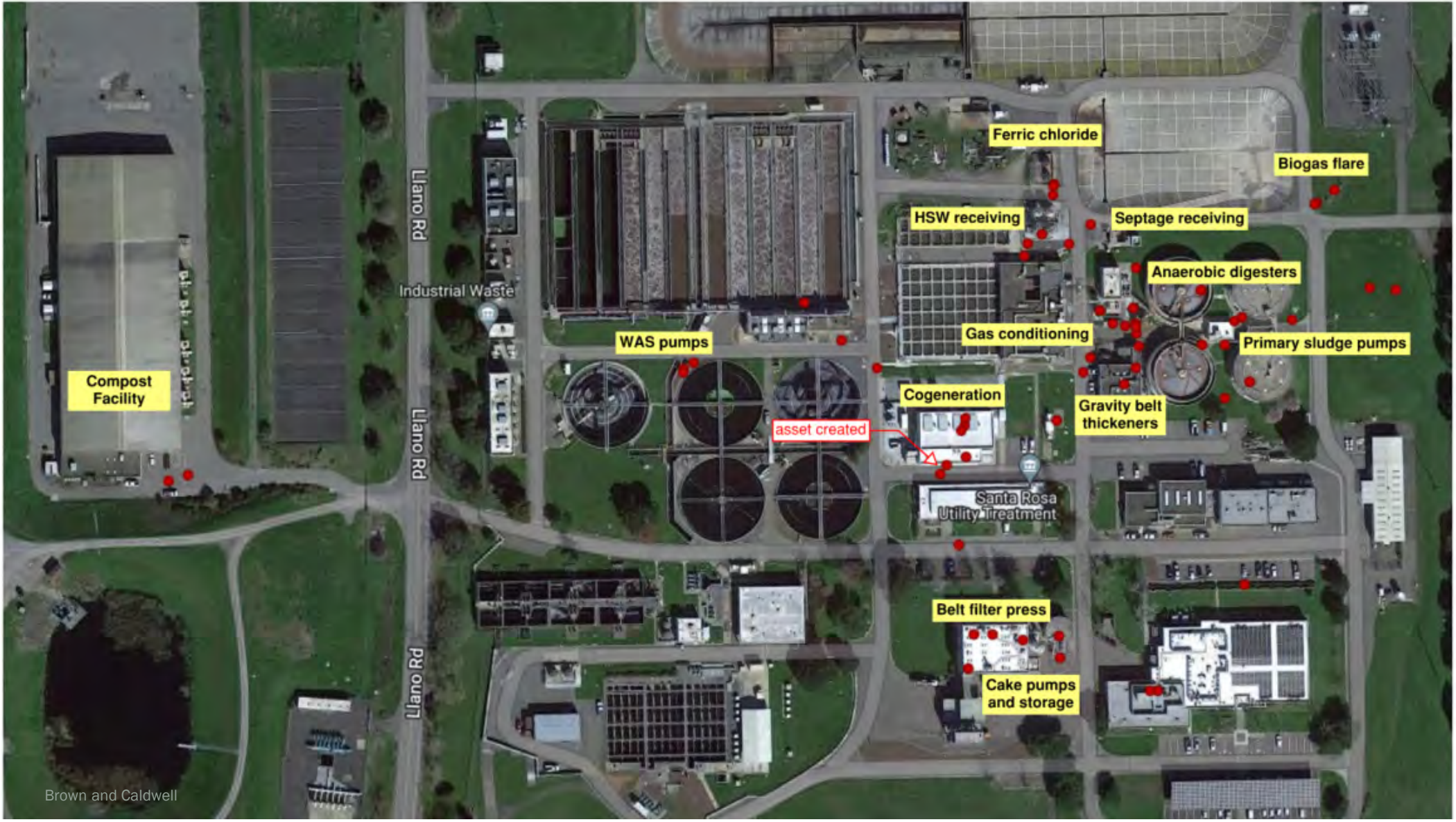
Standardized forms to efficiently collect and process assessment results

Fulcrum



LTP Biosolids Asset

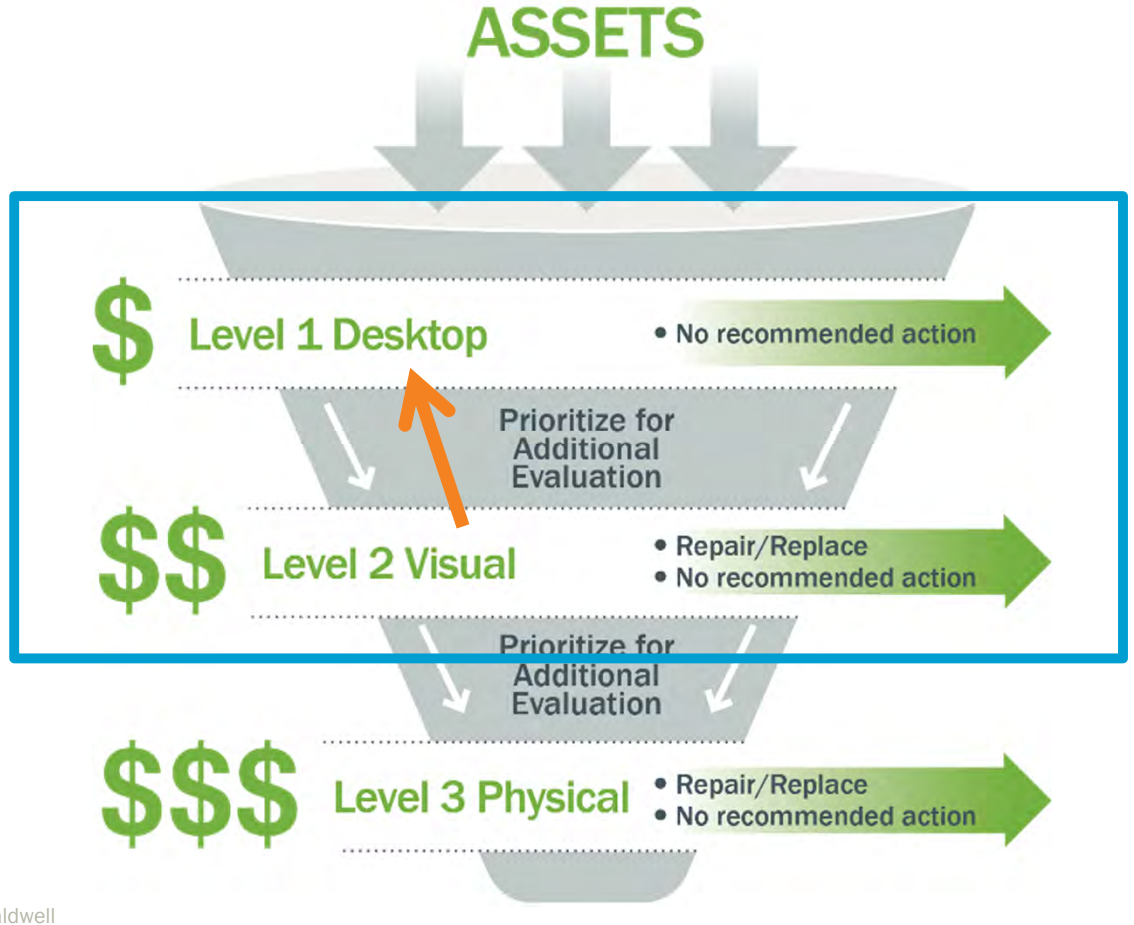



Ferric chloride
Biogas flare
HSW receiving
Septage receiving
Anaerobic digesters
Industrial Waste
Gas conditioning
Primary sludge pumps
WAS pumps
Compost Facility
Cogeneration
Gravity belt thickeners
asset created
Llano Rd
Llano Rd
Llano Rd
Santa Rosa Utility Treatment
Belt filter press
Cake pumps and storage
Brown and Caldwell

Priority issues...

Anaerobic digestion	Digester ragging Capacity concern during digester cleaning periods Mixing improvements
Gas conditioning system	Bottleneck neck in piping from digesters to CHP
Belt filter press and cake pumps	Sub-optimal performance; frustrating inefficiency
Compost facility	
Others?	

Condition Assessment Funnel



Remaining Life

R&R development Risk Scores

Further inspection

Visual Observations

Brown AND Caldwell

HSW Receiving Facility



Mechanical:

- Tanks and equipment observed to be in good condition.
- Exposed SS piping also observed to be in good condition.
- Issues with clogging when taking in some HSW.
- The HSW foul air system is underperforming,

Electrical:

- Motor control center (MCC) MCC 3C-U powers the HSW area equipment; installed in 2016 and is in good condition.
- The remote I/O cabinet contains a Siemens Simatic ET 200M modular IO system. City staff noted that this was recently replaced in 2023.

Structural

- The HSW area was noted as being in good condition with no structural deficiencies identified.

Recommendation:

- HSW odor scrubber improvements will be needed to meet future foul air capacity requirements.
- Capacity of HSW tanks should be further evaluated in the BMSP Alternatives Evaluation.

Septage Receiving



Mechanical:

- The hopper, bar screen, and piping at septage receiving station all have corrosion and are in good to poor working condition, given the location they are in.
- The dumpster appears to be in poor condition and should be replaced soon.

Electrical:

- There is no electrical equipment in this area.

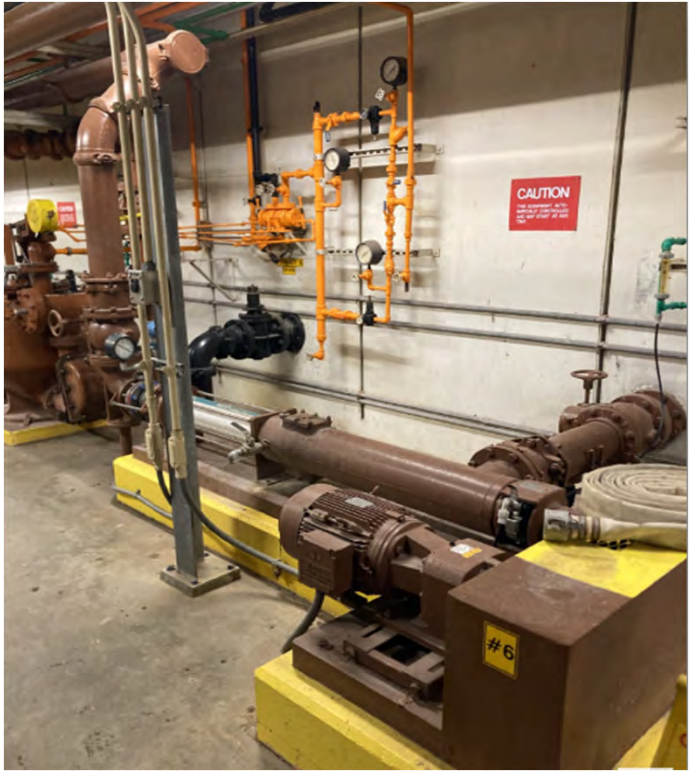
Structural

- Cracks noted in the slab and the walls around septage receiving and were observed to be wide enough to allow water to penetrate.
- Water entering the cracks will eventually cause corrosion of the reinforcement and shorten the lifespan of the structure, which is mostly concrete.

Recommendation:

- Equipment should continue to be monitored and inspected in the future if operational or maintenance issues increase.
- Cracks in the slab and walls should be sealed.

Primary Sludge Pumps



Mechanical:

- All pumps appear to be in good condition with minor coating defects.
- Primary sludge pumps 1 through 6 were installed in 2012 and are older than primary sludge pumps 7 and 8.

Electrical:

- The primary sludge pumps are powered from motor control centers MCC-2B and MCC-2G. Both MCCs are Square D – Model 6 and were installed in 2011. Both MCCs are in good condition and have at least 10-15 years of useful remaining life.
- Plant staff had modified the VFD buckets for each pump to add custom air filters.
- A Westinghouse dry-type lighting transformer feeds the Square D NQOD type lighting panel C. Both are in fair condition; however, they are past their estimated useful life, as they were installed in 1998.
- PLC-5 contains a Siemens Simatic S7-300 PLC which was installed in 2011. Plant staff advised that this model will be discontinued this year, however spare parts will be available until 2033.

Structural

- No structural concerns noted with pump pads or supports.
- There were some structural issues observed of the digester gallery walls, within the tunnel.

Recommendation:

- The City should replace panelboard C and lighting transformer C, as they are past their expected useful life.

WAS Pumps



Mechanical:

- The WAS pumping station includes two self-priming centrifugal pumps that send WAS from the ML channel to the GBTs
- The City noted that they can only get 220 gpm from the WAS pumps and would like to increase the capacity so that they may deliver more WAS to the GBTs

Electrical:

- Switchboard 3H supplies power to the two WAS pump VFDs and other equipment in this area. The GE Spectra Series Switchboard was installed in 2010 and is in good condition.
- Both WAS pump VFDs are Allen-Bradley PowerFlex 70 Series which are housed in a cabinet near the primaries. The VFDs are in good condition but are nearing the end of their useful life as they were installed in 2010.
- The WAS pump station PLC-25 is a Siemens Simatic S7-1200 Series which was installed in 2013. This model is the most current of the Siemens product line.

Structural

- No structural concerns noted with pump pads or supports.

Recommendation:

- No further recommendations unless additional WAS pumping capacity is needed.

Anaerobic Digesters



Structural

- Digester 1-2 gallery, expansion joint sealant has failed in many locations and requires replacement. Some cracks are wide enough to require repair.
- Digester 3 gallery, the joint between digester wall beam and gallery ceiling has staining from groundwater entering through joint. Expansion joint material was noted as falling out of joint.
- Digester 4 gallery, the wall in the gallery has a number of cracks that show signs of previous leakage. Based on discussion with the City, significant leaks were present last time the digester was filled with water for cleaning. A strip of membrane coating was installed on the interior of the crack for minor repair. Leaks not sealed by the membrane self-healed or plugged after being filled with sludge according to the City.
- Sidewalk surrounding the digesters showed signs of settlement and had pulled further away from the digester wall.
- Exterior digester walls had spalling and cracking issues. Large portions of the stucco were removed recently by the City as a safety measure.
- Groundwater was entering the digester gallery area between Digesters 3 and 4 through a buried conduit pipe that enters the gallery through the east wall.

Anaerobic Digesters







Electrical:

- The digester area equipment is powered by MCC-12R and MCC-6K. MCC-12R was manufactured by Brown Boveri Co in 1980 (to be confirmed by City) and the model has been discontinued with no available spare parts. MCC-6K is a Westinghouse Series 1200 which was installed in 1991. Both MCCs are in fair condition, however, are past their useful life.

- Lighting Transformer H and Panelboard H are both manufactured by Sylvania and were installed in XXXX (to be confirmed by City), and both are assumed to be past their useful life. The transformer is in poor condition as water leaking had been leaking on top and it is rusted. A drip shield was installed above it to better protect it.

- Digester PLC-18 is a Siemens Simatic S7-300 which was installed in 2010. Plant staff advised that this model will be discontinued this year, however spare parts will be available until 2033.

Anaerobic Digesters



Mechanical:

- Digester gas piping and the pressure release valves on each digester appear to be in good condition.
- The digester gas mixing system on each digester is past its useful life and should be considered for replacement.
- For digester dewatering, a single 400 gpm rated capacity is available; however, the pump is past its useful life and has no redundancy.
- The dewatering pump is also oversized, causing it to run inefficiently at its lowest speed. A replacement of the dewatering pump with two (2) equal sized smaller pumps at half the capacity, with overhead motors, is recommended.
- Access to replace the dewatering pump in existing pump room beneath digester gallery will be challenging.

Anaerobic Digesters



Recommendation:

- BC recommends further evaluating the replacement of the digester mixing system.
- Installation of two new dewatering pumps to replace the single over-sized dewatering pump at lacks redundancy.
- Replacement of MCC-12R and MCC-6K, as they are both beyond their useful life.
- The panelboard and transformer H should also be replaced as they are both beyond recommended useful life.
- Structural recommendations include epoxy-injecting the observed cracks in the digester gallery walls.
- Joints between the ceiling of digester gallery area and below grade wall should be repaired.
- Backer rod and sealant should be installed at the joints between the digester walls and concrete slabs outside.
- Expansion joint sealant should be replaced, and the adjacent cracks should be routed out and injected with epoxy.
- Further investigation should be made to identify the location of water ingress into the conduit, or to seal the end of the conduit which is allowing the leaking into the digester gallery.

Gravity Belt Thickeners





Mechanical:

- Three GBTs for WAS dewatering with a rated capacity of 340 gpm/each.
- GBT 3 is used for digester re-couperation when only three of four digesters are in operation.
- GBTs 1 and 2 were recently rebuilt by the City with new rollers, while GBT 3 still has the same components as when it was installed in XXXX.
- Thickened WAS pumps are past their useful life and should be designed for the future thickened WAS sludge pumping capacity.

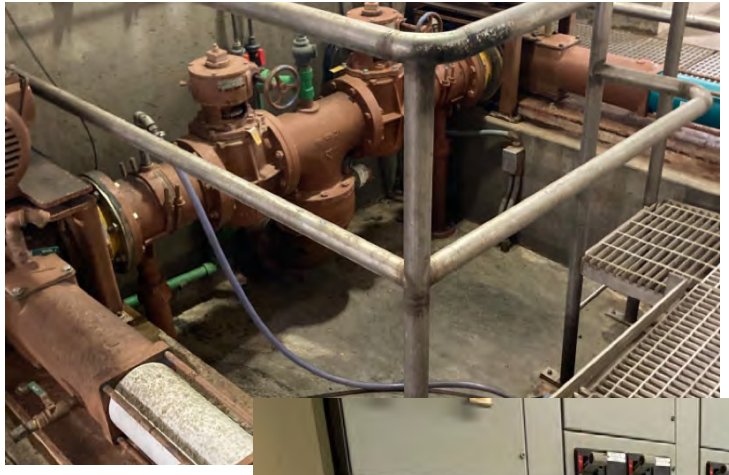
Electrical:

- MCC-11P provides power to the GBTs. The MCC is a Westinghouse Five Star model was installed in 1987 and is in fair condition, however the equipment is past its useful expected life.
- Lighting panelboards and transformers L1 & L2 are manufactured by Westinghouse and installed in 1987. They are in fair condition but also past their useful expected life.
- PLC-20 is a Siemens Simatic S7-300 model and was installed in 2015. Plant staff advised that this model will be discontinued this year, however spare parts will be available until 2033.

Structural

- Hairline cracking was observed in the header beam over coiling door, the exterior side of the building's wall columns, and floor slab.
- Cracks were observed in the floor slab, with some having widths sufficient to justify sealing to prevent water intrusion.

Gravity Belt Thickeners





- Recommendation:
  - Consider installing fourth GBT after confirming GBT capacity requirements.
  - Thickened WAS pumps should be replaced
  - MCC-11P, lighting panelboards L1 & L2, and lighting transformers L1&L2 should also be replaced
  - Structural cracks within the building should continue to be monitored and corrective action should be taken if cracks begin to widen.
  - Cracks in the floor slab that have a large enough width to allow water intrusion should be sealed by the City.
  - A new sealant between the floor and wall joints is also recommended.

Belt Filter Press



Mechanical:

- Only two four BFPs typically are needed for operations at 60 gpm/each.
- BFPs were observed to be in good condition

Electrical:

- MCC-22-T-1 and MCC-22-T-2 provide power to the belt filter press equipment. Both MCCs are Siemens Tiastar model which were installed in 1975. They are both in fair condition, however, they are past their estimated useful life.
- PLC-13 is a Siemens S7-300 which was installed in 2015. The City advised that this model will be discontinued this year, however spare parts will be available until 2033.
- Each BFP has its own control cabinet with Siemens Simatic S7-1200 PLCs and Siemens Simatic HMIs. This model is the most current of the Siemens product line. The control cabinets appear to be in good condition.

Structural:

- Biosolids Dewatering building was observed to be in fair to good condition.
- One significant area of concern is the spalling in the floor slab of the top floor and the associated crack that extends through the slab and seen from the floor below.
- The floor joint sealant at the expansion joint and floor slab has deteriorated and is no longer functioning to prevent water from getting into the joint. Corrosion was visible on the exposed floor slab reinforcement.

Recommendation:

- Replacement of MCC-22-T-1 and MCC-22-T-2 and the aging control console is recommended, along with an integration of controls and logic to PLC-13.
- Repair of the damaged concrete and floor slab, also, that backer rod and sealant be installed at the building's expansion joints

Cake Pumps and Storage





Mechanical:

- Each BFP is installed with a progressive cavity cake pump beneath it on the first floor of the Biosolids Dewatering building.
- The biosolids hopper is located outside and south of the Biosolids Dewatering building as a separate structure.
- Cake pumps do not provide adequate solids capture (total percent solids) for optimal cake pumping. Cake pump operation requires the City to inject water through an injection ring so that the cake pumps may pump the dried solids to the adjacent biosolids hopper.

Electrical:

- Lighting panelboards TL-1, TL-2, and TL-3 power the cake pump and storage equipment. Panelboards TL-1 and TL-2 are Siemens I-T-E Type which were installed in 1988.
- The associated lighting transformer (TT-1 and TT-2) are I-T-E Branded and installed in the same year. Both sets of panelboards are in fair condition, however are past their useful expected life.
- Panelboard TL-3 is a Square D NQOD Series, and its associated Square D branded transformer was installed in 2005. Both are in good condition.
- Each sludge cake pump has a local control panel which contain Eaton SVX 9000 VFDs. The control panels were installed in 2005, so the VFDs are nearing the end of their useful life.

Structural:

- See Belt Filter Press observations. A separate structural assessment of the cake pumps and hopper system was not performed.

Recommendation:

- Consider replacing the cake pumps with Schwing Bioset cake screw pumps, or similar, to improve cake pump pumping capacity and to reduce solids hauling costs.

Gas Conditioning





Mechanical:

- Digester gas is conveyed through 8-inch diameter stainless steel piping above grade and is likely undersized for current and future gas conditioning flows.
- Hydrogen removal vessels (iron sponge) appear to be in good condition, however, may only be operated in a duty/standby configuration, which limits capacity.
- Digester gas heat exchangers, boosters, blowers, and chillers appear to be in good condition. The siloxane removal vessels, which are operated in-series, were also observed to be in good condition with no noted operational issues

Electrical:

- MCC-30N powers the gas conditioning system. The MCC is a Siemens model 95 which was installed in 1995 and is in fair condition.
- PLC-19 is a Siemens Simatic S7-300 PLC which was installed in 2013. Plant staff advised that this model will be discontinued this year, however spare parts will be available until 2033..

Structural:

- Components appear in good condition, however, there is a fair amount of rust staining on adjacent concrete pads at the Gas Booster Building due to rust on the equipment anchor bolts and plates.
- Slab drainage issues were also noted adjacent to the Gas Booster Building, which have created ponding at some pipe supports. The City has installed some grating to prevent the need for staff to walk through rain puddles.
- The concrete slabs in the surrounding areas show significant signs of settlement.

Recommendation:

- Continue modeling of system to identify capacity constraints
- Drainage improvements or sloping of the top of the concrete slab with epoxy group outside the Gas Booster Building.
- Rusted bolts, nuts, and straps with stainless steel should be replaced.
- City should consider specifying only stainless steel on any new pipe supports and anchorage in the area.

CHP Engines





Mechanical:

- There are four Cummins cogeneration engines installed in the CHP building. The cogeneration system was constructed in 2010 under the CHP project
- SCRs are installed on CHP engines 3 and 4 to meet air permit requirements for NOx removal. CHP engines 1 and 2 do not have SCRs.

Electrical:

- The switchgear manufactured by Thompson Technology and installed in 2012 is in excellent condition.
- Two medium voltage transformers (12.4 kV to 4.16 kV) connect the facility to the plants nearby MV distribution equipment. The transformers are Prolec Envirotemp FR3 Type and were installed in 2012. Both are in good condition.
- MCC-118200 powers the ancillary generator equipment. The MCC is a GE Evolution Series E9000 and was installed in 2012 and is in good condition.
- There are 5 battery chargers, one for each generator battery bank and one for the generator switchgear. The chargers are SENS EnerGenius IQ models and were installed in 2012 and are all in good condition.
- PLC-48, PLC-49, and PLC-50 control the CHP switchgear, auxiliary equipment, and gas blending skid, respectively. These are all Siemens Simatic S7-300 PLCs which were installed in 2013. Plant staff advised that this model will be discontinued this year, however spare parts will be available until 2033.

Structural:

- Minimal rusting and cracking.
- Condensate line from the CHP engines drain directly into joint between slab and building foundation, which can cause long term localized settlement concerns.
- There were 2 locations which had uneven grating supports, allowing the grating to partially tip when the corner was stepped on; this is a minor safety hazard.

Recommendation:

- Consider adding SCRs to engines 1 and 2.
- Ease operation and control strategy
- Address condensate drip line and add grating clips to unsupported grating

Biogas Flare



Mechanical:

- The existing candlestick flare by Varec is past its useful life, though serves as a backup for digester gas to the City's cogeneration system.
- Significant corrosion and rust on the biogas flare and above grade piping and controls were observed. The surrounding area of the biogas flare has poor drainage causing large amounts of water buildup around the biogas flare pad.

Electrical:

- The biogas flare is controlled by PLC-64, which is is a Siemens PLC S7-1200 installed in 2015. This model is the most current of the Siemens product line.

Structural:

- Coating on the biogas flare has failed and surface rust is visible, however no noticeable section loss in steel was identified.
- Pipe supports and the riser pipe near the biogas flare were flooded during visual observations. It appears that past flooding has caused rust at the base of pipe supports and is a long-term concern for both pipe supports and the riser pipe.
- Ponding of water at pipe riser may cause long term settlement issues that would add additional stress to the pipe.

Recommendation:

- BC and the City are currently in construction to install a second biogas flare, which will be a low NOx enclosed waste gas burner (WGB) by Varec at a rated capacity of 660 cfm. The existing biogas flare will remain as backup to the new WGB.
- Add a concrete pad in front of the control panel to avoid stepping in puddles during wet weather events.
- Drainage should be improved and direct drainage away from pipe supports and pad.

Compost Facility





Mechanical:

- All mechanical equipment associated with the composting operation will need to be replaced or rehabilitated prior to operation of the composting facility, including the mechanical scraping and compost conveyance equipment, building roofing, and ventilation system

Electrical:

- The compost facility is powered by switchboard MET-19000. The switchboard powers MCC-1, MCC-2, and five exhaust fan VFDs. The switchboard is an Allen-Bradley Centerline model which was installed in XXXX (to be confirmed by City) and is in good condition. MCC-1 and MCC-2 are the Allen-Bradley Centerline model and were installed in XXXX (to be confirmed by City) and are also in good condition. The VFDs are near the end of their useful life.
- Lighting panelboards PNL-190010 (Panel A) and PNL-190020 (Panel B) are Siemens S1 type panelboards. They are both in good condition. The associated lighting transformers, Trans-191000 and Trans-191050, are Siemens QL Type installed in XXXX (to be confirmed by City). Trans-191050 appears to be in fair condition; however, transformer Trans-191000 was extremely louder than normal.
- PLC-59 is a Siemens Simatic S7-300 PLC which was installed in 2008. Plant staff advised that this model will be discontinued this year, however spare parts will be available until 2033.

Structural:

- Significant issues would need to be addressed for the building to be recommissioned.
- Based on conversations with the City, water has collected inside of the roof purlins and may have significant corrosion. BC's visual observations did not include the roof of the facility, so we cannot verify if the gasket washers were used which is intended to prevent water ingress.
- Some wall panels at the covered canopy area appear to be inadvertently receiving a vertical load causing them to bow outward from the adjacent columns.
- Some wall panels had spalled concrete with rebar exposed. This may have been caused by accidental impact loads from equipment.
- There is some significant cracking on the interior side of the wall panels.

Recommendation:

- R&R of all assets associated with the composting operation is recommended

R&R Project Identification

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Table 5-1. Preliminary List of R&R Projects						
ID	Project Name	Scope of Work	LoF Score	CoF Score	Risk Score	Risk Priority
1	HSW Odor Scrubber Improvements					
2	Digester Dewatering Pump Replacement					
3	Ferric Chloride Improvements					
4	Digester Gas Mixing Improvements					
5	GBT Sludge Pump Replacement					
6	SCR Installation for CHP Engines 1 and 2					
7	BFP Cake Pump Replacement					
8	WAS Pump Replacement					
9	Electrical Site Improvements					
10	Compost Facility Improvements					

Next Steps

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Next Steps

1. Address workshop Action Items
2. Address City comments on draft Condition Assessment TM
3. Finalize Level 1 Desktop Evaluation
4. Prepare R&R project descriptions
5. Prepare Final Condition Assessment TM
6. Support other BMSP tasks

Thank you!

Questions?

Brown AND Caldwell



Biosolids Management Strategic Plan

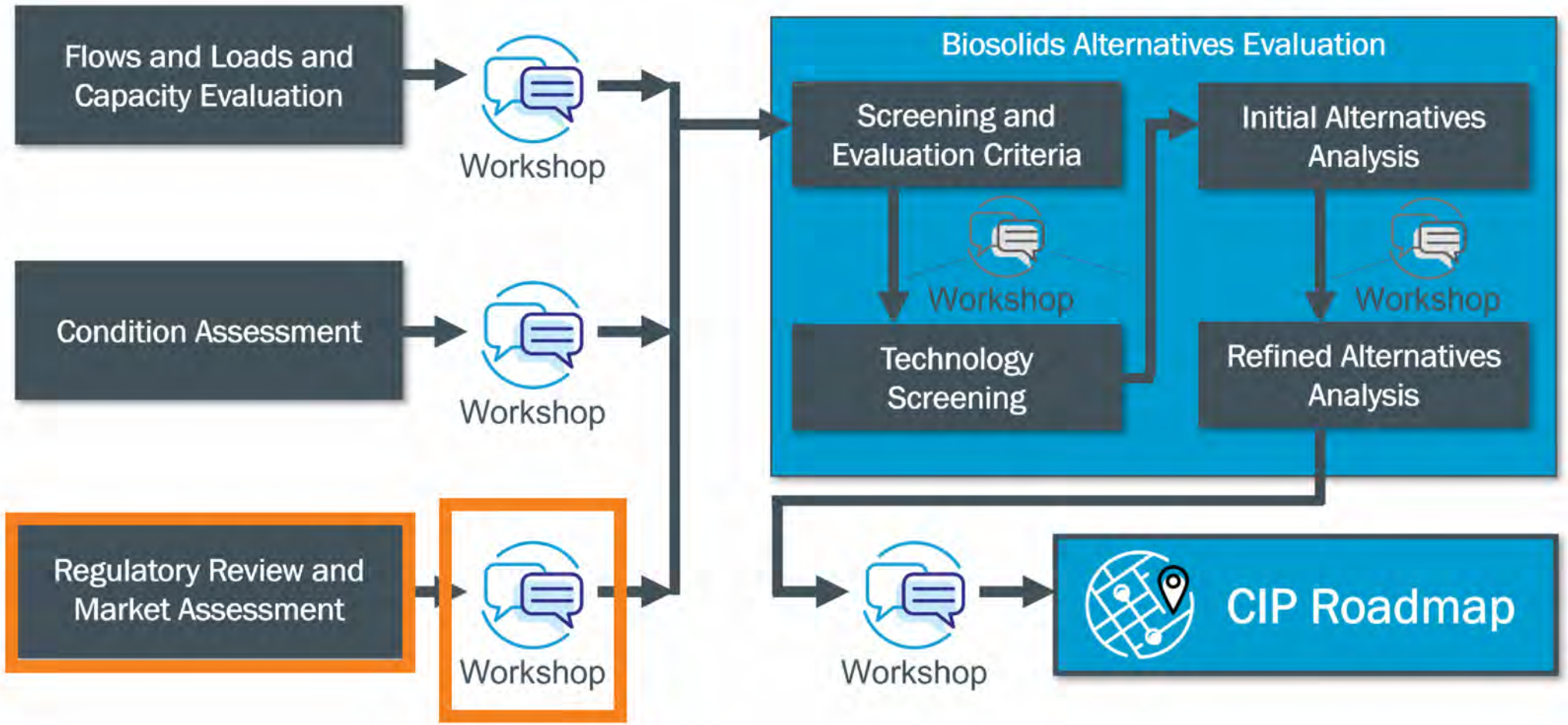
Regulatory and Market Assessment for Biosolids End Products

April 24, 2023

Meeting Agenda

1. Introduction
2. Current Biosolids End-use Program
3. Regulatory Pressures
4. Agricultural Market
5. Commercial Market
6. Regional Considerations
7. Summary and Looking Ahead

Biosolids Management Strategic Plan

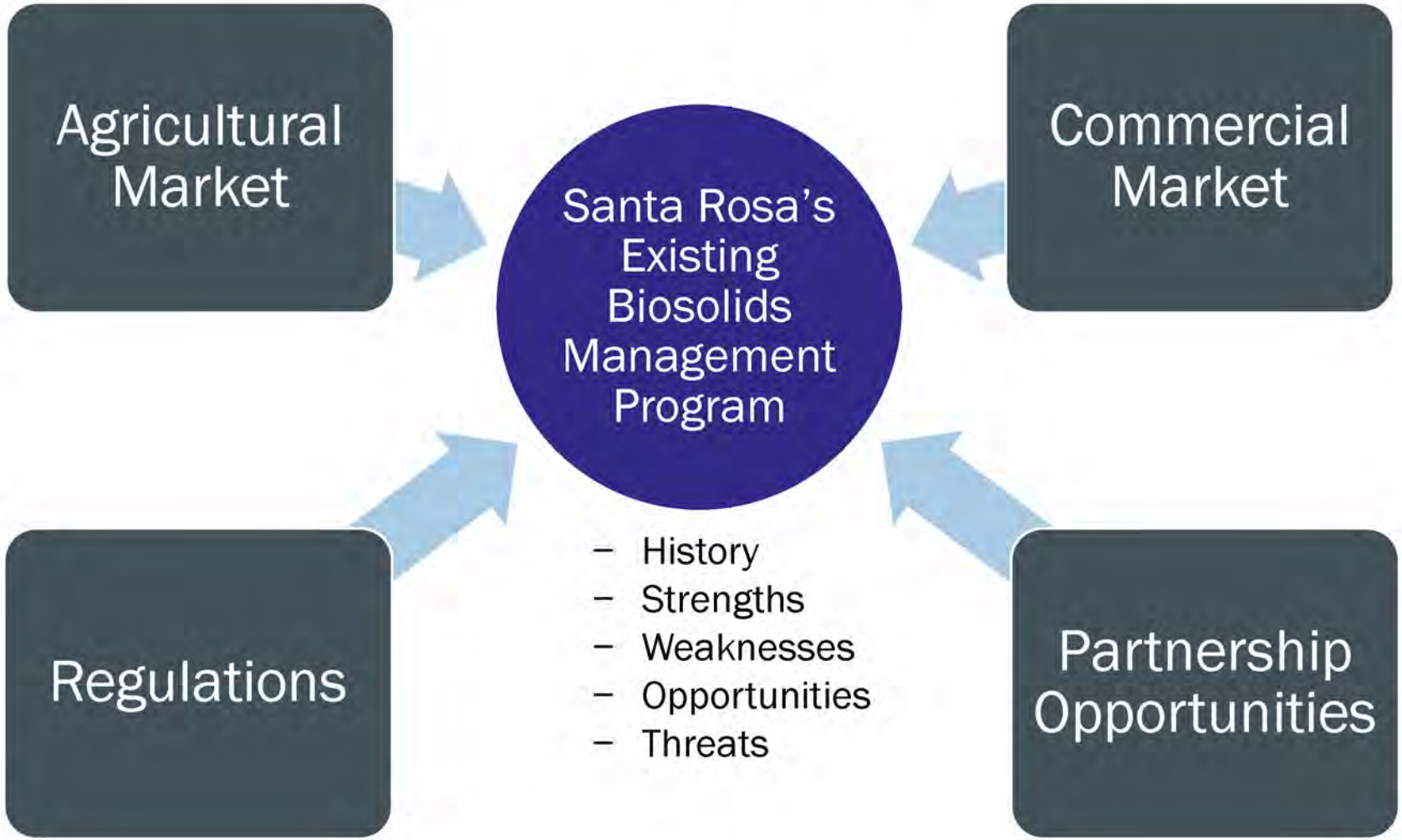


Assessment Objectives

1. *Goals, opportunities, and demand for Class A biosolids*
2. *Current and projected future regional competition for Class A and Class B markets*
3. *Demand for biochar or ash products*
4. *Regionalization opportunities*



Biosolids Market Assessment Approach



Current Biosolids End-Use Program

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Class B Compliance and End-Use

Processes to Significantly Reduce Pathogens (PSRP)

Year	Temperature (°F)	Days Held	VSR (%)
2020	100	20.0	65
2021	98	18.7	60
2022	98	19.0	60

Production and End-use Designation (by Dry Ton)

Year	Total	Applied at Local Farms	# of Farms	Lystek	Landfill
2020*	4,583	3,590	9	719	346
2021	5,071	3,392	9	1,519	46
2022	4,337	2,603	8	1,366	11

**315 DT were composted in 2020.*

Nutrient and Metals Concentrations within Limits

Nutrient Concentrations

Year	% TS	Ammonia	Total N	Total P	Total K
2020	15.4	0.9	6.7	2.8	0.1
2021	14.6	1.0	7.0	2.5	0.2
2022	14.6	1.0	7.4	2.3	0.2

EPA 503 Metal Concentrations

Year	As	Cd	Cr	Cu	Pb	Hg	Mo	Ni	Se	Zn
2020	7.3	2.5	28	306	12	0.6	8.8	201	15	780
2021	6.4	3.2	27	289	15	0.6	8.5	20	16	754
2022	6.9	3.2	31	285	9	0.9	8.5	22	17	703
EPA 503 Ceiling	75	85	35	4300	840	57	75	420	100	7500

High Strength Waste Program

- Began accepting HSW in August 2016
- Statistically significant increase but biologically immaterial

	Ammonia	Total Nitrogen	Total Phosphorus	Total Potassium
Before HSW (2015)	0.8%	6.6%	2.3%	0.14%
After HSW (2019-2022)	0.9%	6.9%	2.5%	0.17%

SWOT Analysis

	Helpful	Harmful
Internal	**Strengths** – Strong programmatic oversight – Strong personal relationships – Long-term, local program – Agricultural application – Historic biosolids management system – Winter storage	**Weaknesses** – Class B only – Heavy reliance on land application – Limited end-use diversity
External	**Opportunities** – Soil blenders and landscape suppliers – State-wide incentives for organics recycling – Regulatory consistency among counties – Local partnerships (including fire reclamation) – Regionalization opportunities	**Threats** – PFAS limitations – Maintaining farms for land application – Wetland conservation – California tiger salamander habitat – Regional biosolids limitations – Sea-level rise

Regulatory Assessment

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California Biosolids Regulations



County Ordinance Requirements and Biosolids Bans
(Map courtesy of CASA)

- Ban on All Land Application
- Ban on Class B
- Condtional Use Permit Required
- Class B Land Application Allowed
- No Regulations Ordinances Enacted

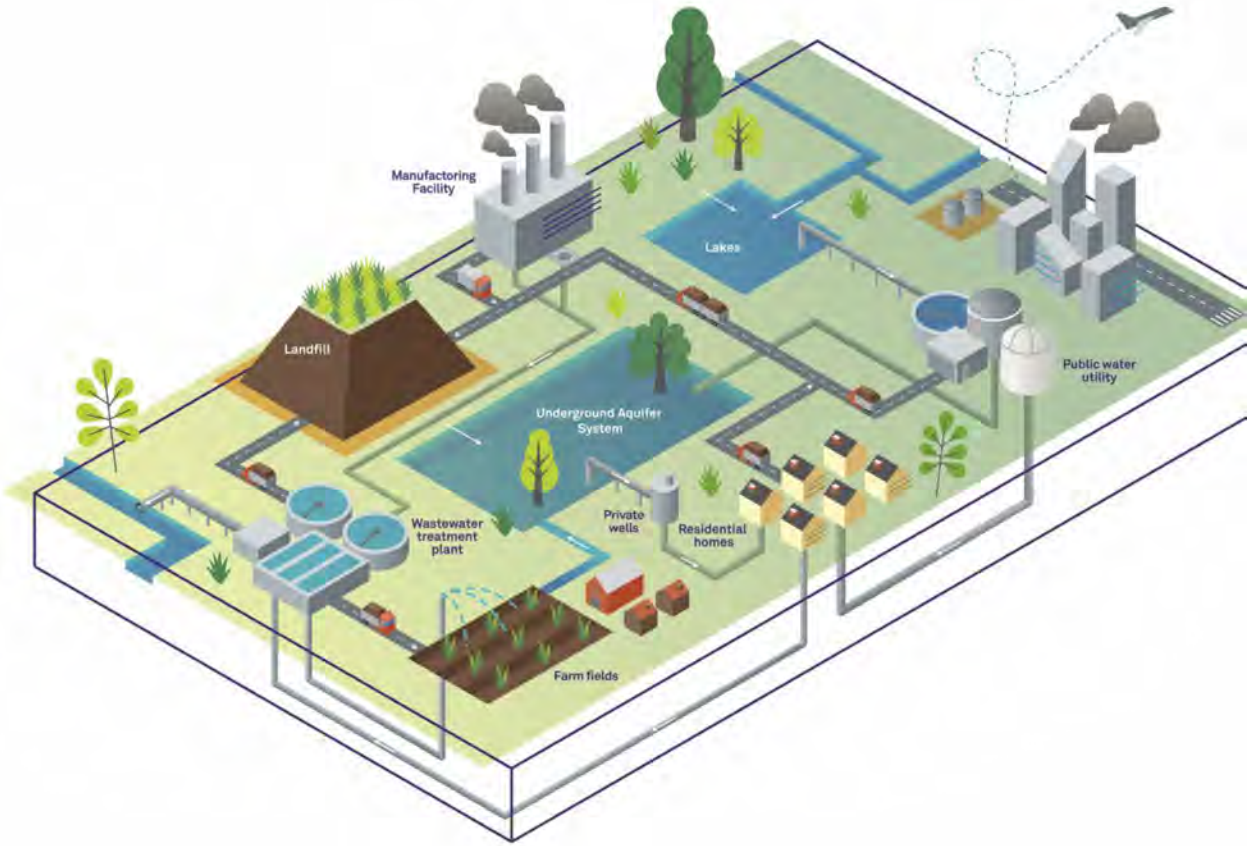
Current PFAS Regulations

EPA

- No regulations on wastewater and biosolids yet, but monitoring through NPDES permits encouraged
- Risk assessment process for PFOA and PFOS underway
- Method: EPA anticipates an approved biosolids analytical method in 2023

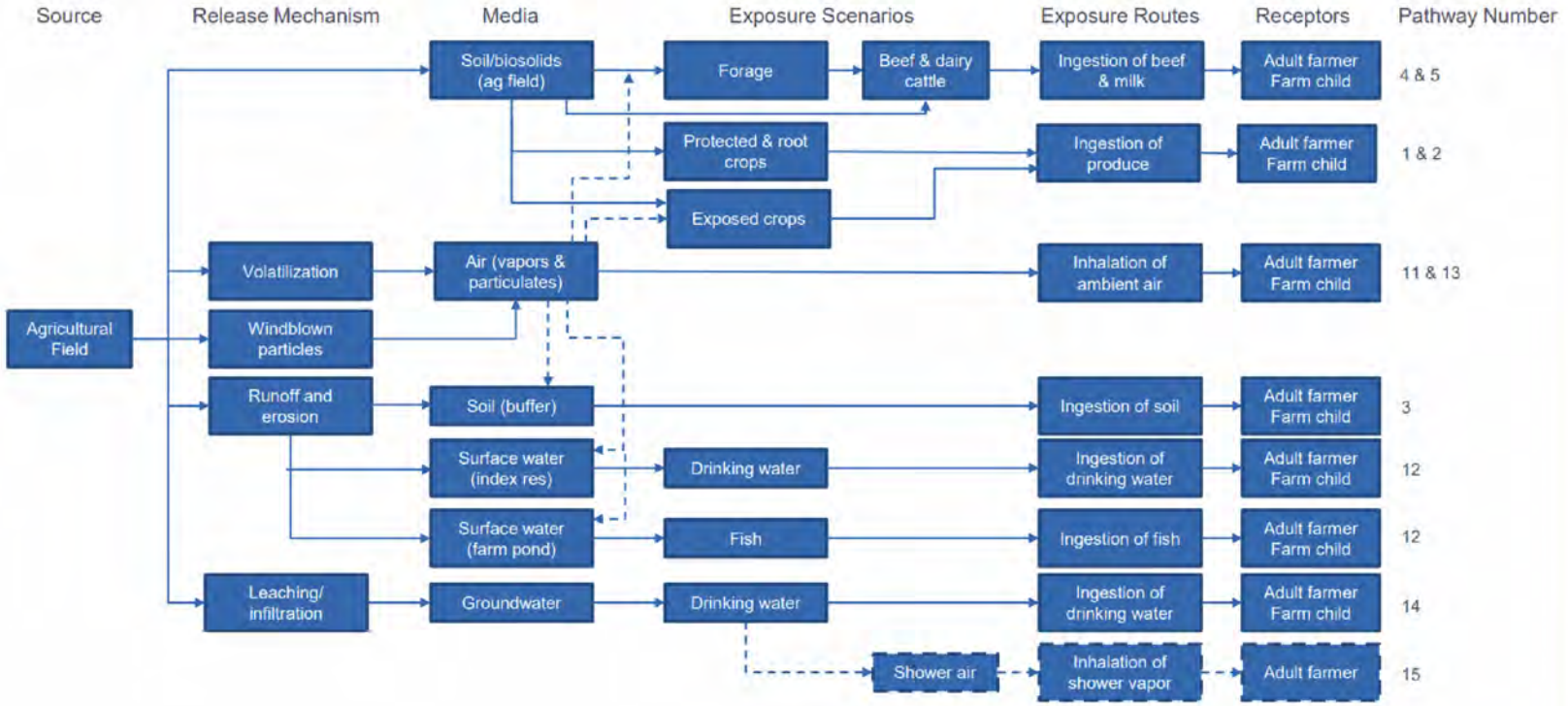
California

- Region 2 has conducted Phase 1 of their PFAS Study
- Studies by California Water Resources Control Board and Bay Area Clean Water Agencies



PFAS in Biosolids and New MCLs

Conceptual Model for the Agricultural Land Application Scenario: Human Exposures



EPA's March 14th Action:

PFOA and PFOS have draft MCLs of 4 ppt

PFNA, PFHxS, PFBS, and GenX regulated on a Hazard Index basis

Just one factor in the biosolids risk assessment

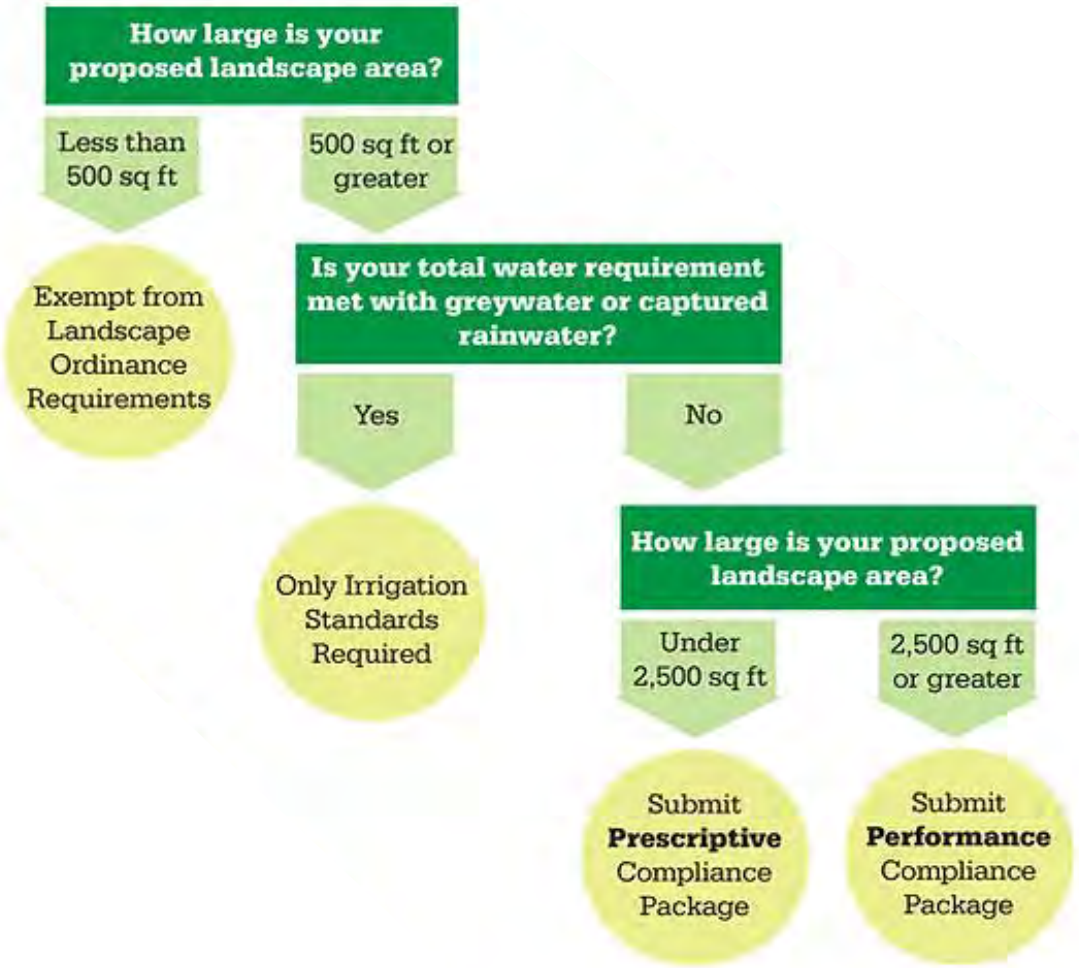
SB 1383 – Part of California's Climate Change Solution

- Targets 40% reduction in methane emissions in California by 2030
- Goal achieved by 75% diversion of organics from landfills
- Multiple companion pieces of legislation, including AB 901
- Sets compost procurement goals for cities and counties
  - Santa Rosa City/County currently procuring <10% CalRecycle compost targets
  - No in-county composting facility



Additional Relevant Regulations

- **Arizona Land Application Update**
- **Napa County and Napa Recycling Co.**
  - Napa County met procurement target in 2022, likely will in 2023
  - Napa City will meet in 2024, unwilling to buy compost now
  - No issues acquiring feedstock
- **Model Water Efficient Landscape Ordinance (MWELO)**
  - Sustainability requirements for landscaping
  - Requires compost usage (not organic)
  - Enforced by CalGreen Building Code and Division of State Architect, depending on landscape location
- **California Transit Compost**
  - Erosion Control guidelines
  - USCC Compost Specs



Regulatory Takeaways

- PFAS regulations are being discussed, but CASA and other agencies are actively representing WWTP interests
- California county ordinance create competition among WWTP agencies/biosolids generators for land application options
- Inter-agency partnership and collaboration opportunities exist for composted biosolids



Agricultural Market

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Sonoma County Ag Census (by acre)



Hay findings

- Vast majority grown in Southern California (Imperial)
- Nearby counties growing hay (150 miles)
  - Yolo – 27,270 acres
  - Sacramento – 16,000 acres
  - Glenn – 10,000 acres
- ~600 acres of hay farming in Napa County
  - Seems to be independent of Napa San's land application (rancher growing sorghum)



Extension Perspectives

- Spoke with 5 Sonoma/Napa extension agents
- Public education required, taboo and pollution concerns (PFAS and metals)
- Class A products more likely to be accepted
  - Shortage of compost in the region
  - Andy Poncia, dominant producer
- Organic-certification limitations were mentioned
- Extension recommendations for distribution: Livestock producers, dairy production, golf courses, landscaping, land reclamation



Agricultural Market Takeaways



Pros

- Strong and established market for Class B product
  - Cost-effective end-use program
- Proven existing program and opportunities for expanded land application locations

Cons

- Greater regulatory uncertainty with Class B land application (PFAS, public acceptance)
- Wet weather and growing season limitations
- Limited distribution range due to current volume
- Endangered species territory limitations (for Class B cake)

Commercial Contacts

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Commercial Market Methodology



- **Focused market survey through phone interviews**
  - Desktop survey, in-person outreach could be recommended
  - 27 contacts from CA assessment done in the last four years
  - 24 new contacts made for Santa Rosa
- **Conversation focus**
  - Class A versus Class B
  - Compost versus dried product
  - General impressions of biosolids
- **Customer types contacted**
  - Landscape suppliers
  - Soil blenders
  - Composters/biosolids service providers

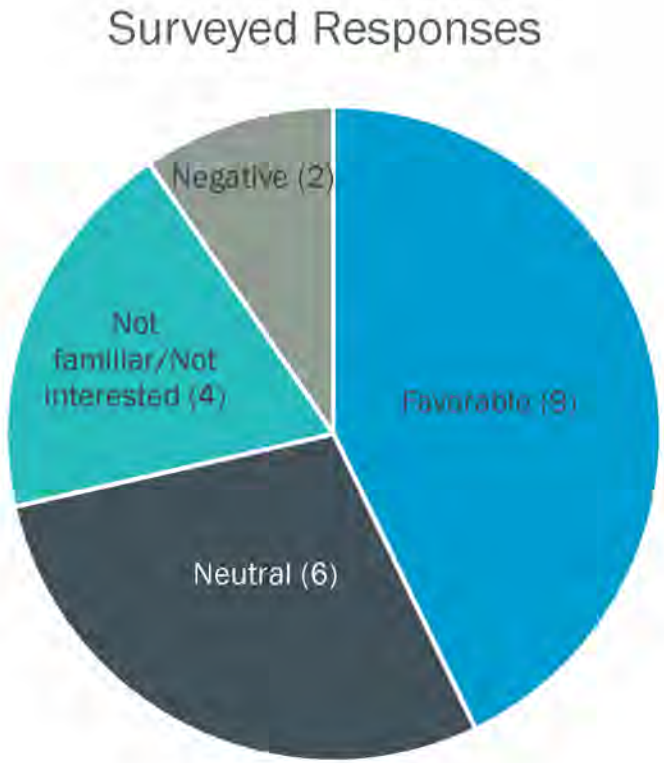
Contact Summary & Overall Impressions

Call Success	Number of End Users
Contacted, no response	11
Contacted, declined survey	9
Completed survey	31
Total contacts	51

Impressions	Number of End Users
Positive (+)	18
Mixed (+/-)	6
Negative (-)	2
Not familiar/ not interested	5
Total surveyed contacts	31

Soil Blenders and Landscape Supply

- Market exists for Class A product
  - Additional education/outreach valuable
- Product type preference
  - Class A cake is not a viable commercial end-product
  - Ease of storage = major concern
  - Dried, granule most preferred, followed by compost
  - Minimal interest in biochar/ash
- Offers seasonal flexibility
  - Landscaping/housing market (MWELO) - compost
  - Many soil blenders blend year-round
- Leads
  - Nimbus Landscape Materials (cake)
  - Sequoia Soil Company
  - United Forest Products

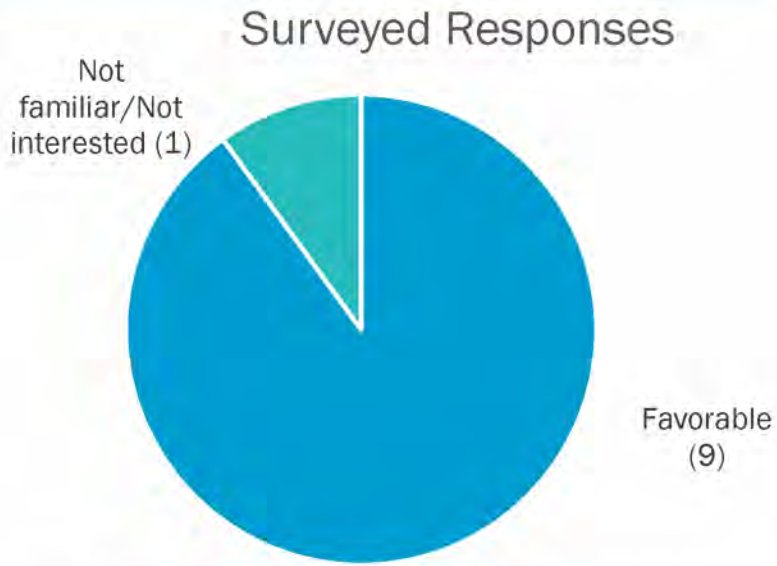


**14 contacts declined or did not respond.*

Biosolids Service Providers and Composters

- Many experienced operators (aware of Bay Area capacity issues)
- Will accept Class A or Class B
- Provides flexibility with product quality and seasonality limitations
- "Chicken and egg" problem
  - More expensive than current pricing, need commitments to activate new options
  - BUT prices will continue to rise as competition rises
- Options under development
  - Class A options in broader region
  - Means of accessing more distant options (e.g., rail)
- Traditional solid waste providers may provide other opportunities for partnership
- Leads
  - Synagro, Denali, Lystek
  - Napa Recycling Company, NorCal Ag Service





**4 contacts declined or did not respond.*

Commercial Market Takeaways

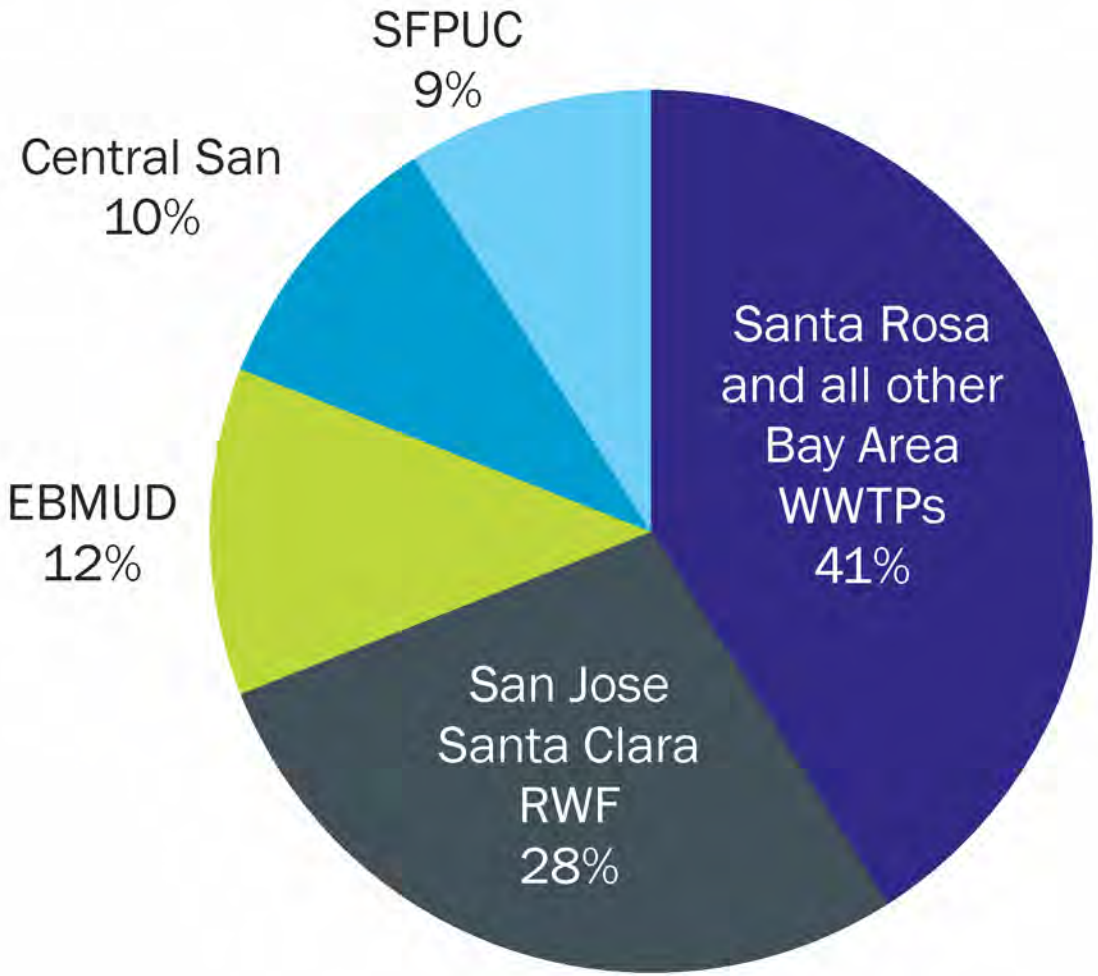
- For soil blenders and landscape suppliers, must be Class A with a preference for dried products
- Biosolids service providers can assist in diversifying the existing program with less investment in upgrading the current solids process
- Producing Class A improves marketability and end-use options



Regional Considerations

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Biosolids Generation in the Bay Area





Impacts from Peer Utilities

- **~180,000 wet tons/year** managed by other utilities in landfills, mostly during wet season
- San Jose's RWF
  - **~122,000 wet tons/year** at startup
  - **61,000 wet tons/year** during wet season
- Like Santa Rosa, some utilities have begun accessing Lystek in wet weather season, along with Merced County land application for the shoulder season

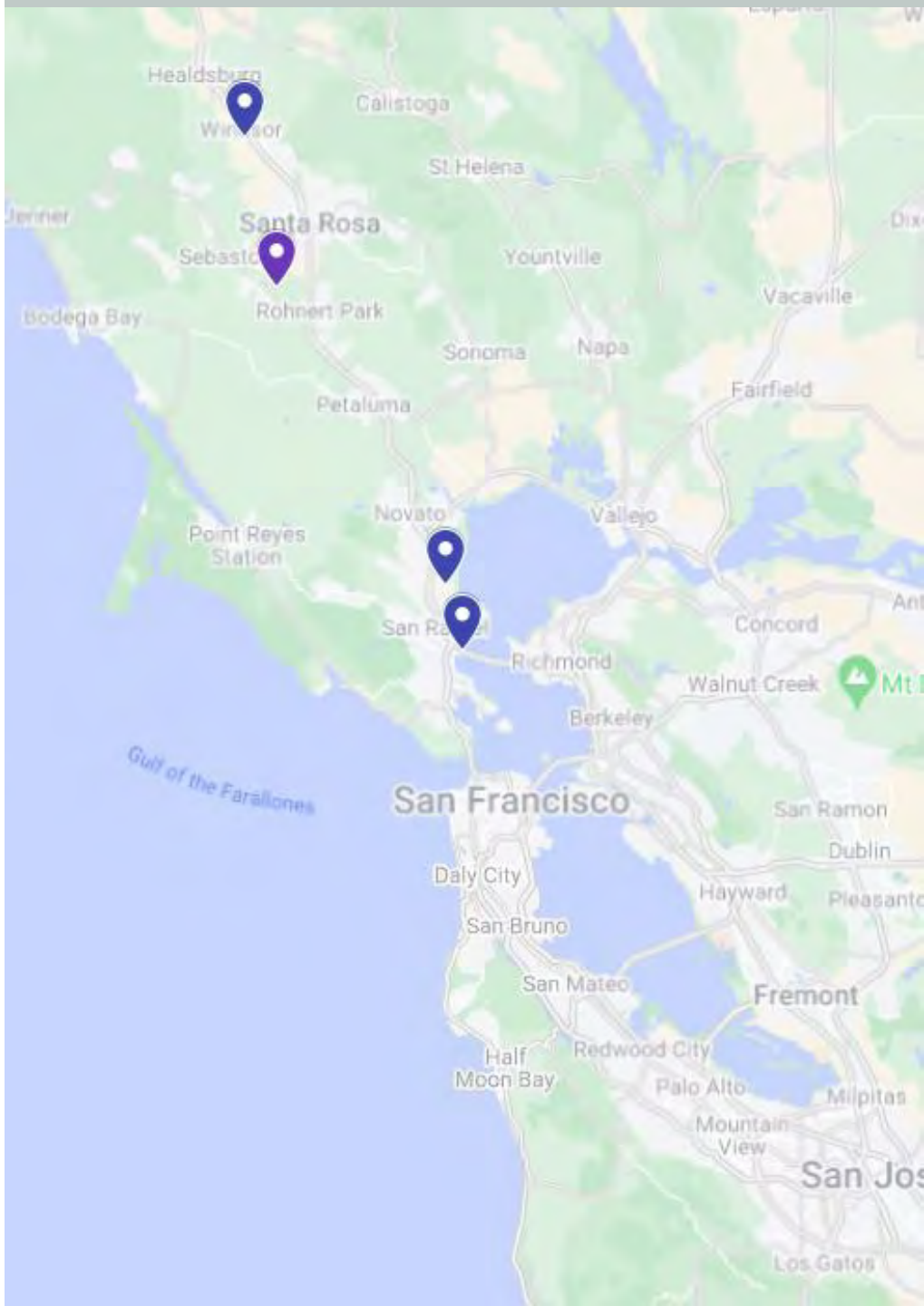
Shifts in Available Capacity

- Class B land application during wet weather will remain a challenge (larger agricultural counties likely to only provide minor capacity relief)
- Capacity shifting from CVC to Liberty Compost, where applicable; CVC becoming more of a Bay Area outlet
- San Jose RWF options likely to access existing capacity near term
- Denali and Synagro projects in development would provide year-round solutions, if exercised



Regional Partnership Potential

- Las Gallinas
  - Pumping to DLD and performing a market assessment to be completed in July
  - Limited by organic hay, alternative milk demand
- CMSA
  - Land application in summer and Lystek contract
  - Interest in regional solution
  - Concerns about Redwood Landfill restrictions
- Windsor
  - Open storage ponds, **Class B land app**
  - 30% design for pyrolysis, spring 2025
  - Open and encouraging being a regional hub for biosolids disposal



Additional Considerations

- Flannery Associates, LLC in Solano County
- Community Soil Foundation
  - Community garden and farm
  - Youth education
  - Fire restoration
  - Requires Class A product
  - TAGRO-model



Takeaways from Regional Considerations

- There is and will continue to be strong competition for land in the Bay area.
- There is interest in a regional solution among smaller WWTPs but would require comprehensive coordination.



Conclusions and Takeaways

- Markets exist for
  1. Class B/Class A cake (agriculture) - Well-managed agricultural program
  2. Class A compost (regulatory) - Local partnerships and circular economy with a composted product
  3. Class A dried products (commercial) - High-end, commercial product with maximum outreach and acceptance potential
- Decision dependent on cost/benefit analysis and Santa Rosa values



What does Class A do for me?

Market	Class B Cake	Class A Cake	Class A Compost	Class A Dried Product
Agricultural land application	√	√	√	√
Lystek	√	×	×	×
Landfill	√	√	√	√
Hay/Pasture	√	√	√	√
Endangered Species Territory	×	√	√	√
Municipal Partnerships (SB 1383 Procurement)	×	×	√	×
Landscaping/ Landscaping Supply	×	×	√	√
Soil Blenders	×	√	√	√
Composters/Biosolids Service Providers	√	√	×	√
Community Outreach	×	×	√	√

Current table reflects which products are appropriate for which market and does not reflect financial advisability.



Biosolids Management Strategic Plan

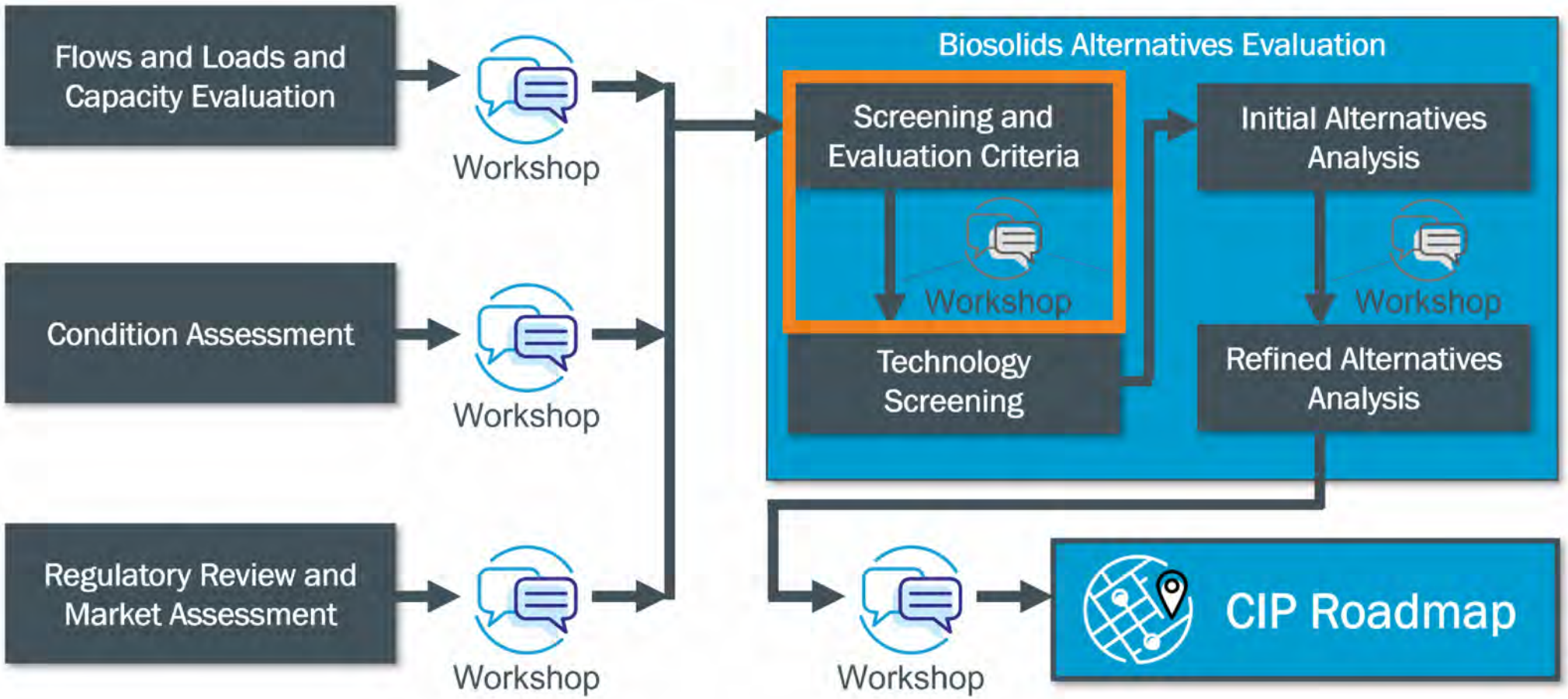
Screening and Evaluation Criteria

April 24, 2023

Goals and Objectives

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Biosolids Management Strategic Plan



Questions for Today

1) What determines a fatal flaw for technology considered at the Laguna Treatment Plant?

- How important is maintaining current staffing level, ease of operations, and qualifications to operate and maintain equipment?
- How comfortable am I with emerging technologies?
- What risk factors do we consider for other major projects?

2) What non-economic evaluation criteria are important? What is the appropriate weight of each criterion?



What are Santa Rosa's Critical Success Factors?

- Address aging solids handling assets
- Ensure system is O&M friendly; easy to own
- Improve regulatory and market resiliency
- Flexibility to meet SB 1383
- Comply with City Ordinances
- Non-ironic solutions
- Others?

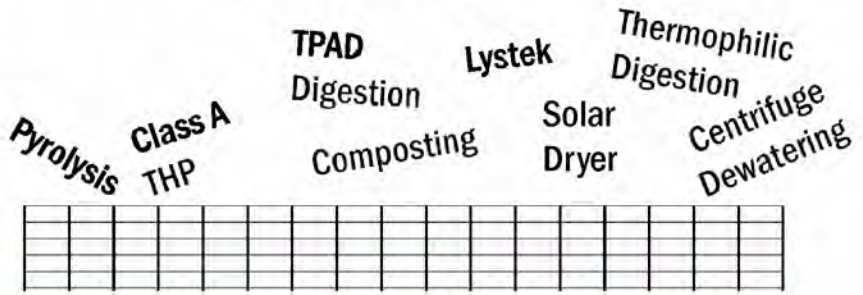
Fatal Flaw Screening Criteria

Brown AND Caldwell

Screening Process

Technologies

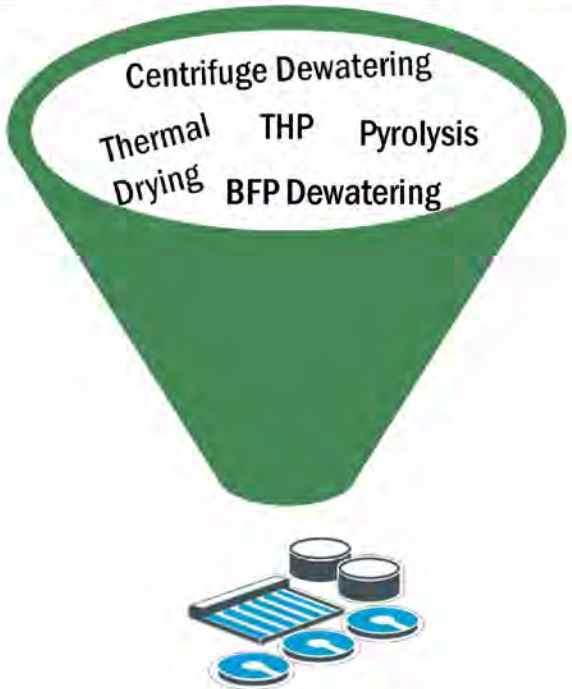
Fatal Flaw Screening
(Pass/Fail)



Evaluation Process

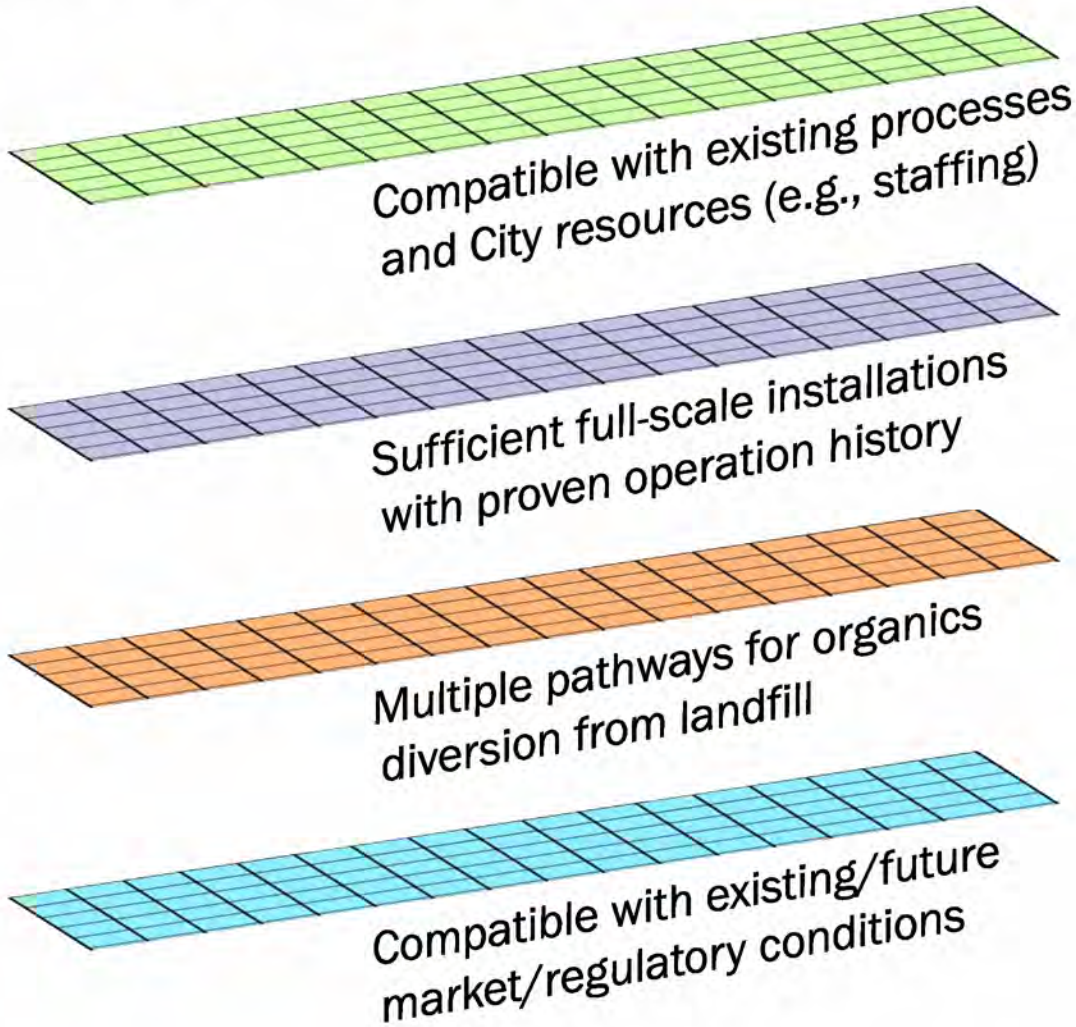
Initial Evaluation
(Quantitative)

Refined Evaluation
(Quantitative and
Qualitative)



Draft Fatal Flaw Screening Criteria Summary

- Plant Compatibility
- Established/Mature
- Diversify Santa Rosa's biosolids management towards beneficial use
- Program reliability



Established/Mature Criteria (Example for Discussion)

Operational History:

- Minimum of 5 reference installations currently operating worldwide with a successful operational history of at least 5 years
- 1 installation must have 5 years or more of consecutive operation
- 2 installations must be operating in North America

Vendor Experience:

- Minimum of 1 vendor/manufacturer that has installed or constructed 3 facilities in North America

To Scale:

- Reference installations treat at least 70 percent municipal wastewater solids
- Reference facilities handle a minimum of 10 mgd influent flow or 5 tons TS/d

Draft Non-Economic Evaluation Criteria

Brown AND Caldwell

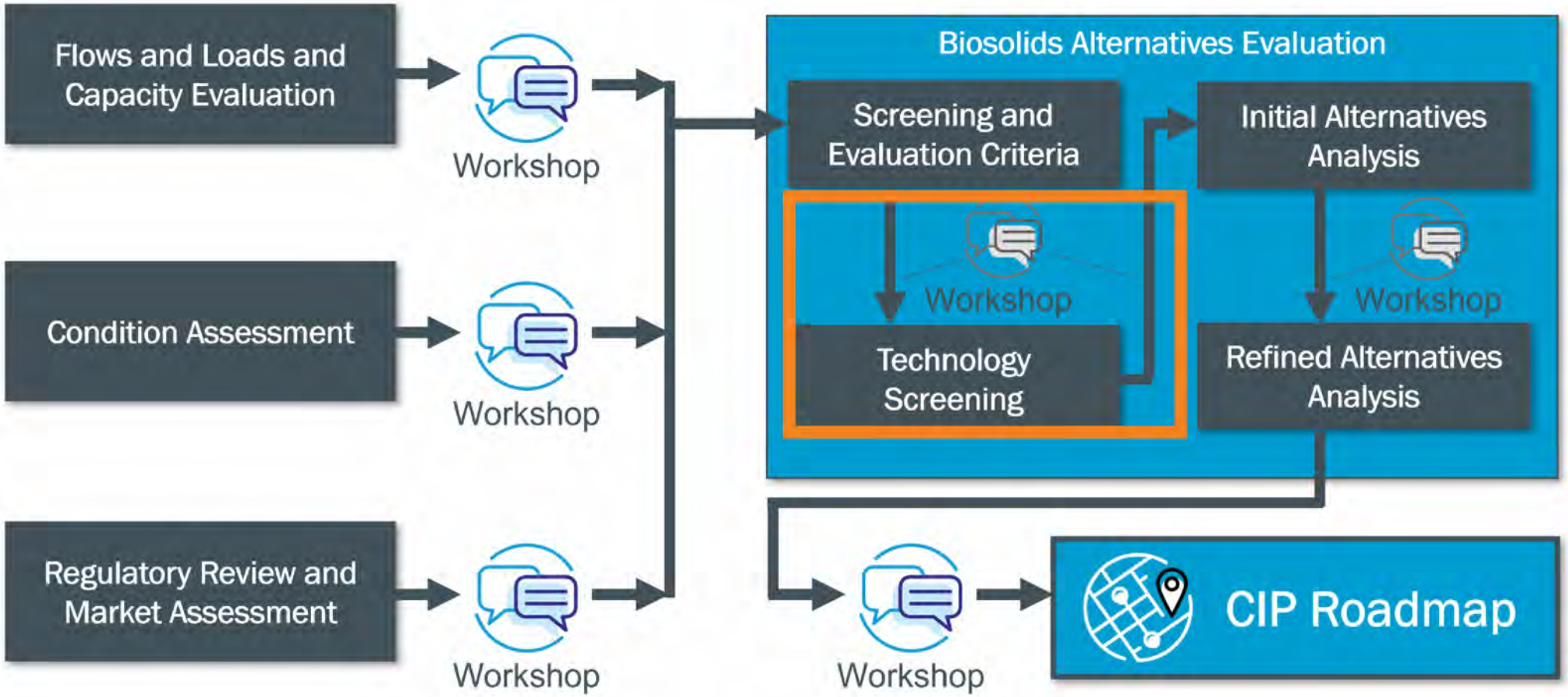
Non-Economic Criteria – Criteria & Example Matrix

Criteria	Weight %	Example Proven Technology	Example Non-Proven Tech.
Proven Technology	Pass/Fail	***Pass***	***Fail***
End Use Market Compatibility	~~25~~ 30	*20*	*N/A*
O&M Impacts	~~25~~ 20	*17*	*N/A*
Existing Site and Process Compatibility	25	*23*	*N/A*
Permitting and Regulatory Risks	~~10~~ 5	*5*	*N/A*
Safety Impacts	10	*8*	*N/A*
Environmental and Community Impacts	~~5~~ 10	*5*	*N/A*
	100	*78*	*N/A*

Looking Ahead
Technologies for Consideration

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Biosolids Management Strategic Plan



Technologies for Alternatives Analysis Screening

Thickening

- Gravity Belt Thickener
- Gravity Thickener
- Dissolved Air Floatation
- Belt Filter Press
- Centrifuge

Hydrolysis

- Thermal Hydrolysis Process (THP)
- Thermal-chemical Hydrolysis

Thermal

- Incineration
- Pyrolysis / Gasification

Digestion

- Mesophilic Anaerobic Digestion (AD)
- Thermophilic AD
- Temperature-Phased Anaerobic Digestion (TPAD)
- Autothermal Thermophilic AD
- Acid/Methane Phase AD

Biogas Utilization

- Engines
- Renewable Natural Gas
- Micro-turbines
- Turbines

Dewatering

- Centrifuges
- Belt Filter Press
- Screw Press
- Rotary Drum Press

Post-Digestion

- Drying Beds
- Solar Drying
- Thermal Drying
- Composting
- Third Party Operations

Discussion / Action Items

Brown AND Caldwell



Biosolids Management Strategic Plan

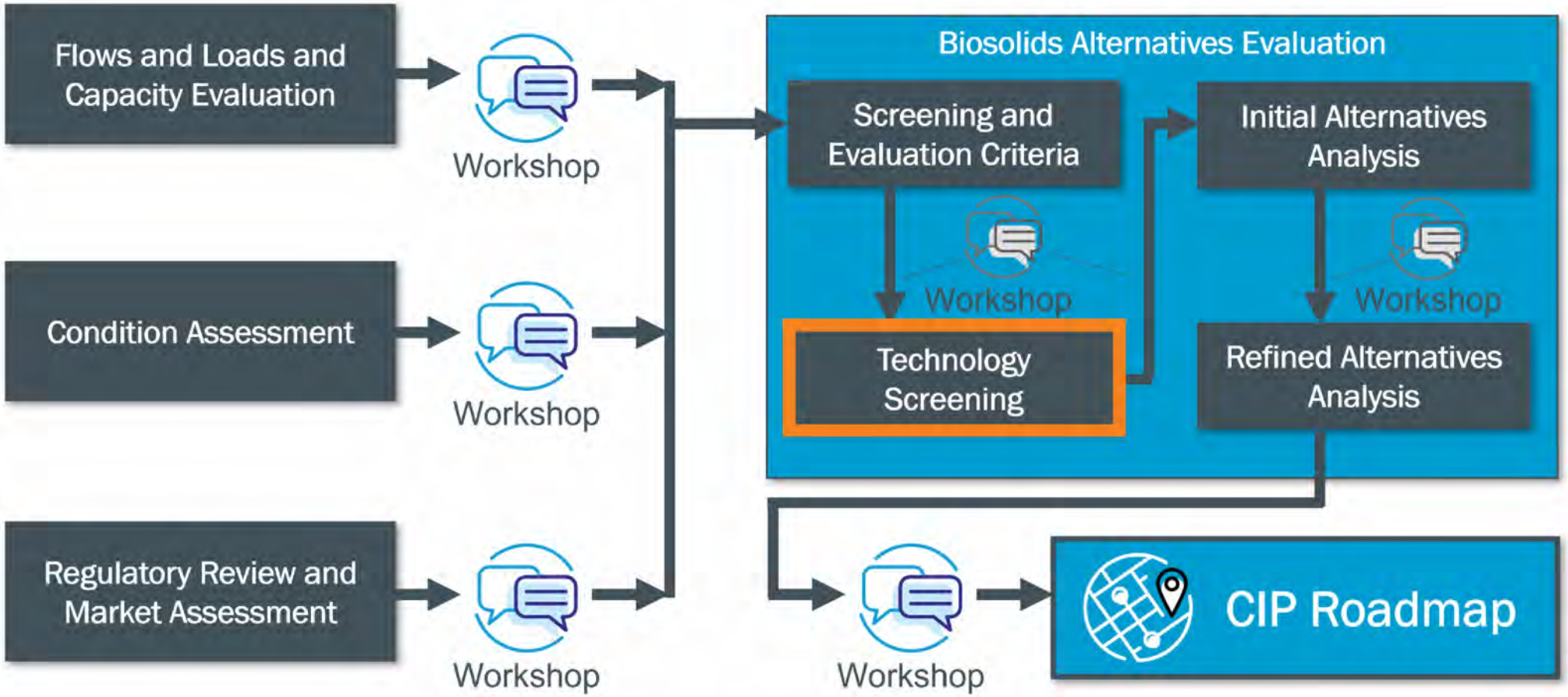
Screening Workshop

May 25, 2023

Agenda

- Introduction to Technology Screening
- Technology Overview
- Preliminary Screening Results
- Preliminary Alternatives Review
- Questions/Discussion

Biosolids Management Strategic Plan



Introduction to Technology Screening

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What are Santa Rosa's Critical Success Factors?

- Address aging solids handling assets
- Ensure system is O&M friendly; easy to own
- Improve regulatory and market resiliency
- Flexibility to meet SB 1383
- Comply with City Ordinances
- Non-ironic solutions

Why is Screening Important?

- **Scope and schedule considerations**
  - Detailed evaluation of every possible approach would take too much time without providing additional benefits
- **Confirmation of all possible viable options**
  - Documenting and brainstorming all possibilities confirms there are not good options we missed
- **Explanation for why some options were not evaluated**
  - Typing screening to planning objectives provides concrete reasoning why an option wasn't considered viable

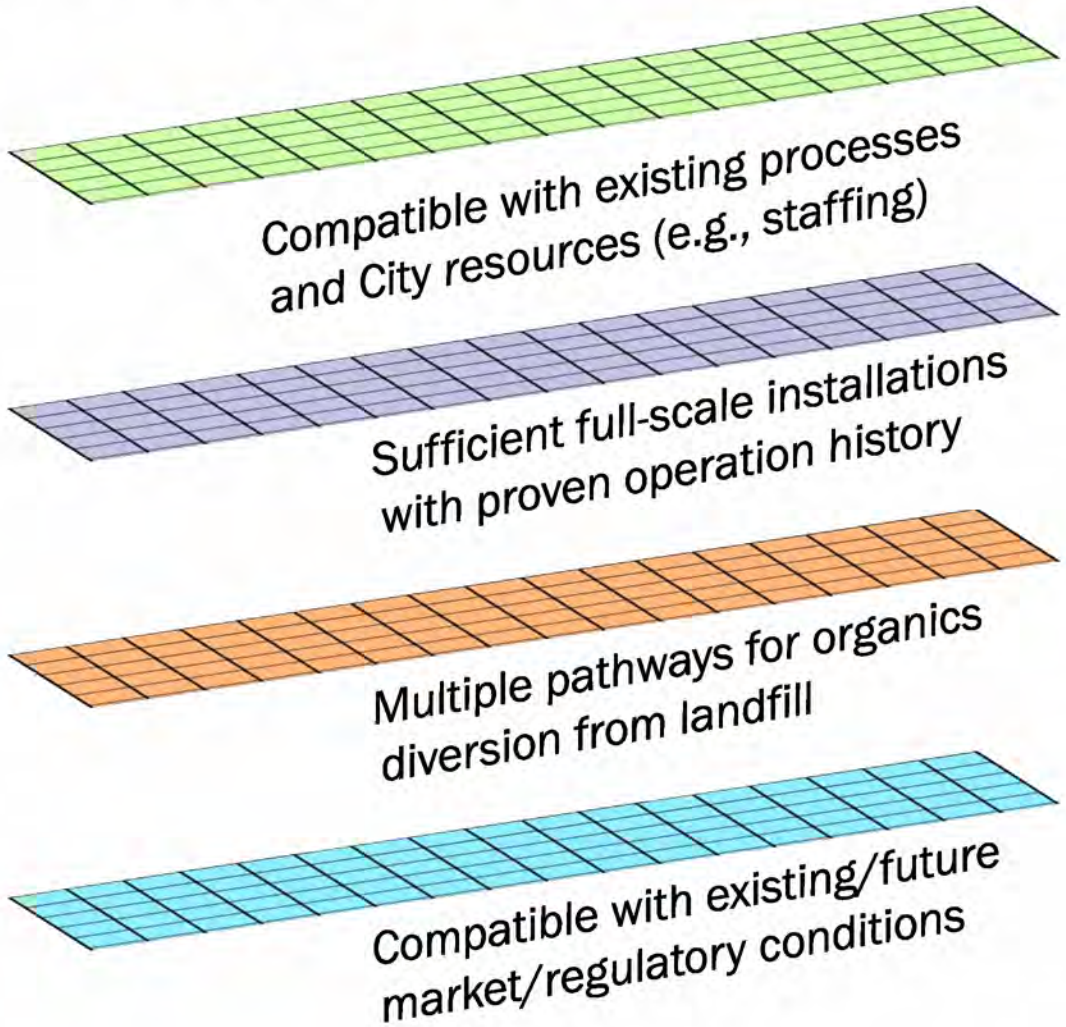
Screening Criteria versus Evaluation Criteria

- Today: Screen to Viable Opportunities
- Future: Evaluate viable opportunities to determine which is preferred

- Screening criteria ➔ What we must have
- Evaluation criteria ➔ What we prefer to have

Draft Fatal Flaw Screening Criteria Summary

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Established/Mature Criteria (Example for Discussion)

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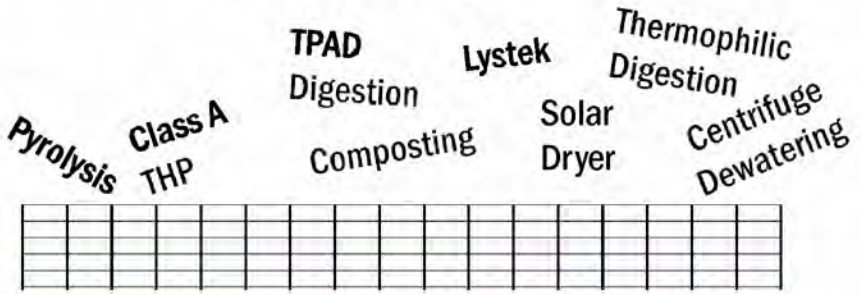
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Screening Process

Technologies

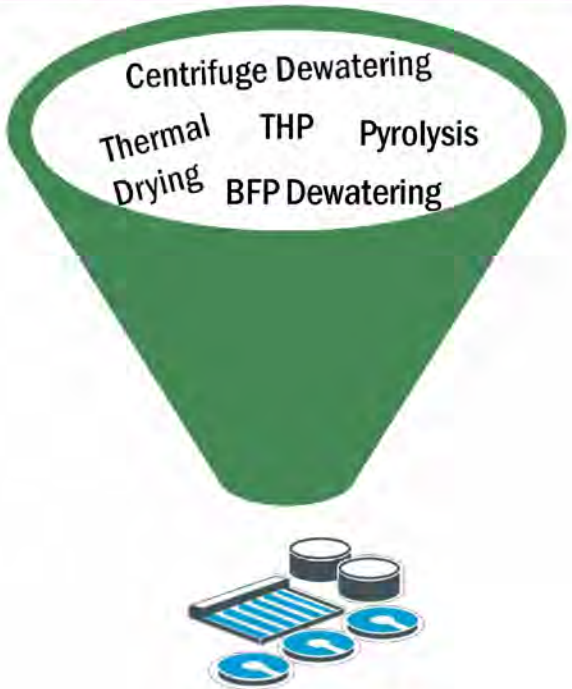
Fatal Flaw Screening
(Pass/Fail)



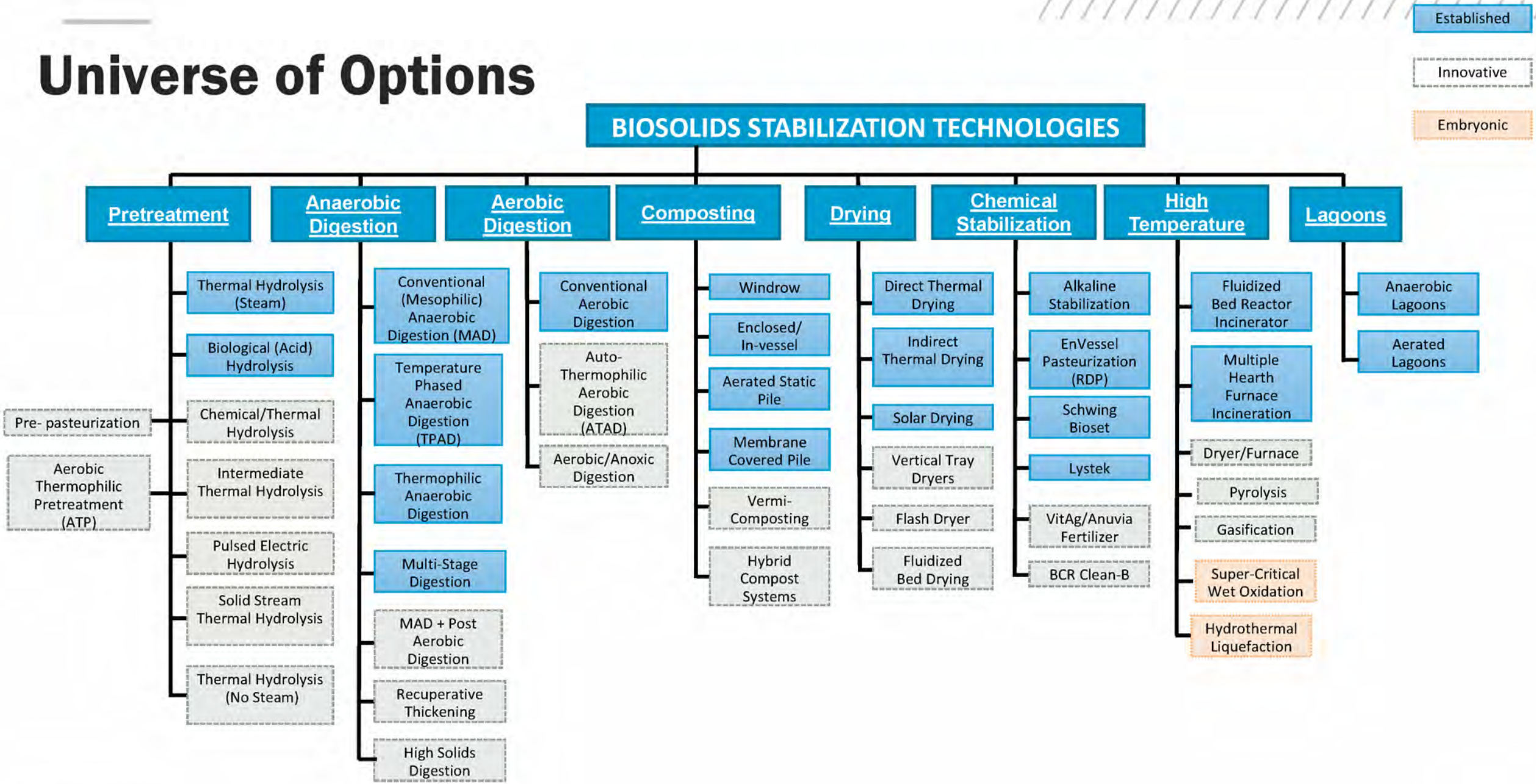
Evaluation Process

Initial Evaluation
(Quantitative)

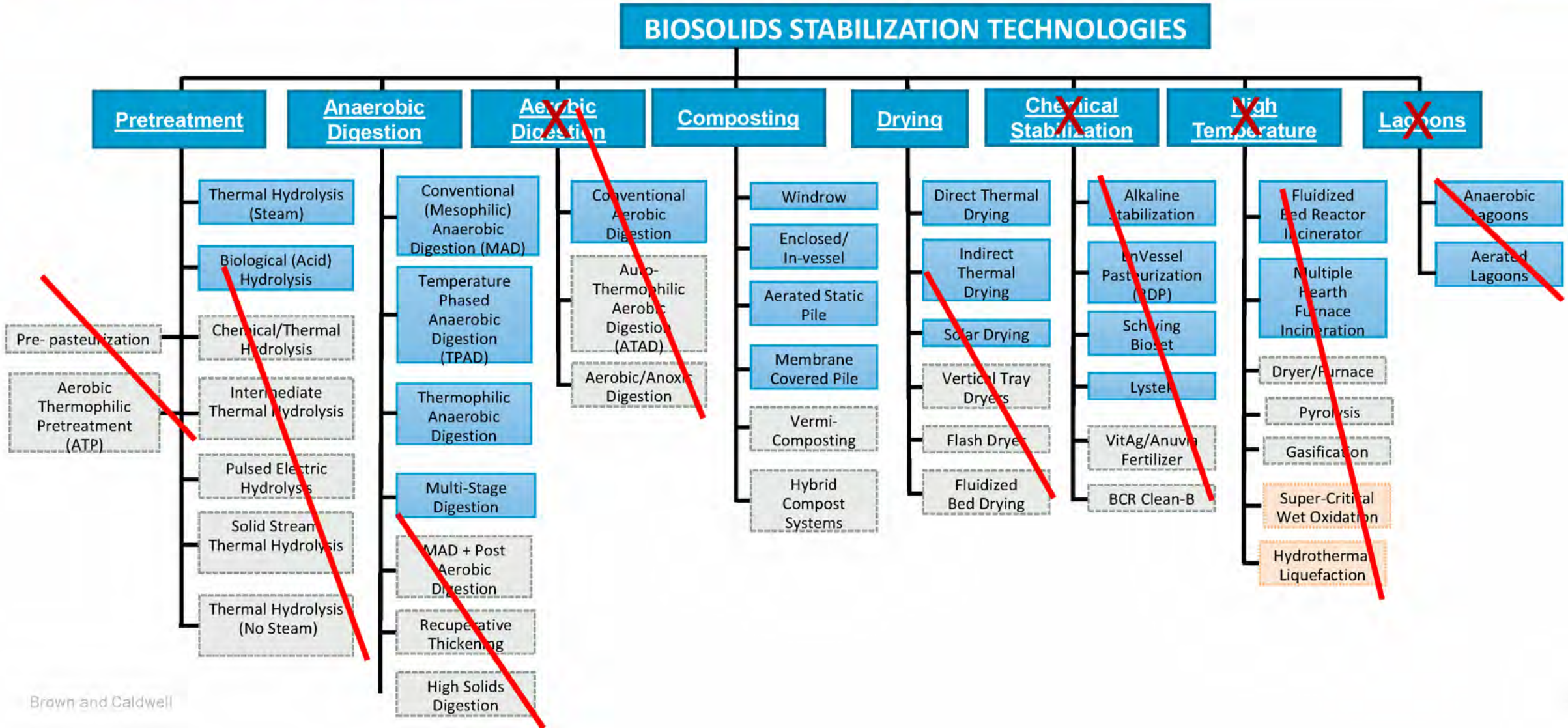
Refined Evaluation
(Quantitative and
Qualitative)



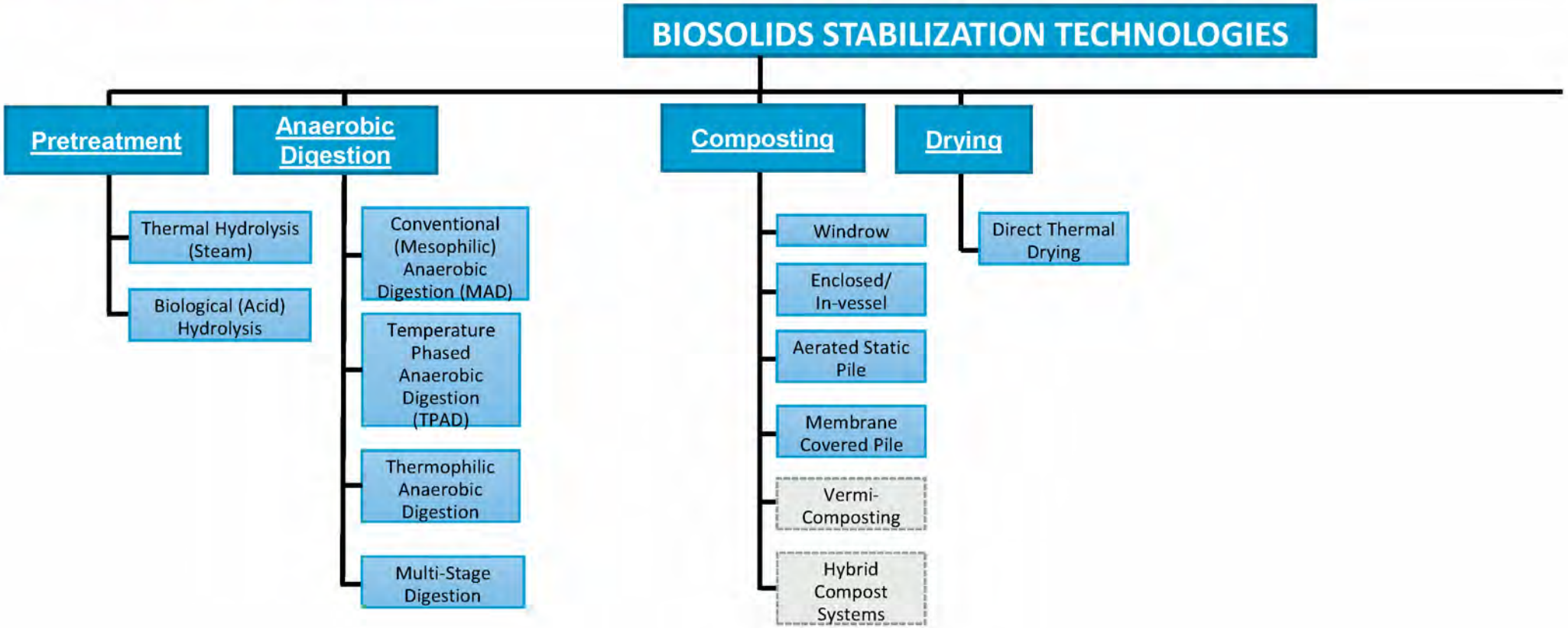
Universe of Options



EXAMPLE ONLY!!



EXAMPLE ONLY!!



Technology

Brown AND Caldwell

Thermal Hydrolysis Processing (THP)

The application of heat, pressure, and/or chemicals to promote the release and solubilization of particulate organic material. Class A product typical.

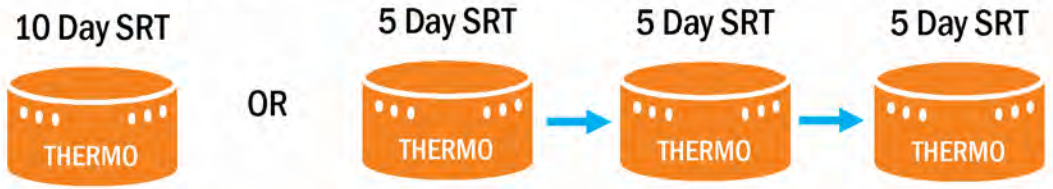




Advantages	Disadvantages
• Improves digester stability/foaming and dewatering consistency • Potential to produce Class A biosolids • Supports regionalization (cake receiving) • Potential increased digester gas production • Increased digestion capacity • Reduced truck traffic	• Requires additional mechanical equipment and asset investment • Requires steam boiler and operator certification • Increased side stream flows and loads, particularly ammonia

Thermophilic Anaerobic Digestion (TAD)

Anaerobic digestion that occurs between 120°F and 135°F. Class A capable.



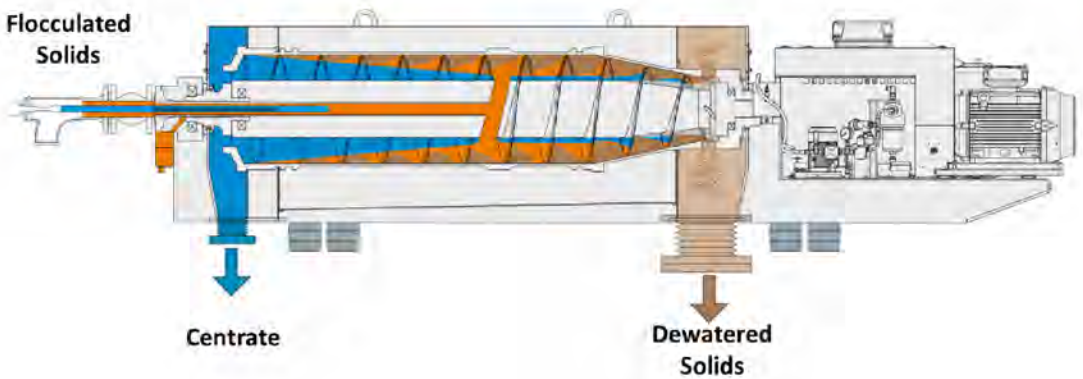


Annacis Island, British Columbia

Advantages	Disadvantages
• Well established technology • Potential for Class A biosolids (with batch tanks) • Fewer digester gas entrainment issues compared to MAD	• Concerns about struvite scaling • Higher heat demand for digester • Potential additional odor treatment • Requires changes to plant heating, gas treatment, and/or structural upgrades

Dewatering Centrifuges

Use centrifugal force via high rotation for continuous solid-liquid separation by accelerating the rate of settling and compressing the solids.

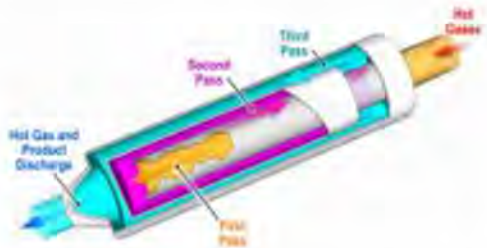


Advantages	Disadvantages
• High cake solids and high performance • High unit capacity per footprint • Fully enclosed	• High energy consumption • High noise and vibration • Off-site maintenance requirements • Grit can cause significant wearing

Parameters

Cake Solids: 19 – 27 %TS
Capture: >95%
Polymer Dose: 20– 30 lb-act/DT
Polymer Type: High MW (expensive)

Dryer Technology

	Belt	Indirect	Rotary Drum
			
Footprint	High	Low	Moderate
Typ. Heating Medium	Hot Water (194°F) Oil (~430°F) Process Air (~300°F)	Oil (430°F)	Process Air (~1,100°F)
O&M Complexity	Low - Moderate	Moderate	High
Typ. Product Quality	Light Granule (1 – 8mm)	Granule (0 – 15mm)	Dense Pellet (2 - 4mm)


Huber


Andritz


Andritz

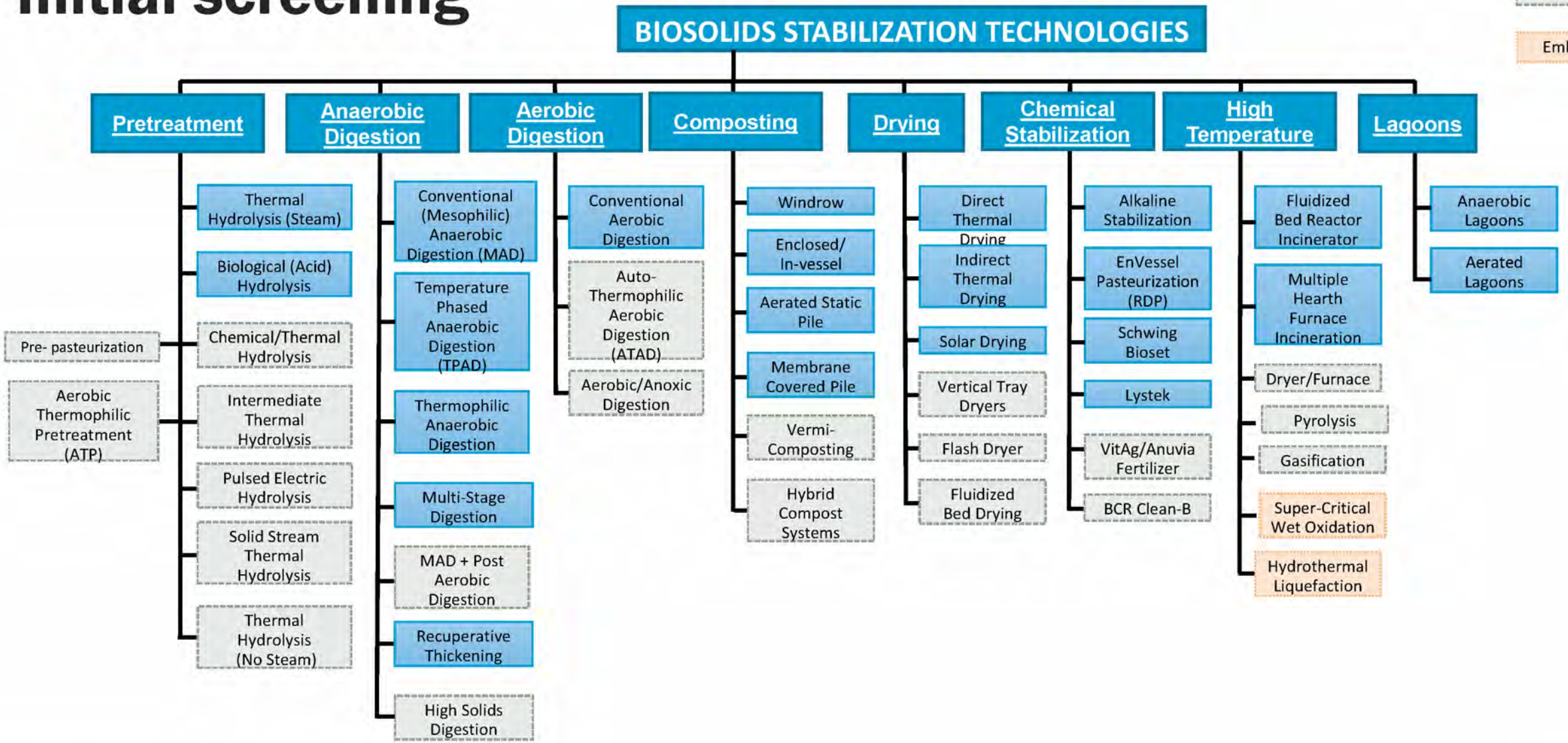
Preliminary Screening Results

Brown AND Caldwell

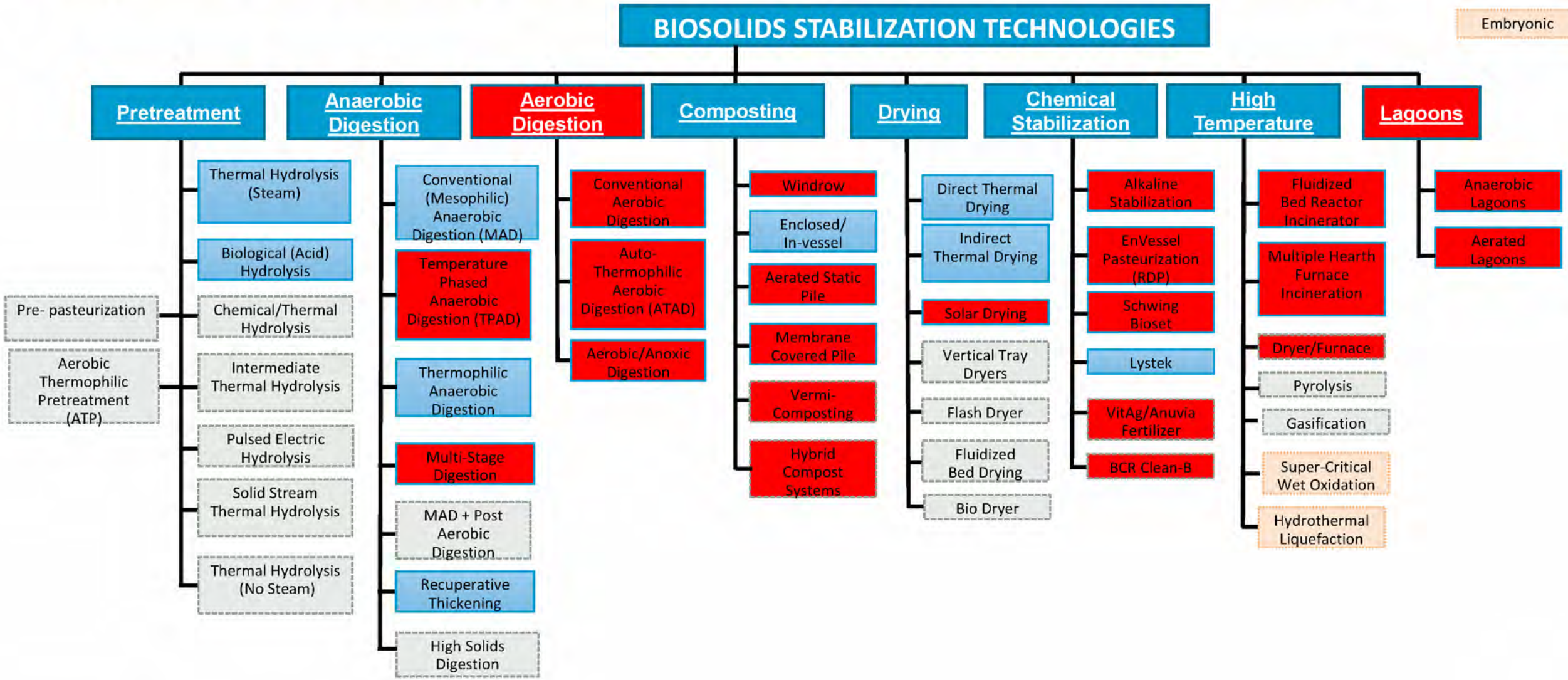
Initial screening – Solids End Use

Options	Utilizes Existing Infrastructure	Multiple Beneficial Use of Biosolids	Allows flexibility for future regs	Does not increase GHG emissions	Proven or emerging approach	Result
Class A fertilizer bulk sales	X	X	X	X	X	PASS
Agricultural land application	X	X	X	X	X	PASS
Lystek	X	X	X	X	X	PASS
Other land application (forestry, mine reclamation)	X	X	X	X	X	PASS
Dried fuel product	X	X	X	X	?	PASS?
Compost land application	X	X	?	?	X	PASS?
Biochar end uses	X	?	X	X	?	PASS?
Ash	X		X			FAIL
Landfill	X		X		X	FAIL

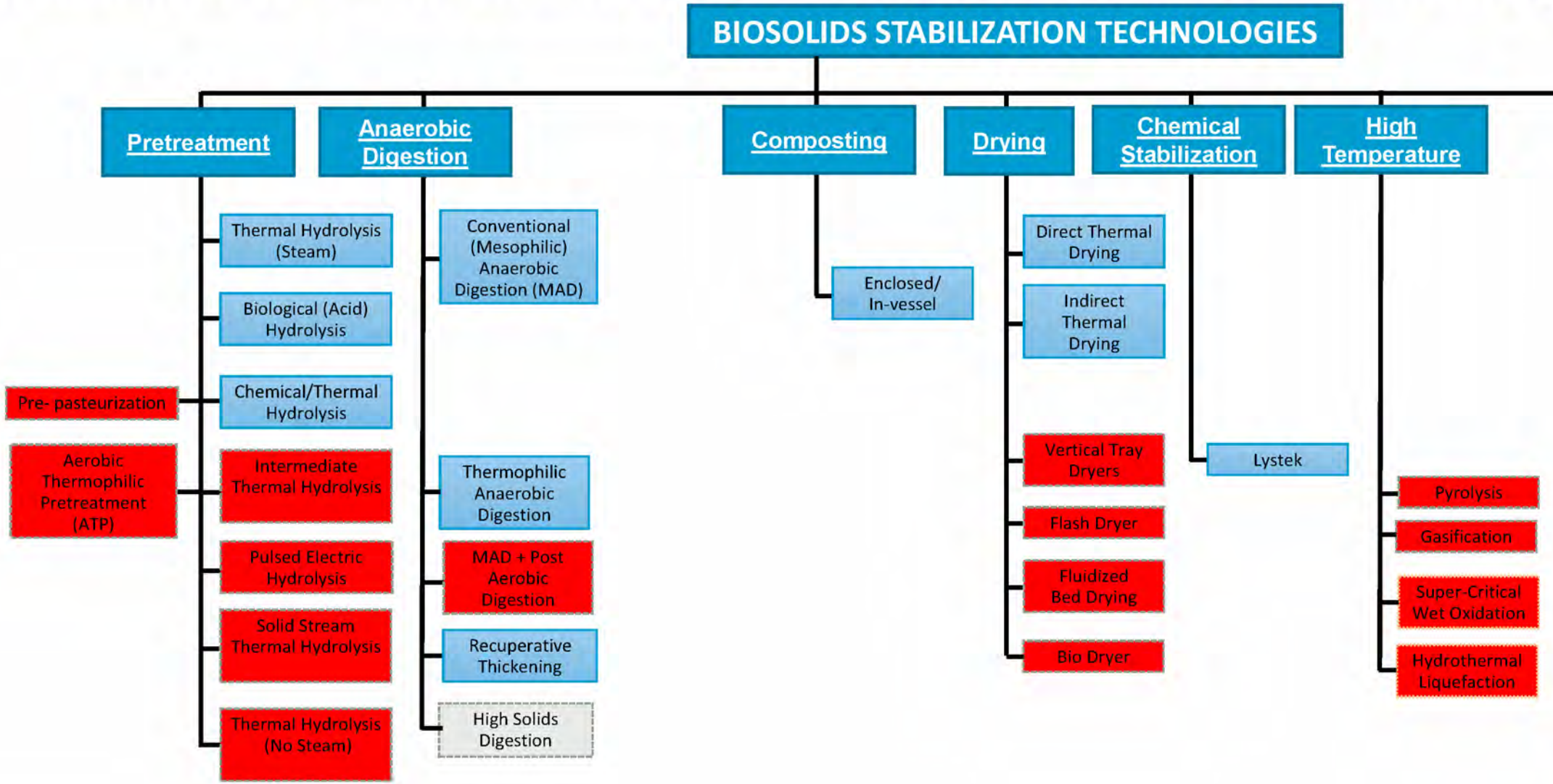
Initial screening



Compatible with existing processes and City resources (e.g., staffing)?



Sufficient full-scale installations with proven operation history?

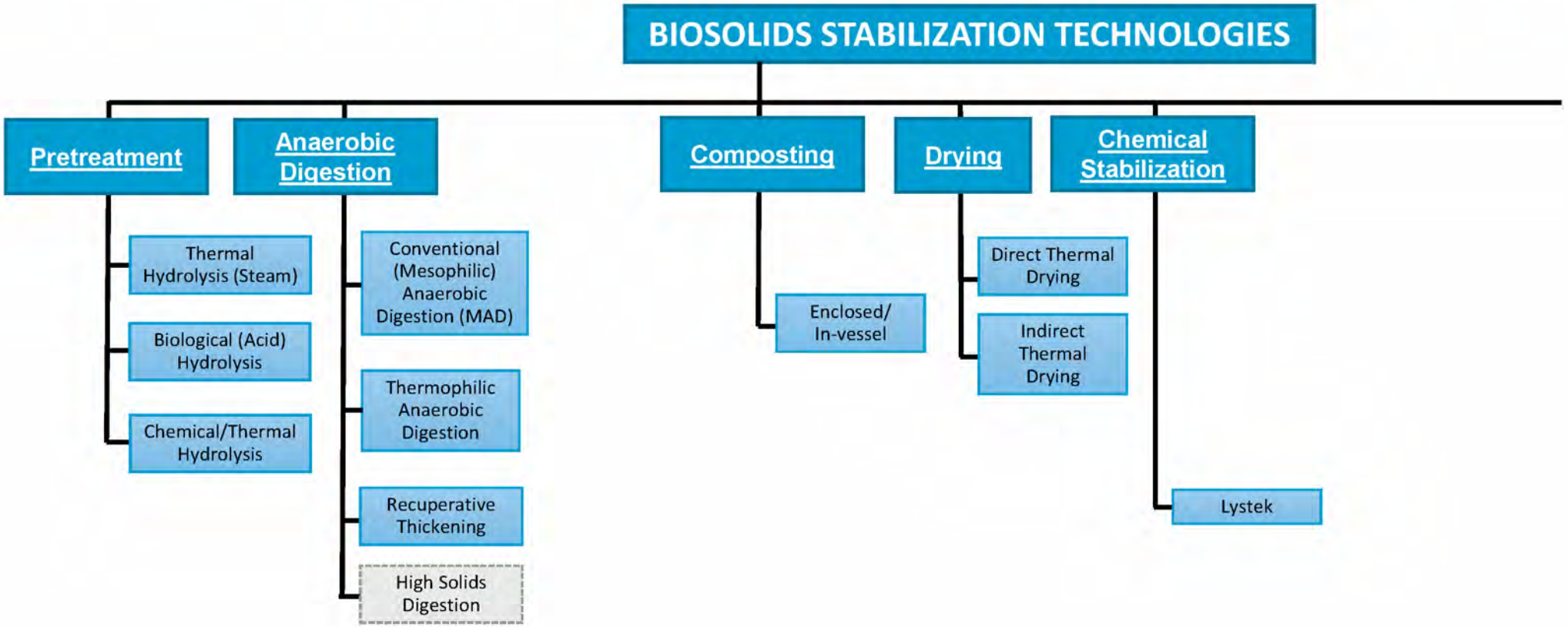


Multiple pathways for organics diversion from landfill?

Established

Innovative

Embryonic

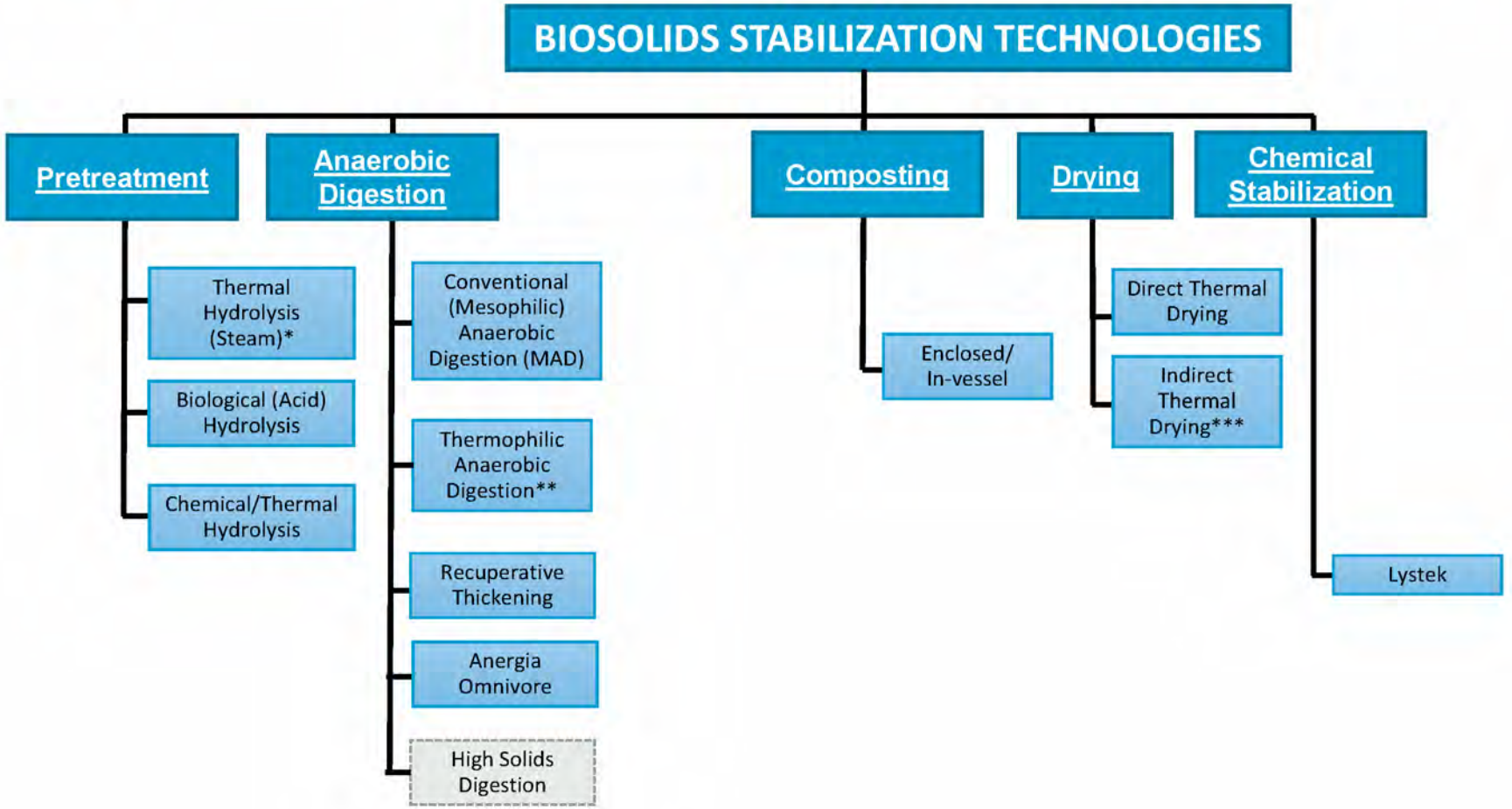


Compatible with existing/future market/regulatory conditions?

Established

Innovative

Embryonic

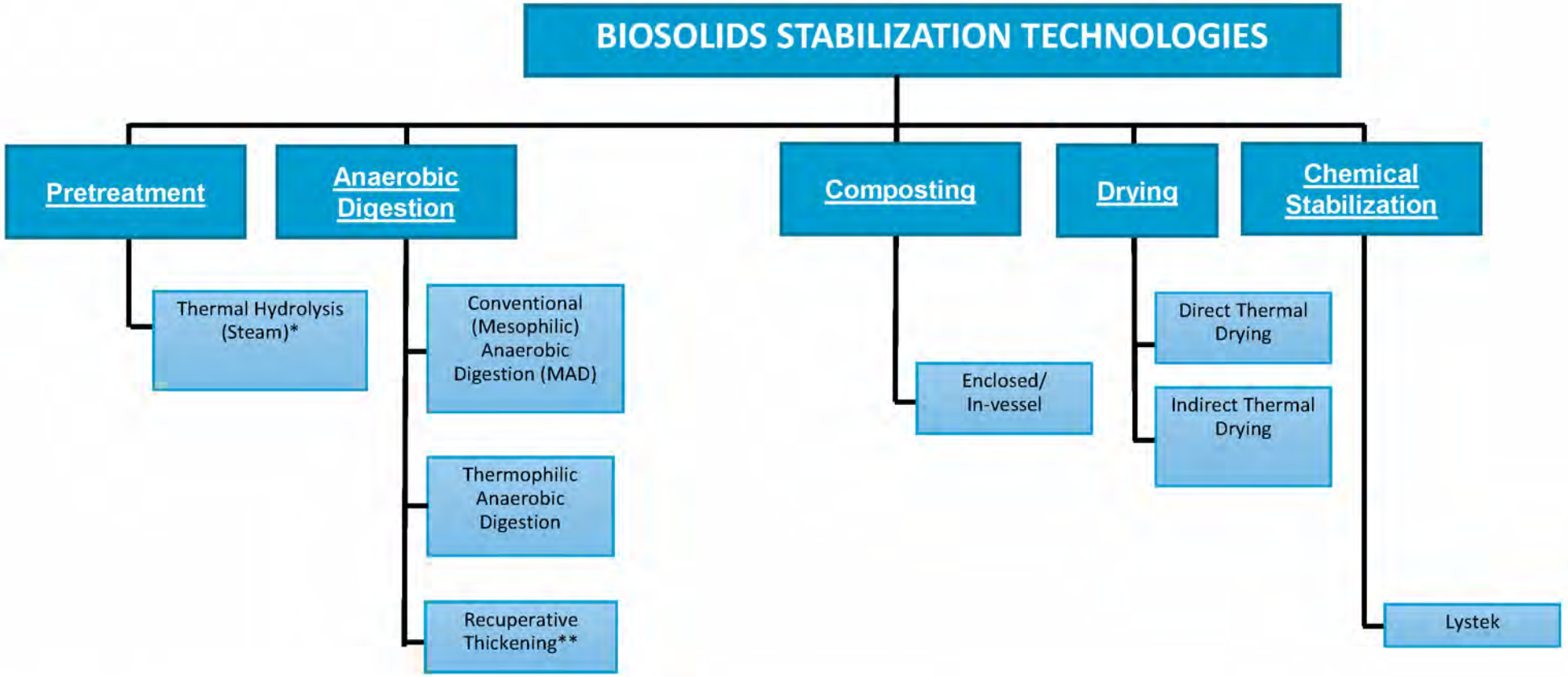


Final Technologies for Consideration

Established

Innovative

Embryonic



*Thermal Hydrolysis (Steam) representative of all thermal hydrolysis processes that passed the screening

** Recuperative Thickening representative of high solids digestion alternatives

Preliminary Alternatives

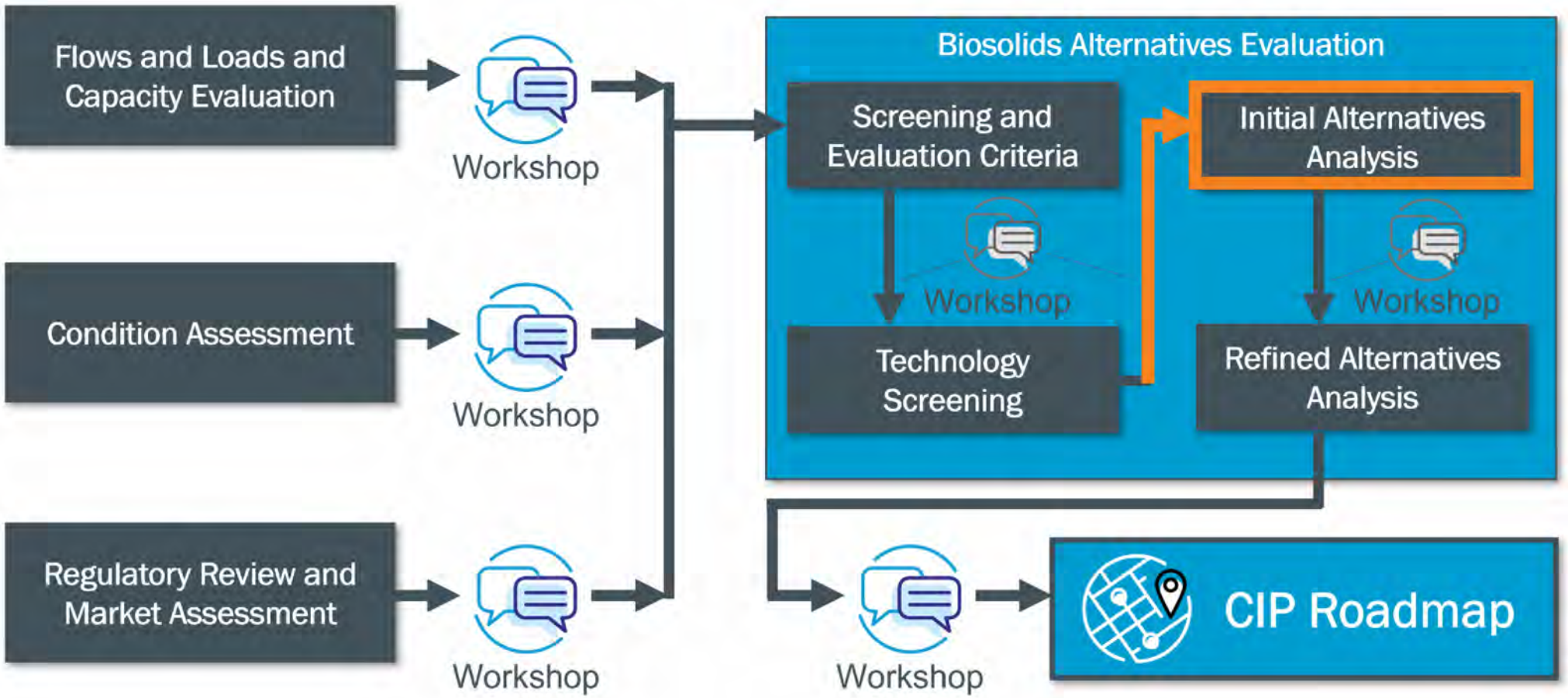
Brown AND Caldwell

Alternative Number	HSW	PreTreatment	Digestion	Dewatering *Belt Press 15% TS assumed unless otherwise stated*	Drying	Product
01	16,900 gpd	-	Meso		-	B
02	46,000 gpd	-	Meso		-	B
03	92,000 gpd	-	Meso		-	B
04	Add Food Waste	-	Meso		-	B
05	16,900 gpd	-	Meso		-	B/Compost
06	16,900 gpd	-	Meso	Centrifuges (25% TS)	-	B
07	16,900 gpd	-	Meso		Thrm Dry (50% TS)	A
08	16,900 gpd	-	Meso		Thrm Dry (90% TS)	A
09	16,900 gpd	-	Meso		-	A/Lystek
10	16,900 gpd	-	Meso (<15d SRT)		-	Compost/A
11	16,900 gpd	-	Thermo (<15d SRT)		-	Compost/A
12	16,900 gpd	-	Meso (<15d SRT)		Thrm Dry (90% TS)	A
13	16,900 gpd	-	High Solids Meso		-	B
14	16,900 gpd	THP	Meso		-	A
15	46,000 gpd	THP	Meso		-	A
16	92,000 gpd	THP	Meso		-	A
17	Add Food Waste	THP	Meso		-	A
18	16,900 gpd	THP	Meso		-	A/Compost
19	16,900 gpd	THP	Meso	Centrifuges (25% TS)	-	A

Looking Ahead

Brown AND Caldwell

Biosolids Management Strategic Plan Next Steps





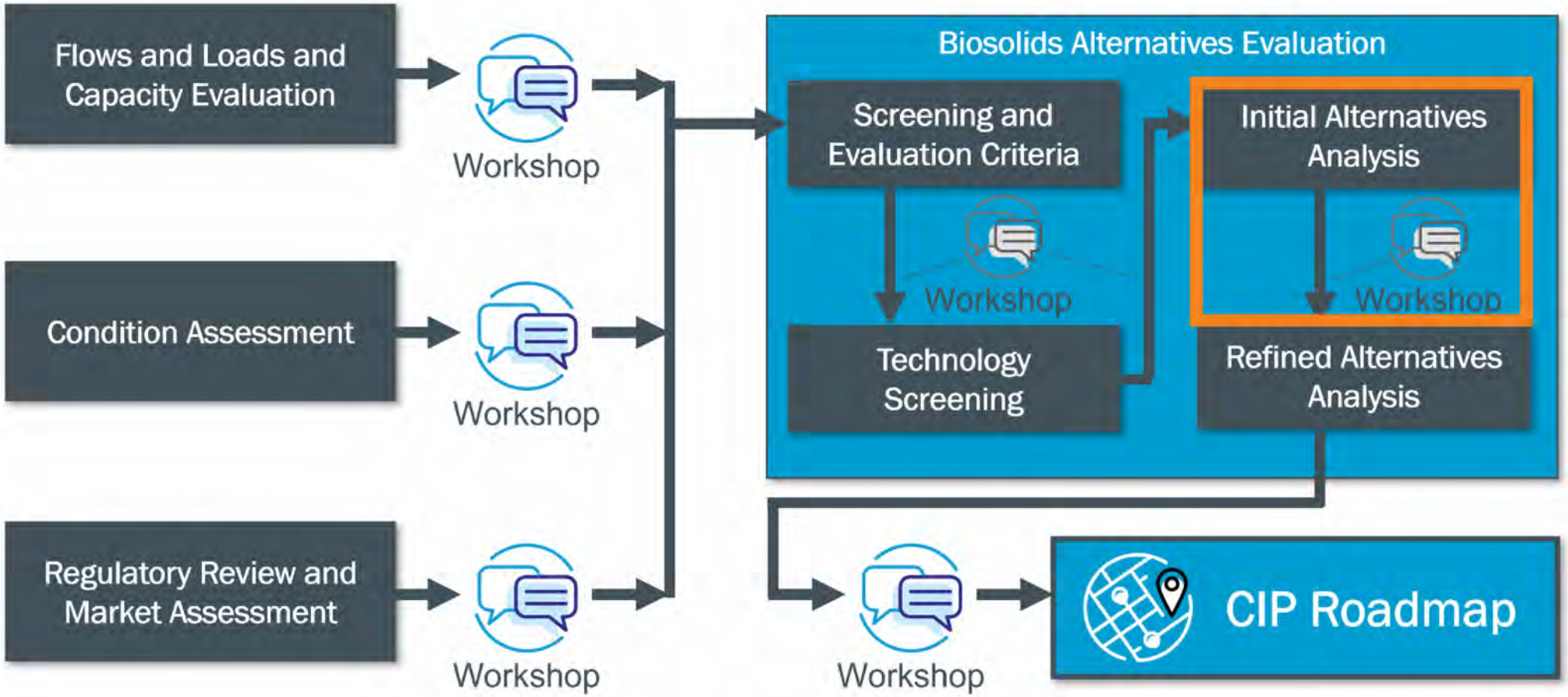
Biosolids Management Strategic Plan

Initial Alternatives Evaluation Workshop

July 6, 2023

City of Santa Rosa

Biosolids Management Strategic Plan





What are the goals of today's workshop?

- Discuss results from alternatives analysis
- Review energy use, O&M costs, construction costs, and benefits/risks
- Select 3 alternatives for detailed refinement

Agenda

- Review Alternatives
- Initial Alternatives Evaluation
  - Approach
  - Performance Predictions
  - Capital Costs, Operating Costs, & Net Present Value
  - Non-economic Evaluation
- Discussion & Next Steps
  - Identify 3 Alternatives for Refined Analysis

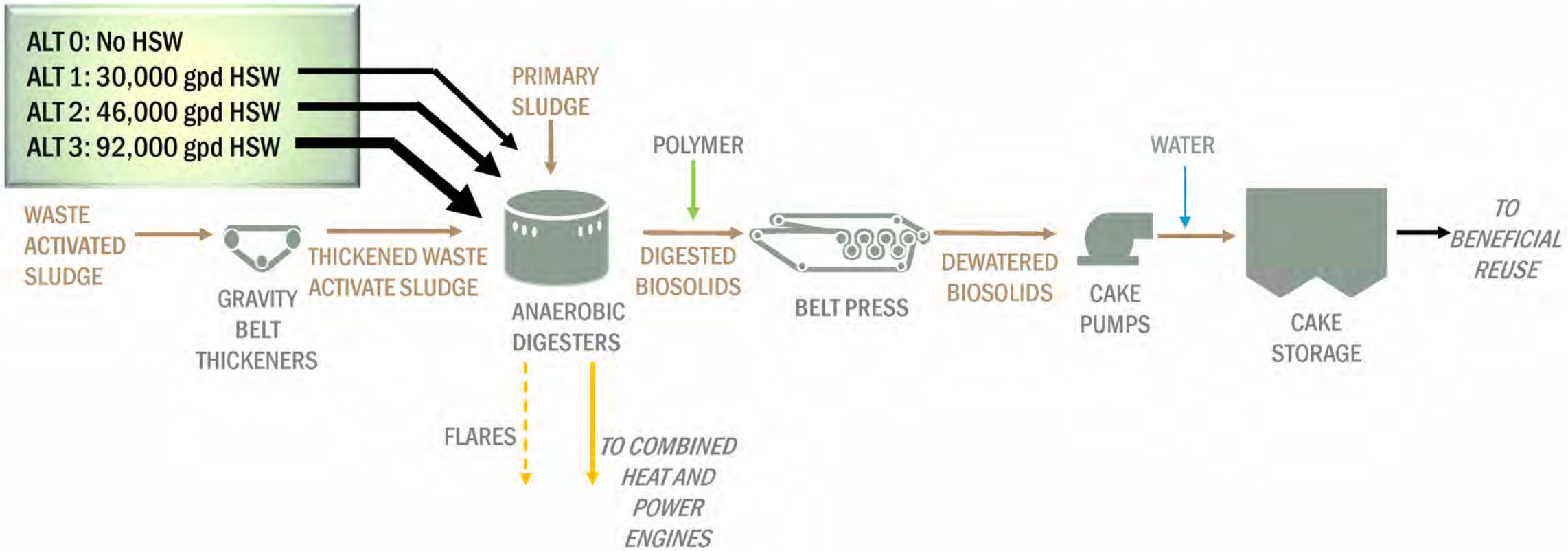
Review of Alternatives

Brown AND Caldwell

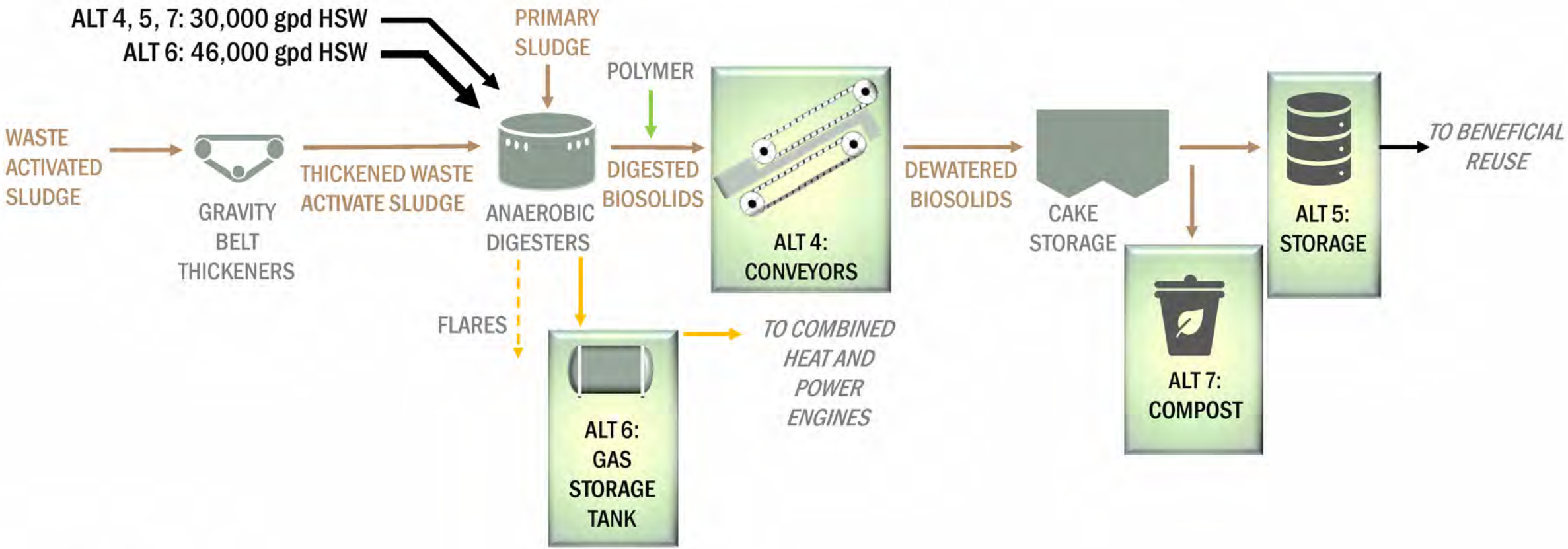
Review of Alternatives

Alt Number.	Alt Name	HSW[1]	PreTreatment	Digestion[2]	Dewatering[3] Belt Press (15% TS) assumed unless otherwise stated	Drying[4]	Conveyance Cake Pumping unless otherwise stated	Product[5]	Gas Storage
00	No HSW	0	-	Meso		-	-	B	
01	Status Quo	30,000 gpd	-	Meso		-		B	
02	Mid HSW-Status Quo	46,000 gpd	-	Meso		-		B	
03	High HSW-Status Quo	92,000 gpd	-	Meso		-		B	
04	Status Quo-Conveyors	30,000 gpd	-	Meso		-	Conveyors	B	
05	Status Quo-New Storage	30,000 gpd	-	Meso		-		B + New Storage	
06	Mid HSW-Status Quo-Gas Storage	46,000 gpd	-	Meso		-		B	Gas Storage
07	Status Quo-Compost	30,000 gpd	-	Meso		-		B + Compost	
08	Meso-Centrifuges-Conveyors	30,000 gpd	-	Meso	Centrifuges 25% TS	-	Conveyors	B	
09	High HSW-Meso-Centrifuges-Conveyors	92000 gpd	-	Meso	Centrifuges 25% TS	-	Conveyors	B	
10	Status Quo-ThrDry50%	30,000 gpd	-	Meso		ThrDry 50% TS		B	
11	Status Quo-ThrDry90%	30,000 gpd	-	Meso		ThrDry 90% TS		A	
12	Status Quo-Lystek	30,000 gpd	-	Meso		-		Lystek + A	
13	Thermo-12dSRT	30,000 gpd	-	Thermo (12d SRT)		-		B	
14	SubB Meso-ThrDry90%	30,000 gpd	-	Meso (12d SRT)		ThrDry 90% TS		A	
15	RecupThk-High Solids Meso	30,000 gpd	Recup Thk	High Solids Meso		-		B	
16	Status Quo-THP	30,000 gpd	THP	Meso		-	Conveyors	B	
17	Mid HSW-THP	46,000 gpd	THP	Meso		-	Conveyors	B	
18	High HSW-THP	92,000 gpd	THP	Meso		-	Conveyors	B	
19	THP-Centrifuges-Conveyors	30,000 gpd	THP	Meso	Centrifuges 25% TS	-	Conveyors	B	

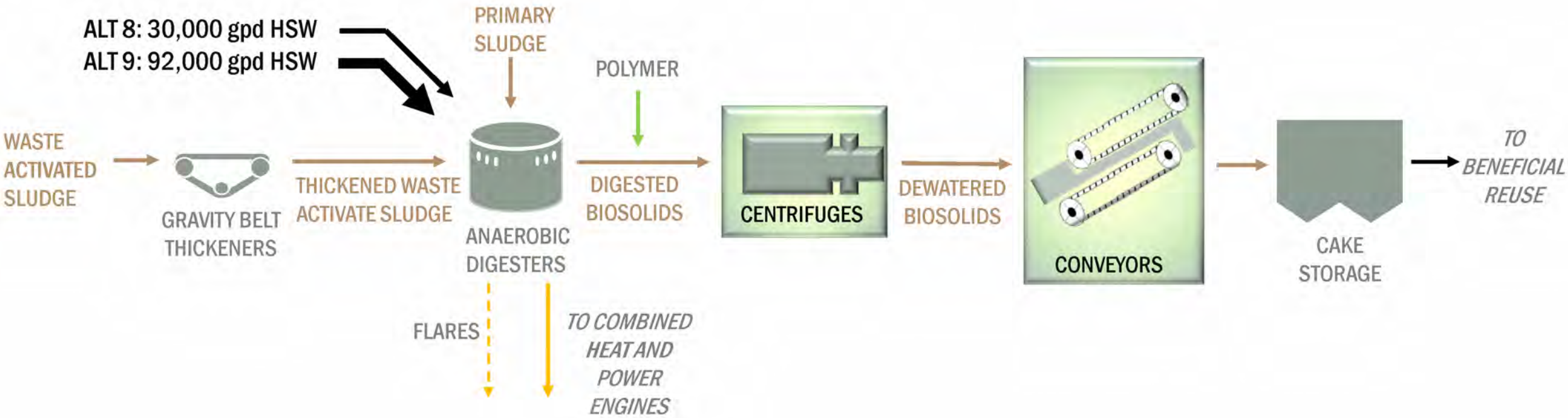
Goal: Expanding HSW Program with Status Quo



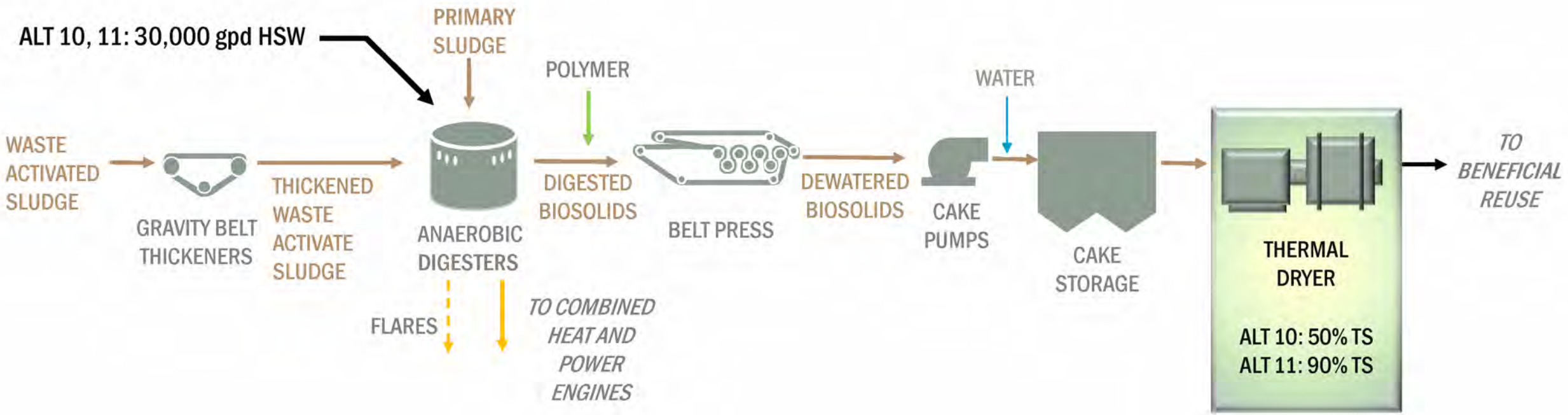
Goal: Status Quo Optimization



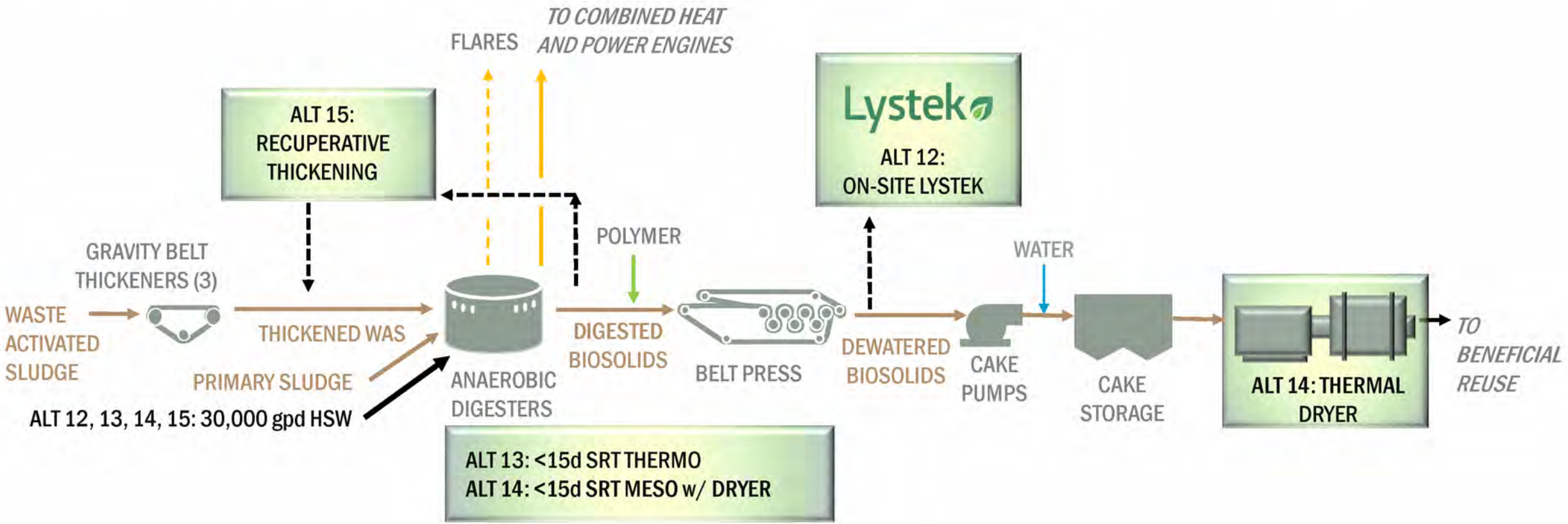
Goal: Drier Cake Product
Centrifuges (25% TS)



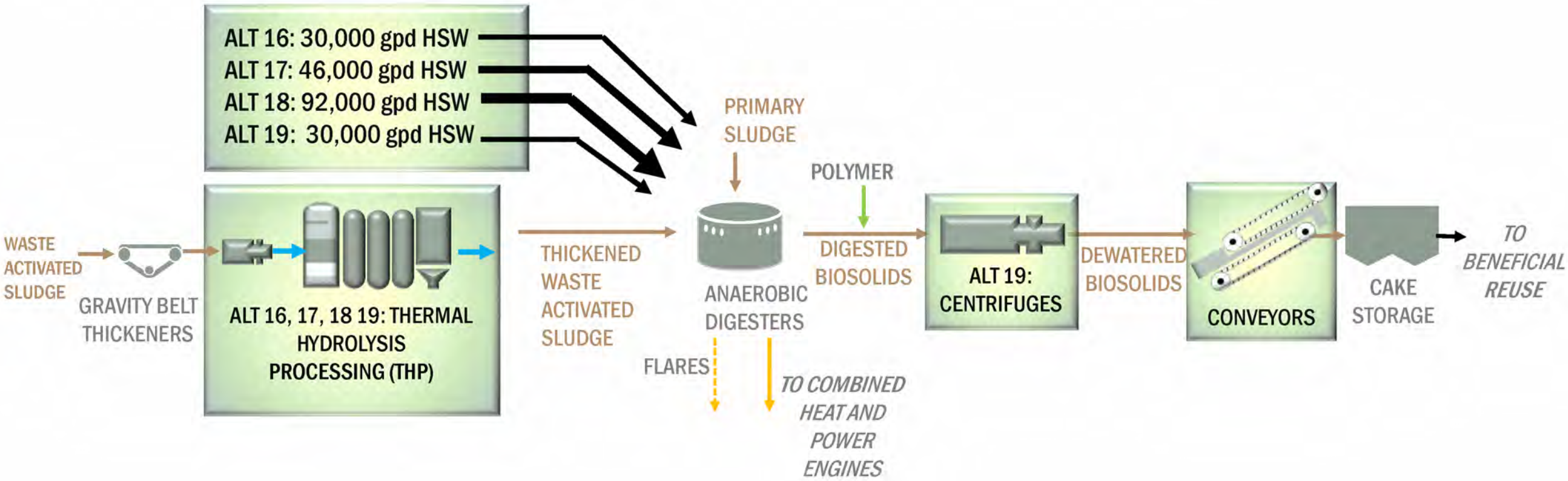
Goal: Significantly Drier Cake Product
Thermal Dryer (50-90% TS)



Goal: Address Digester Capacity with <15d SRT Options



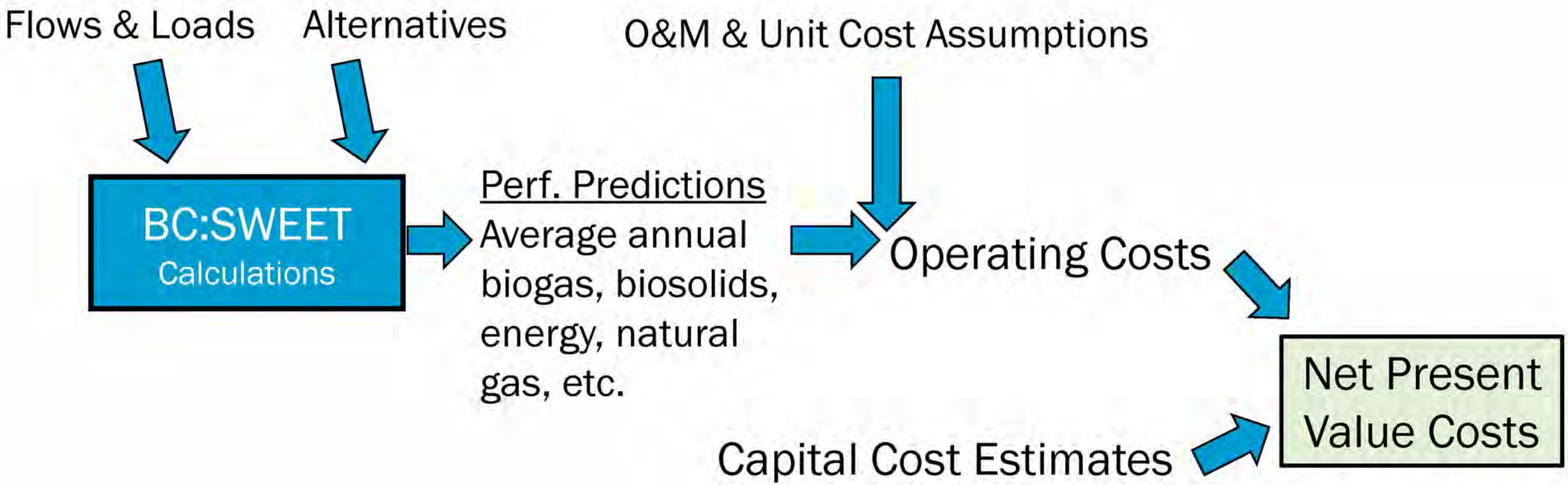
Goal: Address Digester Capacity with THP



Evaluation Approach

Brown AND Caldwell

Initial Alternatives Evaluation Approach:
BC's Solids-Water-Energy Evaluation Tool (BC:SWEET)

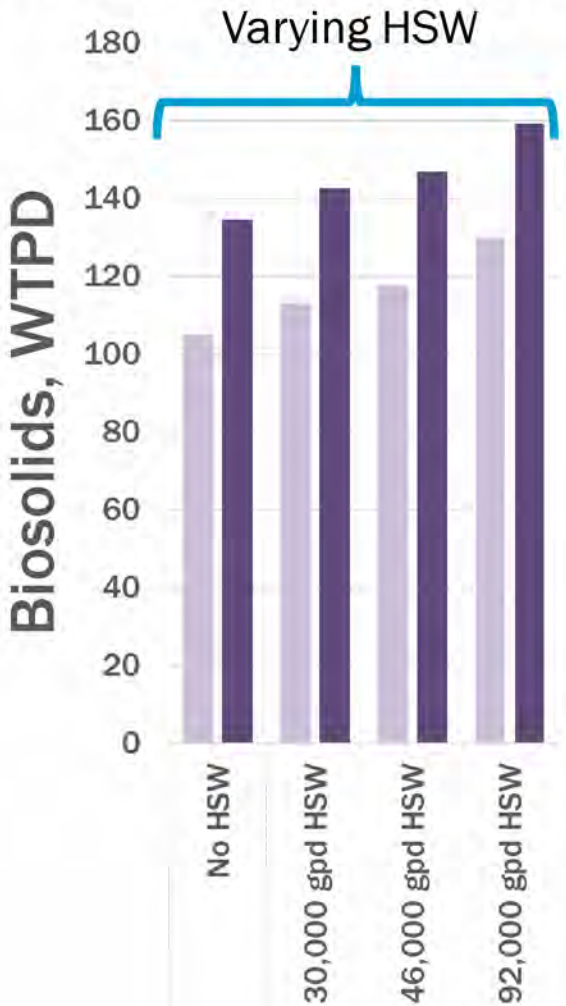


Comparison of Process Performance Predictions

Brown AND Caldwell

Comparison of biosolids production

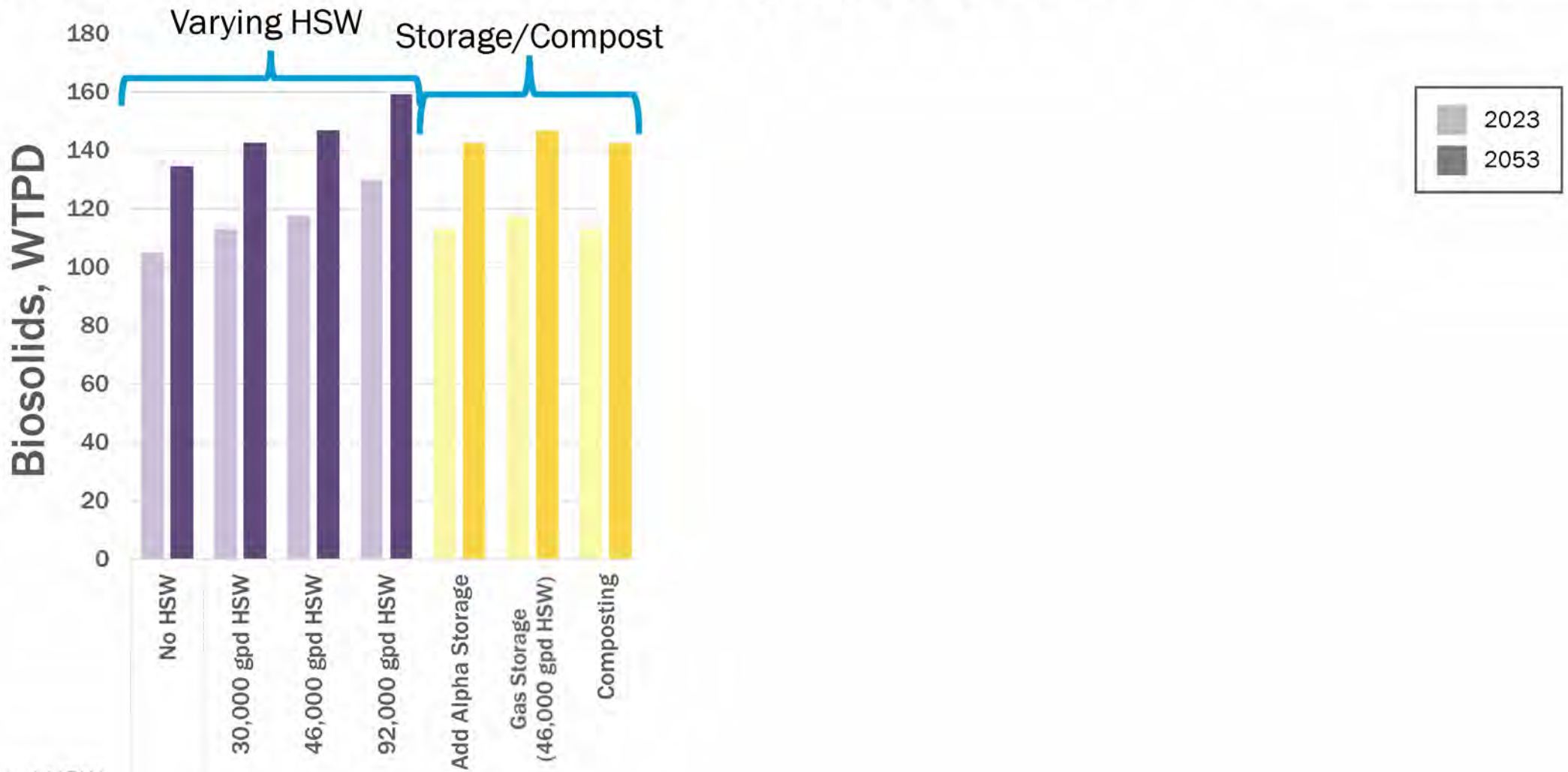
- HSW = High Strength Waste
- HRT = Hydraulic Residence Time
- THP = Thermal hydrolysis process
- WTPD = Wet Tons per Day





Comparison of biosolids production

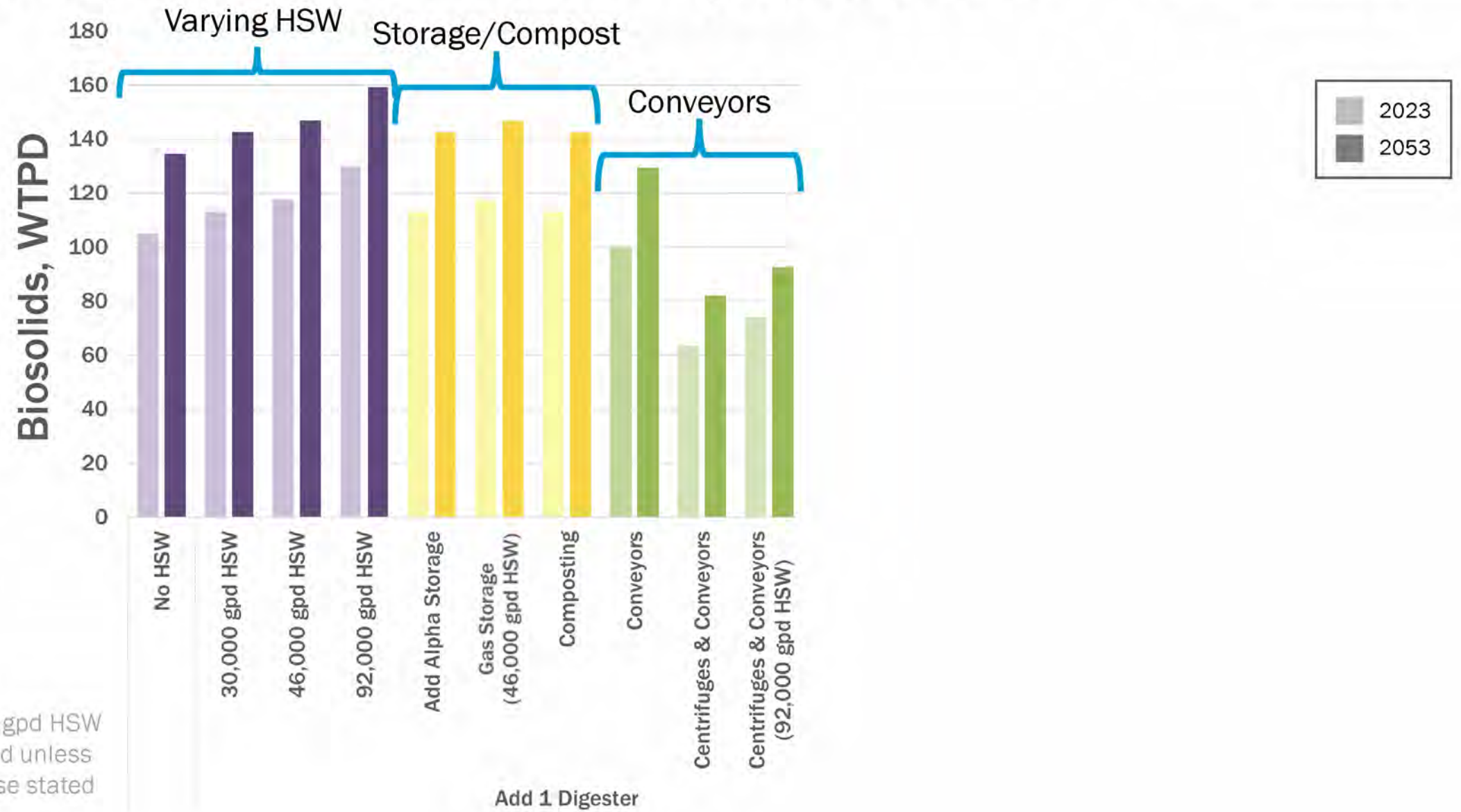
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NOTE:
30,000 gpd HSW assumed unless otherwise stated

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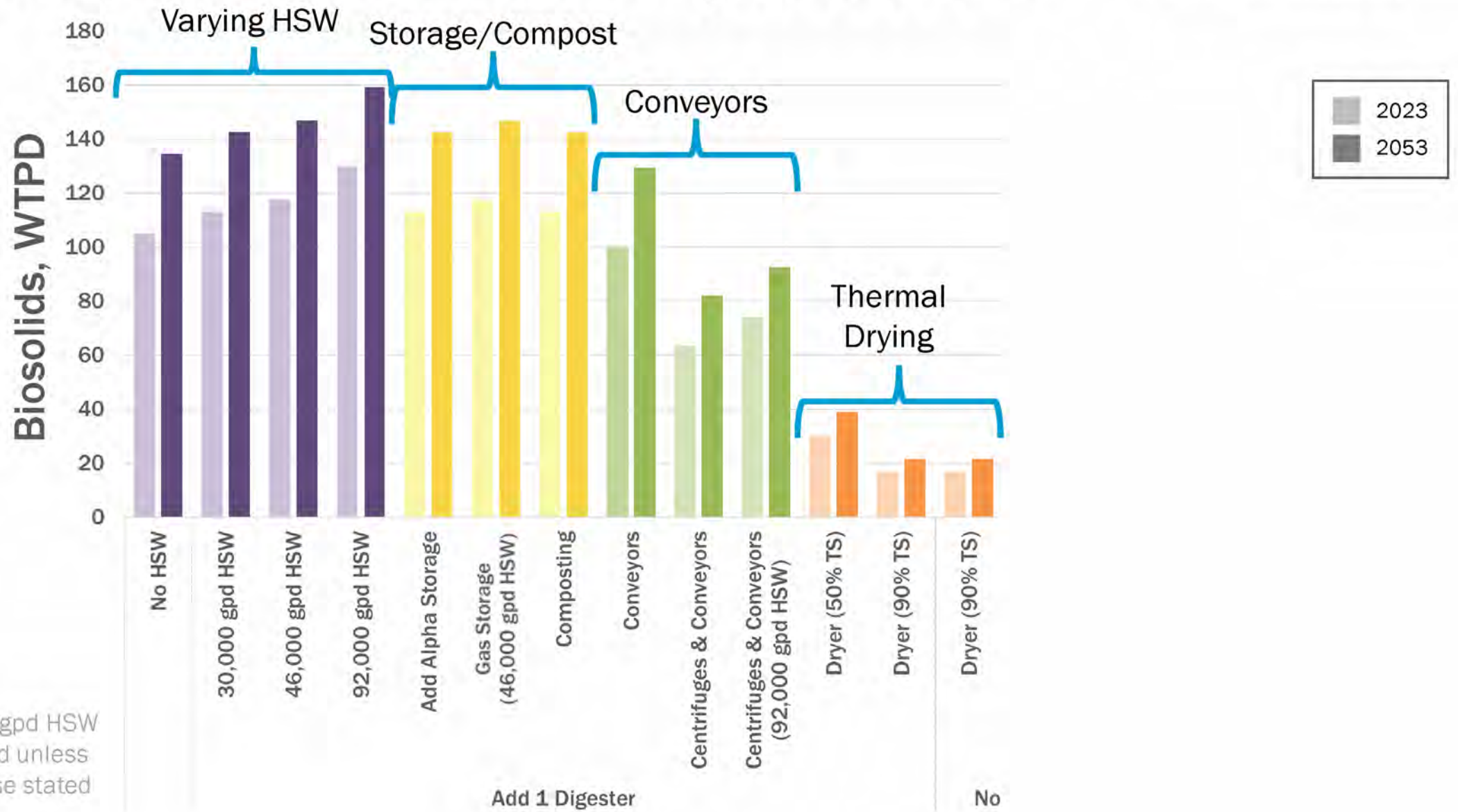
Comparison of biosolids production



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Comparison of biosolids production

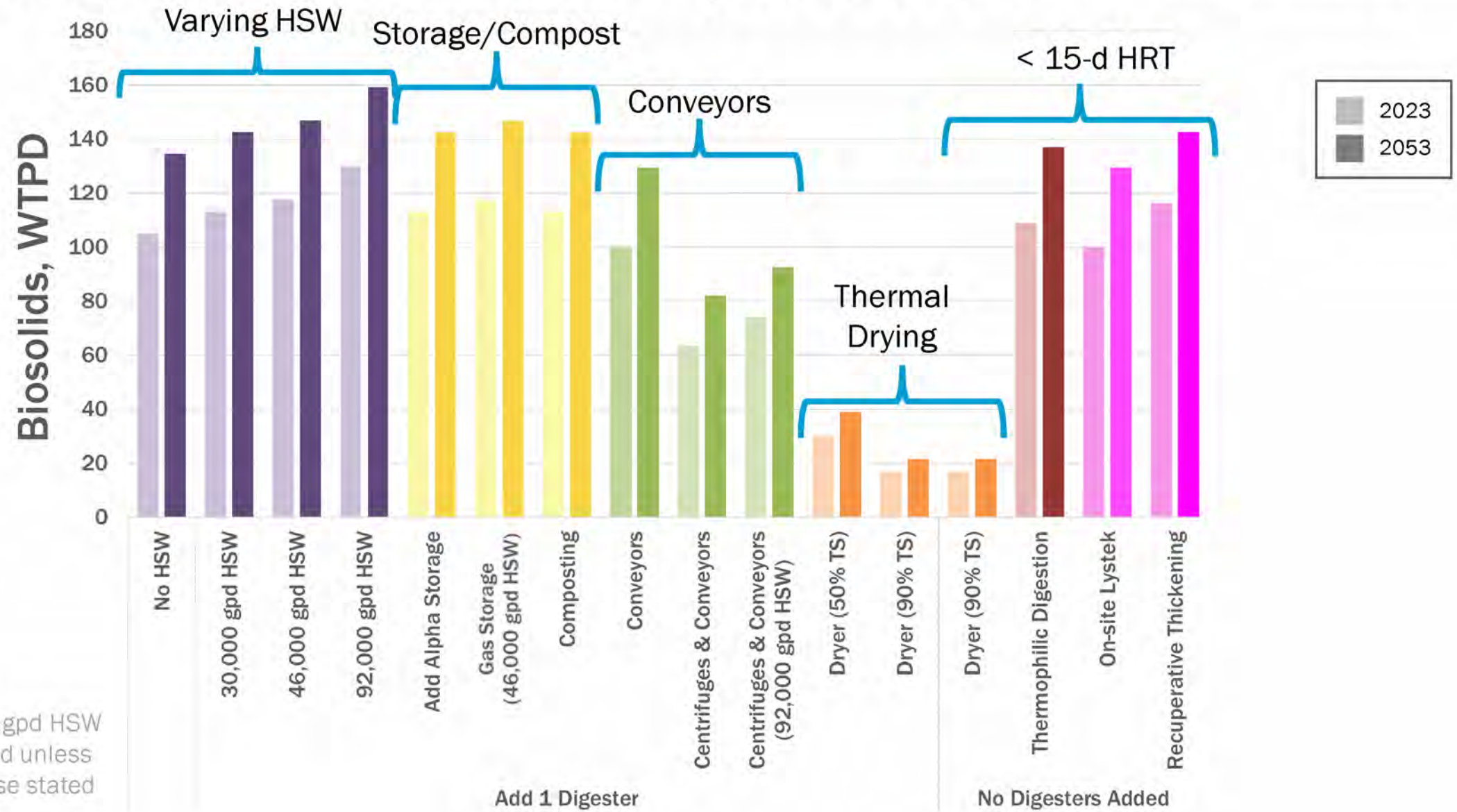
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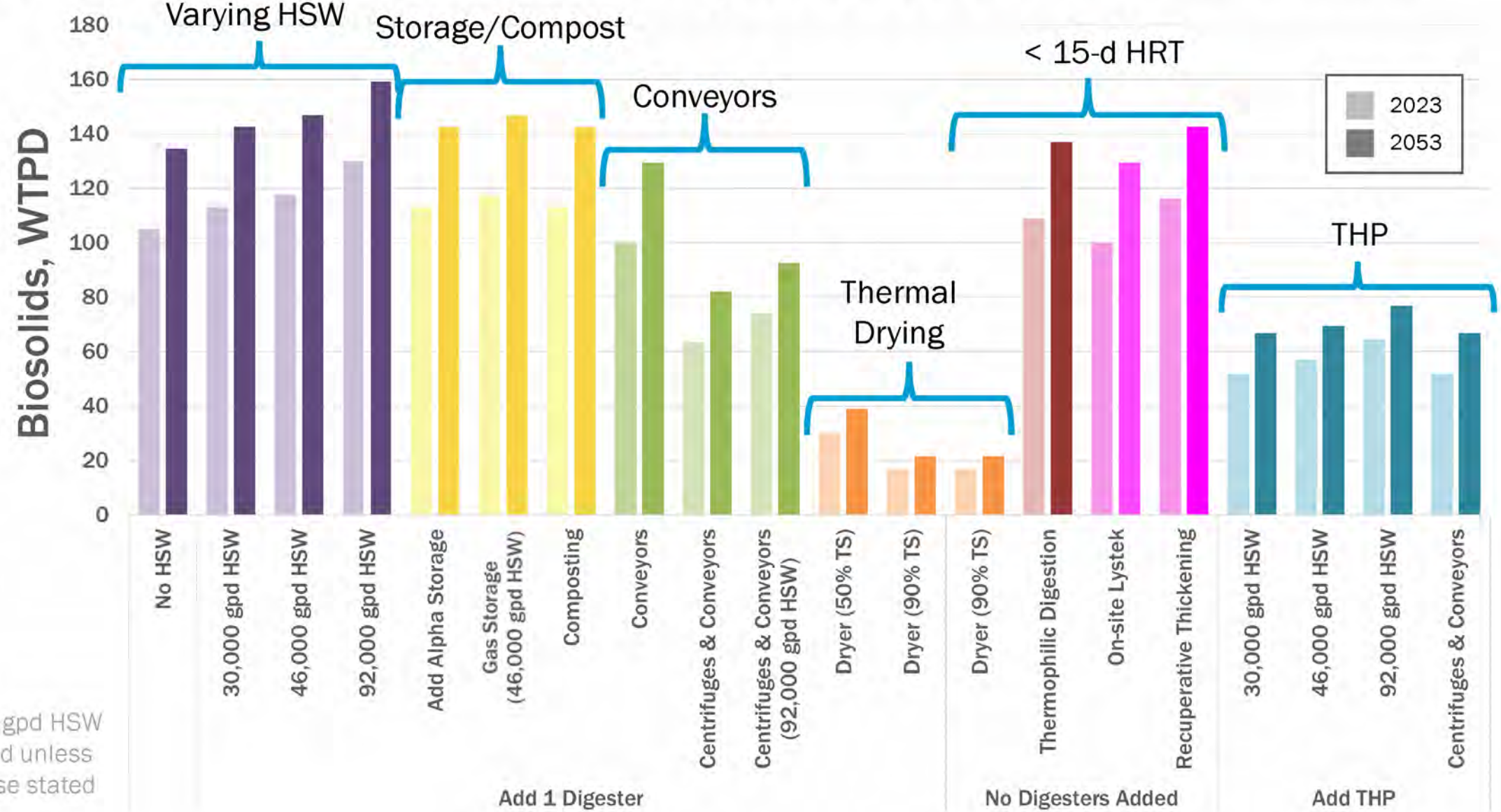
Comparison of biosolids production



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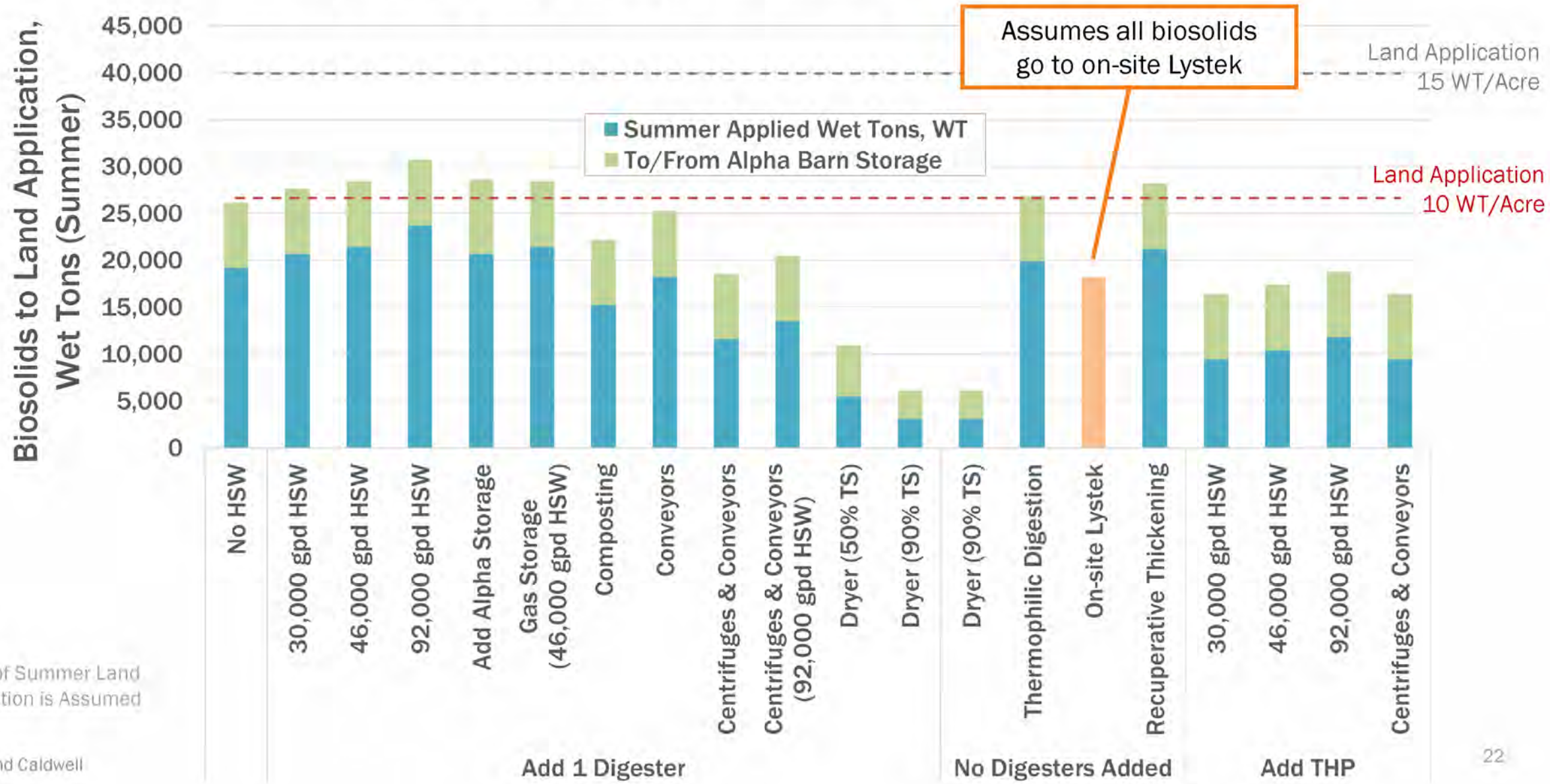
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Comparison of biosolids production



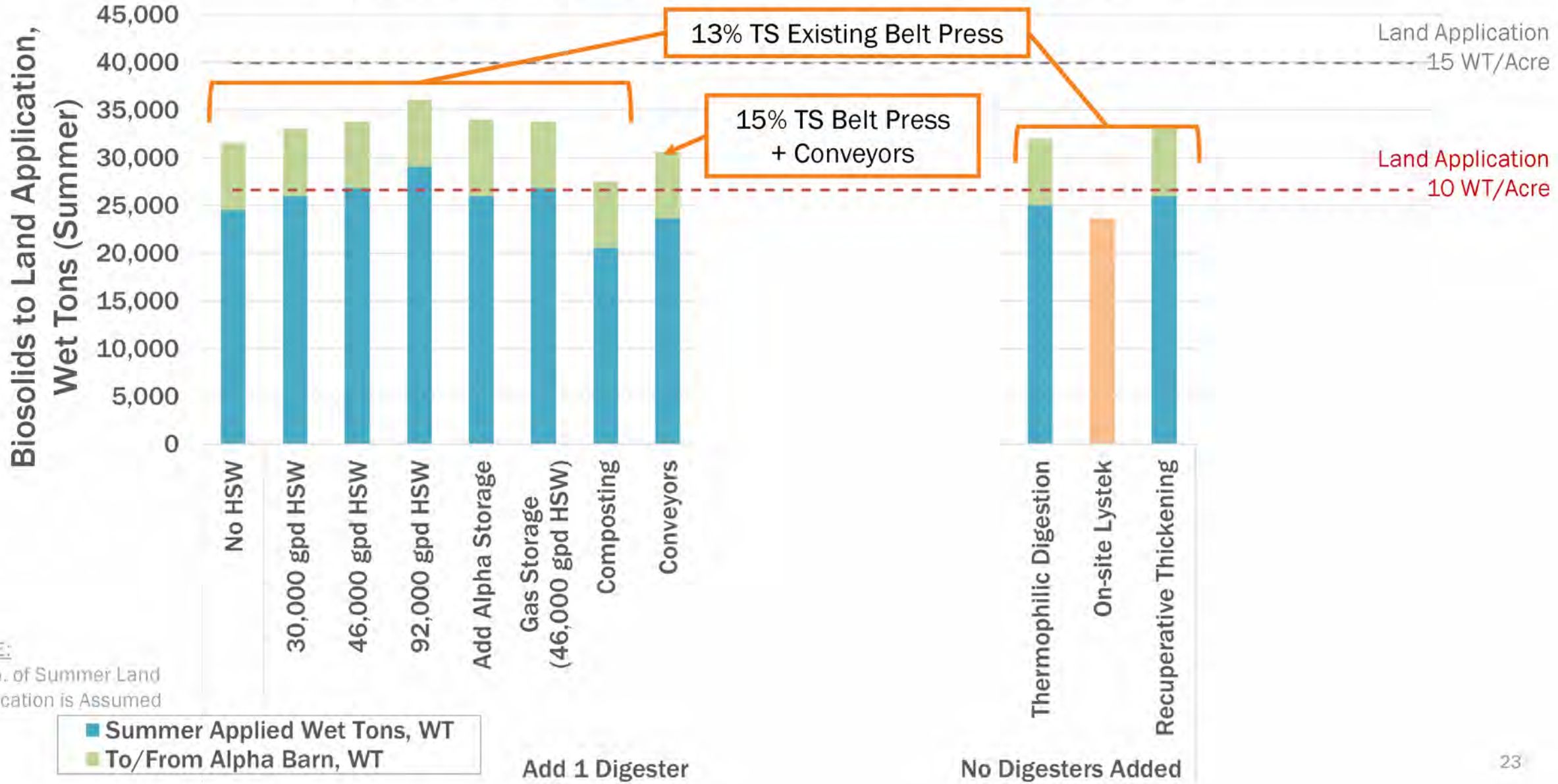
NOTE:
30,000 gpd HSW assumed unless otherwise stated

2023 Biosolids Land Application

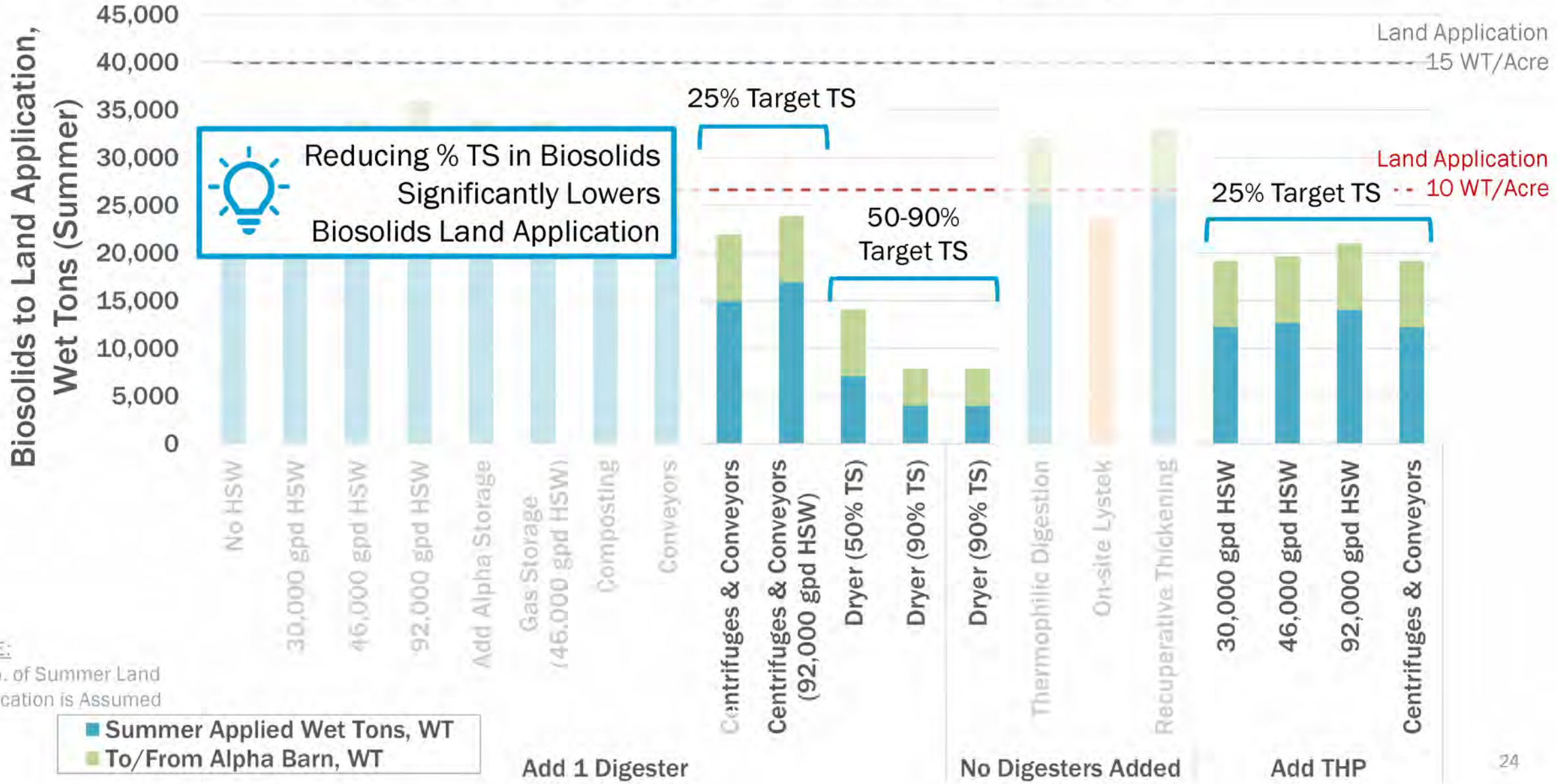


NOTE:
6 mo. of Summer Land Application is Assumed

2053 Biosolids Land Application

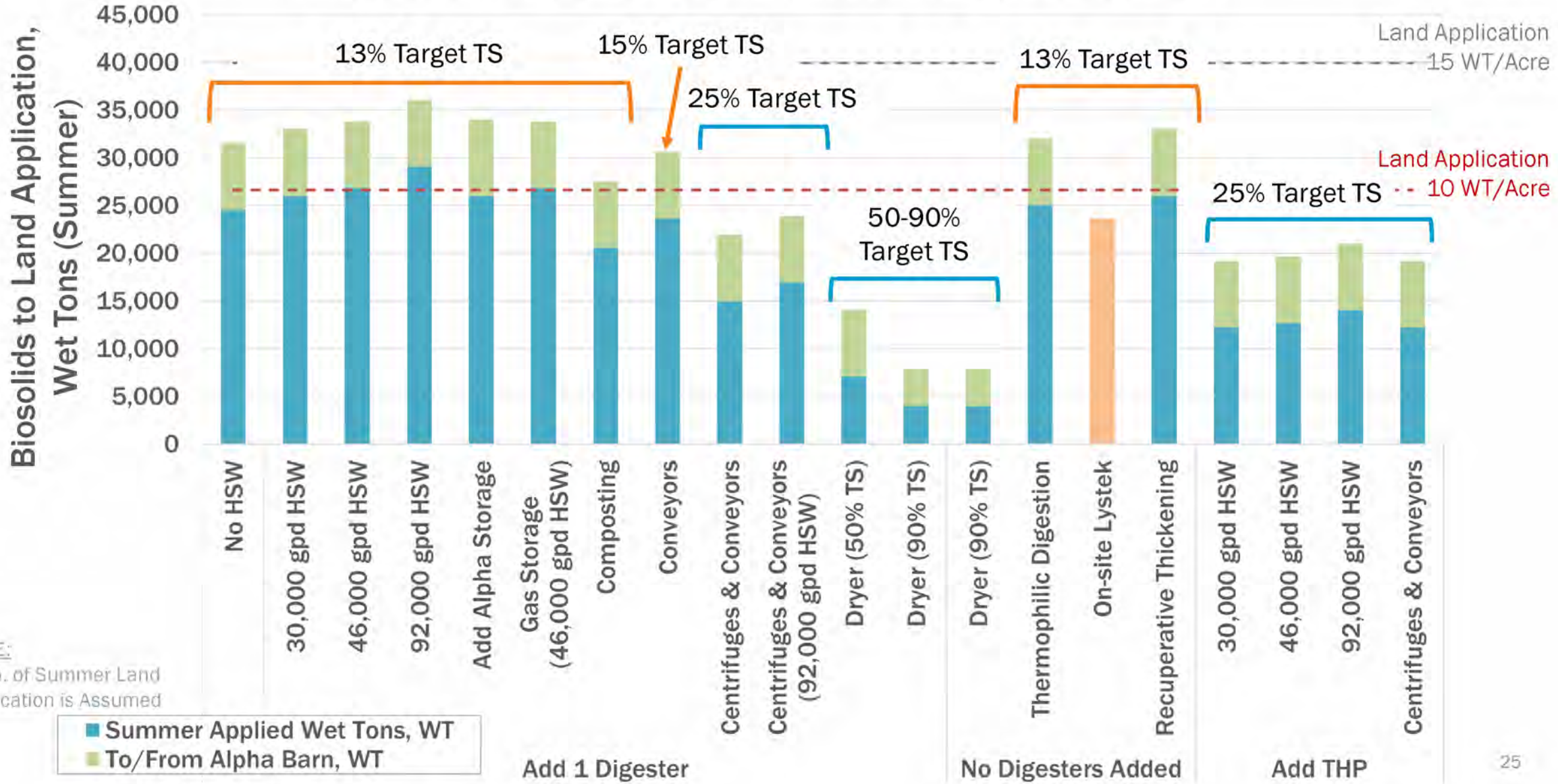


2053 Biosolids Land Application



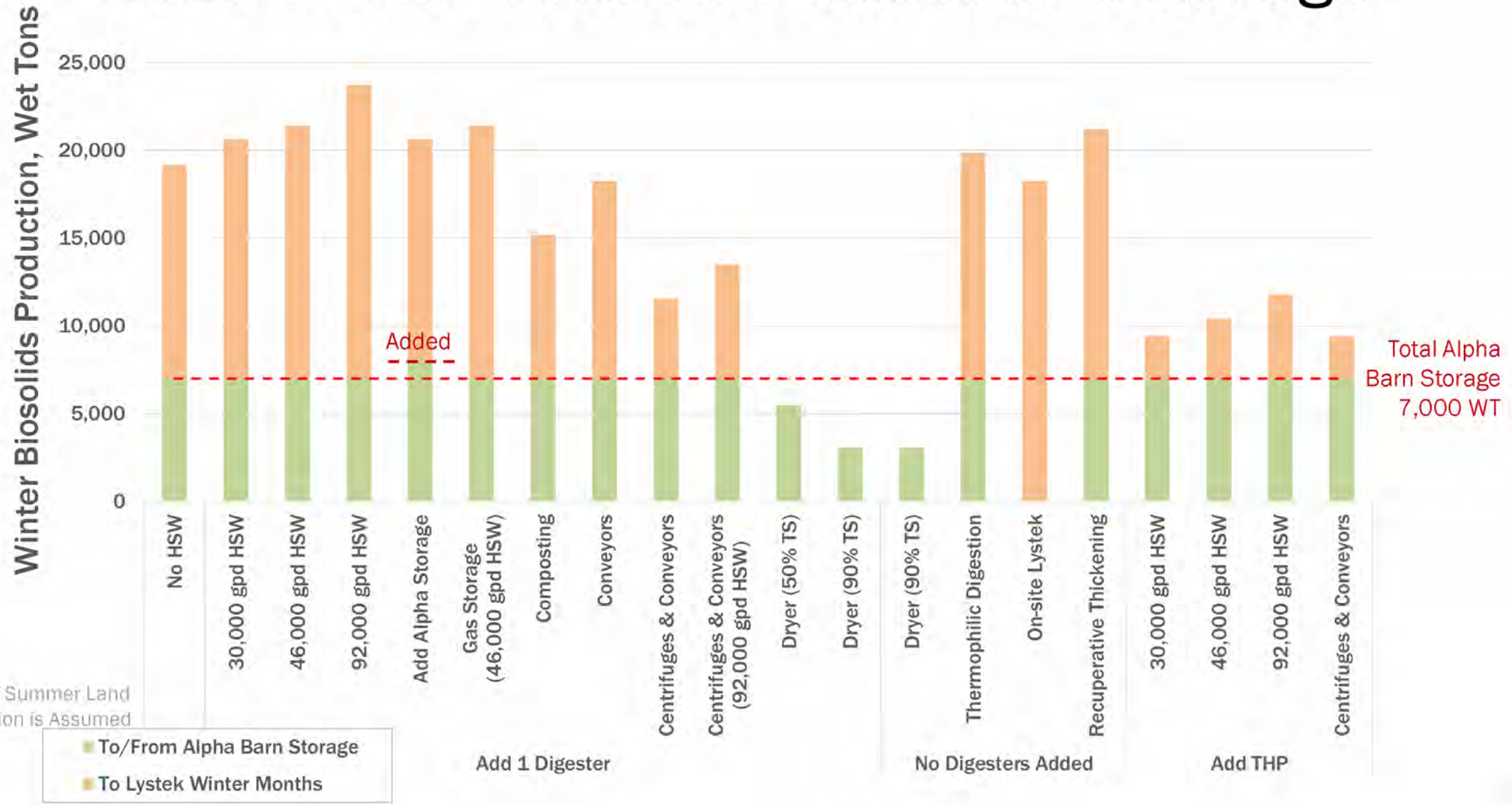
NOTE:
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2053 Biosolids Land Application



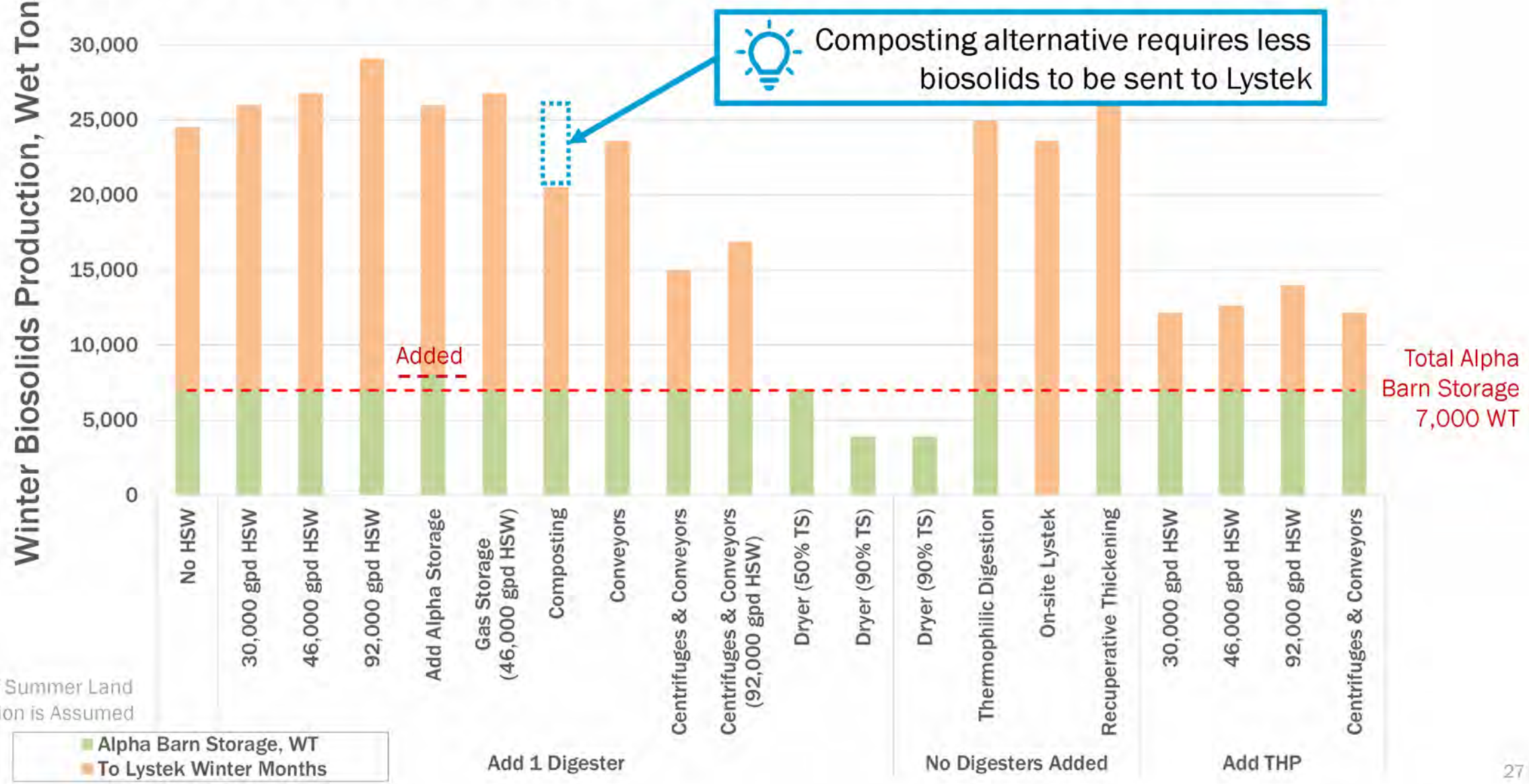
NOTE:
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2023 Winter Biosolids Production & Storage



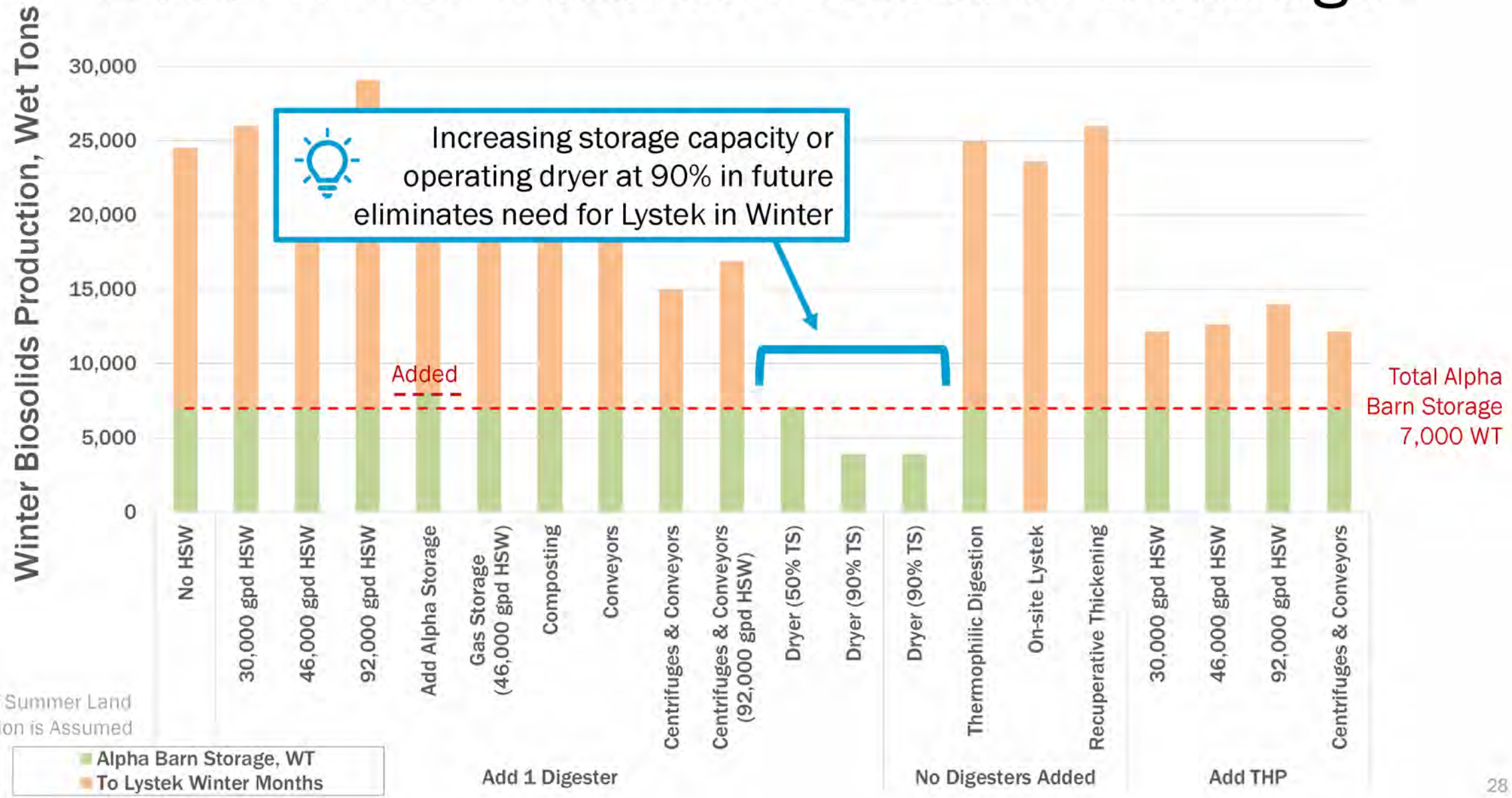
NOTE:
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2053 Winter Biosolids Production & Storage



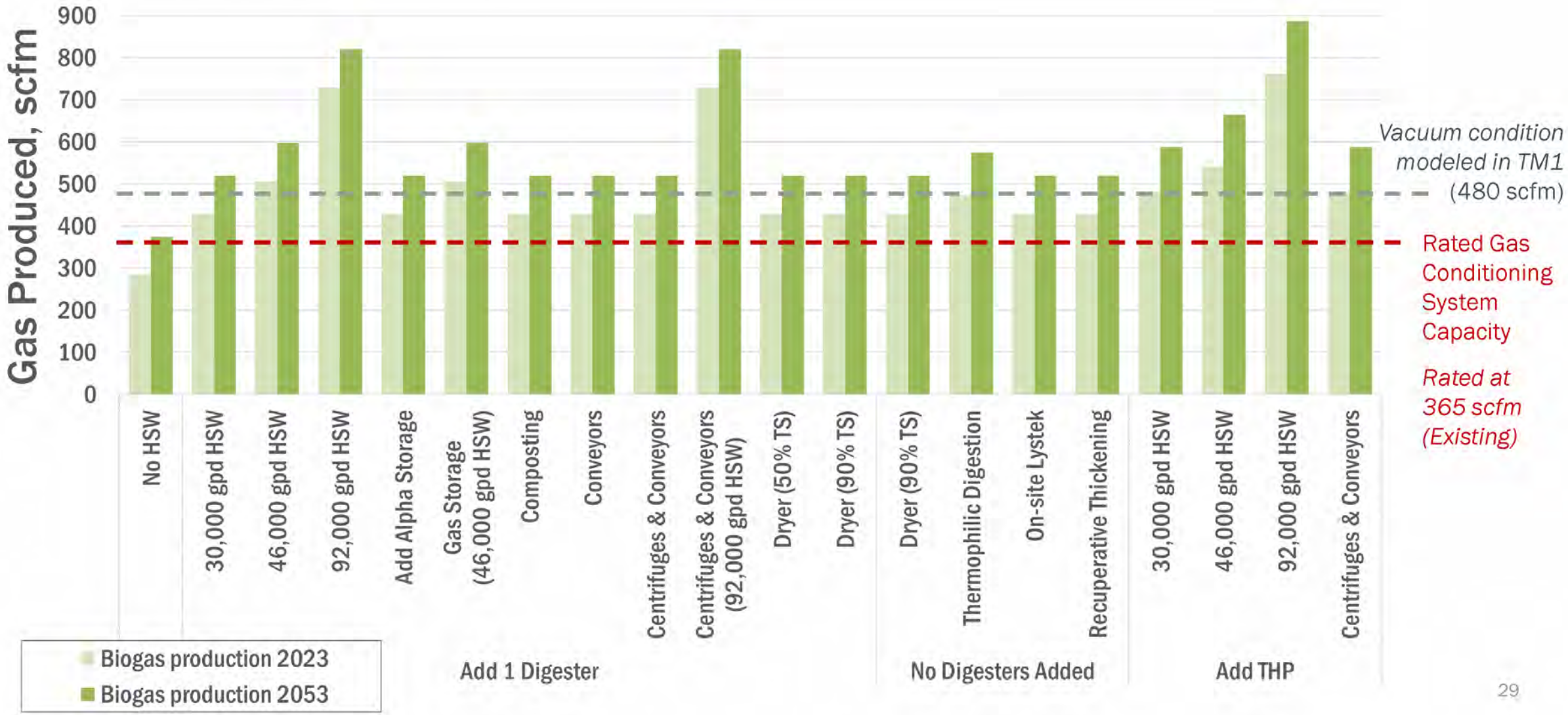
NOTE:
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2053 Winter Biosolids Production & Storage



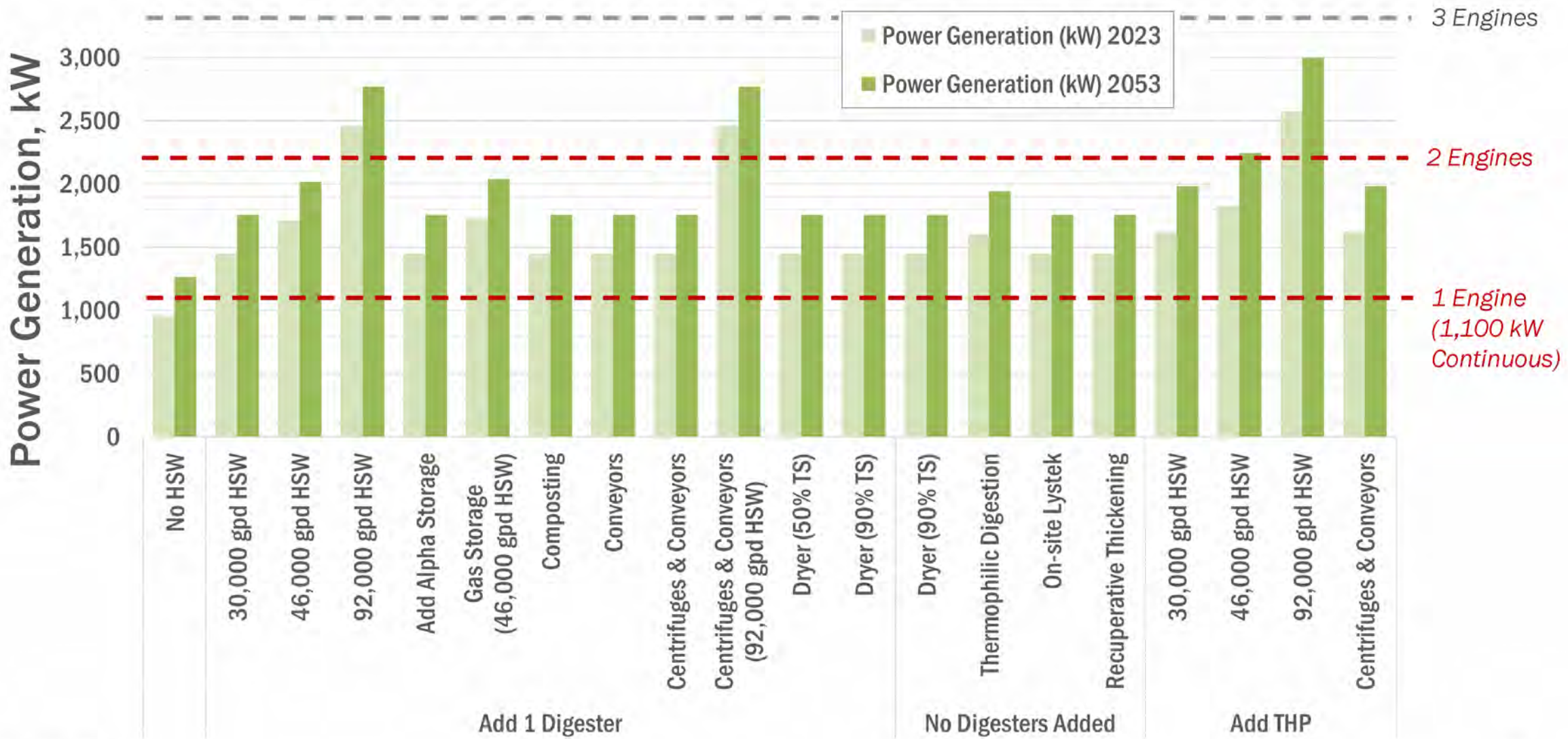
NOTE:
6 mo. of Summer Land Application is Assumed

Gas Production Comparison

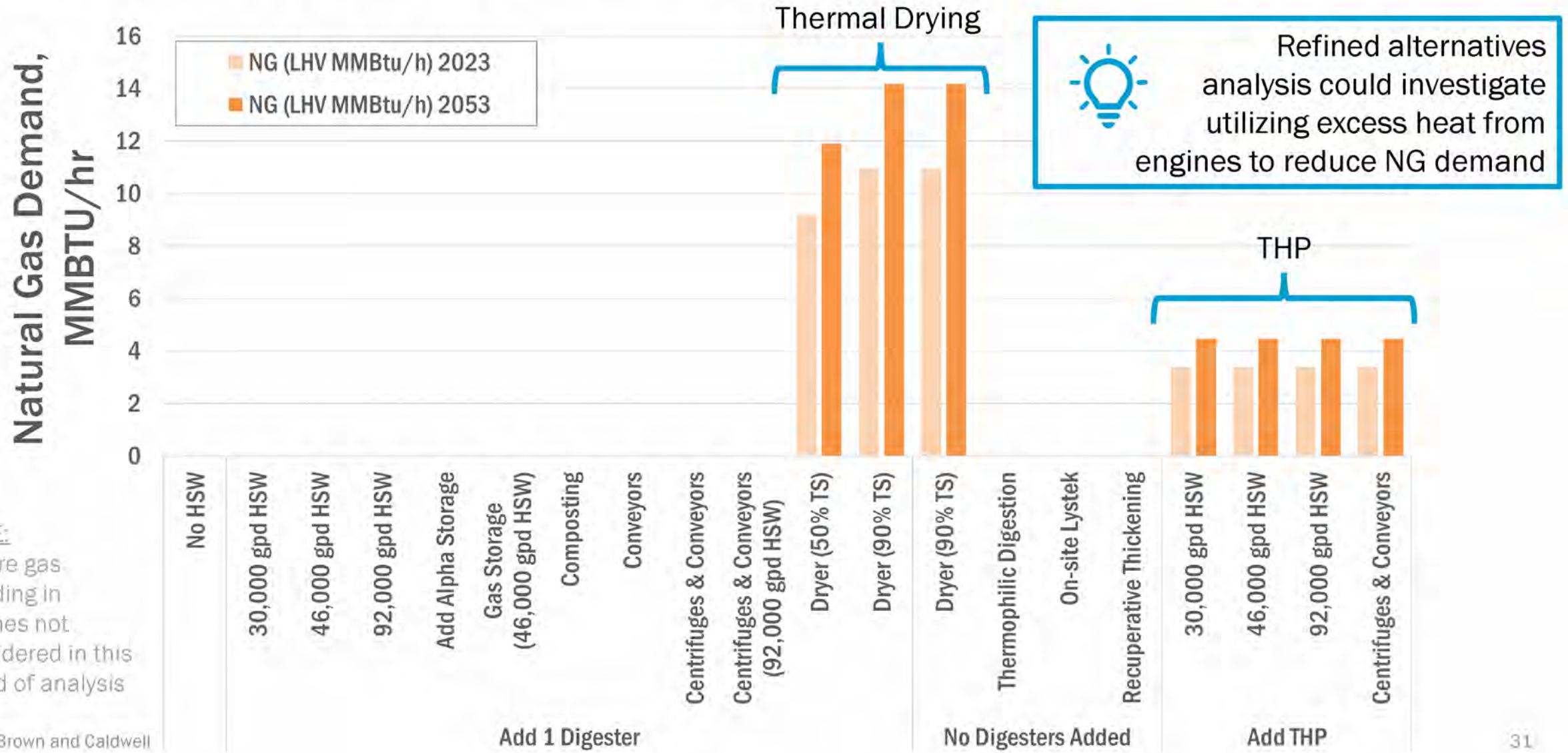


Power Generation Comparison

Does not include NG blending. Power production based off available biogas only.



Comparison of Natural Gas Demand



Refined alternatives analysis could investigate utilizing excess heat from engines to reduce NG demand

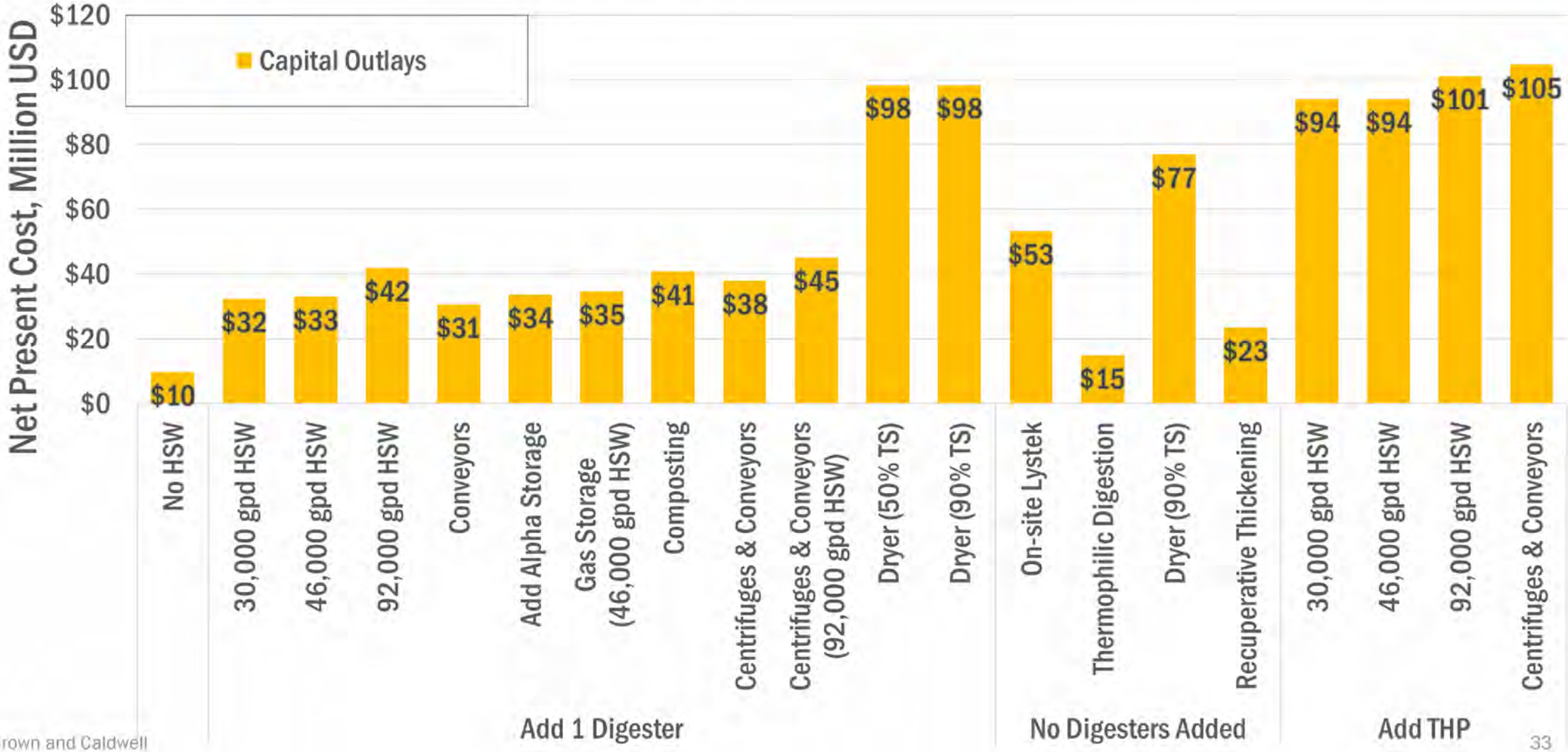
NOTE:
Nature gas blending in engines not considered in this round of analysis

Comparison of Annual and Capital Cost Results

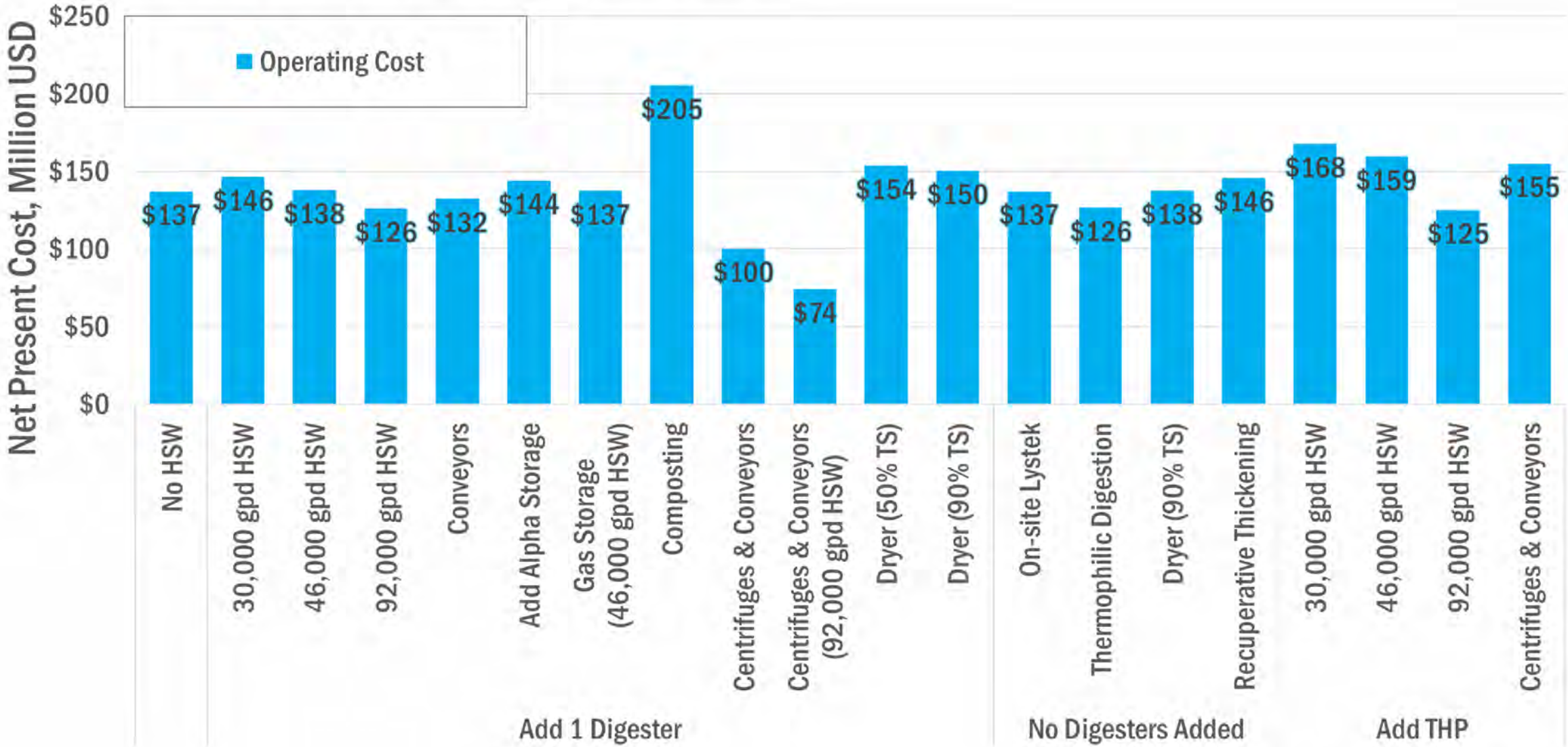
Brown AND Caldwell

Capital Cost Comparison

NOTE: All Alternatives Assume a new GBT, new SCRs, and expanded gas conditioning.

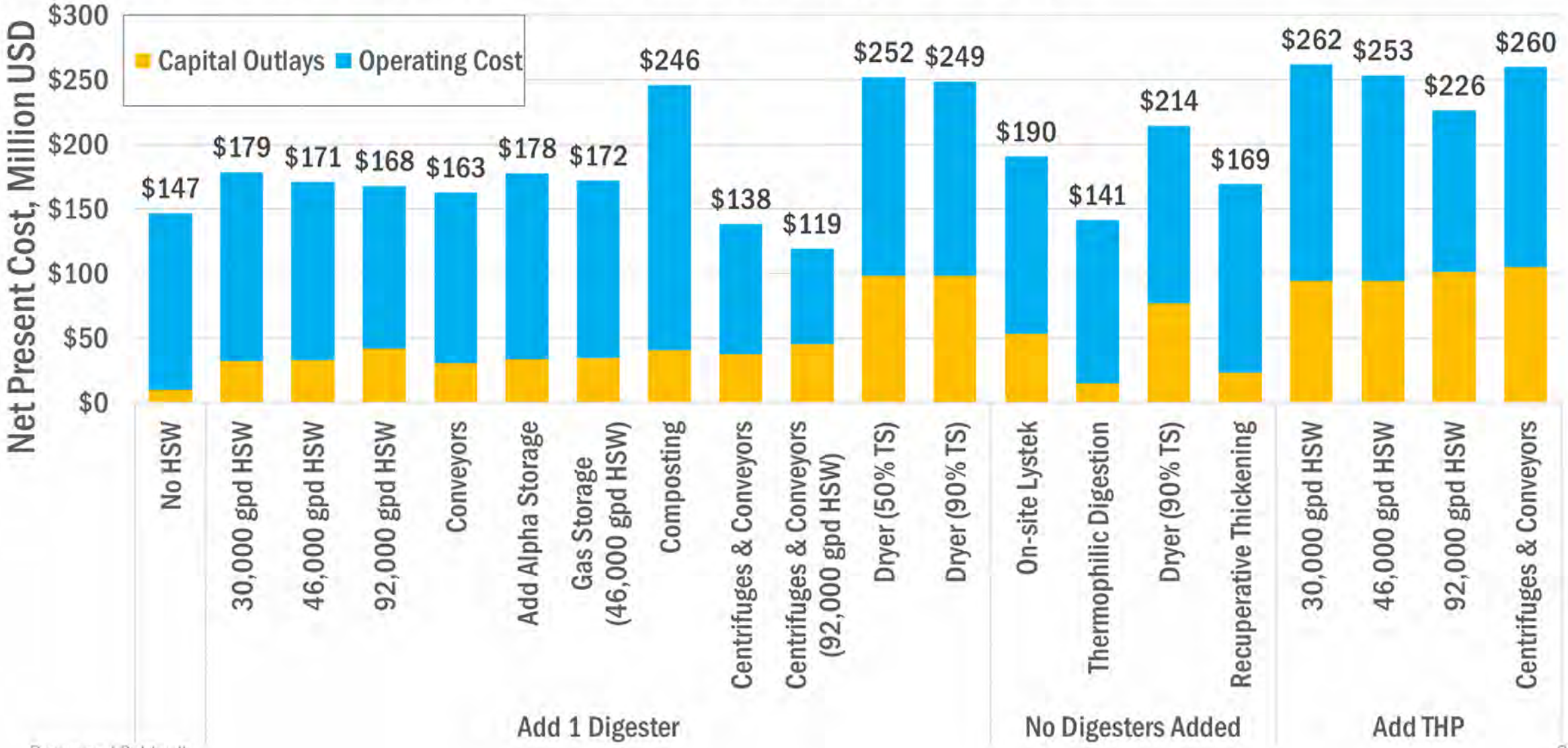


Operating Cost Comparison



Net Present Value Cost Comparison

NOTE: All Alternatives Assume a new GBT, new SCRs, and expanded gas conditioning.

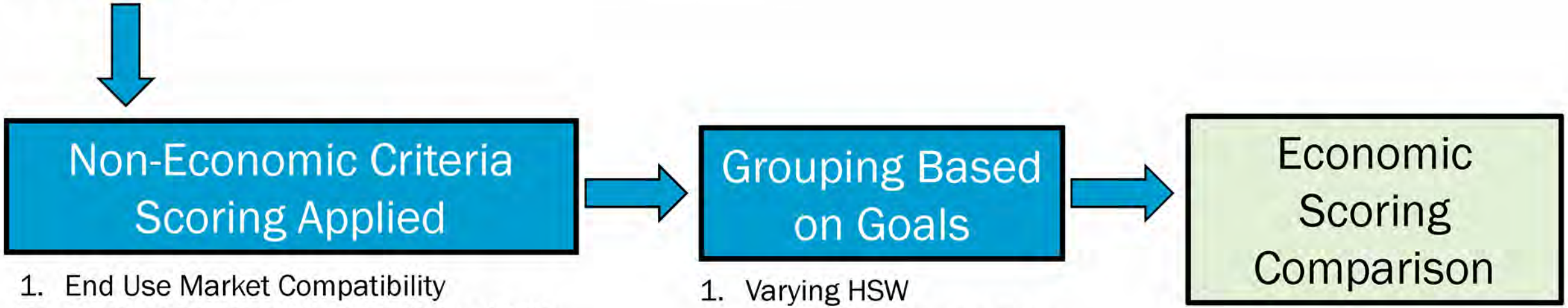


Non-Economic Analysis

Brown AND Caldwell

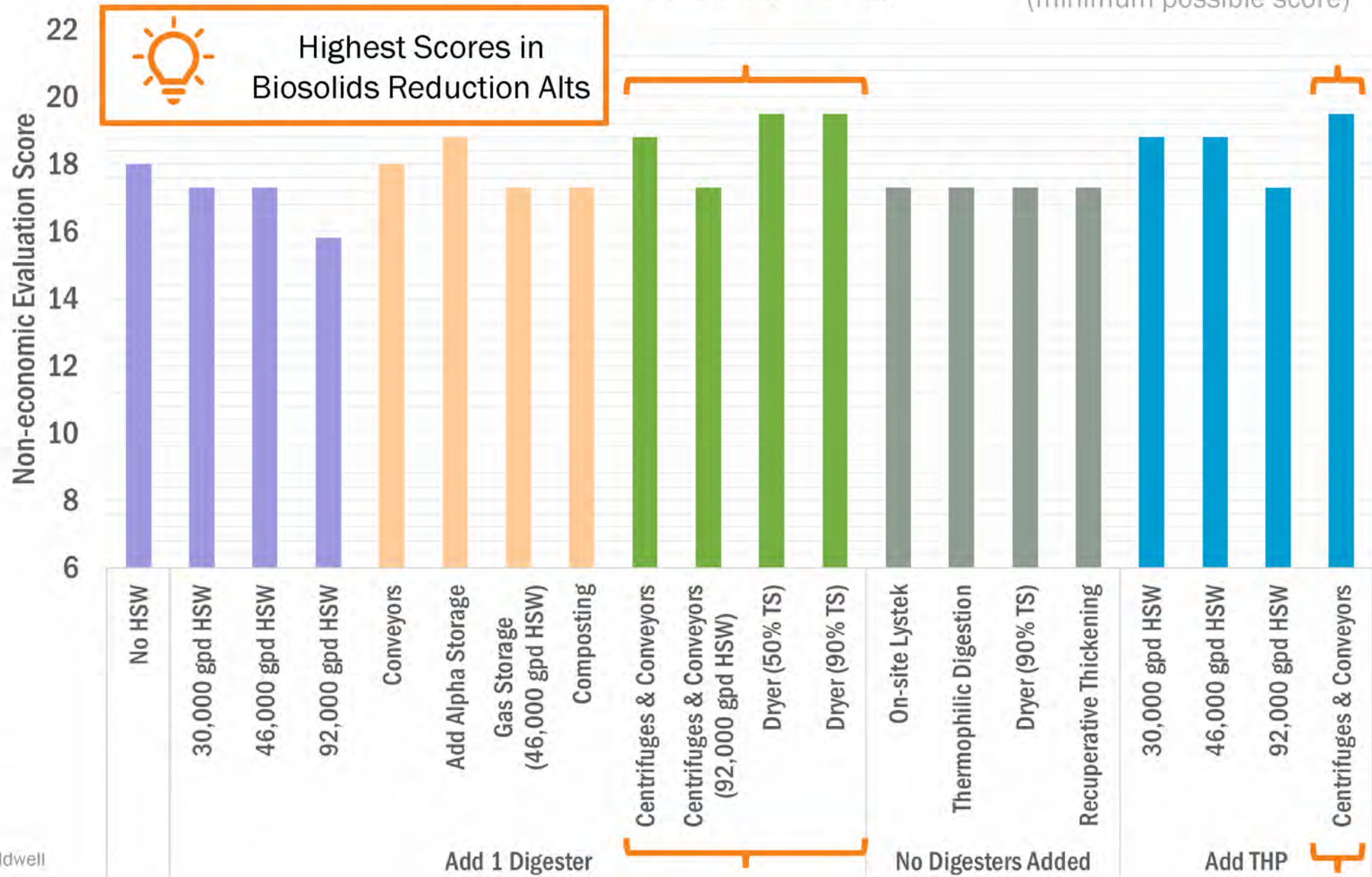
Non-Economic Scoring Approach

Alternatives



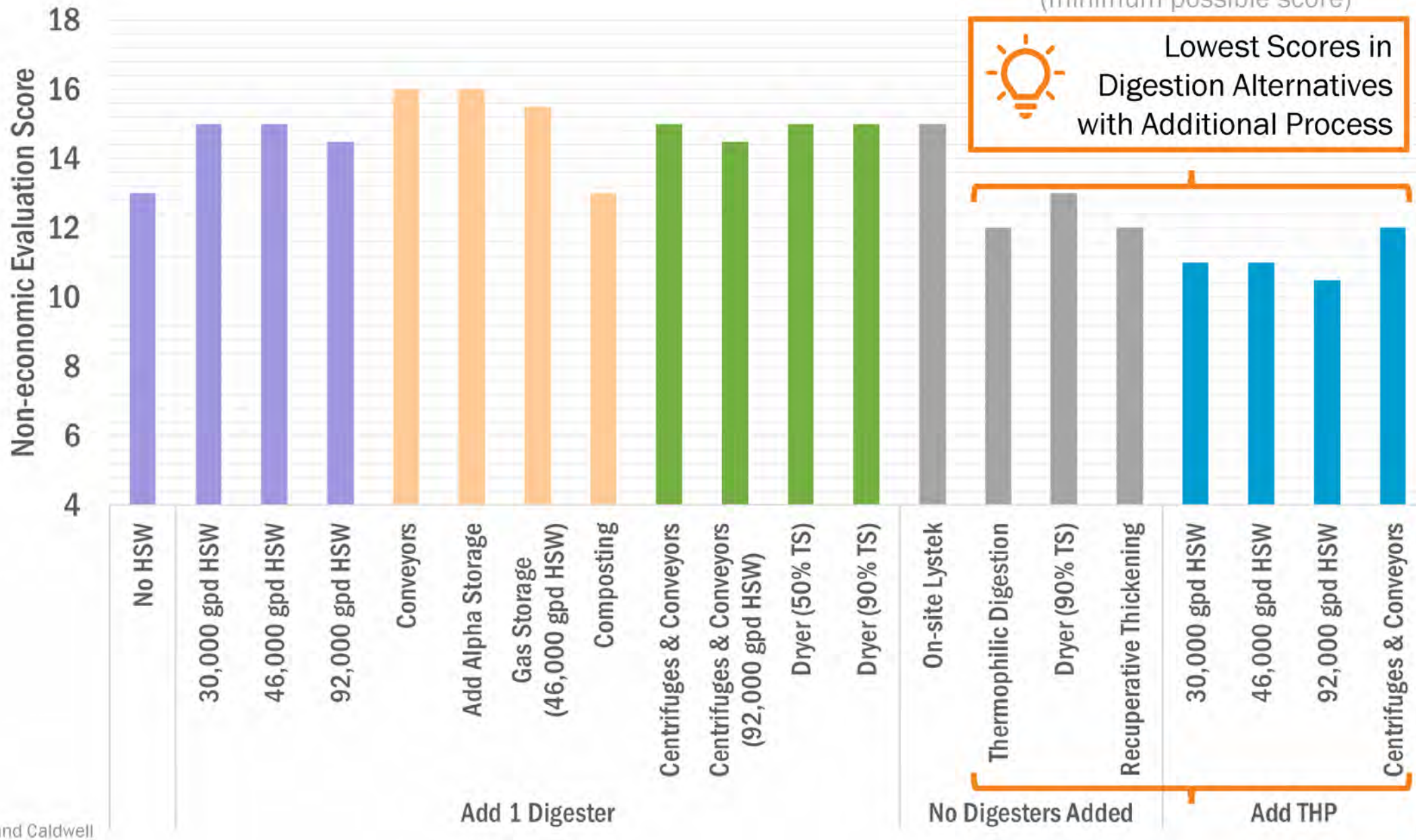
End Use Market Compatibility

NOTE: Y-axis start at 6
(minimum possible score)



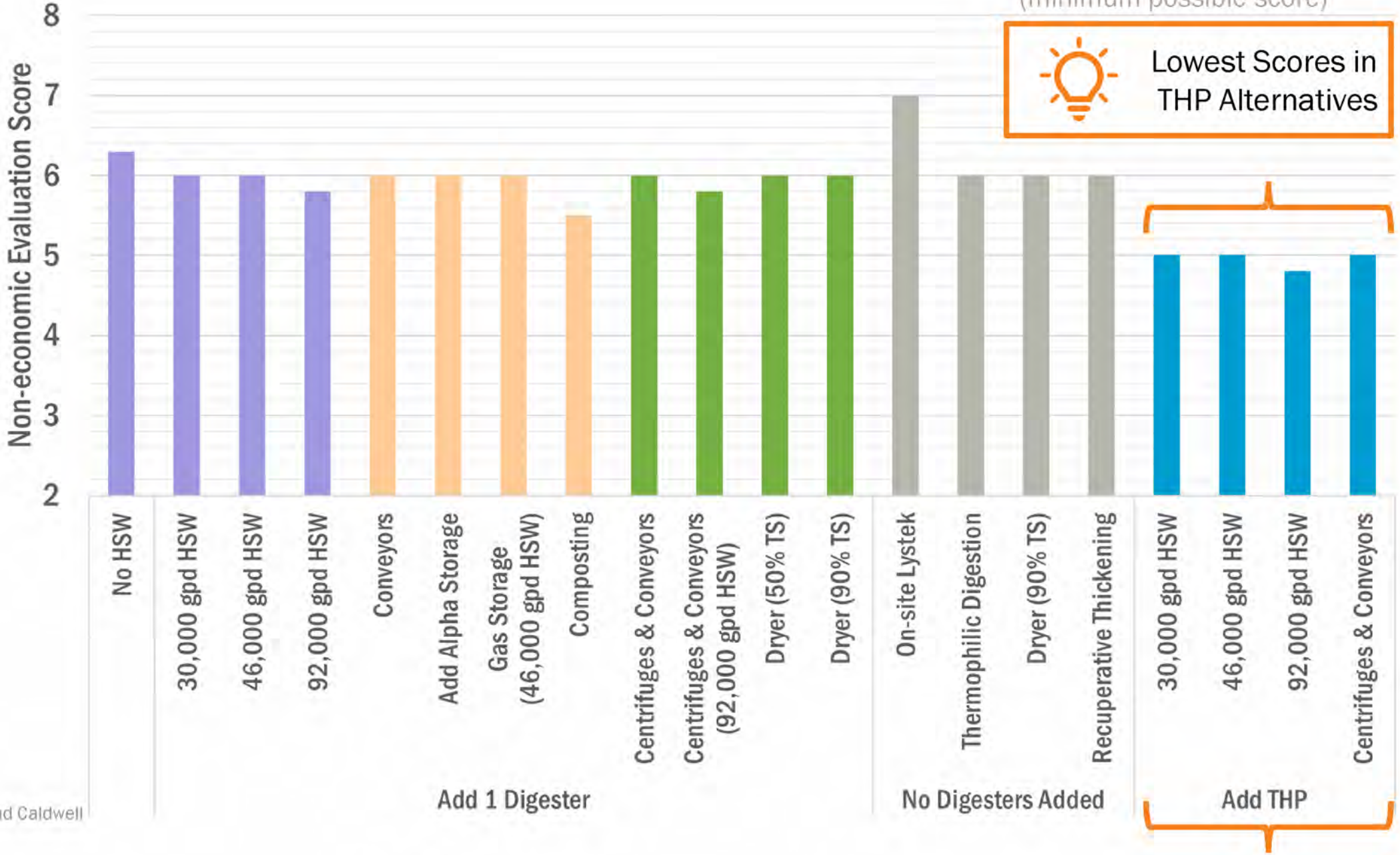
O&M Impacts

NOTE: Y-axis start at 4
(minimum possible score)



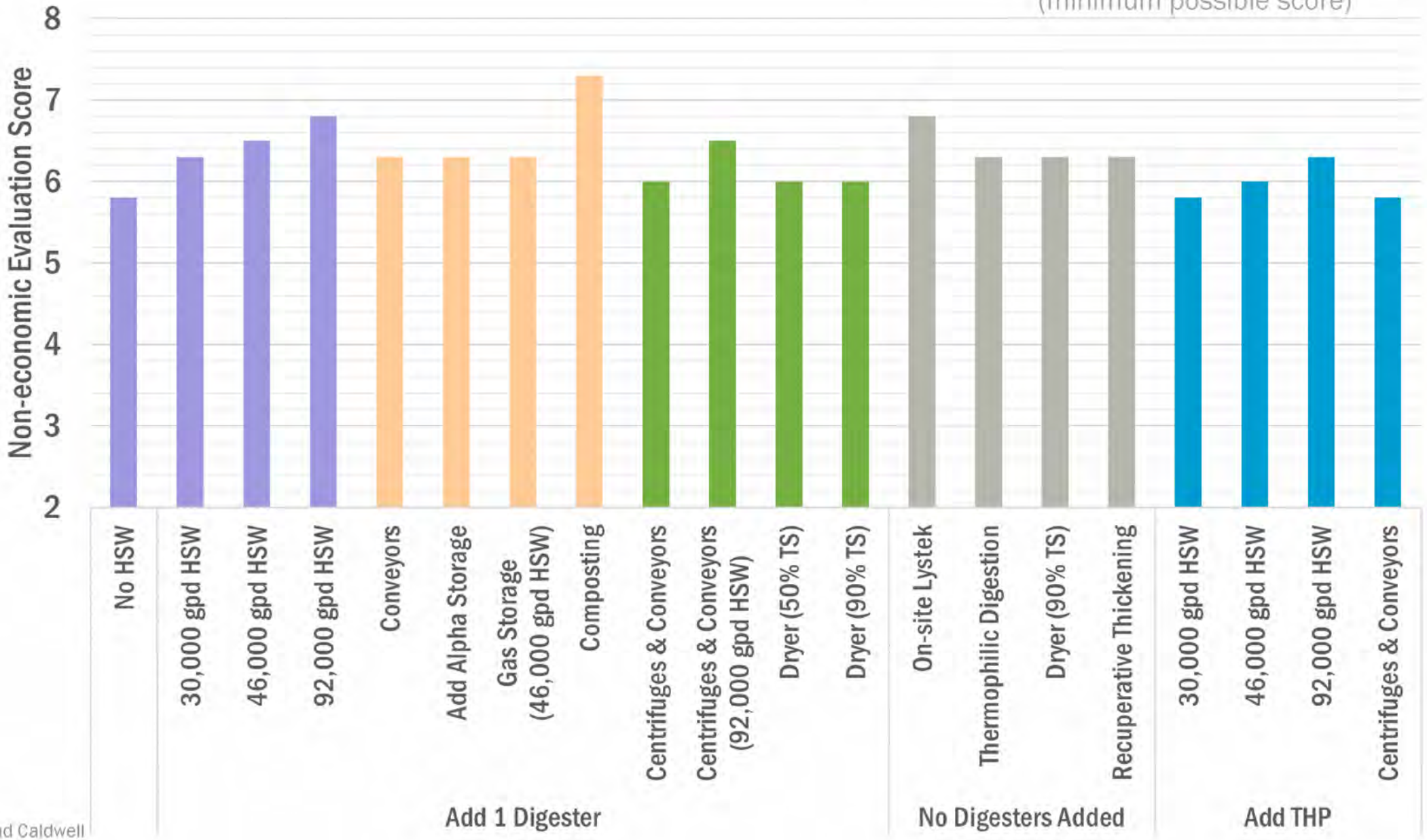
Safety Impacts

NOTE: Y-axis start at 2
(minimum possible score)



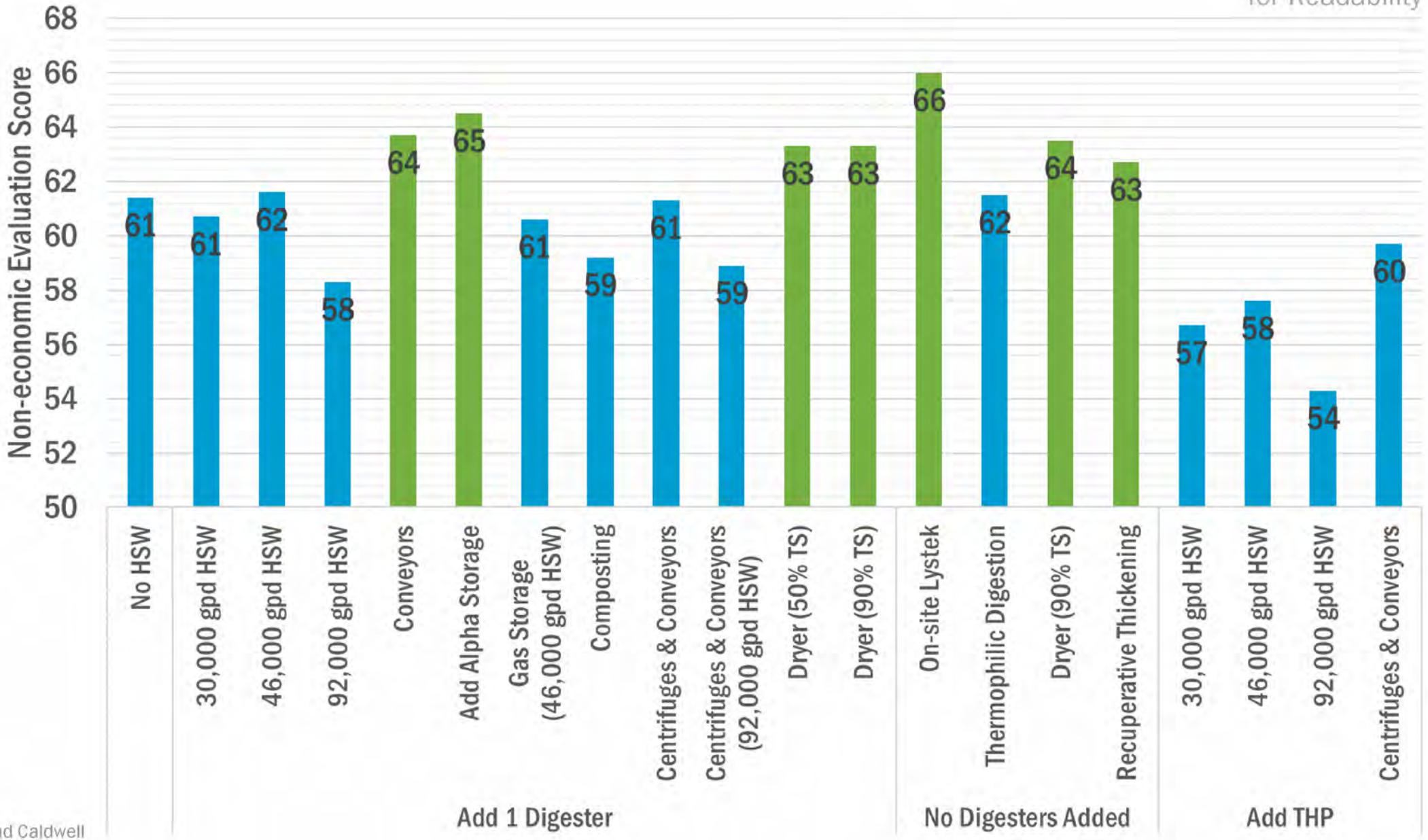
Environmental and Community Impacts

NOTE: Y-axis start at 2
(minimum possible score)



Overall Non-economic Evaluation Scoring

NOTE: Y-axis start at 50 for Readability

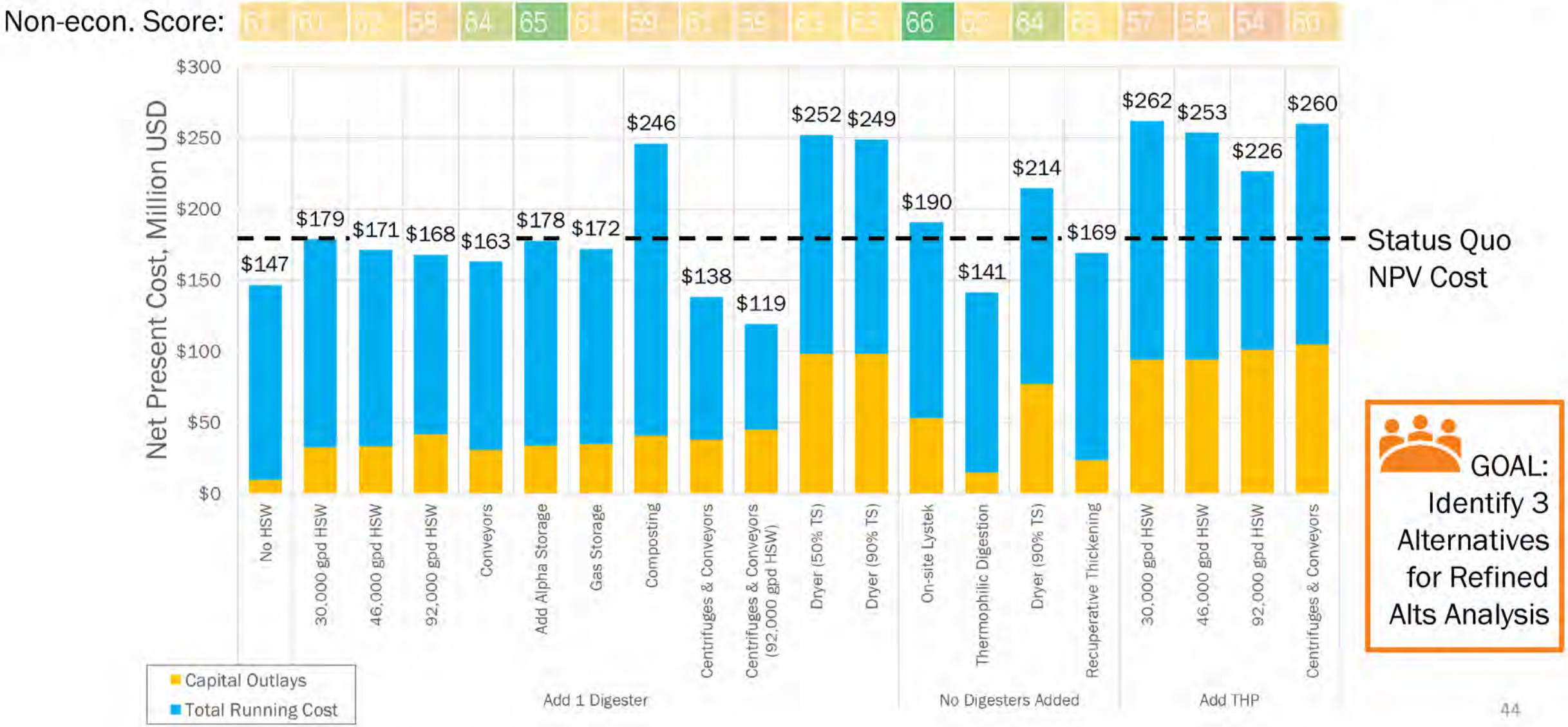


Discussion

- ✓ Review Summary of Initial Alternatives Analysis
- ✓ Identify 3 Alternatives for Refined Analysis

Brown AND Caldwell

Evaluation Summary: NPV Costs & Non-economic Scores



GOAL: Identify 3 Alternatives for Refined Alts Analysis

Next Steps

Brown AND Caldwell

Biosolids Management Strategic Plan Next Steps

July/August

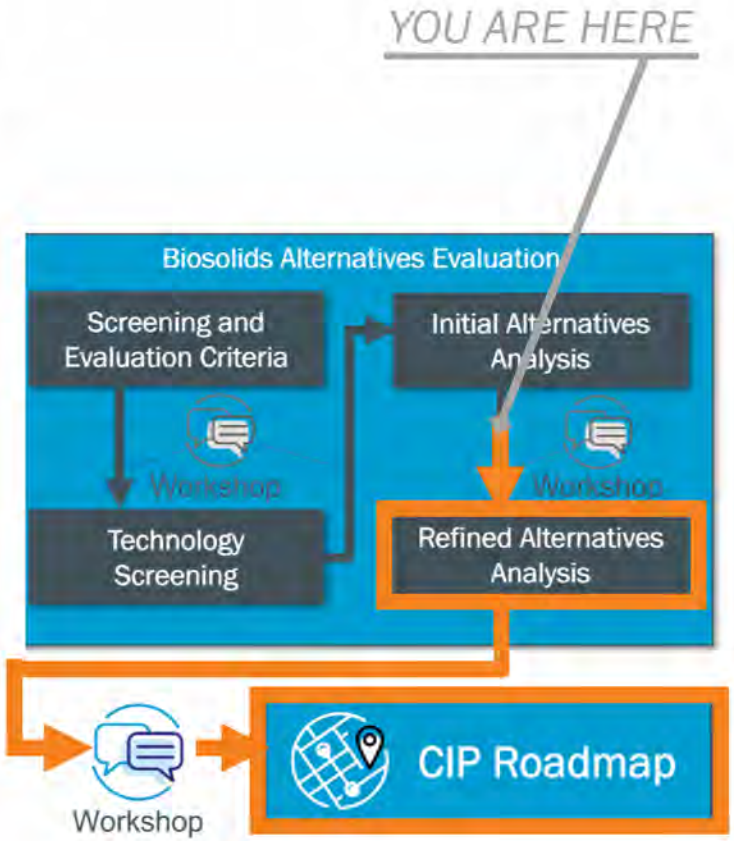
- Finalize 3 Alternatives for Refined Alternatives Analysis
  - Perform Refined Alternatives Analysis
    - Biosolids Alternatives Evaluation TM & QC Review

September

- Biosolids Alternatives Evaluation Draft TM to City (9/8)
  - Refined Alternatives Workshop & City TM Review
    - Final TM to City

October/November

- Draft CIP Plan to City (10/26)
  - CIP Roadmap Workshop
    - Final CIP Plan to City



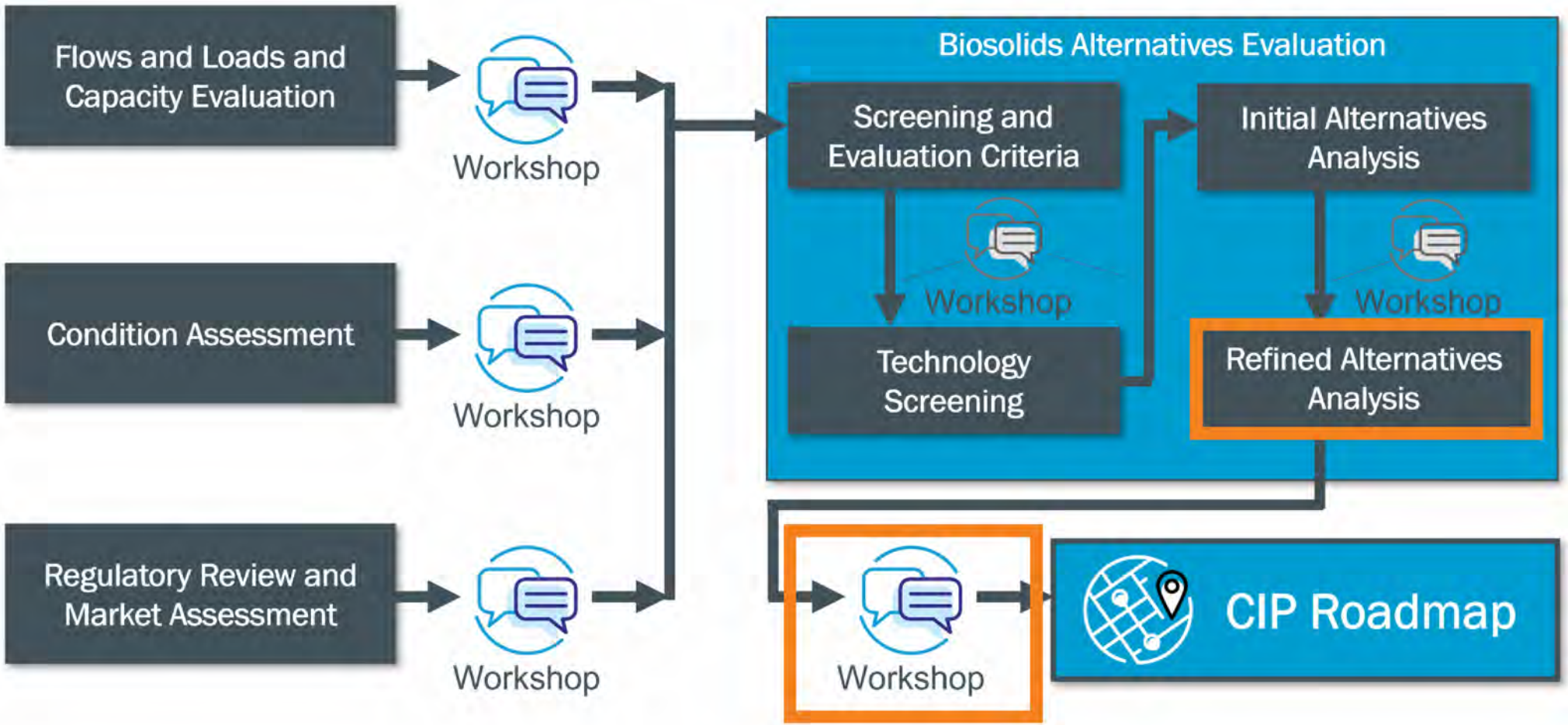


Biosolids Management Strategic Plan

Refined Alternatives Evaluation Workshop

October 12, 2023

Biosolids Management Strategic Plan





What are the goals of today's workshop?

- Discuss results from alternatives analysis
- Review layout, process performance, costs
- Finalize and incorporate results into the capital improvement program (CIP) roadmap

Agenda

- Alternatives Analysis Review
- Refined Alternatives Evaluation & Discussion
  - Drivers & process flow diagrams
  - Site layouts
  - Upstream & downstream process impacts
  - Greenhouse gas emissions
  - Capital and lifecycle costs
  - Phasing and implementation opportunities
- Next Steps & CIP Roadmap Discussion
  - Review of capital projects and estimated costs
  - CIP roadmap discussion

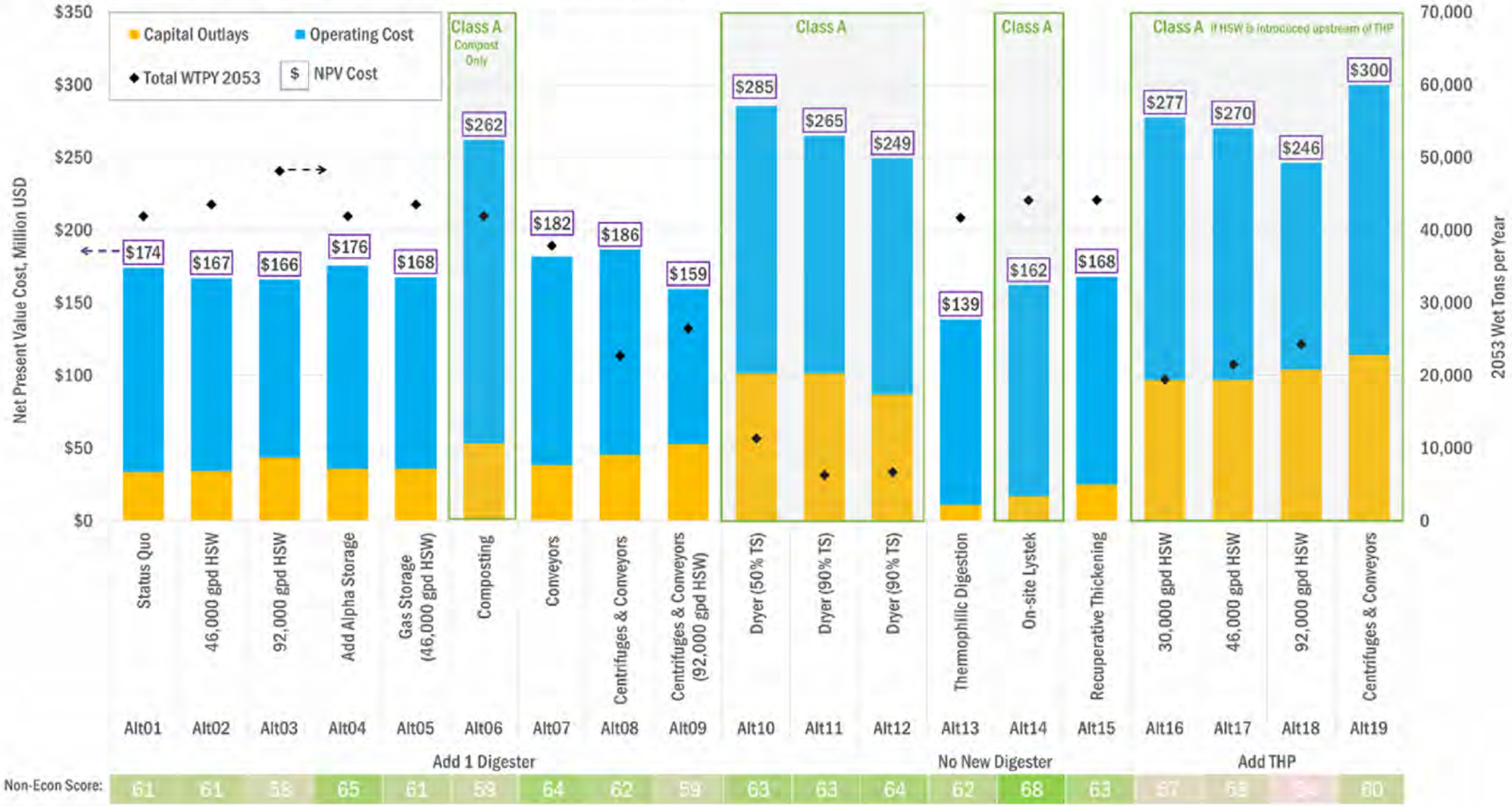
Alternatives Analysis Review

Brown AND Caldwell

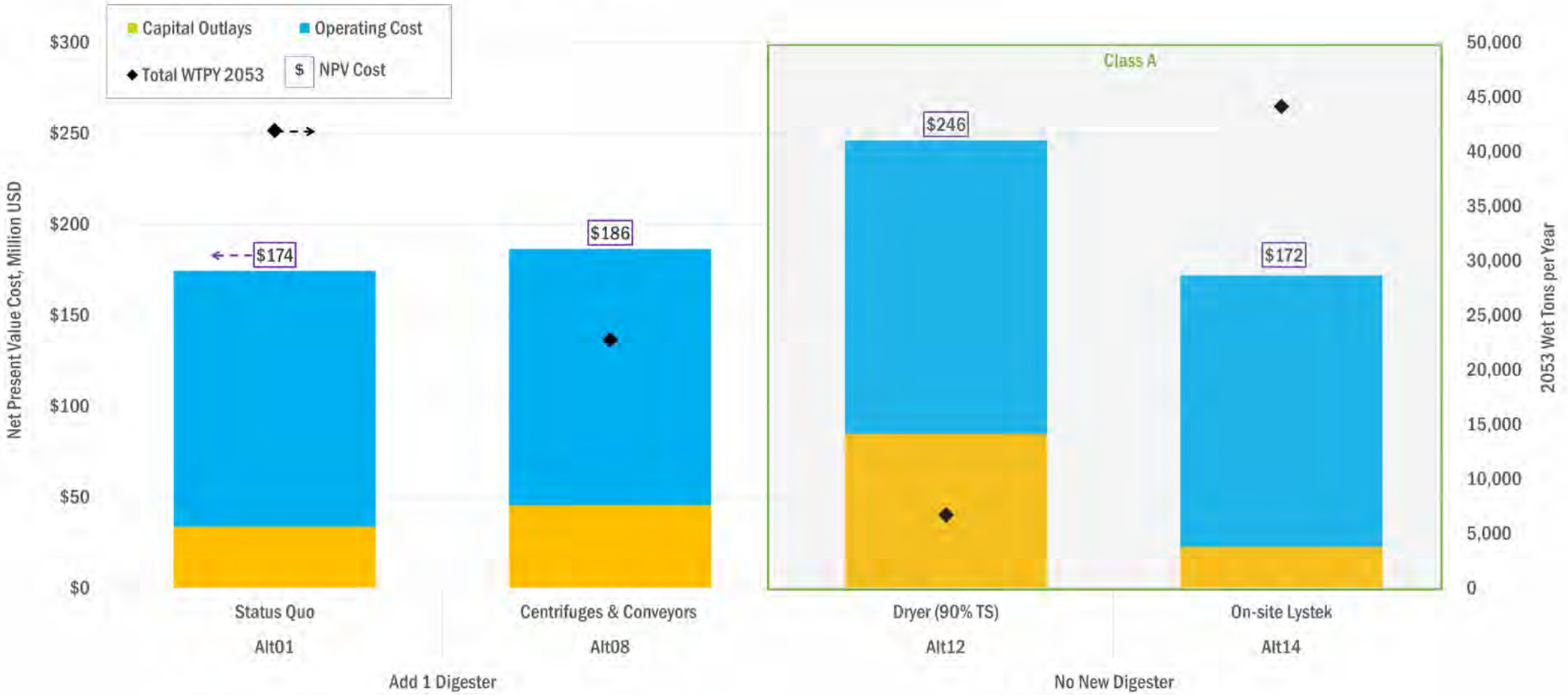
Biosolids Management Strategic Plan Goals

- Reduce operational cost
- Mitigate future regulatory risks
- Provide solutions that best meet needs of the regional community
- Maintain operational flexibility
- Incorporate and align solutions with City's Climate Action Plan
- Determining best use of the composting facility

Initial Alternative Results



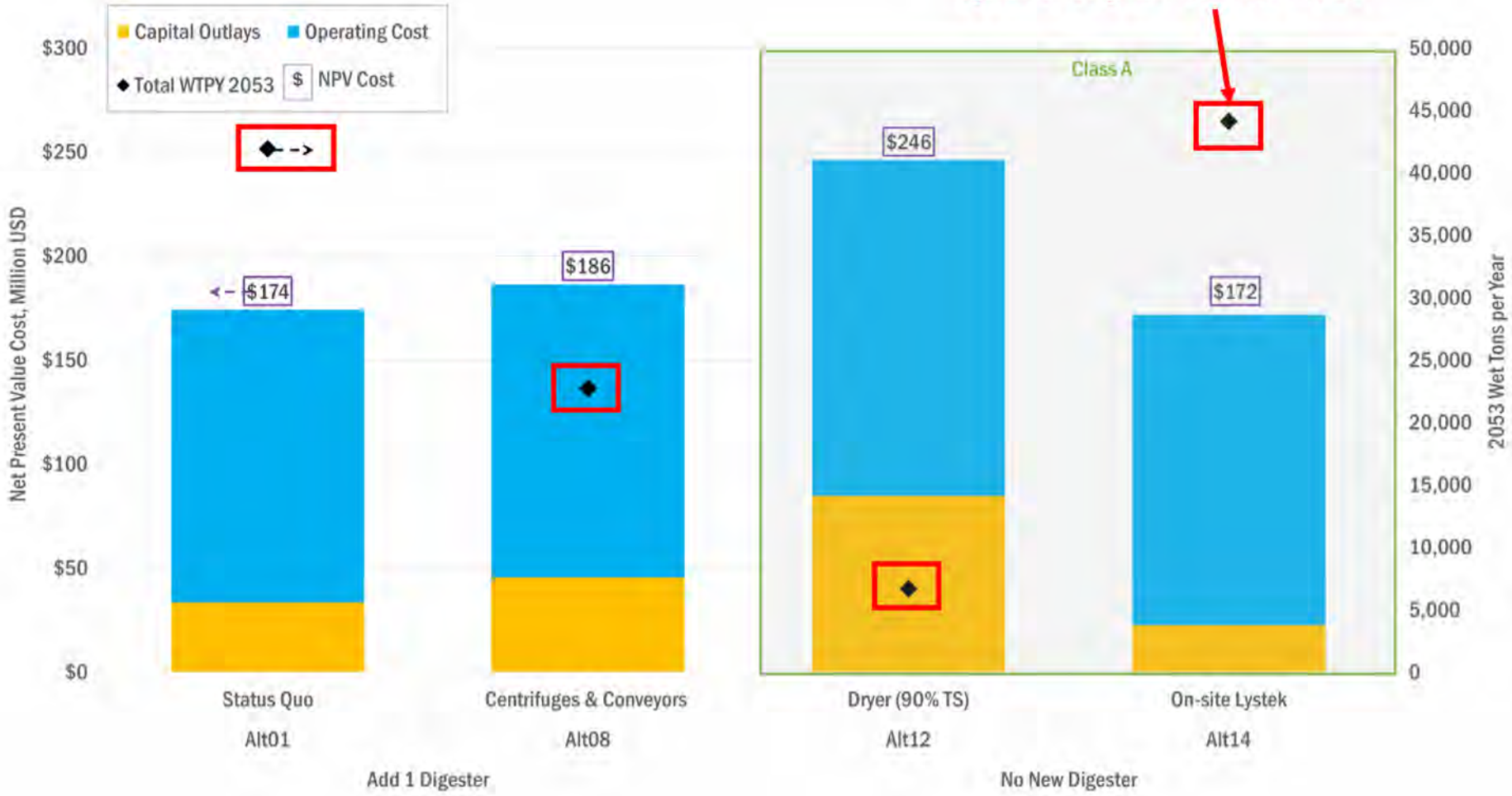
Shortlisted Alternatives



Shortlisted Alternatives

- ✓ Reduction in wet tons produced annually
- ✓ Reduced hauling cost

Eliminates hauling/application by the City of Santa Rosa



Shortlisted Alternatives

✓ Reduction in wet tons produced annually

✓ Reduced hauling cost

✓ Reduced capital cost



Reduced capital cost compared to status quo because digester costs are deferred

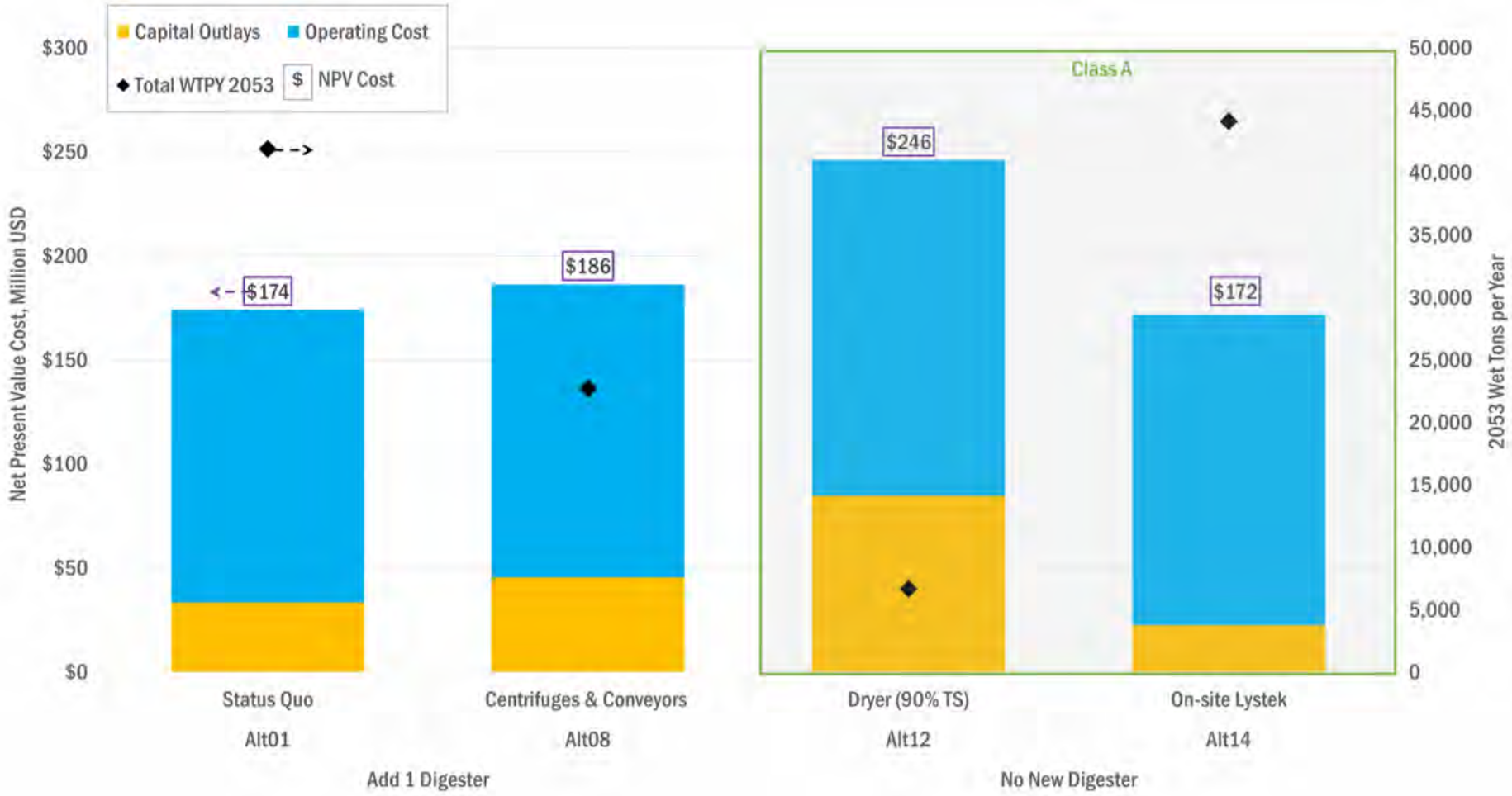
Shortlisted Alternatives

- ✓ Reduction in wet tons produced annually
- ✓ Reduced hauling cost
- ✓ Reduced capital cost
- ✓ Class A outlets



Shortlisted Alternatives

- ✓ Reduction in wet tons produced annually
- ✓ Reduced hauling cost
- ✓ Reduced capital cost
- ✓ Class A outlets
- ✓ Operational flexibility



Refined Alternatives Evaluation & Discussion

Brown AND Caldwell

“Refined” Alternatives Analysis Updates

- Refined capital costs
  - Based on vendor quotes for major equipment and cost estimation using RS Means and preliminary layout drawings
- Refined operating costs
  - Feedback from last workshop implemented. For example, land application limit (and land acquisition cost) is now based on nitrogen loading rather than wet tons.
- Refined lifecycle cost comparisons
  - Removed common projects across each alternative for better comparison (GBT and Gas Conditioning System capacity projects removed)
- Refined Deferred Digester Construction
  - Status Quo (Alt 01) and Centrifuges and Conveyors (Alt 08) assume digester capital costs are required now (2024)
  - Thermal Dryers (Alt 12) and On-Site Lystek (Alt 14) assumes digester capital costs are phased into CIP at year 2043 (defers construction by about 20 years)

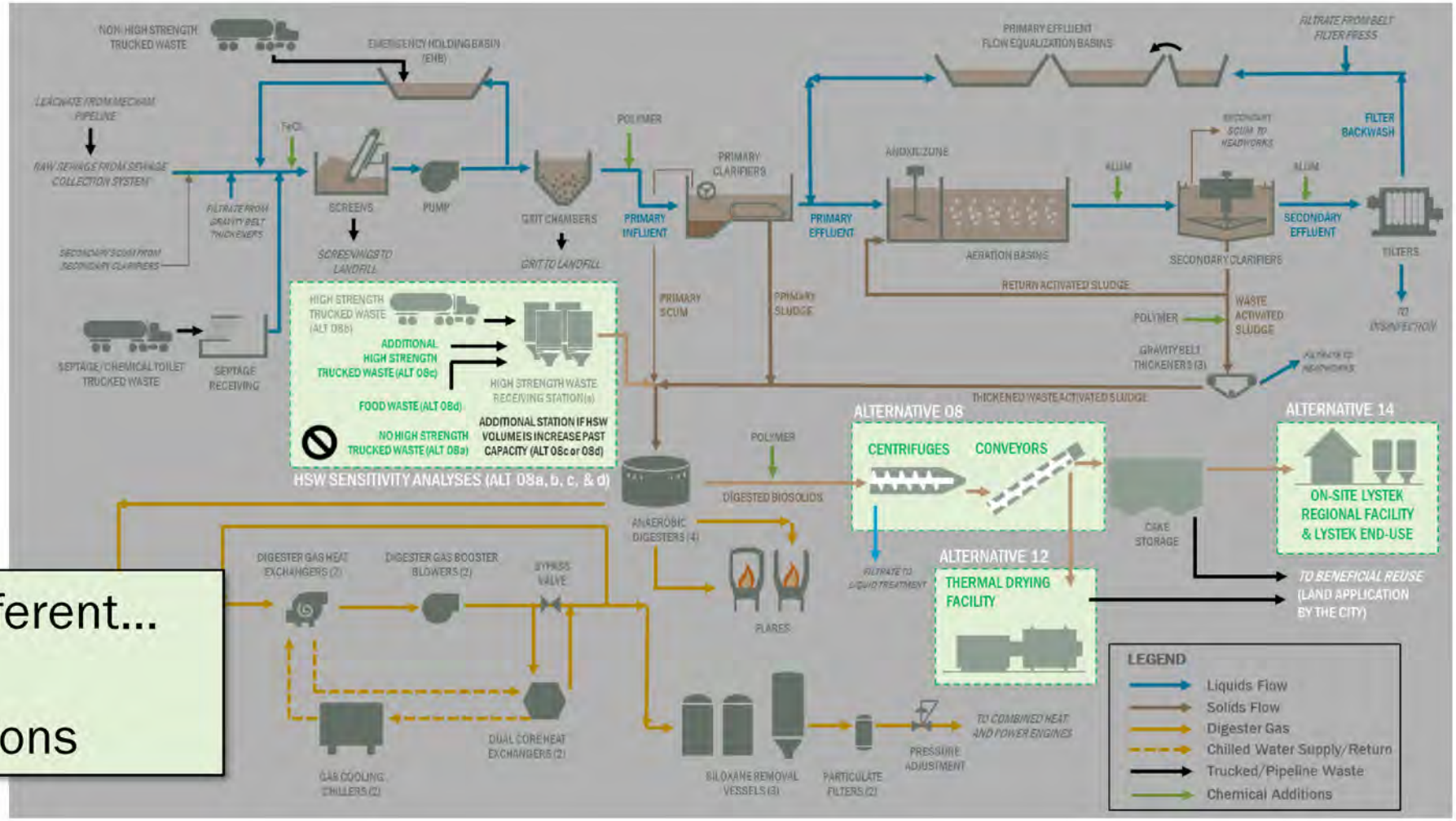
Alternatives in the Refined Evaluation

Alt 01. Status Quo

Alt 08. Centrifuges & Conveyors

Alt 12. Thermal Drying

Alt 14. On-site Lystek

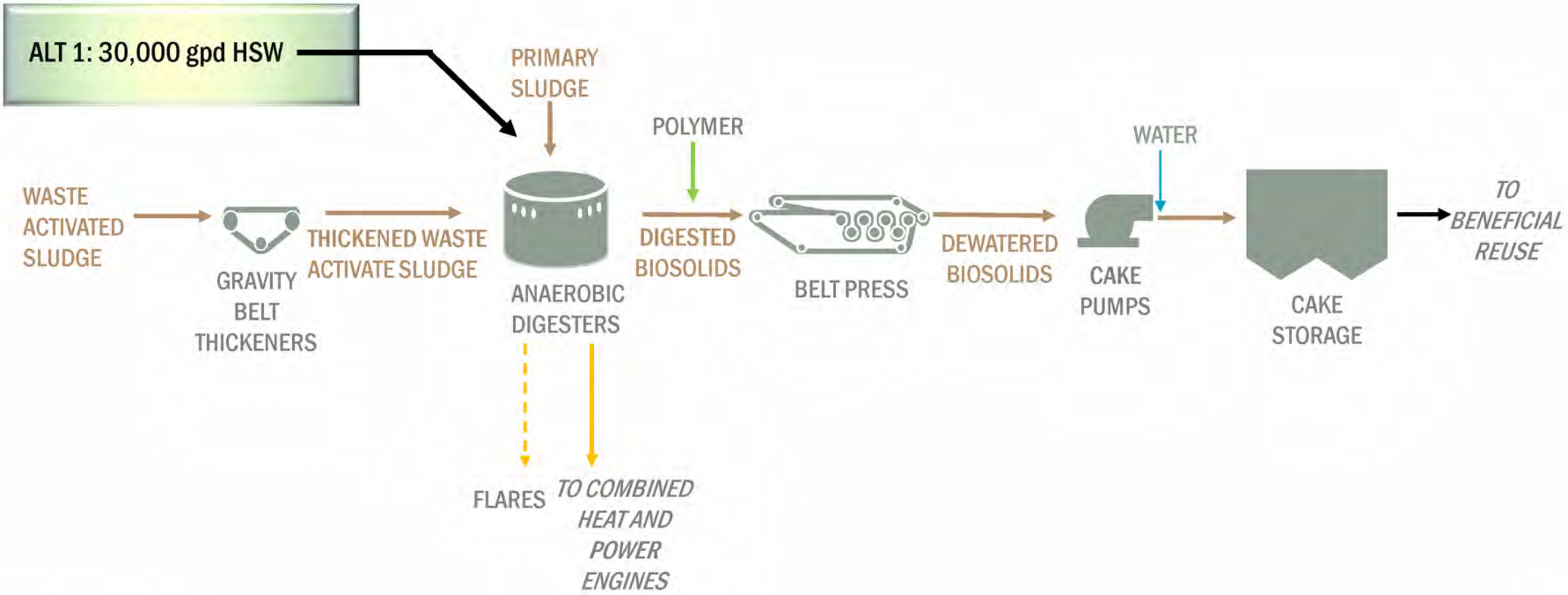


Each alternative has different…

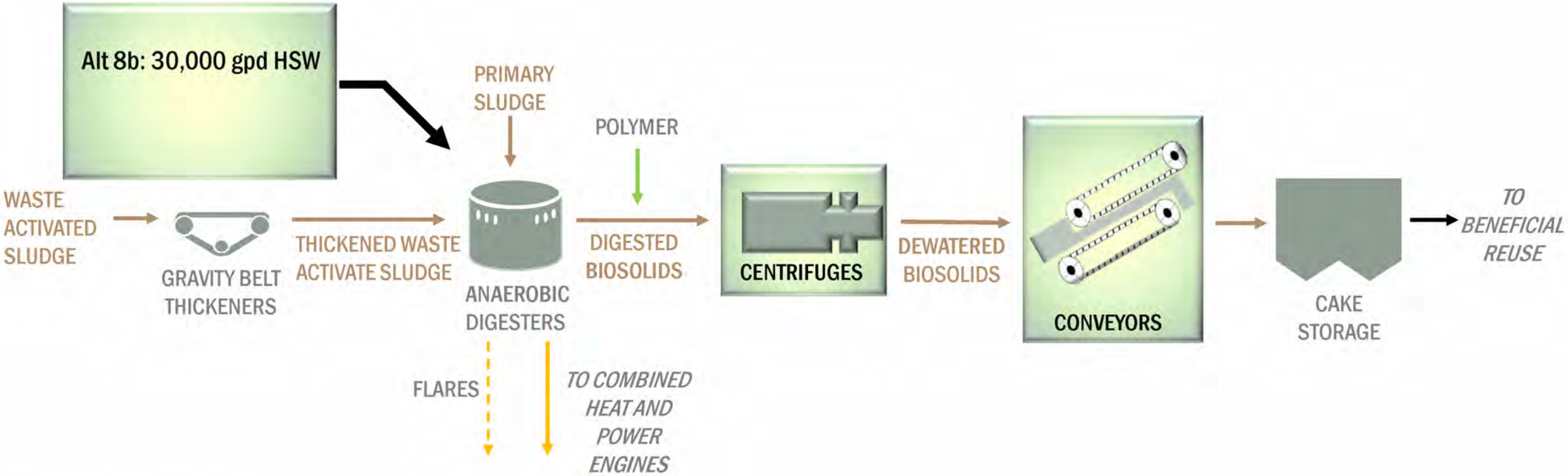
✓ Driver(s)

✓ Sensitivity considerations

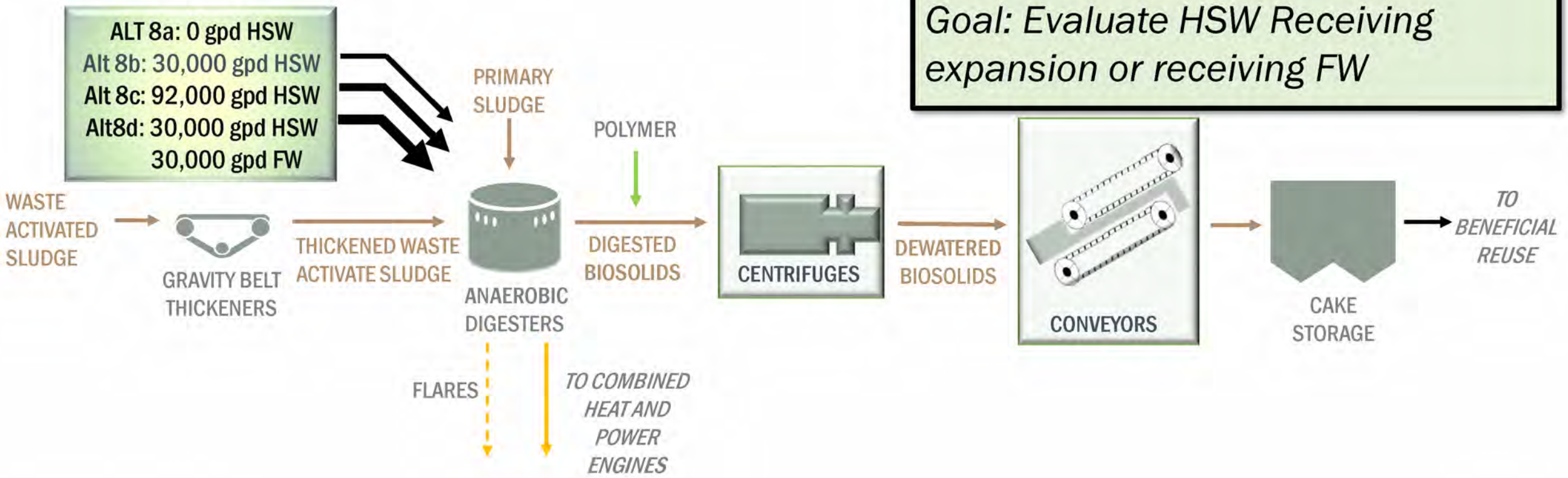
Alternative 01
Status Quo



Alternative 08
Add Centrifuges & Conveyors (25% TS)
Evaluate Economics with Drier Cake Product



Alternative 08
Add Centrifuges & Conveyors (25% TS)



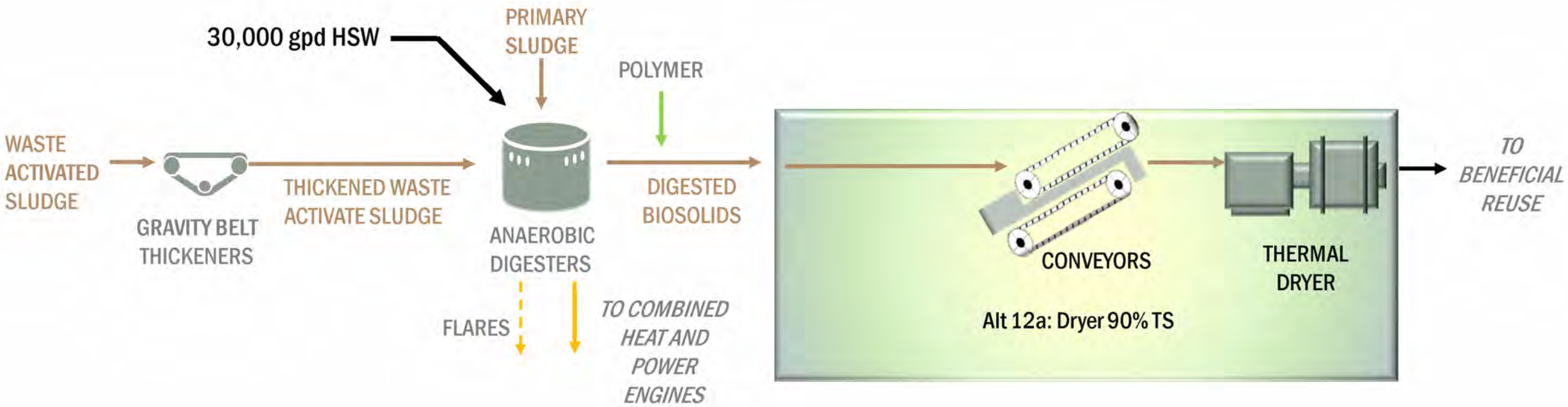
Sensitivity Analysis

Includes evaluation of:

1) No high strength waste (HSW),
2) Doubling HSW, or
3) Adding food waste (FW)

Goal: Evaluate HSW Receiving expansion or receiving FW

Alternative 12
Add Thermal Dryers (90% TS)
Class A Product / Significantly Drier Product / PFAS Mitigation Onramp

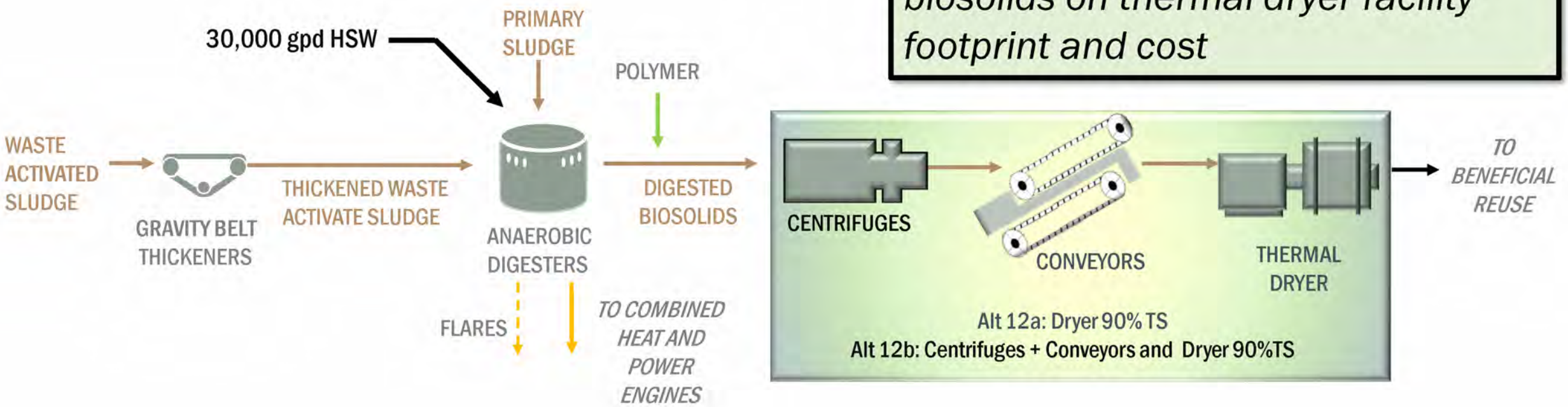


Alternative 12
Add Thermal Dryers (90% TS)

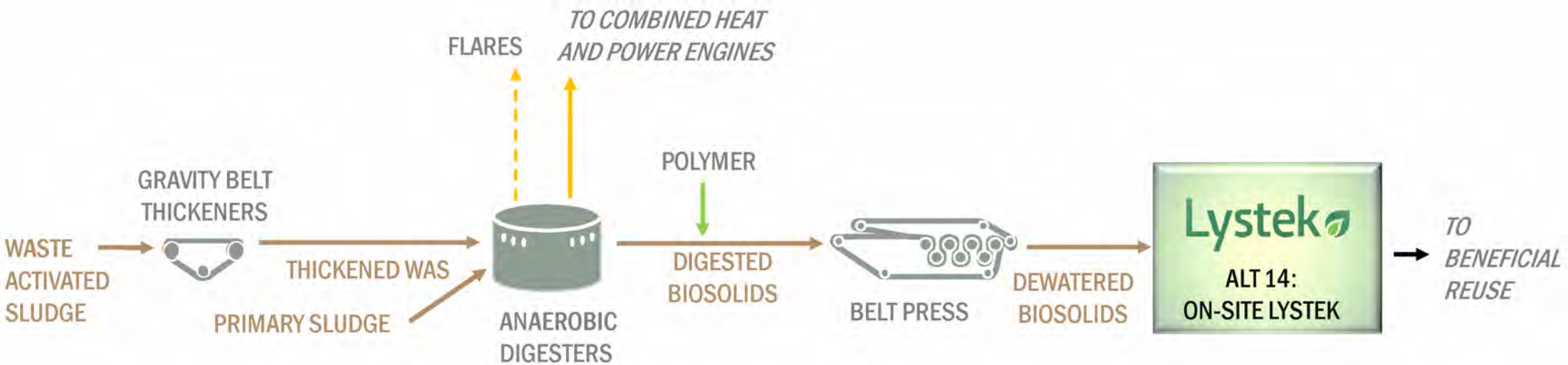
Sensitivity Analysis

Thermal dryer facility cost evaluated with and without centrifuges

Goal: Evaluate impact of drier biosolids on thermal dryer facility footprint and cost



Alternative 14
Onsite Lystek Facility
Class A Product / Offload End-use Operations / Regional Solution

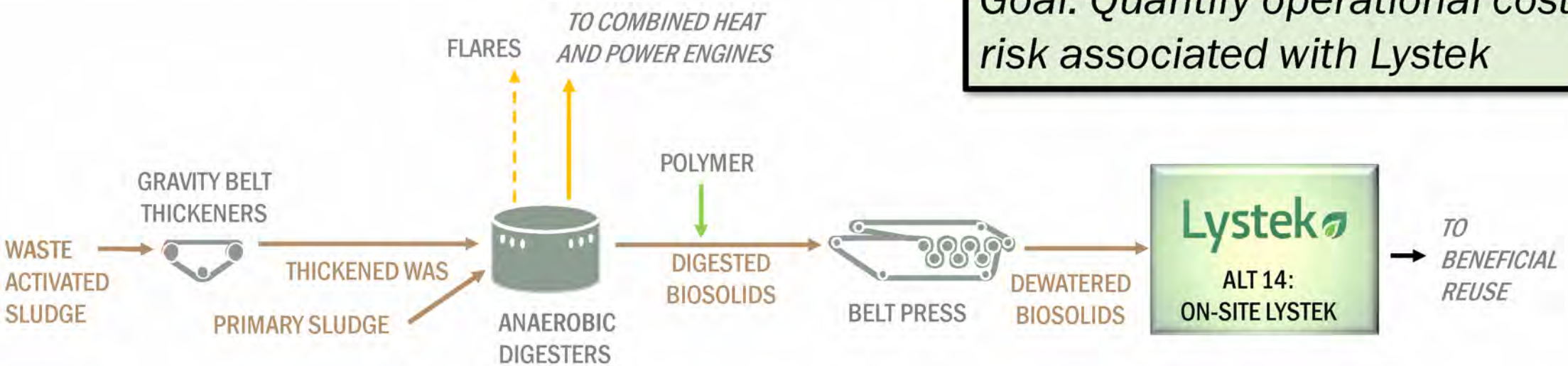


Alternative 14
Onsite Lystek Facility

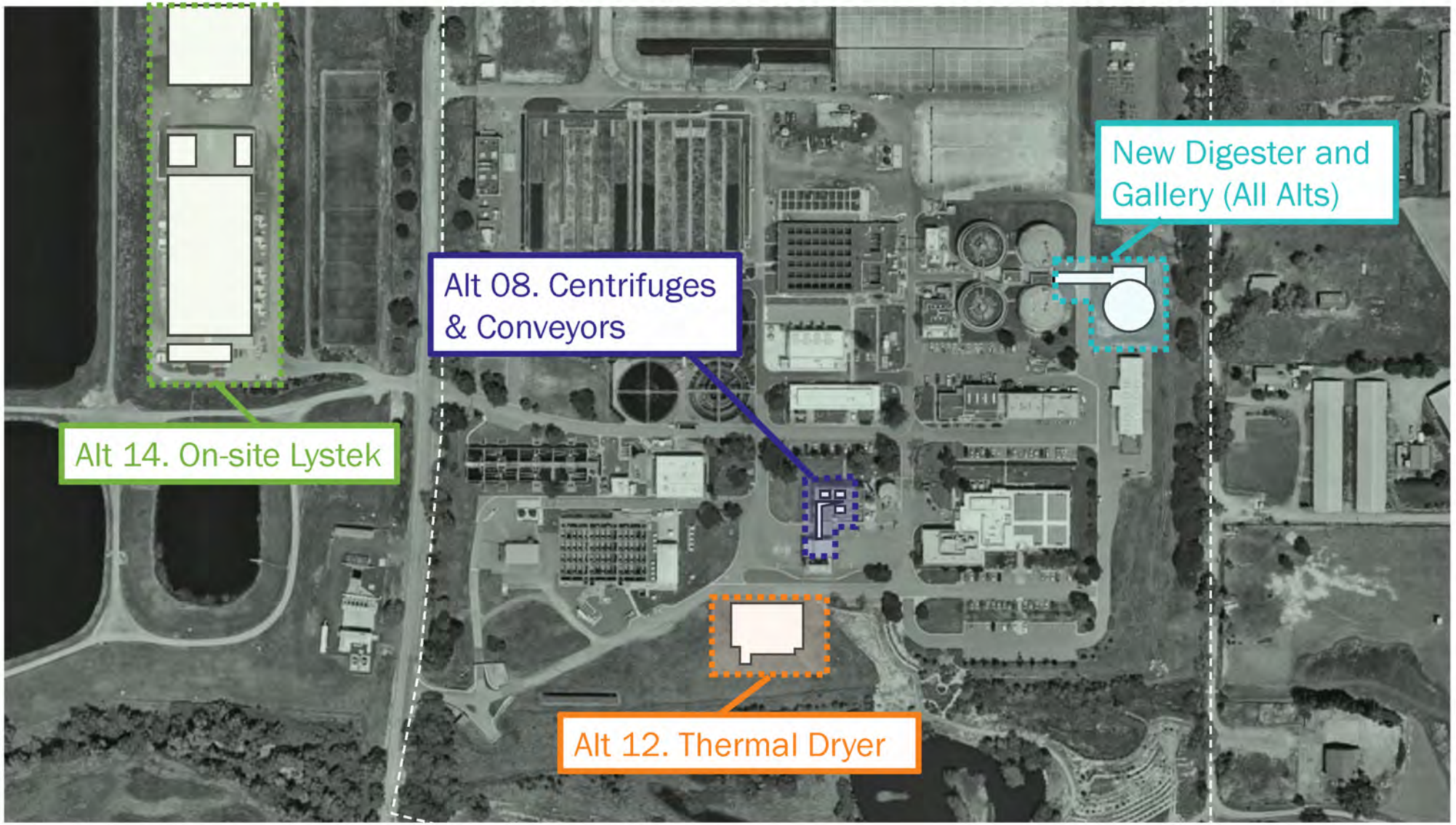
Sensitivity Analysis

Evaluate On-site Lystek lifecycle cost if contract pricing escalation doubles

Goal: Quantify operational cost risk associated with Lystek



Alternatives on Site Layout



Impacts to Labor Requirements

<table>
<tr><th></th><th>Alt 01.
Status Quo</th><th>Alt 08.
Centrifuges &
Conveyors</th><th>Alt 12.
Thermal Dryers</th><th>Alt 14.
On-Site Lystek</th></tr>
<tr><td>Dewatering Operations</td><td colspan="4">No change
1 FTE/yr modeled</td></tr>
<tr><td>Thermal Drying Operations</td><td>N/A</td><td>N/A</td><td rowspan="2">Increase in Effort

2 FTE/yr modeled</td><td>N/A</td></tr>
<tr><td>Biosolids Management</td><td>No change</td><td>Drier Biosolids

No FTE change in model</td><td>Change in Management Approach

No FTE change in model</td></tr>
</table>

NOTES: • FTE = Full Time Employee • “modeled” = assumption impacts operating cost calculations

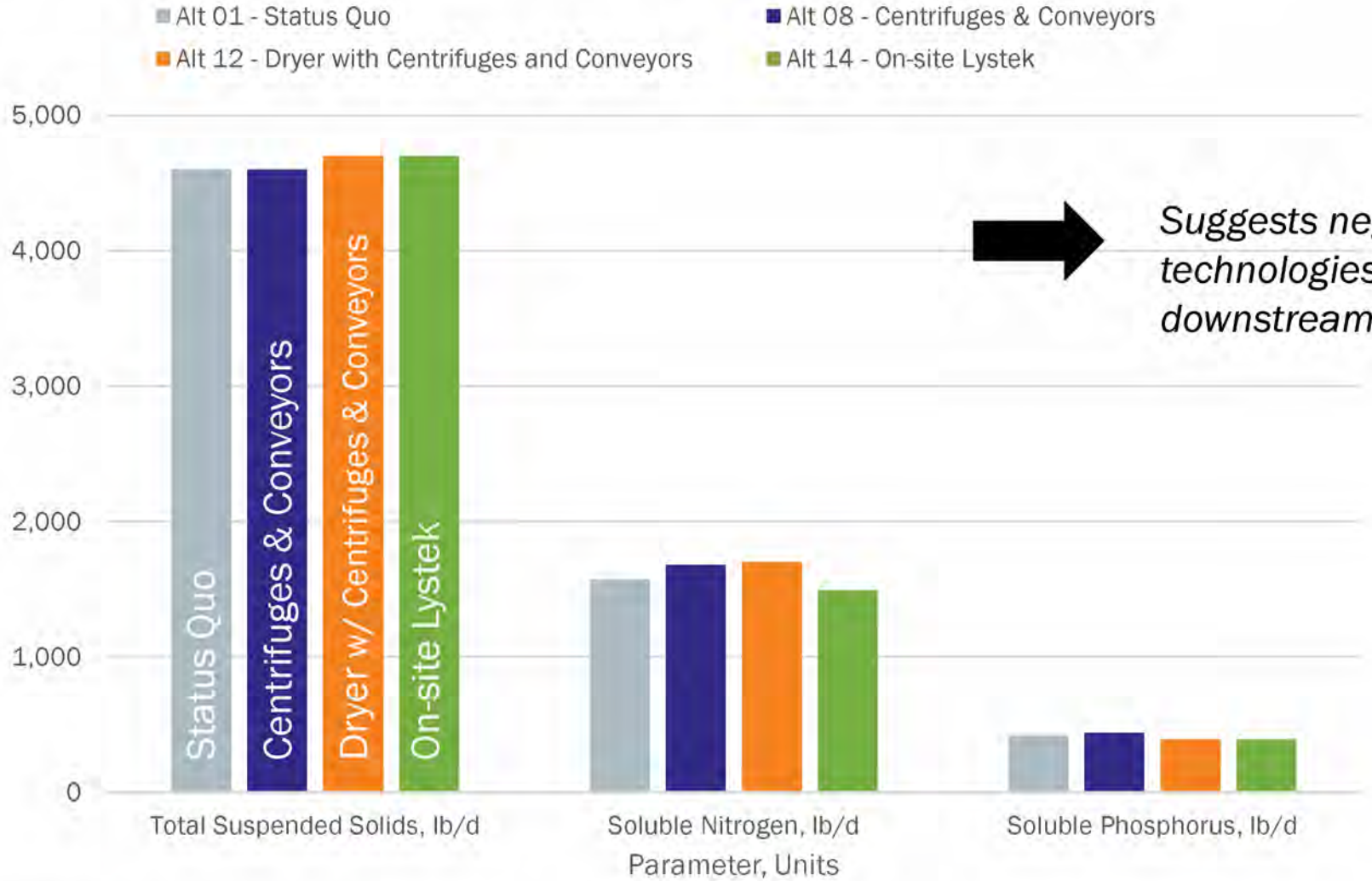
Impacts to Upstream/Downstream Processes

Project Description	New Digester Required Now					New Digester Deferred to 2043		
	01	08a	08b	08c	08d	12a	12b	14
New Anaerobic Digester and Gallery Now	✓	✓	✓	✓	✓			
New Anaerobic Digester and Gallery in 2043						✓	✓	✓
Replace BPs with Centrifuges		✓	✓	✓	✓		✓	
Switch Dewatering Progressive Cavity Pumps to Conveyors		✓	✓	✓	✓			
Construct New HSW Receiving Facility				✓	✓			
Install Thermal Dryer (15 percent cake) – two units						✓		
Install Thermal Dryer (25 percent cake) – one unit							✓	
Water Proofing to Alpha Barn						✓	✓	
Develop On-Site Lystek Facility (70,000 WT/yr capacity)								✓
Additional Land Acquisition Anticipated in Next 30 Years	✓	✓	✓	✓	✓			

Dryers or On-site Lystek alleviate strict 15-day HRT capacity constraint

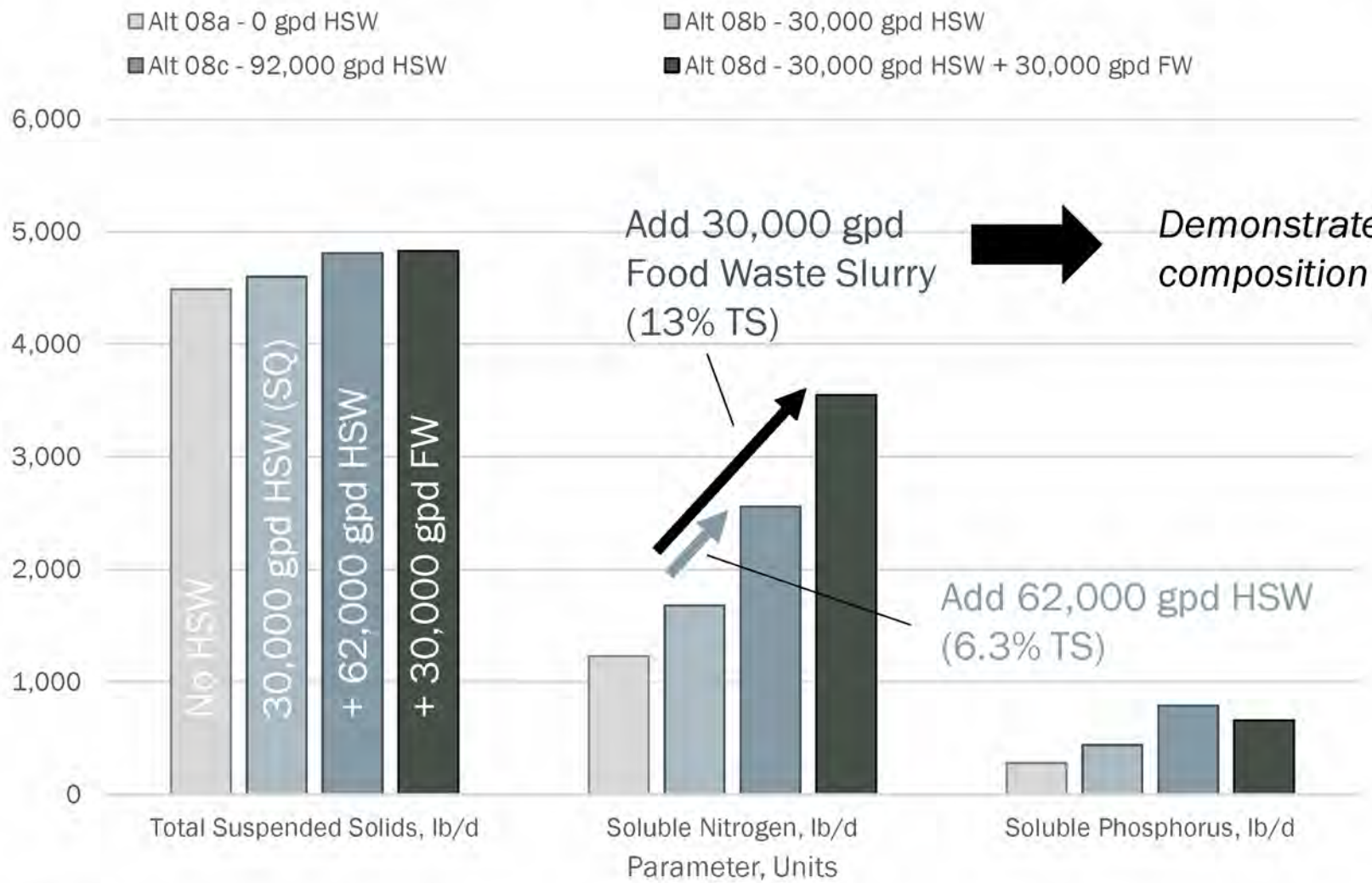
Dryers Impact Product Handling

Sidestream Impact from Alternatives



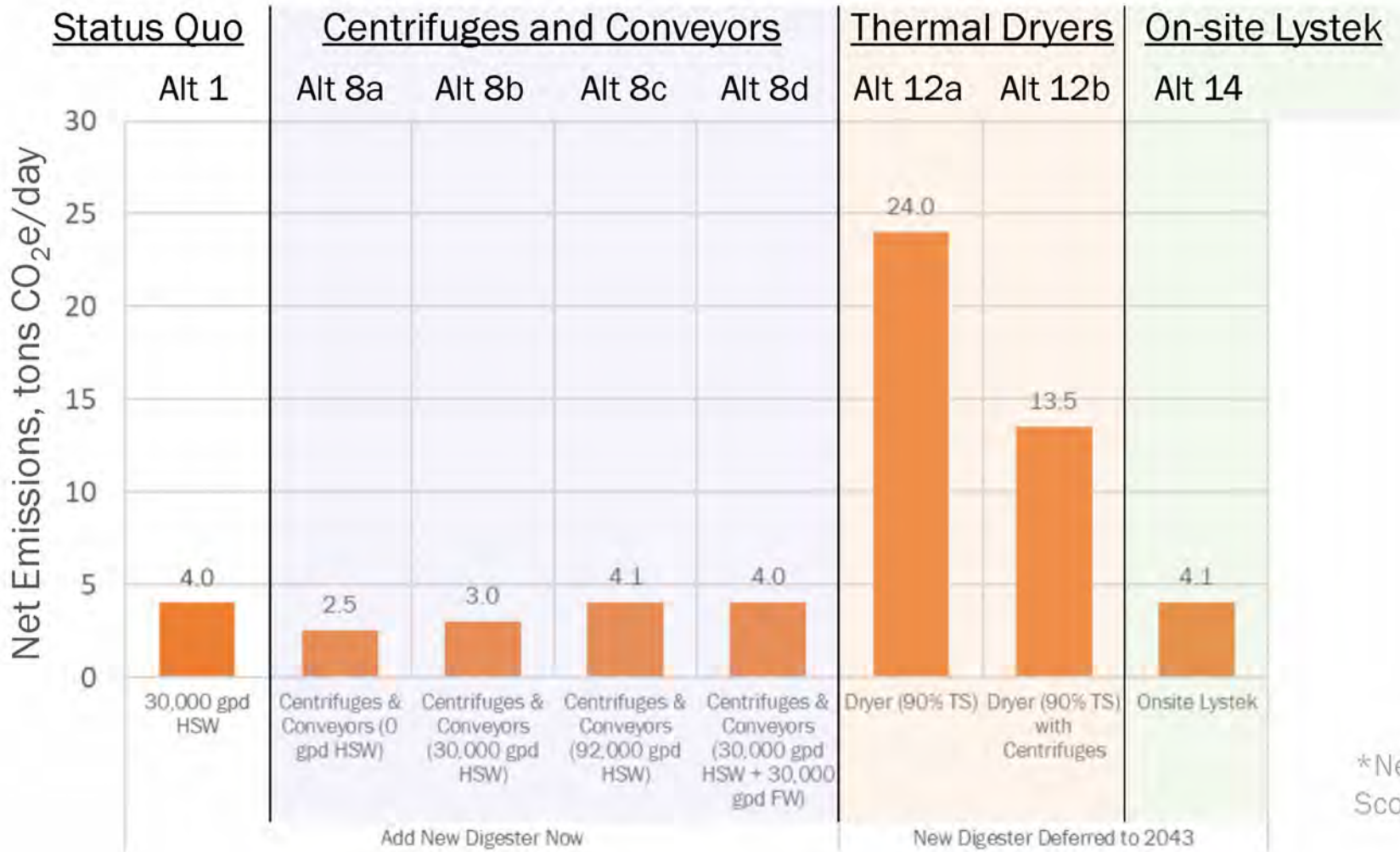
Suggests negligible impact from end-use technologies on the impact to downstream and upstream processes

Sidestream Impact from High Strength Waste



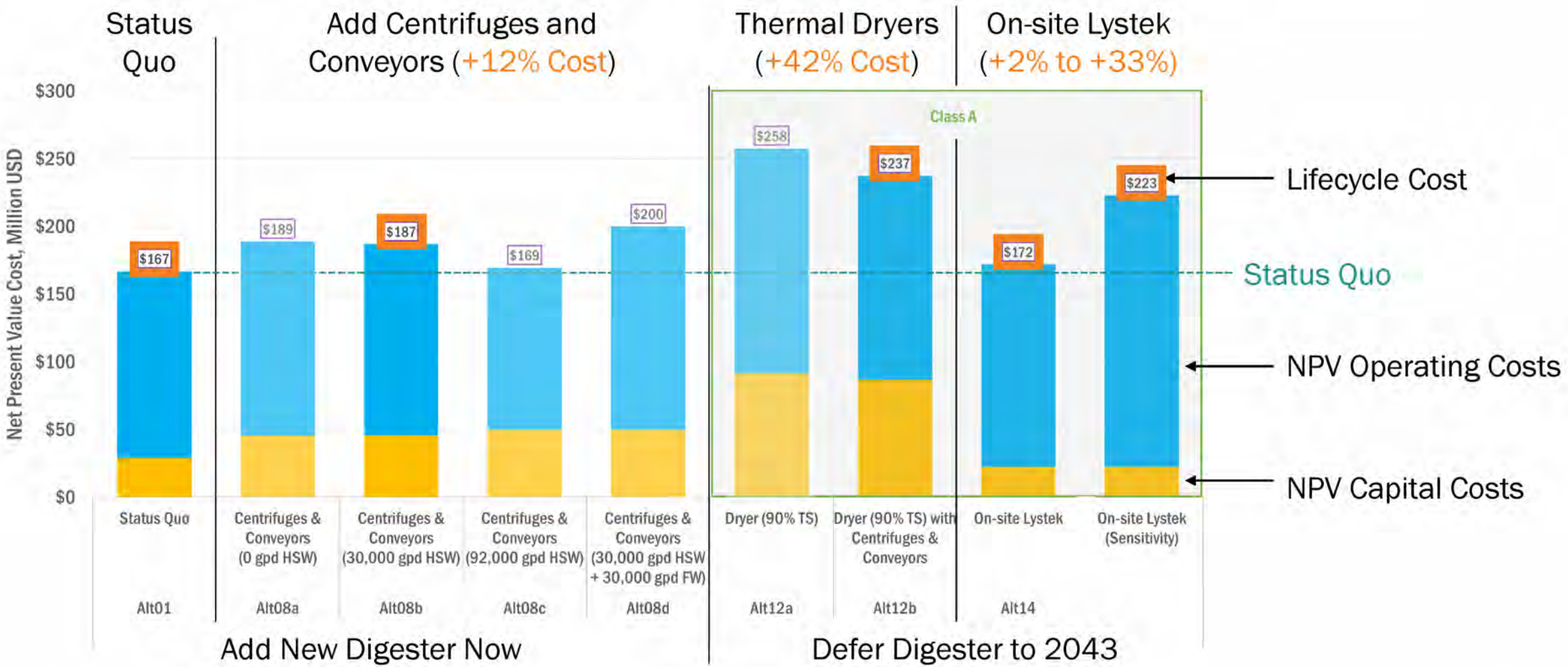
Demonstrates impact of feed stock composition on downstream processes

Greenhouse Gas Emission Estimates



*Net emissions include Scope 1 & Scope 2

Lifecycle Cost Analysis Results



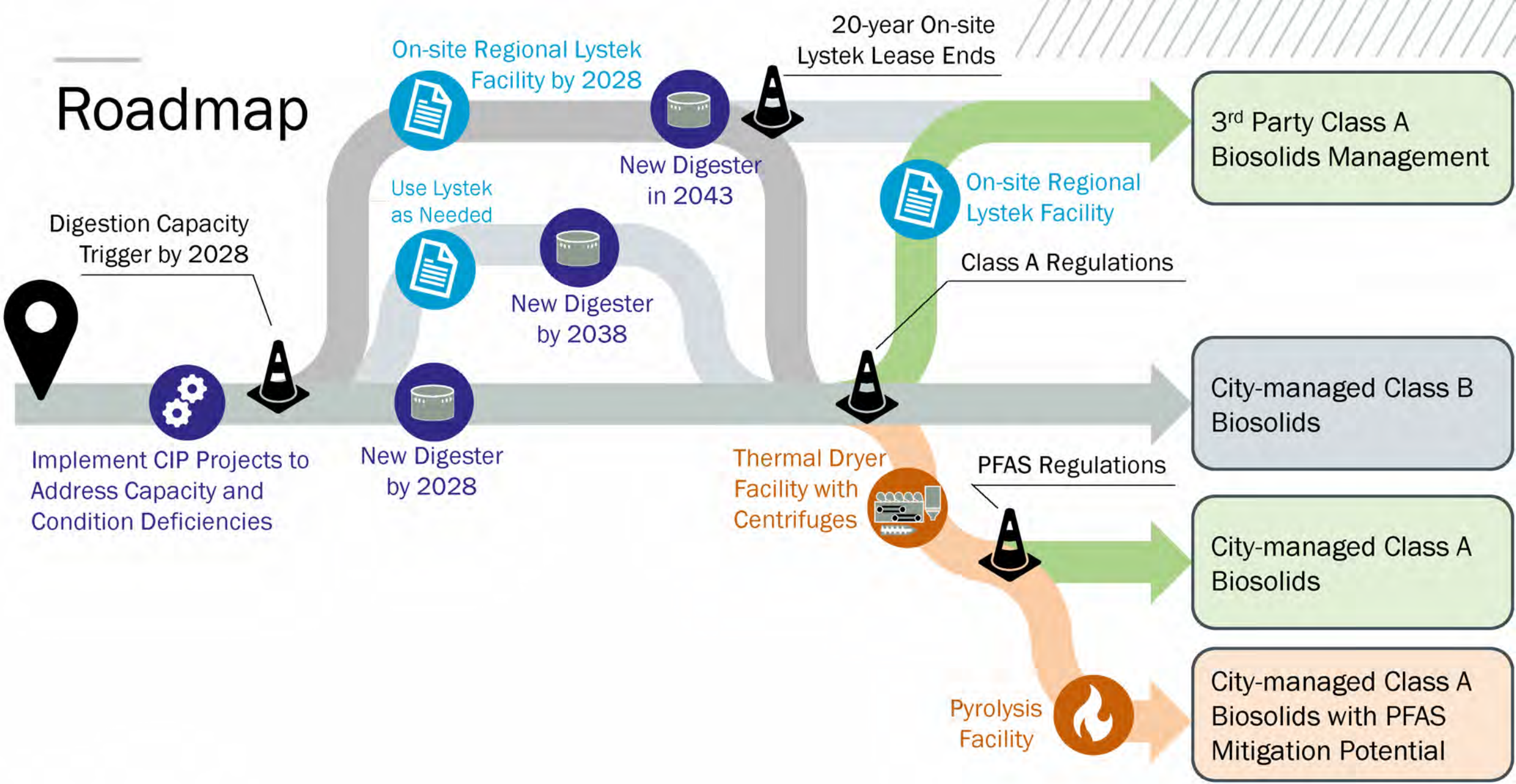
Why Status Quo?

Refined Alternatives Analysis Results & Recommendation

Alt. No.	Alternative Description	Biosolids Quality	30-year NPV Cost (Million $)	Non-Econ. Score	GHG Emissions (MT CO_2e/d)
01	• Status quo dewatering and end-use RECOMMENDED • Build (1) New Anaerobic Digester Now (by 2028)	Class B	Lowest $167	Lowest 61 of 100	Low (4.0)
08	• Replace dewatering equipment with Centrifuges and Conveyors • Build (1) New Anaerobic Digester Now (by 2028)	Class B	Higher $187	Lowest 61 of 100	Lowest (3.0)
12	• Build New Thermal Dryer Facility including Centrifuge for Dewatering before Drying • Build (1) New Anaerobic Digester by 2048	Class A	Highest $237	Middle 64 of 100	Highest (13.5)
14	• Build On-site Regional Lystek Facility; All biosolids to end-use • Build (1) New Anaerobic Digester by 2048	Class A	Higher $172-$223	Highest 68 of 100	Low (4.1)

Available option to defer digester construction
(Not recommended due to regulatory and annual contract pricing risk)

Roadmap


On-site Regional Lystek Facility by 2028
20-year On-site Lystek Lease Ends
New Digester in 2043
Use Lystek as Needed
On-site Regional Lystek Facility
3rd Party Class A Biosolids Management
Digestion Capacity Trigger by 2028
New Digester by 2038
Class A Regulations
City-managed Class B Biosolids
Implement CIP Projects to Address Capacity and Condition Deficiencies
New Digester by 2028
Thermal Dryer Facility with Centrifuges
PFAS Regulations
City-managed Class A Biosolids
Pyrolysis Facility
City-managed Class A Biosolids with PFAS Mitigation Potential



Brown AND Caldwell

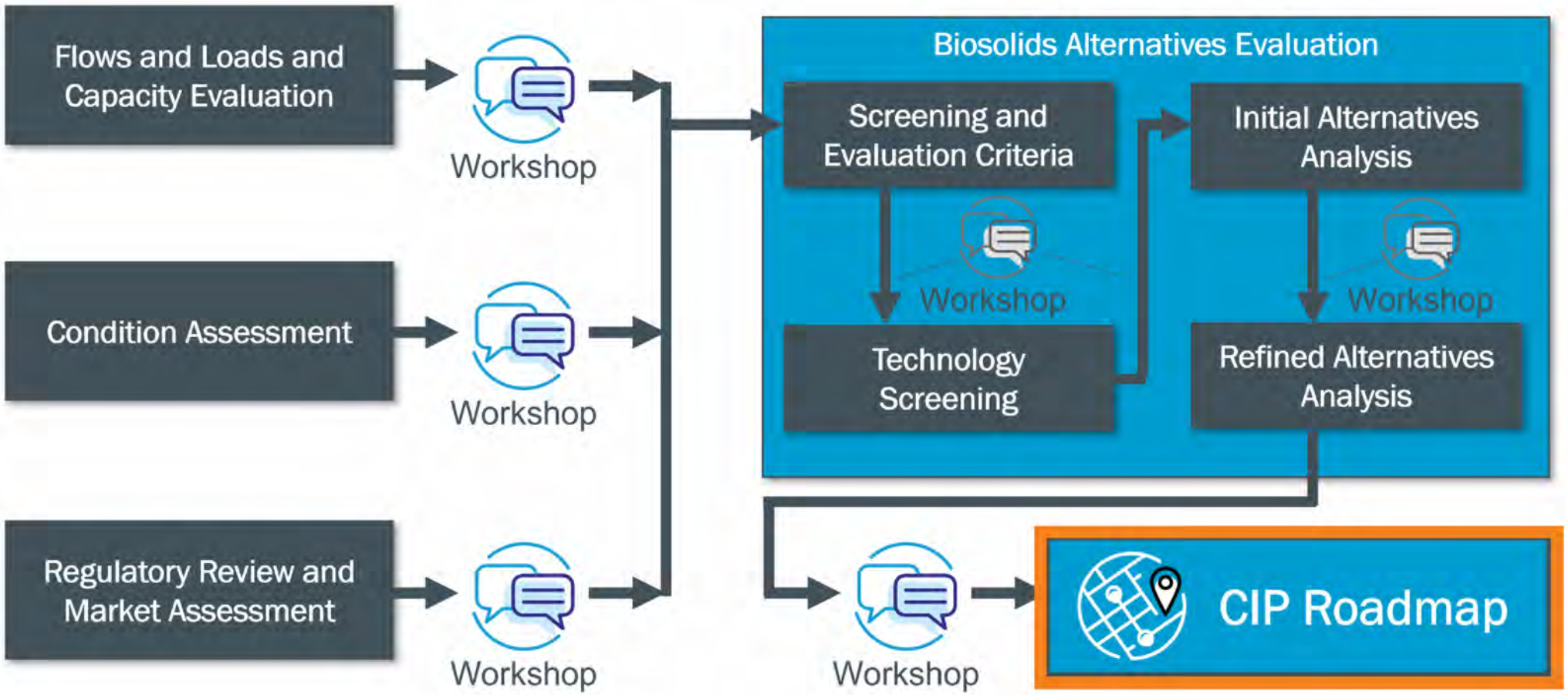
Biosolids Management Strategic Plan

Capital Improvements Implementation Plan

City of Santa Rosa

January 11, 2024

Biosolids Management Strategic Plan





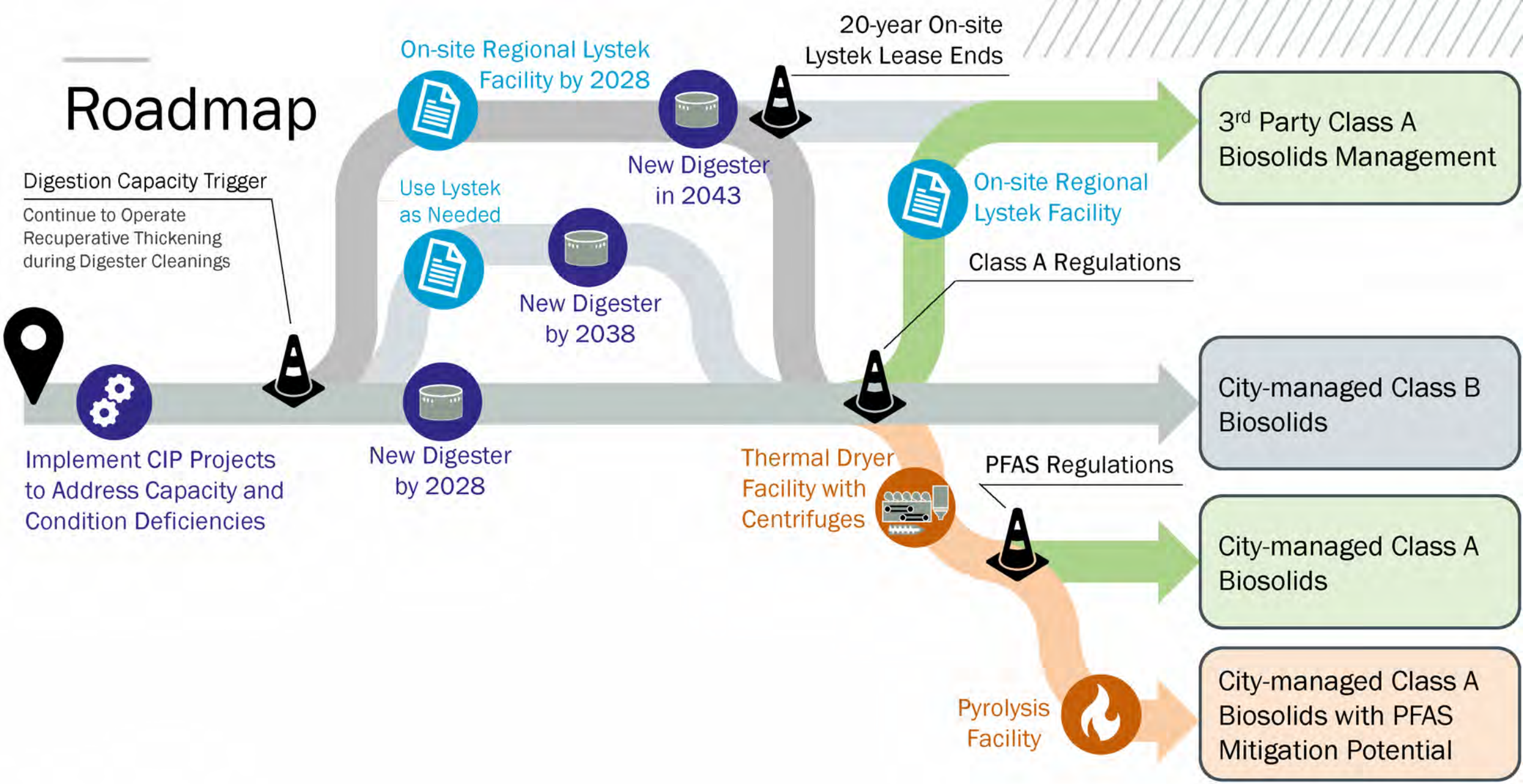
What are the goals of today's workshop?

- Review 20-year capital improvements implementation plan.
- Identify near-term projects that should be prioritized now. Discuss early actions.
- Identify long-term project that should be tracked in City's LTP master plan.
- Review trucked waste program implications and recommendations.

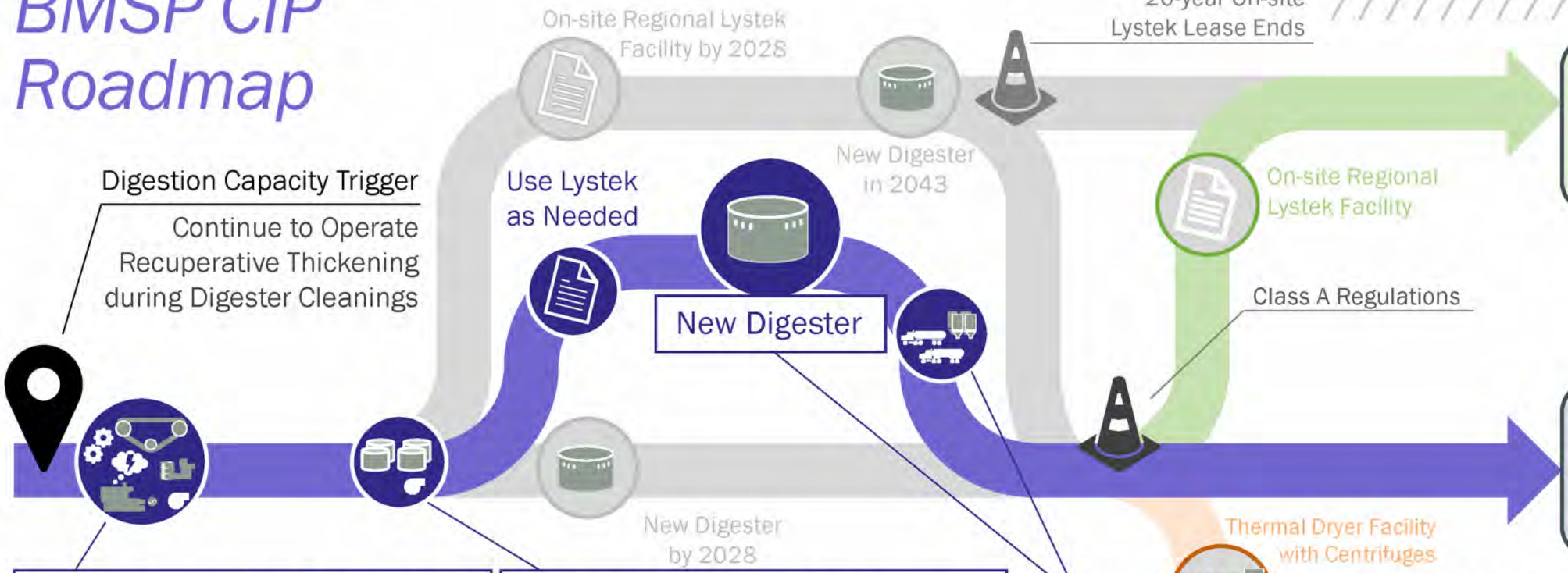
20-Year Capital Improvements Implementation Plan

Brown AND Caldwell

Roadmap


On-site Regional Lystek Facility by 2028
20-year On-site Lystek Lease Ends
New Digester in 2043
3rd Party Class A Biosolids Management
Digestion Capacity Trigger
Continue to Operate Recuperative Thickening during Digester Cleanings
Use Lystek as Needed
On-site Regional Lystek Facility
New Digester by 2038
Class A Regulations
Implement CIP Projects to Address Capacity and Condition Deficiencies
New Digester by 2028
Thermal Dryer Facility with Centrifuges
City-managed Class B Biosolids
PFAS Regulations
City-managed Class A Biosolids
Pyrolysis Facility
City-managed Class A Biosolids with PFAS Mitigation Potential

BMSP CIP Roadmap



1-3 Year Projects — $ 27.6 million (2024-2028)

Address priority capacity and condition deficiencies:

- Add 1 GBT ($2.9 mil)
- Structural Improvements ($0.6 mil)
- Replace digester sludge pump ($0.6 mil)
- $FeCl_3$ improvements ($0.8 mil)
- Electrical site improvements ($2.3 mil)
- HSW odor improvements ($0.2 mil)
- Replace GBT sludge pump ($0.4 mil)
- Increase GCS capacity ($17 mil)
- SCR installations at CHP ($1.9 mil)
- Paving and signage for HSW trucks ($1 mil)

3-5 Year Projects — $ 46.9 million (2028-2033)

Address additional deficiencies and optimize operations:

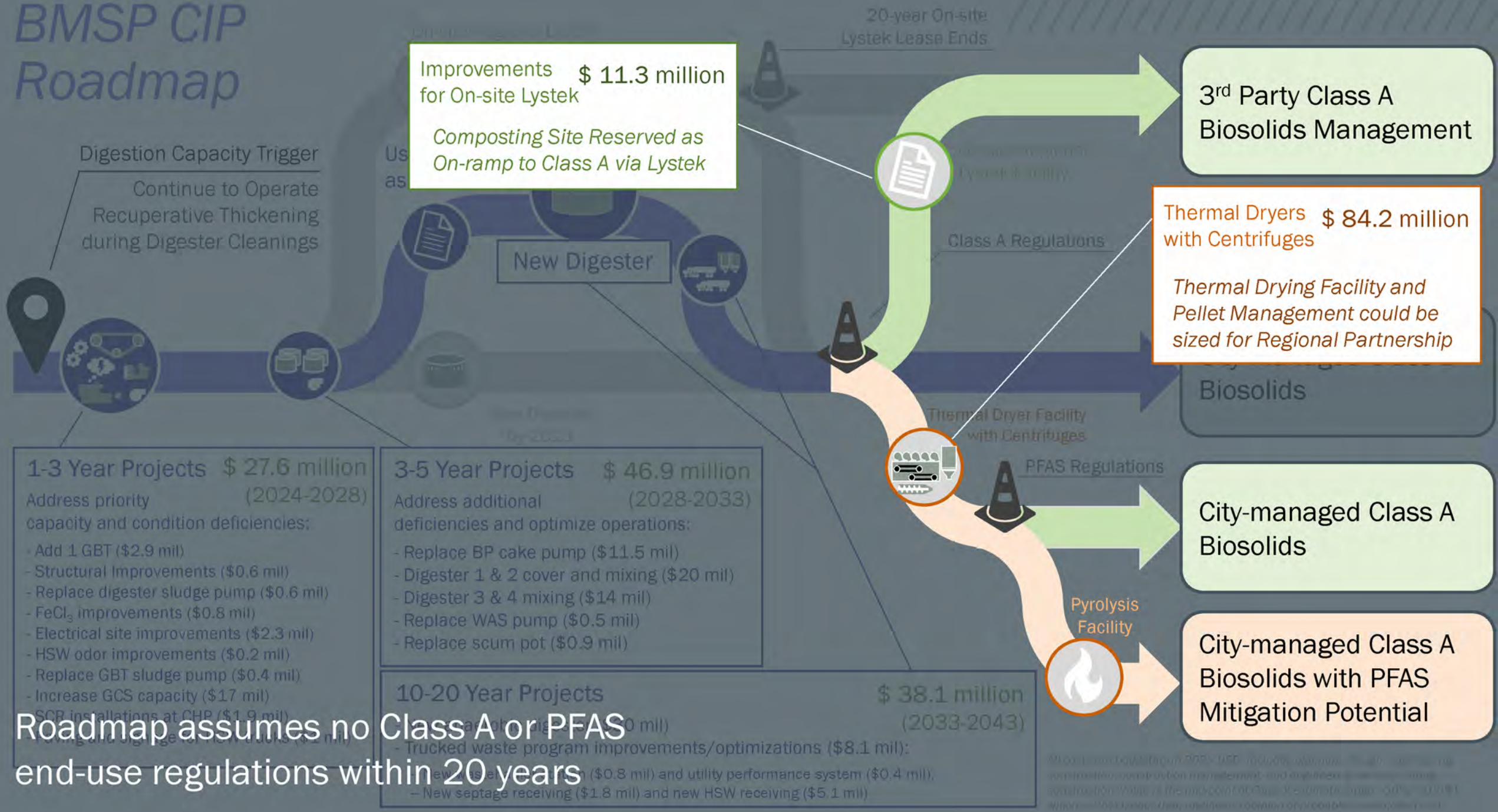
- Replace BP cake pump ($11.5 mil)
- Digester 1 & 2 cover and mixing ($20 mil)
- Digester 3 & 4 mixing ($14 mil)
- Replace WAS pump ($0.5 mil)
- Replace scum pot ($0.9 mil)

10-20 Year Projects — $ 38.1 million (2033-2043)

- New anaerobic digester ($30 mil)
- Trucked waste program improvements/optimizations ($8.1 mil):
  - -- New wastehauler station ($0.8 mil) and utility performance system ($0.4 mil),
  - -- New septage receiving ($1.8 mil) and new HSW receiving ($5.1 mil)

All costs are budgetary in 2023 USD. Includes planning, design, engineering, construction, construction management, and engineering services during construction. Value is the mid-point of Class V estimate range (-50%/+100%), which is 25% higher than engineer's opinion of probable construction cost.

BMSP CIP Roadmap



Roadmap assumes no Class A or PFAS end-use regulations within 20 years

Near Term Projects

Brown AND Caldwell

1 to 3 Year Projects

Early action opportunity (easy start)

Cost optimization opportunity

#	Project / Component	Design + Constr. Duration (years)	Planning, Design, & Permitting Cost	Total Project Cost
1	Add 1 GBT to Existing Thickening Building	1 + 1	$0.4 mil	$2.9 mil
2	Structural Improvements	1 + 1	$0.1 mil	$0.6 mil
3 *	Digester Sludge to Dewatering Pump	1	$0.1 mil	$0.6 mil
4 *	Ferric Chloride Improvements	1	$0.2 mil	$0.8 mil
5	Electrical Site Improvements	1 + 1	$0.3 mil	$2.3 mil
6	High Strength Waste Odor Scrubber Improvements	1	$10k	$0.2 mil
7 *	GBT Sludge Pump Replacement	1 + 1	$0.1 mil	$0.4 mil
8	Increase Gas Conditioning System Capacity	1 + 2	$2.0 mil	$17.0 mil
9	SCR Installation for CHP Engines 1 and 2	1 + 2	$0.3 mil	$1.9 mil
10	Paving and Signage to Reroute Trucked Waste Program Traffic	1	--	$1.0 mil

* Opportunity to complete these projects in-house with vendor or consultant design guidance to lower costs.

3 to 5 Year Projects

Early action opportunity (easy start)

Cost optimization opportunity

#	Project / Component	Design + Constr. Duration (years)	Planning, Design, & Permitting Cost	Total Project Cost
11	Belt Press Cake Pump Replacement	1 + 1	$1.7 mil	$11.5 mil
12	Digester 1 and 2 Cover Replacement and Mixing Improvements	1 + 2	$3.0 mil	$20.0 mil
13	Digester 3 and 4 Mixing Improvements	1 + 2	$2.5 mil	$14.0 mil
14 *	WAS Pump Replacement	1	$0.1 mil	$0.5 mil
15 *	Scum Pot Replacement	1	$0.2 mil	$0.9 mil

Note: BC recommended polymer injection pilot testing at existing belt press cake pumps. This has potential to decrease dilution water and could be tested in near term (1-3 years).

* Opportunity to complete these projects in-house with vendor or consultant design guidance to lower costs.

Long-term Projects

Brown AND Caldwell

10 to 20 Year Projects

#	Project / Component	Design + Constr. Duration (years)	Planning, Design, & Permitting Cost	Total Project Cost
16	New Anaerobic Digester and Gallery	1 + 2	$4.0 mil	$30 mil
17	New Wastehauler Station	1 + 1	$0.1 mil	$0.8 mil
18	Utility Performance System Integration and Analytics	1	--	$0.4 mil
19	New Septage Receiving Station	1 + 1	$0.3 mil	$1.8 mil
20	New HSW Receiving Station	1 + 1	$0.5 mil	$5.1 mil

Trucked Waste Program
Findings and Recommendations

Brown AND Caldwell

Trucked Waste Program Recommendations

Program Baseline

- Profitable
- Valuable service to community
- All costs are born by LTP
- All revenue goes to LTP operations
- Risk to LTP operations if additional staffing/monitoring improvements are not implemented

Program Future

- BC recommends NOT expanding Program UNTIL solids and biogas treatment capacity limitations are addressed
- Trucked waste from the Program impacts capacity
- BC recommends investing revenues from program into staffing and capital improvements (e.g., monitoring improvements or capacity expansion) to secure:
  - Program reliability and operations
  - Mitigation of risk to LTP operations
  - Community benefits
  - Long-term revenue to LTP and City

Next Steps

Brown AND Caldwell

Biosolids Management Strategic Plan Next Steps

January

- Part 2 of CIP Roadmap Workshop (1/29)
- Submit Draft Capital Improvements Implementation Plan Report following 2nd Workshop
- Submit Final Capital Improvements Implementation Plan Report (1/31)
  - Includes all:
    - Final TMs, Final meeting minutes,
    - CIP 11x17 and Project Components Worksheets

February through August

- Early action on near-term projects or optimizations?
- Contract end date: September 2024
- As-need budget remaining: $30,000



Biosolids Management Strategic Plan

Capital Improvements Implementation Plan Workshop 2

January 29, 2024

City of Santa Rosa

What are the goals of today's workshop?



- Review business case evaluation for the construction of new digester and solids treatment projects
- Recommendation to address capacity and condition needs for LTP solids treatment

Digesters are out of capacity.

BMSP has identified
15 projects over next 5 years.

Lack of CIP funding

defers projects

causes

higher O&M costs

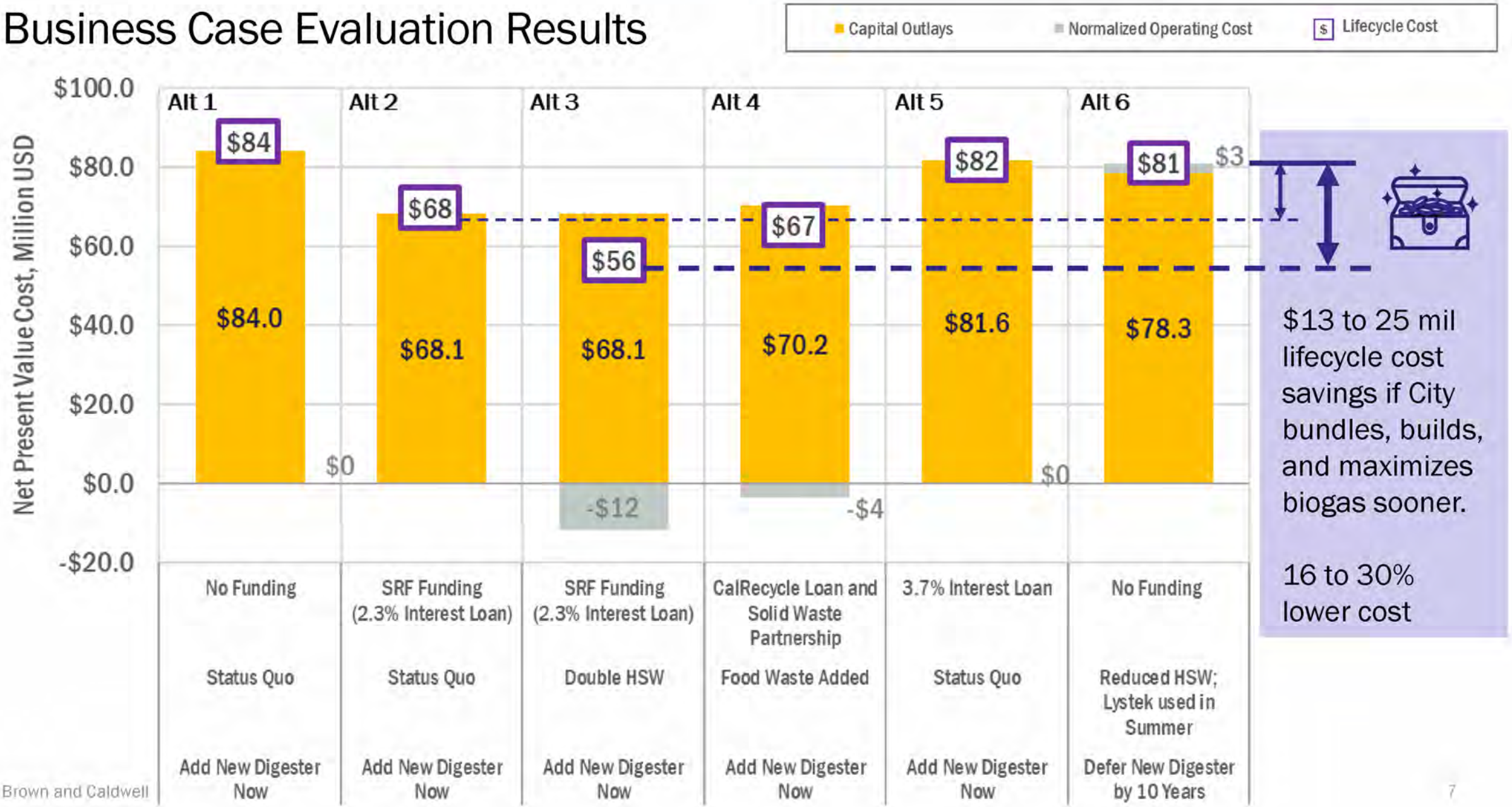
and

more risk.

By deferring projects, City will curtail HSW digestion, eliminate a profitable program, and fall out of sync with funding opportunities.

Is there a way to
increase capacity,
streamline delivery, and
align with funding opportunities?

Business Case Evaluation Results



Get funding-ready by advancing the project to 30 percent design.

Apply for and pursue all funding opportunities.

What types of projects are getting funding now?

Projects that …

Reduce greenhouse gas emissions

Increase renewable energy

What are your low interest funding opportunities?

State Revolving Fund (SRF)

Bond sale

Infrastructure and Economic Development Bank (IBank)

CalRecycle

Supplemental Slides

Not reviewed during workshop

Brown AND Caldwell

Next Steps

Brown AND Caldwell

Biosolids Management Strategic Plan Next Steps

January

- Part 2 of CIP Roadmap Workshop (1/29)
- Submit Draft Capital Improvements Implementation Plan Report following 2nd Workshop
- Submit Final Capital Improvements Implementation Plan Report
  - Includes all:
    - Final TMs, Final meeting minutes,
    - CIP 11x17 and Project Components Worksheets

February through August

- Early action on near-term projects or optimizations?
- Contract end date: September 2024
- As-need budget remaining: $20,000

Review of Projects

Brown AND Caldwell

1 to 3 Year Projects

Early action opportunity (easy start)

Cost optimization opportunity

#	Project / Component	Design + Constr. Duration (years)	Planning, Design, & Permitting Cost	Total Project Cost
1	Add 1 GBT to Existing Thickening Building	1 + 1	$0.4 mil	$2.9 mil
2	Structural Improvements	1 + 1	$0.1 mil	$0.6 mil
3 *	Digester Sludge to Dewatering Pump	1	$0.1 mil	$0.6 mil
4 *	Ferric Chloride Improvements	1	$0.2 mil	$0.8 mil
5	Electrical Site Improvements	1 + 1	$0.3 mil	$2.3 mil
6	High Strength Waste Odor Scrubber Improvements	1	$10k	$0.2 mil
7 *	GBT Sludge Pump Replacement	1 + 1	$0.1 mil	$0.4 mil
8	Increase GCS Capacity (H_2S Vessels and Digester Gas Piping)	1 + 1	$1.2 mil	$6.2 mil
9	SCR Installation for CHP Engines 1 and 2	1 + 2	$0.3 mil	$1.9 mil
10	Paving and Signage to Reroute Trucked Waste Program Traffic	1	--	$1.0 mil

* Opportunity to complete these projects in-house with vendor or consultant design guidance to lower costs.

3 to 5 Year Projects

Early action opportunity (easy start)

Cost optimization opportunity

#	Project / Component	Design + Constr. Duration (years)	Planning, Design, & Permitting Cost	Total Project Cost
11	Belt Press Cake Pump Replacement	1 + 1	$1.7 mil	$11.5 mil
12	Digester 1 and 2 Cover Replacement and Mixing Improvements	1 + 2	$3.0 mil	$20.0 mil
13	Digester 3 and 4 Mixing Improvements	1 + 2	$3.9 mil	$15.0 mil
14 *	WAS Pump Replacement	1	$0.1 mil	$0.5 mil
15 *	Scum Pot Replacement	1	$0.2 mil	$0.9 mil

Note: BC recommended polymer injection pilot testing at existing belt press cake pumps. This has potential to decrease dilution water and could be tested in near term (1-3 years).

* Opportunity to complete these projects in-house with vendor or consultant design guidance to lower costs.

10 to 20 Year Projects

#	Project / Component	Design + Constr. Duration (years)	Planning, Design, & Permitting Cost	Total Project Cost
16	New Anaerobic Digester and Gallery	1 + 2	$4.0 mil	$30 mil
17	New Wastehauler Station	1 + 1	$0.1 mil	$0.8 mil
18	Utility Performance System Integration and Analytics	1	--	$0.4 mil
19	New Septage Receiving Station	1 + 1	$0.3 mil	$1.8 mil
20	New HSW Receiving Station	1 + 1	$0.5 mil	$5.1 mil

Example of Decrease in Project Number

- Add 1 GBT to Existing Thickening Building
- Structural Improvements
- Digester Sludge to Dewatering Pump
- Ferric Chloride Improvements
- Electrical Site Improvements
- High Strength Waste Odor Scrubber Improvements
- GBT Sludge Pump Replacement
- Increase GCS Capacity (H_2S Vessels and Digester Gas Piping)
- SCR Installation for CHP Engines 1 and 2
- Paving and Signage to Reroute Trucked Waste Program Traffic
- Belt Press Cake Pump Replacement
- Digester 1 and 2 Cover Replacement and Mixing Improvements
- Digester 3 and 4 Mixing Improvements
- WAS Pump Replacement
- Scum Pot Replacement
- New Anaerobic Digester and Gallery
- New Wastehauler Station
- Utility Performance System Integration and Analytics
- New Septage Receiving Station
- New HSW Receiving Station

- New GBT and GBT Pump
- Digester Sludge to Dewatering Pump
- Ferric Chloride Improvements
- High Strength Waste Odor Scrubber Improvements

- Digestion, Solids Handling, and Gas Utilization Project

- Paving/Signage to Reroute Trucked Waste Program Traffic
- New Wastehauler Station
- Utility Performance System Integration and Analytics
- New Septage Receiving Station
- New HSW Receiving Station

Business Case Evaluation

Background and Objectives

1. New anaerobic digester is needed to address capacity constraints.
2. Digester has high budgetary capital cost ($30 million) but could be deferred through the use of recuperative thickening during digester cleanings.
3. Deferral of digester construction presents risk to the City due to:
   - Recuperative thickening necessity during cleanings,
   - Potential use of Lystek during cleanings in summer months, and
   - HSW reduction due to lack of digestion capacity.
4. Funding (grants, loans, partnerships) opportunities were investigated.
5. A business case evaluation was completed. Evaluated the different in lifecycle cost between digester construction now versus 10 years later.

Business Case Evaluation *Assumptions/Scenarios*

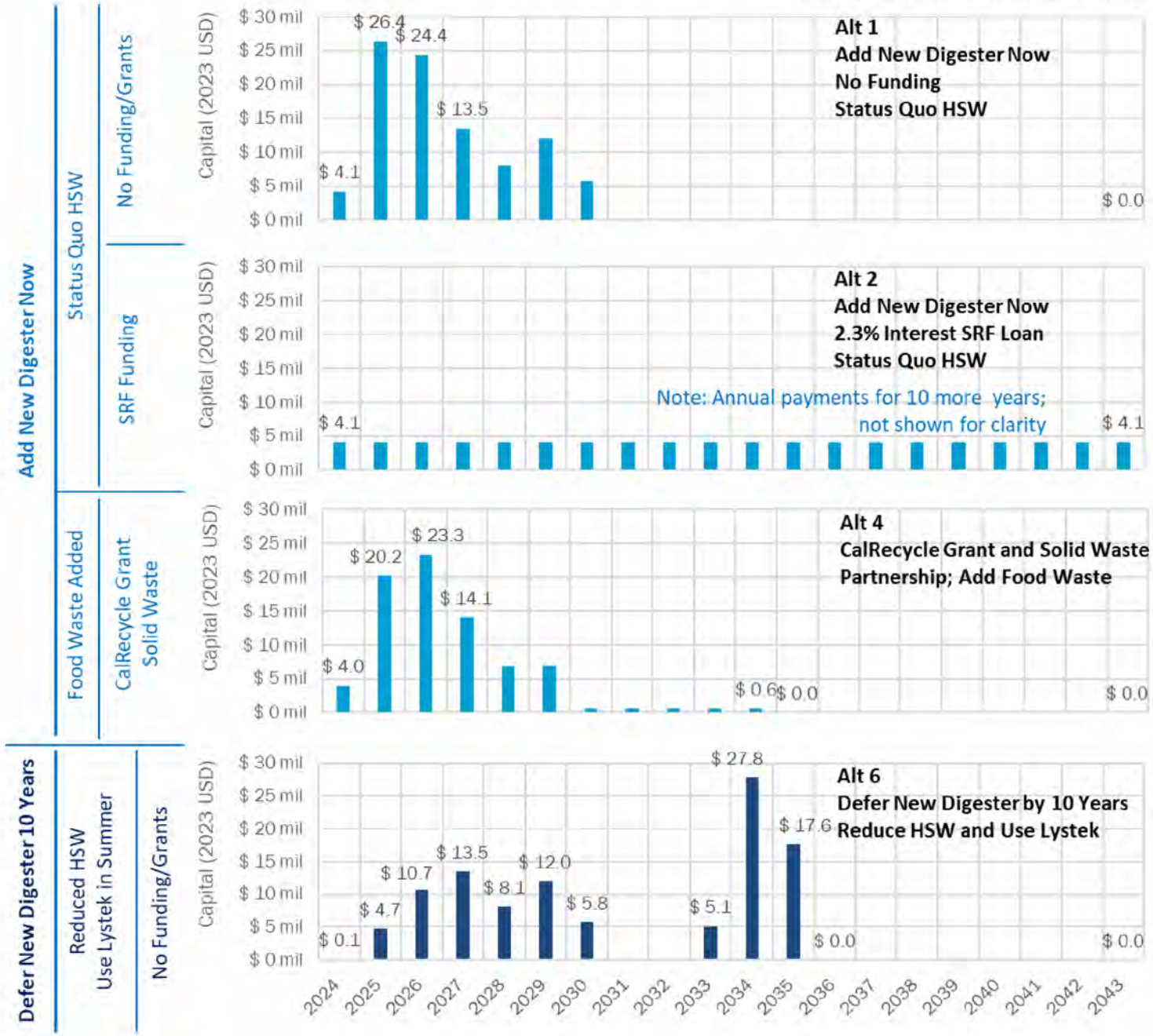
Parameter	Alt 1. Status Quo	Alt 2. SRF Funding	Alt 3. SRF Funding + Add HSW	Alt 4. CalRecycle + Add FW	Alt 5. 3.7% Interest Loan (sensitivity)	Alt 6. Digester Deferral (Lower HSW)
Digester Construction	Start planning, design, and construction process now					Defer by 10 years
Funding/ Loans	None	2.3% annual interest loan	2.3% annual interest loan	4% annual interest loan	3.7% annual interest loan	None
Partnership /Grants	None	None	None	Solid Waste Partnership	None	None
HSW Receiving	Same amount	Same amount	Double HSW	Add Food Waste	Same amount	Decrease HSW 5%/yr
Projects Required*	5-7 projects	1 project	1 project	5-7 projects	1 project	5-7 projects

*New digester/gallery; GCS optimization and upsize biogas piping; 2 SCRs; Digester 1 & 2 cover replacement, mixing improvements, and coating; Digester 3 & 4 mixing improvements and coating; BP cake pump replacement; *and* new GBT and GBT pump replacement.

NPV Assumptions:

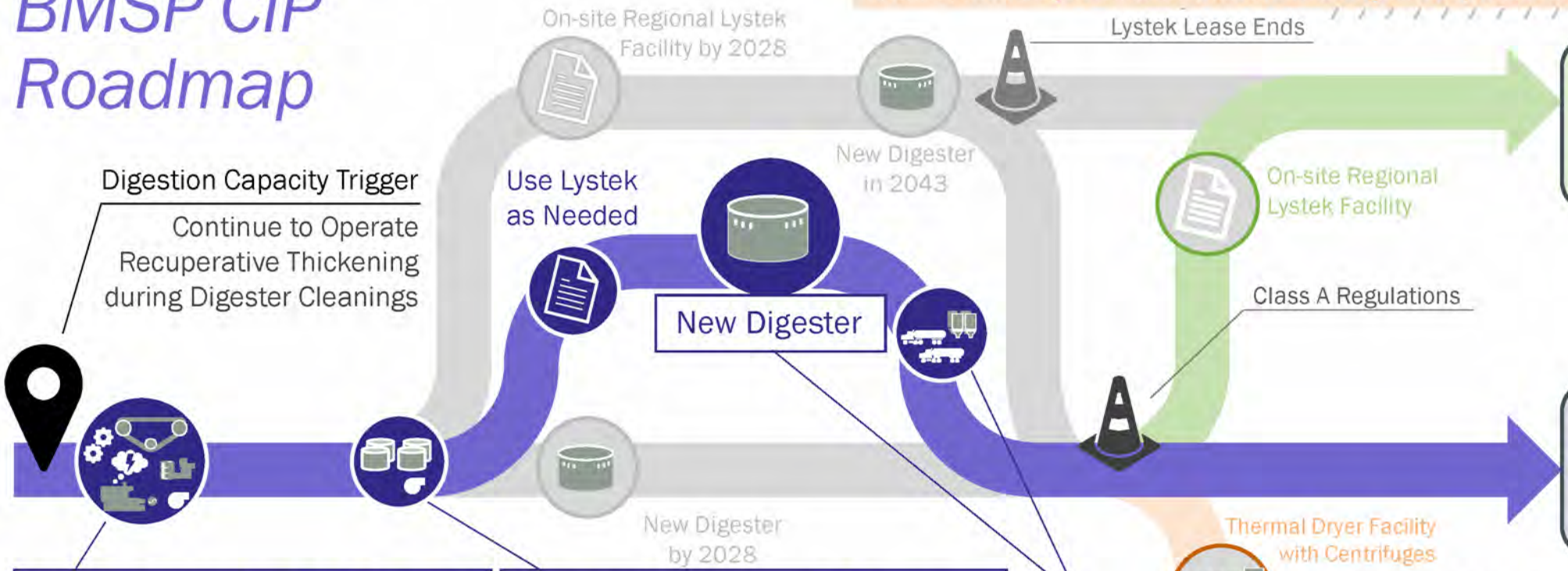
- 4.7% discount rate
- 30-year period

Capital Outlays Modeled in Business Case Evaluation Scenarios



BMSP CIP Roadmap

ARCHIVE; Note: Analysis refinements based on meeting minutes provided at end of this slide set



1-3 Year Projects — $ 16.8 million (2024-2028)

Address priority capacity and condition deficiencies:

- Add 1 GBT ($2.9 mil)
- Structural Improvements ($0.6 mil)
- Replace digester sludge pump ($0.6 mil)
- $FeCl_3$ improvements ($0.8 mil)
- Electrical site improvements ($2.3 mil)
- HSW odor improvements ($0.2 mil)
- Replace GBT sludge pump ($0.4 mil)
- Increase GCS capacity ($6.2 mil)
- SCR installations at CHP ($1.9 mil)
- Paving and signage for HSW trucks ($1 mil)

3-5 Year Projects — $ 47.9 million (2028-2033)

Address additional deficiencies and optimize operations:

- Replace BP cake pump ($11.5 mil)
- Digester 1 & 2 cover and mixing ($20 mil)
- Digester 3 & 4 mixing ($15 mil)
- Replace WAS pump ($0.5 mil)
- Replace scum pot ($0.9 mil)

10-20 Year Projects — $ 38.1 million (2033-2043)

- New anaerobic digester ($30 mil)
- Trucked waste program improvements/optimizations ($8.1 mil):
  - -- New wastehauler station ($0.8 mil) and utility performance system ($0.4 mil),
  - -- New septage receiving ($1.8 mil) and new HSW receiving ($5.1 mil)

All costs are budgetary in 2023 USD. Includes planning, design, engineering, construction, construction management, and engineering services during construction. Value is the mid-point of Class V estimate range (-50%/+100%), which is 25% higher than engineer's opinion of probable construction cost.

Business Case Evaluation for City of Santa Rosa's Laguna Treatment Plant Biosolids Management Strategic Plan Capital Improvements Plan

Brown AND Caldwell

Business Case Evaluation Alternatives

Alts 1 thru 5
New Digester Now

Cons

- City funding barrier

Pros

- Continue HSW program
- Alignment with CA organic co-digestion goals
- Alignment with CA and federal renewable power goals
- Restores solids treatment system to adequate level of service and capacity
- Helps City maintain low biosolids handling costs
- Self-generation of energy protects City from rising power prices

Alt 6
Defer Digester by 10 Years

Cons

- Digesters are currently out of capacity
- Recuperative thickening required for permit compliance
- Increased risk of additional Lystek hauling costs if Class B compliance is not met due to digestion capacity limitations
- Risk of HSW program curtailment without new digester
- Risk of stranded assets if HSW customers leave due to program curtailment

Pros

- Could save money if biosolids regulations change significantly

Business Case Evaluation Alternatives

City missed 40% construction cost savings via IRA;

Insufficient project development, Insufficient capital for other 60% of construction cost.

Predesign documents position the City for funding opportunities.

Alts 1 thru 5
New Digester Now

Cons

- City funding barrier

Pros

- Continue HSW program
- Alignment with CA organic co-digestion goals
- Alignment with CA and federal renewable power goals
- Restores solids treatment system to adequate level of service and capacity
- Helps City maintain low biosolids handling costs
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Alt 6
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- Increased risk of additional Lystek hauling costs if Class B compliance is not met due to digestion capacity limitations
- Risk of HSW program curtailment without new digester
- Risk of stranded assets if HSW customers leave due to program curtailment

Pros

- Could save money if biosolids regulations change significantly

City on precipice of not having enough capacity to rehab existing capacity.

Recuperative thickening is not a standard operating condition by most wastewater treatment plants.

This is a band-aid measure and not recommended to be a default operation for an extended period

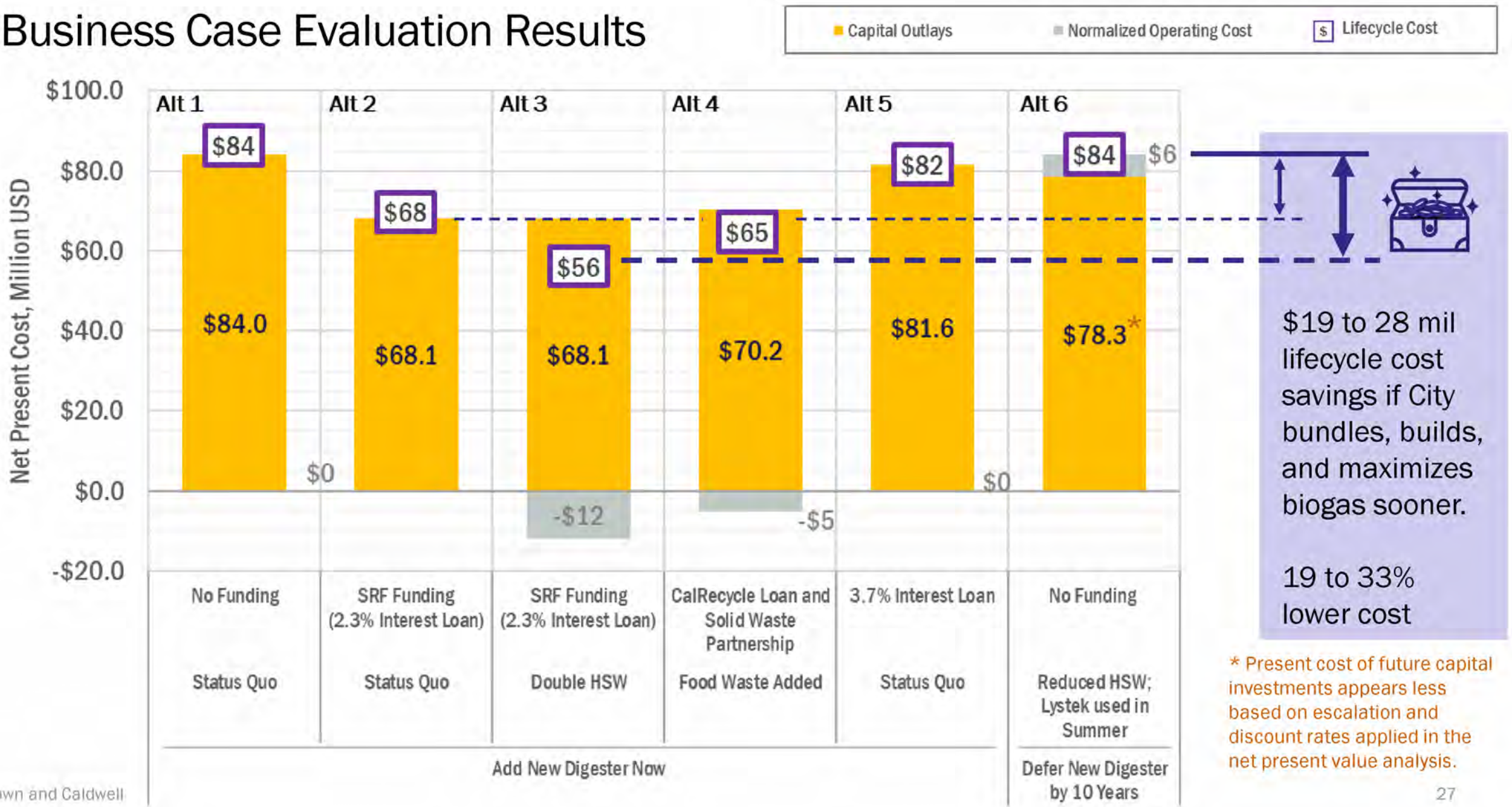
City currently pays about $40/wet ton for biosolids end use – which is about half the cost other facilities pay in the region.

Any failure in solids system could triple disposal cost.

Cost deferral is no longer possible.

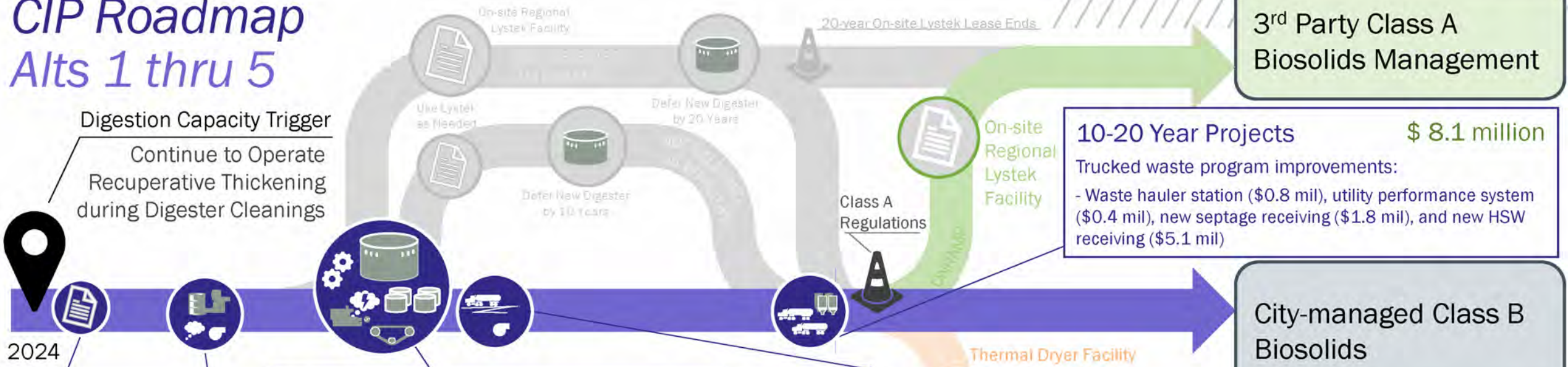
Risk and O&M cost increases will outweigh proactive CIP investment.

Business Case Evaluation Results



* Present cost of future capital investments appears less based on escalation and discount rates applied in the net present value analysis.

CIP Roadmap
Alts 1 thru 5



Digestion Capacity Trigger

Continue to Operate Recuperative Thickening during Digester Cleanings

Year 1 Project

Complete Basis of Design Report through 30% Design for Solids Expansion Project

Use Design Documents to Pursue Grants and Low-Interest Loans for Funding

$ 0.5 million

1-5 Year Project(s)* $ 90.8 million

Solids Expansion Project components:

- Replace BP cake pump ($11.5 mil)
- New anaerobic digester ($30 mil)
- Digester 1 & 2 cover/mixing/coating ($20 mil)
- Digester 3 & 4 mixing and coating ($15 mil)
- Add GBT ($2.9 mil); replace GBT pump ($0.4 mil)
- Structural Improvements ($0.6 mil)
- Electrical site improvements ($2.3 mil)
- Increase GCS capacity ($6.2 mil)
- SCR installations at CHP ($1.9 mil)

* Recommended to Pursue Funding and Complete as Single Project

Funding via Grant, Bond, and/or Loan

1-3 Year Projects $ 1.6 million

Complete projects to address condition deficiencies and mitigate risk:

- Replace digester sludge pump ($0.6 mil)
- $FeCl_3$ improvements ($0.8 mil)
- HSW odor improvements ($0.2 mil)

3-5 Year Projects $ 2.4 million

Complete projects to address addition condition deficiencies identified in plant:

- Paving and signage for HSW trucks ($1 mil)
- Replace WAS pump ($0.5 mil)
- Replace scum pots ($0.9 mil)

10-20 Year Projects $ 8.1 million

Trucked waste program improvements:

- Waste hauler station ($0.8 mil), utility performance system ($0.4 mil), new septage receiving ($1.8 mil), and new HSW receiving ($5.1 mil)

Thermal Dryer Facility with Centrifuges

PFAS Regulations

Pyrolysis Facility

3rd Party Class A Biosolids Management

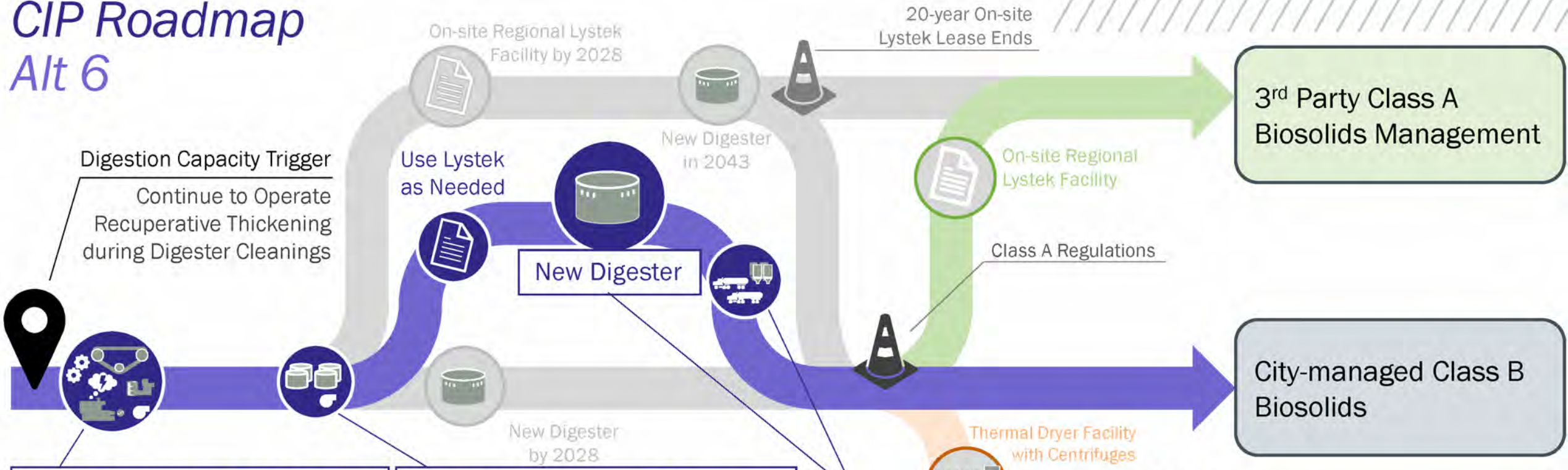
City-managed Class B Biosolids

City-managed Class A Biosolids

City-managed Class A Biosolids with PFAS Mitigation Potential

All costs are budgetary in 2023 USD. Includes planning, design, engineering, construction, construction management, and engineering services during construction. Value is the mid-point of Class V estimate range (-50%/+100%), which is 25% higher than engineer's opinion of probable construction cost.

CIP Roadmap
Alt 6



1-3 Year Projects — $ 16.8 million (2024-2028)

Address priority capacity and condition deficiencies:

- Add 1 GBT ($2.9 mil)
- Structural Improvements ($0.6 mil)
- Replace digester sludge pump ($0.6 mil)
- $FeCl_3$ improvements ($0.8 mil)
- Electrical site improvements ($2.3 mil)
- HSW odor improvements ($0.2 mil)
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- Increase GCS capacity ($6.2 mil)
- SCR installations at CHP ($1.9 mil)
- Paving and signage for HSW trucks ($1 mil)

3-5 Year Projects — $ 47.9 million (2028-2033)

Address additional deficiencies and optimize operations:

- Replace BP cake pump ($11.5 mil)
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10-20 Year Projects — $ 38.1 million (2033-2043)

- New anaerobic digester ($30 mil)
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All costs are budgetary in 2023 USD. Includes planning, design, engineering, construction, construction management, and engineering services during construction. Value is the mid-point of Class V estimate range (-50%/+100%), which is 25% higher than engineer's opinion of probable construction cost.

Appendix H: Capital Projects Summary Sheet

Use of contents on this sheet is subject to the limitations specified at the end of this document.

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Use of contents on this sheet is subject to the limitations specified at the end of this document.
BMSP Cap Impr Impl Plan Final

#	Project Group	Project Name	Implem-entation Timeline	Tier	Driver	Treatment Plant System	Durations for Planning		Budget for Planning [1]			Comments	Source/Reference
							Planning, Design, & Permitting Approximate Duration	Construction Approximate Duration	Total Project Cost (Planning, Design, Permitting, Engineering + Construction, CM, ESDC) 2023 USD	Planning, Design & Permitting Cost 2023 USD	Total Construction Cost 2023 USD		
1	A	Solids Expansion Project - Pre-design	1 year	Tier 1	Capacity	Various / Multiple	1 year	--	$ 500,000	$ 500,000	$ -	Complete basis of design report (BODR) and 30% design to position City to funding. Include projects designated in group "A."	BMSP CIP Roadmap Workshop / Report
2	B	Digester Sludge to Dewatering Pump	1-3 years	Tier 1	Condition	Anaerobic Digestion	1 year	1 year	$ 600,000	$ 150,000	$ 450,000	Option for project cost savings if City performs in house and design cost savings if projects are grouped. CIP assumes projects will be performed in house with design support from consultant(s).	Appendix J, Page J-2
3	B	Ferric Chloride Improvements	1-3 years	Tier 1	Condition	Chemical Feed Systems	1 year	1 year	$ 750,000	$ 150,000	$ 600,000		Appendix J, Page J-3
4	B	Gravity Belt Thickener Sludge Pump Replacement	1-3 years	Tier 1	Condition	Thickening	1 year	1 year	$ 420,000	$ 130,000	$ 290,000		Appendix J, Page J-4
5	A	Add 1 Gravity Belt Thickener to Existing Thickening Building	1-3 years	Tier 1	Capacity	Thickening	1 year	2 years	$ 2,900,000	$ 400,000	$ 2,500,000	Recommended to refine project scope with BODR and complete 30% design as part of BMSP Project #1 (Solids Expansion Project). CIP assumes projects will be grouped to consolidate effort, to pursue external funding, and to improve project management and cost efficiency.	Appendix J, Page J-5
6	A	Electrical Site Improvements	1-3 years	Tier 1	Condition	Various / Multiple	1 year	3 years	$ 2,300,000	$ 300,000	$ 2,000,000		Appendix J, Page J-6
7	A	Structural Improvements	1-3 years	Tier 1	Condition	Various / Multiple	1 year	1 year	$ 580,000	$ 150,000	$ 430,000		Appendix J, Page J-7
8	A	Increase Gas Conditioning System Capacity	1-3 years	Tier 1	Capacity	Trucked Waste Program	1 year	1 year	$ 6,200,000	$ 700,000	$ 5,500,000		Appendix J, Page J-8
9	A	Selective Catalytic Reduction Installation for Combined Heat and Power Engines 1 & 2	1-3 years	Tier 1	Optimization	Trucked Waste Program	1 year	2 years	$ 1,900,000	$ 300,000	$ 1,600,000		Appendix J, Page J-9
10	A	New Anaerobic Digester and Gallery	3-5 years	Tier 1	Capacity	Anaerobic Digestion	1 year	2 years	$ 30,000,000	$ 4,000,000	$ 26,000,000		Appendix J, Page J-10
11	A	Digester 1 & 2 Cover Replacement, Mixing Improvements, and Interior Coating	3-5 years	Tier 1	Condition	Anaerobic Digestion	2 years	3 years	$ 20,000,000	$ 3,000,000	$ 17,000,000	Only 1 digester can be taken offline at a time due to capacity constraints. Group with other "A" projects in BMSP Project #1. Digester 3 visual assessment identified coating failure. Option to address coating and minor structural repairs on digester interior if mixing and cover projects are not advanced in timely manner.	Appendix J, Page J-11
12	A	Digester 3 & 4 Mixing Improvements and Interior Coating	3-5 years	Tier 1	Condition	Anaerobic Digestion	1 year	2 years	$ 15,000,000	$ 2,000,000	$ 13,000,000		Appendix J, Page J-12
13	A	Belt Press Cake Pump Replacement	3-5 years	Tier 1	Condition	Dewatering	1 year	1 year	$ 11,500,000	$ 1,700,000	$ 9,800,000	Recommended to refine project scope with BODR and complete 30% design as part of BMSP Project #1.	Appendix J, Page J-13
14	B	Waste Activated Sludge Pump Replacement	3-5 years	Tier 1	Condition	Secondary Treatment (WAS)	1 year	1 year	$ 470,000	$ 140,000	$ 330,000	Option for project cost savings if City performs in house and design cost savings if projects are grouped. CIP assumes projects will be performed in house with design support from consultant(s).	Appendix J, Page J-14
15	B	Scum Pot Replacement	3-5 years	Tier 1	Condition	Primary Treatment (PS/Scum)	1 year	1 year	$ 880,000	$ 140,000	$ 740,000		Appendix J, Page J-15
16	--	Emergency Holding Basin Flow Control Improvements	3-5 years	Tier 1	Optimization	Trucked Waste Program	1 year	1 year	$ 600,000	$ 110,000	$ 490,000	City proposed this project as a trucked waste program optimization. Refinement of project scope, details, and cost is recommended.	Not Applicable
17	--	Paving and Signage to Re-route Trucked Waste Program Traffic	3-5 years	Tier 2	Condition	Trucked Waste Program	--	1 year	$ 990,000	$ -	$ 990,000	Assumes paving is completed around the south, east, and north sides of the emergency holding basin. Paving scope can be reduced.	Trucked Waste Program Evaluation Report. Appendix E
18	--	New Wastehauler Station	10-20 years	Tier 2	Optimization	Trucked Waste Program	1 year	2 years	$ 770,000	$ 120,000	$ 650,000		Trucked Waste Program Evaluation Report. Appendix E; 15% of total project cost assumed for design fee
19	--	Utility Performance System Integration and Analytics	10-20 years	Tier 2	Optimization	Trucked Waste Program	2 years	--	$ 380,000	$ -	$ 380,000		Trucked Waste Program Evaluation Report. Appendix E
20	--	New Septage Receiving Station	10-20 years	Tier 2	Optimization	Trucked Waste Program	1 year	2 years	$ 1,800,000	$ 300,000	$ 1,500,000		Trucked Waste Program Evaluation Report. Appendix E
21	--	New HSW Receiving Station	10-20 years	Tier 2	Optimization	Trucked Waste Program	1 year	2 years	$ 5,100,000	$ 600,000	$ 4,500,000	New digester required prior to increasing HSW receiving capacity; Evaluate potential liquid treatment impacts from nutrient recycle.	Appendix J, Page J-16

Notes

1 Costs for planning-level budgeting purposes and are mid-point of Class V capital cost estimates (-50%/+100% accuracy), which are 25% higher than the engineer's opinion of probable cost for total project cost and total construction cost.
All costs are presented in 2023 dollars; This summary does not include escalation for projects programmed for design and construction in later years. See documents referenced in the "Source/Reference" column for detailed cost estimation breakdowns.

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Appendix I: Capital Project Component Sheets

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BMSP Cap Impr Impl Plan Final

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Use of contents on this sheet is subject to the limitations specified at the end of this document.
BMSP Cap Impr Impl Plan Final

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
1

Project Component Name: Solids Expansion Project – Pre-design	**Prioritization:** 1-3 Years **BMSP Ranking:** Tier 1

Description:

Pre-design of solids expansion project.

Scope of Work:

Pre-design, including basis of design report, cost estimate, site layout, and specifications. The pre-design will define the technical approach and design criteria for the project.



Justification:

There are several capacity and condition deficiencies within the solids treatment system. Capacity limitations were calculated without high strength waste, which means capacity expansion is needed to keep up with the current and growing subregional population.

This project will create a set of pre-design documents that refines capital cost estimates and can be used to pursue grants and/or loans to pay for needed improvements.

Treatment Plant System:	Various / Multiple
Project Design & Permitting Cost:	$ 500,000
Total Construction Cost: No construction cost associated with this project. See Capital Improvements Implementation Plan Report Page 3-2 for additional details.	--

Comments:

Estimated project duration:
1 year = pre-design submittal

This project should include BMSP Projects #5, 6, 7, 8, 9, 10, 11, 12, and 13.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
2

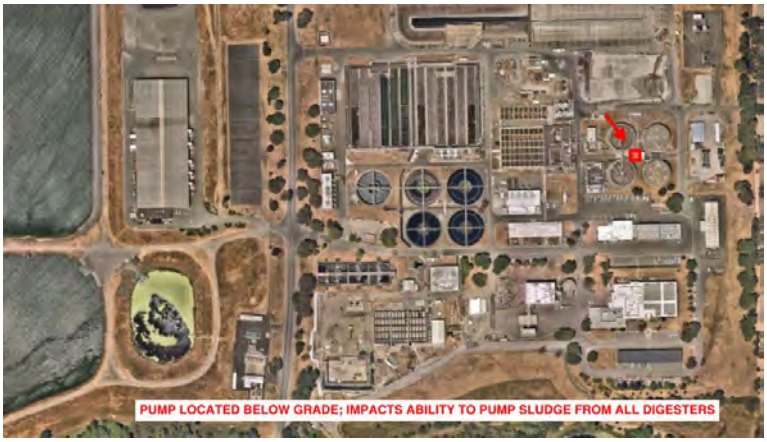
Project Component Name: Digester Sludge to Dewatering Pump	**Prioritization:** 1-3 Years **BMSP Ranking:** Tier 1

Description:

This project will replace the single 400 gpm digester dewatering pump with two smaller pumps.

Scope of Work:

Design new pumps and piping configurations. Remove existing 400 gpm pump. Install two smaller pumps sized at about half the flow capacity with overhead motors. Replace piping, as necessary.



Justification:

A single digester dewatering pump is a critical risk because it is a single point of failure. If the single pump is offline, there is no way to pump flow downstream to dewatering. This can impact upstream processes in the treatment plant and lead to facility-wide disruption.

This project will provide redundancy and improve reliability of pumping from digestion to dewatering. It will mitigate risk of minor injury and performance impacts at and upstream of digestion.

Treatment Plant System:	Anaerobic Digestion
Project Design & Permitting Cost:	$ 150,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-2, included in this report.	$ 450,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

1 year = construction (in-house)

Access to replace pump, piping, and necessary structural supports and pads will be difficult. The condition assessment (TM2) evaluated pump as “past useful life.” Group projects that can be constructed in-house to consolidate design. In-house construction may lower cost.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
3

Project Component Name: Ferric Chloride Improvements	**Prioritization:** 1-3 Years **Ranking:** Tier 1

Description:

This project will replace the two existing ferric chloride tanks and piping. New tanks will extend the useful life of the ferric chloride chemical feed systems.

Scope of Work:

Replace existing ferric chloride storage tanks in-kind. Replace piping and ancillary civil, structural, mechanical, electrical, and instrumentation work associated with the chemical feed system.



Justification:

The existing ferric chloride tanks are past their useful life and need replacement. A failure of this chemical feed system could impact the ability to dose ferric chloride, which impacts hydrogen sulfide removal.

This project will improve ferric chloride system reliability. The consequence of failure could result in minor injury and regulatory air permit compliance violation.

Treatment Plant System:	Chemical Feed Systems
Project Design & Permitting Cost:	$ 150,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-3, included in this report.	$ 600,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

1 year = construction (in-house)

The condition assessment (TM2) evaluated 1 to 10 years of remaining useful life. Group projects that can be constructed in-house to consolidate design. In-house construction may lower cost.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
4

Project Component Name: Gravity Belt Thickener Sludge Pump Replacement	**Prioritization:** 1-3 Years **BMSP Ranking:** Tier 1

Description:

This project will replace two gravity belt thickener (GBT) sludge pumps, which pump thickened waste activated sludge to anaerobic digesters.

Scope of Work:

Replace two GBT pumps that are past useful life.



Justification:

The existing GBT pumps are past their useful life. If one or more pumps are offline, there is potential for treatment system disruption of the liquid treatment process (inability to waste sludge) or the anaerobic digestion process (inability to perform recuperative thickening).

This project will improve system reliability and mitigate risk of system disruptions.

Treatment Plant System:	Thickening
Project Design & Permitting Cost:	$ 130,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-4, included in this report.	$ 290,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

1 year = construction

Group projects that can be constructed in-house to consolidate design. In-house construction may lower cost.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
5

Project Component Name: Add 1 Gravity Belt Thickener to Existing Thickener Building	**Prioritization:** 1-3 Years **BMSP Ranking:** Tier 1

Description:

This project will add a gravity belt thickener (GBT) to the existing thickening building. The existing building has space reserved for a fourth thickener, so minimal civil or structural work is anticipated to install the last GBT.

Scope of Work:

Design and install one GBT in the existing GBT building. Incorporate any structural, mechanical, electrical, and instrumentation necessary for the design. Match manufacturer and model to the existing three GBTs.



Justification:

The three existing GBTs do not provide sufficient thickening capacity when one GBT is out of service. An additional GBT is required to provide redundancy when one GBT is offline or used for recuperative thickening.

This project will provide necessary thickening capacity to meet level of service. This project will mitigate risk of digestion capacity and secondary treatment wasting capacity limitations.

Treatment Plant System:	Thickening
Project Design & Permitting Cost:	$ 400,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-5, included in this report.	$ 2,500,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

2 years = construction

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
6

Project Component Name: Electrical Site Improvements	**Prioritization:** 1-3 Years **BMSP Ranking:** Tier 1

Description:

This project will replace motor control centers (MCCs), lighting panelboards, lighting transformers, and a programmable logic controller (PLC).

Scope of Work:

Replace five MCCs, five lighting panelboards, five lighting transformers, and one PLC.



Justification:

Existing electrical components listed in the scope of work are beyond their useful life and present a risk to the City.

This project will improve system reliability and mitigate risk of system disruptions due to the electrical components, protecting the LTP's ability to operate, meet permit requirements, and reduce safety risks.

Treatment Plant System:	Various / Multiple
Project Design & Permitting Cost:	$ 300,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-6, included in this report.	$ 2,000,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

3 years = construction

The condition assessment (TM2) evaluated 1 to 10 years of remaining useful life.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
7

Project Component Name: Structural Improvements	**Prioritization:** 1-3 Years **BMSP Ranking:** Tier 1

Description:

This project will use repair techniques to improve structures.

Scope of Work:

Repair structural deficiencies, including crack sealing (septage receiving station [SRS], digester galleries, gravity belt thickener [GBT] room, and belt press [BP] room), joint repairs (digester galleries, BP room, engine room), conduit water infiltration repair (digester galleries), and rust repair (selective catalytic reducer [SCR] and old flare).



Justification:

These condition deficiencies were evaluated as high priority, high risk. Therefore, the recommendation is to repair structural deficiencies in the near-term.

This project will improve structures and mitigate risk of structural failures in the near- and long-term.

Treatment Plant System:	Various / Multiple
Project Design & Permitting Cost:	$ 150,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-7, included in this report.	$ 430,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

1 year = construction

City of Santa Rosa

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City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
8

Project Component Name: Increase Gas Conditioning System Capacity	**Prioritization:** 1-3 Years **BMSP Ranking:** Tier 1

Description:

This project will increase gas conditioning system capacity by upsizing digester biogas piping and installing new, larger hydrogen sulfide (H_2S) removal vessels.

Scope of Work:

Increase existing biogas to approximately 14-inch diameter piping (to be confirmed via a basis of design report). Add (2) new H_2S removal vessels.



Justification:

The current gas conditioning system and piping is undersized relative to the current biogas flowrates. The City has observed negative pressures in the biogas piping, and uses controls to mitigate this scenario currently.

This project will maximize the use of biogas generated for use in combined heat and power engines and reduce flaring. Improvements are anticipated to result in more energy production and annual cost savings.

Treatment Plant System:	Trucked Waste Program
Project Design & Permitting Cost:	$ 700,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-8, included in this report.	$ 5,500,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

1 year = construction

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
9

Project Component Name: Selective Catalytic Reduction Installation for Combined Heat and Power Engines 1 & 2	**Prioritization:** 1-3 Years **Ranking:** Tier 1

Description:

This project will add selective catalytic reducers (SCRs) to combined heat and power (CHP) engines 1 and 2.

Scope of Work:

Install two SCRs on CHP engines 1 and 2 outside the existing building. Update necessary instrumentation and control strategies. Air permit modifications are likely required.



Justification:

The air permit limits natural gas usage in the two CHP engines without SCRs. This restricts natural gas blending, can limit engine run time, and creates operational challenges.

This project will allow all four CHP engines to operate in an identical and optimal manner. This provides greater operational flexibility, mitigates a scenario where biogas is wasted due to permit restrictions, and provides the City with an opportunity to increase energy cost savings benefits from co-digestion.

Treatment Plant System:	Trucked Waste Program
Project Design & Permitting Cost:	$ 300,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-9, included in this report.	$ 1,600,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

2 years = construction

City of Santa Rosa

Brown AND Caldwell

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
10

Project Component Name: New Anaerobic Digester and Gallery	**Prioritization:** 3-5 Years **BMSP Ranking:** Tier 1

Description:

A new anaerobic digester is needed to address digestion capacity and redundancy limitations.

Scope of Work:

This project will design and construct a new anaerobic digester and gallery. Digester biogas piping and the new gallery will need to cross the road to connect with the existing infrastructure.



Justification:

The existing digestion capacity is insufficient when one digester is offline for cleaning and maintenance. This is a critical capacity constraint that limits the City's ability to perform preventative maintenance, corrective maintenance, or perform digester improvements.

This project will increase capacity and mitigate risk of losing compliance with Class B biosolids from the digestion process. A new digester is required to meet the City's level of service.

Treatment Plant System:	Anaerobic Digestion
Project Design & Permitting Cost:	$ 4,000,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-10, included in this report.	$ 26,000,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

2 years = construction

Strategies to defer the construction of a new anaerobic digester were discussed in TM4; however, project deferral is not recommended based on the results from a business case evaluation (Appendix J).

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
11

Project Component Name: Digester 1 & 2 Cover Replacement, Mixing Improvements, and Interior Coating	**Prioritization:** 3-5 Years **BMSP Ranking:** Tier 1

Description:

This project includes identical improvements for Digesters 1 & 2.

Scope of Work:

Determine mixing technology through basis of design report. Replace floating covers with fixed concrete covers. Replace mixing technology, re-coat interior of digesters, and complete structural concrete repairs as needed.



Justification:

The existing floating covers need replacement. Floating covers contribute to fugitive methane emissions, which impacts the City's greenhouse gas contributions. New mixing is expected to improve digestion performance and will replace outdated technology. Visual assessment of Digester 3 demonstrated a need to re-coat the interior of digesters and perform minor structural repairs.

This project will mitigate further concrete degradation, improve digester performance, and mitigate fugitive methane and greenhouse gas emissions.

Treatment Plant System:	Anaerobic Digestion
Project Design & Permitting Cost:	$ 3,000,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-11, included in this report.	$ 17,000,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

3 years = construction

Only 1 digester can be taken offline at a time due to capacity constraints. Add a gravity belt thickener and/or digester before these projects are implemented due to capacity limitations when only three digesters are in service.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
12

Project Component Name: Digester 3 & 4 Mixing Improvements and Interior Coating	**Prioritization:** 3-5 Years **BMSP Ranking:** Tier 1

Description:

This project includes identical improvements for Digesters 3 & 4.

Scope of Work:

Determine mixing technology through basis of design report. Replace mixing technology, re-coat interior of digesters, and complete structural concrete repairs as needed.



Justification:

New mixing is expected to improve digestion performance and will replace outdated technology. Visual assessment of Digester 3 demonstrated a need to re-coat the interior of digesters and perform minor structural repairs.

This project will mitigate further concrete degradation, improve digester performance, and mitigate fugitive methane and greenhouse gas emissions.

Note: It is assumed that the condition of Digester 3 is reflective of all digesters.

Treatment Plant System:	Anaerobic Digestion
Project Design & Permitting Cost:	$ 2,000,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-12, included in this report.	$ 13,000,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

2 years = construction

Only 1 digester can be taken offline at a time due to capacity constraints. BC recommends adding a gravity belt thickener and/or digester before these projects are implemented due to capacity limitations when only three digesters are in service.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
13

Project Component Name: Belt Press Cake Pump Replacement	**Prioritization:** 3-5 Years **BMSP Ranking:** Tier 1

Description:

This project replaces the existing progressive cavity pumping system at the dewatering building with a technology that avoids water addition to biosolids downstream of the belt presses.

Scope of Work:

Replace progressive cavity pumps with conveyors or piston pumps. Install ancillary components such as piping, controls, hydraulic power units, etc.



Justification:

The existing cake pumps have an injector water ring downstream of the pump discharge. The purpose of the ring is to add a small amount of water to provide a boundary layer between sludge and pipe walls (i.e., minimize friction). Water injection requirements are significant and dilute biosolids by 1 to 2 percentage points (e.g., reducing biosolids from 15% TS to 13.5% TS).

This project will produce drier biosolids and lower biosolids hauling costs.

Treatment Plant System:	Dewatering
Project Design & Permitting Cost:	$ 1,700,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-13, included in this report.	$ 9,800,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

1 year = construction

Budgetary cost is based on piston pump technology with contingency in case higher pressure rating is required for piping. Conveyors would be an alternative technology. Refine cost based on basis of design report.

City of Santa Rosa

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City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
14

Project Component Name: Waste Activated Sludge Pump Replacement	**Prioritization:** 3-5 Years **BMSP Ranking:** Tier 1

Description:

The waste activated sludge (WAS) pumping capacity is lower than the rated nameplate capacity. This project will evaluate and address the issue.

Scope of Work:

Review existing pump curves and evaluate whether new pumps or installation at a lower elevation is optimal for project costs. Replace pumps and/or lower the elevation of the WAS pumps.



Justification:

The City may elect to increase WAS pumping capacity, if needed, to address wasting needs from the secondary treatment process.

The ability to waste the proper amount of activated sludge is necessary to avoid a scenario where inventory and MLSS concentrations increase to a point where secondary clarifier performance is compromised.

This project will increase wasting capacity from the secondary treatment process.

Treatment Plant System:	Secondary Treatment (WAS)
Project Design & Permitting Cost:	$ 140,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-14, included in this report.	$ 330,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

1 year = construction

Group projects that can be constructed in-house to consolidate design. In-house construction expected to lower cost. Evaluation of the liquid treatment process capacity may be warranted to determine whether this project is necessary or critical.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
15

Project Component Name: Scum Pot Replacement	**Prioritization:** 3-5 Years **BMSP Ranking:** Tier 1

Description:

Replace primary scum pots with an alternative pumping strategy.

Scope of Work:

Evaluate optimal replacement solution; Replace scum pots with progressive cavity pumps, hose pumps, or retrofit piping to leverage existing primary sludge pumps for scum conveyance. Add necessary instrumentation and control strategies.



Justification:

The operations and maintenance requirements for scum pots are extensive. They require constant maintenance.

This project will lower operation and maintenance requirements for the scum conveyance system.

Treatment Plant System:	Primary Treatment (PS/Scum)
Project Design & Permitting Cost:	$ 140,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-15, included in this report.	$ 740,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

1 year = construction

Group projects that can be constructed in-house to consolidate design. In-house construction expected to lower cost.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
16

Project Component Name: Emergency Holding Basin Flow Control Improvements	**Prioritization:** 3-5 Years **Ranking:** Tier 1

Description:

This project will add a slide gate to control flow leaving the emergency holding basin (EHB).

Scope of Work:

Size and select a stainless steel slide gate with motor actuation. Construct a platform that provides access to the slide gate, located at the headwall structure on the south side of the EHB.



Justification:

Trucked waste is discharged into the EHB. This includes leachate waste, which can lower ultraviolet transmittance and impact the disinfection process. The new slide gate will provide the ability to store trucked waste in the emergency holding basin for dilution and to control the flow to headworks.

This project will improve the City's control of the flows from the trucked waste program to the headworks.

Treatment Plant System:	Trucked Waste Program
Project Design & Permitting Cost:	$ 100,000
Total Construction Cost: Includes contractor markups, construction management, etc.	$ 490,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

1 year = construction

Budgetary estimates for this project are recommended to have further refinement, including investigation on feasibility of proposed slide gate location.

City of Santa Rosa

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City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
17

Project Component Name: Paving and Signage to Re-route Trucked Waste Program Traffic	**Prioritization:** 1-3 Years **BMSP Ranking:** Tier 2

Description:

This project paves roadways in need of repair within the laguna treatment plant (LTP). Assumes roadway around the emergency holding basin is paved such that truck traffic could be routed around digesters to alleviate traffic in the central corridor.

Scope of Work:

Site civil improvements, including roadway paving and signage.



Justification:

Waste hauler truck traffic through the LTP cause wear and damage to the existing roadways. Heavy traffic through the central corridor between headworks and the digesters causes conflicts with chemical deliveries. Waste haulers driving at faster speeds through the main corridor presents a safety risk.

This project will repair roadways within the LTP and pave additional roadways for truck traffic to improve plant safety and help mitigate traffic congestion.

Treatment Plant System:	Trucked Waste Program
Project Design & Permitting Cost:	--
Total Construction Cost: Includes contractor markups, construction management, etc. Reference Trucked Waste Program Evaluation Report for detailed cost breakdown.	$ 990,000

Comments:

Estimated project duration:

1 year = planning, design, construction

Cost assumes paving is completed around the south, east, and north sides of emergency holding basin to make road more suitable for regular truck traffic. Option to lower cost if scope is revised and less materials are used.

City of Santa Rosa

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City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
18

Project Component Name: New Waste hauler Station	**Prioritization:** 10-20 Years **BMSP Ranking:** Tier 2

Description:

This project includes the siting and construction of a new waste hauler station to improve monitoring and compliance of trucked waste discharges.

Scope of Work:

Identify siting of a new waste hauler station, including an operations laboratory, two workstations, a restroom, and a window for communication with haulers.



Justification:

The trucked waste program does not have a building suitable for trucked waste staff to complete administrative work, laboratory work, and compliance monitoring for the volume of trucked waste that is received each day by the City.

This project provides a single point of security and compliance for waste haulers and provides permanent staffing with resources needed to complete administration responsibilities while monitoring trucks prior to discharge.

Treatment Plant System:	Trucked Waste Program
Project Design & Permitting Cost:	$ 120,000
Total Construction Cost: Includes contractor markups, construction management, etc. Reference Trucked Waste Program Evaluation Report for detailed cost breakdown.	$ 650,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

2 years = construction

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
19

Project Component Name: Utility Performance System Integration and Analytics	**Prioritization:** 10-20 Years **BMSP Ranking:** Tier 2

Description:

This project implements a utility performance system, which integrate the City's tracking, billing, and analytical testing results systems into a single interface that can be accessed via tablet in the field.

Scope of Work:

Hire a firm to develop the architecture to compile, analyze, and display data from the trucked waste program.



Justification:

The City monitors waste hauler check-ins, including waste hauler ID, hauler company, tank capacity, waste type, and the check-in date/time. The City also tracks billing and revenue from each hauler. Information is manually tracked in the field and samples are collected and analyzed by the lab.

This project would facilitate real-time access to this information and allow for input of field observations into a tablet to improve compliance and monitoring.

Treatment Plant System:	Trucked Waste Program
Project Design & Permitting Cost:	--
Total Construction Cost: Includes contractor markups, construction management, etc. Reference Trucked Waste Program Evaluation Report for detailed cost breakdown.	$ 380,000

Comments:

Estimated project duration:

2 years = implementation, construction

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
20

Project Component Name: New Septage Receiving Station	**Prioritization:** 10-20 Years **BMSP Ranking:** Tier 2

Description:

A new septage receiving station to redirect low strength waste traffic away from congested areas in the Laguna Treatment Plant (LTP).

Scope of Work:

Evaluate siting of new septage receiving. Consider whether additional screening is desired in design. Construct station for septage haulers and low strength waste haulers to discharge waste and connect to headworks.



Justification:

The existing septage receiving station is in an area that has heavy truck traffic from waste haulers and chemical deliveries. The existing station only has a manually raked coarse bar screen for screening of trucked waste. This provides minimal protection to the LTP.

This project will provide an improved septage receiving station and allow the City to site the facility in coordination with any headworks improvements projects that may be programmed in the future.

Treatment Plant System:	Trucked Waste Program
Project Design & Permitting Cost:	$ 300,000
Total Construction Cost: Includes contractor markups, construction management, etc. Reference Trucked Waste Program Evaluation Report for detailed cost breakdown.	$ 1,500,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

2 years = construction

BC recommends grouping with new (or relocated) HSW receiving, if advantageous and recommended in the City's plant-wide master plan.

City of Santa Rosa
Capital Improvement Program
Capital Project Component Sheet

BMSP Project #
21

Project Component Name: New HSW Receiving Station	**Prioritization:** 10-20 Years **BMSP Ranking:** Tier 2

Description:

New high strength waste (HSW) receiving station for the expansion of the trucked waste program.

Scope of Work:

Design and construct new HSW receiving station with similar capacity and features as existing system. Incorporate improvements based on basis of design report and City operations and maintenance feedback.



Justification:

The existing HSW receiving station is limited by an air permit capacity of 46,000 gallons per day. A new receiving station may be desired in the future if the HSW program is expanded to increase revenue after anaerobic digestion capacity is expanded.

This project will provide additional capacity for HSW feedstocks, such as food waste or other high-strength organics.

Treatment Plant System:	Trucked Waste Program
Project Design & Permitting Cost:	$ 600,000
Total Construction Cost: Includes contractor markups, construction management, etc. See Appendix J, Page J-16, included in this report.	$ 4,500,000

Comments:

Estimated project duration:

1 year = planning, design, permitting

2 years = construction

BC recommends grouping with new septage receiving, if advantageous and recommended in the City's plant-wide master plan. A new digester is needed before HSW capacity is increased.

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Appendix J: Cost Calculations for Capital Improvements Implementation Plan Budgetary Values

Use of contents on this sheet is subject to the limitations specified at the end of this document.

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Calculations showing how capital cost estimates from Appendix E (Technical Memorandum 4: Biosolids Screening and Alternatives Evaluation, Attachment D) are used in the development of the Capital Improvements Implementation Plan budgetary costs that are recommended for planning.

Cost estimates are documented in this appendix. A factor of 125% is applied to calculate budgetary costs for planning.

BMSP Project #2

[TM2 -BC-02] Digester Sludge to Dewatering Pump (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) Progressive Cavity Pump Units	$ 31,541 $/EA	$ 63,000	vendor provided package
A - Subtotal Construction Materials and Equipment Cost		**$ 63,000**	
Demolition	15% of "A"	$ 9,000	
Structural	10% of "A"	$ 6,000	
Process Piping	15% of "A"	$ 9,000	
Electrical	25% of "A"	$ 16,000	
Instrumentation and Controls	20% of "A"	$ 13,000	
B - Total Construction Materials and Equipment Costs		**$ 116,000**	
Startup and Construction Sequencing	5% of "B"	$ 6,000	
General Conditions	10% of "B"	$ 12,000	
Contractor Overhead and Profit	15% of "B"	$ 18,000	
Sales Tax	9.25% 1/2 of "B"	$ 5,000	
C - Subtotal Construction Costs		**$ 160,000**	
Escalation to Midpoint	8% of "C"	$ 13,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 173,000**	
Construction Contingency	50% of "D"	$ 85,000	
E - Total Construction Costs		**$ 258,000**	
Planning and Permitting	5% of "E"	$ 13,000	
Engineering	40% of "E"	$ 102,000	Lower engineering & ESDC
Construction Management + ESDC	40% of "E"	$ 102,000	if combined with other work
Total Project Cost		**$ 480,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 258,000.00
	CM and ESDC[5]	$ 102,000.00
	Total Construction[2]	$ 360,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 450,000.00
	Round up to 2 significant figures[7]	$ 450,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 480,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 600,000.00
	Round up to 2 significant figures[7]	$ 600,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula: $Planning, Design\ and\ Permitting\ Cost = \left(\frac{Adj.\ Project}{Cost}\right) - \left(\frac{Adj.\ Constr.}{Cost}\right)$

	Planning, Design & Permitting Cost[7]	$ 150,000.00

Notes

1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-2 from Appendix E ([TM2-BC-02] Digester Sludge to Dewatering Pump).
5. Taken from "Construction Management + ESDC" row on page D-2 from Appendix E ([TM2-BC-02] Digester Sludge to Dewatering Pump).
6. Taken from "Total Project Cost" row on page D-2 from Appendix E ([TM2-BC-02] Digester Sludge to Dewatering Pump).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted

Constr. = Construction

BMSP Project #3

[TM2-BC-03] Ferric Chloride Tank Improvements (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(1) Ferric Chloride Tank System, including: (2) Primary Tank (2) Tank Base (2) Manway (2) Fittings including Dome, Dome Flat, IMFO, & Sidewalls (2) Venting (2) Nameplate (2) Restraint System (2) Expansion Joint	$ 75,000 $/System	$ 75,000	vendor provided inclusive package 8,100 Gallon IMFO D: 11'-"11 H:11'-10" Manway size 24"
A - Subtotal Construction Materials and Equipment Cost		**$ 75,000**	
Demolition	30% of "A"	$ 23,000	Demo existing Ferric Chloride Tanks
Shoring and Dewatering	5% of "A"	$ 4,000	
Civil	10% of "A"	$ 8,000	
Structural	10% of "A"	$ 8,000	
Process Piping	20% of "A"	$ 15,000	
Electrical	20% of "A"	$ 15,000	
Instrumentation and Controls	25% of "A"	$ 19,000	
Excavated Soil Disposal	5% of "A"	$ 4,000	
B - Total Construction Materials and Equipment Costs		**$ 171,000**	
Startup and Construction Sequencing	5% of "B"	$ 8,000	
General Conditions	10% of "B"	$ 17,000	
Contractor Overhead and Profit	15% of "B"	$ 25,000	
Sales Tax	9% 1/2 of "B"	$ 8,000	
C - Subtotal Construction Costs		**$ 230,000**	
Escalation to Midpoint	8% of "C"	$ 18,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 248,000**	
Construction Contingency	50% of "D"	$ 123,000	
E - Total Construction Costs		**$ 371,000**	
Planning and Permitting	5% of "E"	$ 18,000	
Engineering	28% of "E"	$ 103,000	Lower engineering & ESDC
Construction Management + ESDC	28% of "E"	$ 103,000	if combined with other work
Total Project Cost		**$ 600,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 371,000.00
	CM and ESDC[5]	$ 103,000.00
	Total Construction[2]	$ 474,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 592,500.00
	Round up to 2 significant figures[7]	$ 600,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 600,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 750,000.00
	Round up to 2 significant figures[7]	$ 750,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula:

$$Planning, Design\ and\ Permitting\ Cost = \left(Adj.\ Project\ Cost\right) - \left(Adj.\ Constr.\ Cost\right)$$

	Planning, Design & Permitting Cost[7]	$ 150,000.00

Notes

1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-3 from Appendix E ([TM2-BC-03] Ferric Chloride Tank Improvements).
5. Taken from "Construction Management + ESDC" row on page D-3 from Appendix E ([TM2-BC-03] Ferric Chloride Tank Improvements).
6. Taken from "Total Project Cost" row on page D-3 from Appendix E ([TM2-BC-03] Ferric Chloride Tank Improvements).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted

Constr. = Construction

BMSP Project #4

[TM2-BC-05] GBT Sludge Pump Replacement (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) Progressive Cavity Pump Units	$ 15,007 $/EA	$ 30,000	vendor provided package
A - Subtotal Construction Materials and Equipment Cost		**$ 30,000**	
Demolition	15% of "A"	$ 5,000	
Structural	10% of "A"	$ 3,000	
Process Piping	15% of "A"	$ 5,000	
Electrical	25% of "A"	$ 8,000	
Instrumentation and Controls	20% of "A"	$ 6,000	
B - Total Construction Materials and Equipment Costs		**$ 57,000**	
Startup and Construction Sequencing	5% of "B"	$ 3,000	
General Conditions	10% of "B"	$ 6,000	
Contractor Overhead and Profit	15% of "B"	$ 8,000	
Sales Tax	9.25% 1/2 of "B"	$ 3,000	
C - Subtotal Construction Costs		**$ 80,000**	
Escalation to Midpoint	8% of "C"	$ 6,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 86,000**	
Construction Contingency	50% of "D"	$ 40,000	
E - Total Construction Costs		**$ 126,000**	
Planning and Permitting	5% of "E"	$ 6,000	
Engineering	83% of "E"	$ 101,000	Lower engineering & ESDC
Construction Management + ESDC	83% of "E"	$ 101,000	if combined with other work
Total Project Cost		**$ 330,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 126,000.00
	CM and ESDC[5]	$ 101,000.00
	Total Construction[2]	$ 227,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 283,750.00
	Round up to 2 significant figures[7]	$ 290,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 330,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 412,500.00
	Round up to 2 significant figures[7]	$ 420,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula: $Planning, Design\ and\ Permitting\ Cost = (Adj.Project\ Cost) - (Adj.Constr.\ Cost)$

	Planning, Design & Permitting Cost[7]	$ 130,000.00

Notes

1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-5 from Appendix E ([TM2-BC-05] GBT Sludge Pump Replacement).
5. Taken from "Construction Management + ESDC" row on page D-5 from Appendix E ([TM2-BC-05] GBT Sludge Pump Replacement).
6. Taken from "Total Project Cost" row on page D-5 from Appendix E ([TM2-BC-05] GBT Sludge Pump Replacement).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted

Constr. = Construction

BMSP Project #5

Add 1 GBT to existing thickening building (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(1) Gravity Belt Thickener (2m), including: Control Panel hydraulic power unit water booster pump discharge hopper discharge hopper	$326,500 $/total	$ 327,000	vendor provided package
Polymer System	$ 50,000 $/total	$ 50,000	
Flow Meter	$ 5,500 $/total	$ 6,000	
Thickened sludge pump & VFD	$ 45,000 $/total	$ 45,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 428,000**	
Demolition	10% of "A"	$ 43,000	
Structural	10% of "A"	$ 43,000	
Process Piping	15% of "A"	$ 64,000	
Electrical	25% of "A"	$ 107,000	
Instrumentation and Controls	20% of "A"	$ 85,000	
B - Total Construction Materials and Equipment Costs		**$ 770,000**	
Startup and Construction Sequencing	5% of "B"	$ 38,000	
General Conditions	10% of "B"	$ 77,000	
Contractor Overhead and Profit	15% of "B"	$ 115,000	
Sales Tax	9.25% 1/2 of "B"	$ 36,000	
C - Subtotal Construction Costs		**$ 1,040,000**	
Escalation to Midpoint	8.00% of "C"	$ 83,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 1,123,000**	
Construction Contingency	50% of "D"	$ 559,000	
E - Total Construction Costs		**$ 1,682,000**	
Planning and Permitting	5% of "E"	$ 84,000	
Engineering	15% of "E"	$ 251,000	
Construction Management + ESDC	15% of "E"	$ 251,000	
Total Project Cost		**$ 2,270,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes:
- Accuracy Range: -50% to +100%
- Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$
- Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: *Total Constr. Cost = (Constr. Costs) + (CM and ESDC)*

Inputs	Construction costs[4]	$ 1,682,000.00
	CM and ESDC[5]	$ 251,000.00
	Total Construction[2]	$ 1,933,000.00

Formula: *Adj. Const. Cost= (Total Constr. Cost) × 125%*

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 2,416,250.00
	Round up to 2 significant figures[7]	$ 2,500,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj. Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 2,270,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 2,837,500.00
	Round up to 2 significant figures[7]	$ 2,900,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula:

$$Planning, Design\ and\ Permitting\ Cost = \left(Adj.\ Project\ Cost\right) - \left(Adj.\ Constr.\ Cost\right)$$

	Planning, Design & Permitting Cost[7]	$ 400,000.00

Notes
1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-13 from Appendix E (Add 1 GBT to Existing Thickening Building).
5. Taken from "Construction Management + ESDC" row on page D-13 from Appendix E (Add 1 GBT to Existing Thickening Building).
6. Taken from "Total Project Cost" row on page D-13 from Appendix E (Add 1 GBT to Existing Thickening Building).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted
Constr. = Construction

BMSP Project #6

[TM2-BC-09] Electrical Site Improvements (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) Lighting Panel Board 42 circuit	$ 1,200 $/unit	$ 2,000	
Lighting Panel Board 30 circuit	$ 1,200 $/unit	$ 1,000	
Lighting Panel Transformer 45kVA	$ 8,500 $/unit	$ 9,000	
Lighting Panel Transformer 30kVA	$ 6,600 $/unit	$ 7,000	
Lighting Panel Transformer 15kVA	$ 3,800 $/unit	$ 4,000	
MCC 12R	$ 55,000 $/unit	$ 55,000	
MCC 33 T 1	$ 20,000 $/unit	$ 20,000	
MCC 33 T 2	$ 40,000 $/unit	$ 40,000	
MCC 6K	$111,000 $/unit	$ 111,000	
MCC 11P	$ 50,000 $/unit	$ 50,000	
PLC 13 Replacement	$ 9,000 $/system	$ 9,000	
Control Console Replacement	$ 50,000 $/system	$ 50,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 358,000**	
Demolition	15% of "A"	$ 54,000	
Electrical	25% of "A"	$ 89,000	
Instrumentation and Controls	20% of "A"	$ 72,000	
B - Total Construction Materials and Equipment Costs		**$ 573,000**	
Startup and Construction Sequencing	5% of "B"	$ 29,000	
General Conditions	10% of "B"	$ 57,000	
Contractor Overhead and Profit	15% of "B"	$ 86,000	
Sales Tax	9.25% 1/2 of "B"	$ 26,000	
C - Subtotal Construction Costs		**$ 770,000**	
Market Factor	10% of "C"	$ 77,000	Market Factor for escalation of elec.
Escalation to Midpoint	8% of "C"	$ 62,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 909,000**	
Construction Contingency	50% of "D"	$ 454,000	
E - Total Construction Costs		**$ 1,363,000**	
Planning and Permitting	5% of "E"	$ 68,000	
Engineering	15% of "E"	$ 204,000	
Construction Management + ESDC	15% of "E"	$ 204,000	
F - Project Costs without Estimating Contingency		**$ 1,840,000**	
Total Project Cost		**$ 1,840,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 1,363,000.00
	CM and ESDC[5]	$ 204,000.00
	Total Construction[2]	$ 1,567,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 1,958,750.00
	Round up to 2 significant figures[7]	$ 2,000,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 1,840,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 2,300,000.00
	Round up to 2 significant figures[7]	$ 2,300,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula: $Planning, Design\ and\ Permitting\ Cost = \left(\frac{Adj.\ Project}{Cost}\right) - \left(\frac{Adj.\ Constr.}{Cost}\right)$

	Planning, Design & Permitting Cost[7]	$ 300,000.00

Notes

1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-9 from Appendix E ([TM2-BC-09] Electrical Site Improvements).
5. Taken from "Construction Management + ESDC" row on page D-9 from Appendix E ([TM2-BC-09] Electrical Site Improvements).
6. Taken from "Total Project Cost" row on page D-9 from Appendix E ([TM2-BC-09] Electrical Site Improvements).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted

Constr. = Construction

BMSP Project #7

[TM2-BC-11] Structural Site Improvements (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
Digester Gallery Repair, including: (expansion joint & crack repair, water infiltration repair)	$ 50,000	$ 50,000	
Rust Repair/Recoat misc.	$ 100 $/Linear foot	$ 2,000	
Flare Recoat	$ 5,000	$ 5,000	
Flare concrete pad and drainage	$ 10,000	$ 10,000	
Epoxy sealing in at GBTs, Digesters, misc.	$ 50 $/Linear foot	$ 38,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 105,000**	
Demolition	5% of "A"	$ 5,000	
B - Total Construction Materials and Equipment Costs		**$ 110,000**	
Startup and Construction Sequencing	5% of "B"	$ 5,000	
General Conditions	10% of "B"	$ 11,000	
Contractor Overhead and Profit	15% of "B"	$ 16,000	
Sales Tax	9% 1/2 of "B"	$ 5,000	
C - Subtotal Construction Costs		**$ 150,000**	
Escalation to Midpoint	8% of "C"	$ 12,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 162,000**	
Construction Contingency	50% of "D"	$ 80,000	
E - Total Construction Costs		**$ 242,000**	
Planning and Permitting	5% of "E"	$ 12,000	
Engineering	42% of "E"	$ 101,000	Lower engineering & ESDC
Construction Management + ESDC	42% of "E"	$ 101,000	if combined with other work
Total Project Cost		**$ 460,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 242,000.00
	CM and ESDC[5]	$ 101,000.00
	Total Construction[2]	$ 343,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 428,750.00
	Round up to 2 significant figures[7]	$ 430,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 460,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 575,000.00
	Round up to 2 significant figures[7]	$ 580,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula: $Planning, Design\ and\ Permitting\ Cost = (Adj.\ Project\ Cost) - (Adj.\ Constr.\ Cost)$

	Planning, Design & Permitting Cost[7]	$ 150,000.00

Notes
1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-10 from Appendix E ([TM2-BC-11] Structural Site Improvements).
5. Taken from "Construction Management + ESDC" row on page D-10 from Appendix E ([TM2-BC-11] Structural Site Improvements).
6. Taken from "Total Project Cost" row on page D-10 from Appendix E ([TM2-BC-11] Structural Site Improvements).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted
Constr. = Construction

BMSP Project #8

Replace Hydrogen Sulfide Removal Vessel and Biogas Piping (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
Hydrogen Sulfide Removal System	$ 880,000 LS	$ 880,000	Based on bugetary number for 850 scfm scaled down to 600 scfm.
14" 316 Stainless Steel Biogas Piping	$ 1,330 LF	$ 638,000	Assumes 8" dia. piping is replaced
Pipe Support	$ 3,000 EA	$ 81,000	Assumes one support every 10 feet
A - Subtotal Construction Materials and Equipment Cost		**$ 1,599,000**	
Demolition	5% of "A"	$ 80,000	
Shoring and Dewatering	0% of "A"	$ -	
Temporary Construction	0% of "A"	$ -	
Civil	5% of "A"	$ 80,000	
Yard Piping	0% of "A"	$ -	
Structural	5% of "A"	$ 80,000	
Process Piping	10% of "A"	$ 160,000	Allowance for misc. piping
Electrical	0% of "A"	$ -	
Instrumentation and Controls	0% of "A"	$ -	
Excavated Soil Disposal	0% of "A"	$ -	
B - Total Construction Materials and Equipment Costs		**$ 1,999,000**	
Startup and Construction Sequencing	12% of "B"	$ 240,000	
Construction Easements	0% of "B"	$ -	
General Conditions	10% of "B"	$ 200,000	
Contractor Overhead and Profit	15% of "B"	$ 300,000	
Sales Tax	9.25% 1/2 of "B"	$ 92,000	
C - Subtotal Construction Costs		**$ 2,800,000**	
Market Factor	0% of "C"	$ -	
Escalation to Midpoint	8.00% of "C"	$ 227,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 3,027,000**	
Construction Contingency	30% of "D"	$ 917,000	
E - Total Construction Costs		**$ 3,944,000**	
Planning and Permitting	5% of "E"	$ 199,000	
Engineering	10% of "E"	$ 398,000	
Construction Management + ESDC	10% of "E"	$ 398,000	
F - Project Costs without Estimating Contingency		**$ 4,900,000**	
Total Project Cost		**$ 4,900,000**	

- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 3,944,000.00
	CM and ESDC[5]	$ 398,000.00
	Total Construction[2]	$ 4,342,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 5,427,500.00
	Round up to 2 significant figures	$ 5,500,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 4,900,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 6,125,000.00
	Round up to 2 significant figures	$ 6,200,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula: $Planning, Design\ and\ Permitting\ Cost = (Adj.\ Project\ Cost) - (Adj.\ Constr.\ Cost)$

	Planning, Design & Permitting Cost	$ 700,000.00

Notes

1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs.
5. Taken from "Construction Management + ESDC" row.
6. Taken from "Total Project Cost" row.

Adj. = Adjusted

Constr. = Construction

BMSP Project #9

[TM2-BC-06] Selective Catalytic Reduction Units (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) SCR/Oxidation System, including: SCR Housing Oxidation Housing & Catalyst Mixing Sections SCR Control System Dual Ply Bellow (1) Reactant Tank	$177,939 $/system	$ 356,000	vendor provided package 1000 gal tank for both units
A - Subtotal Construction Materials and Equipment Cost		**$ 356,000**	
Demolition	5% of "A"	$ 18,000	
Structural	15% of "A"	$ 53,000	
Process Piping	10% of "A"	$ 36,000	
Electrical	5% of "A"	$ 18,000	
Instrumentation and Controls	5% of "A"	$ 18,000	
B - Total Construction Materials and Equipment Costs		**$ 499,000**	
Startup and Construction Sequencing	5% of "B"	$ 25,000	
General Conditions	10% of "B"	$ 50,000	
Contractor Overhead and Profit	15% of "B"	$ 75,000	
Sales Tax	9% 1/2 of "B"	$ 23,000	
C - Subtotal Construction Costs		**$ 670,000**	
Escalation to Midpoint	8% of "C"	$ 54,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 724,000**	
Construction Contingency	50% of "D"	$ 362,000	
E - Total Construction Costs		**$ 1,086,000**	
Planning and Permitting	5% of "E"	$ 54,000	
Engineering	15% of "E"	$ 163,000	
Construction Management + ESDC	15% of "E"	$ 163,000	
Total Project Cost		**$ 1,470,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 1,086,000.00
	CM and ESDC[5]	$ 163,000.00
	Total Construction[2]	$ 1,249,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 1,561,250.00
	Round up to 2 significant figures[7]	$ 1,600,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 1,470,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 1,837,500.00
	Round up to 2 significant figures[7]	$ 1,900,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula:

$$Planning, Design\ and\ Permitting\ Cost = (Adj.\ Project\ Cost) - (Adj.\ Constr.\ Cost)$$

	Planning, Design & Permitting Cost[7]	$ 300,000.00

Notes
1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-6 from Appendix E ([TM2-BC-06] Selective Catalytic Reduction Units).
5. Taken from "Construction Management + ESDC" row on page D-6 from Appendix E ([TM2-BC-06] Selective Catalytic Reduction Units).
6. Taken from "Total Project Cost" row on page D-6 from Appendix E ([TM2-BC-06] Selective Catalytic Reduction Units).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted
Constr. = Construction

BMSP Project #10

New Anaerobic Digester and Gallery (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(1) 75' Inner Diameter Digester, including:			
Structural	$ 161,387 $/total	$ 161,000	
Dewatering System	$ 101,659 $/total	$ 102,000	
Excavation and Backfill	$ 615,278 $/total	$ 615,000	
Yard Piping	$ 97,608 $/total	$ 98,000	
Sludge mixer	$ 1,237,445 $/total	$ 1,237,000	
Electrical	$ 1,054,600 $/total	$ 1,055,000	
Instrumentation	$ 602,600 $/total	$ 603,000	
Digester Gallery, including:			
Structural	$ 1,050,251 $/total	$ 1,050,000	
Electrical	$ 774,900 $/total	$ 775,000	
Instrumentation	$ 442,800 $/total	$ 443,000	
Dewatering System	$ 135,266 $/total	$ 135,000	
Excavation and Backfill	$ 506,576 $/total	$ 507,000	
Process Equipment	$ 50,027 $/total	$ 50,000	
Process Piping	$ 443,000 $/total	$ 443,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 7,274,000**	
B - Total Construction Materials and Equipment Costs		**$ 7,274,000**	
Startup and Construction Sequencing	12% of "B"	$ 873,000	
General Conditions	10% of "B"	$ 727,000	
Contractor Overhead and Profit	15% of "B"	$ 1,091,000	
Sales Tax	9.25% 1/2 of "B"	$ 336,000	
C - Subtotal Construction Costs		**$ 10,300,000**	
Escalation to Midpoint	16.13% of "C"	$ 1,662,000	Assumed 25 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 11,962,000**	
Construction Contingency	50% of "D"	$ 5,981,000	
E - Total Construction Costs		**$ 17,943,000**	
Planning and Permitting	5% of "E"	$ 897,000	
Engineering	12% of "E"	$ 2,153,000	
Construction Management + ESDC	15% of "E"	$ 2,692,000	
Total Project Cost		**$ 23,690,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes:
Accuracy Range: -50% to +100%
Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$
Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.\ Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 17,943,000.00
	CM and ESDC[5]	$ 2,692,000.00
	Total Construction[2]	$ 20,635,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 25,793,750.00
	Round up to 2 significant figures[7]	$ 26,000,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 23,690,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 29,612,500.00
	Round up to 2 significant figures[7]	$ 30,000,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula: $Planning, Design\ and\ Permitting\ Cost = (Adj.\ Project\ Cost) - (Adj.\ Constr.\ Cost)$

	Planning, Design & Permitting Cost[7]	$ 4,000,000.00

Notes
1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-15 from Appendix E (New Aerobic Digester and Gallery).
5. Taken from "Construction Management + ESDC" row on page D-15 from Appendix E (New Aerobic Digester and Gallery).
6. Taken from "Total Project Cost" row on page D-15 from Appendix E (New Aerobic Digester and Gallery).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted
Constr. = Construction

BMSP Project #11

Digesters 1 & 2 Cover and Mixer Replacement (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) Digester Coating	$ 500,000 $/digester	$ 1,000,000	
(2) Digester Cleaning	$ 200,000 $/digester	$ 400,000	
(2) Digester Membrane Covers with New Mixing System	$ 2,320,000 $/total	$ 2,320,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 3,720,000**	
Demolition	10% of "A"	$ 372,000	
Structural	15% of "A"	$ 558,000	
Electrical and Instrumentation	20% of "A"	$ 744,000	
B - Total Construction Materials and Equipment Costs		**$ 5,394,000**	
Startup and Construction Sequencing	5% of "B"	$ 270,000	
General Conditions	10% of "B"	$ 539,000	
Contractor Overhead and Profit	15% of "B"	$ 809,000	
Sales Tax	9.25% 1/2 of "B"	$ 249,000	
C - Subtotal Construction Costs		**$ 7,300,000**	
Escalation to Midpoint	8.00% of "C"	$ 581,000	Assumed 12 month construction
D - Subtotal Construction Costs with Market Factor		**$ 7,881,000**	
Construction Contingency	50% of "D"	$ 3,921,000	
E - Total Construction Costs		**$ 11,802,000**	
Planning and Permitting	5% of "E"	$ 588,000	
Engineering	10% of "E"	$ 1,176,000	
Construction Management + ESDC	15% of "E"	$ 1,765,000	
Total Project Cost		**$ 15,330,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes:
- Accuracy Range: -50% to +100%
- Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$
- Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.\ Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 11,802,000.00
	CM and ESDC[5]	$ 1,765,000.00
	Total Construction[2]	$ 13,567,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 16,958,750.00
	Round up to 2 significant figures[7]	$ 17,000,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 15,330,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 19,162,500.00
	Round up to 2 significant figures[7]	$ 20,000,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula: $Planning, Design\ and\ Permitting\ Cost = (Adj.\ Project\ Cost) - (Adj.\ Constr.\ Cost)$

	Planning, Design & Permitting Cost[7]	$ 3,000,000.00

Notes
1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-12 from Appendix E (Digesters 1 & 2 Cover and Mixer Replacement).
5. Taken from "Construction Management + ESDC" row on page D-12 from Appendix E (Digesters 1 & 2 Cover and Mixer Replacement).
6. Taken from "Total Project Cost" row on page D-12 from Appendix E (Digesters 1 & 2 Cover and Mixer Replacement).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted
Constr. = Construction

BMSP Project #12

[TM02-BC-04] Digester Mixing Improvements (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(2) Digester Cleaning, Coating, and Structural Repair	$ 200,000 $/digester	$ 400,000	
(2) Internal Sludge Mixer Model SMI11 including control pan	$ 1,581,800 $/2 Mixers	$ 1,582,000	For Fixed Covered Digesters
(2) Digester Coating	$ 5.7 per square foot	$ 218,000	Includes surface prep
A - Subtotal Construction Materials and Equipment Cost		**$ 2,200,000**	
Demolition	10% of "A"	$ 220,000	
Temporary Construction	5% of "A"	$ 110,000	
Structural	5% of "A"	$ 110,000	
Process Piping	10% of "A"	$ 220,000	
Electrical	20% of "A"	$ 440,000	
Instrumentation and Controls	15% of "A"	$ 330,000	
B - Total Construction Materials and Equipment Costs		**$ 3,630,000**	
Startup and Construction Sequencing	10% of "B"	$ 363,000	
General Conditions	10% of "B"	$ 363,000	
Contractor Overhead and Profit	15% of "B"	$ 544,000	
Sales Tax	9.25% 1/2 of "B"	$ 168,000	
C - Subtotal Construction Costs		**$ 5,070,000**	
Escalation to Midpoint	16% of "C"	$ 811,000	Assumed 24 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 5,881,000**	
Construction Contingency	50% of "D"	$ 2,939,000	
E - Total Construction Costs		**$ 8,820,000**	
Planning and Permitting	5% of "E"	$ 441,000	
Engineering	12% of "E"	$ 1,058,000	
Construction Management + ESDC	15% of "E"	$ 1,323,000	
Total Project Cost		**$ 11,600,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes:
- Accuracy Range: -50% to +100%
- Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$
- Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.\ Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 8,820,000.00
	CM and ESDC[5]	$ 1,323,000.00
	Total Construction[2]	$ 10,143,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 12,678,750.00
	Round up to 2 significant figures	$ 13,000,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 11,600,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 14,500,000.00
	Round up to 2 significant figures	$ 15,000,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula: $Planning, Design\ and\ Permitting\ Cost = (Adj.\ Project\ Cost) - (Adj.\ Constr.\ Cost)$

	Planning, Design & Permitting Cost	$ 2,000,000.00

Notes
1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs.
5. Taken from "Construction Management + ESDC" row.
6. Taken from "Total Project Cost" row.

Adj. = Adjusted
Constr. = Construction

BMSP Project #13

[TM2-BC-07] BFP Cake Pump Replacement (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(4) Bioset Piston Pump System (4) Screw Feeder (4) Hydraulic Power Unit (4) Control Panel Lubrication System, Tools, Spare Parts	$ 1,677,500 $/system	$ 1,678,000	vendor provided package based on 16% TS Cake
A - Subtotal Construction Materials and Equipment Cost		**$ 1,678,000**	
Demolition	10% of "A"	$ 168,000	
Structural	10% of "A"	$ 168,000	
Process Piping	35% of "A"	$ 587,000	
Electrical	15% of "A"	$ 252,000	
Instrumentation and Controls	15% of "A"	$ 252,000	
B - Total Construction Materials and Equipment Costs		**$ 3,105,000**	
Startup and Construction Sequencing	5% of "B"	$ 155,000	
General Conditions	10% of "B"	$ 310,000	
Contractor Overhead and Profit	15% of "B"	$ 466,000	
Sales Tax	9% 1/2 of "B"	$ 144,000	
C - Subtotal Construction Costs		**$ 4,180,000**	
Escalation to Midpoint	8% of "C"	$ 334,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 4,514,000**	
Construction Contingency	50% of "D"	$ 2,256,000	
E - Total Construction Costs		**$ 6,770,000**	
Planning and Permitting	5% of "E"	$ 338,000	
Engineering	15% of "E"	$ 1,015,000	
Construction Management + ESDC	15% of "E"	$ 1,015,000	
Total Project Cost		**$ 9,140,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: *Total Constr. Cost = (Constr. Costs) + (CM and ESDC)*

Inputs	Construction costs[4]	$ 6,770,000.00
	CM and ESDC[5]	$ 1,015,000.00
	Total Construction[2]	$ 7,785,000.00

Formula: *Adj. Const. Cost= (Total Constr. Cost)* × 125%

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 9,731,250.00
	Round up to 2 significant figures[7]	$ 9,800,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: *Adj. Project Cost = (Total Project Cost)* × 125%

Input	Total Project Cost[6]	$ 9,140,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 11,425,000.00
	Round up to 3 significant figures[7]	$ 11,500,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula:

$$Planning, Design\ and\ Permitting\ Cost = \left(\frac{Adj. Project}{Cost}\right) - \left(\frac{Adj. Constr.}{Cost}\right)$$

	Planning, Design & Permitting Cost[7]	$ 1,700,000.00

Notes

1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-7 from Appendix E ([TM2-BC-07] BFP Cake Pump Replacement).
5. Taken from "Construction Management + ESDC" row on page D-7 from Appendix E ([TM2-BC-07] BFP Cake Pump Replacement).
6. Taken from "Total Project Cost" row on page D-7 from Appendix E ([TM2-BC-07] BFP Cake Pump Replacement).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted

Constr. = Construction

BMSP Project #14

[TM2-BC-08] WAS Pump Replacement (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(1) WAS Pump (same as existing)	$ 30,000 $/unit	$ 30,000	Cost of new T8A3S-B WAS Pump
electric motor	$ 8,000 $/unit	$ 8,000	
A - Subtotal Construction Materials and Equipment Cost		**$ 38,000**	
Demolition	15% of "A"	$ 6,000	
Structural	20% of "A"	$ 8,000	
Process Piping	15% of "A"	$ 6,000	
Electrical	25% of "A"	$ 10,000	
Instrumentation and Controls	20% of "A"	$ 8,000	
B - Total Construction Materials and Equipment Costs		**$ 76,000**	
Startup and Construction Sequencing	5% of "B"	$ 4,000	
General Conditions	10% of "B"	$ 7,000	
Contractor Overhead and Profit	15% of "B"	$ 11,000	
Sales Tax	9% 1/2 of "B"	$ 3,000	
C - Subtotal Construction Costs		**$ 100,000**	
Escalation to Midpoint	8% of "C"	$ 8,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 108,000**	
Construction Contingency	50% of "D"	$ 54,000	
E - Total Construction Costs		**$ 162,000**	
Planning and Permitting	5% of "E"	$ 8,000	
Engineering	62% of "E"	$ 100,000	Lower engineering & ESDC
Construction Management + ESDC	62% of "E"	$ 100,000	if combined with other work
Total Project Cost		**$ 370,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes:
Accuracy Range: -50% to +100%
Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$
Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$	162,000.00
	CM and ESDC[5]	$	100,000.00
	Total Construction[2]	$	262,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor		125%
	Adjusted Construction Cost[2]	$	327,500.00
	Round up to 2 significant figures[7]	$	330,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$	370,000.00
	Applied factor		125%
	Adjusted Project Cost[3]	$	462,500.00
	Round up to 2 significant figures[7]	$	470,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula: $Planning, Design\ and\ Permitting\ Cost = \left(Adj.\ Project\ Cost\right) - \left(Adj.\ Constr.\ Cost\right)$

	Planning, Design & Permitting Cost[7]	$	140,000.00

Notes
1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-8 from Appendix E ([TM2-BC-08] WAS Pump Replacement).
5. Taken from "Construction Management + ESDC" row on page D-8 from Appendix E ([TM2-BC-08] WAS Pump Replacement).
6. Taken from "Total Project Cost" row on page D-8 from Appendix E ([TM2-BC-08] WAS Pump Replacement).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted
Constr. = Construction

BMSP Project #15

[TM2-BC-12] Scum Pot Replacement (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
(8) Progressive Cavity Pump Units	$ 10,108 $/EA	$ 81,000	vendor provided package
A - Subtotal Construction Materials and Equipment Cost		**$ 81,000**	
Demolition	50% of "A"	$ 40,000	
Civil	10% of "A"	$ 8,000	
Process Piping	30% of "A"	$ 24,000	
Electrical	25% of "A"	$ 20,000	
Instrumentation and Controls	30% of "A"	$ 24,000	
B - Total Construction Materials and Equipment Costs		**$ 197,000**	
Startup and Construction Sequencing	20% of "B"	$ 40,000	
Construction Easements	0% of "B"	$ -	
General Conditions	10% of "B"	$ 20,000	
Contractor Overhead and Profit	15% of "B"	$ 30,000	
Sales Tax	9.25% 1/2 of "B"	$ 9,000	
C - Subtotal Construction Costs		**$ 300,000**	
Escalation to Midpoint	8% of "C"	$ 24,000	Assumed 12 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 324,000**	
Construction Contingency	50% of "D"	$ 160,000	
E - Total Construction Costs		**$ 484,000**	
Planning and Permitting	5% of "E"	$ 24,000	
Engineering	21% of "E"	$ 101,000	Lower engineering & ESDC
Construction Management + ESDC	21% of "E"	$ 101,000	if combined with other work
Total Project Cost		**$ 700,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 484,000.00
	CM and ESDC[5]	$ 101,000.00
	Total Construction[2]	$ 585,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 731,250.00
	Round up to 2 significant figures[7]	$ 740,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[6]	$ 700,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 875,000.00
	Round up to 2 significant figures[7]	$ 880,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula:

$$Planning, Design\ and\ Permitting\ Cost = \left(Adj.\ Project\ Cost\right) - \left(Adj.\ Constr.\ Cost\right)$$

	Planning, Design & Permitting Cost[7]	$ 140,000.00

Notes

1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-11 from Appendix E ([TM2-BC-12] Scum Pot Replacement).
5. Taken from "Construction Management + ESDC" row on page D-11 from Appendix E ([TM2-BC-12] Scum Pot Replacement).
6. Taken from "Total Project Cost" row on page D-11 from Appendix E ([TM2-BC-12] Scum Pot Replacement).
7. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted

Constr. = Construction

BMSP Project #21

New High Strength Waste Receiving (Class V Cost Estimate)			
Item	**Unit Cost / Allowance**	**Item Cost**	**Notes**
High-Strength Waste Receiving Facility	$ 1,491,000 LS	$ 1,491,000	
		$ -	
A - Subtotal Construction Materials and Equipment Cost		**$ 1,491,000**	
B - Total Construction Materials and Equipment Costs		**$ 1,491,000**	
Startup and Construction Sequencing	12% of "B"	$ 179,000	
Construction Easements	0% of "B"	$ -	
General Conditions	10% of "B"	$ 149,000	
Contractor Overhead and Profit	15% of "B"	$ 224,000	
Sales Tax	9.25% 1/2 of "B"	$ 69,000	
C - Subtotal Construction Costs		**$ 2,100,000**	
Escalation to Midpoint	16.13% of "C"	$ 341,000	Assumed 25 Month Construction
D - Subtotal Construction Costs with Market Factor		**$ 2,441,000**	
Construction Contingency	0% of "D"	$ -	
E - Total Construction Costs		**$ 2,441,000**	
Planning and Permitting	5% of "E"	$ 123,000	
Engineering	10% of "E"	$ 245,000	
Construction Management + ESDC	10% of "E"	$ 245,000	
F - Project Costs without Estimating Contingency		**$ 3,100,000**	
Estimating Contingency	30% of "F"	$ 920,000	
Total Project Cost		**$ 4,020,000**	

Notes:
- All costs presented in 2023 dollars
- All costs are rounded

Calculations to Develop "Budget for Planning" Values based on Class V Cost Estimate[1]

Class V Estimate Notes

Accuracy Range: -50% to +100%

Average of Range: $\frac{(100\% - 50\%) + (100\% + 100\%)}{2} = 125\%$

Factor of 125% applied to determine the Budget for Planning costs.

Total Construction[2] Cost Calculations (2023 USD)

Formula: $Total\ Constr.\ Cost = (Constr.\ Costs) + (CM\ and\ ESDC)$

Inputs	Construction costs[4]	$ 2,441,000.00
	CM and ESDC[5]	$ 245,000.00
	Estimating Contingency[6]	$ 920,000.00
	Total Construction[2]	$ 3,606,000.00

Formula: $Adj.\ Const.\ Cost = (Total\ Constr.\ Cost) \times 125\%$

	Applied factor	125%
	Adjusted Construction Cost[2]	$ 4,507,500.00
	Round to 2 significant figures[8]	$ 4,500,000.00

Total Project[3] Cost Calculations (2023 USD)

Formula: $Adj.\ Project\ Cost = (Total\ Project\ Cost) \times 125\%$

Input	Total Project Cost[7]	$ 4,020,000.00
	Applied factor	125%
	Adjusted Project Cost[3]	$ 5,025,000.00
	Round up to 2 significant figures[8]	$ 5,100,000.00

Planning, Design & Permitting Cost Calculations (2023 USD)

Formula:

$$Planning,\ Design\ and\ Permitting\ Cost = \left(Adj.\ Project\ Cost\right) - \left(Adj.\ Constr.\ Cost\right)$$

	Planning, Design & Permitting Cost[8]	$ 600,000.00

Notes

1. Calculations in this table were completed to develop Budget for Planning values presented in the Capital Improvements Implementation Plan Report, including values shown in Appendix H and I.
2. Includes Construction Management (CM) and Engineering Services During Construction (ESDC) costs.
3. Includes planning, design, permitting, engineering and construction, CM, and ESDC.
4. Taken from Row E - Total Construction Costs on page D-16 from Appendix E (New High Strength Waste Receiving).
5. Taken from "Construction Management + ESDC" row on page D-16 from Appendix E (New High Strength Waste Receiving).
6. Taken from "Estimating Contingency" row on page D-16 from Appendix E (New High Strength Waste Receiving).
7. Taken from "Total Project Cost" row on page D-16 from Appendix E (New High Strength Waste Receiving).
8. Calculated value represents the recommended "Budget for Planning" values shown in Capital Improvements Implementation Plan report, including Appendix H and I.

Adj. = Adjusted

Constr. = Construction

Appendix K: Grant and Funding Opportunities

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This section documents grant and funding opportunities that may be applicable to CIP projects described in this report.

K.1 Low Interest Loan and Grant Funding Opportunities

There are federal and state low interest loan and grant funding opportunities for projects that reduce GHG emissions. The City may elect to pursue these opportunities to fund capital projects partially or fully. There are several factors that should be considered or addressed to increase the probability of successfully securing external funding including:

- **Funding Program Focus/Priorities.** Most low interest loan and grant programs target a specific type of project or purpose/priority. For a project to be competitive, it needs to meet the intent of the program, support program priorities and have sufficient definition to demonstrate the fit.
- **Established Application Timelines.** Application timing is critical for most grant and loan programs. While some funding agencies accept applications on a rolling basis, most have prescribed submission dates. Typically, programs release funding announcements once a year with a 45- to 60-day window to apply, while some vary year to year pending appropriations. Identifying and advancing technical documentation to meet these timelines is critical to align a project for a funding opportunity.
- **Project Readiness.** Typically, for funding agencies, the proposed grant or loan applications require demonstration of the ability to construct, operate, and maintain the project without grant funding. An assessment of project document readiness compared to funding program requirements is important to ensure the appropriate level of documentation (e.g., engineering, environmental, and financial) is available to support the grant application.
- **Does not cover the full cost of the project.** Most grant programs do not cover the full cost of the project, requiring the sponsoring agency to provide a minimum cost share ranging from 25 to 75 percent (in-kind donations are applicable matches). Often there is a minimum funding requirement or maximum limit of award. Some agencies secure loan financing for the entire project and in parallel pursue appropriate grants where the entity will be competitive.
- **Grant award or funding authorization is NOT a promise of grant reimbursement.** Most low interest loan and grant programs are reimbursements of cost incurred and not cash up front. This requires that a source of funding be available for the construction of the project. In addition, program funding is subject to federal and state appropriations process and thus disbursement of funds on schedule is not guaranteed.

The following is a list of Federal and State of California funding and grant opportunities that may provide external funding opportunities to support the City's BMSP and biosolids management.

K.1.1 CalRecycle Greenhouse Gas Reduction Grant and Loan Program

The GHG Reduction Fund (GHGRF) Grant and Loan Programs support projects by providing capital investments in infrastructure for aerobic composting, anaerobic digestion and recycling and manufacturing facilities that will reduce GHG emissions. A priority is to realize benefits in disadvantaged and low-income areas. This program is also part of California Climate Investments. California Climate Investments projects include affordable housing, renewable energy, public transportation, zero-emission vehicles, environmental restoration, more sustainable agriculture, recycling, etc. At least 35 percent of these investments are made in disadvantaged and low-income communities. The GHGRF Grant and Loan Program is a highly competitive program with most programs require project definition, design completion (90/100 percent) and environmental documentation.

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Some of the grant opportunities under this Program, that merit further investigation as to applicability upon project definition, include:

- Food Waste Prevention and Rescue Grant Program
- Organics Grant Program
- Co-Digestion Grant Program
- GHG Reduction Loan Program (discussed below)

K.1.1.1 CalRecycle Greenhouse Gas Reduction Loan Program

The purpose of this program is lower the overall GHG emissions by providing loans to expand existing capacity or establish new facilities to process generated waste materials into new value added products. Eligible projects include organics projects, feedstock/waste material diversion projects and other. Projects that can be grouped under this application include the anaerobic digester, digester improvements, biogas conditioning system, and the SCR. These projects can be lumped together and justified to increase the amount of HSW that can be received in the next 10 or 20 years. An element of accepting food waste would also need to be added to increase the competition of the application.

CalRecycle distributed approximately $11 million and $9 million in loans for capital improvements, equipment, capital, and onerous debt in the FY 2022 and 2021 funding cycles, respectively. Approximately $5 million in funds were available for FY 2024, of which $4,875,000 in loans have already been distributed to two agencies. Due to the demand on the program, it has become competitive, requiring a clear statement of project components, detailed information on feedstock materials and quantities, anticipated GHG reduction calculations, staff creation, equipment and facility information, loan request amount, work plan, and air and water quality benefits. Applications require calculations and an explanation on how much GHG emissions will be reduced, the tons of organic materials that will be diverted, and the benefits to disadvantaged communities.

If the City elects to pursue CalRecycle loan funding, the preparation of a clearly defined project scope, workplan, benefits and application materials prior to June 2024 is advised such that the City's application is submitted at the start of the funding agency's fiscal cycle (increasing opportunities for award).

K.1.2 Clean Water State Revolving Fund

The State of California's Clean Water State Revolving Fund (CWSRF) is overseen by the California State Water Resources Control Board (SWRCB). The CWSRF program provides low interest loan financing for the planning/design and construction of wastewater treatment facilities (including biosolids), green infrastructure, and other projects. The CWSRF program can provide financing for up to 100 percent of the eligible planning/design and construction costs for the useful life of the facilities or up to 30-years. The CWSRF interest rate is set at one-half of the state general obligation bond rate and has recently averaged around 2.1 percent. The CWSRF loan repayment does not begin until one year following completion of the eligible project. Projects receiving CWSRF funding must comply with all federal requirements (including California Environmental Quality Act [CEQA]-Plus, American Iron and Steel, Davis Bacon, Disbarment, Disadvantaged Business Enterprise [DBE], reporting, etc.).

Applications (General, Technical, Environmental and Financial packages) must be submitted by December 31st to be considered for the following year's "Intended Use Plan" for funding. The process is highly competitive and requires that complete applications be submitted including design and environmental (CEQA-Plus). Applications are given a priority score, which is used to rank and add projects to the CWSRF fundable list. Projects implementing corrective measures receive higher

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scores than those with preventative or improvement measures. Based on capacity and condition assessments as part of the BMSP, the City's projects would likely be scored as "preventative" unless violations are incurred and documented prior to the application. Secondary points are given for projects that align with certain statements provided by the SWRCB and for projects that are ready to go to construction.

Associated with the Bipartisan Infrastructure Law (BIL), the CWSRF program has seen an increase in overall appropriations to the CWSRF program and is anticipated to see this increase through FY 2026.

Based on the current level of project definitions and design and the CWSRF program requirements, the project would not score competitively for CWSRF financing. To pursue CWSRF financing, a minimum of 89 percent design completion and environmental documentation is recommended to be competitive and earn 2 out of 2 points for project readiness. Design completion above 49 percent would earn 1 out of 2 points for project readiness.

K.1.3 Infrastructure and Economic Development Bank

The Infrastructure and Economic Development Bank's (IBank) Infrastructure State Revolving Fund (ISRF) program provides low-cost, direct financing in the form of fixed interest rate loans to local governments for water, sewage, solid waste, organic-recycling projects, and for a variety of other infrastructure and economic development projects within California. Eligible project cost for financing includes all or any part of the cost of demolition, construction and renovation, machinery and equipment, engineering, and/or other expenses necessary to determine feasibility of the project. Funding is provided via three programs including the ISRF Direct Loan Program, California Lending for Energy and Environmental Needs (CLEEN) Center Direct Financing, and the Statewide Energy Efficiency Program.

Financing is available from $1 million up to $65 million with loan terms for the useful life of the project up to a maximum of 30 years. Municipalities may submit applications continuously with the application process taking on average 7-9 months. Loans are provided on a "first come, first served" basis and due to IBank's ability to issue bonds, the program is not competitive. There are no grant opportunities and typically the interest rate of this program is higher than CWSRF and either higher or comparable to the Water Infrastructure Finance and Innovation Act (WIFIA) Program. Recent ISRF program loans approved interest rates ranging from 4.04 to 4.67 percent during FY 2022 to 2023. An origination fee is required of either $25,000 or 1 percent of the original loan amount, whichever is greater.

The IBank application requires a detailed project description, project timeline, current capital improvement plan, detailed cost estimates, bids, and construction contracts and financials (five years of audited financial statements, any applicable revenue projections, and cash flows).

K.1.4 Climate Pollution Reduction Grant Program (Federal)

The Climate Pollution Reduction Grant (CPRG) program[1] is another federal funding opportunity created through the Inflation Reduction Act (IRA) and administered by the EPA.

This program consists of two phases:

- Phase 1: $250 million for noncompetitive planning grants
- Phase 2: $4.6 billion for competitive implementation grants

[1] https://www.epa.gov/inflation-reduction-act/climate-pollution-reduction-grants

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The first round of grants was provided to states, local governments, tribes, and territories to develop and plan for reducing GHG emissions and other harmful air pollution. California outlined a climate action plan (CAP).

Phase 2 implementation grants will target implementation of actions outlined in California's CAP for eligible agencies including state and territorial agencies, municipalities, air pollution control agencies, and tribes. BMSP projects may be eligible for Phase 2 implementation grants if they reduce GHG emissions[2].

BMSP projects would have been competitive for this program, but based on the current level of definitions and design and the funding opportunity requirements, they are not aligned to competitively pursue the opportunity at this time. The application for this program is due April 1, 2024.

K.1.5 Water Infrastructure Finance and Innovation Act (Federal)

The WIFIA[3] is a federal program administered by EPA to provide low interest rate financing for large dollar value water, wastewater, stormwater infrastructure projects. WIFIA funds projects that are eligible for the CWSRF (see Section I.1). Projects that serve large communities (over 25,000 people) must have a minimum project cost of $20 million to apply for WIFIA and the program provides up to 49 percent of the project financing. Multiple projects can also be grouped in a WIFIA application if they serve a common purpose, are completed within a 5 to 6-year timeline and the loan is repaid from the same revenue stream. In previous years, WIFIA has funded major capital improvements for wastewater facilities, including several biosolids programs.

To pursue WIFIA financing the total project cost (single project or package of projects to be completed over a period of 5 years) must total greater $20 million. To pursue the program, at a minimum, preliminary design to 30 percent design documentation is required as well as sufficient project definition to clear environmental review.

K.1.6 Congressional Directed Spending Requests (Federal)

Congressionally Directed Spending Requests[4] are a mechanism by which members of Congress can request funding for specific projects in their district to serve the public good. State and local government entities and nonprofits submit projects for consideration to their congressperson who can request funding for up to 15 projects. It is not guaranteed that all will be funded. Congressional Directed Spending Requests are limited to no more than 1 percent of discretionary spending with a state/local match required. As a point of reference, in FY 2023 (October 2022 through September 2023) the average funding ranged from $1 to $3 million. The House and Senate ultimately select projects. If approved, funding is distributed as part of the federal appropriations process the next fiscal year.

K.1.7 Inflation Tax Credit and Production Tax Credit (Federal) K

The IRA covers new and reinstated tax laws that are expanded to include tax-exempt organizations, such as municipalities and water authorities/utilities. There are opportunities to take advantage of the pre-existing Investment Tax Credit (ITC) or Production Tax Credits (PTC), which were previously only available to tax-paying entities. Additionally, the IRA introduced new energy property categories,

[2] https://ww2.arb.ca.gov/sites/default/files/2023-06/CA%20CPRG%20Workplan%20Narrative_052523.pdf

[3] https://www.epa.gov/wifia

[4] https://www.appropriations.senate.gov/fy-2024-congressionally-directed-spending

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one of which is "qualified biogas property." This addition allows ITC or PTC funds to be claimed for projects that convert biomass into a gas that is captured for sale or productive use; applicable projects are those on which construction starts on or before December 31, 2024. In November 2023, the Internal Revenue Service (IRS) released guidance stating that thickening, digestion, and cogeneration projects are included as eligible basis for. In addition, the IRA added a Clean Electricity Investment Credit for installing carbon-free-electricity qualified property for projects that begin construction between January 1, 2025, and December 31, 2032. The ITC is prescriptive and is non-competitive with credit values ranging from 30 percent to 50 percent of eligible project costs such that wage and apprenticeship requirements are met.

K.1.8 Solids Wastes Infrastructure for Recycling

The City could partner with the local solid waste group to take advantage of the Solids Waste Infrastructure for Recycling grants[5]. The goals of these grants are to expand access to recycling and composting programs nationwide, modernize existing solid waste management infrastructure, improve consumer education and outreach, and help reduce contamination of the recycling and organics waste streams. The City could partner with a solid waste group to receive funding that would support pre-processing food waste infrastructure and expand digestion capacity at the City to accept food waste.

K.1.9 Other Programs

Other potential federal and state programs offering opportunities for research, planning, design and construction are summarized below. These opportunities should be further investigated for applicability, availability and eligibility as the project is better defined and design documents are advanced.

EPA:

- Wastewater Efficiency Grant Pilot Program
- National Clean Investment Fund (GHGRF)

Department of Energy:

- Research and Development for Advanced Water Resources (research)
- Decarbonization of Water Resources and Recovery Facilities (research)
- Energy Efficiency and Conservation Block Grant Program
- Title 17 Clean Energy Financing Program

United States Department of Agriculture:

- Fertilizer Production Expansion Program

State of California:

- California Energy Commission Energy Conservation Assistance Act Program
- Governor's Office Integrated Climate Adaptation and Resiliency Program

As presented, there are low interest loan and grant funding opportunities that are available to fund wastewater and biosolids projects. The programs have become competitive and critical to the success of pursuing funding is the readiness of the project document, readiness to proceed, fit of the project with a funding program and the readiness to apply.

[5] https://www.epa.gov/infrastructure/solid-waste-infrastructure-recycling-grant-program

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Appendix L: Business Case Evaluation for Building a New Digester

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L.1 Business Case Evaluation

A business case evaluation was completed to evaluate whether a new anaerobic digester, gas conditioning system, and SCR should be constructed now or deferred by 10 years. These projects unlock additional capacity for solids stabilization and biogas utilization. A new anaerobic digester is necessary to treat increasing flows and loads from primary sludge and TWAS when capacity is limited during digester cleanings. New biogas conditioning equipment, upsized biogas piping, and new SCRs are needed if acceptance of HSW is maintained because current biogas rates exceed the capacity of the existing systems.

The goal of the analysis was to provide the City with enough information to make a business case for one of two options: 1) securing grants and/or loans and building capital projects now, or 2) deferring capital projects and curtailing HSW receiving. The following alternatives were considered in the evaluation:

- **Alt 1. No Funding, Status Quo HSW, Add New Digester Now.** This alternative demonstrates costs incurred by the City if a new digester is constructed now. This is considered the baseline condition, and therefore operating costs are normalized to zero to simplify the comparison of operating costs between alternatives.
- **Alt 2. SRF Funding, Status Quo HSW, Add New Digester Now.** This alternative is identical to the previous alternative in terms of construction and LTP operations. In this alternative, the anaerobic digester is financed by the state revolving fund (SRF) loan with 2.3 percent interest and annual payments over a 30-year period.
- **Alt 3. SRF Funding, Increase HSW, Add New Digester Now.** This alternative is identical to the previous alternative but assumes HSW is doubled, which increases the annual revenue and provides a benefit to the City.
- **Alt 4. CalRecycle Funding, Food Waste is Accepted, Add New Digester Now.** This alternative assumes the City secures $5 million in CalRecycle funding to offset new digester construction and that the City partners with a solids waste company. This assumes the solids waste company would construct a food waste receiving facility at the LTP. They would also pre-process food waste to remove contamination and provide the City with a pumpable food waste slurry. The calculations demonstrate a nominal annual operating benefit: cogeneration electricity benefits offset the predicted increases in electricity, chemicals, and biosolids hauling costs from food waste. The CalRecycle loan was assumed to have 4 percent annual interest and monthly payments over a 10-year period.
- **Alt 5. Loan Sensitivity, Status Quo HSW, Add New Digester Now.** This alternative is identical to alternative 2 but had the interest rate adjusted for a sensitivity analysis on the interest rate required to provide a lifecycle cost benefit to the City compared to deferring construction of the new digester. A 3.9 percent interest rate with annual payments over a 30-year period was assumed.
- **Alt 6. No Funding, Reduced HSW and Lystek used during Digester Cleanings, Defer New Digester by 10 Years.** This alternative assumes the City operates in a recuperative thickening mode during digester cleanings to maintain Class B biosolids. HSW is decreased by about 365,000 gallons per year (i.e., 1,000 gallons per day on average) to offset population growth. It was assumed that the City would need to go to Lystek for three summer months every other year during digester cleanings. It was also assumed the City would need to go to Lystek for three summer months in 2026 and 2028 during digester improvement projects in the near term. This captures the financial risk to the City if biosolids are not compliant with Class B solids retention

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time requirements during recuperative thickening operations and construction of digester improvements. Gas conditioning system improvements and SCRs are assumed to be implemented in the near term for this alternative as population growth could still impact biogas production and necessitate an increase in biogas utilization capacity.

All alternatives assume digester improvements (cover replacements, mixing improvements, and interior coating repairs) and BP cake pump replacements are implemented in the near term because the condition assessment recommended these as high-priority projects. Near term installation of a new GBT is also assumed because it is needed to address capacity limitations.

Figure L-1 shows the results of the business case evaluation. The 30-year net present cost comparison between alternatives demonstrates that the lowest lifecycle cost is associated with constructing a digester now with a low interest loan and maximizing biogas utilization benefits (Alternative 3). Partnering with a solids waste company is also an economically viable alternative. The costs associated with hauling food waste residuals for disposal offset some of the benefits realized by the additional biogas and tipping fees. This may be seen as a risk for end-use biosolids management.

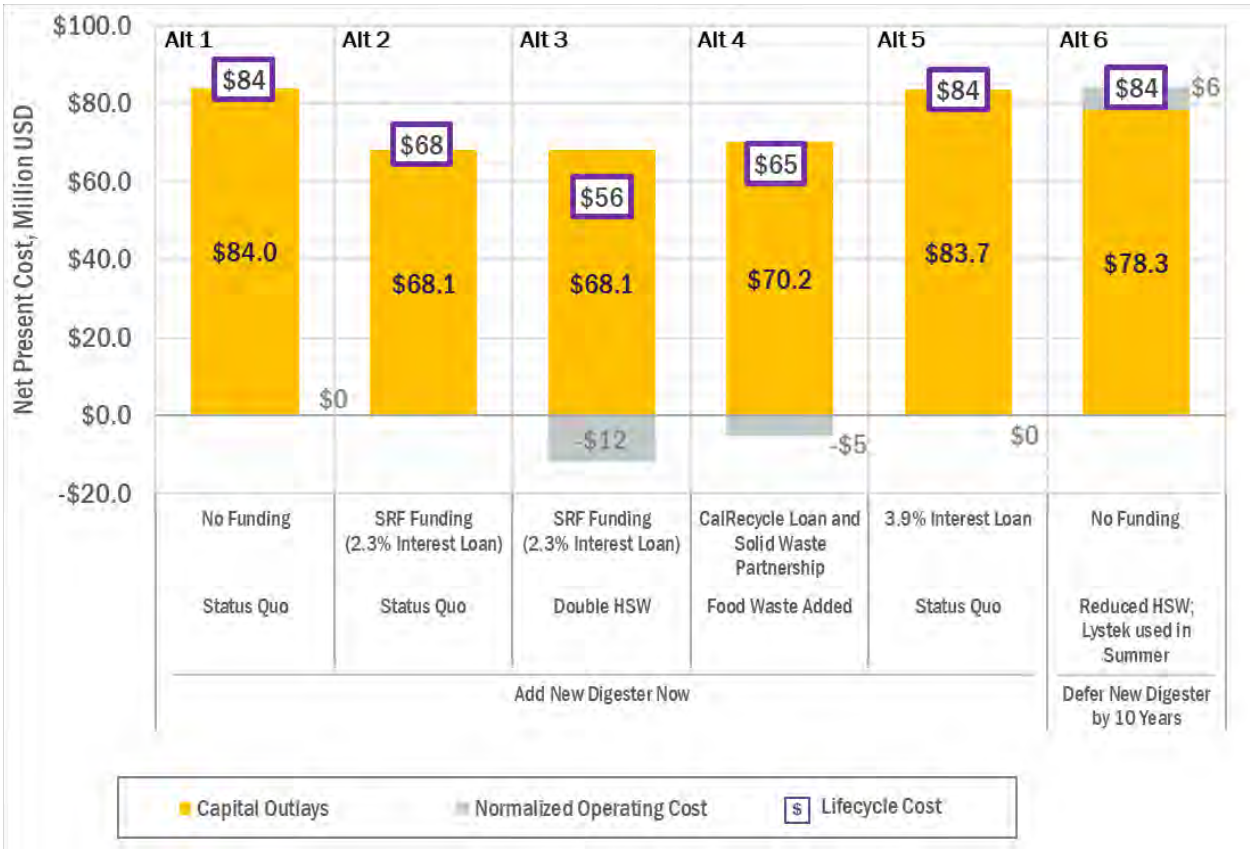


Figure L-1. Net present value cost comparison between cost/benefit analysis alternatives

All alternatives assume gas conditioning system improvements (new hydrogen sulfide [H_2S] removal vessels; upsize biogas piping and SCR projects), digester improvements (cover replacements, mixing improvements, and interior coating repairs), BP cake pump replacements, and addition of a new GBT are implemented now.

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Deferring a new digester risks higher operating costs. This alternative also would reduce the amount of HSW received by the LTP, which could impact the City's carbon footprint and climate action goals.

A loan interest rate of 3.9 percent or lower was shown to have similar lifecycle cost to deferring the construction of a new digester. However, this alternative would also have the benefit of combining solids treatment and gas utilization projects. Combining projects would simplify project management for the City and could result in additional project cost savings through administration efficiencies.

L.2 Recommendations

The net present cost (i.e., lifecycle cost) demonstrates the financial merit of securing a low interest loan to facilitate the earliest possible construction of a new anaerobic digester. This lowers compliance risk to the City by establishing sufficient digestion capacity. This would also provide operational flexibility to continue or expand HSW receiving.

Several of the grant, loan, tax credit, and funding opportunities released in 2022 are part of a 10-year plan to reduce GHG emissions and mitigate climate change. BC recommends the City group projects that align with the intent and goals of these funding opportunities as soon as possible, and while they are still prioritized on a state and federal level. Most of these grants and/or low interest loans are scored higher if the applicant can demonstrate a real project the funds will be spent on; supporting documents can include GHG emissions calculations, detailed design contracts, construction contracts, or preliminary design reports. Initiating a design project with a comprehensive scope and deliverables would position the City to apply for grants and loans as new opportunities are announced, but it is challenging to develop an application without clear vision and intent.

The following CIP projects could be combined in a grant-ready package to maximize benefits to the City:

- New Anaerobic Digester and Gallery
- Increase Gas Conditioning System Capacity (new H_2S vessels and increase size of biogas piping)
- SCR Installation for CHP Engines 1 & 2
- Add 1 GBT to Existing Thickening Building
- Digester 1 and 2 Cover Replacement, Mixing Improvements, and Coating
- Digester 3 and 4 Mixing Improvements and Coating
- Structural Improvements
- Electrical Site Improvements
- BP Cake Pump Replacement

Deferring capital costs and projects creates more risk for the City. Higher annual operating costs could be incurred if Lystek is required for biosolids disposal during Summer months when digester cleaning or digester improvement projects are scheduled.

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