Encina Wastewater Authority

2022 Biosolids Management Plan Update

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June 2022

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2022 Biosolids Management Plan Update

Final

June 2022

Prepared for:

Encina Wastewater Authority

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We appreciate the time, attention, review, and insights of the following Encina Wastewater Authority staff as we collaborated and developed the recommendations in this report:

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Executive Summary

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Acronyms

BEE	Biosolids, Energy and Emission Plan
BMP	Biosolids Management Plan
CFR	*Code of Federal Regulations*
EHH	enzymatic hyperthermophilic hydrolysis
EQ	Exceptional Quality
EWA	Encina Wastewater Authority
EWPCF	Encina Water Pollution Control Facility
GHG	greenhouse gas
HEX	heat exchanger
JPA	Joints Powers Agreement
MAD	mesophilic anerobic digestion
MGD	million gallons per day
NG	natural gas
O&M	operations and maintenance
PFAS	per- and polyfluoroalkyl substances
PMP	Process Master Plan
RFP	Request for Proposals
SCADA	supervisory control and data acquisition
TAD	thermophilic anaerobic digestion
VSR	volatile solids reduction

Glossary

Biosolids: An organic solids product produced by wastewater treatment processes that can be beneficially recycled. For these organic solids to become biosolids, they need to meet the requirements of U.S. Environmental Protection Agency 40 *Code of Federal Regulations* (CFR) 503, which further distinguishes biosolids between Class A and Class B.

Class A Biosolids: Biosolids that have been processed to significantly reduce pathogens and vector attraction and can be beneficially used without restrictions (such as on farms, home lawns, and gardens).

Class A Exceptional Quality (EQ) Biosolids: Class A biosolids that meet low-pollutant requirements (that is, heavy metals) and have almost no pathogens.

Class B Biosolids: Biosolids that have been processed to reduce pathogens and vector attraction and can be beneficially used for land application of certain crops and grazing animals, with restricted public access.

Cake biosolids: Consistency of biosolids, regardless of classification. Water content is in the 65-85% range.

Dried biosolids: Consistency of biosolids with water content in the 0-25% range. It is common that dried biosolids have achieved Class A requirements.

Granules: Dried biosolids that have gone through certain drying technologies that produce this type of dry product.

Pellets: Describes the consistency of dried biosolids that have gone through a drying process and a post-processing steps to enhance product characteristics (pelletizing).

ES1. Introduction

The Encina Wastewater Authority (EWA) is governed by a Joint Powers Agreement (JPA), where the following six owners share in EWA's capital, operational, and management costs: City of Carlsbad, City of Vista, City of Encinitas, Vallecitos Water District, Buena Sanitation District, and Leucadia Wastewater District. The EWA treats wastewater for nearly 400,000 North San Diego County residents at the Encina Water Pollution Control Facility (EWPCF) in Carlsbad, California. The EWPCF has an existing hydraulic design capacity of 40.5 million gallons per day (MGD) (Brown and Caldwell 2018). Figure ES-1 shows an aerial view of the EWPCF site, with the solids processing area highlighted in yellow.

Figure ES-1. Encina Water Pollution Control Facility

Source: Aerial photo courtesy of EWA

ES1.1 History of Encina Biosolids Management

Figure ES-2 shows some of the EWPCF biosolids management milestones. Prior to 2008, EWPCF produced only Class B biosolids per the 40 *Code of Federal Regulations* (CFR) 503. To reduce risks associated with potential regulations or ordinances that could impact land application of Class B biosolids, EWA installed a rotary drum heat dryer as part of the EWPCF Phase V Expansion to generate Class A dried biosolids (granule form) for beneficial use to increase biosolids distribution options. In 2014, EWA began to market the PURE GREEN Class A dried biosolids as fertilizer in pelletized form.

Figure ES-2. History of Biosolids Management at Encina Water Pollution Control Facility

EWA completed a *Biosolids Management Plan* (BMP) in 2008 (Black & Veatch 2008) that focused on adding a new heat dryer to generate Class A dried biosolids granules for beneficial use. EWA further evaluated biosolids processing and the need for increased solid handling capacity in the 2016 *Process Master Plan* (PMP) (Carollo 2016) and the 2018 *Biosolids, Energy and Emission Plan* (BEE) (Brown and Caldwell 2018).

The 2008 BMP recommended securing 200% disposal capacity by year 2, 100% beneficial use by year 5, and the reassessment of biosolids management considering future changes. EWA has successfully achieved these first two recommendations. The next effort is focused on the reassessment of biosolids management based on new regulations, lessons learned, market trends, and innovations in technology (Figure ES-3).

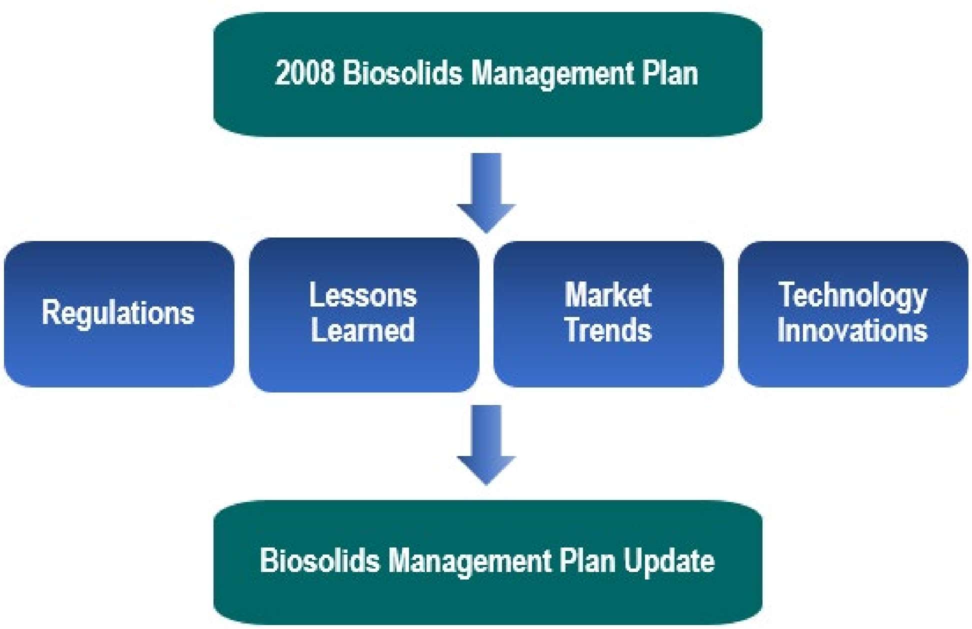


Figure ES-3. Biosolids Management Plan Update

EWA retained Jacobs to update the BMP, and investigate improvements to the management and beneficial use of biosolids generated at EWPCF, with a focus on the factors shown on Figure ES-4.

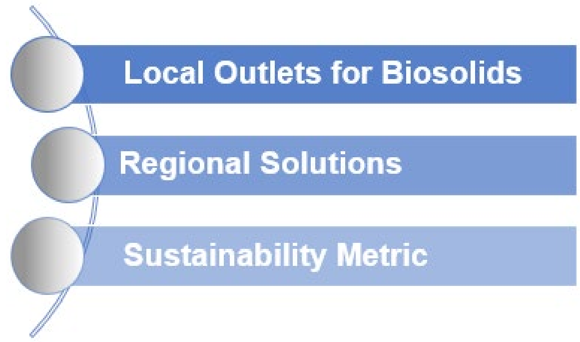


Figure ES-4. New Components for Evaluation of Biosolids Management Alternatives

As Figure ES-5 shows, the overall biosolids management goals are to balance infrastructure, sustainability, and economics, resulting in both near- and long-term benefits for EWA.

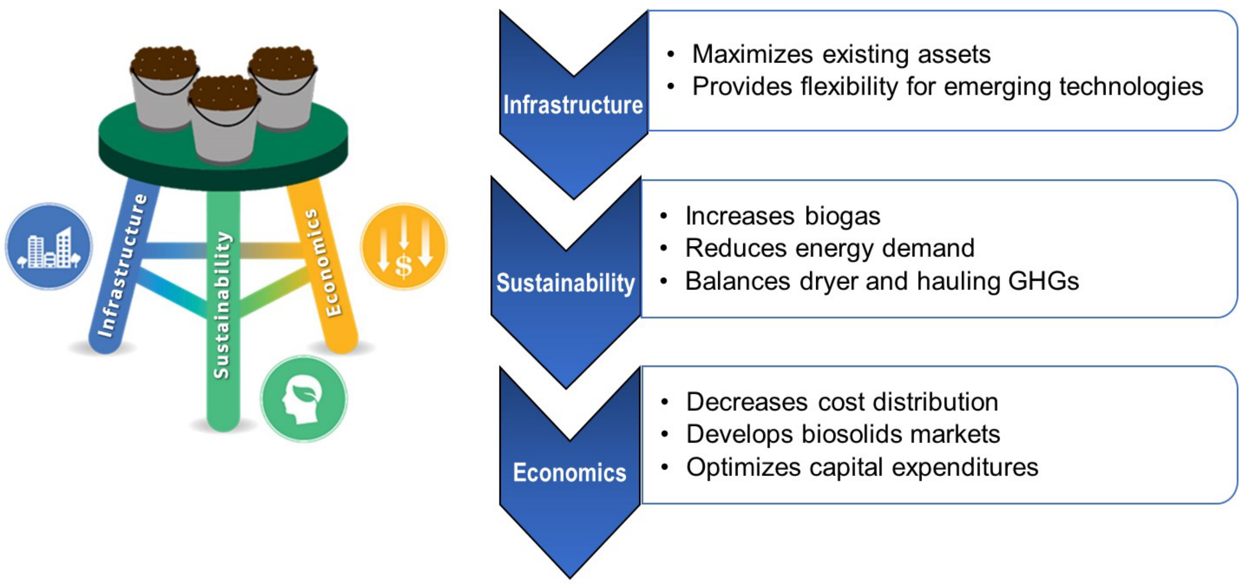


Figure ES-5. Balancing Objectives for Biosolids Management Plan Update Goals

ES2. Current Biosolids Practice (TM 1)

EWPCF produces Class B biosolids cake using a combination of treatment processes, including thickening, anaerobic digestion, and centrifuge dewatering (Figure ES-6). The Class B biosolids are further treated with a heat dryer to produce dried Class A biosolids in granule form.

EWPCF solids production has been steadily increasing since 2009. The primary and secondary solids are conveyed to three anaerobic digesters and then dewatered using three centrifuges. In the final step, dewatered cake is treated in a single rotary drum dryer to further reduce water content and produce Class A biosolids. Currently, EWA contracts with Denali, a third party, for land application of both Class A (granules) and B (cake) biosolids; data show that the main locations for land application are near Yuma, Arizona, as well as several smaller local agricultural outlets.

EWA markets Class A granules under the PURE GREEN label in bags and small totes and has a small local outlet for less than 15% of the biosolids generated, according to 2016 to 2020 data provided by EWA.

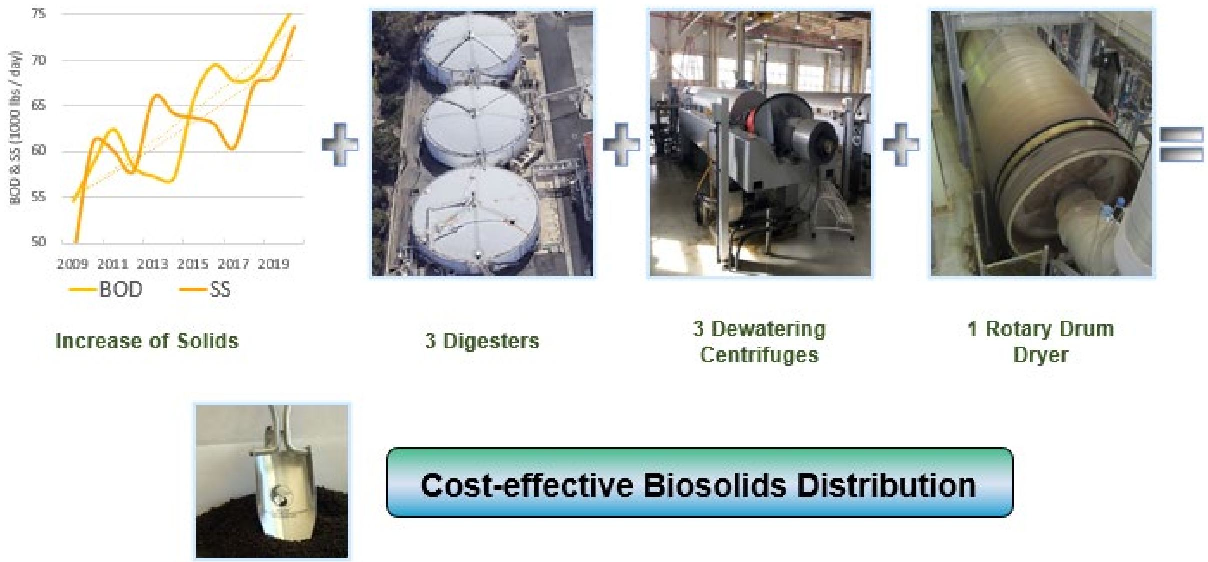


Figure ES-6. Current Encina Water Pollution Control Facility Biosolids Treatment Process

The EWPCF produces primarily Class A Exceptional Quality (EQ) dried biosolids (PURE GREEN product) after the rotary drum dryer treatment. However, when the dryer is offline due to maintenance, EWPCF can only produce Class B cake biosolids. Figure ES-7 shows the change in biosolids production by class type and year since 2017. Biosolids production increased each year from 2017 until 2019, with a small decrease in solids production in 2020.

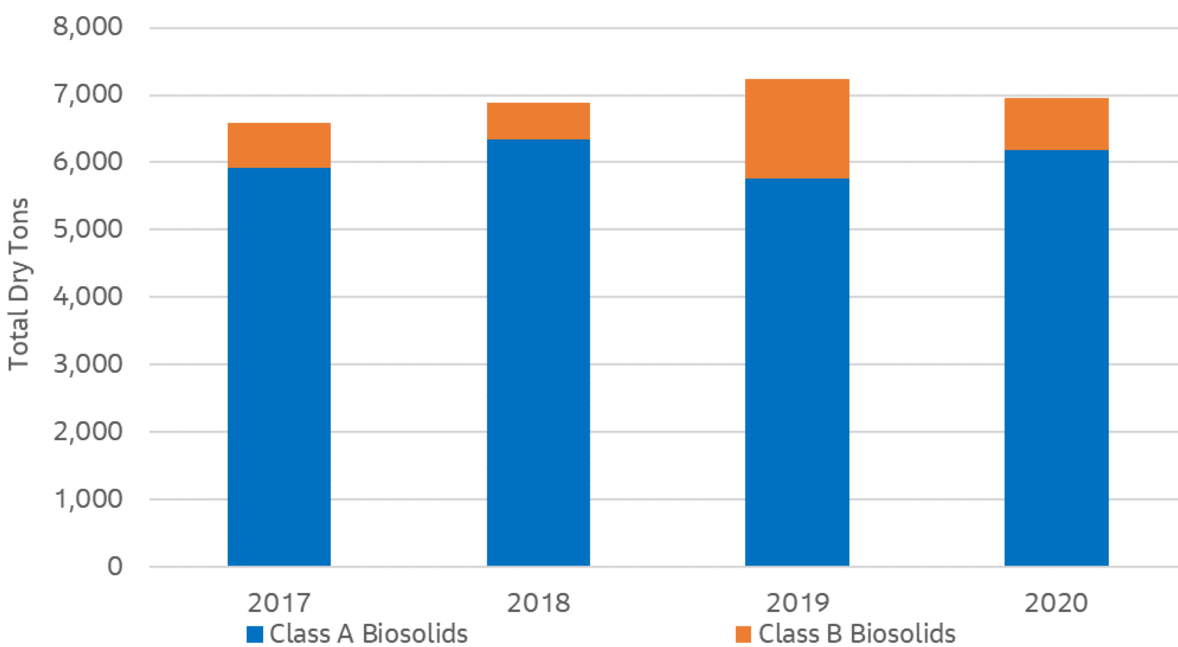


Figure ES-7. Biosolids Production Since 2017 by Class

ES2.1 Projected Flows and Loadings Assessment

So that EWA maintains 100% beneficial use, the EWPCF treatment processes must be able to meet capacity and redundancy requirements for projected flows and loadings while also meeting future regulatory limits that may impact EWPCF operations and beneficial use criteria for Class A and B biosolids. Existing treatment processes and equipment may need to be expanded to accommodate increases in flows and loadings. Alternatively, new types of treatment processes and equipment may be necessary due to limited available space at EWPCF, or to provide a more cost-effective, beneficial means of treatment.

Figure ES-8 shows the average daily combined sludge production and resulting flows to digestion using BEE projections (Brown and Caldwell 2018) and the updated projections from the present study adjusted for observed 2020 data. The data show similar solids loadings to digestion and downstream systems and an increase in hydraulic loadings that impact process capacity and redundancy.

This analysis was the result of coordination between EWA and Jacobs to determine data source reliability, leading to a consensus on the projections to be used throughout this BMP Update.

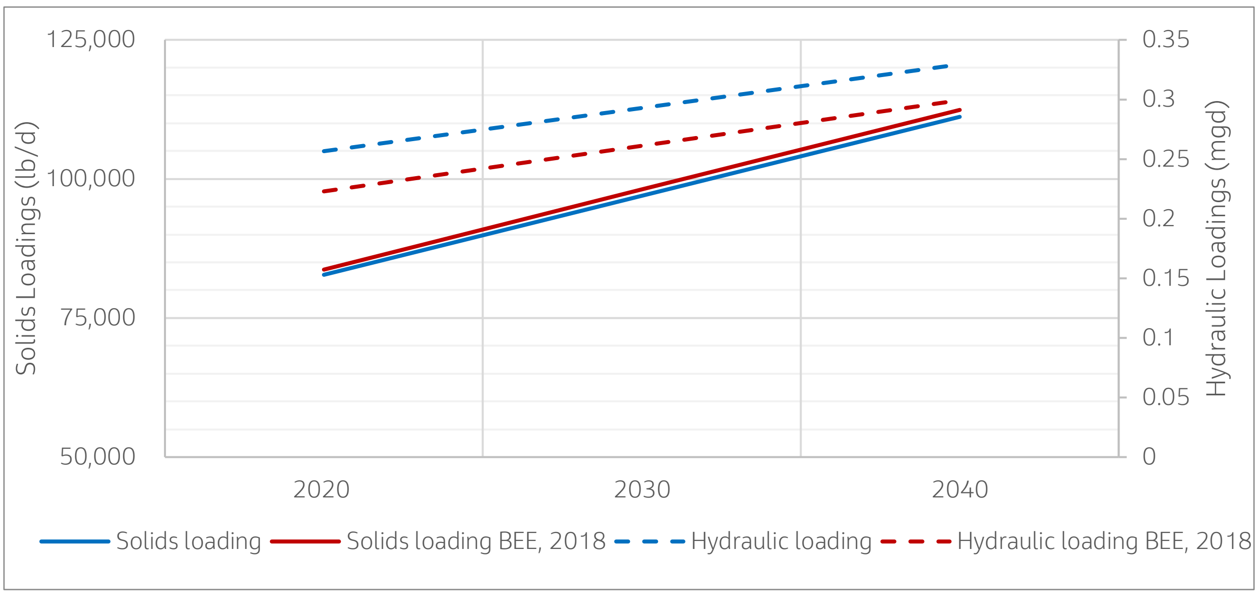


Figure ES-8. Comparison of Future Solids Production Projections

Analysis of current operations and projected flows shown on Figure ES-9 indicates that the digestion system redundancy is not met under 14-day peak flow conditions (that is, the system would not be able to meet the criteria to achieve Class B biosolids if one of the three digesters is taken offline for cleaning or repairs). Modifications in treatment processes and operations will be needed to maintain 100% biosolids beneficial use.

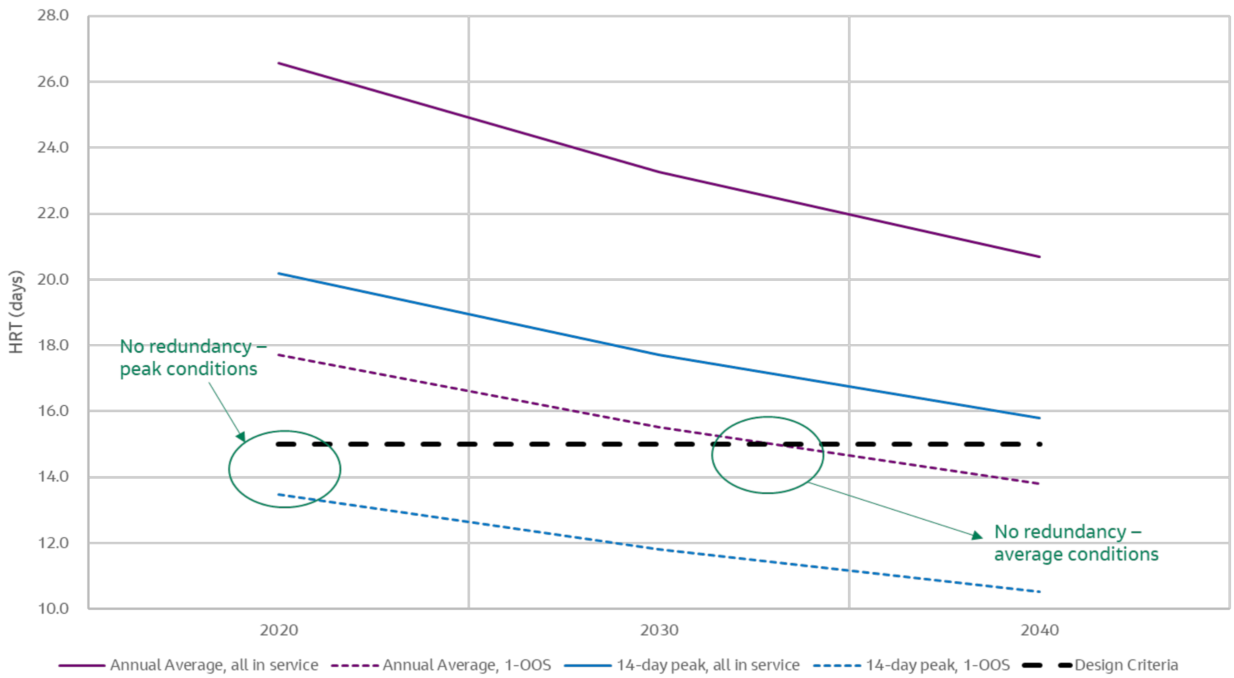


Figure ES-9. Digestion Hydraulic Capacity and Redundancy under Current and Projected Flows

Other conclusions include the following:

- EWPCF currently operates three anaerobic digesters. Despite there being enough digestion capacity throughout the planning period in terms of solids loadings (as opposed to hydraulic loadings), the redundancy criteria would not be met by 2032 under 14-day peak solids loading conditions.
- EWPCF currently operates three centrifuges. Typical operation is to use the two units, reserving the third unit for redundancy or peak period operation (Brown and Caldwell 2018). Based on projected flows and loadings, the existing centrifuges have sufficient total capacity through 2040. However, beyond 2030, all three units will need to be in operation.
- EWPCF operates a single thermal dryer to convert dewatered cake into high-quality dried granules that are marketed as PURE GREEN. Annually, the dryer is currently operating near 90% capacity. When the dryer capacity is exceeded or the dryer is out of service, Class B biosolids cake has been hauled and land applied to agricultural farmland, or landfilled. California regulation SB 1383 came into effect January 1, 2022. This regulation is focused on diversion of organic wastes from landfill and increases the risks related to landfilling of biosolids as a back-up management option.

ES2.2 Biosolids Management Evaluation Criteria

The objective of the nonmonetary criteria is to provide elements for the primary screening of potential alternatives that includes EWA's priorities beyond the capital and operations and maintenance (O&M) costs. The criteria developed in the 2008 BMP were updated with an additional sustainability metric to be consistent with EWA and member agencies' values and concerns. Specific and quantifiable definitions are then associated with each metric so that it can be used to evaluate each potential alternative.

The development of the nonmonetary criteria early in the process was important to understanding EWA's critical success factors and preferences prior to developing management options (Figure ES-10).

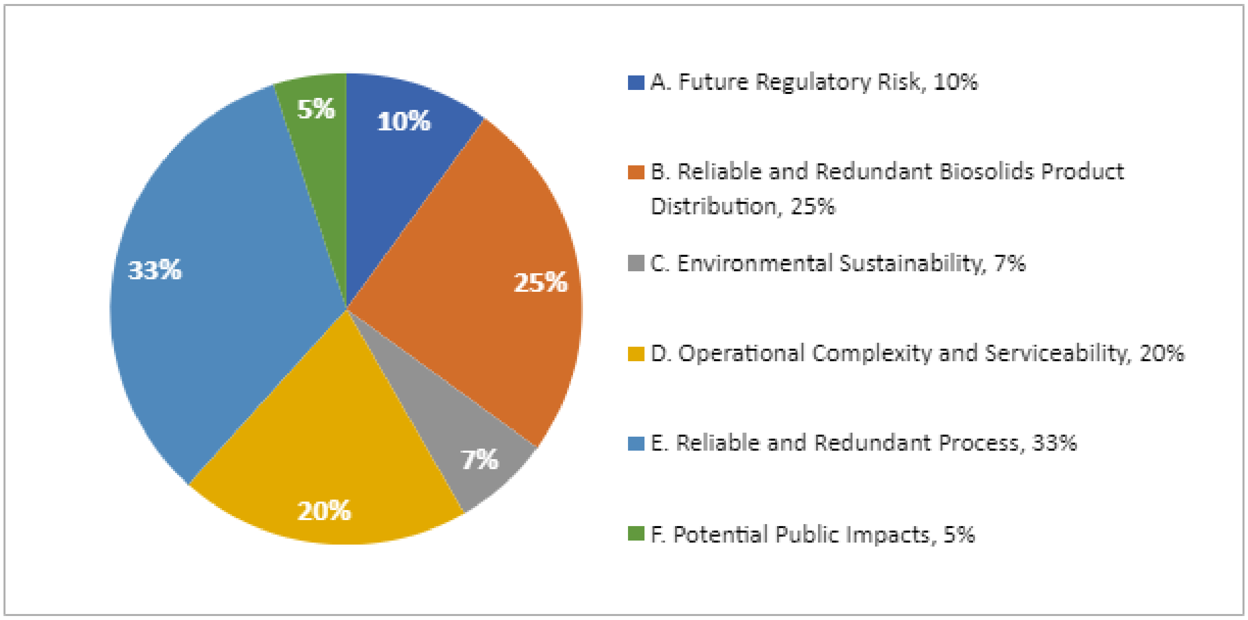
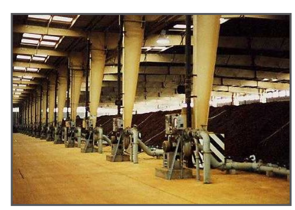


Figure ES-10. Nonmonetary Criteria Weighting

ES3. Biosolids Market Outlook (TM 2)

Regional market research was conducted to identify other markets closer to EWPCF for the Class A granules so EWA can reliably transport large quantities at lower cost than the current disposal contract. Class A granules were determined to have potential markets in the EWA service area and surrounding areas. Organizations with potential to accept large quantities in bulk were contacted for the market research, including:

- **Agriculture –** Opportunity exists for direct sale of the biosolids product to farmers but would require dedicated sales staff. Instead, farmers may be accessed by working through agricultural spreading companies (for example, ET, Inc.). Companies already selling other bulk products to farmers, such as a composter or gypsum suppliers, could also serve in this function.



- **Composters –** Interest was not identified by composters for the use of biosolids granules as an additive to composting (for nutrient enhancement). However, Agromin (a Los Angeles area composter and packager) showed interest in using the product for their blended soil products.

- **Fertilizer Blenders and Packagers –** There was limited interest among new fertilizer blenders and packagers. However, Nutrients PLUS and Upcycle & Company showed continued interest in working with the EWA product and are preparing proposals for larger volumes of product.
- **Fertilizer Brokers and Biosolids Managers –** Companies such as MANNCO and WeCare/Denali showed significant interest in working with the EWA fertilizer. Both companies are experienced at marketing granulated biosolids.

- **Soil Blenders –** There was limited interest from bulk soil blenders except for Agromin (a Los Angeles area composter and packager). None of the other soil blenders interviewed were interested in using a Class A dewatered cake product due to odor issues and the added handling.

The current contract between EWA and its contract hauler provides the ability to haul and land apply Class A granules and Class B cake to agricultural farmland at a set cost. This provides a reliable biosolids handling solution, with both Class A and B products being beneficially used on agricultural land or by fertilizer blenders. In 2020, 89% of the solids produced were able to be dried to Class A EQ biosolids granules. However, only 15% of the granules produced was sold as Class A EQ, so the remaining 85% was land applied at a cost to EWA.

Several marketing options exist for managing the biosolids granules EWA produces. The most typical options are summarized in Table ES-1. There is potential to reduce biosolids granule management costs by increasing the market share. However, historically, this has been a challenge due to consistent market demand and need to blend the biosolids to provide a complete fertilizer. As part of this BMP, EWA took a fresh look to assess their marketing options, which includes reviewing overall BMP goals, internal strengths and weaknesses, and risk perception when considering which marketing option to implement.

Table ES-1. Granule Marketing Options

Options	Advantages	Disadvantages
Develop in-house marketing program	▪ Provides the most potential income ▪ Provides the most control for the producer	▪ Requires most staffing and internal effort ▪ Results in more responsibility and risk for the producer
Contract with broker or biosolids management firm, or both	▪ Reduces EWA management responsibilities due to being contracted or committed to one or a few companies ▪ Shifts the marketing risk to the contractor	▪ Producer may lose ability to brand product (internal) due to commoditizing the product ▪ Producer may be required to pay a distribution fee
Issue an RFP for purchase of product	▪ Casts a broad net, identifying potential interested parties ▪ Transfers the marketing risk to contractor	▪ Often advertised to the wrong organizations ▪ Typically reduces value of the product by transferring risk to the contractor

RFP = Request for Proposals

ES4. Evaluation of Biosolids Management Options (TM 3)

EWPCF's current biosolids management approach is based on anaerobic digestion followed by thermal drying. These two processes are closely dependent on each other because the digestion capacity, redundancy and performance impacts loadings to the dryer, while dryer capacity can provide redundancy to the digestion process. Jacobs and EWA staff evaluated a wide range of biosolids management options that address the main challenges of capacity, process redundancy, equipment reliability, and opportunities to optimize both digestion and thermal processes, leveraging previous work conducted by EWA in the past 6 years.

Initially, the team developed 21 alternatives under 6 themes, ranging from no modifications being made, to solutions that could provide the most benefits to the EWA biosolids program with different mid- and long-term phasing implementations without considering cost. These alternatives were evaluated using the nonmonetary criteria developed in Task 1 to determine how each management alternative complies with EWA's priorities.

Figure ES-11 shows the result of this nonmonetary evaluation. This scoring methodology highlights the potential of different alternatives to match EWA priorities without considering cost. However, the highest scored alternatives are not necessarily those selected for cost estimation and comparison. The alternatives that provided reliable and redundant process and product distribution scored most favorably in the nonmonetary evaluation. This process resulted in EWA staff selecting three main alternatives to further evaluate cost to benefit ratio and quantify environmental sustainability.

Main alternatives selected for capital and lifecycle cost evaluation:

- Alternative 8: Rehabilitate digesters 1, 2, and 3 in the midterm and upgrade them to thermophilic anaerobic digestion (TAD) in the future.
- Alternative 9a: Add a second drum dryer at the 2040 100% projected capacity demand.
- Alternative 9b: Add a belt dryer at the 2040 100% projected capacity demand.

Boundary alternatives selected for further evaluation along with main alternatives:

- Alternative 0: Base Case, do not implement any short-term modifications.
- Alternative 18: Add an integrated (drying, pyrolyzing, and gasifying) process in the midterm.

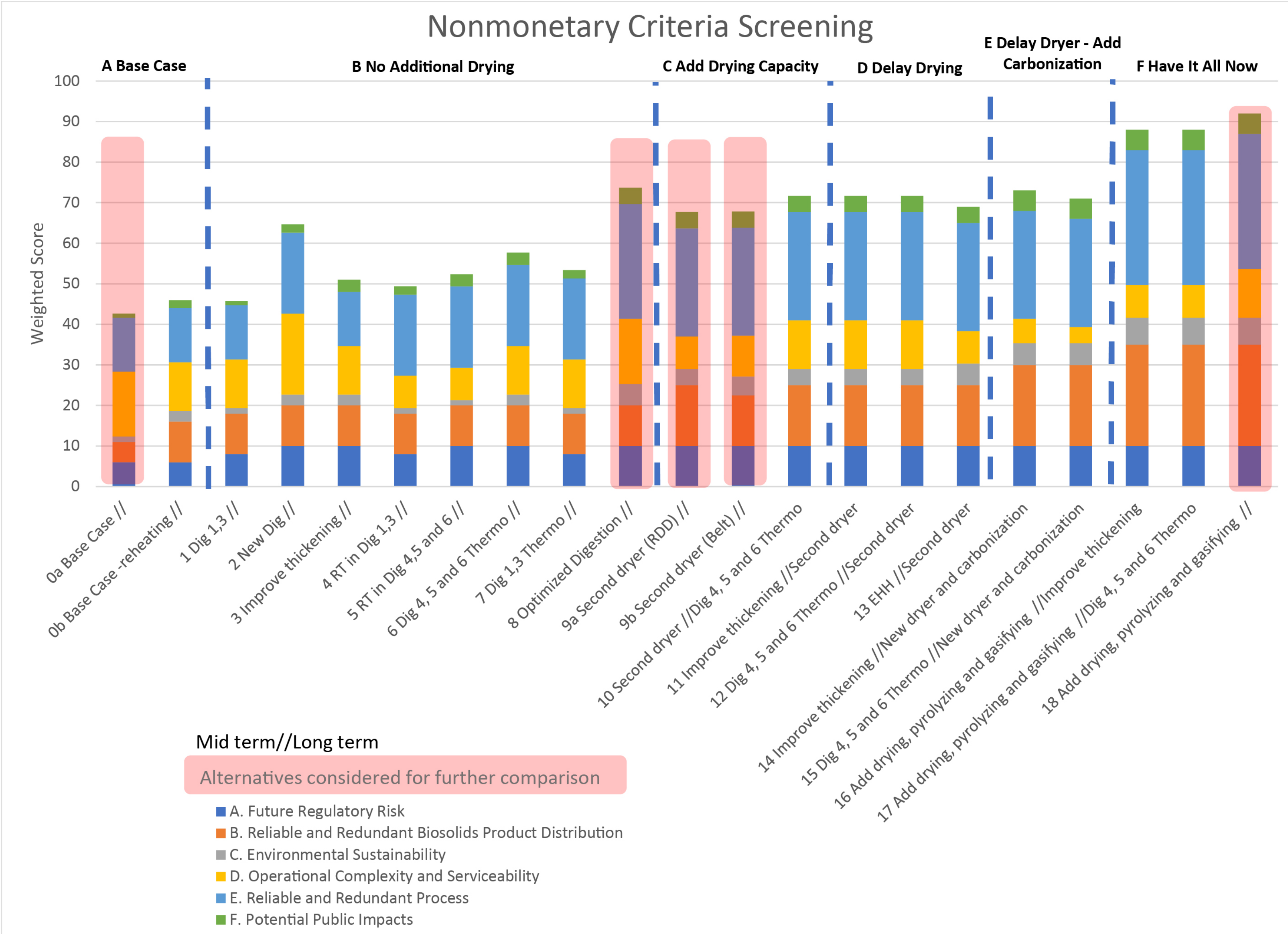


Figure ES-11. Nonmonetary Criteria Evaluation Results

After conducting the nonmonetary alternatives screening for 21 potential biosolids management options, a budgetary cost estimate was prepared in 2021 for the 2 boundary alternatives and the 3 main alternatives. These cost estimates (Figure ES-12) provided a reference cost for comparison and planning. Proposals were received for major equipment from vendors following the design criteria established in this BMP Update. The proposals aided in determining project costs, as well as refining nonmonetary criteria (for example, GHG emissions).

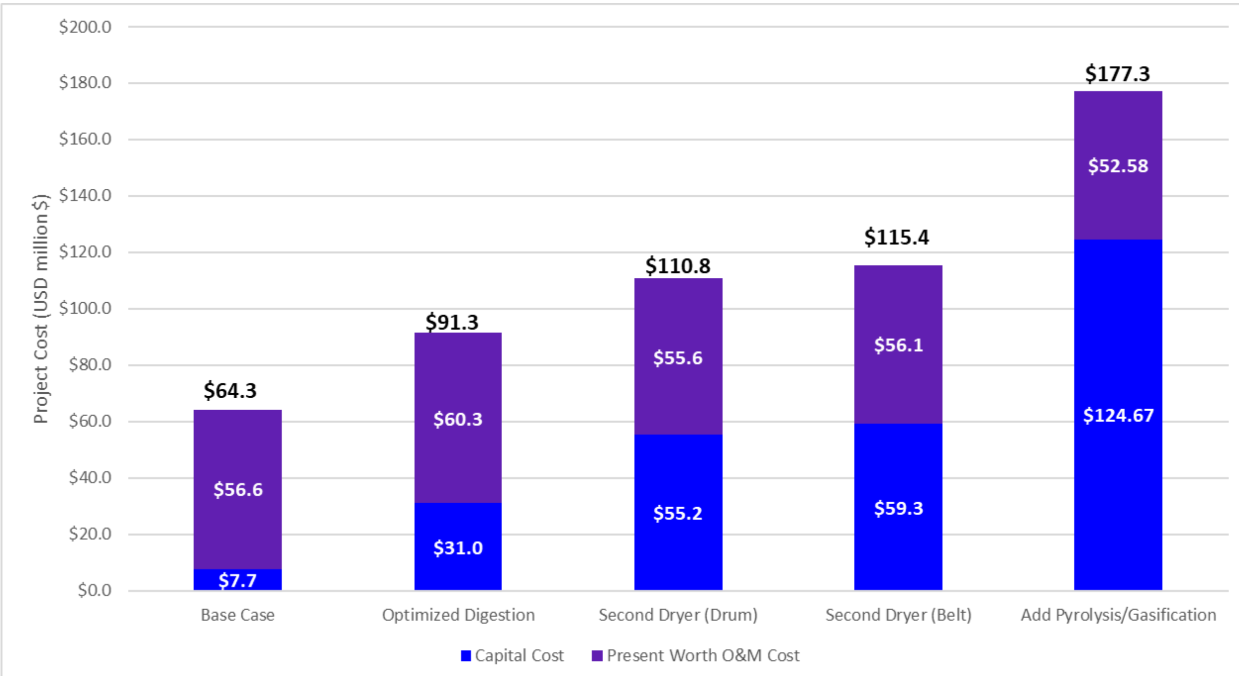


Figure ES-12. Monetary Criteria Evaluation Results

Figure ES-13 shows the results of the cost to benefit analysis comparing the five alternatives.

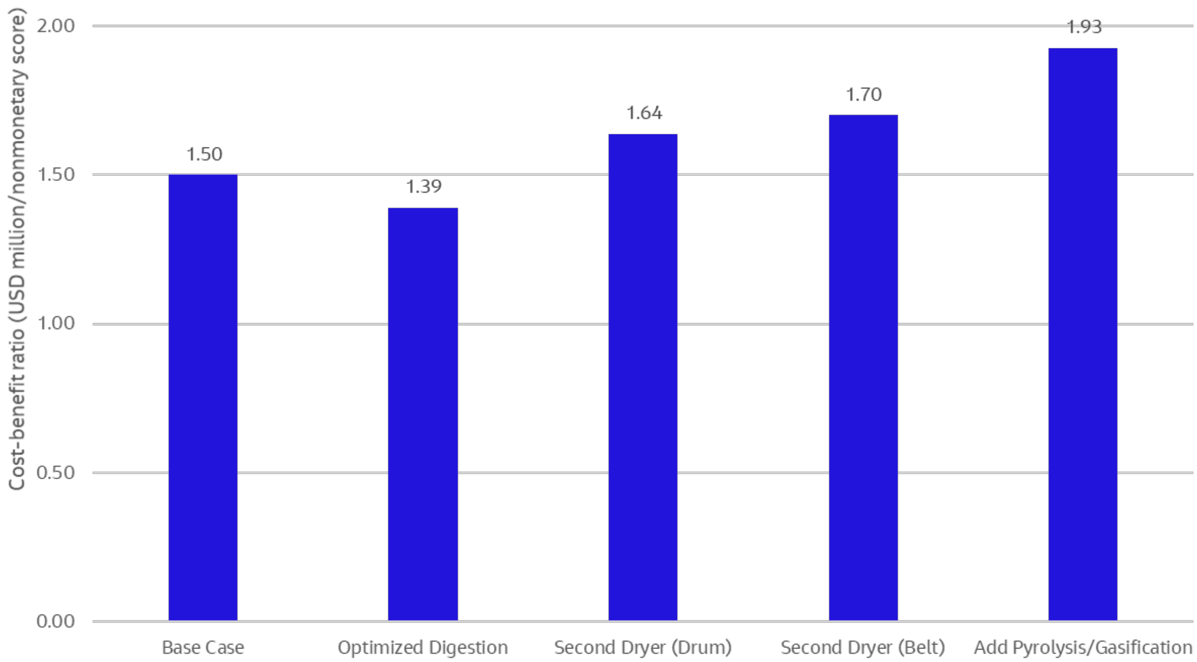


Figure ES-13. Nonmonetary Criteria Evaluation Results

The boundary alternatives (Alternative 0; Base Case; and Alternative 18, adding an integrated thermal [drying, pyrolysis, and gasification] process) were not further considered in the EWA's Biosolids Management Program, as they did not meet the project goals. The three main alternatives analyzed presented both advantages and challenges for the program, as summarized in Table ES-2.

Table ES-2. Advantages and Disadvantages of Three Biosolids Management Plan Alternatives

Result	Alt 8, Optimized Digestion	Alt 9a, Second Dryer (Drum)	Alt 9b, Second Dryer (Belt)
Advantage	▪ Provides digestion redundancy ▪ Reduces size of future second dryer ▪ Increases digestion capacity	▪ Provides a consistent product ▪ Operators have previous knowledge ▪ Needs a smaller footprint ▪ Provides dryer redundancy	▪ Is a less complicated process ▪ Has fewer safety considerations ▪ Has the potential to use waste heat from cogeneration to offset NG requirements ▪ Provides dryer redundancy
Disadvantage	▪ Does not produce a Class A product	▪ Has more safety considerations ▪ Is not able to use waste heat from cogeneration to offset NG requirements	▪ Produces different product quality and potentially requires a second loadout facility ▪ Requires a larger process footprint ▪ Has higher GHG emissions
Capital Cost, USD million	31.0	55.2	59.3

Alt = alternative
NG = natural gas
USD = United States dollar(s)

EWA staff and Jacobs' recommendation was to move forward with Alternative 8 (digestion optimization), which is the preferred midterm alternative to provide digestion capacity and redundancy throughout 2035. The recommended alternative allows future implementation of the enzymatic hyperthermophilic hydrolysis (EHH) process using digesters 1, 2, and 3. EHH is an innovative biological process that enhances anaerobic digestion, reducing solids production and boosting biogas production. The EHH process can be implemented with recuperative thickening to both enhance performance and increase anaerobic digestion capacity. Bench-scale testing of the EHH process showed the potential to increase the performance of the digestion system by 25% (measured by increases in volatile solids reduction).

Additional pilot-scale testing may be desired before full-scale implementation. The incorporation of a second dryer should be considered when declining performance of the existing dryer coupled with increased capacity needs and the cost of biosolids hauling and handling become too expensive. The dryer selection (drum or belt dryer) can be deferred until results from the current marketing program developments are assessed to account for the preferred end product.

The innovative integrated thermal (drying, pyrolyzing, gasifying) process could also be considered in the future as it is implemented at other facilities at full-scale and proves to be a reliable technology.

ES5. Strategic Implementation (TM 4)

To develop a clear implementation plan and schedule of activities associated with the preferred alternative identified in the alternatives analysis of Task 3, EWA and Jacobs evaluated the decision points, updated capital costs, and developed an implementation schedule.

Through a series of workshops, it was recommended to proceed with implementing TAD in digesters 1, 2, and 3, while continuing evaluation of the EHH process for future implementation. With the digestion improvements, the improvements to the thermal processes can be delayed until the next BMP Update, anticipated in 2028.

In planning the space required for the improvements to digesters 1, 2, and 3, a new digested solids tank is required to rehabilitate Digester 2 (Figure ES-14).

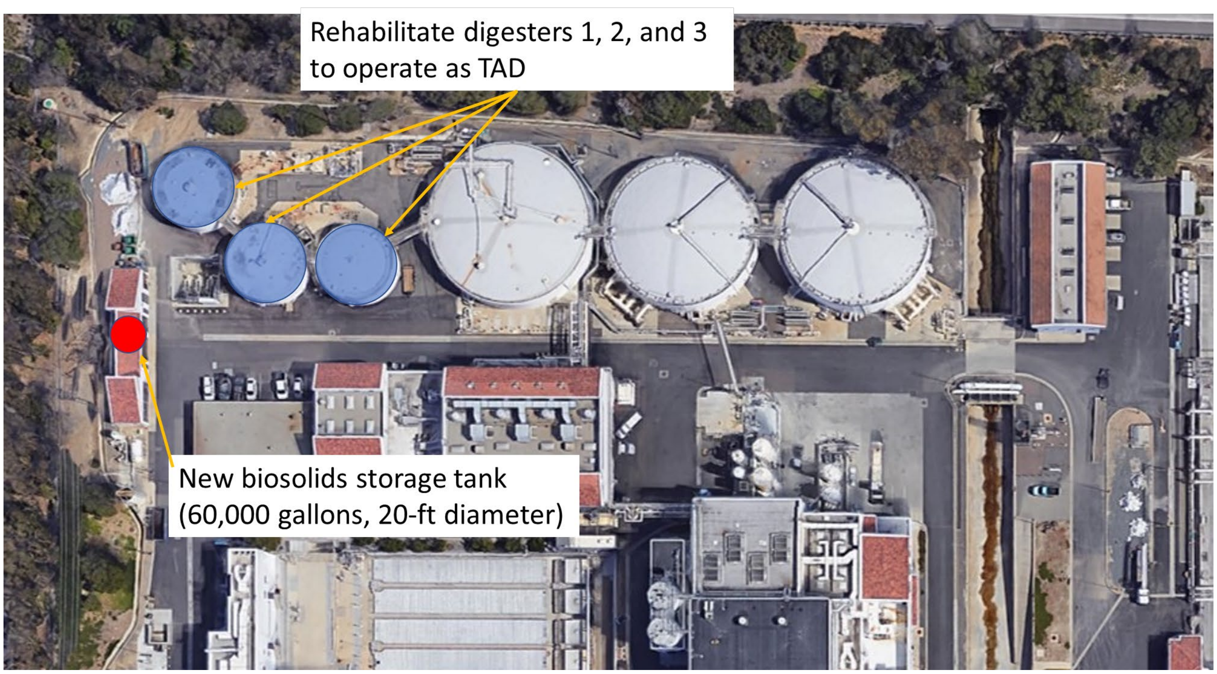


Photo Source: Updated with permission from EWA.

Figure ES-14. Preferred Solution: Thermophilic Anaerobic Digestion in Digesters 1, 2, and 3

The addition of digester volume, new heat exchangers, and storage tank provides increased flexibility in digester operation, while maximizing use of existing infrastructure. The heat exchangers will be sized to operate under all of the proposed conditions, and the interconnected piping will provide versatility in operational strategies and redundancy.

Figure ES-15 shows the timing of planned biosolids management facilities implementation. The main trigger is the timing of the digester cleaning because one digester will be out of service; therefore, the other two digesters will not meet the hydraulic residence time at peak 14-day operation. The next BMP Update will focus on the thermal optimization requirements after EWA has evaluated emerging technologies and the success of their biosolids granules marketing effort.

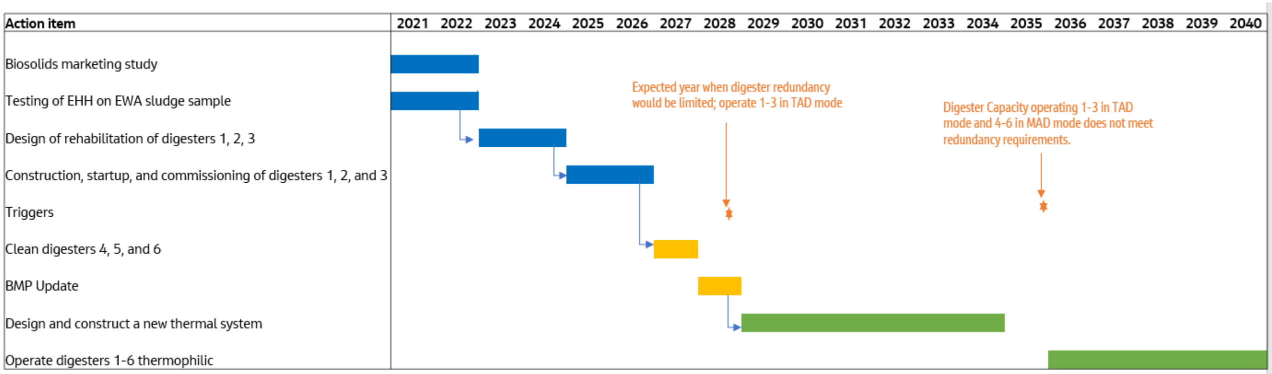


Figure ES-15. Strategic Implementation Schedule

Near-term (2021-2026) activities include:

- Develop a Biosolids Market Broker RFP to obtain a 5-year contract with a broker to increase local use of Class A biosolids and gain insights on product marketability. Completed February 2022.
- Perform bench-scale testing of the EHH process using EWA solids, and determine performance and potential applicability with digester improvements planned. Completed October 2021.
- Design, construct, and start up the rehabilitation of digesters 1, 2, and 3 prior to the scheduled digester cleaning in 2027.
- Revisit results from this BMP Update considering potential changes in EWA priorities and state-of-the-practice in 2028.

Long-term (2027-2040) activities include:

- Operate all six digesters to consistently meet Class B standards, and consider implementation of EHH if bench- and pilot-scale testing proves cost effective. After rehabilitation of digesters 1, 2, and 3, they could be operated in TAD or mesophilic anerobic digestion (MAD) mode.
- Pending results of EHH testing, implement EHH with or without recuperative thickening to increase the performance of digesters 4, 5, and 6. With recuperative thickening, EHH would both increase performance and capacity of the entire digestion system.
- Design and construct a new thermal system to optimize operations and balance the cost or income of distribution with the cost to produce specific product characteristics. The new system should consider the environmental sustainability, operational flexibility, and process reliability and redundancy criteria evaluated in the alternatives evaluation in this BMP Update.

ES6. Recommendations and Considerations

ES6.1 Balanced Recommendation

The preferred solution of rehabilitating digesters 1, 2, and 3 to operate thermophilically will provide EWA with flexibility and capacity to consistently meet Class B biosolids for beneficial reuse. A portion of the Class A dried product would still be produced at the current dryer capacity, thus continuing implementation and evaluation of the marketing program.

Under the proposed modifications, the main priorities in the EWA BMP are balanced:

- Providing reliable, redundant, and serviceable equipment
- Minimizing operational complexity of the biosolids process
- Allowing secure product distribution
- Increasing environmental sustainability
- Minimizing lifecycle costs
- Proving flexibility for near- and midterm operations, while planning for a long-term approach
- Allowing for adaptability to manage regulatory changes and add technology developments

ES6.2 Considerations and Triggers

As EWA implements the recommendations in this BMP Update, there are four areas to consider for the timing and trajectory of this approach:

1) Budgetary Implications and Cost Effectiveness
2) Regulatory Perspective: Finding the Right Mix of Class A and B Biosolids
3) Environmental Sustainability
4) Technology Innovations to Consider

ES6.2.1 Cost Effectiveness of the Preferred Solution

Table ES-3 summarizes the preferred solution's updated and refined costs. These costs for Alternative 8 – Improved Anaerobic Digestion do not include costs for expected dryer repairs and other improvements already considered in the EWA planning budget, as opposed to the costs on Figure ES-12 used for alternative comparison that do show expected repair and improvement costs. The preferred solution's budgetary cost estimate of $13 million is less than implementing a new dryer, which was estimated as $40 million (Brown and Caldwell 2018). Deferring large capital cost items until regulatory, technology, and market requirements are confirmed is part of this BMP Update's balanced approach.

Table ES-3. Class 5 Opinion of Probable Cost for the Preferred Alternative

Cost Components	Estimate ($)
Digesters 1, 2, and 3 Rehabilitation	3,498,000
60,000-gallon storage tank	320,000
HEX in Digesters 4, 5, and 6	315,500
Total Equipment Cost	4,133,500
Equipment Installation	826,500
Construction Costs (Demolition, Sitework, EWPCF SCADA System, Yard Piping, and Electrical)	1,290,000
Contractor Overhead, Profit, Mobilization, Bonds, Insurance	1,875,000

Table ES-3. Class 5 Opinion of Probable Cost for the Preferred Alternative

Cost Components	Estimate ($)
Construction Contingency	1,875,000
Total Construction Cost	10,000,000
Permitting, Legal, and Administration	250,000
Engineering	1,200,000
SCADA System Integration	1,000,000
Services during Construction, Commissioning and Startup	600,000
Total Capital Cost	**13,050,000**

HEX = heat exchanger
SCADA = supervisory control and data acquisition

ES6.2.2 Regulatory Considerations

Historically, the regulatory trends dictate the available outlets for Class A and B biosolids. Upcoming trends may provide additional outlets to EWA for both:

- **State of California, State Bill 1383 -** Regulations have been adopted and include language that disallows local ordinances prohibiting or unreasonably restricting the land application of biosolids, effective January 1, 2022. This change may make local entities more open to discussions.
- **CalRecycle Requirements -** Proposed regulations may be enforceable in 2022 and will likely lead to an incentive to maximize biosolids uses, such as land application (CalRecycle 2021).
- **California Healthy Soils Initiative** - One component of the initiative focuses on using natural and working lands to store and remove carbon from the atmosphere. While the plan has not yet developed new programs, biosolids management will likely be an aspect of sequestering carbon (California Department of Food and Agriculture 2022).

The team evaluated the costs, environmental, and operational considerations of producing both Class A and B biosolids. The general trend of increasing Class B production when the existing dryer is being maintained is an appropriate near-term solution. The digester improvements will result in increased capacity of the digestion process and ability to consistently meet Class B requirements.

ES6.2.3 Environmental Sustainability

Environmental sustainability is one of the main metrics evaluated in this BMP Update. The team chose GHG emissions as a quantifiable metric to compare the environmental sustainability of adding a second dryer versus improving digestion and increased truck traffic from hauling more Class B product. Figure ES-16 shows the evaluation results. With the given assumptions, less GHG emissions will be produced by hauling more Class B product than with implementing a second dryer onsite mainly due to the use of NG for drying.

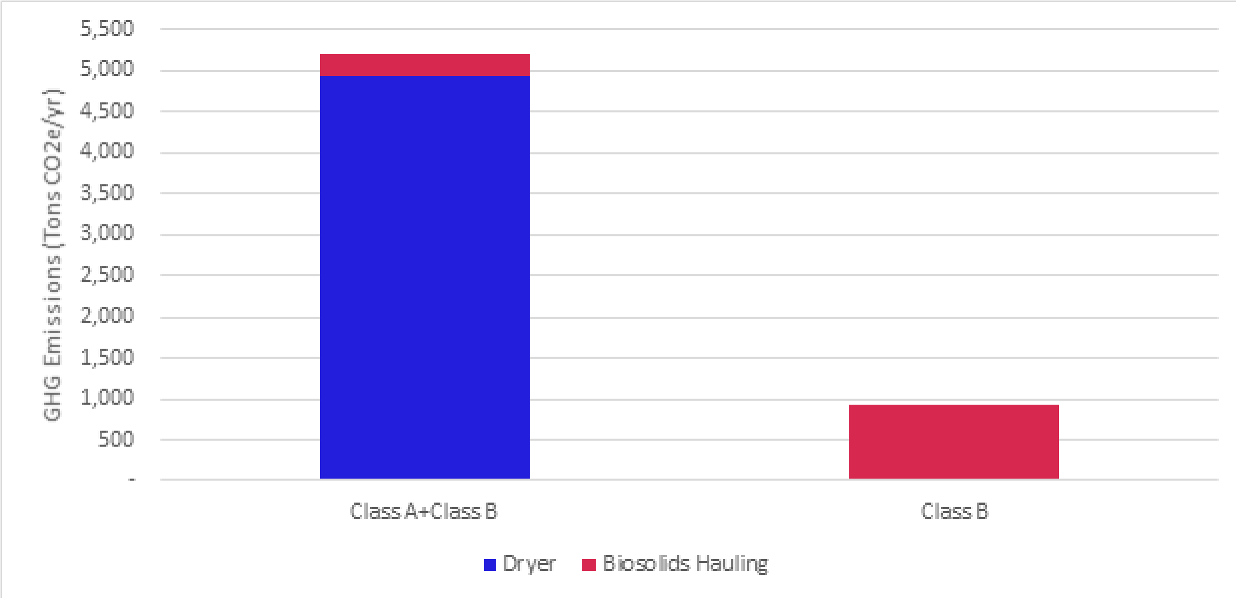


Figure ES-16. Greenhouse Gas Emission Comparison – Production of Class B Cake Only and Class A Granules and Class B Cake

ES6.2.4 Technology Innovations

One of the decision points is evaluation of emerging technologies that may optimize digestion or the thermal process. Figure ES-17 shows the decision process for implementing emerging technologies in the mid- and long-terms.

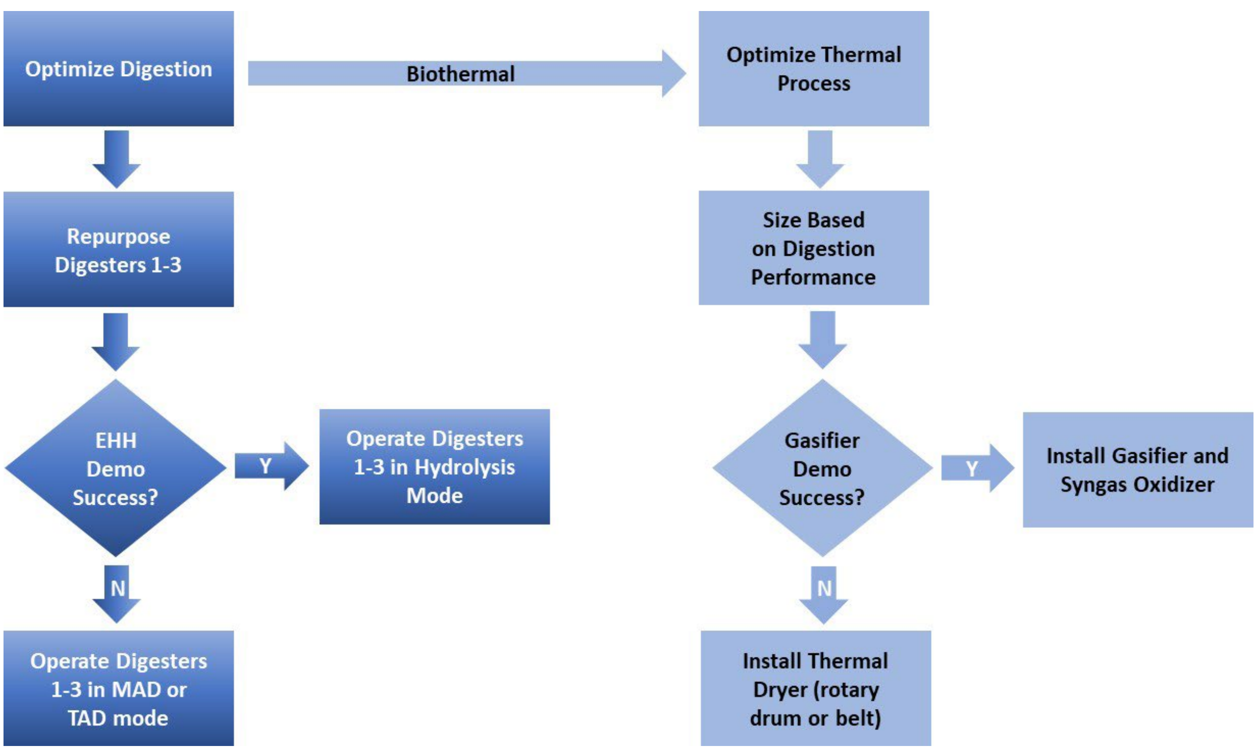


Figure ES-17. Encina Wastewater Authority Biosolids Management Decision Tree

EWA conducted an EHH bench-scale test with promising results in September and October 2021, which are summarized in TM 6. The results show the potential for EHH to increase the performance of the anaerobic digestion system from an average volatile solids reduction (VSR) of 60% to a VSR of greater than 75%: a 25% improvement (60*1.25=75) in performance. With the promising results at bench-scale, demonstration of EHH at a pilot-scale is being considered to further validate expected EWPCF digester performance.

Successful demonstration of the integrated thermal (drying, pyrolyzing, gasifying) process at other full-scale facilities would result in considering this technology for EWA. The gasification process includes a syngas oxidizer that would reduce and nearly eliminate demand for supplemental NG for thermal drying.

ES7. References

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TM 1 – Current Biosolids Management Practices and Outlook

Jacobs

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Reinventing tomorrow.

2022 Biosolids Management Plan Update

TM 1 – Current Biosolids Management Practices and Outlook

Final

June 2022

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Encina Wastewater Authority

2022 Biosolids Management Plan Update

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Acronyms and Abbreviations

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
BEE	Biosolids, Energy and Emission Plan
BMP	Biosolids Management Plan
CASA	California Association of Sanitization Agencies
CFR	Code of Federal Regulations
DAF	dissolved air flotation
DS	digested solids
dT/d	dry ton(s) per day
EPA	U.S. Environmental Protection Agency
EQ	Exceptional Quality (EPA)
EQPC	Exceptional Quality Pollutant Concentration
EWA	Encina Wastewater Authority
EWPCF	Encina Water Pollution Control Facility
FOG	fats, oils, and grease
GHG	greenhouse gas
gpm	gallon(s) per minute
gpd	gallon(s) per day
HRT	hydraulic residence time
JPA	Joint Powers Agreement
HSW	high-strength waste
lb/d	pound(s) per day
lb/h	pound(s) per hour
lb/h/d	pound(s) per hour per day
$lb/h/ft^2$	pound(s) per hour per square foot
LHA	Lifetime Health Advisory
MG	million gallons
mg/kg	milligram(s) per kilogram
MGD	million gallons per day
N	nitrogen
NACWA	National Association of Clean Water Agencies
No.	number
NO_2	nitrite

NO_3-N	nitrate-nitrogen
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PMP	Process Master Plan
ppb	part(s) per billion
ppt	part(s) per trillion
PS	primary sludge
RDT	rotary drum thickener
SB	State Bill
TKN	total kjeldahl nitrogen
TM	technical memorandum
TN	total nitrogen
TS	total solids
TWAS	thickened waste activated sludge
U.S.	United States
VS	volatile solids
VS/ft^3/d	volatile solids per cubic foot (feet) per day
VS/ft^3/DV/d	volatile solids per cubic foot (feet) of digester volume per day
VSLR	volatile solids loading rate
WAS	waste activated sludge

1. Introduction

The Encina Wastewater Authority (EWA) treats wastewater for more than 379,000 North San Diego County residents at the Encina Water Pollution Control Facility (EWPCF) (EWA 2022).

EWA is owned by six public agencies (Figure 1-1):

1) City of Carlsbad
2) City of Vista
3) City of Encinitas
4) Vallecitos Water District
5) Buena Sanitation District
6) Leucadia Wastewater District

EWA is governed by a Joint Powers Agreement (JPA), where the six owners share in EWA's capital, operational, and management costs (EWA 2022).

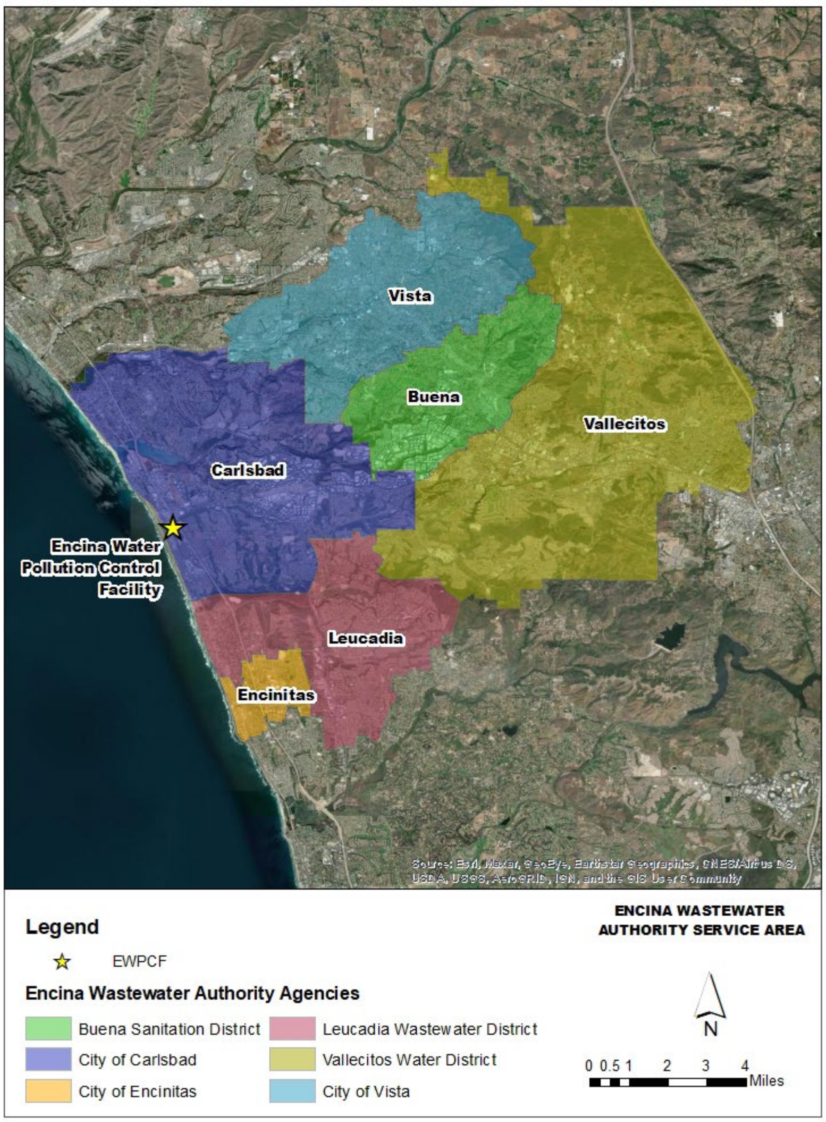

Figure 1-1. Encina Wastewater Authority Service Area

The EWPCF has an existing hydraulic design capacity of 40.5 million gallons per day (MGD) (Brown and Caldwell 2018). Figure 1-2 shows an aerial view of the plant.

Figure 1-2. Encina Water Pollution Control Facility

Source: (Aerial photo courtesy of EWA)

EWA completed a Biosolids Management Plan (BMP) in 2008 (Black & Veatch 2008), which focused on the Phase V Expansion and achieving the beneficial use of Class A biosolids (40 *Code of Federal Regulations* [CFR] 503) pellets generated from the heat dryer system. EWA has further evaluated biosolids processing and the need for expansion in the 2016 Process Master Plan (PMP) (Carollo 2016) and the *2018 Biosolids, Energy and Emission Plan* (BEE) (Brown and Caldwell 2018). Data and reports cited in the 2022 BMP Update documents have been provided to Jacobs by EWA and are used with EWA's permission.

EWA retained Jacobs to complete the following scope for this 2022 BMP update:

- Evaluate the current biosolids management practices.
- Incorporate planned projects from the PMP and BEE.
- Update the regulatory outlook.
- Identify local beneficial use markets and potential regional solutions.

The criteria for evaluating biosolids alternatives build on previous efforts and add a sustainability metric to include environmental considerations.

2. Goals and Objectives

The overall 2022 BMP Update goals were as follows:

- Balance existing infrastructure, sustainability, and economics.
- Identify and initiate a reliable distribution network that meets 200% capacity.
- Identify opportunities for revenue generation or cost reduction.
- Cultivate local markets and encourage the local use of biosolids product, sustainability, and reduced greenhouse gases (GHGs).
- Develop a strategic implementation plan that outlines triggers and decision points moving forward.
- Support JPA budgeting efforts by outlining a schedule of improvements to biosolids systems.

Within this context, the objectives of this report (TM 1) are as follows:

- Summarize the current biosolids management practices and the changes that have occurred since the 2008 BMP.
- Address changes in the regulatory landscape.
- Develop updated evaluation criteria for use in subsequent phases of the 2022 BMP Update.

TM 1 presents updated solids production projections through 2040 that will be used to evaluate the performance and capacity of the EWPCF's existing solids handling processes, and to determine the appropriate sizing criteria for analysis of potential improvements.

3. Current Biosolids Management Practices

3.1 Solids Processing – Current and Projected Flows and Loads

The solids process stream at EWPCF produces Class B biosolids per the 40 CFR 503 biosolids rule, using a combination of thickening, mesophilic anaerobic digestion, and centrifuge dewatering. The Class B product is then further refined with a heat dryer to produce dried pellets that achieve Class A standards, consistent with 40 CFR 503 requirements.

Figure 1-3 is a schematic flow diagram of the solids handling processes.

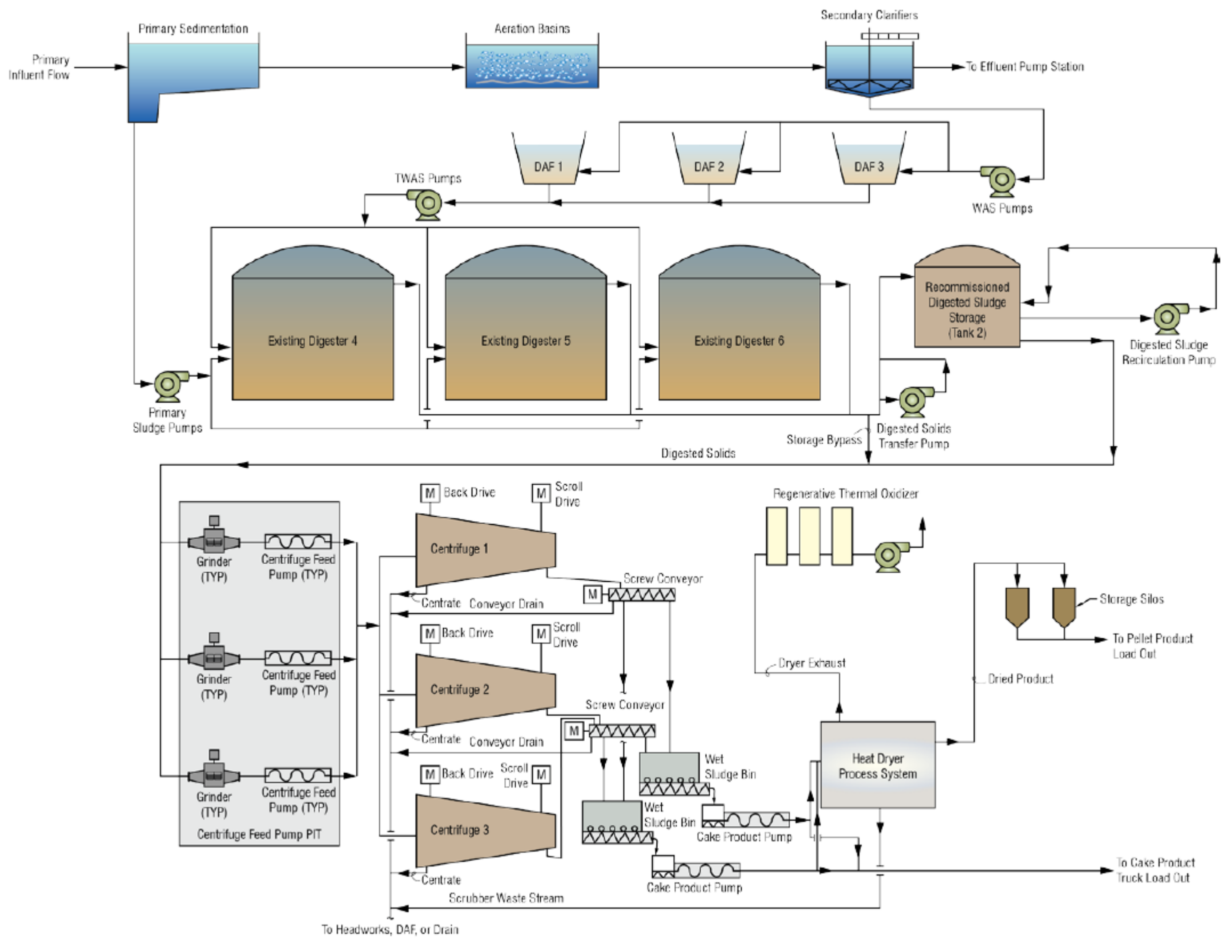

Figure 1-3. Encina Water Pollution Control Facility Solids Handling Processes

Source: Carollo 2016 (Alternate Fuel Receiving Facility and feed not shown)

The plant discharges waste activated sludge (WAS) from the aeration basins to the dissolved air flotation (DAF) thickeners, which produce thickened waste activated sludge (TWAS) at a total solids (TS) concentration of roughly 5.5%. Primary sludge (PS) is thickened in the primary clarifiers to approximately 4.1% TS. The plant also receives high-strength waste (HSW) streams in the form of fats, oils, and grease (FOG), which is hauled in 5 to 6 days per week, and brewery waste, which is received Monday through Friday. The PS, TWAS, and HSW streams are sent directly to three mesophilic anaerobic digesters that operate in parallel and provide stabilization to Class B biosolids, generate biogas, and reduce overall sludge volume. Digested solids (DS) are subsequently dewatered in three centrifuges to approximately 22% TS.

In the final step, dewatered cake is processed in a rotary kiln direct heat dryer to further reduce water content and to condition the solids to Class A biosolids per 40 CFR 503 standards. EWA contracts hauling to Denali, a third party, for land application near Yuma, Arizona, as well as several smaller local agricultural outlets.

3.1.1 Primary Sludge Projections

As part of the evaluation for TM 1, Jacobs compared current EWPCF PS production rates with the BEE solids projections, the source of the most recent solids projections available (Brown and Caldwell 2018). This comparison indicated the BEE-projected PS loading for 2020 was significantly less than current loads, and BEE-projected loading for 2030 was equal to current loads. Table 1-1 summarizes the comparison of current average annual PS production with projected PS production from the BEE.

Table 1-1. Primary Sludge – Current Production and Biosolids, Energy and Emission Plan – Projected Rates

Year	Observed		Projections (Brown and Caldwell 2018)	
	PS Flow (gpd)	PS Loading (lb/d)	PS Flow (gpd)	PS Loading (lb/d)
2016	159,729	51,639	--	--
2017	166,575	55,224	--	--
2018	183,228	65,695	130,000	47,500
2019	174,821	66,737	--	--
2020	167,528	60,800	140,000	50,600
2030	--	--	170,000	60,800
2040	--	--	200,000	71,100

-- = not applicable
gpd = gallon(s) per day
lb/d = pound(s) per day

Figure 1-4 shows the PS loading from 2016 through 2020, in terms of lb/d.

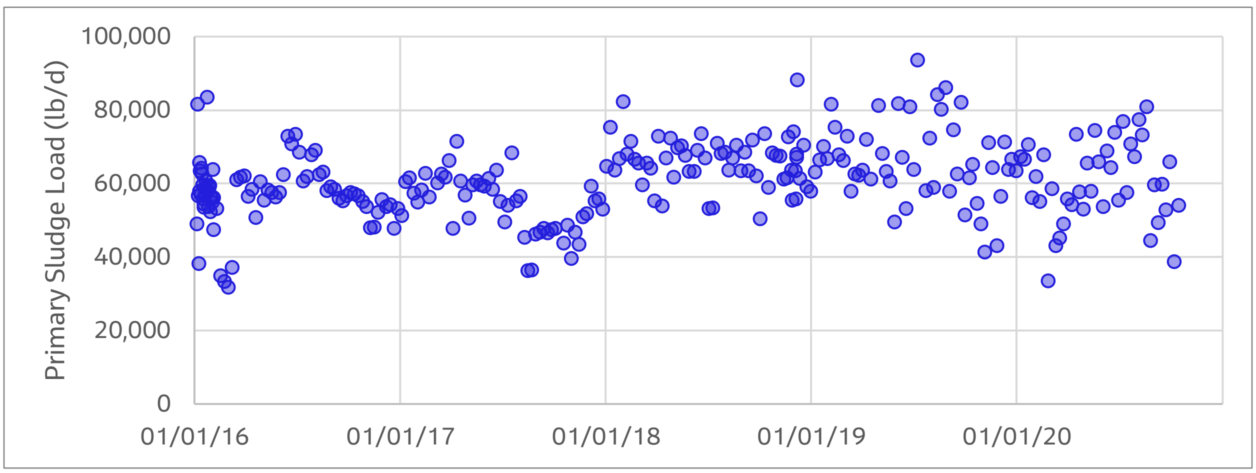

Figure 1-4. Daily Average Primary Sludge Production, 2016 to 2020

As Table 1-1 shows, the average annual PS production in 2020 exceeded the BEE estimates by roughly 17%. As part of the current study, the BEE projections have been updated to incorporate recent data by increasing the 2020 baseline BEE projections to equal the average annual recorded production from 2020. Data from 2020 were selected as the baseline due to higher-than-average PS production in 2018 and 2019 that resulted from atypical operating conditions in those years.

The BEE projection for 2020 was 50,600 lb/d of PS (Brown and Caldwell 2018), while the average observed daily PS production was 60,800 lb/d. The revised projected 2020 baseline was increased to

60,800 lb/d, and the 2030 and 2040 projections were calculated by assuming the same linear-regression-based growth rate presented in the BEE.

Figure 1-5 compares the average annual PS production with the BEE projections and the updated projections from the present study.

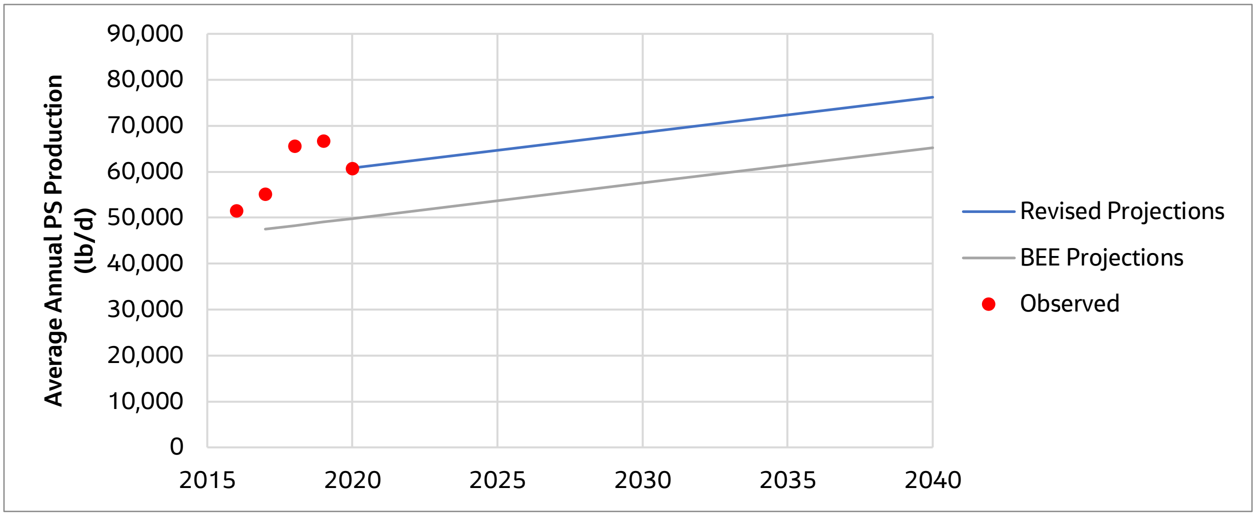

Figure 1-5. Comparison of Historical Primary Sludge Production with Projected Loading

To estimate peak period PS production rates, Jacobs and EWA agreed with the approach of using BEE peaking factors applied to the revised annual average projections. Table 1-2 reproduces the BEE peaking factors and presents revised PS projections based on those factors.

Table 1-2. Revised Primary Sludge Projections

Parameter	Year	Average Annual (lb/d)	Peak Month (lb/d)	Peak 14-day (lb/d)
Peaking Factor (Brown and Caldwell 2018)	--	--	1.23	1.30
Revised Projections	2030	68,500	84,200	89,000
	2040	76,200	93,700	99,000

3.1.2 Waste Activated Sludge Projections

Jacobs also compared WAS production rates with the BEE's solids projections. This comparison indicated projected WAS loading was also less than current loads. Table 1-3 summarizes the comparison of average annual WAS production for 2016 through 2020 with BEE-projected WAS production.

Table 1-3. Waste Activated Solids – Current Production and Previous Projections

Year	Observed		Projections (Brown and Caldwell 2018)	
	WAS Flow (MGD)	WAS Loading (lb/d)	WAS Flow (MGD)	WAS Loading (lb/d)
2016	0.74	39,200	--	--
2017	0.76	43,100	--	--
2018	0.56	39,300	0.71	29,400
2019	0.59	39,500	--	--
2020	0.76	38,100	0.76	31,600
2030	--	--	0.94	39,000
2040	--	--	1.11	46,300

Figure 1-6 shows the daily average WAS production rates from 2016 to 2020.

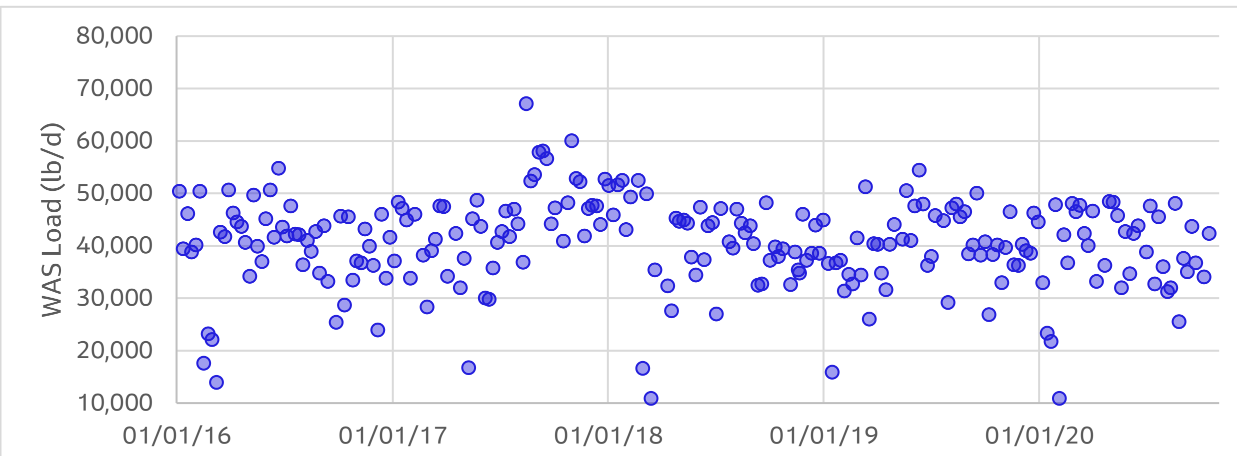

Figure 1-6. Daily Average Waste Activated Sludge Production, 2016 to 2020

As Table 1-3 shows, the average annual WAS production in 2020 exceeded BEE-projected loads by roughly 20%. As part of the current study, the projections have been updated to incorporate recent data by increasing the baseline of the projections to equal the average annual recorded production in 2020. The BEE's projection for 2020 was 31,600 lb/d, while the average observed production in 2020 was 38,100 lb/d. The 2020 average was set as the baseline for the updated projections. Using the same approach as for the PS projections, the revised WAS projections for 2030 and 2040 were calculated from the baseline using the same linear-regression-based growth rate presented in the BEE (Brown and Caldwell 2018).

Figure 1-7 compares the average annual WAS production with the BEE projections, as well as the updated projections from the current work. Table 1-4 summarizes the projected WAS loadings to be used in this project for future analysis work.

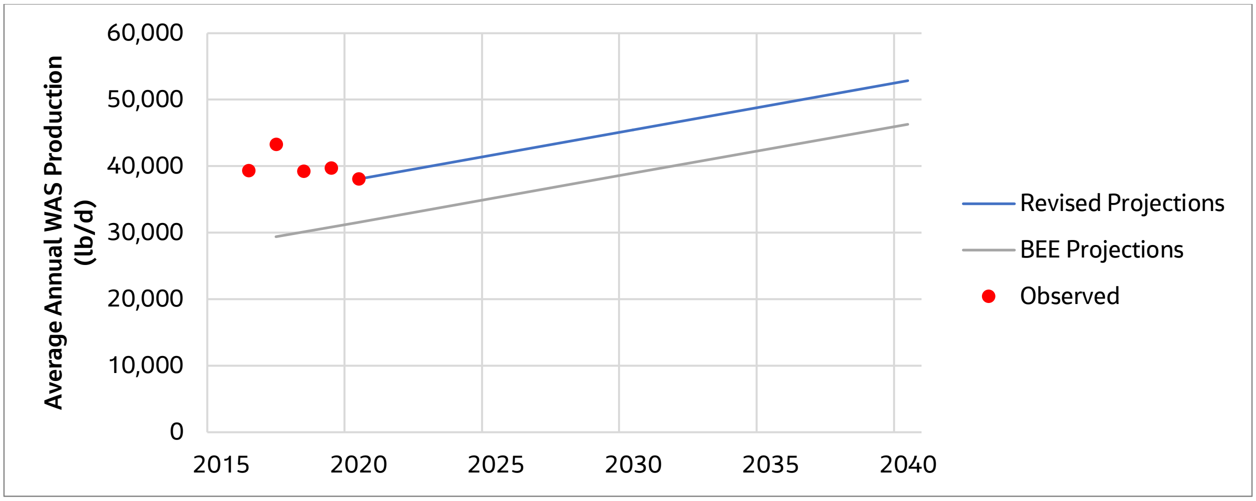

Figure 1-7. Comparison of Historical Waste Activated Sludge Production with Projected Loading

Table 1-4. Projected Waste Activated Sludge Production

Parameter	Year	Average Annual (lb/d)	Peak Month (lb/d)	Peak 14-day (lb/d)
Peaking Factor	--	--	1.23	1.3
Revised Projections, lb/d	2030	45,500	56,000	59,100
	2040	53,700	66,000	69,800

3.1.3 Summary of Revised Projections

Table 1-5 summarizes the revised annual average solids loading projections for use in subsequent analysis, and Figure 1-8 shows digester loading projections. Total feed to the digesters comprises PS, TWAS, FOG, and brewery waste. FOG and brewery waste volumes are projected to remain steady at 7,300 and 7,200 gpd through 2040, respectively. TWAS loading was determined by applying a historical (2020) capture rate of 98% to the WAS projections developed in Table 1-4. The 2020 data provided covered January 1 through October 20.

Table 1- 5. Projected Average Annual Future Solids Loadings

Loading	Unit	2020	2030	2040
PS	lb/d	60,800	68,500	76,200
	gpd	167,600	188,800	210,000
WAS	lb/d	38,100	45,500	52,900
	gpd	671,500	802,000	946,000
TWAS	lb/d	37,600	45,300	53,000
	gpd	74,500	89,700	104,900
FOG	lb/d	4,000	4,000	4,000
	gpd	7,300	7,300	7,300
Brewery Waste	lb/d	4,500	4,500	4,500
	gpd	7,200	7,200	7,200
Total Digester Feed	lb/d	106,900	122,300	137,700
	gpd	256,600	293,000	329,400

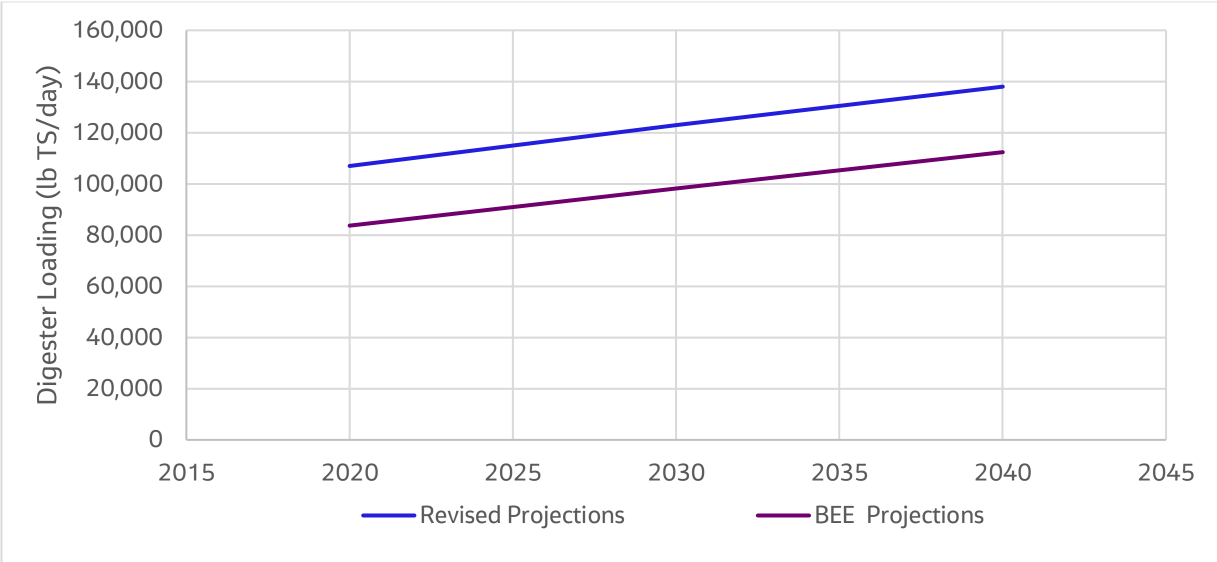

Figure 1-8. Digester Loading Projections from Jacobs (based on 2020 data) and Brown and Caldwell (2018)

3.2 Solids Processing – Capacity and Performance

Jacobs applied the BEE design criteria for the solids handling processes (Brown and Caldwell 2018) to estimate the available capacity based on the updated projections. The following subsections present the results of that analysis.

3.2.1 Solids Thickening

EWA uses DAF to thicken the WAS before anaerobic digestion. The system consists of three DAF units: two 40-foot-diameter and one 45-foot-diameter. Two of these units are typically in operation, with the remaining unit as a standby for redundancy (Figure 1-9). Table 1-6 summarizes the design capacity of the existing dissolved air flotation thickeners (DAFTs).

Figure 1-9. Dissolved Air Flotation Thickeners
Photographs taken by Jacobs during site walk on November 5, 2020

Table 1-6. Dissolved Air Flotation Thickener Design Criteria

Total Units (No.)	Total Units in Normal Service (No.)	Design Loading Rate[a] (lb/h/ft²)	Operating Loading Rate[b] (lb/h/ft²)	Total Service Capacity (lb/d)[c]	Normal Operating Capacity (lb/d)[d]
3	2	0.72	1.1	108,300	66,400

[a] Based on design loading rate from the BEE (Brown and Caldwell 2018).

[b] Based on historical operating data, which demonstrate that DAFs can effectively operate at a higher loading rate than reported in the BEE.

[c] Based on all three DAFTs online at the Operating Loading Rate.

[d] Based on two 40-foot diameter DAFTs online at the Operating Loading Rate

lb/h/ft² = pound(s) per hour per square foot

No. = number

Figure 1-10 shows the projected DAFT capacity rated on the peak 14-day condition, shown as the solid line. Applying that criterion, sufficient DAF thickening capacity exists to meet projected loading during the planning period.

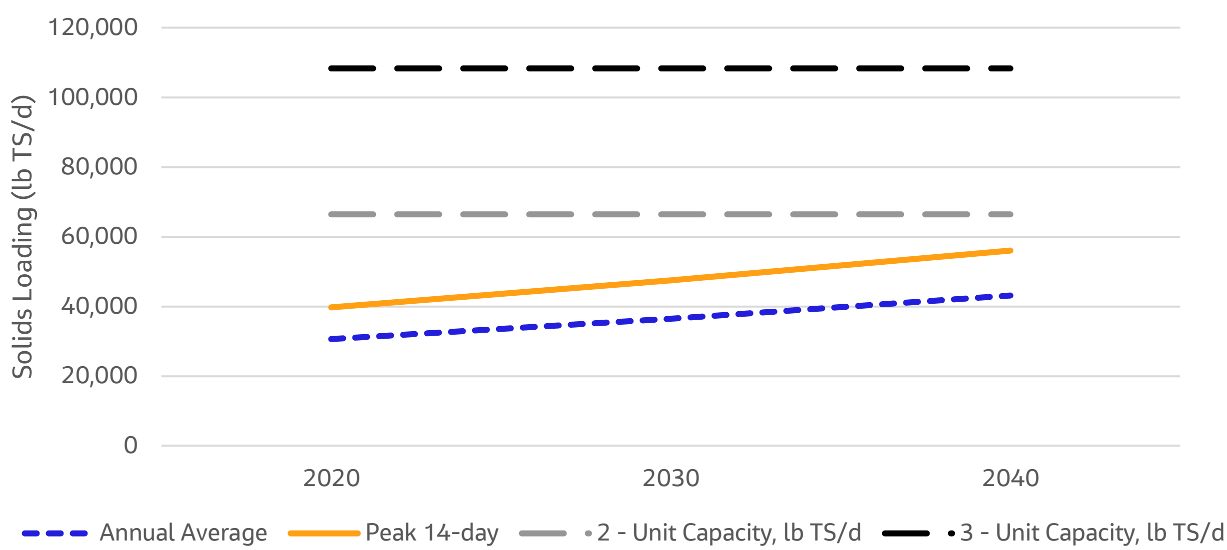

Figure 1-10. Projected Dissolved Air Flotation Thickener Solids Loading and Capacity

The BEE (Brown and Caldwell 2018) included the recommendation to upgrade solids thickening to use multiple rotary drum thickeners (RDTs) to thicken WAS. The RDTs would provide similar WAS thickening performance as the DAF, but within a smaller footprint. Before the current study, EWA completed a preliminary design report for a conversion to RDT for WAS thickening, although the potential project has not yet proceeded into more detailed design (Tucker, pers. comm. 2020). The efficacy of adding RDTs to the plant will be one of the potential options evaluated during subsequent phases of this study.

3.2.2 Digester Performance and Capacity

EWPCF currently operates three mesophilic anaerobic digesters: digesters 4, 5, and 6. The two larger digesters have a volume of 2.06 million gallons (MG) each, while the smaller digester has a volume of 2.01 MG. Table 1-7 summarizes the design criteria for the anaerobic digesters. Figure 1-11 shows Digester 5.

Table 1-7. Anaerobic Digester Design Criteria

Total Units (No.)	Total Units in Normal Service (No.)	Condition	Design Criteria (Brown and Caldwell 2018)
3	2	Average VS loading; all units in service	0.15 lb VS/ft^3/d
		Average VS loading; two units in service	0.18 lb VS/ft^3/d
		Peak 14-day VS loading; all units in service	0.18 lb VS/ft^3/d
		Hydraulic loading (peak 14-day conditions)	15-day minimum

VS = volatile solids

VS/ft^3/d = volatile solids per cubic foot (feet) per day

Figure 1-11. Anaerobic Digester 5

Photograph taken by Jacobs during site walk on November 5, 2020

Based on the historical performance presented in the BEE (Brown and Caldwell 2018), the digesters are capable of providing VS reduction of approximately 60%. The anaerobic digestion system is designed so that proper operation achieves a minimum hydraulic residence time (HRT) of 15 days to produce Class B biosolids. The BEE establishes the digester loading capacity as presented in Table 1-7. The BEE criteria state the digesters can be loaded to a maximum volatile solids loading rate (VSLR) of 0.15 pound of VS per cubic foot of digester volume per day (VS/ft^3/DV/d) when three units are in service up to maximum month conditions. During peak 14-day conditions with three digesters or when only two digesters are operating, the digesters may be loaded to a maximum VSLR of 0.18 pound of VS/ft^3/d.

Figures 1-12 and 1-13 show the current and anticipated solids and hydraulic loadings into the digester system, in terms of VSLR and digester HRT, respectively, as well as normal operating and full capacities. Digester loading is based on peak 14-day conditions, as shown by the solid red line. Both the solids and hydraulic capacity of the system are likely to be exceeded with all digesters in service before 2040.

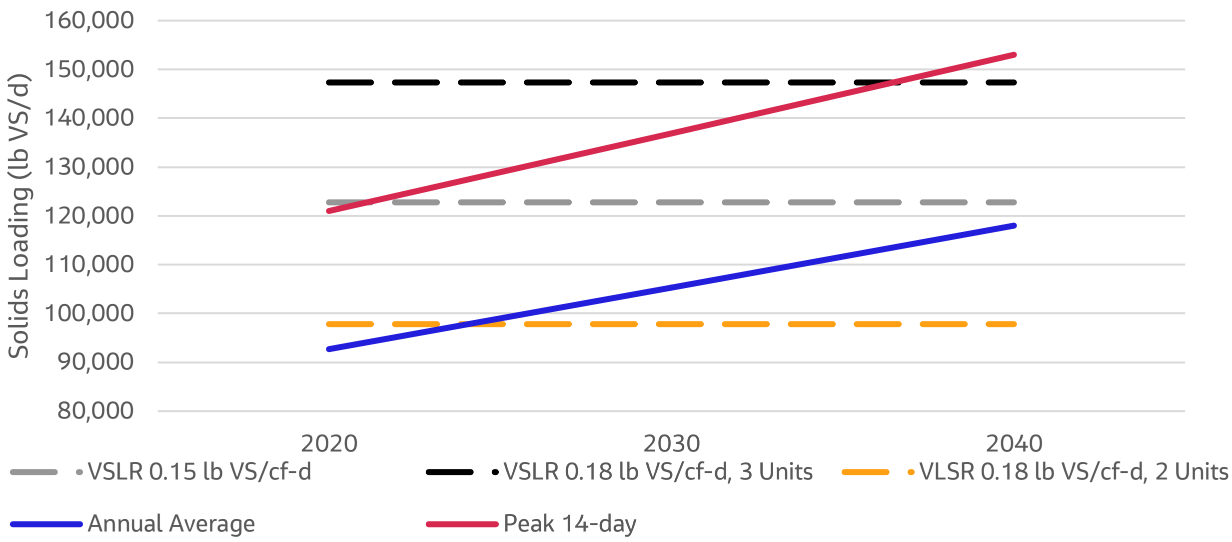

Figure 1-12. Digester Solids Loading and Capacity

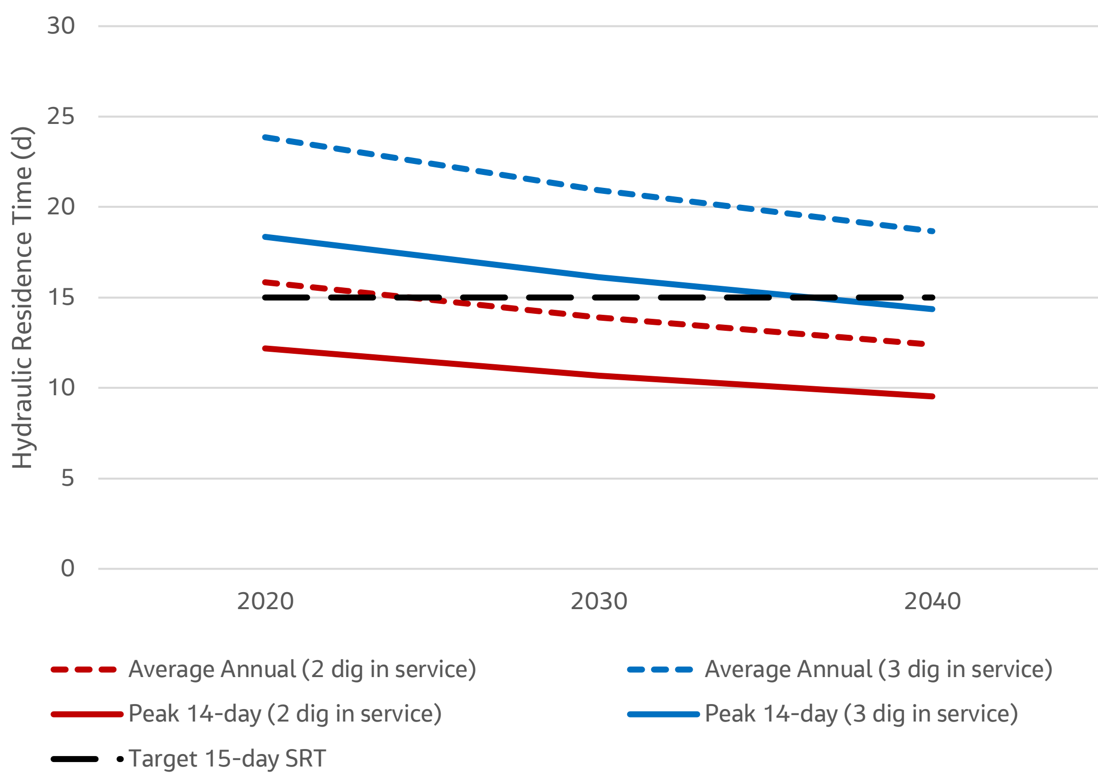

Figure 1-13. Digester Hydraulic Residence Time

3.2.3 Solids Dewatering

EWPCF currently operates three centrifuges (two duty and one standby) to dewater DS (Figure 1-14). Typical operation is to use the two duty units, reserving the third unit for redundancy or peak period operation (Brown and Caldwell 2018). Table 1-8 summarizes the design criteria for the dewatering centrifuges. Dewatering capacity is based on peak month conditions.

Figure 1-14. Three Existing Centrifuges

Photograph taken by Jacobs during site walk on November 5, 2020

Table 1-8. Centrifuge Design Criteria and Capacity

Total Units (No.)	Total Units in Normal Service (No.)	Solids Design Criteria (per centrifuge) (lb/h)	Total Service Capacity (lb/d)	Normal Operating Service Capacity (lb/d)	Hydraulic Design Criteria (gpm)	Maximum Operating Rate (per centrifuge) (gpm)	Total Service Capacity (gpm)	Normal Operating Service Capacity (gpm)
3	2	3,000 lb/h/d	216,000	144,000	300	125	375	250

gpm = gallon(s) per minute
lb/h = pound(s) per hour

Each unit is rated to process 3,000 pounds of dry solids per hour, for a maximum operation of 72,000 lb/d if operated for 24 hours. In practice, the centrifuges can operate at a maximum of 125 gpm, achieving 22% dewatered cake at a 95% capture rate (Brown and Caldwell 2018). Due to this significant limitation, the centrifuges are not solids-limited but primarily flow-limited, as shown on Figure 1-15.

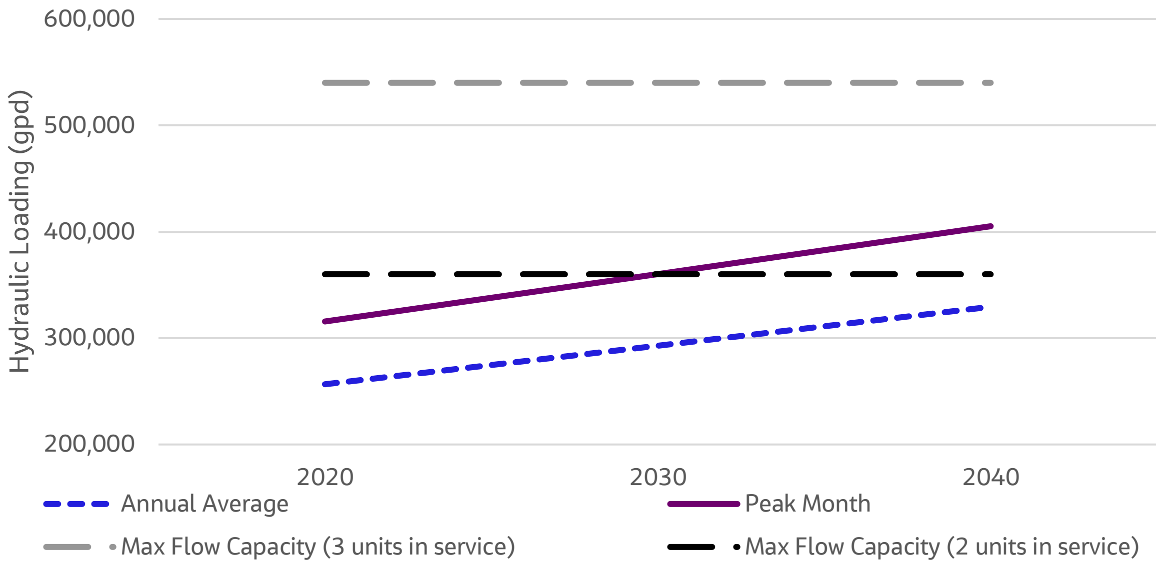

Figure 1-15. Dewatering Centrifuge Hydraulic Loading and Capacity

Based on the revised projections, the existing centrifuges have sufficient total capacity to treat the annual average flows through 2040. Beyond 2030, the third, redundant centrifuge will be required to be brought online to treat peak month flows and loads. The DS storage tank provides additional buffering capacity to dampen peak day loads.

3.2.4 Dryer

EWPCF operates a single Andritz DDS-40 thermal dryer to convert dewatered cake into high-quality dried pellets that are marketed as PURE GREEN. To produce the PURE GREEN dried product, dewatered cake is first blended with fines recycled from the previously dried product in a mixer. The blended sludge forms pellets in the mixer, with the wetter dewatered cake coating the exterior of the recycled dried sludge. The pelletized mixture is then dropped into the rotating drum of the dryer, where it is dried with heated air from the furnace, operating on either natural gas or dual fuel (natural gas and digester biogas). The heated air is blended with recycled furnace exhaust to between 850 and 950 degrees Fahrenheit (°F) and forced through the rotating dryer drum at high speeds to dry the pellets.

After drying, the separator unit splits forced air and dried pellets into two different streams. The exhaust air stream then passes through a two-stage condenser and scrubber to remove solids particles. Most of the exhaust air is recycled to the furnace to conserve heat energy demand, while the remaining waste exhaust is treated in the regenerative thermal oxidizer before discharging to the atmosphere. The regenerative thermal oxidizer oxidizes organics and mitigates foul air by increasing the exhaust temperature to 1,600 °F.

After the separator, the dried pellets are screened to remove properly sized particles. Pellets ready for distribution are cooled and stored in silos above the truck loading bay, while the rejected screenings are used as the recycled dried product that is blended with the dewatered cake at the start of the process in the upstream mixer. Figure 1-16 is an overview of the heat dryer process, while Figure 1-17 provides photographs of current heat drying equipment.

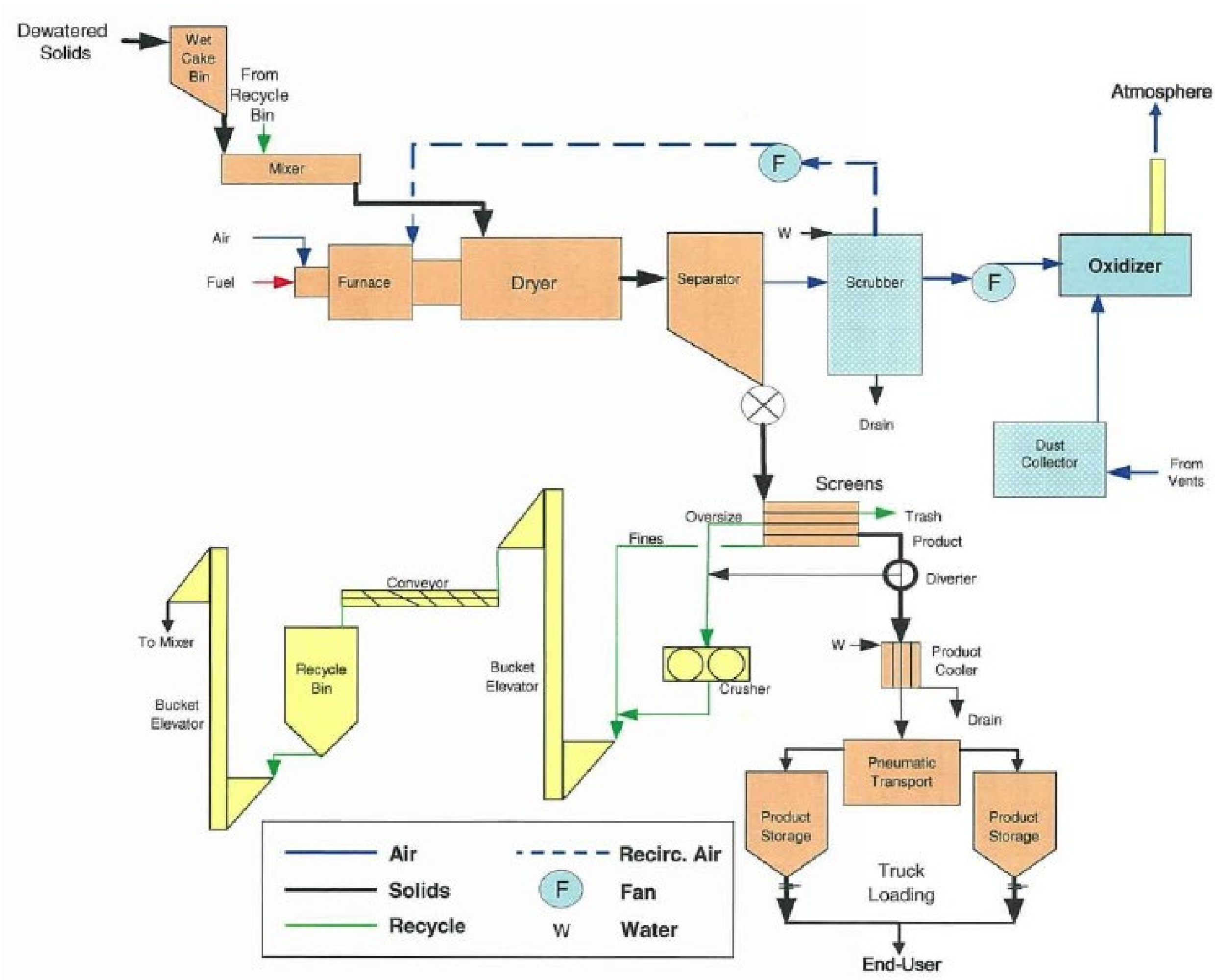

Figure 1-16. Dryer System Process

Source: Black & Veatch 2008

Figure 1-17. Existing Heat Dryer System

Photographs taken by Jacobs during site walk on November 5, 2020

Table 1-9 summarizes the capacity of the Andritz DDS-40 thermal dryer, based on average annual conditions. Dryer operation information was provided by EWA during the TM 1 Workshop. During normal operations, the dryer is operated on a 2-week schedule: 10 days operating and 4 days offline for maintenance. The dryer evaporation rate is 8,800 pounds per hour (lb/h). Assuming 22% dewatered cake, this equates to a solids loading rate of 30 dry tons per day. Maintenance requirements constrain the operating schedule to roughly 270 days per year, reducing the effective operational capacity to an annual average of 23.5 dT/d.

Table 1-9. Thermal Dryer Design Criteria

Total Units (No.)	Dryer Evaporation Rate (lb/h)	Solids Loading Design Criteria (dT/d)	TS Loading Capacity (dT/d)	Operating Solids Loading Capacity (dT/d)
1	8,800	30	30	23.5

Figure 1-18 shows the projected loading to the dryer compared to the available capacity. The dryer is currently operating near 90% capacity annually. The DS storage tank provides a buffer to dampen peak loads. When the dryer capacity is exceeded or the dryer is out of service, Class B biosolids cake can be hauled and land-applied to agricultural farmland or landfilled.

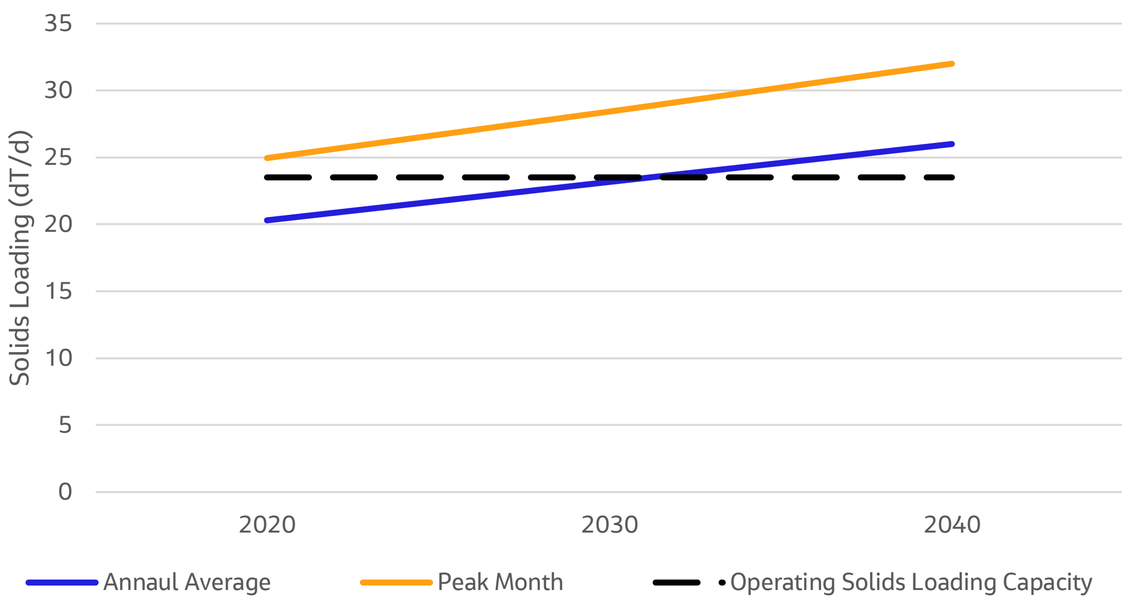

Figure 1-18. Projected Thermal Dryer Solids Loading

3.3 Biosolids Quality and Use

The EWPCF thermal drying process produces primarily Class A Exceptional Quality (EQ) biosolids per 40 CFR Part 503 standards. However, when the dryer is offline due to maintenance, EWPCF produces Class B dewatered cake biosolids. Figure 1-19 provides a breakdown of biosolids production by class type and by year since 2017. Biosolids production increased each year from 2017 until 2019; however, there was a small decrease in solids production in 2020.

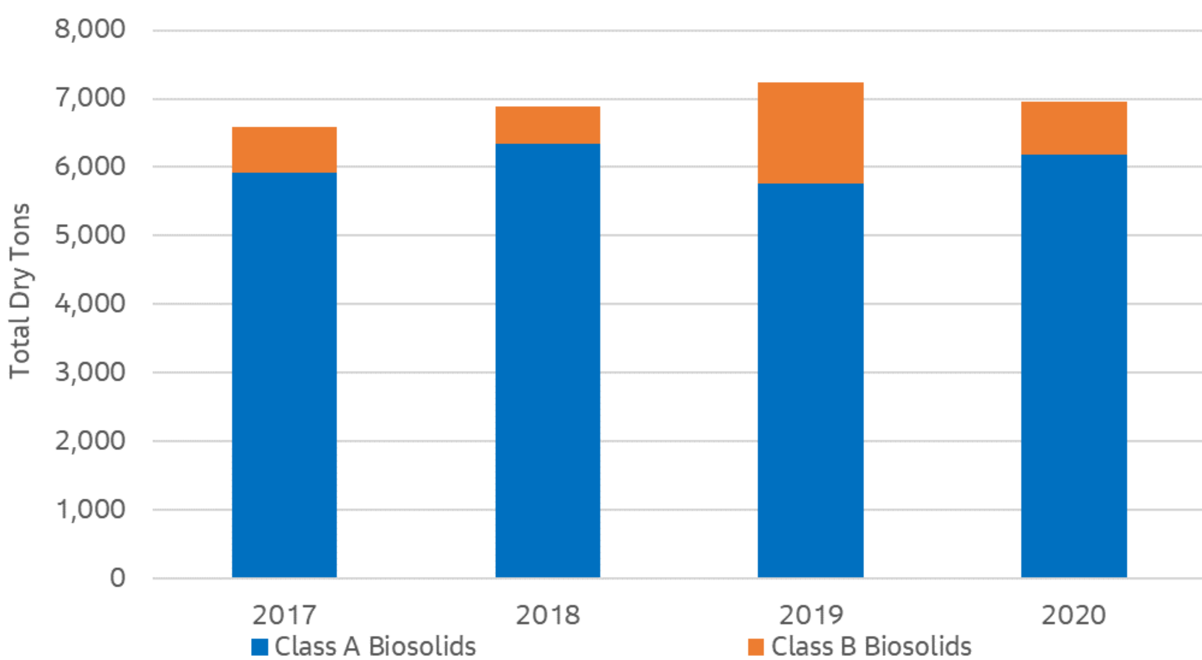

Figure 1-19. Biosolids Production Since 2017 per 40 CFR 503 Biosolids Class Standards

Table 1-10 summarizes the first half of 2019's biosolids production quantities and quality for biosolids meeting Class A pathogen reduction and EQ requirements. The biosolids produced by EWA are consistently less than the ceiling and pollutant concentrations allowed by the U.S. Environmental Protection Agency (EPA) in 40 CFR 503.

Table 1-10. Granulated Biosolids Characteristics

Constituent or Parameter	EPA EQPC Limit	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Avg.
% Solids Granules	--	93	94	94	94	94	94	94
Wet (U.S. tons)	--	354	591	117	121	383	400	328
Dry (U.S. tons)	--	331	558	110	113	361	363	306
Arsenic (mg/kg)	41	--	3.1	--	4.3	--	--	3.7
Cadmium (mg/kg)	39	--	1.3	--	0.7	--	0.6	0.9
Copper (mg/kg)	1,500	--	390	--	380	--	320	363
Lead (mg/kg)	300	--	6.2	--	1.8	--	6.2	4.7
Mercury (mg/kg)	17	--	0.8	--	1.0	--	0.7	0.8
Nickel (mg/kg)	420	--	13	--	13	--	13	13
Selenium (mg/kg)	100	--	6.3	--	7.4	--	4.7	6.1
Zinc (mg/kg)	2,800	--	660	--	690	--	580	643
TKN (mg/kg)	--	--	16,000	--	63,000	--	50,000	43,000
Ammonia - N (mg/kg)	--	--	2,200	--	1,600	--	1,000	1,600
Organic - N (mg/kg)	--	--	1,380	--	61,400	--	49,000	37,260
NO_2/NO_3-N (mg/kg)	--	--	2.0	--	6.0	--	2.0	3.0

Avg. = average
EQPC = Exceptional Quality Pollutant Concentration
mg/kg = milligram(s) per kilogram
N = nitrogen
NO_2 = nitrite
NO_3-N = nitrate-nitrogen
TKN = total kjeldahl nitrogen

Table 1-11 summarizes the nutrient components of the EWPCF biosolids. PURE GREEN is marketed as a 5-5-0.2 (nitrogen-phosphorus-potassium) fertilizer.

Table 1-11. Encina Water Pollution Control Facility PURE GREEN Biosolids Nutrients

Date	TN (%)	Phosphorus as P_2O_5 (%)	Potassium as K_2O (%)
September 2018	5.06	7.14	0.20
April 2019	5.66	7.58	0.20

TN = total nitrogen

Figure 1-20 shows the biosolids customer types for the first 7 months of 2019 based on current plant records for granule sales. End usage of sold product during that period amounted to 473 tons and was limited to specialty agriculture and fertilizer distributors. This compares to the total production of approximately 4,400 tons of granules produced during that same period, or roughly 10% of all production. The rest of the granules and the 943 wet tons of Class B cake produced during this time period were hauled to agricultural farmland outside the local area by EWA's hauling and land application contractor.

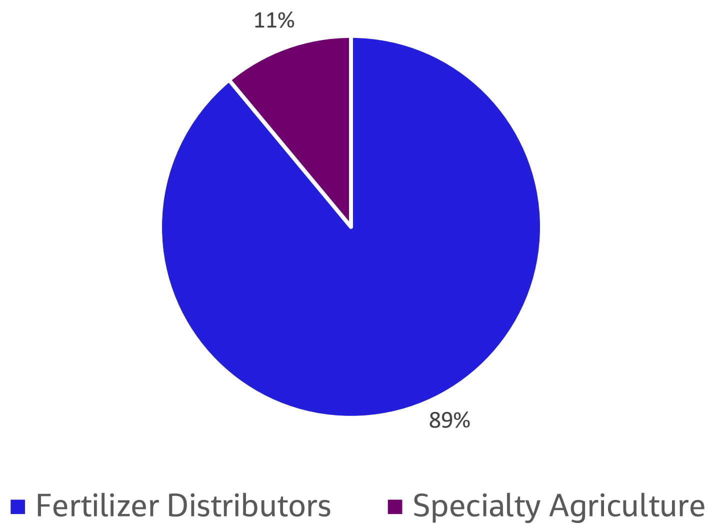

Figure 1-20. 2019 Biosolids End Use, as a Percentage of Total Volume

3.4 Energy Production and Use

Digester biogas produced at EWPCF is used both as a fuel for cogeneration engines to generate electricity and as fuel for the thermal dryer. There are three engines that have the capability to power the entire plant during high demand. The engines run primarily on digester gas and are occasionally supplemented by diluted natural gas if required (Brown and Caldwell 2018). Figure 1-21 summarizes the amount of digester gas compared to natural gas. In 2020, 89% of the fuel used by the dryer came from natural gas supplied to the plant.

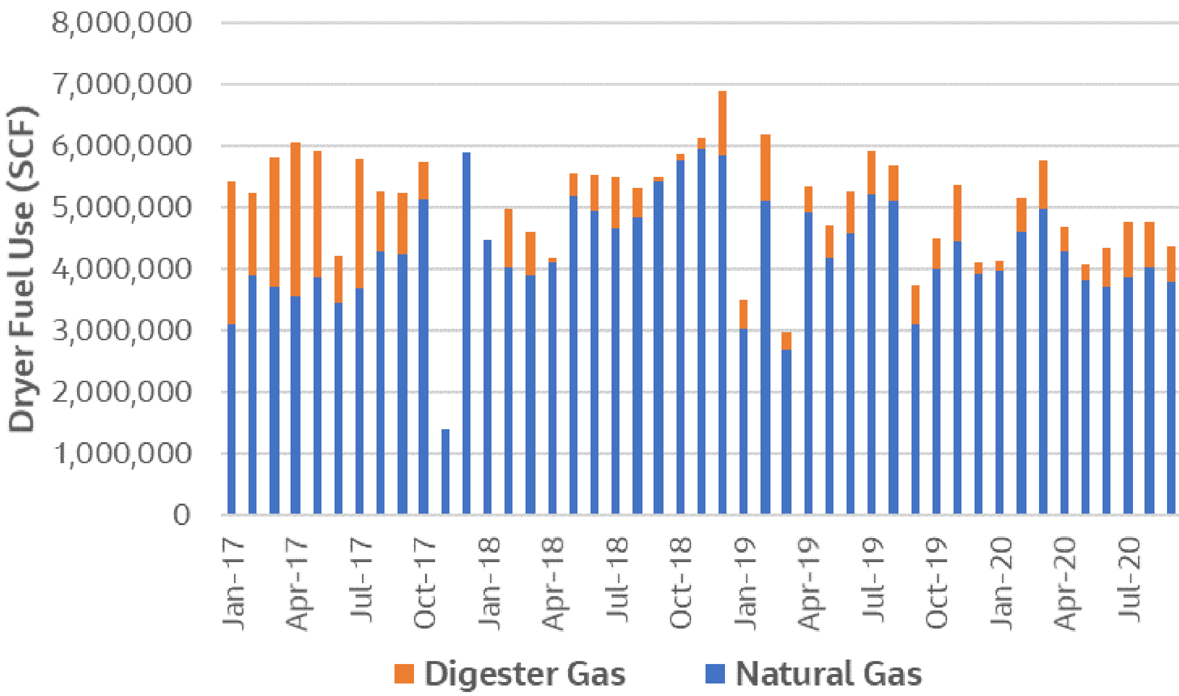

Figure 1-21. Thermal Dryer Fuel Use, 2017 to 2020

4. Regulatory Outlook

This section provides a summary of the regulatory review conducted by Jacobs in 2020 with regard to regulations and initiatives relevant to EWA's biosolids management practices and plans. Information about the State of California's State Bill (SB) 1383 has been updated in this TM to reflect the status as of June 2022. The following items are included in this section of the report:

- Biosolids federal regulations
- Pollutants of concern
- County, state, and regional regulations
- New initiatives
- Agricultural considerations

4.1 Biosolids Federal Regulations

Land application of biosolids has been regulated at the federal level by 40 CFR 503 since 1993. The pathogen reduction requirements for sewage sludge are divided into two categories: Class A and Class B. These requirements use a combination of technological and microbiological requirements to reduce pathogens.

The implicit goal of the Class A requirements is to reduce the pathogens in sewage sludge (including enteric viruses, pathogenic bacteria, and viable helminth ova) to less than detectable levels, as defined in the 1993 regulation.

The implicit goal of the Class B requirements is to reduce pathogens in sewage sludge to levels that are unlikely to pose a threat to public health and the environment under the specific use conditions. For Class B biosolids that are applied to land, site use restrictions are imposed to minimize the potential for human or animal exposure to Class B biosolids for a period of time following land application and until environmental factors (such as sunlight or desiccation) have further reduced pathogens. Both Class A treatment of the sewage sludge, which reduces pathogens to less than detectable levels, and the combination of Class B sewage sludge treatment and use restrictions on the land application site protect public health and the environment (EPA 2003).

EQ biosolids are biosolids that have met the 40 CFR 503 pollutant concentration limits (Table 3 of Section 503.13) and the Class A pathogen reduction requirements and one of the first eight vector attraction reduction options listed in 503.33(b)(1) through (b)(8). EQ biosolids may be land-applied without site restrictions (EPA 2003).

Class B biosolids must be applied in compliance with site restrictions. Because it is not possible for regulators to follow the land application of biosolids applied on lawns and home gardens, Class B biosolids cannot be sold or given away in bags or other containers or applied on lawns and home gardens (EPA 2003).

Currently, the anaerobic digestion process used at EWPCF meets Class B biosolids standards by achieving a minimum of 38% VS reduction and a minimum 15-day solids retention time in the digesters. The thermal drying process meets Class A biosolids standards by exposing the particles to temperatures greater than 80 degrees Celsius (°C) and drying to more than 90% solids, as listed in Appendix B of 40 CFR 503. Metals concentrations for both Class A and Class B biosolids produced by EWPCF meet EPA EQ standards.

Every 2 years, the EPA is required to perform a review to identify pollutants in biosolids and determine whether there is sufficient scientific evidence to create additional regulations. The most recent survey available was performed in 2016-2017 and did not result in additional regulated pollutants but did identify some chemicals, such as perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS), for additional research (EPA 2019b).

4.2 Pollutants of Concern

4.2.1 What are Per- and Polyfluoroalkyl Substances, and Why the Concern

Per- and polyfluoroalkyl substances (PFAS) constitute a suite of more than 4,000 known chemical varieties that have been in production and found in the environment since the 1940s. Recently, these chemicals have been detected in elevated concentrations in groundwater in certain parts of the country, especially near airports and military bases where aqueous film-forming foams were used, as well as near industrial manufacturing sites (Jacobs 2019).

These synthetic chemical substances are engineered and used specifically for their strong carbon-fluorine bonds, which are enormously effective at resisting heat, water, and oil. As such, PFAS chemicals are commonly found in everyday consumer products, including the following (Jacobs 2019):

- Fast food containers
- Nonstick cookware
- Stain-resistant coatings
- Water-resistant clothing
- Personal care products

Due to their chemical structure and their commercial value and widespread use, PFAS are ubiquitous in the environment. They are also persistent, they bioaccumulate, and they do not readily degrade. In recent years, PFAS have become a topic of public concern, particularly when they are discovered in community drinking water supplies. Their prevalence in the environment has raised concerns about the possibility of adverse health impacts (Jacobs 2019).

4.2.2 Per- and Polyfluoroalkyl Substances Regulation

In 2016, a drinking water Lifetime Health Advisory (LHA) of 70 parts per trillion (ppt) for the sum of PFOA and PFOS was established by EPA. The LHA is not a promulgated, enforceable standard, but a guidance value.

Even with its PFAS Action Plan released in February 2019, EPA is taking a cautious approach in considering a standard (EPA 2019a). Meanwhile, the United States (U.S.) and Canada are using a variety of approaches to derive standards. In some areas, drinking water concentration limits have been established at much less than EPA's 70 ppt LHA (EPA 2020).

Some states are also evaluating the potential impacts on the environment from the presence of PFAS in biosolids. Many of these limits have had significant impacts on biosolids beneficial use programs, with reductions in the land application of biosolids products. For example, Maine promulgated a standard in 2018 limiting the concentrations of PFOA and PFAS to 2.5 and 5.2 parts per billion (ppb), respectively, for these compounds. This standard has severely limited the previously successful land application of biosolids on agricultural farmland in Maine (Beecher 2019).

California is initiating a data-gathering effort requiring all wastewater treatment facilities in the state to begin testing effluents and biosolids produced for PFAS, starting in late 2020 and extending through 2021. Plants greater than 5 MGD in capacity are required to sample and test for PFAS quarterly during this time. Smaller plants (less than 1 MGD in capacity) are required to sample and test for PFAS only once during this same time. At the end of this period, data review and potential regulation development could occur, which could limit land application or impact biosolids land application costs (NACWA et al. 2020).

An October 2020 study was released by National Association of Clean Water Agencies (NACWA et al. 2020) entitled *Cost Analysis of the Impacts on Municipal Utilities and Biosolids Management to Address PFAS Contamination*. That study concluded that utilities that have had to respond to regulatory changes and other concerns associated with PFAS have been faced with a 37% increase in biosolids management costs in less than 2 years. In addition, utilities that had to abandon beneficial use programs and switch to landfilling biosolids as their management method suffered a doubling of management costs during the same time period.

For these and other reasons, biosolids management programs such as EWA's must consider flexibility, including alternative plans for managing biosolids should regulatory, economic, or social conditions related to PFAS or other emerging biosolids contaminant concerns change in the future.

4.3 County, State, and Regional Regulations

The biosolids produced by EWA are expected to be used for land application, primarily in California or Arizona; specifically, in San Diego, Imperial, and Riverside counties in California, and Yuma County in Arizona. An investigation into the regulations specific to these locations and potential modifications to those regulations has been performed and is summarized in the following sections.

4.3.1 California

In 2004, the California State Water Resources Control Board adopted Water Quality Order Number (No.) 2004-12-DWQ. This general order intends to serve as an addition to the 40 CFR 503 regulations, as well as to expand upon it for California, while still allowing local municipalities the ability to further regulate the use of biosolids in land application.

In California, several areas are regulated by a specific act that are not covered by the general order. To begin biosolids applications, a Notice of Intent, as well as the required fees and an issued Notice of Applicability from the Regional Water Quality Board, are required. Some jurisdictions within California have additional requirements for the land application of biosolids as listed here. However, according to California Association of Sanitization Agencies (CASA) (2019), the regulations to implement SB 1383 have been adopted, and they include language that disallows local ordinances prohibiting or unreasonably restricting the land application of biosolids. SB 1383 became effective January 1, 2022, and will invalidate restrictive sewage sludge or biosolids land application ordinances in California.

4.3.1.1 CalRecycle Requirements

CalRecycle is the State of California's department responsible for the state's recycling and waste management. CalRecycle coordinates several different ways to use biosolids besides typical farmland application. Provided that the state and federal regulations are satisfied, CalRecycle lists the following alternative uses for biosolids (CalRecycle 2022):

- Application to reclaim burned or deforested areas
- Composting
- Waste to energy
- Alternative material supplies

Based on data reported by CalRecycle, approximately 56% of all biosolids generated in California are ultimately land-applied (CASA 2019). While not a legal requirement, CalRecycle has proposed some best management practices that should be followed so the biosolids land application is a success and minimizes odors or health risks that could occur, to encourage more popular support for land application. Restricting public access, as well as incorporating the biosolids into the existing soil, are two of the best management practices that should be considered during a biosolids land application (CalRecycle 2021).

Unfortunately, biosolids and any compost derived from biosolids are prohibited from being labeled as organic by the U.S. Department of Agriculture (CalRecycle 2021). Composting applications require an additional solid waste permit, which either requires partnering with an existing facility that has excess capacity or investing in a new facility permitted to handle the solid material.

Biosolids may be used in landfills for different reasons. About 19% of biosolids are used for alternative daily cover in California. The biosolids are added at the end of the day or when a landfill site is completed to reduce vectors. Some regions in California may not have landfills able to use biosolids (CalRecycle 2022).

As a result of a law signed by Governor Brown in 2016, CalRecycle has been given authority to issue regulations to reduce methane emissions as part of SB 1383. This bill created legal targets to reduce the amount of organic waste disposed by 50% by 2020 compared to the 2014 level, and to achieve a 75% reduction by 2025. One cited method to reduce organic waste going to landfills is through expanding composting options, as well as by anaerobic codigestion.

SB 1383 came into force January 1, 2022, and is administered by CalRecycle (CalRecycle 2022). The bill will likely lead to an increase in interest in codigestion capabilities, as well as potential financial penalties for landfill disposal of biosolids, providing an incentive to maximize biosolids uses, such as land application.

A small amount of California's biosolids, about 2.5%, are incinerated; however, there are just three facilities in California that can incinerate biosolids, resulting in a limited capacity. According to CalRecycle, air quality regulations make it unlikely that any new facilities will be permitted in the future (CalRecycle 2022).

4.3.1.2 Imperial County

Imperial County allows for the land application of biosolids in A-3 (agricultural) zones if a conditional use permit is first obtained (Imperial County 2021).

4.3.1.3 Riverside County

Riverside County Ordinance Chapter 13, Section 24 regulates the use of Class A sewage sludge (biosolids) in the county, specifically related to agricultural land application. The ordinance states the following under 13.24.020 – Purpose and Intent (Riverside County 2007):

> *"A. It is the purpose and intent of this chapter to regulate the land application of bulk Class A sewage sludge in a manner that is consistent with agronomic rates and protects public health, ground and surface water, soils, and agricultural markets.*
>
> *B. This chapter shall not regulate the distribution of Class A EQ products for uses such as horticultural, industrial, commercial or residential property development or golf courses. This chapter is only intended to apply to commercial farming applications."*
>
> *Further, this regulation requires each generator, processor and transporter shall be registered with the department prior to conducting activities regulated under the chapter.*
>
> *In addition, Riverside County Ordinance Chapter 8 section 29 adopted in 2000, expressly prohibits the land application of Class B biosolids (Sewage Sludge) within Riverside County."*

4.3.2 Arizona

By law in Arizona, agencies must review their rules every 5 years per the Arizona Governor's Review Council. The most current rules on biosolids applications are contained in Title 18, Chapter 9, Article 10 of the Arizona Administrative Code (State of Arizona 2021). The article does not include any stricter pollutant requirements than mandated by the CFR.

Additional restrictions on biosolids application include proximity to drinking water wells and the drinking water table. In addition to these restrictions, locations that may have biosolids applied also have restrictions against applications exceeding nutrient demands or where application runoff may enter a wetland or navigable waterway unless there is an Arizona Department of Economic Security permit to cover it (State of Arizona 2021).

4.3.2.1 Yuma County

No specific ordinances regarding biosolids applications were found for Yuma County.

4.4 New Initiatives

California Governor Gavin Newsom launched a new California Healthy Soils Initiative in October 2020, with the goal of conserving 30% of California's land and coastal water, and using the natural and working lands to store and remove carbon from the atmosphere. As part of the Governor's order, the state's agencies and departments, led by the California Department of Food and Agriculture, are to promote the development of healthy soils. A combination of innovative farm and land management practices contribute to building adequate soil organic matter that can increase carbon sequestration and reduce overall GHG emissions. Agencies are instructed to work together and pursue new ideas to accomplish the following goals (Governor Newsom 2020):

- Encourage healthy soils
- Restore wetlands
- Improve forest management
- Increase green infrastructure

While the plan is too new to have created any new programs, biosolids management will likely be an aspect of sequestering carbon in the land. According to CalRecycle, 13% of biosolids are disposed in landfills and 2.5% go to incineration (CalRecycle 2021). Harnessing the carbon in those biosolids instead of allowing it to be converted to carbon dioxide and methane can provide significant progress to achieve the goals set out by Governor Newsom. It will be important to monitor developments in California that may arise from this order.

4.5 Agricultural Considerations

The healthy soils grant program seeks to incentivize and demonstrate management decisions that promote healthy soils in the state. There are incentives available to encourage specific soil management practices. Unfortunately, at this point, grant funding is only available to biosolids projects as a demonstration project. Projects funded as a demonstration are required to collect scientific data to help inform future standards for biosolids use in the future (California Department of Food and Agriculture 2020a).

5. Biosolids Management Evaluation Criteria

Jacobs updated the biosolids management option evaluation criteria developed in the 2008 BMP (Table 1-12) with an additional sustainability metric to be consistent with EWA and member agencies' values and concerns. The descriptions and weighting of the criteria will be used to clarify project objectives and select the recommended option in collaboration with EWA staff. Figure 1-22 provides examples of multicriteria categories that are considered in master planning efforts, which provide both monetary and nonmonetary analysis.

Table 1-12. Evaluation Criteria from 2008 Biosolids Management Plan

Objective	Criteria	Comments and Considerations
Reliability	▪ Seasonality ▪ 5- to 10-year Outlook ▪ Competing Products	The criteria listed for this objective focus on the markets, but the process and the markets have aspects of reliability.
Flexibility	▪ Adaptability to Product Changes ▪ Delivery Schedule ▪ Onsite Processing Needs ▪ Product Form	--
Regulatory Issues	▪ Ability to Permit ▪ Environmental Compliance ▪ Public Health ▪ New Regulations	--
Risk Exposure	▪ Safety ▪ Litigation and Liability ▪ Product Handling	--
Implementation Issues	▪ Regulatory Hurdles ▪ Public Acceptability ▪ Schedule	The criteria in this objective overlap with the Regulatory Issues objective.

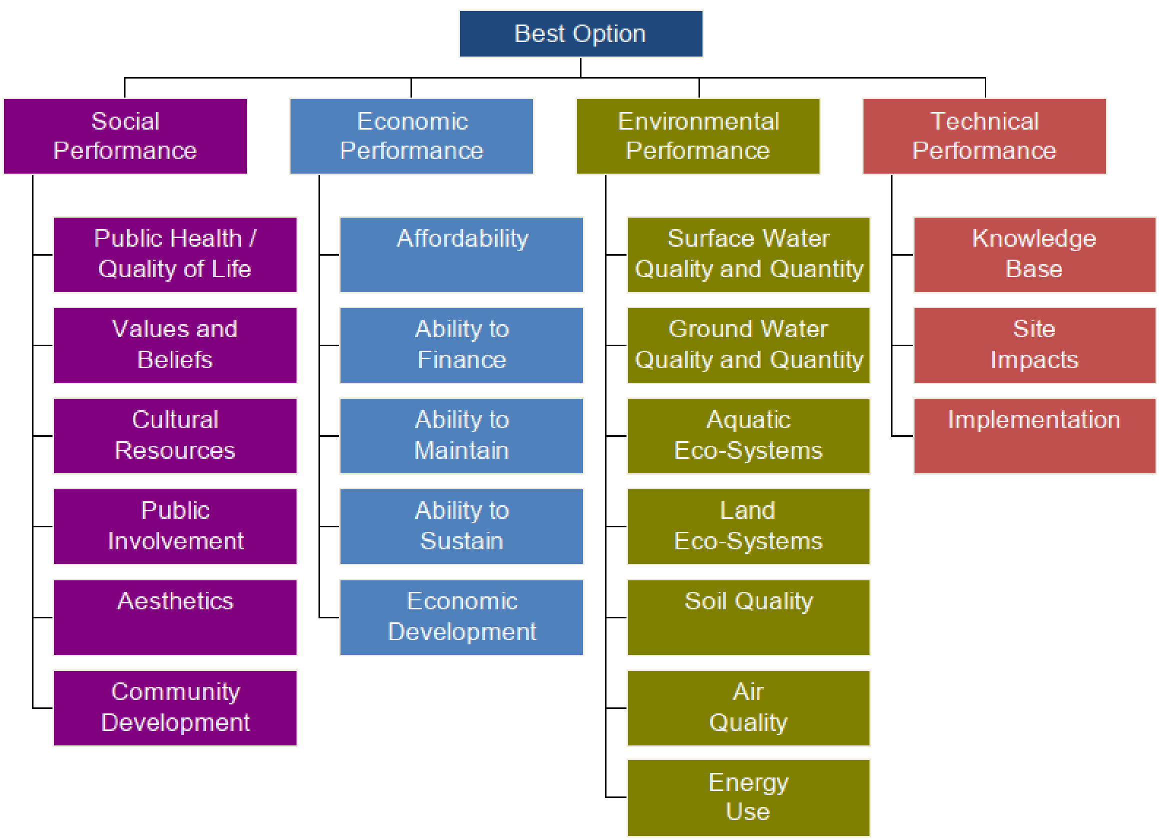

Figure 1-22. Examples of Multicriteria Categories

The criteria that define each overall consideration were identified so that specific, quantifiable definitions could be developed. Each criterion must be measurable and independent. If they are not independent, interdependent criteria receive a higher consideration and value-weighting than intended. Values ultimately drive decision-making when different sets of considerations (such as environmental versus economics versus infrastructure) are being considered.

Developed from a collaborative discussion with EWA, Jacobs summarized the nonmonetary criteria in Table 1-13. These nonmonetary criteria are weighted and provide a benefit evaluation that will be considered as part of a future benefit-to-cost ratio.

Table 1-13. Nonmonetary Criteria

Criteria	Description	Comparative Scoring Criteria
Future Regulatory Risk	Ability to adapt to potential changes in regulation. The challenges associated with permitting new and existing processes or management methods.	An uncertain permitting scenario outcome is a lower score, while process flexibility would provide higher score.
Reliable and Redundant Biosolids Product Distribution	Marketability and value of biosolids product and the ability to diversify outlets locally and to provide 200% outlet capacity (Class A or Class B or subclass B).	Higher scores are obtained for processes that support local use and that have multiple potential uses or outlets to provide 200% outlet capacity.
Environmental Sustainability	Ability of the alternative to reduce energy consumption or produce clean or renewable energy to reduce GHG emissions (carbon footprint and carbon sequestration).	Higher scores are obtained for alternatives with a smaller carbon footprint and increased resource recovery.
Operational Complexity and Serviceability and Flexibility	Impact on plant operations and maintenance staff as a result of increasing system complexity. Incorporates serviceability and proven technology.	Higher scores are obtained for processes that are known or have been operated without significant specialization.
Reliable and Redundant Process	Ability of alternative to provide the required capacity and quality of product, including longevity of the process.	Higher scores are obtained for processes that can be sustained or adapted to provide effective solutions over time.
Potential Public Impacts	Potential of the process and biosolids product to cause a public nuisance, including at the plant site, during transport of material, and at final product usage.	Processes that result in more noise, traffic, visual impacts, and odor result in a lower score.
Safety Aspects	Safety measures required for process to maintain safety of EWA staff, safety of process, and safety of product.	More safety mitigations result in a lower score.

The nonmonetary criteria were discussed and weightings assigned for each criterion in a workshop setting. It was important to confirm that each criterion accurately reflects EWA values. Through a collaborative process, each criterion was compared to the other criteria through what is known as a forced-choice exercise. Based on the definitions for each criterion, the group decided which criterion is most important compared to the others. The result of the exercise shows a defensible forced weighting of the EWA-specific criteria. These percentages are shown in graphical form on Figure 1-23 and will be subsequently applied to ranking of the technology options identified in TM 3.

The safety aspects parameter was set apart for subsequent evaluation after the initial evaluation so that safety could be fully considered. Therefore, the biosolids management options were first screened using fatal flaw analysis; then evaluated using the EWA-specific criteria described on Figure 1-24; then reviewed with a focus on safety aspects; and finally compared using a combination of the evaluation criteria and cost analysis.

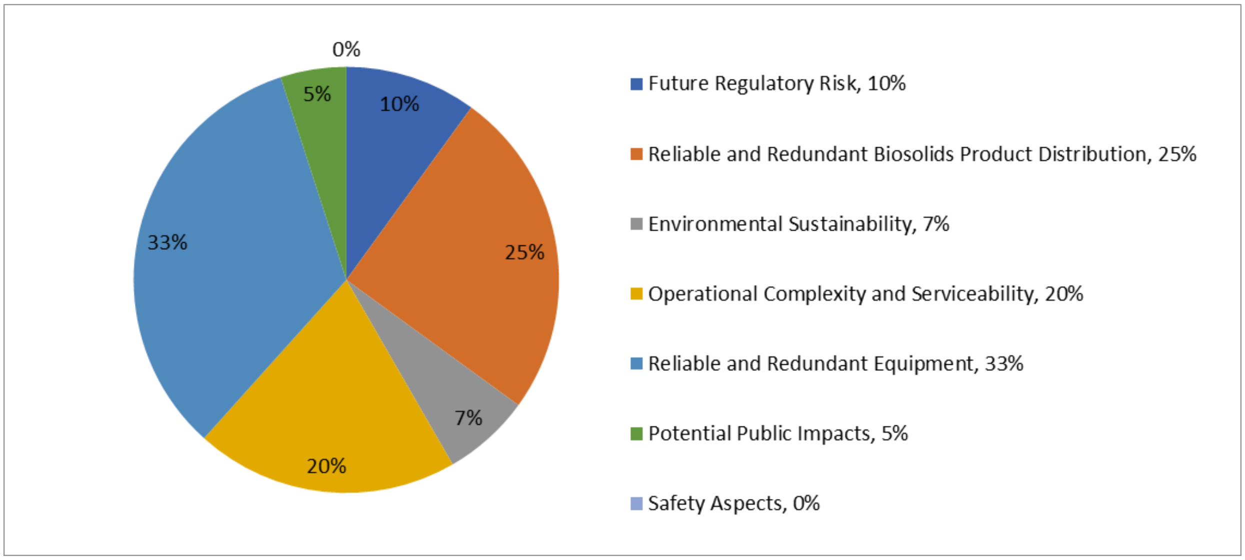

Figure 1-23. Forced Weighting of Nonmonetary Criteria

To evaluate the impact of the weighted criteria, the current operation of the plant was scored and compared to short-term modifications to operation. This scoring was achieved in a collaborative process with the EWA staff, using a scale of 0 to 5, where 5 was the highest score. The discussion during the scoring exercise provided insights to the importance of each factor to EWA staff. The nonmonetary factors will be used to evaluate the biosolids options as part of TM 3. These nonmonetary factors will be combined with the estimated capital and operating costs to develop a cost-benefit ratio of the biosolids options.

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TM 2 – Updated Portfolio of Biosolids Outlets

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2022 Biosolids Management Plan Update

TM 2 – Updated Portfolio of Biosolids Outlets

Final

June 2022

Prepared for:

Encina Wastewater Authority

2022 Biosolids Management Plan Update

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Acronyms and Abbreviations

Denali	Denali Water Solutions
dt	dry ton(s)
EPA	U.S. Environmental Protection Agency
EWA	Encina Wastewater Authority
EWPCF	Encina Water Pollution Control Facility
Fe	iron
FOB	Free On Board
IRWD	Irvine Ranch Water District
K_2O	potassium oxide
lb	pound(s)
lb/cf	pound(s) per cubic foot
mg/kg dw	milligram(s) per kilogram dry weight
mm	millimeter(s)
P_2O_5	phosphorus pentoxide
SGN	Size Guide Number
SOFCO	Synagro Organic Fertilizer Company of Sacramento, Inc.
t/a	ton(s) per annum
U.S.	United States
wt	wet ton(s)

1. Introduction

The Jacobs Team conducted regional market research focusing on Southern California to identify potential 40 *Code of Federal Regulations* 503 Class A and Class B biosolids product demand and options for outlets in the Encina Wastewater Authority (EWA) service area and surrounding areas in Southern California. The goal of this effort was to identify potential large-volume customers and verify product characteristic requirements.

The Jacobs Team's review of potential outlets for both Class A and Class B products throughout the region revealed Class A and Class B cake land application or disposal options are located in the far eastern areas of California and western Yuma Arizona. Only Class A granules were determined to have potential markets in the EWA service area and surrounding areas.

From this initial evaluation, and through discussions with EWA staff, it was agreed that the market research in this task would focus on Class A granule markets and only on large-volume users who could demonstrate consistent product demand and have capability to move at least 1,000 tons per annum (t/a)of granule product. The effort was further focused on identifying potential local or regional buyers or distributors with the ability to receive granules regularly (weekly) for less cost than EWA's current contract hauling and land application arrangement. In addition to Class A biosolids granules, interest in the use of biochar, should it be available in the future, was determined.

Surveying was completed over the telephone, and samples of EWA's PURE GREEN product were sent to interested parties for them to review the physical characteristics of the product first-hand. Data were obtained regarding the following factors:

Preferred product characteristics (moisture content, dust content, physical granule, and other requirements)

- Storage capabilities
- Other product quality issues (such as nutrient content)
- Seasonality of use
- Usage volumes
- Product value
- Product biases

In addition to Class A biosolids granules, consideration was given to potential markets for Class A or Class B biosolids cake. Because Class A and Class B biosolids cake generally have similar physical and visual characteristics, biosolids cake distributors view land application on agricultural farmland as the primary outlet for both materials, confirmed during the market research summarized in Appendix 2-A. The agricultural market is not a paying market but typically allows the use of biosolids products on their farms to supplement fertilization needs, so it is a net haul and land apply cost that must be paid by the generator.

Agricultural farmland sufficiently large enough to sustain biosolids land application is found in Imperial County, California, or in the Yuma region of Arizona, over 150 miles from Encina Water Pollution Control Facility (EWPCF). Class B biosolids cake and a large portion of Class A granules produced by EWA are land applied by the current contractor in the Yuma, Arizona area located 200 miles from the EWPCF, per the July 2019 Biosolids Hauling and Handling Services agreement, Admin19-13719, which is the current hauling and land application contract.

The main focus of this biosolids outlet task was to identify other markets for the Class A granules that are closer to EWPCF and can reliably move large quantities of Class A granules at lower cost than the current hauling and land application contract. This report summarizes the results of this research, including strategic recommendations to enhance EWA's ability to develop and secure long-term markets for their Class A granule product.

2. Existing Class A Product and Distribution

The marketability and value of dried biosolids products are greatly influenced by their chemical and physical characteristics. It is well understood what granulation technologies (for example, rotary kiln dryers, such as the Andritz dryer at EWPCF) can produce a product with physically acceptable characteristics (for example, dense, over 40 pounds per cubic foot [lb/cf]) and can vary particle sizing. The EWA operates such a system.

2.1 Product Characteristics (Current and Past)

Although customer feedback has suggested that there had been some issues in the past with producing a dusty and uncoated product, EWA has been producing a consistently high-quality granule for several years (Moriarity, pers. comm. 2020). As illustrated in Table 2-1, based on weekly testing conducted by EWA staff, the product normally contains only a minimal amount of dust or pan, which is measured less than 1 millimeter (mm). Most of the product has particle sizes between 1.5 and 2.5 mm, which is appropriate for a variety of fertilizer applications.

The product has a musty odor that one local fertilizer salesperson suggested some end users take offense to (Brunnell, pers. comm. 2020).

Potential users and customers like the uniform particle size and most likely would demand that particle size be maintained into the future. This particle size preference would require the use of a rotary drum dyer. If a belt dryer is added in the future, the belt dryer would need the ability to reform or resize particles into granules using back-mixing to ensure a marketable product.

Table 2-1. Encina Wastewater Authority Granule Particle Size

Date of Sample	Time of Sample	Product Particle Size Analysis							Bulk Density (lb/cf)
		6 (3.6 mm)	8 (2.38 mm)	12 (1.68 mm)	14 (1.41 mm)	16 (1.19 mm)	Pan (< 1 mm)	Sample Weight (grams)	
8/9/20	4:20 p.m.	1.20	59.20	31.90	6.80	0.74	0.32	100.23	42.0
8/15/20	6:30 p.m.	1.65	66.34	26.98	4.44	0.41	0.18	100.00	41.0
8/16/20	6:30 p.m.	1.24	60.15	31.71	6.05	0.55	0.30	100.00	41.0
8/17/20	6:30 p.m.	1.79	63.92	28.33	5.19	0.64	0.13	100.00	42.0
8/23/20	2:00 p.m.	1.52	65.14	29.30	4.36	0.28	0.11	100.62	42.0
8/30/20	6:30 p.m.	0.81	57.01	37.09	4.41	0.38	0.30	100.00	43.0
9/1/20	4:30 a.m.	0.97	58.75	34.05	5.38	0.46	0.39	100.00	42.0
9/11/20	10:25 p.m.	0.91	69.62	26.84	2.38	0.26	0.15	100.02	47.0
9/16/20	8:25 a.m.	1.52	68.94	25.77	2.15	0.15	0.13	100.08	42.0
9/22/20	12:00 a.m.	1.23	63.51	28.79	5.50	0.74	0.23	100.02	43.0
9/30/20	7:30 a.m.	1.08	59.24	33.47	5.47	0.48	0.17	100.00	40.5
10/4/20	2:00 a.m.	0.71	56.09	38.58	3.99	0.30	0.33	100.00	42.5
10/8/20	1:30 a.m.	0.75	44.02	39.84	12.67	2.28	0.57	100.02	44.0

Table 2-1. Encina Wastewater Authority Granule Particle Size

Date of Sample	Time of Sample	Product Particle Size Analysis							Bulk Density (lb/cf)
		6 (3.6 mm)	8 (2.38 mm)	12 (1.68 mm)	14 (1.41 mm)	16 (1.19 mm)	Pan (< 1 mm)	Sample Weight (grams)	
10/17/20	12:00 a.m.	1.87	64.74	28.87	4.18	0.39	0.23	100.01	43.0
10/18/20	3:15 p.m.	0.93	49.63	39.75	9.16	0.88	0.14	100.43	44.0
11/6/20	9:00 p.m.	1.02	64.74	29.05	4.57	0.48	0.15	100.03	43.0
12/7/20	8:50 a.m.	2.53	78.99	19.69	1.23	0.07	0.08	100.11	41.5
12/10/20	8:20 p.m.	1.87	75.83	20.76	1.48	0.09	0.07	100.12	44.0
12/22/20	7:50 p.m.	1.18	63.64	28.99	5.53	0.54	0.19	100.07	41.5

< = less than

a.m. = morning

p.m. = afternoon and evening

Table 2-2 shows the nutrient content of the EWA dried biosolids product based on the most recent laboratory analyses provided by EWA. The product is currently registered through the California Department of Food and Agriculture as a 5-5-0.2 (total nitrate [TN] – phosphorus pentoxide [P_2O_5] – potassium oxide [K_2O]) specialty fertilizer with the brand name PURE GREEN. The product's 5% nitrogen content is a substantial benefit, as many other biosolids-based fertilizers don't have as much nitrogen.

The product also has a higher phosphorus content than many other biosolids-based fertilizers. However, this is not currently considered to be a benefit, as many states (though not yet California or Arizona) have instituted phosphorus limit requirements on specialty fertilizers sold in their jurisdictions destined for use on turf.

Table 2-2. Encina Wastewater Authority Granule Nutrient Content

Date	Carbon	TN	TP	P_2O_5	Total Potassium	K_2O	Iron	% Solids
	(% dw)[a]							
4/30/18	40.00	6.00	2.54	5.82	0.13	0.13	2.90	93.6
10/2/18	33.00	5.00	3.13	7.14	0.17	0.20	4.90	94.0
4/26/19	36.00	5.66	3.31	7.58	0.17	0.20	3.90	92.1
11/10/20	37.40	5.99	3.00	6.87	0.18	0.22	2.90	92.9
Average	36.60	5.66	2.99	6.85	0.16	1.87	3.65	93.2

[a] Data provided on an as-received basis.

dw = dry weight

TP = total phosphorus

Table 2-3 lists the U.S. Environmental Protection Agency (EPA) regulated metal concentrations of the product. Metal concentration levels are less than the EPA Exceptional Quality Pollutant Concentration limits.

Table 2-3. Encina Wastewater Authority Granule EPA-regulated Metal Content

Constituent	EPA Limits	Feb-19	Apr-19	Jun-19	Average
	(mg/kg dw)				
Arsenic	41	3.1	4.3	--	3.7
Cadmium	39	1.3	0.7	0.6	0.9
Copper	1,500	390	380	320	363
Lead	300	6.2	1.8	6.2	4.7
Mercury	17	0.8	1.0	0.7	0.8
Nickel	420	13	13	13	13
Selenium	100	6.3	7.4	4.7	6.1
Zinc	2,800	660	690	580	643

-- = not applicable

mg/kg dw = milligram(s) per kilogram dry weight

2.2 Potential Product Improvements

The primary negative product characteristic is that it reheats and can smolder. One current customer (Moriarity, pers. comm. 2021) indicated that reheating is not as bad as it once was. However, it can heat to such a degree that fertilizer blenders are concerned about storing and using it. Reheating in storage has been an ongoing issue, and it is well known among regional fertilizer blenders, who are the higher-value bulk end users. Addressing the reheat safety issue is paramount in developing paying markets for the product.

Potential reheating mitigation to be investigated includes the following:

- Improve cooling of the granules before storage.
- Increase dust reduction.
- Reduce the iron content in the sludge.
- Modify storage silos to make them more airtight to prevent reheating.

Facility modification options to address these issues will be presented under separate cover in Technical Memorandum 3.

2.3 Past Marketing Efforts

EWA provided Jacobs with the information described in this section.

The EWA has not provided full-time staff support for distribution and marketing of the granules since 2015. There has been no one actively marketing the product since, and a significant drop in product sales has followed (Figure 2-1).

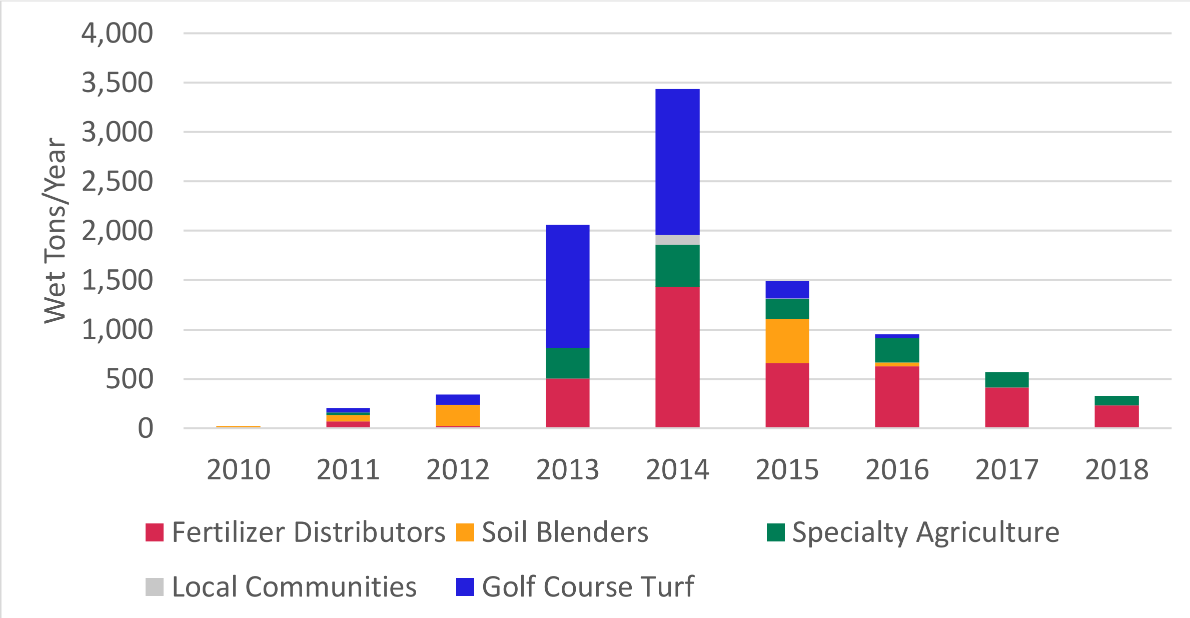

Figure 2-1. PURE GREEN Sales History

The EWA staff currently involved in product distribution are primarily engaged in distribution logistics. The access to trucking for deliveries is being well managed. However, it appears that no single person is solely responsible for product distribution, although a variety of people are involved. For this reason, EWA should consider re-evaluation of the current practices and streamlining marketing and distribution decisions by establishing a small group of people with responsibility for product distribution and decision making (including pricing negotiations and customer communications), with only one person to serve as the unified voice of EWA in discussions and negotiations with customers.

The reheating of the product and the lack of sales and marketing activity has reduced the volume of PURE GREEN actually sold in 2020 to less than 15% of granule production. Most product is hauled off under a contract with Denali Water Solutions (Denali) to farm sites in Arizona at a cost of $51.50 per wet ton (wt). Table 2-4 provides details on 2020 EWA biosolids distribution totals that are considered representative of the typical annual distribution split.

Table 2-4. 2020 Encina Wastewater Authority Biosolids Distribution Totals

2020	Total (dt)	Total (wt)	Class A Land Application (dt)	Class A Land Application[a] (wt)	PURE GREEN Sales (dt)	PURE GREEN[b] (wt)	Class B Cake (dt)	Class B Cake (wt)
Jan	610.0	1,154.7	423.7	452.2	22.0	23.5	164.3	679.1
Feb	542.2	706.5	442.4	474.0	60.7	65.0	39.1	167.4
Mar	597.9	756.8	438.3	471.5	126.1	135.6	33.5	149.7
Apr	546.0	710.8	463.8	493.4	42.6	45.3	39.6	172.1
May	556.7	1,008.7	331.0	355.5	105.3	113.1	120.4	540.1
Jun	599.3	1,121.3	332.9	357.3	129.5	139.0	136.9	625.0
Jul	605.9	895.4	410.8	443.6	136.7	147.7	58.4	304.2
Aug	609.7	720.6	494.0	457.8	72.3	72.3	43.4	190.5

Table 2-4. 2020 Encina Wastewater Authority Biosolids Distribution Totals

2020	Total (dt)	Total (wt)	Class A Land Application (dt)	Class A Land Application[a] (wt)	PURE GREEN Sales (dt)	PURE GREEN[b] (wt)	Class B Cake (dt)	Class B Cake (wt)
Sep	591.6	944.1	396.7	425.7	106.0	113.8	88.9	404.7
Oct	596.3	658.7	558.0	599.8	33.2	35.7	5.1	23.3
Nov	565.6	606.8	544.5	584.1	21.1	22.7	0.0	0.0
Dec	543.0	878.8	444.0	436.1	49.0	75.7	50.0	366.9
Total	6,964.2	10,163.3	5,280.1	5,551.0	904.5	989.3	779.6	3,623.0

[a] Dried and granulated product land applied by contractor

[b] Dried and granulated product sold

dt = dry ton(s)

3. Market Region Demographics

Carlsbad is located 35 miles from San Diego and within 100 miles of Los Angeles, allowing access to a huge population base. This population base fuels a large lawn and garden industry that includes millions of residents and thousands of commercial businesses (for example, landscapers, garden centers, and home centers). Also, large turf management (residential, commercial, and sports) and sod production industries exist in Southern California, although turf installation is being discouraged to reduce water usage. There are 728 golf courses in Los Angeles, Orange, Riverside, and San Diego Counties alone. Carlsbad is also within 150 miles of huge tracts of agricultural land, and there is a substantial fertilizer blending and distribution industry in the region.

Tables 2-5 and 2-6 provide distances to regional geographic markets and the number of commercial horticulture and fertilizer businesses in the region that could potentially use larger volumes of EWA product. Again, potential markets within a reasonable hauling distance are significant and diversified.

Table 2-5. Market Distances from Carlsbad

City	Distance (miles)	Primary Markets
Arizona		
Yuma	200	Agricultural
California		
Barstow	158	Agricultural
El Centro	141	Agricultural
Los Angeles	99	Horticultural
Riverside	85	Horticultural
San Diego	35	Horticultural
Temecula	34	Agricultural

Table 2-6. Select Horticultural and Fertilizer Market Demographics

Businesses (within 75 miles of Carlsbad)	Landscape Suppliers	Topsoil Blenders	Sod Producers	Fertilizer Wholesalers	Fertilizer Retailers
Number of Businesses	166	54	52	54	22

The regional climate is typically referred to as semi-arid and Mediterranean, and the rainfall is limited (12 inches per annum on average). In this type of climate, plant and crop care is provided year-round, which results in a steady fertilizer and horticultural product demand.

Soil is variable: sandy near the coast, and finely textured and low in organic matter away from the coast. Agricultural farmers in the region are more likely to apply organic matter to their soils (than are farmers in many other regions of the country) as a means to reduce irrigation needs and to improve soil health. Using a slow-releasing nutrient product that also provides organic matter (such as EWA's PURE GREEN product) is highly beneficial in the region's climate and soil conditions.

4. Potential Granule Markets

A variety of markets for biosolids granules have developed over the years. For example, Milorganite developed commercial markets around golf course and professional turf applications, for at least the past two decades. Milorganite has also developed strong retail markets for its product. The consistent availability and branding efforts over 8 decades have helped it overcome most biosolids-based stigmas.

Most other producers of biosolids granules have focused their marketing efforts on the fertilizer production and farming industries; however, product characteristics, marketing infrastructure of the producer, and market demographics heavily affect market concentration.

4.1 Market Categories Evaluated

To support the BMP 2022 Update, markets to be contacted and considered were divided into two main categories:

- Tier 1 Markets - Contract agriculture, biofuel products, and landfill disposal
- Tier 2 Markets - Fertilizer distributors (and blenders), soil blenders (bulk and packaged), specialty agriculture, local communities (turf and landscape management), and golf courses and turf management

Tier 1 markets represent large buyers who would pay little to nothing for the product or those that the EWA would potentially have to pay to manage it. Tier 2 markets are commercial customers who would likely pay for the product. Of course, certain end users within this category (for example, golf courses) could realistically only use product that is provided in 1-ton totes or smaller packages.

4.2 Focus of Research

EWA acknowledged that most of their granulated product has been distributed through its existing Denali hauling contract at a cost of $51.50 per ton due to the ease and consistency this option provides regardless of season, granule quality, or volume produced. EWA further indicated concern that revenues that might be generated would require substantial internal effort and that the cost of doing so would be greater than the savings realized from product sales. The Jacobs Team performed a conceptual cost comparison of several marketing options, including this one, all of which are described in detail in Section 9.

For these reasons, EWA is unlikely to hire an internal sales person to help build markets for the product. As such, they asked the project team to concentrate market research efforts on the following:

- Buyers who could use 1,000 tons or more of product annually
- Buyers who were geographically located more locally or regionally

EWA further confirmed that they were willing to contract with buyers they would pay to take the product, as long as this cost is less than the current contract management costs. EWA is open to considering arrangements with product brokers and distributors, not only larger end users.

5. Market Research Findings

Data obtained during the market research efforts are summarized within this section.

5.1 Entities Surveyed

Based on discussions with EWA management, the project team's efforts focused on contacting companies that have potential to move larger quantities of granulated biosolids on a bulk basis; these are generally categorized as Tier 2 markets. Table 2-7 categorizes the organizations contacted during market research.

Table 2-7. Market Research Contact Categories and Counts

Market Category	Number
Agriculture	2
Composters	4
Energy	3
Fertilizer Blenders and Packagers	4
Fertilizer Brokers and Sales	5
Soil Blenders (Bulk)	3
Soil Packagers	1
Total	**22**

5.2 Research Findings

Based on market research findings, significant damage has been done to the California biosolids granule marketplace, which has reduced overall product demand and value. Damage has been caused by various biosolids granule manufacturers producing a poor-quality product (that is, a product that is dusty, lacks coating, or has reheating problems during storage) and an inconsistent supply due to prolonged facility shutdowns. Inconsistent supply has made once interested, and even enthusiastic, parties less inclined to work with such products because their marketing momentum was negatively impacted whenever unexpected production interruptions (weeks or months in length) occurred, as discussed in Appendix 2-A.

With that stated, the following are market segment-based findings:

- **Agriculture –** Opportunity exists for direct sale of product to farmers, but that would require dedicated sales staff. Instead, farmers may be accessed by working through agricultural spreading companies (for example, Eggleton Trucking, Inc.) that complete contract spreading of fertilizer and gypsum and act as a product distributor. Companies already selling other bulk products to farmers, such as a composter or gypsum suppliers, could also serve in this function if they are interested in expanding their product line.
- **Cement Kilns –** Although successfully used as an alternative energy source in industrial applications, the regional cement companies did not express interest in an EWA product. Use of such products would require them to obtain an air permit change, and there is also concern about potential mercury emissions from use of the product. Permit changes are not deemed worthwhile because this sector would require at least 20,000 t/a of granules to generate interest. Air regulators closely monitor companies using alternative energy sources for mercury release. This avenue could be evaluated further in the future, if EWA were to fund all costs associated with demonstration testing and permit modification work.
- **Composters –** Interest was not able to be identified by composters for the use of the biosolids granules as an additive to composting (for nutrient enhancement). However, Agromin (a Los Angeles area composter and packager) showed interest in using the product in some of their blended soil products. To use it, the product would likely have to be delivered to their Oxnard location for free. Imperial Valley Compost, located in Brawley, showed interest in distributing the product and is showing samples to some of their compost customers.
- **Fertilizer Blenders and Packagers –** Limited interest was identified among new fertilizer blenders and packagers. However, Nutrients PLUS and Upcycle & Company showed continued interest in working with the EWA product. They are both preparing proposals for EWA to use and manage larger volumes of product. None of the fertilizer blenders or brokers could use a belt-dried biosolids product, as consistency of product size and density is critical for them.
- **Fertilizer Brokers and Biosolids Managers –** Companies such as MANNCO and WeCare/Denali showed significant interest in working with the EWA fertilizer. They are both experienced at marketing granulated biosolids and would likely offer a distribution agreement in which they would be paid a fee to distribute the product, as they were developing paying markets for it. These fees would be tonnage-based, likely starting at $40 per ton, and would potentially be reduced annually based on progress with the goal to get to zero.
- **Soil Blenders –** Limited interest was shown by bulk soil blenders, but interest was shown by Agromin, a large, packaged soil producer. Great Soils, LLC, another local bulk soil blender, was initially enthusiastically interested in using 1,000 t/a of the product. However, when they received a trial 20-ton load of the product, it was very hot and looked to be smoldering. Even after the EWA product was blended with a woody product to create a potential blend, the product continued to smolder. Great Soils, Inc. viewed this as a safety issue and is no longer interested in the product unless the reheating issue is addressed. None of the soil blenders interviewed were interested in use of a Class A dewatered cake product primarily because of odor issues and the added handling. Soil blenders and one potential distribution partner were familiar with and did express interest in biochar if it were produced.
- **Sod Producers –** A large amount of sod is produced in the region, so there should be interest in using the EWA product. However, after repeated efforts in reaching out to Pacific Sod and West Coast Sod (largest sod producers in the region), the project team was unable to successfully contact them due to the impact of COVID-19 shutdowns.

Table 2-8 lists potential large-volume marketing and distribution partners that have been identified for the EWA. Reheating of the product is an impediment to developing higher-paying markets, particularly in the local area where regional blenders are located, which would impact product pricing because of the longer hauling distances to reach higher-value markets not so concerned about the product reheating issue. However, it is believed that all of these potential partners would be able to market the product even if the reheating issue is not corrected.

Table 2-8. Encina Wastewater Authority Potential Marketing and Distribution Partners

Potential Partner	Initial Interest and Comments
Agromin	▪ Interested in the potential use of the granules, and have obtained a trial load from EWA. ▪ Has some interest in using the product if EWA ships the product to their Oxnard facility for free. ▪ May have interest in marketing the product in the future.
MANNCO	▪ Experienced biosolids granule marketing company, but not currently operating in California. ▪ Provided a marketing agreement to EWA for consideration.
Nutrients PLUS	▪ Operates locally. Open to marketing or using a larger volume of product, or both. ▪ Provided a marketing agreement to EWA for consideration (but had difficulties obtaining larger volumes of EWA product in 2020).
Upcycle & Co	▪ Has been packaging and selling the EWA product for some time, selling it in 4-lb bags, with usage of 20 to 30 tons (total) over the past few years. ▪ They want to be using larger volumes of product on a more consistent basis. ▪ They are interested in managing product for EWA and in being one of the companies taking 1,000 tons. ▪ They are working on a plan and potential proposal for EWA.
WeCare/Denali LLC	▪ Open to managing granule through a creative distribution option, and are open to an introductory call. ▪ Their plan would be for EWA to pay them to move the granules while developing markets, leading to a cost neutral (or pay) service on a 5-year contract.

lb = pound(s)

5.3 Product Requirements

As mentioned earlier, the EWA currently produces a quality biosolids granule that is sized properly, has an acceptable bulk density, and has a manageable odor. Furthermore, according to EWA Operations, the product contains a substantial amount of nitrogen (between 5 and 6%) and meets EPA Exceptional Quality Standards for pathogen reduction and metal content. The only significant improvement necessary is to reduce the reheating characteristics of the product. This issue is significantly reducing the ability to sell large volumes of product to paying markets. Additionally, the issue has become well known to fertilizer blenders.

5.4 Customer Service Requirements

Customer service complaints were registered by a few current and past clients, primarily related to past shifts in product quality, as well as obtaining additional product or negotiating price to increase usage. It is suggested that EWA create standard operating procedures to address queries and complaints rapidly and consistently from the marketplace. Furthermore, identifying and empowering a staff member or team to be responsible for overall granule marketing and distribution is important.

6. Marketing Suggestions

6.1 Market Strategy

From EWA's historical product marketing experience, and based on the Jacobs review and analysis of options (Section 9), the Jacobs Team explored the possibility of existing EWA staff taking on additional responsibilities to manage product distribution to a small number of large customers (or contractors), working at it on a part-time basis. An internal evaluation may be required to determine who would manage this important function. Five companies (Agromin, MANNCO, Nutrients PLUS, Upcycle & Co, and WeCare/Denali) were identified that the EWA could negotiate large distribution or usage arrangements with, or both.

Finally, there were additional potential large buyers identified (for example, Eggleton Trucking, Inc., an agricultural spreading company; and Imperial Valley Composting, a composter looking to expand sales of non-compost products) that showed interest in the product but were not ready to make a commitment at this time.

6.2 Encina Wastewater Authority In-house Management of Distribution

With the approach of using existing EWA staff without adding another full-time position for a product marketing specialist, the Jacobs Team approached the marketing program options with the goal of working with one to five large end users or marketing partners to minimize additional staff responsibilities. The following issues with this approach would need to be addressed:

- Confirmation of the organization's overall biosolids distribution strategy
- Understanding the contractual limitations and equipment limitations to supplying a consistent quantity and quality of product

7. Existing Thermal Drying Facilities Survey Results

Existing biosolids drying and granulation facilities were contacted to obtain relevant data regarding product manufacture and distribution and marketing. Table 2-9 summarizes the survey response data, compared to EWPCF's data, which is shown first.

Table 2-9. Thermal Drying Facility Contacts

Facility	Product Data	Market Data
EWPCF Carlsbad, CA	Produce 6,500 t/a of a 5-6-0 % product, using an Andritz drum dryer. Dryer is operated at capacity, with excess product hauled to agriculture by a third-party contractor. Sell granulated product in bulk with some totes but very limited capacity to market in totes.	Having limited success marketing, primarily to a fertilizer blender who enhances the product. Less than 1,000 tons sold annually for $30/ton or less. Majority distributed, at a cost of $51.50/ton, through contract with Denali.
City of Corona Corona, CA	Produce 8,000 t/a of a 6-6-0 % product, using a Siemens Water Technologies rotary drum dryer. Facility experienced a	Had been selling all product to and through Nutrients PLUS, whose management thought that they had done well. Nutrients PLUS

Table 2-9. Thermal Drying Facility Contacts

Facility	Product Data	Market Data
	fire in 2020. Expect to rebuild and start production again; likely taking 1 to 2 years.	purchased the product that they used in fertilizer blending ($10/ton) and received the product distributed to farmers for free.
IRWD Irvine, CA	New Andritz belt dryer system completed in 2021, producing approximately 3,600 t/a of a 4-3-0 % or 5-3-0 % product. Will have some spare processing capacity.	They will not have internal sales staff for the product but are looking for sales agreements. Unknown whether they will be paid for the product in the short term.
Milorganite Milwaukee, WI	Produce 46,000 to 48,000 t/a, of a 6-4-0, 2.5% Fe (150 SGN) product. Currently selling out, and have some interest in the sale of product that they do not produce, to gain distant supply and help the industry.	Could use 5,000 to 10,000 t/a source, west of the Rockies. Said the product does not have to have the same particle size or nutrient content. The efficacy of the product, consistency, and long-term stability of the program is important.
Pierce County Public Works University Place, WA	Produce 2,400 t/a of a 5-5-0 % fertilizer product, using the Andritz rotary drum dryer technology. Call product SoundGro. Sell product in bulk, 1-ton totes and 50-lb bags (in pallet quantities only).	All product is now ordered online with nine companies reselling bags in WA. Pricing: ▪ Loose tons - $66.36 ▪ 1-ton totes - $85.95 ▪ Pallet of fifty 40-lb bags - $300.38/ton After struggling to expand sales, with no dedicated sales staff, they report to be currently selling out.
Sacramento Regional County Sanitation District (SOFCO - operated by Synagro) Elk Grove, CA	Produce 7,300 t/a of a 5-3-0 % using an Andritz rotary drum dryer. Have 100 tons of silo storage but try not to use it because of reheating. Coat granules sold to fertilizer blenders with oil.	Fertilizer blenders pay $60-65/ ton and farmers pay $20-25/ton, FOB. Facility does not run every week, so need to give lead time for orders. Their sales person is located in Bakersfield.

Fe = iron
FOB = Free On Board
IRWD = Irvine Ranch Water District
SGN = Size Guide Number
SOFCO Synagro Organic Fertilizer Company of Sacramento, Inc.

7.1 Marketing and Distribution Strategies

Of the four facilities in current operation, three operate their own in-house marketing programs, while the one (Corona) uses a broker. The IRWD will also likely use a broker. Milorganite and SoundGro are marketed using municipal staff, with markets taking significant effort to develop. Synagro operates the SOFCO facility (and many other drying facilities) and markets their product with in-house staff. Synagro has a long history of marketing biosolids granules and has sales staff throughout the Unites States (U.S.), marketing various biosolids products. The successful marketing at Corona and of Milorganite and SOFCO followed assertive sales efforts, with sales staff in the field.

7.2 Marketing and Distribution Successes and Failures

Today, Milorganite is almost entirely marketed through fertilizer distributors and through mass merchants. Their marketing program has existed for over 80 years. Their successful branding has made biosolids stigma much less relevant for them, when compared to other products and programs. Both Milorganite and SoundGro have been successfully sold in retail-sized bags, while SoundGro and EWA's PURE GREEN have had some success selling in tote (1-ton) volumes. Marketing the product in packaged form increases the product's value, but also substantially increases production and marketing costs. Most biosolids drying operations that practice bagging move only a small portion (less than 10-20%) of their overall production volumes in bags as a means of branding and market exposure.

The Corona and SOFCO marketing programs, much like EWA, use distribution to agriculture (sometimes being paid for the product and sometimes not) as a means to manage excess supply. The SOFCO and EWA products have product reheating problems documented by fertilizer blenders, which require alternative distribution strategies. While some fertilizer blenders still use these products, they are very cautious about doing so, while many other fertilizer blenders will no longer use them. The reheating issue forces distribution of the product directly to farmers, which are lower-value markets and often cost the producer a management fee to haul and distribute it on their land.

7.3 Potential Concerns and Risk Mitigation Strategies

Granule producers continually complete analytical testing to reduce concerns about potential environmental contamination caused by their product. To minimize risk related to reheating, several facilities avoid long-term storage in silos, and instead market to farmers (who often store the product outdoors). Of course, selling or distributing to farmers, or both, also helps facilities manage excess production volumes. The ability to sell granules in bulk form to fertilizer (or soil) blenders is viewed as a means to 'make the product disappear' (into another product), diluting it, and thereby reducing perceived liability risk.

8. Regional Solutions

Regional biosolids management solutions considered included the following options:

1) EWA becoming a regional service provider and receiving dewatered solids from other service providers onsite to further process through drying or another technology solution
2) EWA participating with another regional service provider to further process biosolids at another location
3) EWA and other service providers participating in a new biosolids processing facility to be developed at a neutral site by a consortium of service providers or a third-party contractor to further process biosolids

Accordingly, discussions were held with leaders from several wastewater service providers (including Oceanside and San Elijo) regarding existing biosolids management programs to gauge each agency's level of interest in participating in a potential regional biosolids management solution.

Initial interest was expressed regarding participation in a regional solution based on discussions with Oceanside. Oceanside has two water resource recovery facilities that produce approximately 3,100 dt annually of anaerobically digested Class B cake. Oceanside has a very competitive contract with a land applier to haul and land apply this material in Yuma County, Arizona. Although there is interest, the current unit cost Oceanside pays to their contractor is less than EWA's current contract. However, Oceanside is in the middle of a food waste-to-energy biosolids master plan to look at the future of both high-value organic waste and biosolids, which could increase their level of interest in a potential regional facility.

San Elijo was the other agency interviewed. San Elijo is smaller and produces roughly 900 dt of anaerobically digested biosolids annually. They have a third-party contractor that also hauls their Class B Biosolids to Yuma County, Arizona for agricultural land application at a slightly lower unit cost than EWA's. San Elijo recently completed a study that evaluated alternatives, including a regional option of hauling biosolids elsewhere to be processed. Based on the cost evaluation completed by their consultant, San Elijo does not believe a regional option would make economic sense for them to pursue further.

One of the wastewater service providers had recently inquired about hauling to a third-party compost operation instead of land application and was told the unit cost likely would be much higher than the current contract pricing.

It is apparent that the economics of a regional solution appear to be significantly more costly than the costs of EWA's current program and that of the other utilities surveyed. This situation should be monitored and unless the economics, regulatory conditions, or other indicators change, a regional solution does not have the necessary support to pursue further at this time.

9. Portfolio of Market Options

The current contract between EWA and its contract hauler provides the ability to haul and land apply Class A granules and Class B cake to agricultural farmland at a set cost. This provides a reliable biosolids handling solution, with both Class A and Class B products being beneficially used on agricultural land or by fertilizer blenders. In 2020, 89% of the solids produced were able to be dried to Class A EQ biosolids granules. However, based on operational data provided by EWA, only 15% of the granule production was sold with 85% being land applied at significant cost.

Several marketing options exist for managing the biosolids granules EWA produces. Table 2-10 summarizes the most typical options. The potential exists for lowering biosolids granule management costs by capturing more market share, as Table 2-10 also shows. There have always been some challenges to being able to realize this goal due to issues, such as product reheating, consistent availability, and ability to service peak periods of demand. Whether a public or private entity is involved, when considering which marketing option to implement, it is important to consider the organization's overall goals and its internal strengths and weaknesses. How risk is perceived is also an important factor when considering marketing options.

Developing in-house marketing programs requires great attention, and public entities are not always well suited to operate such programs. Furthermore, marketing programs often offer the product in packaged and bulk form. A typical brokerage option that has existed for granulated biosolids products entails the producer paying a management fee (price per ton) that shrinks to zero, or a payment for the product, over time. These contracts are typically 3 to 5 years in duration. In view of EWA goals and operating philosophies, this approach is a very good fit for EWA if certain changes and steps are taken.

Several potential marketing and distribution partners have been identified who show significant interest in the EWA PURE GREEN product, and some have already developed draft contracts for EWA review and consideration. EWA has the opportunity to engage in focused dialogue with these potential partners to reset the current marketing program and develop a long-term marketing program, which is sustainable for years to come with potential to lower overall operating costs and provide sustainable outlets.

Table 2-10. Granule Marketing Options

Options	Advantages	Disadvantages
Develop in-house marketing program.	▪ Can generate the greatest income and publicity ▪ Provides the producer with the greatest control	▪ Requires staffing and the most internal effort ▪ Producer assumes the greatest amount of responsibility and risk
Contract with broker or biosolids management firm, or both.	▪ Entails large volumes contracted or committed to one or a few companies, reducing management requirements ▪ Transfers marketing risk to the contractor	▪ Potential for product to become commoditized, and the producer typically loses the ability to brand the product (internal) ▪ Depending on who the contract is with, may require producer paying a fee for distribution
Issue a Request for Proposals for purchase of product.	▪ Can cast a broad net, identifying potential interested parties ▪ Transfers marketing risk to contractor	▪ Often poorly executed (advertised to the wrong organizations) ▪ Typically reduces value of the product

Based on feedback from the surveys and input received from potential marketing and distribution partners listed in Table 2-8, Jacobs performed a cost evaluation of three of the most likely biosolids marketing options over a 5-year period. They included:

1) **Hauling to Agriculture –** This option uses EWA's current contract hauling program to beneficially use both Class A and Class B products in agriculture by hauling and applying these products on farmland located primarily in Pima County, Arizona. A portion of Class A granule would be sold, as is done currently, while the balance is land applied on farmland at a cost. The dried granule production would remain constant, and the amount of Class B cake would slightly increase annually due to growth over the 5-year period.

2) **Internal Sales –** This option includes creation of a new full-time position within EWA and hiring an internal biosolids product marketing person in this position. Initially, this option would increase the cost of marketing EWA biosolids due to the added labor and advertising costs associated with developing Class A granule product markets over several years. Experience at other drying facilities has shown that this approach can be effective at optimizing revenue from product sales, but several years are needed to develop a sustainable program through outreach and education of potential users. EWA's current contract hauling program would remain in place to manage Class A and Class B biosolids while higher-value Class A granule markets are developed. This option has the potential to move more product into markets locally than the option of hauling to agriculture.

3) **Broker Sales –** This option relies on a multi-year business arrangement with a third-party marketing and distribution partner or broker that would take the responsibility of hauling and distributing Class A granules. This broker would assume the risk of moving the product reliably and developing paying markets. Initially, the broker would charge a unit cost per ton of product to cover their marketing costs. Over time, this cost would reduce as a greater volume of the granules produced are moved into paying markets. Eventually, the broker would develop a large enough customer base to move the entire granule production to paying markets. About 5 years is needed to achieve this. Any excess biosolids cake produced (not dried) would rely on EWA's current contract hauling program to remain in place. This option also has potential to move more volume of granules into the local market than the option of hauling to agriculture.

Figure 2-2 shows the comparison of the costs of these three programs over a 5-year period, the amount of time deemed necessary to achieve a steady-state marketing program.

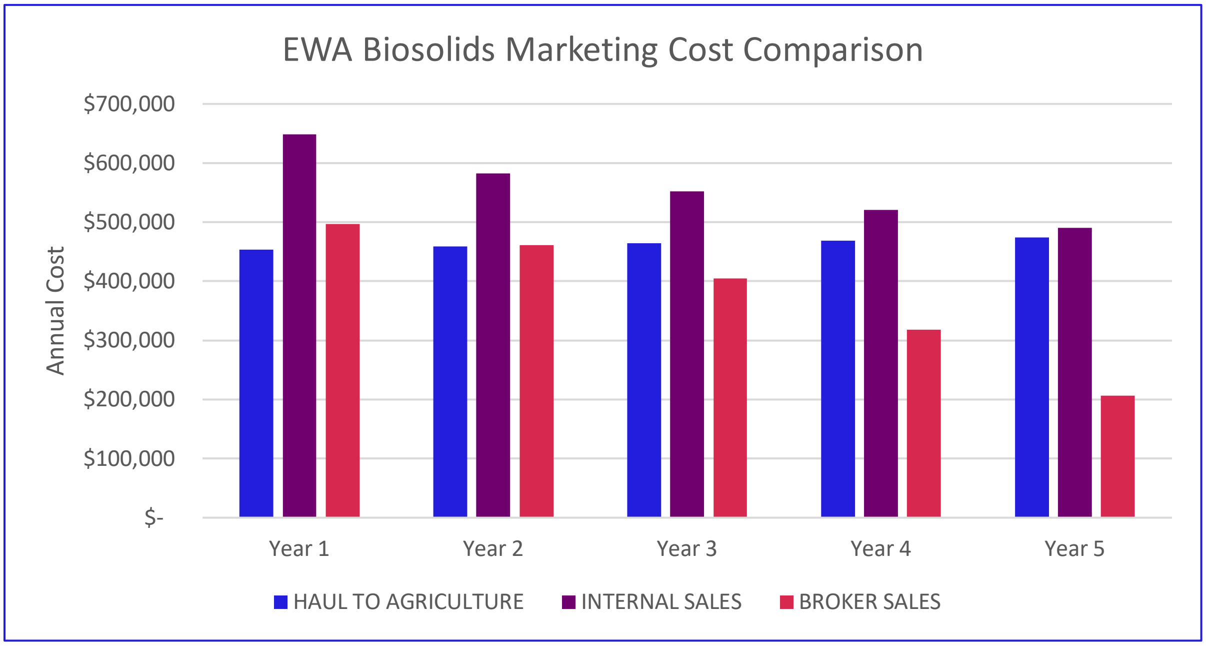

Figure 2-2. Comparison of Various Biosolids Marketing Options' Annual Costs

Based on this work developing a portfolio of biosolids outlet options and the cost comparison of the three marketing options outlined, the best option for EWA appears to be to engage a broker, as it carries the least risk to EWA and could result in the least cost over a 5-year period and well into the future.

10. References

Brunnell, Chris, Fertilizer sales contractor. 2020. Personal communication (telephone call) with Ron Alexander, Jacobs subcontractor. December 22.

Moriarity, John, President, Nutrients PLUA. 2020. Personal communication (telephone call) with Ron Alexander, Jacobs subcontractor. December 15.

Moriarity, John, President, Nutrients PLUA. 2021. Personal communication (telephone call) with Ron Alexander, Jacobs subcontractor. January 13.

Appendix 2-A
Detailed Market Research Spreadsheet

	Company Types	Location	Contact	Phone	Type	General information	Processing and Marketing	Interest
End Users / Distributors								
1	Agromin	Oxnard	Bill Camarillo / Dave Green	805-485-9200	Composter / Packager	Large composter and packager. Use various fertilizers, but have no stand-alone fertilizer line. Sell compost (and soil products) into landscape and agricultural industries; sell both bagged and bulk. Has used granulated biosolids at CA and TN plants in soil mixes in the past; bought from Synagro. Sacramento product was 200 SGN, 40-44 lbs/CF, 5-7% moisture, NPK 4/5-3-0. Not using biosolids fertilizer like they had in the past, as it had been hard to get an acceptable product and a lot of the San Diego County turf market has shrunk.	However, open to use, as well as packaging for others. Would consider using to amend soil mixes to enhance value. Would consider packaging it and creating fertilizer line. Is open to managing full volume; they would take in bulk and bulk bag it for storage and then resale. Do large turf sales in San Diego county, expect the same with the fertilizer. Would love to sell the fertilizer into ag, but expects that most would go into turf. Would schedule a time to discuss marketing all for EWA; would have to pay them at first.	Yes
2	Agriservice	Oceanside	Mary Matava	800-262-4167	Composter	Tried to work with EWA in the past (twice), but was burned. Can't take the product to their Oceanside facility now anyway, permitting situation.	Thinks that turf farmers could use, as well as golf courses.	No
3	Blue Ribbon Landscape Supplies	Orange, CA		714-633-3666	Topsoil, ldsp materials	Do wholsale and retail sales, selling several bulk products and some soil products in bags (Kelloggs line). Have their own large truck to pick up compost, and smaller truck to deliver.	Used to use IERCA compost for many years (1,000-1,500 CY/wk), is a little smelly, but he likes how well it works. Rodieck's sold company and resell soil (from Terra Verde) instead of blending it themselves	No
4	N/A	Oceanside	Chris Brunnell	760-803-1858	Fertilizer sales	Use to work for CPS and Anderson's (fertilizer companies), and was a turf buyer. Would have possible interest in being in-house salesperson for EWA. Sold the product for CPS to golf courses.	The product was efficatious, but smell was a problem for golf courses (as was dust). Benita Golf Course had problem with product 'smoking'. Should consider blending product in order to sell. Would be helpful if EWA could add N to change its sales positioning (finished product instead of ingredient).	Maybe
5	CalPortland Company	Riverside	Hartmut Riess	626-852-6289	Energy	Have not used alternative fuels, but interested, now permitted to use us to 500 t/d of secondary fuel sources. That stated, they are in the early days of investigating secondary fuel sources.	Are more interested in identifying large sources of fuel, but keep in touch. Would require extensive testing (oxides, heavy metals, S, Cl, Fe, Al, etc.). Stated that EWA volume is extremely small for them.	No
6	Dune / Gowan	San Marcos	Gib Crowell	760-445-4116	Fertilizer	Large privately held SW US fertilizer company. Carry/sell both conventional and organic fertilizers.	"Not able to interest management in biosolids products, not innovators."	No
7	Eastman Soil Amendments	San Marcos	Emily, Bill Eastman	760-744-5422 o, 760-842-3323 m	Topsoil	Medium soil blending yard. Been using mushroom soil as soil amendmen for many years, gets it for free (he picks-up). Was looking at trying IERCA compost, but would be $8-9/CY del'd in.	Couldn't handle dewatered Class A at their site, showed some interest in biochar. Sent sample to review. Could not see using it, 'do not add fertilizers to their soil blends'.	Yes
8	Eggleton Trucking, Inc.	Temecula	Dan Eggleton	951-536-8185	Spreader	Does a lot of compost spreading in Riverside County; a lot with biosolids compost from IERCA and Synagro. Many farmers are getting compost spread for free.	Can spread fertilizer and was willing to talk to farmers about it, especially if EWA is willing to pay costs (probably $30/t). He does not have the ability to stockpile product, but believes that some buyers (wineries) will. Sent sample for evaluation. Liked the sample, is going to ask a winery he knows about it.	Yes
9	Great Soil	San Marcos	Graeme Fairlie	760-740-9191	Soil blender	Large soil blender, uses over 10,000 CY/yr. of IERCA biosolids compost. People have not asked him about the biosolids content of the compost for years. Huge sales year because of COVID; beautification and veggie gardens. Owns a truck & transfer trailer that can haul 26 tons; location is close to the facility. Could not use a Class A cake (potential odor and handling/mixing issues).	Is interested in biochar (pizzazz factor) if he could purchase for $25/t. Tried Fallbrook granules, but were smelly. Was open to considering the use of Encina granules, and liked the sample. Offered 1,000 t for free (he picks up). Sent a free load, 12/8/20, but the product smoldered (even after blending), so said was too risky for him to use. Call if fix reheating.	Yes
10	Growmore	Gardena	John Atwill	310-515-1700	Fertilizer	Dry fertilizer company; sells conventional and 'organic' fertilizers. Primarily sell specialty fertilizers into turf and landscape. Has used pellets from Encina & SOFCO. Primarily sold biosolids granules as stand-alone product, but could bulk blend. Busiest season is March - Oct. Not pleased with the way Encina dealt with the marketplace.	Still buy granules from several sources. Concerned about public entities 'messing up the market' (undermining their efforts). Could be a moderately sized buyer. Cannot provide much offsite storage. He claims he can build a large market but would need consistency and a set price.	Yes
11	IERCA	Rancho Cucamunga	Jeff Ziegenbein	909-573-6190	Composter	Interested in the concept of adding pellets to compost, to enhance NPK for sales to ag market (improve value?). However, not selling as much to ag as in the past.	Just hired a new sales person; will discuss specialty ag market sales with pellets. Compost is currently sold out, so reducing sales to farms. Selling to them for diversification, is a 'financial loser'.	Maybe
12	Imperial Valley Compost	Brawley	Bruce Singh	760-427-4526 m	Composter	Sell large volumes of compost to organic farmers and may get into sellling/producing organic fertilizers.	Would consider marketing biosolids granules if no county use restrictions. Sent sample , test data, and needs proof of biosolids bans ending. Like products, asking clients about it	Maybe
13	MANNCO	Conway, AR	Bradley Mannis	501-327-1771	Fertilizer broker	MANNCO markets 27,000 tons per year of Class A biosolids from Louisville, Waco, Pensacola, and Nashville (with most are non-exclusive marketing contractor). They do not market in CA, but are evaluating opportunities. MANNCO has the potential to manage full production of facility over time. Likes Andritz dryer products.	Sell into agriculture/ landscape/ municipal/ golf markets. Wants a product 40 lbs/CF minimum and 95/96% TS, with little dust. Likes 1.8-3.0 SGN product. Interested into committing for part of the production volume; submitted a proposal.	Yes
14	Mitsubishi	Lucerne Valley	Dave Rib	760 248-5184	Energy	Won't use because of presence of mercury in the solids (we are only 0.2 ppm)	They are measuring mercury in fuels in ppb	No

Encina Wastewater Authority
Biosolids Management Plan Update
Market Research Summary

	Company Types	Location	Contact	Phone	Type	General information	Processing and Marketing	Interest
15	Nutrients PLUS	Virginia Beach	John Moriarty	757 573-8741	Fertilizer broker / blender	Been selling in CA for over 10 years, selling all Corona product (but had fire) as well as Encina and Sacramento granules. Has a 'history' with Encina. Had reheating problems and moved most of what he took to farmers. Had good experience with Eric Have and Kevin Hardy, concentrated on quality and customer service; not so with Debbie Biggs.	Concentrates on blending branded products sold to wholesale landscaping outlets: Ewing Irrigation & Site One (formerly John Deere Outlets). Paying Encina $30/t. Could guarantee removal if paid a tip fee; mentioned $40/t. Submitted a proposal. Main seasons are: late Oct > Dec and late Feb > June. In California, dryers have had quality and production disruption issues holding back market expansion.	Yes
16	Nutrients PLUS	Local Rep	Eric Have	757-718-1470	Fertilizer broker / blender	Before fire, had sold all of Corona's product for 3 years. Get it for free (when goes to land app) and pay $10/ton when use in fert blending process. On-going availability and a low price are key for getting the market to expand. Can be difficult working with EWA staff. Are no quality SOP's in place. Believes that he could build markets for all the project if EWA helped.	Joe will only let them buy 2 loads/week, and cannot lower price to incentivise expanding usage/resale. Sees the mgt of distribution under Doug, who is the compliance guy, as a problem. Also use SOFCO product, but reheats worse than EWA. Thinks EWA needs a larger cooler and needs to product a slightly larger product (180 SGN) to reduce reheating risk.	Yes
17	Red Star Fertilizer / Gro-Well Brands	Corona	Roc White	951-505-8359	Soil packager	Produce soil products, and don't add any fertilizers. Using IERCA biosolids compost in some of their mixes.	Probably can't use because LEA is on their back (but reach out to Henry V). (Could't reach Henry).	No
18	Scotts Miracle-Gro / Hawthorne	Marysville, OH	Michelle Schott	937-578-5387 o 937-553-4406 m	Fertilizer	Largest lawn/garden supply company in the US. Had not carried any biosolids products, but now selling an unblended biosolids in their EcoScraps line.	She left Hawthorne in 10/20 and is back with SMG. Thinks that Ecoscraps is in the core fertline, so is still with her. Andrew King works for her. Will check interest / have COVID	Unknown
19	N/A - ex-CEMEX	N/A	Monica Sowders	937-673-1519	Energy	Used to work for CEMEX with their alternative fuels. Left and moved to TN, but does energy consulting in CA.	She said that she would ask some people about products usage. Need test data: moisture content, BTU, nutients / metals (Cl, Mg, Hg).	N/A
20	Stage Ranch	Temecula	Gary Winder	951-255-4200	Ranch Manager	Manages 500 a of conventional and 110 a of organic acreage (grapes, avos, lemon). Uses a lot of compost, but is skeptical about the use of biosolids (heavy metals).	He cannot stockpile, but vineyards may. Would need a substantial supply at one time. Sent sample for evaluation, liked it, but doesn't want to use a biosolids product.	No
21	Upcycle & Co	Fresno	Jared Criscuolo / John Kasian	619-768-3556	Fertilizer Packager	Been packaging and selling the EWA product for some time. They sell in 4lb bags, with usage of 20-30 tons over the past few years. Stated that they are adding materials to fertilizer, but not nutrients. Selling in 40 + states in mass merchandisers.	Have done research on the product at Fresno State. Want to be using consistently, and find usage locations for extra product. They are interested in managing the product for EWA, and being one of the people taking 1,000 t, but not ready to guarantee yet.	Yes
22	WeCare / Denali	NYS	Jeff LeBlanc - President	315-374-5098	Broker / Biosolids mgt	Open to managing granule through creative distribution option, open to an introductory call. Discuss with him, Jeff Thurber (west coast VP) works for him.	Their plan would be for EWA to pay them to move the granules while developing market, leading to a cost neutral (or pay) service; 5 year contract. Discuss with him, not Jeff Thurber.	Yes
Granule Producers								
1	City of Corona	Corona	Tom Moody (GM), Frank Garza	951-736-2477 951-736-2234	Fertilizer Manuf'r	Produced 2,000 t/a, 6-6-0 product, called Pure Green. Operated a Siemens Water Technologies dryer. Burnt down because a build up of natural gas	Have been selling all to / through Nutrients-Plus. They did a good job. Expect to rebuild, RFP is taking a while. Could be 1-2 years to re-start.	N/A
2	IRWD	Irvine	Jose Zepeda	949-453-5572	Fertilizer Manuf'r	Starting their own Andritz system over the winter of 2019/20. Will produce approx. 3,600 t/a of a 4-3-0 or 5-3-0 product. Have spare processing capacity. Know EWA and do not want to compete with them.	IRWD is not intested at this point in discussing the management of excess EWA biosolids. They will not have internal sales staff for the product, are looking for off-take agreements. Unknown if they will be paid for the product in the short-term	No
3	Milorganite	Milwaukee, WI	Jeff Spence, Jamie Staufenbeil	414-221-6816	Fertilizer Manuf'r	Most famous biosolids fertilizer; sold for over 80 years. Producing 46-48,000 tons sold (selling out). Have interest in leveraging their brand; but will not move fast. Considering using brand to sell product that they do not produce, to gain distant supply and help the industry. Challenge - not all biosolids are the same.	They are a 6-4-0, 2.5 Fe% and 150 SGN. Could probably use a west of Rockies source of 5-10,000 t/a. Said the product does not necessarily have to have the same sizing or nutrient content. The efficacy of the product (do some research trials), consistency and long-term stabilitiy of the program is key. Sent sample and FU note, no success getting response.	Unknown
4	Pierce Cty Public Works	University Place, WA	Angelee Lillie	253-798-4005	Fertilizer Manuf'r	Produce 2,400 t/a of a 5-5-0 fertilizer product, Andritz technology. Call product "SoundGro". Sell product in bulk, 1 ton totes and 50 lb bags (in pallet quantities only).	All product is ordered on-line, are 9 companies reselling bags in WA. Pricing: loose tons- $66.36, totes - $85.95, pallet of bags - $300.38. Are selling out now.	N/A
5	SOFCO - Sacramento / Synagro	Elk Grove	Vino Bhatia - plant mgr, Bob Ford - sales	916-606-1803 323-843-7265	Fertilizer Manuf'r	Produce 7,300 t/a of 5-3-0 using an Andritz dryer. Have 100 tons of silo storage, but try not to use because of reheating. Coat some granules with oil.	Fertilizer blenders pay @$60-65/ton and farmers pay $20-25/ton, FOB. Facility does not run every week, so need to have order lead time. Sales guy is located in Bakersfield.	N/A
6	Ventura Regional Sanitation District	Oxnard	Chris Theisen (GM)	805-335-0146 805-658-4644	Fertilizer Manuf'r	Decommissioned many years ago	Was a Fenton dryer	N/A

TM 3 – Evaluation of Biosolids Management Options

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2022 Biosolids Management Plan Update

TM 3 – Evaluation of Biosolids Management Options

Final

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2022 Biosolids Management Plan Update

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Acronyms and Abbreviations

°C	degree(s) Celsius
24/5	24 hours per day, 5 days a week
24/7	24 hours per day, 7 days a week
AACE	AACE International
BEE	Biosolids, Energy and Emission Plan
BMP	Biosolids Management Plan
Btu/ft^3	British thermal unit(s) per cubic foot
C	carbon
C bescii	*Caldicellulosiruptor bescii*
CAMX	California and Mexico
CBHP	C. bescii hydrolysis process
CEPT	chemically enhanced primary treatment
CFR	*Code of Federal Regulations*
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DAFT	dissolved air flotation thickener
DG	digester gas
dT/d	dry ton(s) per day
EHH	enzymatic hyperthermophilic hydrolysis
EWA	Encina Wastewater Authority
EWPCF	Encina Water Pollution Control Facility
g CH_4/mi	gram(s) of methane per mile
g CH_4/MMBtu	gram(s) of methane per 1 million British thermal units
g CO_2e/g CH_4	gram(s) of carbon dioxide equivalent per gram of methane
g CO_2e/g N_2O	gram(s) of carbon dioxide equivalent per gram of nitrous oxide
g N_2O/mi	gram(s) of nitrous oxide per mile
g N_2O/MMBtu	gram(s) of nitrous oxide per 1 million British thermal units
GHG	greenhouse gas
HRT	hydraulic residence time
IC	internal combustion
ID	identification
kg/m^3	kilogram(s) per cubic meter
kg/MMBtu	kilogram(s) per 1 million British thermal units
kg CO_2/gal	kilogram(s) of carbon dioxide per gallon

kg CO_2/MMBtu	kilogram(s) of carbon dioxide per 1 million British thermal units
kg CO_2/MWh	kilogram(s) of carbon dioxide per megawatt
kg CO_2e/kg	kilogram(s) of carbon dioxide equivalent per kilogram
kg CO_2e/MMBtu	kilogram(s) of carbon dioxide equivalent per 1 million British thermal units
kWh	kilowatt-hour(s)
lb/h	pound(s) per hour
lb VS/ft^3/d	pound(s) of volatile solids per cubic foot per day
MAD	mesophilic anaerobic digestion
MMBtu/h	million British thermal units per hour
MMSD	Milwaukee Metropolitan Sewerage District
N_2O	nitrous oxide
NG	natural gas
O&M	operations and maintenance
PFAS	per- and polyfluoroalkyl substances
PMP	*Process Master Plan*
pygas	pyrolysis gas
RDD	rotary drum dryer
RDT	rotary drum thickener
RTO	regenerative thermal oxidizer
SB	State Bill
SRT	solids retention time
T/d	ton(s) per day
THP	thermal hydrolysis process
TM	technical memorandum
TS	total solids
U.S.	United States
USD	United States dollar(s)
VS	volatile solids
VSLR	volatile solids loading rate
WAS	waste activated sludge
WECC	Western Electricity Coordinating Council
wT	wet ton(s)
wT/d	wet ton(s) per day
wT/y	wet ton(s) per year

1. Introduction

As part of the Encina Wastewater Authority (EWA) 2022 Biosolids Management Plan (BMP) Update, Jacobs was tasked to perform an evaluation of biosolids management options considering current practices, the regulatory outlook (Technical Memorandum [TM] 1), and an updated portfolio of biosolids outlets in the region reported in TM 2.

Jacobs reviewed the analysis of the current practices and the revised biosolids projections for the Encina Water Pollution Control Facility (EWPCF) developed in Task 1 and reported in TM 1. The analysis highlighted the limited additional capacity in the digesters to have a redundant process meeting 40 *Code of Federal Regulations* (CFR) 503 Class B biosolids quality beyond 2025 if one digester is out of service and the process is challenged with 14-day peak loading conditions.

An important conclusion of the market research previously reported in TM 2 was the limited demand for cake material, either in the form of 40 CFR 503 Class A or Class B biosolids, and the potential for expanding outlets for pelletized product, especially if the current dry product reheating issues are resolved. The current biosolids management approach at EWPCF is based on digestion followed by thermal drying. This approach means these two processes inherently rely on each other: the digestion capacity and performance impacts loadings to the dryer, while dryer capacity can provide redundancy to the digestion process.

The Project Team, consisting of Jacobs and EWA staff, evaluated a wide range of biosolids management options that address these main challenges and opportunities, leveraging previous work conducted by EWA in the past 6 years. As is further described in this TM, management options selected for analysis include a combination of digestion optimization and postdigestion processes, such as thermal drying (drum dryers and belt dryers) and carbonization (pyrolysis and gasification).

This TM documents the development and selection of the potential biosolids management options that resulted in the recommended alternative. In Task 4, a strategic implementation plan was developed for this alternative. The evaluation for this TM included a preliminary screening of technologies based on Jacobs' recommendations and EWA's previous work.

This screening led to the development of management themes, each with a range of potential management alternatives. These alternatives were ranked by their alignment with EWA's priorities. The weighted nonmonetary criteria developed in Task 1 (TM 1) provided the basis for evaluation of those management alternatives that lead to reliable and redundant process and biosolids product outlets and other criteria including:

- Safety
- Ease of operation and serviceability
- Future regulatory risk
- Potential for public impacts
- Environmental sustainability

The evaluation resulted in three biosolids management alternatives selected for comparison with the Base Case (current practice) and with the alternative scoring the highest in the evaluation using the nonmonetary criteria. This comparison included high-level conceptual cost estimates for capital, operations and maintenance (O&M), and lifecycle costs that were incorporated into a benefit to cost ratio in combination with the nonmonetary criteria scores.

2. Identification of Appropriate Technology Solutions

2.1 Preliminary Screening

The many different biosolids stabilization technologies can be classified into one of six overall categories:

1) Anaerobic digestion
2) Aerobic digestion
3) Composting
4) Drying
5) Chemical stabilization
6) High-temperature conversion

Within these categories, there are many different technology solutions, as shown on Figure 3-1. Solutions for EWPCF do not have to be from only one category. Using multiple different technologies can potentiallly lead to effective biosolids management approaches. EWA's currently used technologies of mesophilic anaerobic digestion (MAD) and direct thermal drying are highlighted in green on Figure 3-1. This figure presents the currently available biosolids stabilization technology options.

A range of technology options was reviewed in the *Process Master Plan* (PMP) (Carollo 2016) and again in detail during development of the *Biosolids, Energy and Emission Plan* (BEE) (Brown and Caldwell 2018). Figure 3-2 shows the BEE's technology screening framework. The BEE review shortlisted enhanced digestion options, with the focus of increasing energy production, and adding drying capacity and chemical stabilization, as technologies considered for the creation of end-to-end alternatives.

In this 2022 BMP Update, Jacobs and EWA staff revisited the currently available stabilization technologies for a preliminary screening and to identify changes since the BEE was delivered. On Figure 3-3, the options in gold are those considered for further evaluation in this TM under biosolids management alternatives using the nonmonetary criteria developed in TM 1. The blue option represents emerging technology that was not part of the previous plans and that could be considered by the EWPCF.

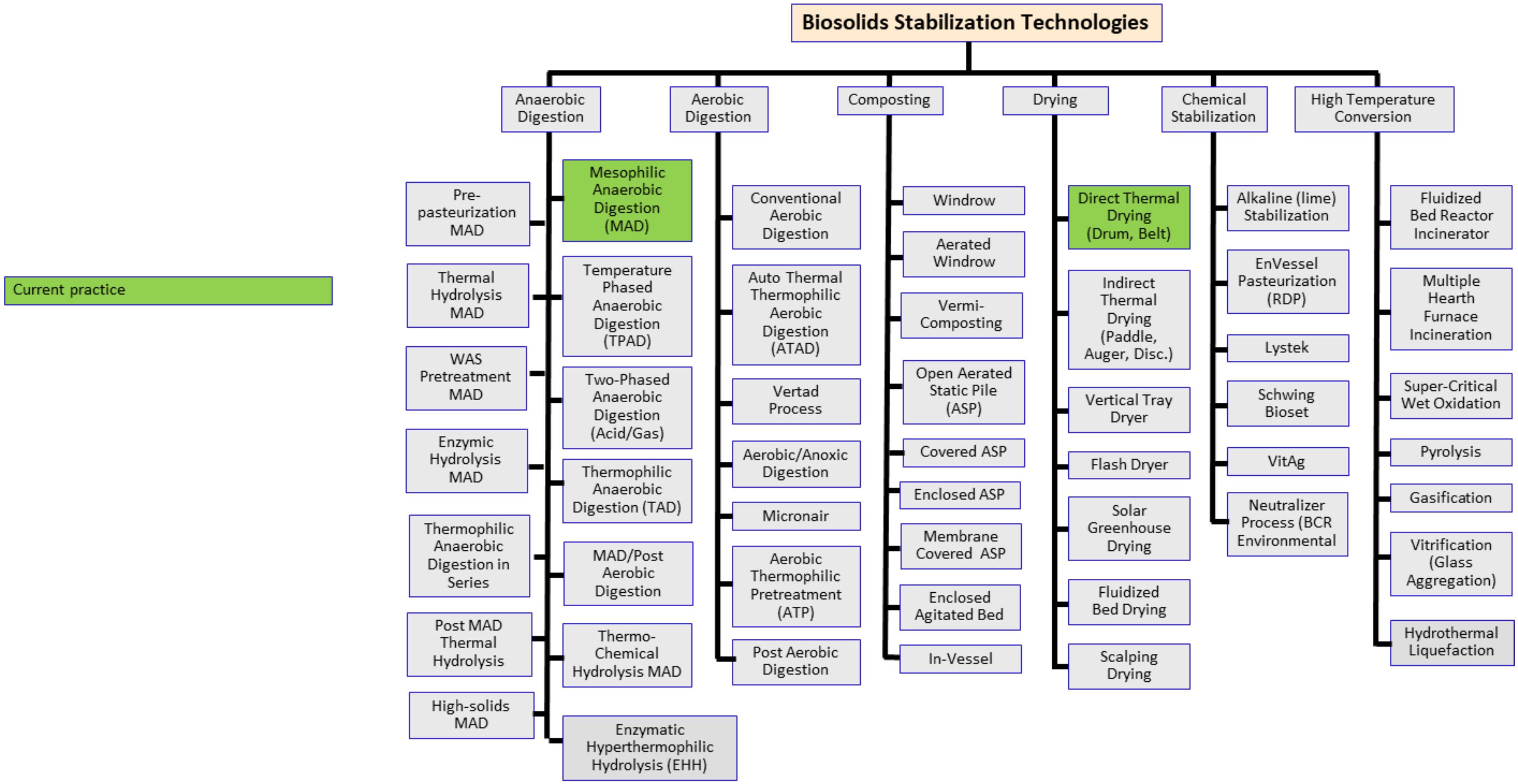


Figure 3-1. Currently Used Biosolids Stabilization Technology Options

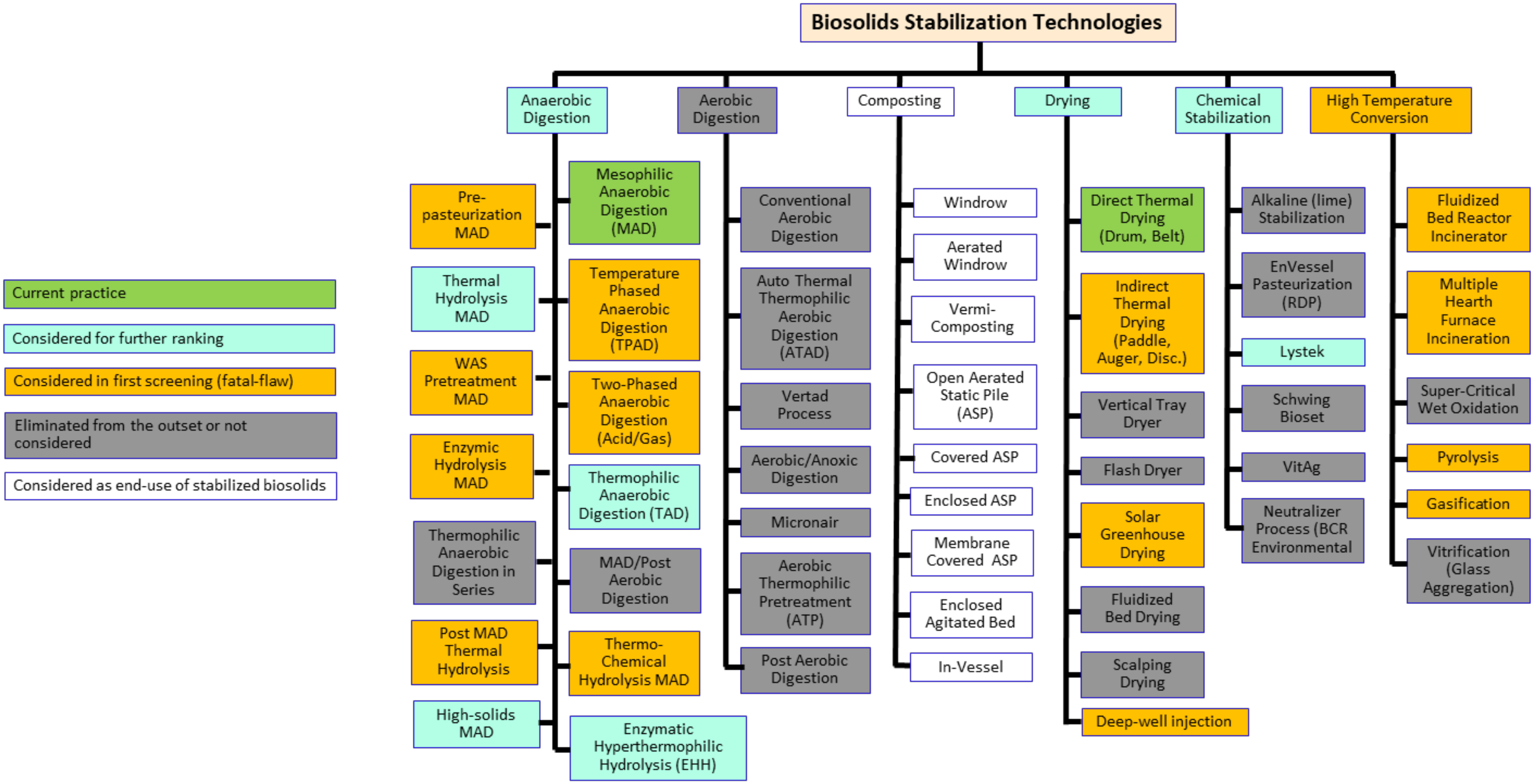


Figure 3-2. 2018 Biosolids Stabilization Technology Options

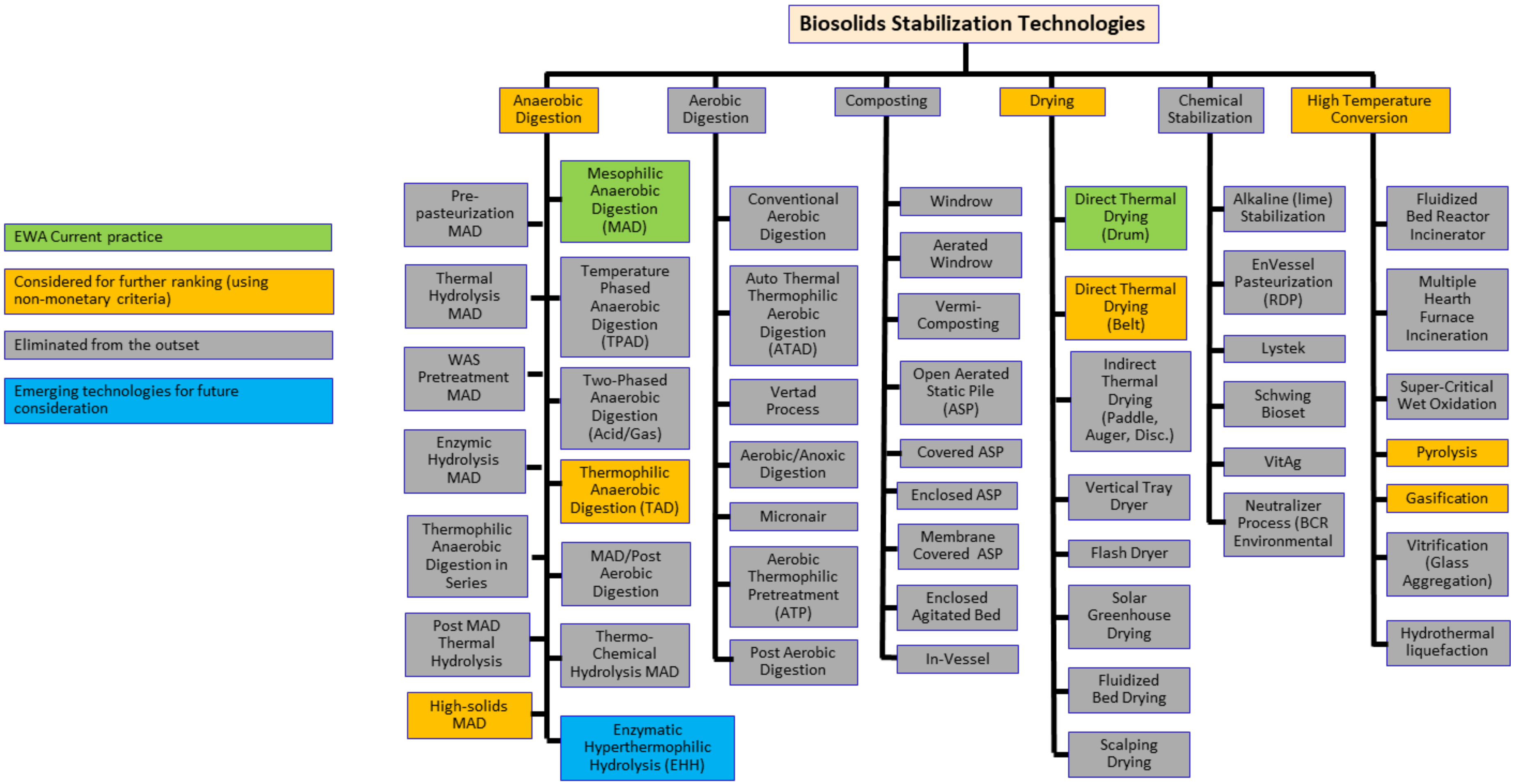


Figure 3-3. 2021 Biosolids Stabilization Technology Options

At the outset of this evaluation, several technologies were eliminated due to their fatal flaws, including aerobic digestion, chemical stabilization, incineration, thermal hydrolysis processes , and composting. These results are consistent with previous studies that EWA staff have developed, including:

- Aerobic digestion was eliminated because it is considered energy intensive and does not align with EWA's goals for energy optimization.
- Chemical stabilization is not able to yield a marketable product, so it was eliminated.
- Incineration was not considered practicable in the region due to perceived permit and public acceptance risk.
- THP was removed because it is considered disruptive to the current solids process, and it is not compatible with the existing drying process, nor is there a local market for Class A cake biosolids.
- Composting was not considered as a potential alternative to be implemented onsite given space limitations.

The preliminary screening resulted in technology options for anaerobic digestion optimization, including:

- Current conventional MAD
- Thermophilic anaerobic digestion
- High-solids mesophilic digestion
- Hyperthermophilic enzymatic hydrolysis

Options for postdigestion optimization included:

- Direct thermal drying with drum dryer
- Direct thermal drying with belt dryer
- High-temperature conversion after drying using pyrolysis or gasification

These technology options are briefly described in the following subsections and are the basis of the biosolids management alternatives evaluated in Section 3.

2.2 Technology Descriptions

2.2.1 Anaerobic Digestion Options

The anaerobic digester options use existing digester capabilities with greater efficiency and capacity to provide a reliable and redundant process to produce Class B biosolids quality and effectively reduce solids loading to the dryer. This would include options that increase total digester volume, such as the addition of a new Digester 7 or reactivating digesters 1, 2, or 3 (or a combination of these). Increasing digester volume by itself will not introduce new technology to the EWPCF but will increase the overall digestion capacity.

New or additional solutions to improve digestion could include:

- Improving thickening with rotary drum thickeners (RDTs) to operate digesters as high-solids MAD
- Incorporating recuperative thickening for high-solids MAD to operate digesters as high-solids MAD
- Upgrading digesters to operate at thermophilic temperatures
- Upgrading to enzymatic hyperthermophilic hydrolysis (EHH)

Upgrading predigestion thickening with RDTs could increase the feed solids concentration to greater than 6% total solids (TS), which could require upgrades to mixing and feed pumping but would allow the digesters to process more solids while maintaining the required 15-day solids retention time (SRT).

High-solids MAD is commonly based on implementing recuperative thickening; this technology decouples the hydraulic residence time (HRT) from the SRT. This can allow for higher SRTs at the same HRT. This decoupling is achieved by manipulating the waste from the digester through physical separation (thickening) and returning a portion of the digester solids back to the digester.

Thermophilic digestion requires a shorter SRT for biosolids operation, down to 10 days under peak conditions. It also allows for increased organic loading rate of 0.3 pound of volatile solids per cubic foot per day (lb VS/ft^3/d), which nearly doubles the average annual capacity for mesophilic digestion. Thermophilic digestion allows for a greater hydraulic flow due to the lower required residence time, while also being able to handle higher volatile solids (VS) loading than a typical mesophilic system. However, it does require a higher operating temperature that will require additional heating and has not been performed at EWA previously.

A further enhancement to optimize digestion is EHH, which uses a hyperthermophilic (heated to 75 degrees Celsius [°C]) bacteria called *Caldicellulosiruptor bescii* (C bescii) that is capable of hydrolyzing cellulose and other recalcitrant solids. The C bescii hydrolysis process (CBHP) uses enzymes to hydrolyze recalcitrant solids and enable their digestion in mesophilic or thermophilic digesters. EHH would work as an integral process with the existing digestion process to greatly increase VS reduction and biogas production, and reduce the residual biosolids. However, this is a new technology that must be tested and proven before it is considered for full-scale implementation at EWA.

2.2.2 Drying

Biosolids are currently dried with thermal drying using a drum dryer. The major benefits of thermal drying include reduction of volume and the production of a Class A product that can be marketed. Drying technologies considered include a drum dryer (current practice) and a belt dryer. Currently at EWPCF, there is a drum dryer able to produce uniform biosolids pellets. A challenge in marketing these pellets effectively is finding contractors that will work with EWA to manage their potential to reheat, which was identified in TM 2 and is further discussed in Section 3.

Operation of a thermal belt dryer involves pumping cake of about 22% solids concentration through a die to generate pastilles with a good surface to volume ratio to improve the drying process. The pastilles are dropped on a stainless-steel belt and gently moved through the dryer while the cake is heated. The moisture in the cake is gradually evaporated and removed from the system by circulating dry air. The final dried products are irregular granules that are greater than 90% solids concentration. Belt dryers do require a larger footprint but are not as tall as the rotary drum dryer (RDD) alternatives.

The belt-dried product differs from the current pellet product produced from the drum dryer. The thermal belt dryer operates at lower air temperatures compared to other thermal dryers and is considered safer and less expensive, better fitted to take recovered heat, and has moderate complexity compared to other thermal drying options, such as RDDs. One belt dryer manufacturer (Andritz) offers backmixing, which produces a granule very similar in size and characteristic to that produced by an RDD; whereas, other belt dryers do not offer this advantage and produce an irregular-shaped, dried product, which is generally less desirable as a soil amendment product.

2.2.3 High-temperature Conversion

High-temperature (typically 450 to 900°C) conversion can be achieved in a noncombustion process without oxygen using dried biosolids (greater than 90% TS) as a feedstock to produce an energy-laden pyrolysis gas (pygas) and a charcoal-like material referred to as char. Operation at the higher end of the temperature range with partial oxidation leads to gasification, which produces higher pygas quantities and minimum amounts of ash-like material that could be land applied.

An important benefit of these high-temperature conversion alternatives is that they ultimately produce an energy-laden pygas that can be used to run the pyrolysis system and possibly the sludge dryer. The char produced reportedly (Grand View Research 2019) has significant value in the marketplace for use in agriculture or other applications, such as a supplemental fuel in cement kilns. This technology continues to emerge as a solution to high disposal costs, energy efficiency, and treatment of emerging contaminants. Globally, there are a few operating facilities, including three commercial installations in the United States (U.S.), with capacity ranging from 14 to 36 wet tons per day (wT/d). Other facilities have run demonstration trials, and there are a number of facilities in design or construction.

A recently determined benefit of this alternative (Kundu et al. 2021) is that high-temperature conversion processes have been found to eliminate the emerging contaminant class of per- and polyfluoroalkyl substances (PFAS) from the dried biosolids so that the char produced is virtually PFAS free. High-temperature conversion can be considered as part of the planned upgrades immediately but can also be added later to respond to future regulatory requirements to reduce or remove PFAS from the biosolids.

3. Potential Alternatives for Biosolids Management

3.1 Biosolids Management Themes

Considering the prescreened technology solutions, a list of biosolids management options that would meet EWA's goals was developed. The Jacobs Team crafted these options considering feedback from EWA staff to evaluate the potential implementation with actions in the short-term (0 to 6 years), midterm (7 to 9 years), and long-term (10+ years). This led to more potential alternatives.

To add clarity to the development process, a set of biosolids management themes was designed encompassing the technology groups (Figure 3-4). The resulting six themes provide increasingly improved enhancements from maintaining the Base Case (no action) to management alternatives that could bring the most benefits (without considering cost at this stage) to the EWA Biosolids Management Program.

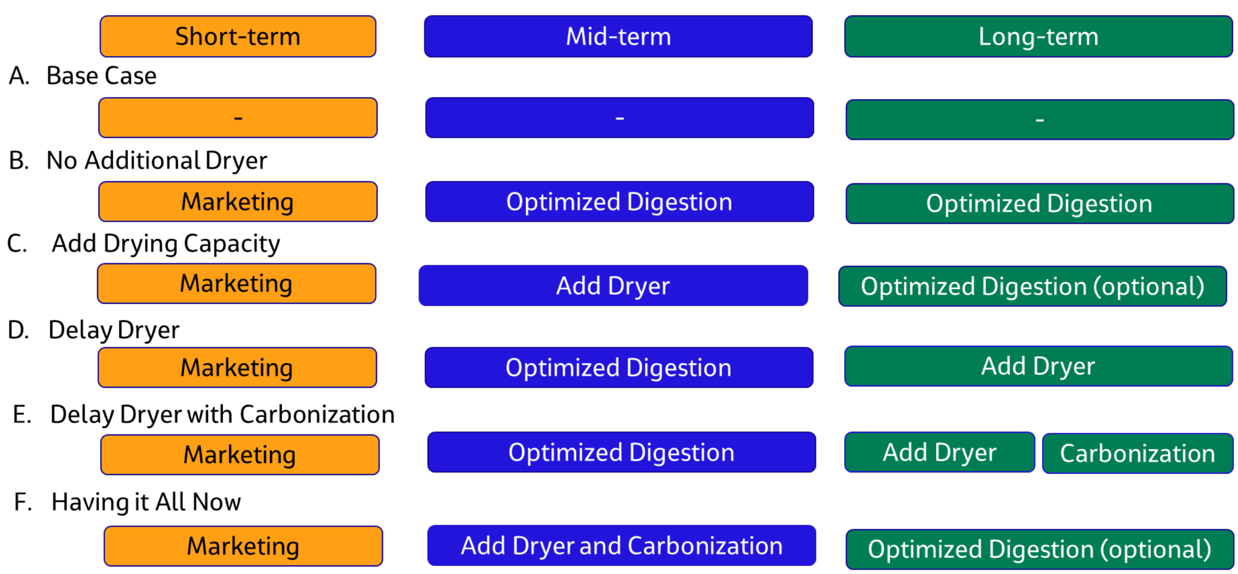


Figure 3-4. Biosolids Management Themes

Short-term implementation strategies included those related to dried product marketing identified in TM 2, such as engaging with potential brokers to expand biosolids outlets and evaluating the potential to address product reheating issues.

3.1.1 Managing Reheating Potential

Reheating dried biosolids has been acknowledged by EWA and some other facilities that produce a dried biosolids product. To Jacobs' knowledge, there are no definitive answers as to the source of dry biosolids reheating (or self-heating). A potential source is the reaction with iron species in the product. Operations at EWPCF uses chemically enhanced primary treatment (CEPT) with the addition of ferric chloride to aid settling. This ferric is carried through the solids processing, benefiting biogas quality by precipitating iron sulfides. Prior to CEPT, ferric was added directly to the digesters for sulfide control. There is evidence that, under specific storage conditions of residence time, temperature, moisture, and oxygen levels, ferric sulfide can be oxidized in an exothermic reaction, causing the temperature increase (Bertani et al. 2016).

Iron addition is of benefit to the overall EWPCF operation. However, an alternative to ferric chloride, such as alum for CEPT, could be evaluated from the perspective of CEPT performance, biogas quality, and dried product reheating. Alum does not have the same sulfide bonding capabilities as ferric, so micro-aeration in the anaerobic digesters could be implemented to improve digester gas (DG) quality by reducing hydrogen sulfide concentrations.

Jacobs also contacted facilities with known reheating issues in their dry product to gather information on mitigation practices. Milwaukee Metropolitan Sewerage District (MMSD) has successfully marketed biosolids dry granules under their Milorganite brand name, and they have managed self-heating challenges by adjusting storage times and temperatures in their dry product silos, in addition to maintaining a nitrogen blanket in the silos to prevent oxidation. Milorganite is packaged onsite in 40-pound bags, and bulk material is also shipped in railcars to other states for bagging without reheating issues. Similar to EWA, one of the plants that provide feedstock for the production of Milorganite uses ferric salts for CEPT and, in addition, add ferric to aid dewatering.

Additional options for addressing reheating issues at EWPCF could be adding dry product storage flexibility and a product cool-down step before storing in the silos. However, this would require additional equipment and systems, and a modification in operation.

Early discussions with potential end users of the dry product indicate that reheating could also be addressed in how the material is handled after it leaves the plant. For this evaluation, it is assumed that dried product reheating potential will be discussed with future haulers, and safety considerations will be addressed appropriately.

3.2 Biosolids Management Alternatives

A list of 21 alternatives (Table 3-1) under the presented themes was generated, ranging from no modifications being made, to solutions that could provide the most benefits (without considering cost) to the EWA biosolids program with different mid- and long-term phasing implementations. These alternatives were subjected to an evaluation using the nonmonetary criteria developed in Task 1 to determine how each management alternative complies with EWA's priorities.

Table 3-1. Potential Biosolids Management Alternatives

Theme	Alternative ID	Alternative Description
Base Case	0	Do not make any short-term modifications.
No additional dryer	1	Rehabilitate and operate digesters 1 and 3 in the midterm.
	2	Build a new Digester 7 the same size as digesters 4 and 5 in the mid- to long-term.
	3	Improve thickening systems (RDTs) to operate digestion at higher solids concentrations in the mid- to long-term.
	4	Implement recuperative thickening in digesters 1 and 3 in the mid- to long-term.
	5	Implement recuperative thickening in digesters 4, 5, and 6 in the mid- to long-term.
	6	Operate digester 4, 5, and 6 as thermophilic digesters in the mid- to long-term.
	7	Incorporate digesters 1 and 3 as thermophilic digesters.
	8	Rehabilitate digesters 1, 2, and 3 in the midterm; upgrade them to thermophilic in the future.
Add drying capacity in the midterm	9a	Add a second drum dryer at the 2040 100% estimated capacity demand in the midterm.
	9b	Add a second dryer (belt dryer) at the 2040 100% estimated capacity demand in the midterm.
	10	Add a second dryer (whichever scores higher from 9a and 9b using nonmonetary criteria) in the midterm; optional consideration to operate digesters 4, 5, and 6 as thermophilic digesters in the long-term.
Delay additional dryer	11	Improve thickening in the midterm; add a second dryer (whichever scores higher from 9a and 9b using nonmonetary criteria) in the long-term.
	12	Operate digesters 4, 5, and 6 as thermophilic in the midterm. Add a second dryer in the long-term.
	13	Operate EHH in the midterm. Add a second dryer in the long-term.
Delay additional dryer with carbonization	14	Improve thickening system in the midterm; add a second dryer and carbonization in the long-term.
	15	Operate digesters 4, 5, and 6 as thermophilic in the midterm; add a second dryer and carbonization in the long-term.
Have it all now	16	Add drying, pyrolyzing, and gasifying in the midterm; improve the thickening system in the future.
	17	Add drying, pyrolyzing, and gasifying in the midterm; operate digesters 4, 5, and 6 as thermophilic in the long-term.
	18	Add drying, pyrolyzing, and gasifying in the midterm.

ID = identification

3.3 Nonmonetary Criteria Scoring

After the potential solutions (alternatives) discussed in Section 3.1 were presented and understood by the EWA Team during a weighting meeting as part of this Task 3 effort, the next activity was for Jacobs to score these potential solutions using the nonmonetary criteria developed and weighted during Task 1 (TM 1 provides a full description and weights for each criterion). This scoring was achieved in a collaborative process using a scale of 0 to 5, where 5 was the highest score, and all alternatives were compared.

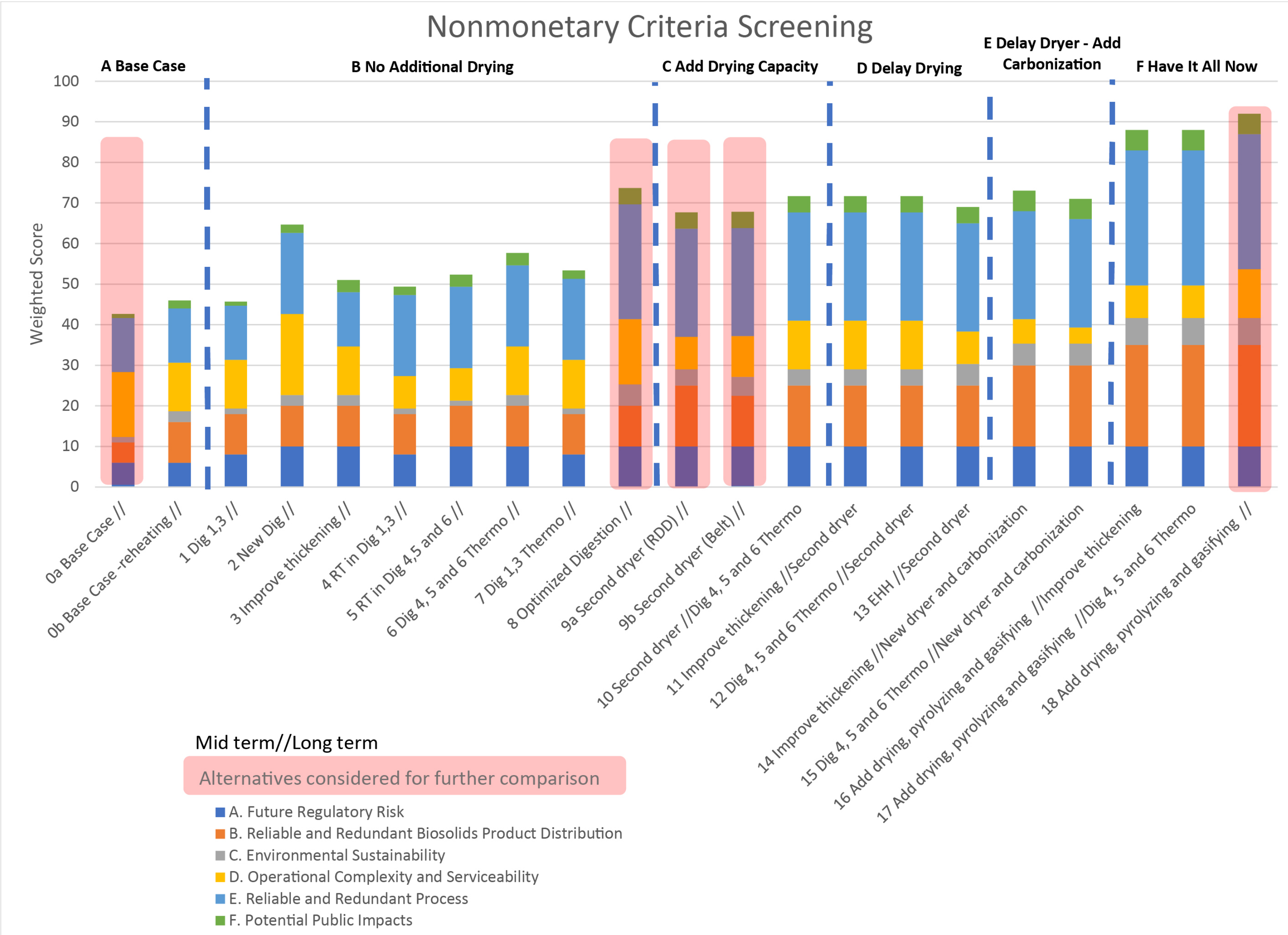
The results of this exercise incorporated the EWA's values (weighted nonmonetary criteria) into the comparison of potential solutions, as illustrated on Figure 3-5. Results were presented to EWA staff to highlight the advantages and disadvantages that each of the 21 alternatives would bring to the overall Biosolids Management Program. Some important observations from this exercise include the following:

- There is a noticeable trend between themes, showing the benefits of moving toward increasing drying capacity compared to alternatives with increased Class B cake biosolids production during the planning period. This is mainly due to the high scores on highly weighted criteria, such as reliable and redundant process, and reliable and redundant biosolids product distribution.
- The Base Case alternatives scored the lowest overall, but had high scores for operational complexity and serviceability because they are known processes that EWPCF staff are familiar with. The possibility of not providing enough redundancy in the process to meet Class B would increase EWA's risk of having to landfill a portion of the solids when maintenance is required in one of the existing digesters. In addition, increase in production of Class B cake given limited drying capacity could potentially limit the ability to beneficially reuse all biosolids produced.
- In general, optimized digestion scored high on operational complexity and serviceability when compared to alternatives incorporating drying and carbonization. Yet the overall score of digestion optimization alone was lower due to the expected increase in production of Class B cake and the additional volume needed to be hauled and distributed.
- Being a reliable and redundant process is a highly weighted criterion, and alternatives that increase digestion capacity received higher scores than the Base Case; alternatives that considered adding drying capacity and those within the Have It All Now theme also scored even higher under this criterion, with the assumption that the solution would be sized to meet full loading capacity, with additional redundancy provided by the existing drum dryer.
- Potential for public impacts was assessed from the perspective of truck traffic and product quality (odors). Under this criterion, alternatives that decrease the overall tonnage of material to be hauled with higher-quality product received higher scores.

This scoring methodology highlights the potential of different alternatives to match EWA priorities without considering cost, and it is not necessarily a process where the highest scored alternatives are the ones to be further compared to develop cost estimates. Instead, the alternative selection was made through a collaborative discussion between the Project Team (EWA and Jacobs) to identify clearly separate options that would provide a comparison of the scores for each process by itself. Appendix 3A provides the detailed results of this scoring process.

This process resulted in EWA staff selecting three main alternatives to evaluate, with two additional alternatives to provide bookends for management options, as follows:

- Main alternatives selected for further evaluation:
  - Alternative 8: Rehabilitate digesters 1, 2, and 3 in the midterm; upgrade them to thermophilic in the future.
  - Alternative 9a: Add a second drum dryer at the 2040 100% projected capacity demand in the midterm.
  - Alternative 9b: Add a belt dryer at the 2040 100% projected capacity demand in the midterm.
- Bookend alternatives selected for further evaluation along with main alternatives:
  - Alternative 0: Base Case, no short-term modifications are implemented.
  - Alternative 18: Add drying, pyrolyzing, and gasifying in the midterm.



Note: Table 3-1 provides a detailed description of each alternative.

Figure 3-5. Nonmonetary Criteria Scoring Results

4. Selected Alternatives Descriptions

Following the selection of the alternatives to further compare using monetary criteria, it is important to detail the characteristics that led to their further consideration. The rest of this report describes these considerations under the same framework, showing an alternative description, major modifications involved, layouts, and characteristics as they relate to the nonmonetary criteria.

Greenhouse gas (GHG) emissions were chosen by the Project Team as the environmental sustainability metric, using a relative comparison of each alternative's carbon footprint. The methodology for this GHG accounting is described in this section, along with specific assumptions for each alternative.

Biosolids production projections defined in Task 1 were further reviewed under this task to properly compare the selected treatment processes and biosolids management options. The mass balance for solids production based on plant data showed higher loadings to the digesters than estimated using biosolids hauling data and normal digestion performance reported in TM 1. Figure 3-6 shows the comparison of these projections for solids and hydraulic loadings to the digestion process. Deeper analysis and discussion with the Project Team concluded that, for this project, the most reliable data for evaluating hydraulic loadings comes directly from the flow meters in the solids stream (plant data), while solids loadings would be more reliably evaluated using the solids weights leaving the plant (hauling data).

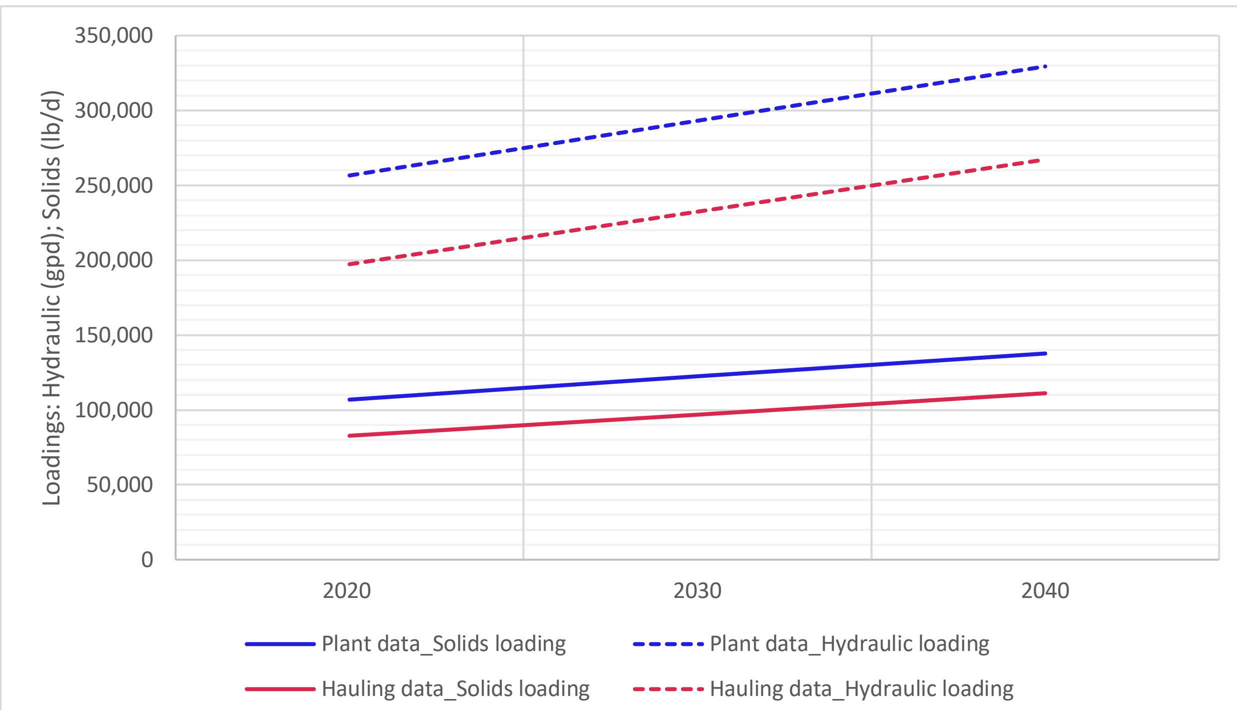


Figure 3-6. Comparison of Digester Loading Projections using Hauling and Plant Data

gpd = gallon(s) per day
lb/d = pound(s) per day

To account for the uncertainty in the measurements, a sensitivity analysis was conducted to estimate process capacity in each alternative, GHG emissions (Section 4.1), and O&M costs (Section 5). The sensitivity analysis used both scenarios and considered both hauling and plant data.

Worth noting is the opportunity to further investigate the sources of uncertainty in the loadings, as future planning and potential designs will need to include accurate data. Common sources of uncertainty are flow measurements based on pump capacities and uncalibrated flow meter totalizers, as well as sludge sampling locations.

4.1 Greenhouse Gas Accounting Assumptions

GHG emissions were estimated for each alternative considering the sources and sinks represented for each unit process. These sources and sinks are described in this section and classified under their respective categories (or scopes).

Sources:

- GHG Emissions Scope 1:
  - Natural gas (NG) combustion and incomplete combustion, including:
    - Internal combustion (IC) engines
    - Dryer and regenerative thermal oxidizer (RTO)
    - Flare
  - Fugitive emissions, (including from incomplete combustion of DG):
    - IC engines
    - Dryer
    - Flare
  - Biogas combustion is not included in net emissions, as these emissions are considered biogenic (of biological origins)
- GHG Emissions Scope 2:
  - Purchased electricity (assumes energy for solids processing is not met by IC engines)
- GHG Emissions Scope 3:
  - Chemical use (polymer for dewatering)
  - Fuel use (biosolids hauling only; chemical delivered is not considered in this exercise, as it is negligible)

Sinks:

- Beneficial reuse of biosolids, including:
  - Carbon sequestration
  - Fertilizer offset

GHG emission estimates are shown for the five selected alternatives using biosolids production estimates considering hauling data (Figure 3-7) and plant data (Figure 3-8). Estimates are an annual average for the entire planning horizon calculated using projected 2030 average flows and loads. These results provide a relative comparison of the alternatives, and the two figures show the sensitivity of different biosolids projections. Results are further discussed for each alternative in the following subsections.

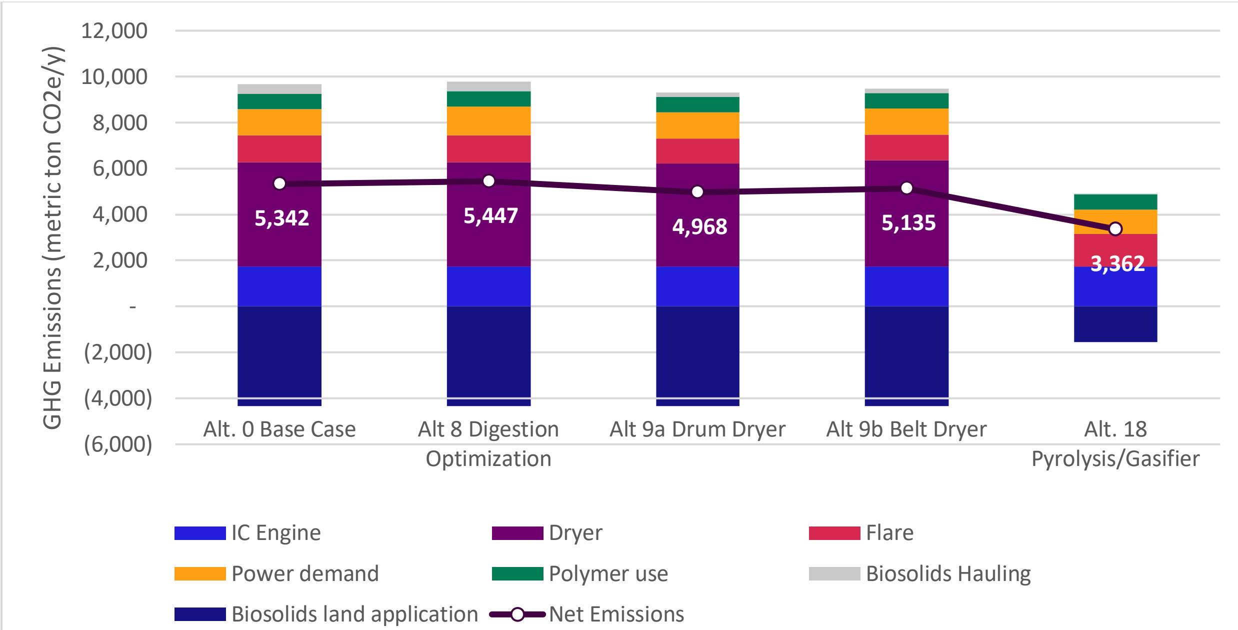


Figure 3-7. Greenhouse Gas Emission Estimates for the Selected Alternatives Based on Hauling Data.
Note: Annual average emissions through the planning horizon (using 2030 projected average flows and loads).

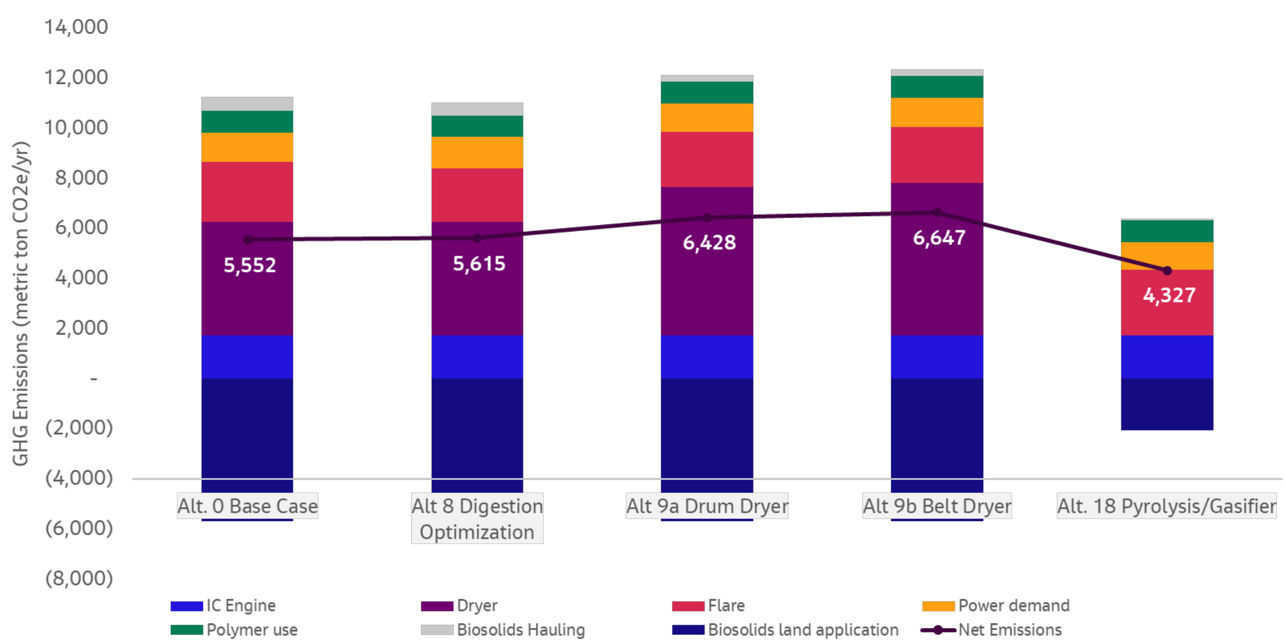


Figure 3-8. Greenhouse Gas Emission Estimates for the Selected Alternatives Based on Plant Data.
Note: Annual average emissions through the planning horizon (using 2030 projected average flows and loads).

Emission factors for the different sources and sinks within wastewater treatment facilities can vary greatly, depending on the literature cited and specific site conditions. For this planning-level GHG accounting, Table 3-2 lists the recognized and updated emission factors used for this evaluation.

Table 3-2. Greenhouse Gas Emission Factors

GHG Emission Factors	Value	Unit	Source
Polymer Production Emissions	9	kg CO_2e/kg polymer	(SYLVIS 2009)
NG Production and Combustion Emissions	53.06	kg CO_2/MMBtu	(TCR 2020)
	0.037	g CH_4/MMBtu	(TCR 2020)
	0.035	g N_2O/MMBtu	(TCR 2020)
	53.07	kg CO_2e/MMBtu	Calculated
Biogas Combustion Emissions	52.01	kg CO_2e/MMBtu	(TCR 2020)
Land Application -C Sequestration	-0.25	kg CO_2e/kg dry biosolids	(SYLVIS 2009; Brown et al. 2010)
Land Application -Fertilizer Offset	-0.23	kg CO_2e/kg dry biosolids	(SYLVIS 2009; Brown et al. 2010)
Landfill Emissions (CO_2, CH_4, N_2O)	1.48	kg CO_2e/kg dry solids	Brown et al. 2010
Electricity Generation Emissions (CAMX - WECC California)	240.4	kg CO_2/MWh	(EPA 2018)
Diesel Fuel	10.21	kg CO_2/gal	(EPA 2018)
	0.0051	g CH_4/mi	(EPA 2018)
	0.0048	g N_2O/mi	(EPA 2018)
IC Engine CH_4 Emissions	1.5%	% of total CH_4 fed	(Willis et al. 2017)
Candlestick Flare CH_4 Emissions	5%	% of total CH_4 fed	(Willis et al. 2017)
Dryer CH_4 Emissions	1.5%	% of total CH_4 fed	Assume same as IC engines
Biogas CH_4 Composition	15.892	kg/MMBtu	Assumes 1.25 kg/m^3, 600 Btu/ft^3, and 60% CH_4
NG CH_4 Composition	25.162	kg/MMBtu	Assumes 0.75 kg/m^3, 1000 Btu/ft^3, and 95% CH_4
CO_2e	25	g CO_2e/g CH_4	(TCR 2020)
	265	g CO_2e/g N_2O	(TCR 2020)

Btu/ft^3 = British thermal unit(s) per cubic foot
C = carbon
CAMX = California and Mexico
CH_4 = methane
CO_2 = carbon dioxide
CO_2e = carbon dioxide equivalent
g CH_4/mi = gram(s) of methane per mile
g CH_4/MMBtu = gram(s) of methane per 1 million British thermal units
g CO_2e/g CH_4 = gram(s) of carbon dioxide equivalent per gram of methane
g CO_2e/g N_2O = gram(s) of carbon dioxide equivalent per gram of nitrous oxide
g N_2O/mi = gram(s) of nitrous oxide per mile
g N_2O/MMBtu = gram(s) of nitrous oxide per 1 million British thermal units
kg CO_2/gal = kilogram(s) of carbon dioxide per gallon
kg CO_2/MMBtu = kilogram(s) of carbon dioxide per 1 million British thermal units
kg CO_2/MWh = kilogram(s) of carbon dioxide per megawatt
kg CO_2e/kg = kilogram(s) of carbon dioxide equivalent per kilogram
kg CO_2e/MMBtu = kilogram(s) of carbon dioxide equivalent per 1 million British thermal units
kg/m^3 = kilogram(s) per cubic meter
kg/MMBtu = kilogram(s) per 1 million British thermal units
N_2O = nitrous oxide
WECC = Western Electricity Coordinating Council

Currently, Class A granules and Class B cake are land applied in Yuma, Arizona; to account for the potential of developing more local markets for Class A granules, which would reduce the transportation GHG emissions, different distances were assumed for land application of Class A dry product (300-mile round trip, the distance from EWPCF to El Centro, California) and land application of Class B cake material (400-mile round trip, the distance from EWPCF to Yuma, Arizona). This estimated mileage was based on potentially large users identified during Task 2, not including the most optimistic market in San Diego. Overall, the emissions from biosolids hauling are the lowest contributors in this analysis, as shown on Figures 3-7 and 3-8.

For the GHG analysis, it was assumed that a maximum 20% of the dryer heat demand was supplied by DG for all options. The RTO uses only NG.

For the GHG analysis, it was assumed that all options use the maximum quantity of Class A pellets produced based on the dryer capacity, resulting in alternatives 0 and 8 producing a reduced quantity of Class A pellets based on the capacity of the existing dryer, whereas alternatives 9A and 9B have capacity for 100% Class A pellets.

4.2 Alternative 0, Base Case

Alternative 0 represents the Base Case scenario, where no additional upgrades to solids handling are implemented at EWPCF. It is considered one of the bookend alternatives to provide reference to the three main alternatives under evaluation. This case involves operating with limited capacity and redundancy in the drying and digestion processes.

Figure 3-9 shows the projected hydraulic and organic loading to the digestion process using plant and hauling data. The horizontal lines signify operating conditions using design volatile solids loading rates (VSLRs), while the red and blue lines are projections, both annual average and peak 14 day. For both projections, the digesters are limited with one out of service to handle the peak 14-day scenario. This scenario occurs when a digester is removed from service for cleaning and maintenance. The plant data shows the design criteria to maintain redundancy not being met beyond 2025; similarly, the design criteria to meet capacity are not met beyond 2035. Redundancy is an important parameter for scoring using the nonmonetary criteria, given that this alternative could lead to the production and landfilling of material that does not meet Class B requirements, and will not comply with the State Bill (SB) 1383 regulation related to organic waste emissions reductions.

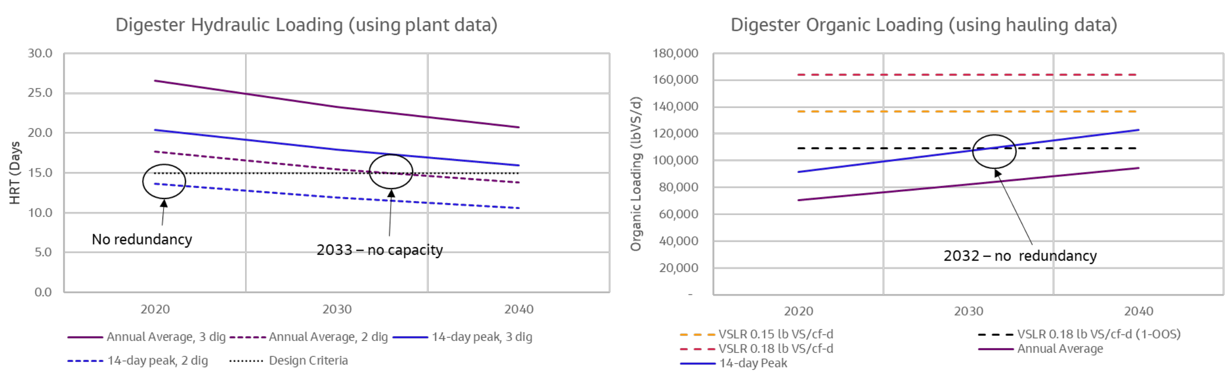


Figure 3-9. Projected Hydraulic and Organic Loading to Digestion Process

Note: Plant and hauling data are shown.

dig = digester
lb VS/d = pound(s) per volatile solids per day
OOS = out of service

It is assumed that the existing dryer is used to maximize the production of Class A biosolids. However, the existing dryer cannot deliver redundant and reliable Class A biosolids distribution, given the limited drying capacity and the need to operate at less than 80% uptime (11 days online and 3 days offline). This leads to the production of Class B cake biosolids, and the amount will only continue to increase as the solids loadings increase over time. As such, the potential for public impacts due to the increase in truck traffic will increase as well.

Risks of future regulations, such as limitations on land application of Class B biosolids in Arizona, although unlikely, but not impossible, and regulations on biosolids land application related to PFAS, would not be mitigated under this management alternative. If only Class B biosolids were produced in this alternative (that is, the dryer was not operated), the GHG emissions would be considerably less than if producing a Class A dried product that consumes NG.

GHGs are reported on Figure 3-7 and 3-8 from the nonmonetary criteria perspective. The overall emissions are primarily from the NG consumption in the dryer, which in 2020, accounted for 89% of the dryer gas demand, including the RTO (TM 1). From a safety perspective, this alternative is a well-known solution for EWA staff, and the only consideration is the increase in truck traffic and potential increase in foul odors as more material needs to be hauled. Figure 3-10 shows the projected amounts of biosolids generated and truck traffic.

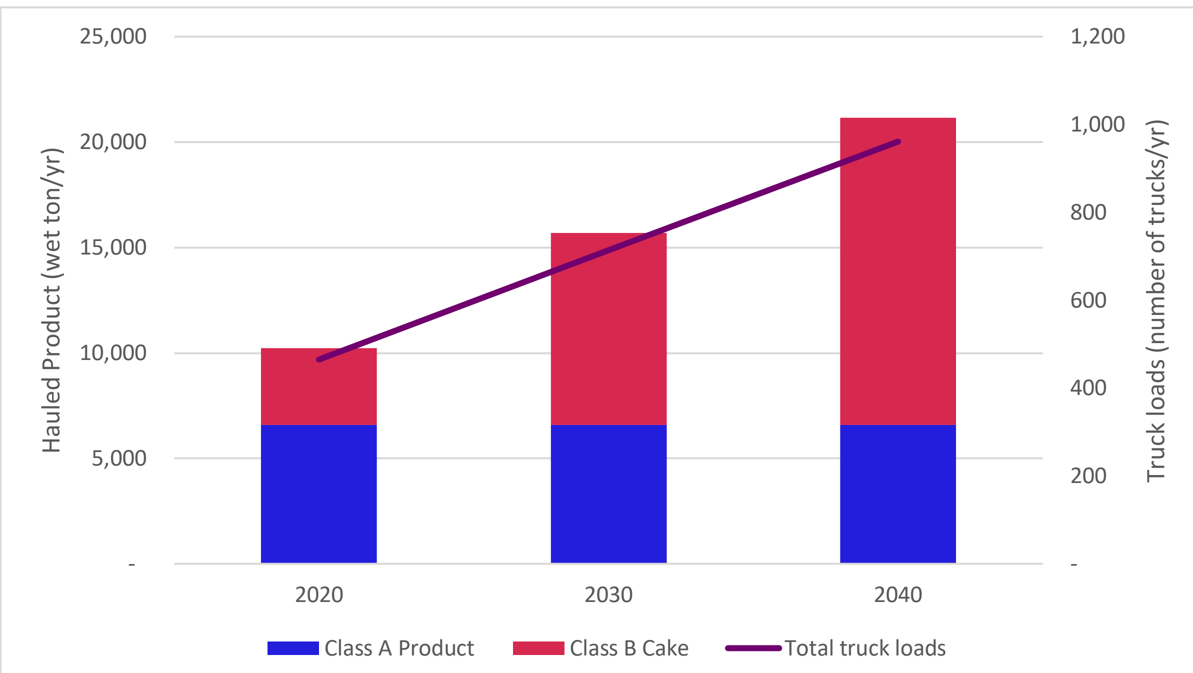


Figure 3-10. Biosolids Production Projection and Truck Traffic for Alternative 0 Base Case

Note: Hauling data were used as the base for projections; assumes 22 tons per truck load.

Figure 3-11 shows an aerial of the EWPCF site under the Base Case with no modifications. Continuing operation of the dryer through the end of the current planning horizon (2040), will require reconditioning of the drum surface, safety upgrades, and other major components. The BEE (Brown and Caldwell 2018) also highlighted the potential need for improvements in the Class B cake loadout, odor control, and traffic management improvements.

Source: Aerial photo courtesy of EWA

Figure 3-11. Encina Water Pollution Control Facility

4.2.1 Class A and Class B Evaluation

EWA is interested in applying the evaluation criteria and developing an economic analysis of two scenarios for operation of the current Biosolids Management Program, using hauling data from 2020:

1) **Class B production.** This scenario considers hauling and handling of Class B cake only, meaning that the dryer is offline, and no dried granules are produced. Potential benefits include not operating and maintaining the dryer, which results in less NG and electricity use. Drawbacks to consider are the increase in total wet tons of biosolids to be disposed of, the resulting increase in truck traffic, and the potential for odor complaints due to product quality.
2) **Class A production.** This scenario considers hauling and handling a combination of Class B cake and Class A granules using the current drum dryer. This would require significantly less hauling when compared to the Class B production scenario, but this scenario does require O&M of the dryer.

The evaluation of Class A and Class B focused on the cost of operating and maintaining the dryer and the disposal cost. Assumptions include:

- The two scenarios are defined starting from the dewatered cake.
- The cost of power required to operate the dryer is included in the analysis.
- 20% of the dryer heat demand (excluding the RTO) is met with DG.

Figure 3-12 shows the results of this comparison for 2020 hauling data. At 2020 costs for NG, hauling, and handling, operating the dryer results in a slightly higher cost than production of Class B cake only. These results are comparable to those reported by Raftelis (2018), adjusted for 2020 costs.

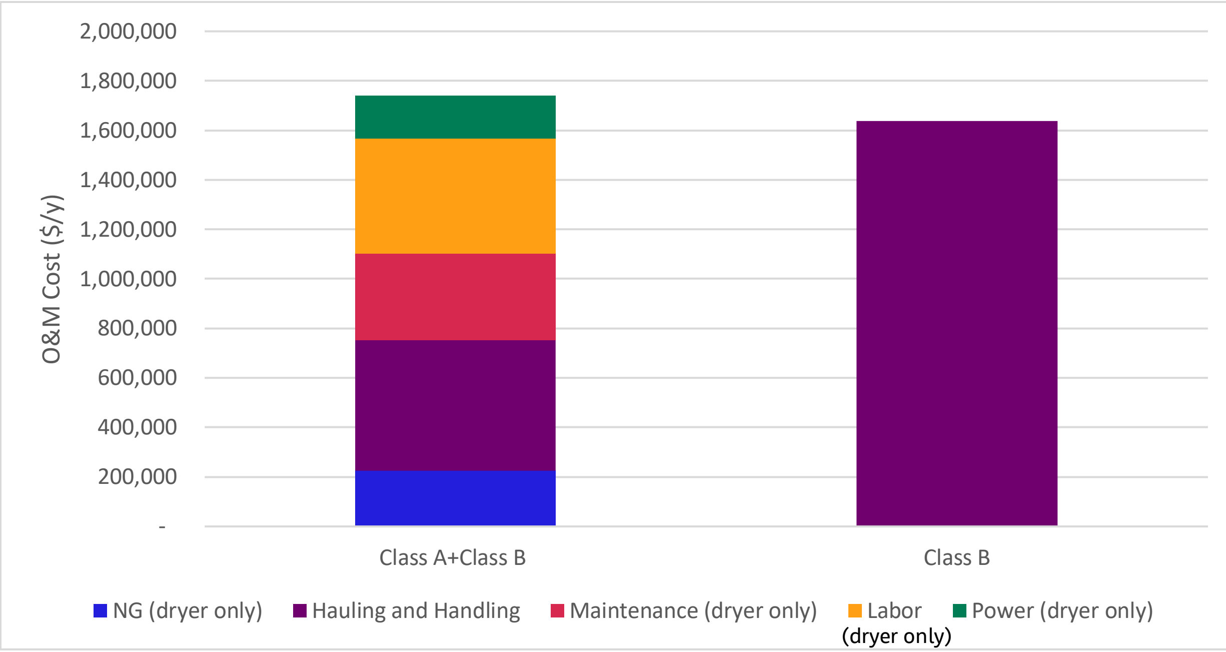


Figure 3-12. Economic Comparison – Production of Class B Cake Only and with Class A Granules

Note: Based on 2020 hauling data

In addition, GHG emissions from both alternatives were estimated and compared on Figure 13 for 2020 hauling data, showing that the use of NG by the dryer results in higher GHG emissions than the increase in hauling of Class B cake.

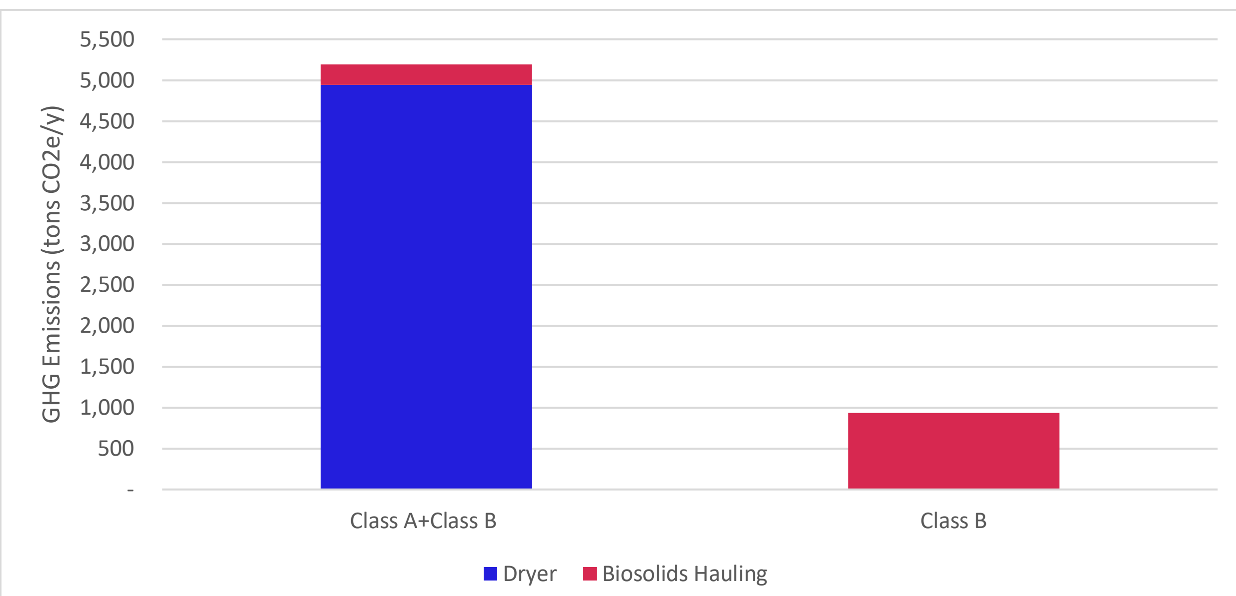


Figure 3-13. Greenhouse Gas Emission Comparison – Production of Class B Cake Only and with Class A Granules

4.3 Alternative 8, Rehabilitate Digesters 1, 2, and 3 with Provisions for Thermophilic Digestion

Alternative 8 considers adding digestion volume to increase redundancy and reliability of the solids stabilization process to meet Class B requirements throughout the planning horizon, based on the hauling data solids loading projections. Under Alternative 8, digesters 1, 2, and 3 would be rehabilitated and placed into operation as MAD digesters in the midterm, which will provide capacity and redundancy through 2037. Figure 3-14 compares digestion capacity and redundancy between Alternative 0 and this Alternative 8 with all digesters operating at mesophilic temperatures.

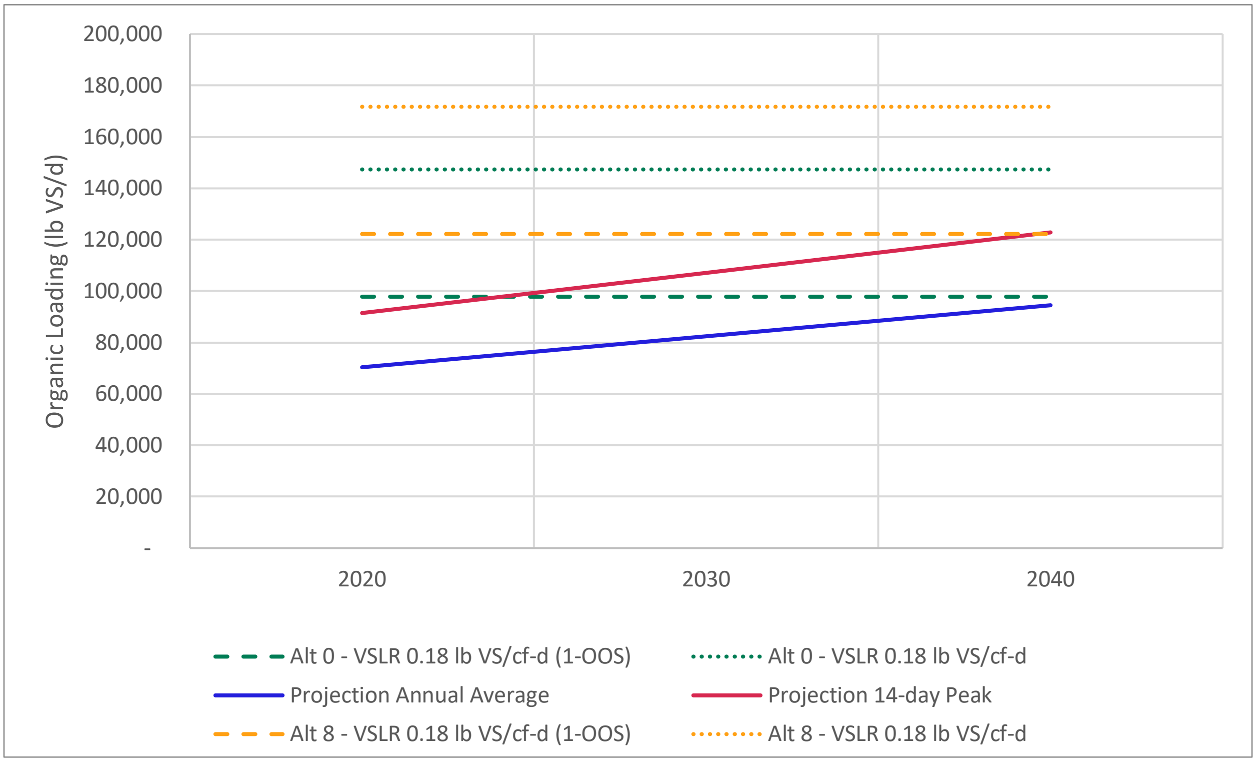
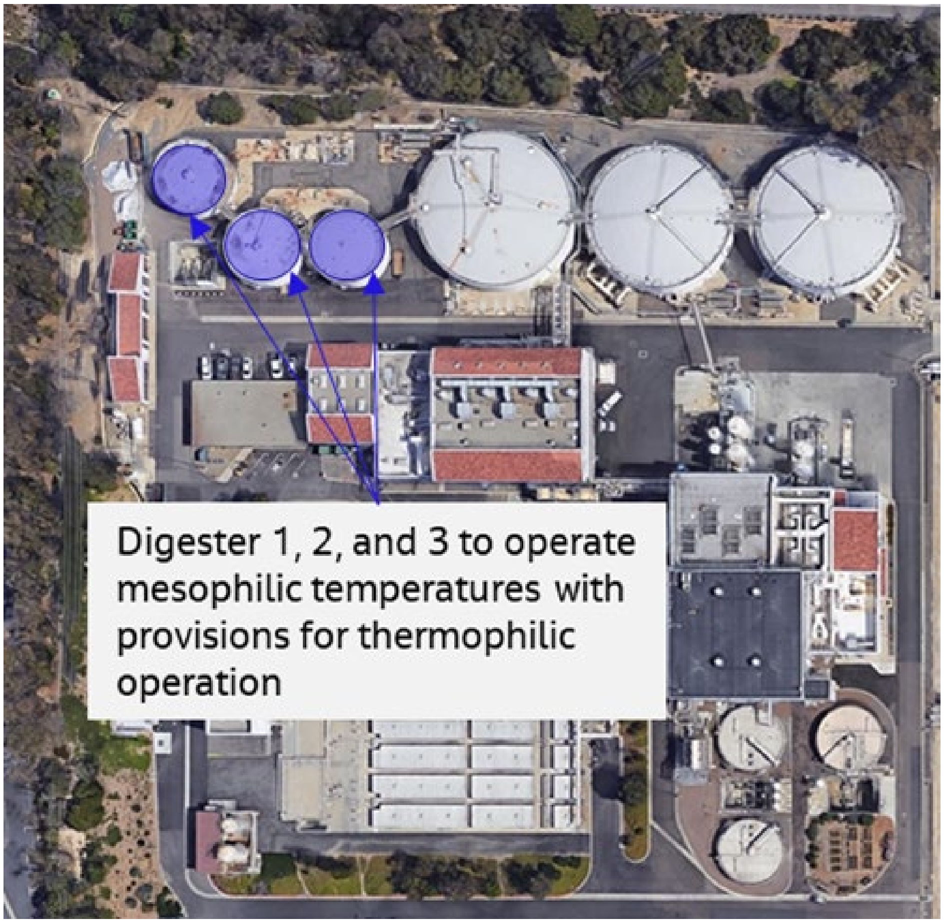


Figure 3-14. Capacity Comparison of Alternative 0 and Alternative 8

Notes: Based on hauling data

This option includes provisions to operate at temperatures for thermophilic digestion in the long-term to meet capacity needs beyond 2037. Operating these three digesters at thermophilic temperatures provides flexibility to use EHH, but would require an additional blending tank prior to dewatering. The costs and benefits of EHH are not included in this evaluation.

Heat exchanger capacities would need to be increased, as well as digester insulation to minimize heat losses. A structural evaluation will be required to determine the capability of the existing digesters to handle thermophilic and hyperthermophilic temperatures (55-80°C). Current mesophilic operation of digesters 4, 5, and 6 use waste heat from the IC engines to heat the sludge to digestion; and it is likely that the heat demand for operating digesters 1, 2, and 3 in thermophilic mode could be met using excess recovered heat. No changes to the capacity or operation of the existing drum dryer are considered beyond reconditioning of the drum surface and other major components, as described for Alternative 0, Base Case. Figure 3-15 shows the layout for Alternative 8.



Aerial photo courtesy of EWA

Figure 3-15. Alternative 8, Thermophilic Digestion in Digesters 1, 2, and 3

By rehabilitating digesters 1, 2, and 3 and operating in mesophilic temperatures in the midterm and thermophilic temperatures when additional capacity is required, this alternative provides EWA with a more reliable and redundant digestion process through the planning horizon, which increases its benefits under the nonmonetary criteria. However, not addressing drying capacity decreases the potential benefits in terms of reliable and redundant biosolids product distribution, potential for public impacts (truck traffic), and future regulatory risks (land application of Class B and PFAS); and increases the operational complexity over Alternative 0, given the added number of tanks and associated mechanical equipment.

Safety considerations for Alternative 8 include the operation of higher temperatures in the digestion process in the long-term. However, this is not of significant concern because this process is known to EWA's staff. The EHH process is still under development, including evaluating its safety considerations beyond operating digesters at temperatures higher than thermophilic digestion. Estimated GHG emissions from Alternative 8 (Figure 3-7) are similar to Alternative 0. The use of the additional DG produced in these digesters could improve the GHG emissions balance but was not considered in this evaluation.

4.4 Alternative 9a, Addition of a New Thermal Drum Dryer

Alternative 9a would increase drying capacity within the next 5-10 years to meet projected maximum month solids loadings through 2040, assuming 22% TS in the feed digester cake and 94% TS in the dried product. Operation is assumed to be 24 hours per day, 5 days a week (24/5). Technology similar to the existing drum dryer was considered. The new equipment would have capacity to process the entire loadings through 2040.

Table 3-3 presents the design criteria for the second dryer using hauling data to estimate 2040 loadings. Should the plant data based on projected loadings be used, the proposed dryer sizing could meet the throughput demand by operating 24 hours per day, 7 days a week (24/7).

Table 3-3. Alternatives 9a and 9b Design Criteria for Second Dryer [a]

Design Load	2040 Maximum Month
Technology	Drum dryer (Alt 9a), Belt dryer (Alt 9b)
Schedule	24/5
Solids loading per unit, dT/d (24/5 schedule)	44.4
Feed solids concentration, %	22
VS content, % of TS	68
Wet solids loading per unit, T/d	201.6
Target solids concentration, %	92
Evaporation rate, lb/h	12,780

Source: Jacobs 2022

[a] Hauling data were used to estimate solids production.

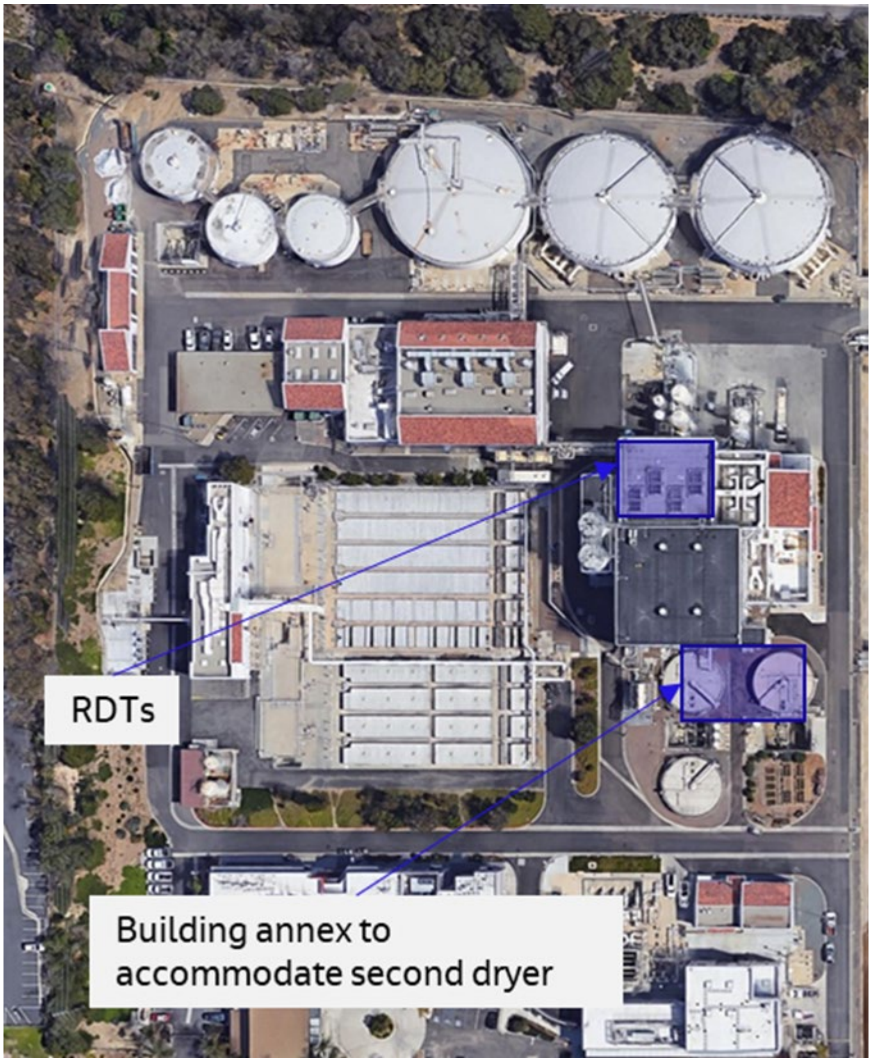
Notes:

Solids loading was based on actual hauling data from 2020, 7000 dT/y x 1.23 peaking factor for maximum month x 1.343 estimate factor to 2040 /365 days/y x 7/5 days of operation (peaking factors and projections per the BEE).

Alt = alternative
dT/d = dry ton(s) per day
lb/h = pound(s) per hour
T/d = ton(s) per day

Andritz technology is considered for this planning-level comparison; their DDS-60 model meets the total throughput required as opposed to the smaller DDS-40 currently operated at the EWPCF. The current drying building includes provision for a second dryer of the same size; however, previous evaluations (Brown and Caldwell 2018) determined there is not enough space to allow dryer maintenance. Moreover, the selected design criteria for this second dryer would require a larger footprint. To account for this, a building annex could be added adjacent to the existing building to accommodate the new equipment, and it would need to extend over the existing dissolved air flotation thickeners (DAFTs). As such, RDTs would be needed to thicken waste activated sludge (WAS) before feeding to digestion. Figure 3-16 shows the layout for this alternative.

Under this alternative, the potential impacts of not providing optimized digestion to address possible future redundancy issues in meeting Class B through digestion is mitigated by sizing the dryer system to accommodate the full 2040 maximum month loads. However, this alternative does not provide the additional digester redundancy to mitigate EWA Operations' concerns to improve solids processing stabilization when one digester is out of service.



Aerial photo courtesy of EWA

Figure 3-16. Alternative 9a, Drum Dryer

Alternative 9a greatly improves the reliable and redundant process for creating a Class A product and biosolids product distribution scores compared to the Base Case (Alternative 0) and Digestion Optimization (Alternative 8). Currently, EWPCF operates with only a single dryer system that needs to be periodically shut down for maintenance or unexpected issues. During these shutdowns, Class B cake is hauled for land application. The addition of a second dryer of the proposed size will provide additional drying capacity and redundancy during these periods and throughout the planning horizon.

The operational complexity and serviceability aspect scored lower than the Base Case and Alternative 8, as it involves adding complex new equipment, which also increases the risk from a safety perspective. However, the technology is known to EWA staff, and with less TS being hauled, there will be less truck traffic.

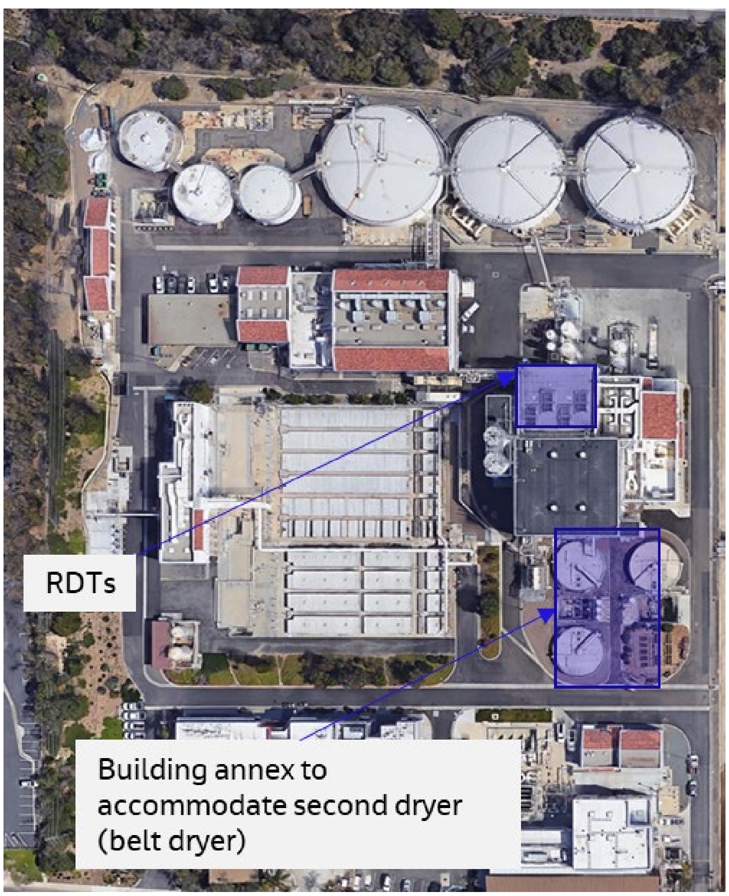
Future regulatory risks on land application of Class B biosolids would be mitigated by the 100% production of Class A material. If PFAS in biosolids were to become an issue, drying on its own may not be able to address this future regulatory risk.

Figure 3-7 shows the results of GHG emissions for this alternative. Higher energy demand would be expected for processing larger amount of biosolids; however, vendor data suggest (Commerford, pers. comm. 2021) that the DDS-60 model requires less energy per pound of water evaporated (including the RTO) as compared to the existing DDS-40 operated at the EWPCF. As such, Alternative 9a results in heat demand similar to the Base Case throughout the planning horizon. Fewer overall tons of material hauled would decrease the carbon footprint of this alternative when compared to the emissions from hauling in the Base Case and Alternative 8, although not enough to significantly lower overall emissions. However, if higher loadings are considered, as estimated using plant data, the increase in biosolids amounts through the drying process would require more NG, thus resulting in more GHG emissions.

4.5 Alternative 9b, Addition of a New Belt Dryer

Alternative 9b is similar to 9a, as it considers providing additional drying capacity to meet solids loading through 2040 but differs in the technology selection, with a new belt dryer working together with the existing drum dryer. Belt dryers are simpler to maintain and operate than an RDD, and this contributes to this alternative's higher score in operational complexity and serviceability than Alternative 9a. This alternative also provides slightly better reliability and redundancy in the process compared to using a new drum dryer.

However, Alternative 9b would require a new annex dryer building compared to Alternative 9a and would come into conflict with all DAFT units at EWPCF. This is considered in the cost estimate in Section 5 by adding RDTs to thicken WAS. Figure 3-17 shows a layout of Alternative 9b.



Aerial photo courtesy of EWA

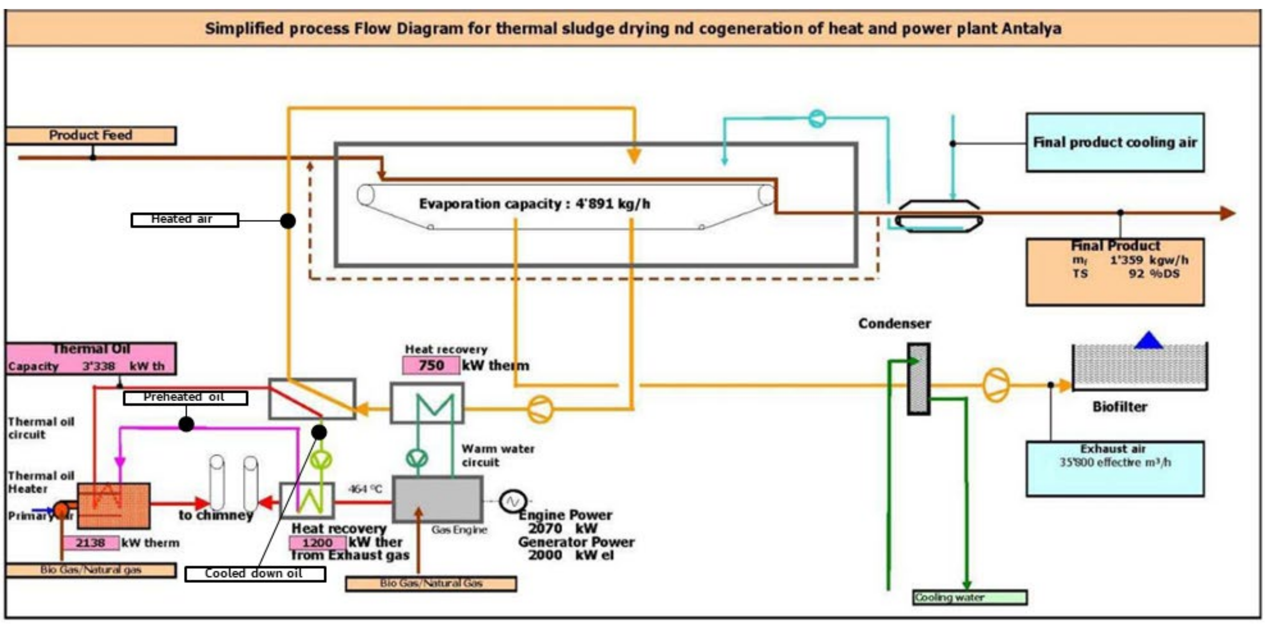
Figure 3-17. Alternative 9b, Belt Dryer

Table 3-3 summarizes the design criteria for the belt dryer in Alternative 9b. As mentioned in Section 2.2.2, belt dryers are safer to operate than drum dryers; however, training would be required, as it's a new technology for EWPCF staff. Characteristics for this alternative in terms of nonmonetary criteria (potential for public impacts and future regulatory risk) are similar to those for Alternative 9a.

GHG emissions are similar to those in Alternative 9a (using a drum dryer), given that a belt dryer would most likely also require an RTO in California for emissions control; this RTO requires NG, with an overall energy demand similar to that reported for the drum dryer. However, given the lower operating temperatures, belt dryers have the potential to incorporate alternative heat sources, such as heat recovered from the IC engines at EWPCF.

Based on the BEE (Brown and Caldwell 2018), there's about 4.8 million British thermal units per hour (MMBtu/h) of excess heat from the IC engines that can be available to offset some of the dryer heat demand. Currently, heat from the IC engines jacket water and exhaust at EWPCF is recovered in the plant hot water loop; typical temperature from this water loop is approximately 99°C as compared to the belt dryer-required inlet air temperature between 120 and 150°C. Direct heat recovery from engine exhaust has been implemented in other facilities but requires proximity between the engine exhaust and the dryer, which is not the case at the EWPCF. A two-step approach using the hot water loop from the jacket water and separate heat recovered from the engines exhaust has been in use since 2008 in Antayla, Turkiye.

Figure 3-18 shows a diagram of this application, where almost 50% of the dryer heat demand is offset by this recovery system; this result is considered system specific. Implementing a comparable approach for Alternative 9b using a belt dryer at the EWPCF would require further investigation to determine actual potential for heat demand offset, and expansion of the hot water loop from the IC engines to the dryer building. The benefits would include a reduction in NG purchase and GHG emissions.



Source: Courtesy of Andritz.

Figure 3-18. Thermal Sludge Drying Process and Cogeneration of Heat and Power Plant, Antalya, Turkiye

4.6 Alternative 18, Integrated Drying, Pyrolysis, and Gasification

The results from the nonmonetary criteria scoring shows Alternative 18 is the highest scoring alternative evaluated. It has been included in this comparison to provide a second bookend reference point in addition to the Base Case, Alternative 0. Alternative 18 involves an all-in-one, Have It All Now solution for postdigestion, with a system able to produce dried product (drying), biochar (pyrolysis), or ash (gasification); and that, under the pyrolysis and gasification mode, is also able to produce the energy that the process demands.

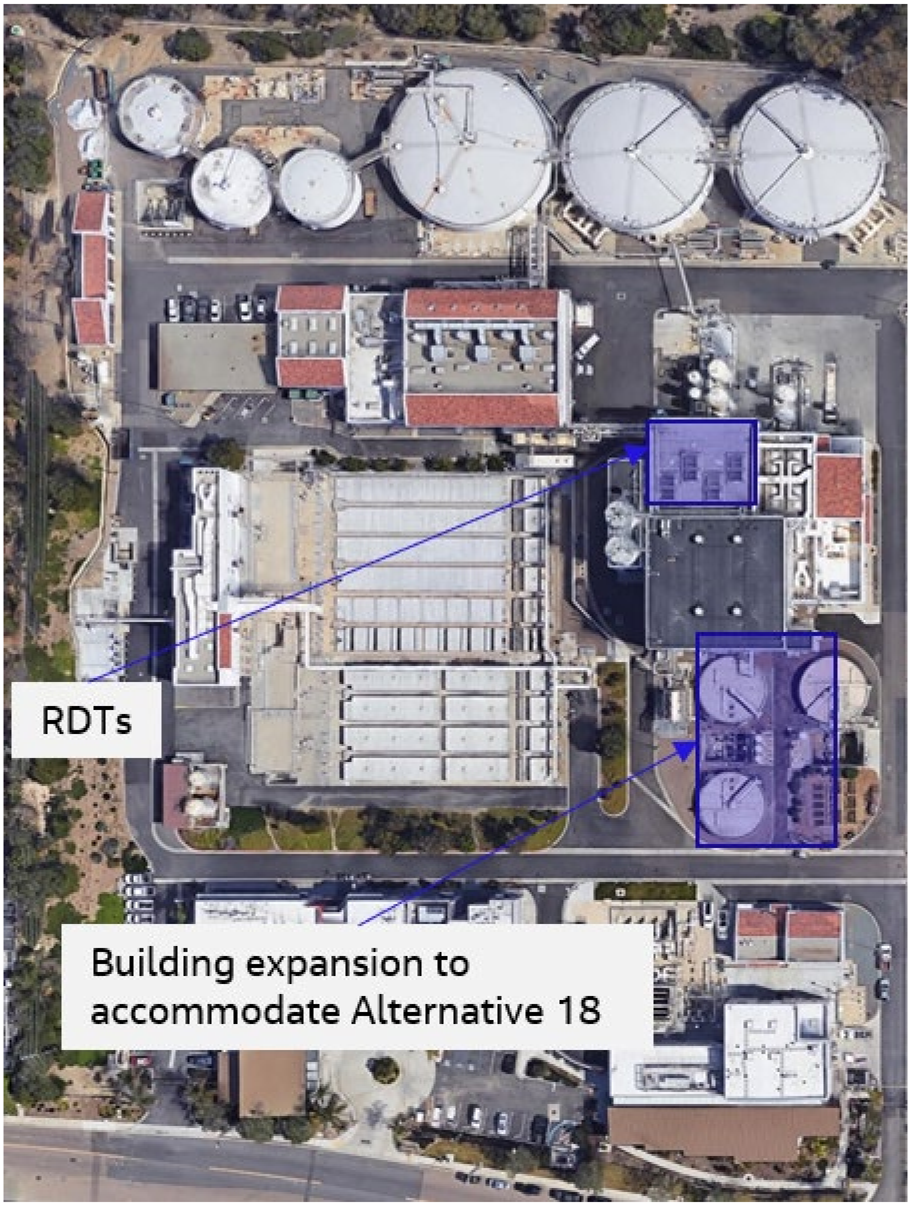
This alternative is expected to be the most expensive, as described in Section 5. However, it is included in this comparison given the benefits it would provide to the EWA Biosolids Management Program. Similar to alternatives 9a and 9b, the potential impacts of not providing optimized digestion for addressing possible future redundancy issues in meeting Class B through digestion is mitigated by sizing the system to accommodate the full 2040 maximum month loads using hauling data to estimate 2040 loadings. The system is sized to operate under a 24/5 schedule. Should the estimated loadings based on plant data be used, the proposed dryer sizing could meet the throughput demand by operating 24/7, which would not allow adequate downtime for the needed periodic maintenance.

Table 3-4 summarizes the design criteria for processing solids under this alternative. This alternative would require a larger footprint than Alternative 9a but is similar to Alternative 9b, with the belt dryer impacting the DAFT system in a similar way and requiring RDTs. Figure 3-19 shows the expected required footprint.

Table 3-4. Alternative 18 Design Criteria for Integrated Drying, Pyrolysis, and Gasification System[a]

Design Load	2040 Maximum Month
Technology	Dryer and gasifier trains
Schedule	24/5
Solids loading per unit, dT/d (24/5 schedule)	42.27
Feed solids concentration, %	22
VS content, % of TS	68
Wet solids loading per unit, T/d	192.0
Dryer evaporative capacity, lb water/hr	12,255
Target solids concentration, %	94 for dried product, and100 for biochar and ash

[a] Hauling data were used to estimate solids production.



Aerial photo courtesy of EWA

Figure 3-19. Alternative 18, Integrated Drying, Pyrolysis, and Gasification

Alternative 18 includes redundancy built in, as two trains would be provided. This, in addition to overall system sizing, provides the highest scoring alternative in reliable and redundant processes. The flexibility to produce either marketable dry material, biochar, or ash means the alternative provides reliable and redundant biosolids product distribution and lessens the potential for public impacts. Future regulatory risks are also mitigated by including technology that has been shown to address PFAS in biosolids (Kundu et al. 2021).

This alternative does score lower in operational complexity and serviceability compared to Alternative 0 (Base Case) and Alternative 8 (Thermophilic Digestion in Digesters 1, 2, and 3), given the new technology because access to spare parts and service may not be as readily available as the current drum dryer. Similarly, training of staff and proper design would be important to mitigate potential safety concerns, as pyrolysis and gasification are (1) uncommon technology and (2) operate at high temperatures (450-1000°C).

In terms of GHG emissions, Alternative 18 has the least carbon emissions, assuming production of biochar, where only a small amount of NG would be required to start the process (no co-firing required). There are, however, lower carbon sinks (carbon sequestration and carbon emissions offset from the production of fertilizers), given the lesser amounts of biosolids that are land applied.

5. Cost Estimate

Cost estimates were developed for the four alternatives and the Base Case to evaluate the best alternatives for EWA to manage biosolids. A study-level Class 5 opinion of probable construction cost (capital cost) was determined for each alternative. According to AACE International (AACE), a Class 5 cost estimate is appropriate for this planning phase and has an accuracy of -50% to +100% of the estimated cost.

The cost estimates in this report were developed in 2021. Due to inflation, Covid-related impacts, and international events over the last 18 months, there have been significant cost increases and pricing volatility, particularly for commodities. Availability and transportation of raw material, products, and construction materials have also been constrained, impacting costs and schedules for equipment supply and construction projects. Budgets and funding allocations for near- and midterm projects should allow additional cost and schedule contingency factors for current and anticipated pricing and delivery conditions.

Major equipment costs were obtained from specific vendor quotes for this or similar projects using the design criteria presented in Section 4. In addition to direct vendor quotes, discussion with EWA concluded that capital costs reported in the BEE (Brown and Caldwell 2018) were to be reviewed and included as appropriate. This was the case for the estimated costs to recondition the drum and other major modifications for the current dryer, which were included in all alternatives. The addition of RDTs was part of the capital expenses in those alternatives that required expansion of the drying building. Similarly, the Brown and Caldwell opinion (2018) was used as a guide to include the capital cost in Alternative 8. Table 3-5 summarizes the main assumptions and markups used to estimate construction costs.

Table 3-5. Construction Cost Markups

Markup	Value	Unit
Construction Costs		
Demolition (general)	2	% of installed equipment cost
Demolition (DAFT only)	2	Million USD, based on EWA input
Overall Sitework	2	% of installed equipment cost
Plant Computer System	7	% of installed equipment cost
Yard Electrical	8	% of installed equipment cost
Yard Piping	5	% of installed equipment cost
Building Cost	225	$/square foot
Installation Contingency	20	% of equipment cost
Contractor Markups		
Contractor Overhead	10	% of construction cost
Profit	15	% of construction cost
Mobilization, Bonds, and Insurance	5	% of construction cost
Contingency	30	% of construction cost

Table 3-5. Construction Cost Markups

Markup	Value	Unit
Nonconstruction Costs		
Permitting	2	% of construction cost with markups
Engineering	12	% of construction cost with markups
Services during Construction	5	% of construction cost with markups
Commissioning and Startup	1	% of construction cost with markups
Legal and Administration	1	% of construction cost with markups

USD = United States dollar(s)

O&M costs were included in the total project cost as well as estimates of present value lifecycle costs. To develop these cost estimates, several inputs were considered and assumptions made. The projected average loadings in year 2030 were used to estimate the resources demands and resulting O&M costs under both scenarios of solids projections (based on hauling and plant data). Year 2030 is considered the midpoint in the planning period and represents the annual average cost to estimate the lifecycle cost of operating the different alternatives. Table 3-6 summarizes the inputs and assumptions for estimating O&M costs, and they are the same as those presented in the BEE (Brown and Caldwell 2018) after discussion among this Project Team.

Table 3-6. Annual Cost and Lifecycle Assumptions

Parameter	Value	Units
Interest Rate	4	%, agreed upon in workshop
Discount Rate	3.5	%, agreed upon in workshop
Planning and Finance Periods	20	Years, agreed upon in workshop
Power Cost[a]	0.090	$/kWh, from BEE (Brown and Caldwell 2018) and confirmed during workshop
Polymer Cost	1.2	$/lb, from BEE (Brown and Caldwell 2018) and confirmed during workshop
NG Cost	3.1	$/MMBtu, from BEE (Brown and Caldwell 2018) and confirmed during workshop
Biosolids Handling and Hauling Costs	51.5	$/wT; from EWA, assumes preferred site
Biochar Product Cost and Revenue	0	$/wT; assumes potential revenue and handling costs are the same
Labor, Operations	69.79	$/h, from BEE (Brown and Caldwell 2018) and confirmed during workshop
Labor, Maintenance	69.63	$/h, from BEE (Brown and Caldwell 2018) and confirmed during workshop
Maintenance	2	% of installed equipment cost, agreed upon in workshop

[a] Power demands in solids processing were assumed to be imported from the power utility for the cost estimate.

h = hour(s)
kWh = kilowatt-hour(s)
wT = wet ton(s)

5.1 Results

Capital and O&M costs were consolidated in the lifecycle cost considering a planning period to year 2040. Table 3-7 summarizes the capital costs for the Base Case and the four alternatives and includes cost ranges based on a planning-level Class 5 (-50% +100%) cost estimate. Annual O&M costs were estimated for each alternative as well. Tables 3-8 and 3-9 provide a summary of these results. Tables 3-10 and 3-11 summarize the total lifecycle costs to facilitate comparison between alternatives. Figure 3-20 summarizes the total project costs. These results are used in Section 6 to establish the cost to benefit ratio of each alternative. Appendix 3B provides the extended table with added cost estimate detail.

The Base Case resulted in the alternative with the lowest capital cost, followed by optimizing digestion by incorporating digesters 1, 2, and 3. It was previously discussed that belt dryers are less expensive than drum dryers. However, the need for an RTO to operate in the California results in similar capital costs for both drying options. In addition, a second product storage and loadout facility is required for the belt drying option, requiring added capital cost for this alternative.

Alternative 9b (belt dryer) has a slightly higher overall cost (present value) than Alternative 9a (drum dryer). Alternative 18, Have It All Now, has the highest capital cost of all alternatives. These estimated costs were used in conjunction with the nonmonetary criteria to develop the cost to benefit analysis presented in Section 6.

Table 3-7. Capital Cost Estimate Summary – Class 5 Estimate

Alternative	Alt 0 Base Case ($)	Alt 8 Optimized Digestion ($)	Alt 9a Drum Dryer ($)	Alt 9b Belt Dryer ($)	Alt 18 Pyrolysis and Gasifier ($)
Estimated Capital Cost	7,712,000	31,004,000	55,197,000	59,298,000	124,667,000
Upper range	15,424,000	62,008,000	110,394,000	118,596,000	249,334,000
Lower range	3,856,000	15,502,000	27,598,000	29,649,000	62,334,000

Notes:

All costs in 2021 USD.

Table 3-8. Hauling Data Annual Operations and Maintenance Estimate Summary [a,b]

Alternative	Alt 0 Base Case ($)	Alt 8 Optimized Digestion ($)	Alt 9a Drum Dryer ($)	Alt 9b Belt Dryer ($)	Alt. 18 Pyrolysis and Gasifier ($)
Electricity	434,400	473,800	423,400	428,100	406,200
NG	275,600	275,600	271,700	278,800	51,100
Polymer	196,900	196,900	196,900	196,900	196,900
Maintenance	350,000	566,100	680,700	704,400	1,154,700
Labor	1,890,300	1,890,300	1,890,300	1,890,300	1,890,300
Hauling and handling	808,800	808,800	449,500	449,500	0
Annual cost	3,956,000	4,211,600	3,912,500	3,948,000	3,699,200

[a] All costs in 2021 USD.

[b] Hauling data were used to estimate solids production.

Table 3-9. Plant Data Annual Operations and Maintenance Estimate Summary[a, b]

Alternative	Alt 0 Base Case ($)	Alt 8 Optimized Digestion ($)	Alt 9a Drum Dryer ($)	Alt 9b Belt Dryer ($)	Alt. 18 Pyrolysis and Gasifier ($)
Electricity	434,682	473,149	428,202	428,202	406,415
NG	275,587	275,587	341,759	351,025	51,075
Polymer	258,778	246,415	258,778	258,778	258,778
Maintenance	350,000	512,378	657,060	680,813	1,131,115
Labor	1,890,304	1,890,304	1,890,304	1,890,304	1,890,304
Hauling and handling	1,062,737	1,011,965	590,738	590,738	0
Annual cost	4,272,100	4,409,800	4,166,800	4,199,900	3,737,700

[a] All costs in 2021 USD.

[b] Plant data were used to estimate solids production.

Table 3-10. Hauling Data Capital, Operations and Maintenance, and Lifecycle Cost Estimate Summary[a,b]

Alternative	Alt 0 Base Case ($)	Alt 8 Optimized Digestion ($)	Alt 9a Drum Dryer ($)	Alt 9b Belt Dryer ($)	Alt. 18 Pyrolysis and Gasifier ($)
Capital Cost	7,712,000	31,004,000	55,197,000	59,298,000	124,667,000
O&M Annual Cost	3,956,000	4,211,600	3,912,500	3,948,000	3,699,200
Present Worth O&M Cost	56, 224,000	59,857,000	55, 606,000	56,111,000	52,575,000
Total Project Cost	63,936,000	90,862,000	110,803,000	115,409,000	177,242,000
Upper range	71,584,000	121,036,000	184,343,000	192,978,000	320,170,000
Lower range	60,016,000	74,530,000	87,539,000	90,025,500	119,161,000

[a] All costs in 2021 USD.

[b] Hauling data were used to estimate solids production (total project cost, 20-year period).

Table 3-11. Plant Data Capital, Operations and Maintenance, and Lifecycle Cost Estimate Summary[a, b]

Alternative	Alt 0 Base Case ($)	Alt 8 Optimized Digestion ($)	Alt 9a Drum Dryer ($)	Alt 9b Belt Dryer ($)	Alt. 18 Pyrolysis and Gasifier ($)
Capital Cost	7,712,000	31,004,000	64,536,000	68,635,000	134,006,000
O&M Annual Cost	4,272,100	4,409,800	4,166,800	4,199,900	3,737,700
Present Worth O&M Cost	60,717,000	62,674,000	59,220,000	59,691,000	53,122,000
Total Project Cost	68,429,000	93,678,000	123,756,000	128,326,000	187,128,000
Upper range	71,648,000	121,867,000	166,000,000	174,707,000	301,909,000
Lower range	60,080,000	75,359,500	83,204,500	85,760,000	114,908,500

[a] All costs in 2021 USD.

[b] Plant data were used to estimate solids production (total project cost, 20-year period).

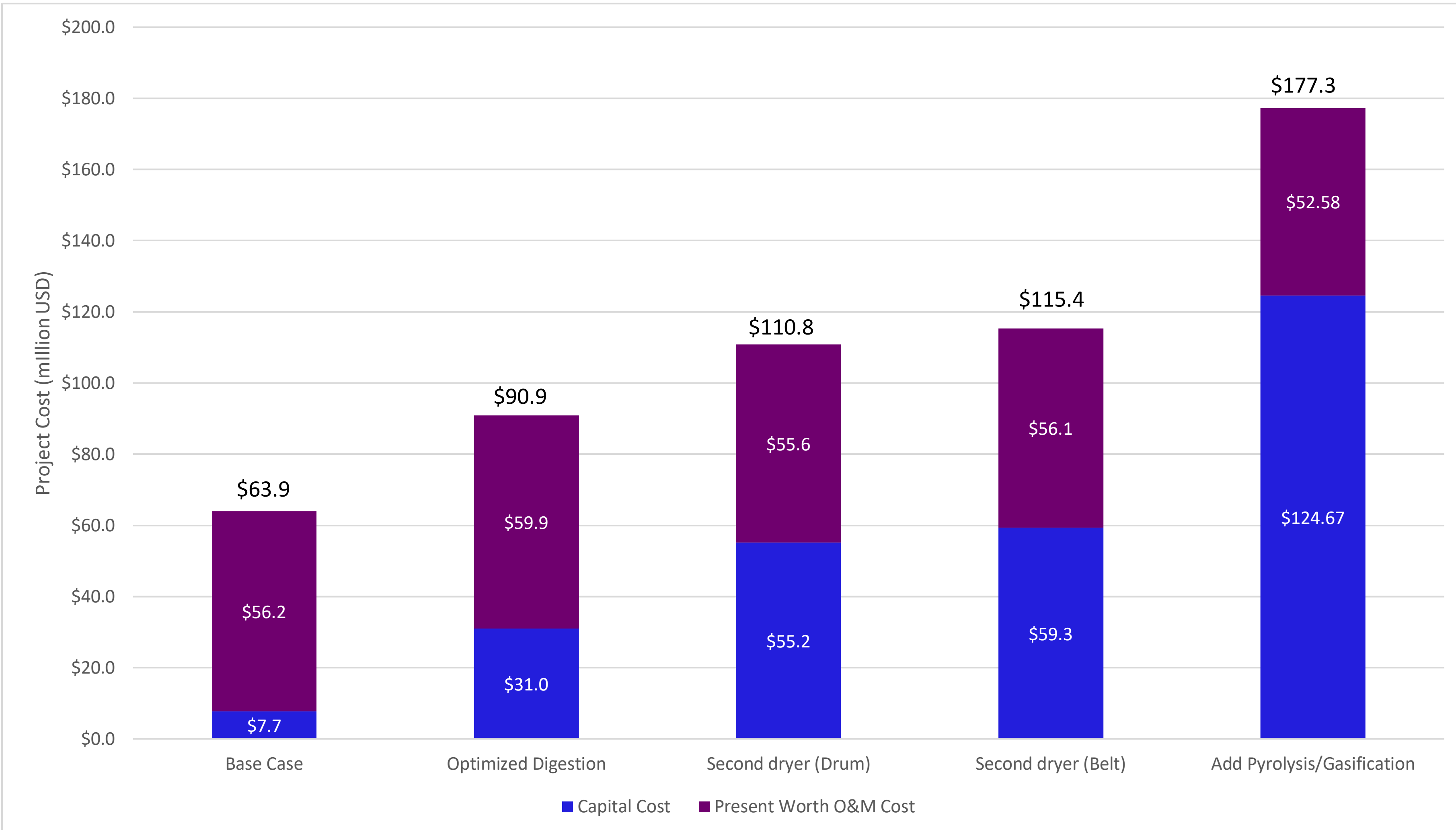


Figure 3-20. Total Project 2021 Costs for the Selected Alternatives Assuming Hauling Data for Solids Projections

6. Cost to Benefit Analysis

The comparison of the screened alternatives was supported by developing a cost to benefit ratio using the total project cost divided by the nonmonetary criteria scoring (benefits). This approach provides the cost of the benefits that each alternative would provide to EWA's Biosolids Management Program. Similar to the nonmonetary scores presented in Section 3.2, the cost to benefit ratio serves as a comparison to provide insights for further analysis rather than pointing out the best alternative to consider for implementation. The lower the cost to benefit ratio, the better the alternative is ranked. Figure 3-21 shows the cost to benefit ratios for the selected alternatives.

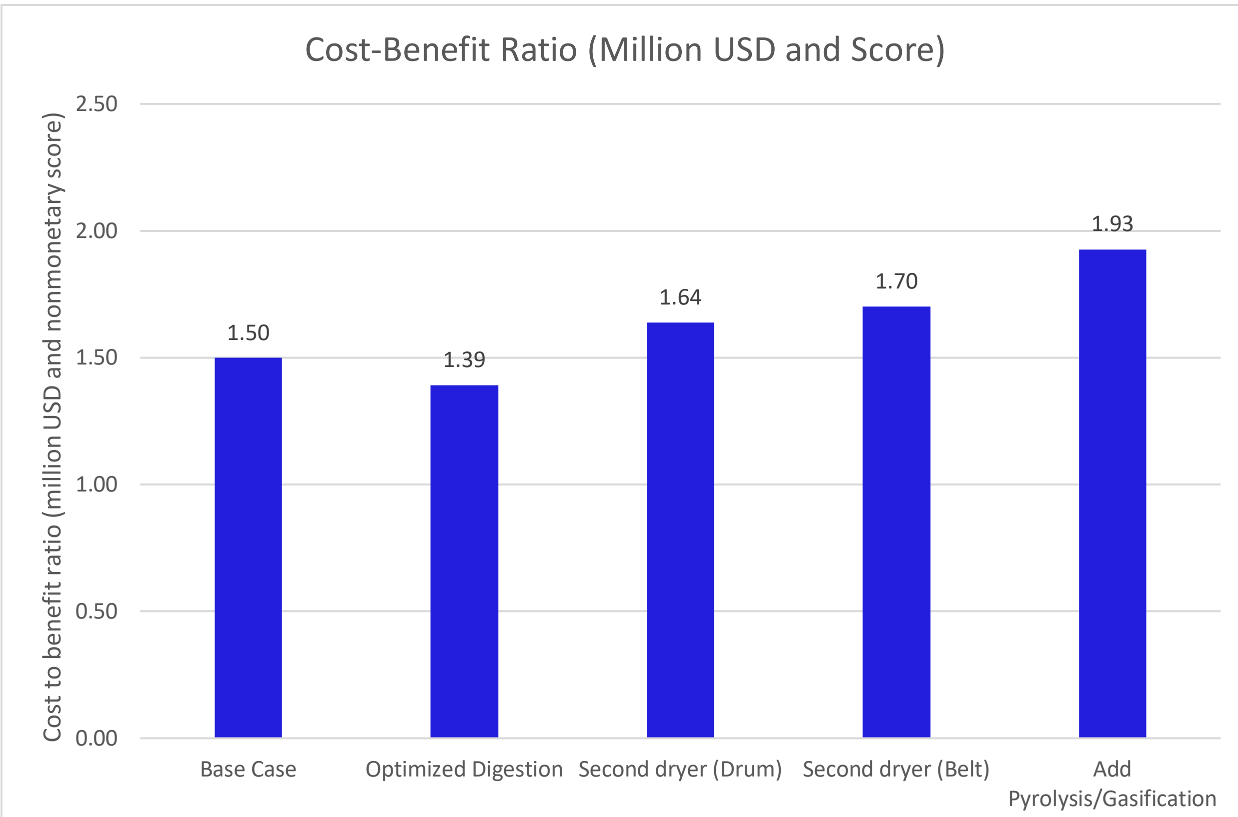


Figure 3-21. Cost to Benefit Ratio for the Selected Alternatives, Assuming Hauling Data for Solids Projections

Important outcomes of the cost to benefit analysis and the overall evaluation presented in this TM are described in this section. The two bookend alternatives provided the reference in terms of lowest cost but least benefits (Base Case) and highest cost but most benefits (Have It All Now), yet neither meet the EWA's current goals for the Biosolids Management Program. The main alternatives under evaluation are described as follows:

- **Bookend Alternatives:**
  - **Alternative 0, Base Case**, resulted in a low cost to benefit ratio (1.50), given the low level of capital investment needed, yet there are fewer benefits compared to the alternatives under evaluation (Figure 3-5). The Base Case alternative does not meet EWA's Biosolids Management Program goal to minimize risk of disposing material that does not meet Class B requirements. Additionally, the risks related to disposal of biosolids that do not meet Class B biosolids

requirements have recently become a significant consideration with the enforcement of SB 1383, effective January 1, 2022, limiting the landfilling of organic wastes. EWPCF's digestion capacity is currently under stress (due to minimal redundancy) and is expected to be out of redundancy to consistently meet Class B requirements by 2025 with one digester out of service. Therefore, Alternative 0, Base Case, is not considered further.

  – **Alternative 18**, which considers adding a system with the flexibility to produce a marketable dried product, biochar or ash, provides the most benefits to EWA under the nonmonetary criteria. This alternative 18 resulted in the most environmentally sustainable option, measured as GHG emissions, with the most reliable and redundant process and biosolids product distribution. However, the considerably higher capital cost led to a cost to benefit ratio of 1.93, the highest among the alternatives under comparison, despite having slightly lower present worth O&M costs. As such, it was the Project Team's decision that this alternative not be considered for further evaluation.

- **Main Alternatives:**
  – **Alternative 8**: This alternative includes optimizing digestion through the addition of digesters 1, 2, and 3 under mesophilic operation. There are provisions to operate these digesters under thermophilic temperatures in the future to further increase digestion capacity. This option provides EWA with enough process capacity and redundancy throughout the planning period to produce Class B biosolids, thus preventing EWA from having to landfill material that does not meet Class B requirements. Realizing the benefits of this alternative would require a capital investment of $31 million. Alternative 8 resulted in the lowest and best cost to benefit ratio (1.38). This alternative offers the potential for implementation in the short-term, as the required modifications are consistent with digester evaluations already performed by EWA.

  – **Alternatives 9a and 9b**: Two alternatives were considered for increasing drying capacity without considering options for addressing digestion process capacity. Alternative 9a includes a drum dryer with enough capacity to process estimated 2040 maximum month loads. Alternative 9b includes a belt dryer with the same capacity as Alternative 9a. The overall project costs for both alternatives are similar, with Alternative 9b belt dryer having both a slightly higher capital cost for the larger building and other facilities (+$4 million) and higher present worth O&M costs (+$0.5 million) compared with Alternative 9a drum dryer.

    The cost to benefit ratio for Alternative 9b belt dryer (1.83) was higher than the ratio for Alternative 9a drum dryer (1.77). The belt dryer is considered a slightly better solution in terms of safety, operational complexity, and serviceability; and it provides a reliable and redundant process. In addition, the potential exists for using heat recovered from the current IC engines to offset energy demand in the dryer, thus reducing O&M costs and GHG emissions. However, Alternative 9b presents some implementation challenges, given the large footprint required, which would displace the current DAFTs. In addition, this option requires operating two different types of dryers that produce two different products. As such, marketing of the belt-dried product would need to be evaluated further. A new loadout facility to manage the second product would add onsite truck access complexity.

    Adding a second larger drum dryer, Alternative 9a would provide a reliable and redundant process. The biosolids product generated would align with current granule marketing programs. Alternative 9a presents EWA with the opportunity to minimize biosolids hauling and handling costs, and produce a consistent dried product within a smaller footprint compared to Alternative 9b. Capital cost for this alternative is estimated at $64.5 million, with net present worth O&M costs less than the Base Case. The reduction in O&M costs is based on the vendor, Andritz-provided efficiencies and estimates of O&M costs for the new dryer. Adding a drum dryer, however, does not allow for potential heat recovery to offset NG demand, which would be a disadvantage compared with Alternative 9b.

7. Conclusions and Next Steps

After conducting the nonmonetary alternatives screening for 21 potential biosolids management options, an AACE Class 5 cost estimate was prepared in 2021 for the two bookend alternatives and the three main alternatives. These cost estimates provide a reference cost for comparison and planning. Proposals were received for major equipment from vendors following the design criteria established in this BMP. The proposals aided in determining project costs, as well as refining nonmonetary criteria (for example, GHG emissions). A cost to benefit analysis was then performed to compare the five alternatives.

The bookend alternatives (Alternative 0; Base Case; and Alternative 18, adding drying, pyrolysis, and gasification) will not be further considered in the EWA's Biosolids Management Program, as they did not meet the project goals. The three main alternatives analyzed presented both advantages and challenges for EWA's Biosolids Management Program, as summarized in Table 3-12.

Table 3-12. Biosolids Management Plan Alternative Advantages and Disadvantages

Process	Alt 8, Optimized Digestion	Alt 9a, Second Dryer (Drum)	Alt 9b, Second Dryer (Belt)
Advantage	▪ Increase digestion capacity ▪ Reduce size of second dryer needed in the future ▪ Provide digestion redundancy	▪ Provides a consistent product ▪ Operators already have knowledge ▪ Needs a smaller footprint ▪ Provides dryer redundancy	▪ Is a less complicated process ▪ There are fewer safety considerations ▪ There is a potential to use waste heat from cogeneration to offset NG requirements ▪ Provides dryer redundancy
Disadvantage	▪ Does not produce a Class A product	▪ There are more safety considerations ▪ Not able to use waste heat from cogeneration to offset NG requirements	▪ Produces different product quality and potentially requires a second loadout facility ▪ Requires a larger process footprint ▪ Has higher GHG emissions
Capital Cost, $ million	31.0	55.2	59.3

EWA staff and Jacobs' recommendation is to move forward with Alternative 8 (digestion optimization), which is the preferred alternative for short- to midterm implementation. The recommended alternative allows future implementation of thermophilic digestion in digesters 1, 2, 3 and EHH implementation, pending results of bench and pilot-scale testing. The incorporation of a second dryer should be considered at a trigger point, likely in the midterm planning horizon, when declining performance of the existing dryer coupled with capacity needs and the cost of biosolids hauling and handling become excessive. The dryer selection, drum or belt dryer, can be deferred until then, when results from the current marketing program are assessed and product acceptance can provide a clearer direction about a preferred end product.

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Appendix 3-A
Nonmonetary Evaluation Detail Spreadsheet

Appendix 3-A. Nonmonetary Evaluation Detail Spreadsheet

Alternative	A. Future Regulatory Risk	B. Reliable and Redundant Biosolids Product Distribution	C. Environmental Sustainability	D. Operational Complexity and Serviceability	E. Reliable and Redundant Process	F. Potential Public Impacts	Nonmonetary Weighted Score (based on 100 points)
Weight	*10%*	*25%*	*7%*	*20%*	*33%*	*5%*	-
0a Base Case	3	1	1	4	2	1	43
0b Base Case - reheating	3	2	2	3	2	2	46
1 Rehabilitate digesters 1, 3	4	2	1	3	2	1	46
2 New digester	5	2	2	5	3	2	65
3 Improve thickening	5	2	2	3	2	3	51
4 Recuperative thickening in digesters 1, 3	4	2	1	2	3	2	49
5 Recuperative thickening in digesters 4, 5, 6	5	2	1	2	3	3	52
6 Digesters 4, 5, 6 thermophilic	5	2	2	3	3	3	58
7 Digesters 1, 3 thermophilic	4	2	1	3	3	2	53
8 Rehabilitate digesters 1, 2, 3 mesophilic//thermophilic	5	2	4	4	3	4	65
9a Second dryer (RDT)	5	3	3	2	4	4	68
9b Second dryer (belt)	5	2.5	3.5	2.5	4	4	68
10 Second dryer// digesters 4, 5, 6 thermophilic	5	3	3	3	4	4	72

Alternative	A. Future Regulatory Risk	B. Reliable and Redundant Biosolids Product Distribution	C. Environmental Sustainability	D. Operational Complexity and Serviceability	E. Reliable and Redundant Process	F. Potential Public Impacts	Nonmonetary Weighted Score (based on 100 points)
11 Improve thickening// second dryer	5	3	3	3	4	4	72
12 Digesters 4, 5, 6 thermophilic// second dryer	5	3	3	3	4	4	72
13 EHH // second dryer	5	3	4	2	4	4	69
14 Improve thickening // new dryer and carbonization	5	4	4	2	4	5	75
15 Digesters 4, 5, 6 thermophilic// new dryer and carbonization	5	4	4	1	4	5	71
16 Add drying, pyrolyzing, and gasifying //improve thickening	5	5	5	2	5	5	88
17 Add drying, pyrolyzing, and gasifying // digesters 4, 5, 6 thermophilic	5	5	5	2	5	5	88
18 Add drying, pyrolyzing, and gasifying	5	5	5	3	5	5	92

Notes:

// = midterm and long-term
EHH = enzymatic hyperthermophilic hydrolysis
RDT = rotary drum thickener

Appendix 3-B
Detailed Cost Estimate – Results

Appendix 3-B. Cost Estimate Details

Table 3-B-1 provides the results of the detailed cost estimate.

Table 3-B-1. Detailed Cost Estimate

Cost	Alt 0, Base Case ($)	Alt 8, Optimized Digestion ($)	Alt 9a, Drum Dryer ($)	Alt 9b, Belt Dryer (DG Use) ($)	Alt 18, Pyrolysis and Gasifier ($)
Capital costs					
Digesters 1, 2, and 3 rehabilitation	–	8,119,000	–	–	–
Existing dryer - Reconditioning drum and other major components	2,688,300	2,688,300	2,688,300	2,688,300	2,688,300
Second dryer	–	–	15,353,000	16,541,000	–
Pyrolysis	–	–	–	–	39,055,800
RDTs	–	–	3,091,500	3,091,500	3,091,500
Total equipment cost	2,688,000	10,807,000	16,533,000	17,721,000	40,236,000
Equipment installation	537,600	2,161,400	3,306,600	3,544,200	8,047,200
Installed equipment cost	3,225,600	12,968,400	19,839,600	21,265,200	48,283,200
Building cost	–	–	1,635,100	1,924,900	2,250,000
Installed equipment cost and building	3,225,600	12,968,400	21,474,700	23,190,100	50,533,200
Construction cost					
Demolition (general)	64,500	259,400	429,500	463,800	1,010,700
Demolition (DAFT only)	–	–	2,000,000	2,000,000	2,000,000
Overall sitework	64,500	259,400	429,500	463,800	1,010,700
Plant computer system	225,800	907,800	1,503,200	1,623,300	3,537,300
Yard electrical	258,000	1,037,500	1,718,000	1,855,200	4,042,700
Yard piping	161,300	648,400	1,073,700	1,159,500	2,526,700
Construction costs	4,000,000	16,081,000	28,629,000	30,756,000	64,661,000
Contractor markups					
Contractor overhead	400,000	1,608,100	2,862,900	3,075,600	6,466,100
Profit	600,000	2,412,200	4,294,400	4,613,400	9,699,200
Mobilization, bonds, and insurance	200,000	804,100	1,431,500	1,537,800	3,233,100
Contingency	1,200,000	4,824,300	8,588,700	9,226,800	19,398,300
Construction Cost with markups	6,400,000	25,730,000	45,807,000	49,210,000	103,458,000

Cost	Alt 0, Base Case ($)	Alt 8, Optimized Digestion ($)	Alt 9a, Drum Dryer ($)	Alt 9b, Belt Dryer (DG Use) ($)	Alt 18, Pyrolysis and Gasifier ($)
Nonconstruction costs					
Permitting	128,000	514,600	916,100	984,200	2,069,200
Engineering	768,000	3,087,600	5,496,800	5,905,200	12,415,000
Services during construction	320,000	1,286,500	2,290,400	2,460,500	5,172,900
Commissioning and startup	64,000	257,300	458,100	492,100	1,034,600
Legal and administration	32,000	128,700	229,000	246,100	517,300
Total capital cost	7,712,000	31,005,000	55,197,000	59,298,000	124,667,000
Annual O&M cost estimate (AA 2030)					
Electricity consumption	434,407	473,832	423,410	428,124	406,178
NG	275,587	275,587	271,745	278,795	51,075
Chemicals (polymer)	196,896	196,896	196,896	196,896	196,896
Maintenance (% of equipment cost)	350,000	566,140	680,660	704,420	1,154,720
Labor	1,890,304	1,890,304	1,890,304	1,890,304	1,890,304
Hauling and handling	808,799	808,799	449,474	449,474	-
Subtotal O&M per year	3,956,000	4,211,600	3,912,500	3,948,000	3,699,200
O&M present worth value of annual cost	56,224,000	59,857,000	55,606,000	56,111,000	52,575,000
Net present value	63,936,000	90,862,000	110,803,000	115,409,000	177,242,000

- = not applicable
AA =annual average
Alt = alternative
DAFT = dissolved air flotation thickener
DG = digester gas
NG = natural gas
O&M = operations and maintenance
RDT = rotary drum thickener

Table 3-B-2 provides the sources and assumptions for equipment costs.

Table 3-B-2. Sources and Assumptions for Equipment Costs

Project	Cost (million USD)	Source	Observations
Digesters 1, 2, and 3 rehabilitation	2.19 per digester	Adapted from Brown and Caldwell (2020)	Also adds a 0.38-MG storage tank at $1.56 million, estimated using Jacobs proprietary estimating tool (Replica-Parametric)
Existing Dryer - Reconditioning drum and other major components	4	Tucker Southern (2021)	Construction cost
Second dryer (belt dryer)	10.75	Andritz proposal for EWA (2021)	-
Second dryer (drum dryer)	11.94	Andritz proposal for EWA (2021)	-
Pyrolysis	34.45	Proposal from a similar project in the Jacobs portfolio	-
RDTs	4.60	Brown and Caldwell (2018)	Construction cost

EWA = Encina Wastewater Authority
MG = million gallons
USD = United States dollar(s)

TM 4 – Strategic Implementation Plan

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2022 Biosolids Management Plan Update

TM 4 – Strategic Implementation Plan

Final

June 2022

Prepared for:

Encina Wastewater Authority

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Acronyms and Abbreviations

°C	degree(s) Celsius
AACE	AACE International
BDS	belt drying system
BMP	Biosolids Management Plan
BST	biosolids storage tank
BTU/h	British thermal unit(s) per hour
CFR	Code of Federal Regulations
DNE	does not exist
EHH	enzymatic hyperthermophilic hydrolysis
EWA	Encina Wastewater Authority
EWPCF	Encina Water Pollution Control Facility
FLG	fluid lift gasifier
GHG	greenhouse gas
HEX	heat exchanger
I&C	instrumentation and control
MAD	mesophilic anaerobic digestion
MMBTU/h	million British thermal units per hour
NG	natural gas
O&M	operations and maintenance
OOS	out of service
RDD	rotary drum dryer
RFP	Request for Proposal
SCADA	supervisory control and data acquisition
TAD	thermophilic anaerobic digestion

1. Introduction

As part of the Encina Wastewater Authority (EWA) Biosolids Management Plan (BMP) Update, Jacobs was tasked to perform an evaluation of biosolids management options considering current practices, write a description of the regulatory outlook (TM 1) and provide an updated portfolio of biosolids outlets in the region (TM 2).

Task 3 of the BMP Update focused on the evaluation of the potential biosolids management options and resulted in the preferred alternative for implementation (TM 3). The evaluation included a preliminary screening of technologies based on Jacobs' recommendations and EWA's previous work.

Management solutions were developed and ranked by their alignment with EWA's priorities (nonmonetary criteria) to perform the screening. This screening resulted in three management options selected for further analysis and included:

1) Alternative 8, optimized digestion
2) Alternative 9a, adding a second dryer (rotary drum)
3) Alternative 9b, adding a second dryer, (belt)

Two additional scenarios were considered as reference points:

4) Alternative 0, Base Case
5) Alternative 18, adding drying, pyrolysis, and gasification

After conducting the nonmonetary analysis screening for 21 potential biosolids management options, an AACE International (AACE) Class 5 cost estimate was prepared for the two reference alternatives and the three main alternatives. These cost estimates provided a reference cost for comparison and planning.

Proposals were received for major equipment from vendors after establishing design criteria in this BMP Update. The proposals aided in determining project capital and operations and maintenance (O&M) costs, as well as refining nonmonetary criteria (for example, greenhouse gas [GHG] emissions). A cost to benefit analysis was then performed to compare the five alternatives.

A series of virtual workshops was conducted with the project team to discuss the results of the alternatives evaluation that led to the following conclusions regarding the preferred management option:

- The boundary alternative (Alternative 0, Base Case) was eliminated from further consideration in the EWA's Biosolids Management Program, as it did not meet the project goals. The other boundary alternative (Alternative 18, adding drying, pyrolysis, and gasification) was postponed for further consideration for long-term implementation.
- Digestion optimization was selected as the preferred solution for short- to midterm implementation to provide increased redundancy and operational flexibility beyond 2025 and throughout the planning period (2040).
- The incorporation of a second dryer and possibly pyrolysis and gasification will be considered at a trigger point for optimizing the thermal process, when declining performance of the existing dryer coupled with throughput capacity needs and the cost of biosolids hauling and handling becomes too expensive. The dryer selection, drum or belt dryer, will be deferred until then, when results from the current marketing program developments are assessed. Figure 4-1 is a decision tree developed for implementation of the Biosolids Management Program.

The evaluation of biosolids management options documented in Task 3 (Jacobs 2021c) provided the basis for the development of a strategic implementation plan that is part of the EWA BMP Update. In addition to the analysis presented in TM 3, the project team developed this plan considering input from the stakeholders during project workshops. This TM 4 presents the strategic implementation plan of the preferred solution that aligns with the goals and vision for EWA's BMP. The implementation plan clearly defines the preferred solution; identifies short-, mid-, and long-term actions; and presents an updated AACE Class 5 cost estimate.

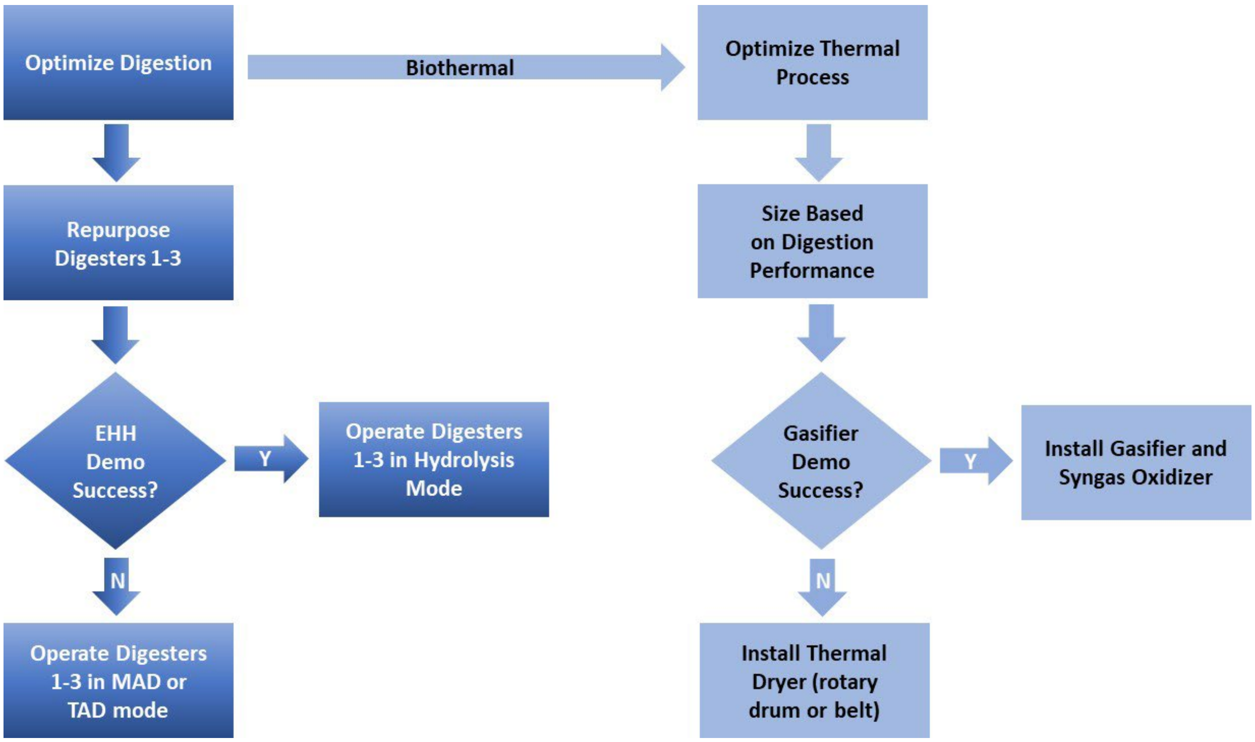


Figure 4-1. EWA Biosolids Management Decision Tree

demo = demonstration

EHH = enzymatic hyperthermophilic hydrolysis

MAD = mesophilic anaerobic digestion

TAD = thermophilic anaerobic digestion

2. Preferred Solution

The preferred solution is Alternative 8, rehabilitation of digesters 1, 2, and 3 to thermophilic anaerobic digestion (TAD). Digesters 1, 2, and 3 would be rehabilitated and placed into operation as thermophilic digesters in the short-term to provide capacity and redundancy through 2035 (assuming 14-day loading plant data for solids production estimates and with one digester out of service). This alternative also includes provisions to increase digestion capacity to increase redundancy and reliability of the solids stabilization process to meet Class B requirements per the 40 *Code of Federal Regulations* (CFR) 503 biosolids rule throughout the planning horizon (2040) by operating digesters 4, 5, and 6 as TAD.

Converting digesters 1, 2, and 3 to TAD would require the addition of a sludge storage tank prior to dewatering; and the addition of heating, mixing, and a new digester coating system to each digester. Optimization of the digestion process with enzymatic hyperthermophilic hydrolysis (EHH) could be accommodated in this alternative working with digesters 4, 5, and 6 either using mesophilic anaerobic digestion (MAD) or TAD.

Adding the flexibility to operate digesters 1 through 6 as TAD digesters or digesters 1, 2, and 3 to use the EHH process will require consideration of heat demand and sludge piping configuration. The addition of the EHH heating system would provide the heat required to operate digesters 4, 5, and 6 as TAD. The coating for these digesters would need to be compatible with thermophilic operating temperatures.

Implementation of the requirements for both options (TAD and EHH) to meet the design criteria through the planning horizon are included in this alternative; the ultimate buildout and discussion on how and when they should be operated is presented in Section 2.2 and Section 3 of this TM, respectively. The structural integrity of each digester to determine the ability to operate at higher temperatures (TAD and EHH) needs to be confirmed.

Consideration of the thermal drying process determined that additional capacity will not be added at this time, leading to an increase in production of Class B biosolids cake. As a minimum, reconditioning of the existing drum surface and other major components will be required to extend its useful life. Based on feedback from the dryer manufacturer, rehabilitation of the existing dryer is expected to provide operation at current capacity through 2040.

2.1 Site Requirements and Conceptual Layouts

As described, 17% additional digestion volume would result from rehabilitating the existing digesters 1, 2, and 3. The *Digester Rehabilitation and Improvements Project* (Brown and Caldwell 2020) documented the needs to rehabilitate digesters 1 and 3, and it is expected that the same modifications would be required for digester 2. Rehabilitation needs included the following considerations:

- New covers (in-kind)
- New mechanical equipment, such as transfer pumps, heat exchangers (HEXs), sludge recirculation and withdrawal pumps, digester gas piping, and heat loop extension
- New instrumentation and control (I&C)
- Electrical rehabilitations
- New digester coating system to handle thermophilic temperatures

Modifications to the HEXs and a new biosolids storage tank will be required to provide the process flexibility to operate these three digesters as TAD or as part of the EHH process, with digesters 4, 5, and 6 as TAD in the future. The HEXs required will be sized for estimated peak 14-day operations in 2040. Table 4-1 shows the heat requirements for the various operational strategies.

Table 4-1. Heating Requirements for Different Operating Configurations

Operating Configuration	Heat Requirement (MMBtu/h)	Assumed Operating Temperature Digesters 1-3 (°C)	Assumed Operating Temperature Digesters 4-6 (°C)
Digesters 1-6 MAD	5.10	35	35
Digesters 1-6 TAD[a]	8.44	55	55
Digesters 1-3 TAD and digesters 4-6 MAD	6.81	55	35
Digesters 1-3 EHH and digesters 4-6 MAD	6.79	80	35
Digesters 1-3 EHH and digesters 4-6 TAD[a]	7.95	80	55

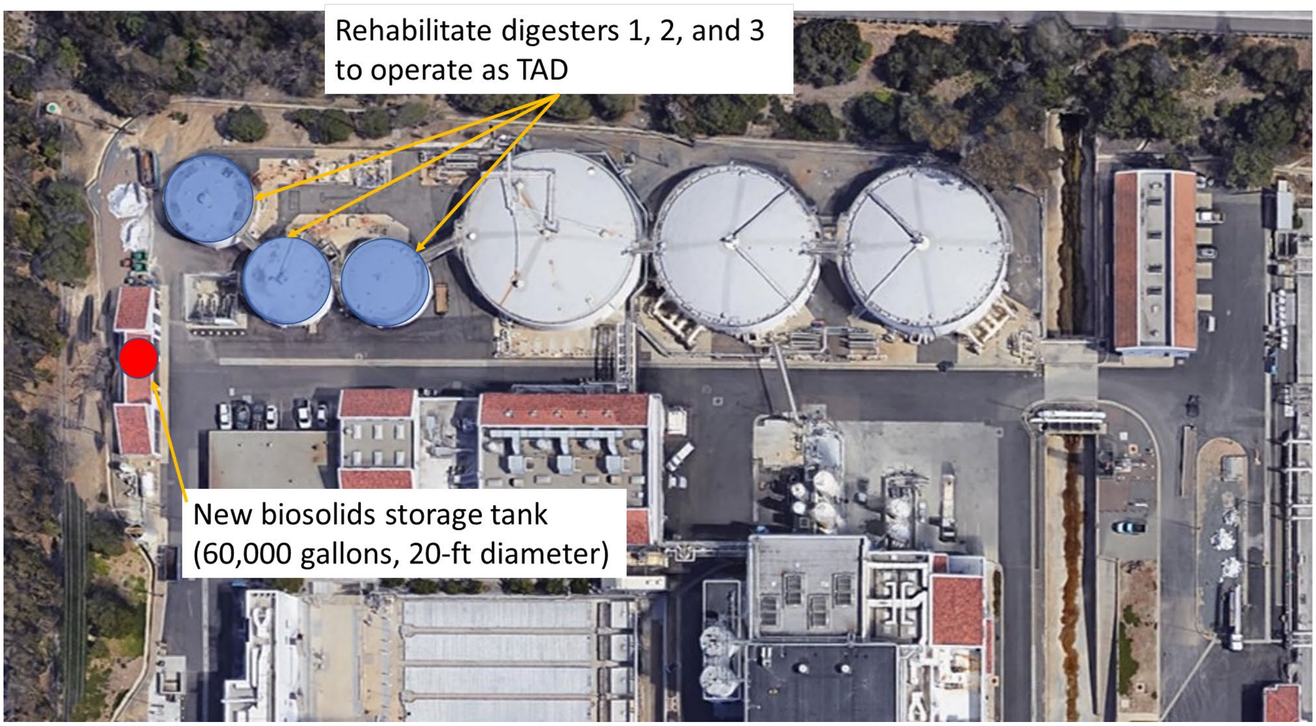
[a] Assumes heat recovery before dewatering

°C = degree(s) Celsius

MMBtu/h = million British thermal unit(s) per hour

Biosolids storage will require a 60,000-gallon tank to provide a 4-hour retention time (14-day peak for 2040 digestate loads) prior to dewatering. Figure 4-2 provides a conceptual layout, showing an aboveground tank that is 20 feet in diameter, 29 feet tall (including 3 feet of free board), and is constructed of coated coiled steel based on using Lipp GmbH's LIPP technology.

The structural evaluation conducted by Brown and Caldwell (2020) to determine the needs to rehabilitate digesters 1 and 3 did not include an evaluation to operate these digesters at temperatures exceeding what is required for MAD. As such, a new structural evaluation of digesters 1, 2, and 3 is recommended to confirm whether their structural integrity is suitable for the proposed operating conditions of 55°C (thermophilic for TAD) and 80°C (hyperthermophilic for EHH). Similarly, a coating system evaluation of digesters 4, 5, and 6 is required to confirm whether they can operate as thermophilic digesters at 55°C.



Source: Updated with permission from EWA.

Figure 4-2. Preferred Solution: Alternative 8, Thermophilic Anaerobic Digestion in Digesters 1, 2, and 3

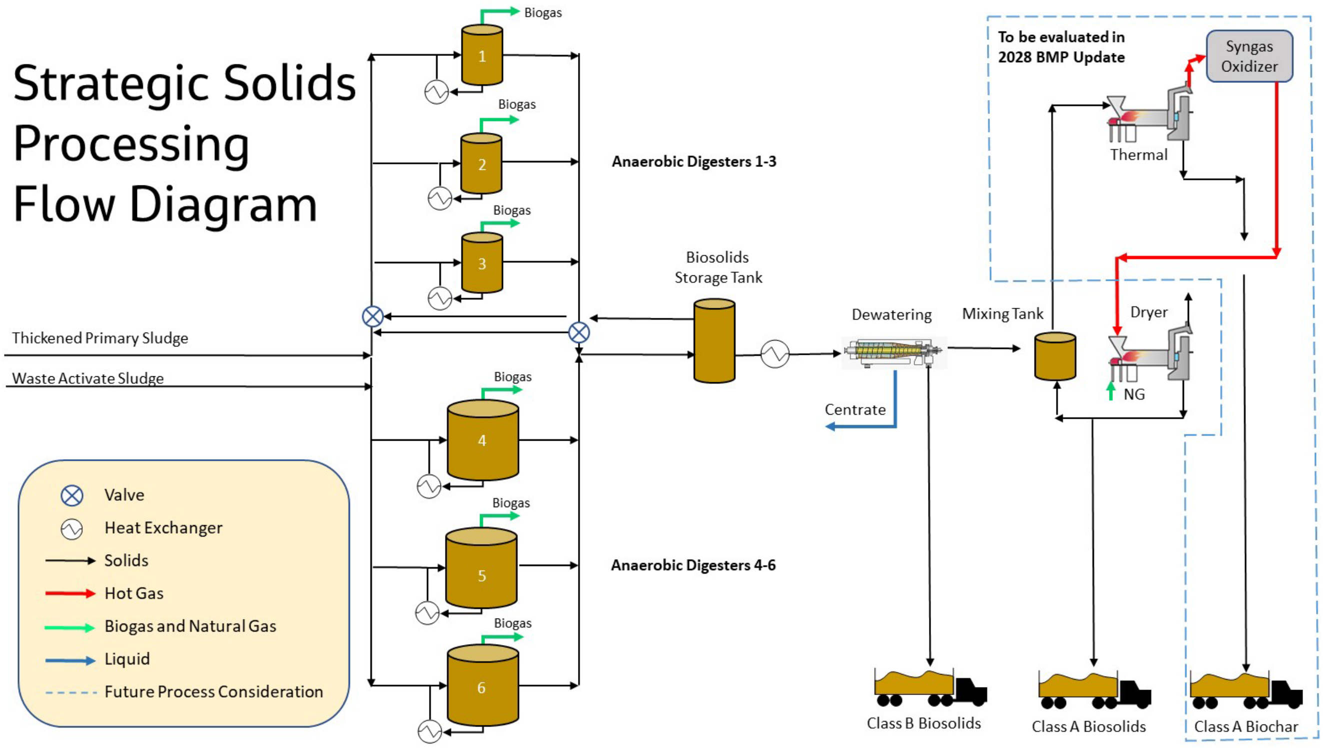
2.2 Operation Strategies

The preferred solution will provide the EWA Biosolids Management system with capacity to consistently meet Class B biosolids for beneficial reuse. Some Class A dried product would still be produced at the current dryer capacity and allow for a marketing program to continue to be implemented and evaluated.

Under the proposed modifications, the main priorities in the EWA BMP are balanced:

- Providing reliable, redundant, and serviceable equipment
- Minimizing operational complexity of the biosolids process
- Allowing secure product distribution
- Increasing environmental sustainability
- Minimizing lifecycle costs
- Proving flexibility for near- and midterm operations while planning for a long-term approach
- Allowing for adaptability to manage regulatory changes and add technology developments

The proposed digester, HEXs, and storage tank arrangement shown on Figure 4-3 offers flexibility in digester operation. The HEXs will be sized to operate under all of the proposed conditions, and the interconnected piping will also allow for versatility in operational strategies and provide redundancy. Each of the four operational strategies presented in the following subsections offers increased solids loading capacity and can be implemented as required by increases in plant loading or changes in management goals. All four operational strategies shown on Figure 4-3 are possible, as Table 4-1 summarizes.



Note: The preferred solution provides the flexibility to operate in any of the proposed operational strategies.
NG = natural gas

Figure 4-3. Preferred Alternative Process Flow Diagram

2.2.1 Mesophilic Anaerobic Digestion

In this scenario, digesters 1 through 6 will all be operated at mesophilic temperatures (35°C). Sludge is fed to all the digesters and sent to the biosolids storage tank after digestion and before dewatering. It is estimated that this process configuration will provide capacity and redundancy through 2028 (assuming 14-day peak loading plant data for solids production estimates and with one digester out of service).

To extend beyond 2028, digesters 1, 2, and 3 would require the modifications mentioned, including adding HEXs and providing a digester coating that can withstand the higher temperatures to operate as TAD digesters. Drying operation will continue with the existing dryer through the planning horizon (2040) at current capacity. This will lead to a consistent quantity of Class A biosolids production, with increasing production of Class B biosolids cake as solids loadings increase.

2.2.2 Thermophilic and Mesophilic Anaerobic Digestion – Preferred Alternative

In this scenario, digesters 1, 2, and 3 will be operated at thermophilic temperatures (55°C), while digesters 4, 5, and 6 are maintained at mesophilic temperatures (35°C). Operating at thermophilic conditions in digesters 1, 2, and 3 will reduce the required residence time compared to mesophilic operation and allows for increases in the overall loading capacity.

After being digested, all sludge is directed to the biosolids storage tank for blending and cooling (as needed), followed by dewatering. Drying operation will continue with the existing dryer through the planning horizon (2040) at current capacity. This will lead to a consistent quantity of Class A biosolids production, with increasing production of Class B biosolids cake as solids loadings increase.

2.2.3 Enzymatic Hyperthermophilic Hydrolysis and Mesophilic Anaerobic Digestion

In this scenario, digesters 1, 2, and 3 will be operated at EHH conditions (80°C) to encourage growth of certain bacteria to better break down cellulose, while digesters 4, 5, and 6 are maintained at mesophilic conditions (35°C). This configuration leads to an increase in solids reduction and biogas production; therefore, decreasing the resultant biosolids quantity produced and increasing potential energy production from the biogas.

In this operational strategy, feed sludge will flow to digesters 4, 5, and 6, where it will be treated under mesophilic conditions. The digested sludge will then flow to the biosolids storage tank, where a controlled portion can be fed to digesters 1, 2, and 3. This sludge would then be heated from mesophilic temperatures to hyperthermophilic temperatures in the presence of microorganisms capable of hydrolyzing cellulose.

After further digestion, this sludge would then be mixed back with the feed sludge before entering the mesophilic digestion phase. Heat balance estimations of this configuration showed that the blending of digestate from digesters 1, 2, and 3 with the feed sludge leads to MAD operation without requiring additional heating.

Drying operation will continue with the existing dryer through the planning horizon (2040) at current capacity. This will lead to a consistent quantity of Class A biosolids production, with increasing production of Class B biosolids cake as solids loadings increase.

2.2.4 Enzymatic Hyperthermophilic Hydrolysis and Thermophilic Anaerobic Digestion

The last operating scenario considered will be to operate digesters 1, 2, and 3 at EHH temperatures (80°C); and digesters 4, 5, and 6 operate at thermophilic temperatures (55°C). This scenario is similar to the previous scenario but differs in two aspects. First, the sludge coming from digesters 1, 2, and 3 does not need to be cooled because it can be mixed with the influent sludge to heat it to thermophilic conditions. Second, once the sludge is ready for dewatering, a HEX needs to cool the sludge and recover heat before dewatering.

Drying operation will continue with the existing dryer through the planning horizon (2040) at current capacity. This will lead to a consistent quantity of Class A biosolids production, with increasing production of Class B biosolids cake as solids loadings increase. Similar to the previous operating condition, this configuration will increase biogas production, allowing for more potential energy production; and the improved solids reduction will reduce the amount of biosolids to be managed.

2.2.5 Implementation of Operational Strategies

Several factors will influence the implementation of possible operational strategies under the proposed digestion optimization efforts. These factors range, for example, from the results of EHH bench-scale testing (as described in Section 3) to observed plant loadings in the mid- and long-terms. Table 4-2 shows an outlook of when the different configurations could be implemented.

Table 4-2. Outlook for Sequenced Implementation

Process	Existing	Near-term	Midterm	Long-term	Long-term
Digester 1	OOS	MAD	MAD or EHH	TAD or EHH	TAD or EHH
Digester 2	BST	MAD	MAD or EHH	TAD or EHH	TAD or EHH
Digester 3	OOS	MAD	MAD or EHH	TAD or EHH	TAD or EHH
Digester 4	MAD	MAD	MAD	MAD or TAD	MAD or TAD
Digester 5	MAD	MAD	MAD	MAD or TAD	MAD or TAD
Digester 6	MAD	MAD	MAD	MAD or TAD	MAD or TAD
Storage Tank	DNE	BST	BST	BST	BST
Thermal Process 1	RDD	RDD	RDD	RDD	RDD
Thermal Process 2	DNE	DNE	DNE	RDD or BDS	FLG

Notes:

Near-term: 2021-2026; Midterm: 2027-2030; Long-term: 2031-2040

BDS = belt drying system

BST = biosolids storage tank

DNE = does not exist

FLG = fluid lift gasifier

OOS = out of service

RDD = rotary drum dryer

2.3 Cost Estimate

For cost estimation, the preferred alternative considers short-term actions to rehabilitate anaerobic digesters 1, 2, and 3 to operate under thermophilic temperatures to increase process redundancy and a new 60,000-gallon digested sludge storage tank, sized for 4-hour retention time (14-day peak for 2040 solids flow) prior to dewatering. The recommendations also provide additional flexibility to operate these three digesters at hyperthermophilic temperatures in the midterm, allowing incorporation of EHH for the benefit of the overall EWA Biosolids Management Program. Long-term operation of the digestion process will provide TAD in digesters 4, 5, and 6 to further increase redundancy and increase operational flexibility. Finally, the preferred alternative includes the repairs needed to extend the operating life of the existing drum dryer.

EWA previously obtained an opinion of probable cost for the rehabilitation of digesters 1 and 3 that included conversion to recuperative thickening (Brown and Caldwell 2020). At the direction of EWA, this was used as the basis of the cost estimate for the preferred alternative under this BMP Update. The cost for the dryer repairs is already accounted for in EWA's planning; therefore, it is not included in the cost estimates presented in this section.

Table 4-3 presents the AACE Class 5 opinion of probable costs (capital cost) for the preferred alternative. Subtotals and the total are rounded to the nearest thousand. According to AACE (2020), a Class 5 cost estimate is appropriate for this planning phase and has an accuracy of -50% to +100% of the estimated cost.

In terms of O&M costs, the estimates are detailed in TM 3 and are slightly higher than the estimate for the Base Case, with a total estimated O&M annual cost of $4.16 million per year; the main expenditures are labor ($1.9 million per year), increased biosolids hauling and handling ($0.80 million per year) to accommodate more Class B solids to distribute, and an increase in maintenance costs due to the addition of HEXs and other mechanical equipment associated with the three additional digesters.

Table 4-3. Class 5 Opinion of Probable Cost for the Preferred Alternative

Cost Estimate	Amount ($)	Assumption
Digesters 1, 2, and 3 Rehabilitation	3,498,000	Table 4-4 provides the cost detail per digester ($1,166,000/digester)
60,000-gallon storage tank	320,000	Planning-level proposal from Centrisys Corporation (Appendix 4-A)
HEXs in Digesters 4, 5, and 6	315,500	Estimated using the Jacobs cost estimating tool (CPES)
Total Equipment Cost	4,133,500	-
Equipment Installation	826,700	20% of equipment cost
Installed Equipment Costs	4,960,000	-
Construction Costs		
Demolition	198,400	4% of installed equipment costs
Overall Sitework	99,200	2% of installed equipment costs
Plant Computer System	347,200	7% of installed equipment costs
Yard Electrical	396,800	8% of installed equipment costs
Yard Piping	248,000	5% of installed equipment costs
Construction Costs	6,250,000	-
Contractor Markups		
Contractor Overhead	625,000	10% of construction cost
Profit	937,500	15% of construction cost
Mobilization, Bonds, and Insurance	312,500	5% of construction cost
Contingency	1,875,000	30% of construction cost
Construction Cost with Markups	10,000,000	-
Nonconstruction Costs		
Permitting	200,000	2% of construction cost with markups
Engineering	1,200,000	12% of construction cost with markups
SCADA System Integration	1,000,000	10% of construction cost
Services during Construction	500,000	5% of construction cost with markups
Commissioning and Startup	100,000	1% of construction cost with markups
Legal and Administration	50,000	0.5% of construction cost with markups
Total Capital Cost	13,050,000	-

- = not applicable

SCADA = supervisory control and data acquisition

Table 4-4 presents the breakdown of the equipment cost per digester. An updated structural evaluation is recommended on all digesters to confirm that operating at either thermophilic or EHH temperatures will not detrimentally impact the structures. Additional capital costs may be required based on the results of this future structural evaluation.

Table 4-4. Cost Estimate Detail per Digester for Digestion Improvements [a]

Cost Estimate	Amount ($)	Assumption
Concrete work	17,000	
Structural steel work	40,000	
Digester coating	202,661	
Sludge recirculation piping	14,689	
Sludge feed piping	7,344	
Heat loop piping	40,480	
Gas piping	83,562	
Fixed cover	281,250	
Tank improvements	50,000	
HEXs 1, 2, and 3	89,000	Estimated using Jacobs cost estimating tool (CPES).
Sludge recirculation pump	16,606	
Hot water pump	12,000	
Digester gas appurtenances	141,450	
Sludge withdrawal pump	30,000	
Mixers	140,000	Estimated from previous project experience.
Subtotal per digester 1, 2, and 3	1,166,000	

[a] Based on Brown and Caldwell (2020) unless otherwise noted.

3. Implementation Strategy

The preferred solution provides additional capacity redundancy to the digesters beyond 2025, considering peak loadings while one digester is out of service. The preferred solution also provides operational versatility throughout the project horizon to consistently meet Class B biosolids requirements. This solution also allows for flexibility in the overall Biosolids Management Program and capital planning as relevant information becomes available in the short- and midterm for better defined and efficient decision making for the long-term. This strategic implementation plan has been developed considering trigger points, the actions associated with each of them, and the resulting schedule.

Table 4-5 summarizes the implementation strategy, and Figure 4-4 shows the proposed implementation schedule. For this plan, the different terms are defined as follows:

- Near-term: 2021-2026
- Midterm: 2027-2028
- Long-term: 2029-2040

4. References

AACE International (AACE). 2020. *Recommended Practice No. 18R-97 Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries TCM Framework: 7.3 – Cost Estimating and Budgeting*. Revision August 7.

Brown and Caldwell. 2020. *Digester Rehabilitation and Improvements Project*. January 31.

Table 4-5. Biosolids Management Plan Update Implementation Strategy

Action Item	Implementation Term	Trigger	Activity	Description	Beginning by Year	Completed by Year	Considerations
1	Near-term	Biosolids marketing trends	Develop a Biosolids Market Broker RFP	Prepare an RFP, evaluate potential brokers, and obtain a 5-year contract with a broker to increase local use of Class A biosolids and gain insights on product marketability	2021	2022	The results are used in the near-term management program of obtaining 200% product distribution and sets the baseline for long-term evaluation of product marketability.
2		Technology development	Test EHH on an EWA sludge sample	Perform bench-scale testing of the EHH process using EWA solids, and determine performance and potential applicability to the EWA BMP	2021	2022	Results of this testing would provide insights on the potential benefits of implementing EHH at the EWPCF. These results, in addition to technology implementation at other facilities, would lead to considerations of whether to operate the digestion process under this configuration in the midterm.
3		Next scheduled digester cleaning is for 2027; there is no digester redundancy under 14-day peak loading with one digester out of service	Design rehabilitation of digesters 1, 2, and 3	Incorporate into the design a 60,000-gallon biosolids storage tank and HEXs to allow for any of the proposed operational configurations	2023	2024	Starts the addition of digester volume to meet redundancy needs before the next digester cleaning. It should incorporate the results from EHH testing (see near-term action item 2) to include provisions to operate under this configuration.
4			Begin construction, startup, and commissioning of digesters 1, 2, and 3	Construct, start-up, commission and operate digesters 1, 2, and 3 in TAD mode	2025	2026	Needed to meet redundancy requirements before the next digester cleaning in 2027.
5	Midterm	Next scheduled digester cleaning is for 2027; there is no digester redundancy under 14-day peak loading with one digester out of service	Clean digesters 4, 5, and 6	Already scheduled maintenance item needed to sustain reliable and redundant operation of the digestion process	2027	2027	Requires digesters 1, 2, and 3 to be rehabilitated and in operation (see near-term implementation action items 3 and 4).
6		Dryer life and dryer use, regulatory changes, technology advancements, and biosolids market changes	Complete this BMP Update	Revisit results from this BMP Update considering potential changes in EWA priorities and state-of-the-practice	2028	2028	An important goal of the 2028 BMP Update should be to assess dryer use and updates on expected remaining useful life. It is imperative that this BMP Update determines the need for a new thermal process and which one this should be, including considerations for the current (at that time) more advanced thermal systems, such as FLGs and their state of practice at that point. It should also incorporate results from the marketing study and marketing efforts to date (see near-term action item 1), and the results from the EHH testing (see near-term implementation action item 2) and its full-scale implementation (if applicable).
7	Long-term	Dryer life and dryer use	Design and construct a new thermal system	Implement recommendations from the 2028 BMP Update to design and construct a new thermal system	2029	2034	For implementation, this strategy recommends considering preparations for a new thermal system in case the existing dryer does not maintain (or is not expected to maintain) reliable operation after 2035. This need will be determined during the 2028 BMP Update (see midterm action item 6). However, cost estimates for the preferred alternative assume that the useful life of the existing dryer will extend to year 2040.
8		Digester redundancy under 14-day peak loading with one digester out of service and digesters 1, 2, and 3 in TAD mode is limited to 2035	Operate digesters 4, 5, and 6 in TAD mode	Operate digesters 1-6 in TAD mode as needed to consistently meet Class B biosolids requirements	2034	Depends on updated estimates and recommendations in the 2028 BMP Update	Applicable if no other modifications are recommended in the 2028 BMP Update and if the existing dryer continues to operate without additional capacity. Shift in digestion configuration will depend on the results of the EHH testing (see near-term implementation action item 2) and its full-scale implementation (if applicable).

EWPCF = Encina Water Pollution Control Facility

RFP = Request for Proposal

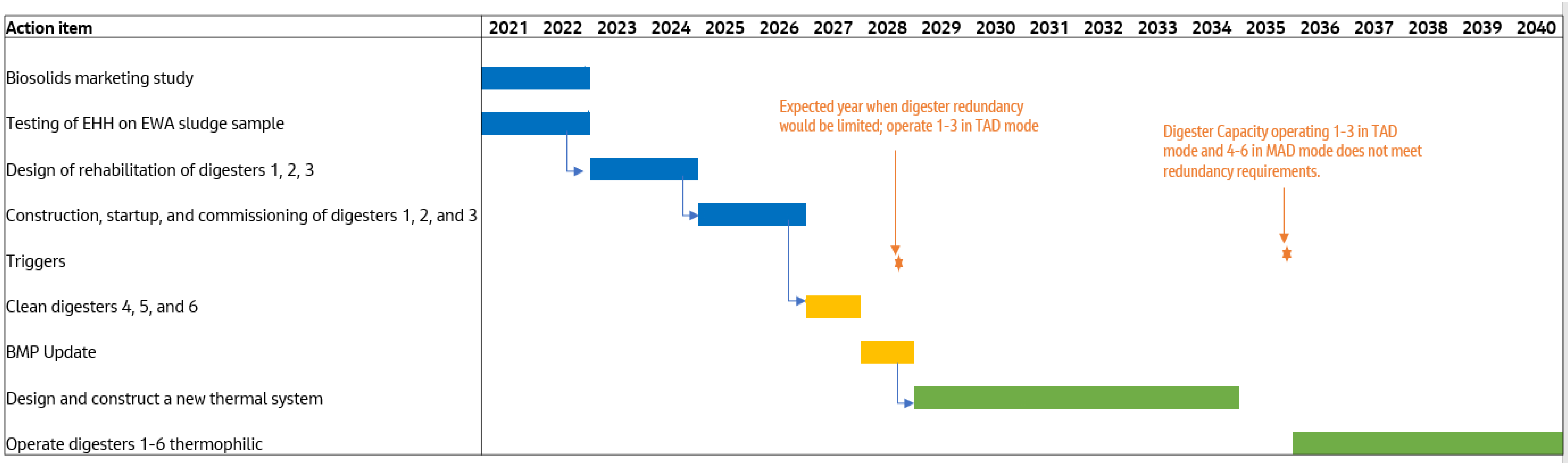


Figure 4-4. Strategic Implementation Schedule

Appendix 4-A
Centrisys Proposal Sludge Storage Tank

NUMBER:	11567	**DATE:**	05/04/2021
TO:	Encina Wastewater Authority Attn: James Mattern	**REF.:**	LIPP Sludge Storage Tanks

Proposal for
Encina, CA
One(1) 60,000 Gallon Sludge Storage Tank

Centrisys Contact
Jerod Swanson
Regional Sales Manager
9586 58th place
Kenosha, WI 53144
Ph: (262) 654 6006
Direct: (612) 401-2006
Email: Jerod.swanson@centrisys.us

Centrisys Rep Contact
Tom Roberson
Misco Water
27101 Burbank, Suite B
Foothill Ranch, CA 92610
Ph: 949-458-5555
Direct: 949-521-1301
Email: troberson@miscowater.com

ITEM 1 PRODUCT DESCRIPTION – LIPP TANKS AND THE DOUBLE-FOLD SYSTEM

OVERVIEW

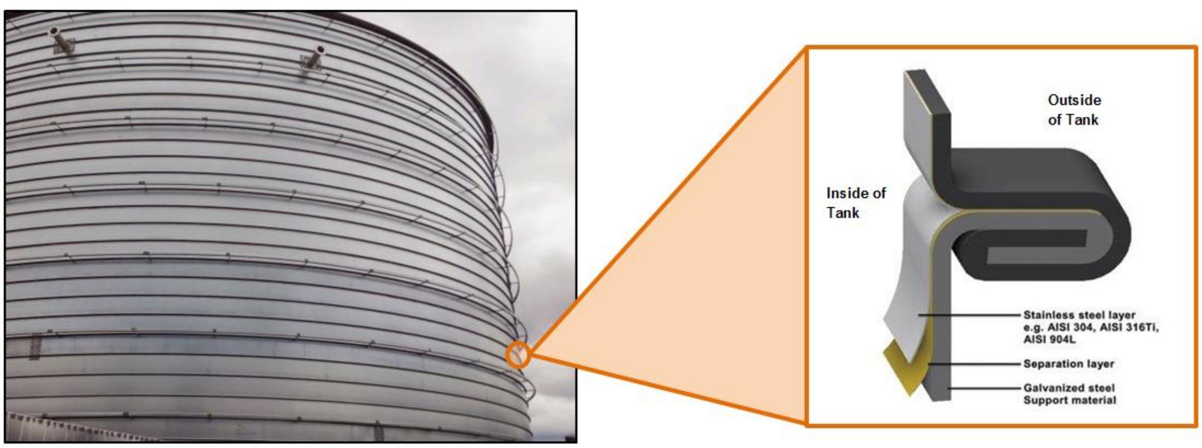
LIPP GmBH is headquartered Tannhausen, Germany and its subsidiary, Lipp America Tank Systems is based in Muskegon, MI. As of 2017 Centrisys Corporation is the licensed distributor for Lipp Tanks in the United States. Lipp is a family owned business which developed the technology to machine erect steel and stainless tanks using *Double-Fold* System. Lipp tanks have been erected in over 80 countries with tens of thousands of tanks built world-wide.

THE DOUBLE-FOLD SYSTEM

The *Double-Fold System is* the process by which Lipp Tanks are mechanically manufactured on-site from coiled steel using stationary machine temporarily mounted to the foundation floor to implement a two-stage folding process resulting in the *Double-Fold seam*.

With use of the *Double-Fold System,* the need for bolts is virtually eliminated from the structure, with the exception of appurtenances, etc.

Lipp Machine at Work



Detail on the Double-Fold System and the Verinox System

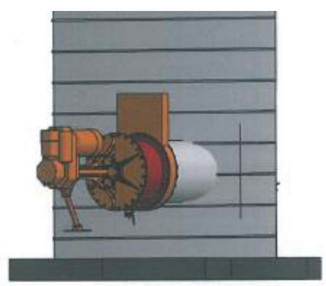
VERINOX COATING

In addition to the *Double Fold System* Lipp has developed the *Verinox* coating system which adheres a thin-sheet of stainless steel on-top of a thick-sheet of galvanized carbon steel. This creates a superior tank which provides the structural integrity of a carbon steel tank with the corrosion resistance of a stainless steel tank and eliminates the need for specialized coatings such as glass or epoxy lining.

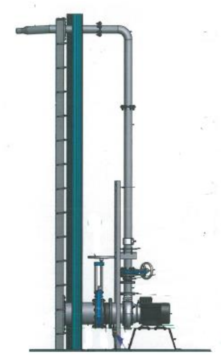
Tank Mixing – For the *Sludge Storage tank system*, Lipp uses two mixing systems in tandem:

1. Side-mounted impeller mixers manufactured by Doda. This is used to create rotational mixing within the reactor. Noteworthy, is that these mixers can be removed from the tank without draining or entering the tank.

2. Hydraulic pump mixing using Simplex system by Landia. This is used to break up foam on top of the liquid layer and to ensure uniform heat distribution from top to bottom by pumping liquid from floor level via a chopper-style pump and spraying it above the top liquid layer.



Mixing System 1 - Doda Side-mount Inpellar Mixer



Mxing System 2 - Landia Simplex Pump-Mix System

ITEM 2 BASIS OF DESIGN

Application:	Sludge Storage Tank
Number of Reactors:	One (1)
Approx. Volume:	60,000 gallons
Required Free Board:	3 feet
Target Dimensions:	20 ft diameter x 29 ft height
Operating Temperature:	Max 140 °F
Planned Mixing System:	One (1) Sidewall “Doda” mixer
Wind Load:	100 mph
Seismic Zone Level:	4

ITEM 3 LIPP TANK SPECS

Number of Reactors:	1
Process Volume per Reactor:	60,000 gallons
Tank Diameter:	20 feet
Tank Height:	29.0 feet
Filling Height:	26.0 feet
Max Operating Temperature:	140 °F
Operating Pressure:	2” W.C

ITEM 4 **SCOPE OF SUPPLY – MATERIALS**

1. One (1) no. of Lipp Tank/s @ 60,000 gallons per tank
2. Flat insulated Roof Structure
    a. Includes 316 Stainless Steel Membrane Covering
3. Mixing Systems
    a. One (1) Sidewall entry Extensible "Doda" mixer assemble units complete / 18.5Kw (50hz)
    b. One(1) Sidewall entry Simplex "Landia" Pump assemble units complete / 18.5Kw (50hz)
4. Pipe Connections
    a. Two (2) 6" flange nozzles / 150# connections.
    b. One (1) 3" flange nozzles / 150# connection
    c. One (1) 4" flange nozzles/ 150# connection
    d. One (1) 10" Overflow flange & piping assemble / 150# connection
5. One (1) sampling pipe at 6" dia. From sump to sidewall connection
6. Manway
    a. One (1) manway at 31" Diameter
    b. Mounted with support backing plate
7. Gas Measurement Gauge
    a. Made of PE pipe with interior weight
8. Safety Systems
    a. Hydraulic Pressure Safety System with Water Trap
    b. One (1) Over /under pressure device

ITEM 5 **SERVICES**

1. Provide Verifiable Structural Calculations
2. Provide Foundation Design

A. Detail, install, and reinforcement plans for all concrete work

3. Erection of Tank
4. Installation of all appurtenances listed herein
5. Sealing Between Foundation Plant And Tank Wall

ITEM 6 SCOPE EXCLUSIONS

- Excavation suitable for supporting the tank in a secure and level position, 2500 psf soils
- Foundation contruction, concrete/ in-floor heating installation
- Uninterrupted accessibility to the job site
- Suitable storage space immediately adjacent to the work area
- All concrete foundation may be required and is NOT included in the price below. – the tank design will be provided to include a foundation drawing and calculations.
- Management of the job site, including the preparation of ramps, snow removal, access roads, and gravel as required for mud control, etc.
- This offer is based on the project site will be an earthquake zone for California local values, and the snow load of max. 20 PSF will not be exceeded.
- Site electricity
- Site or soils testing or reports
- Laboratory testing of any kind
- Site waste disposal (if required)
- Water and disposal of for hydrostatic and pressure testing
- Permits, licenses, approvals, taxes or any other requirements by any government agency
- Bonding
- Piping of any type, other than specified
- Sanitary facilities
- Winter or holiday construction.
- Any other services or products not specifically presented in this proposal

ITEM 7 PRICING

All of the Above.. **$ 319,200.00 USD**

F.O.B. Kenosha-WI, freight excluded, taxes excluded.

ITEM 8 VALIDITY

Purchase Price is valid for twenty (20) calendar days from Quotation date, for shipment of Equipment within the timetable stated below in ITEM 4.

ITEM 9 PAYMENT TERMS

Terms Net 30 days upon invoice

25% due upon purchase order
25% due upon drawings submittal & fabrication approval
30% due upon materials shipment to site
10% due upon completion of tank sidewall
10% due upon final testing and turnover

ITEM 10 TIMETABLE

Submittal phase:	4-6 weeks after the order receipt
Approval phase:	4 weeks for the customer to approve the drawings
Shipment phase:	Following receipt of approval on drawings –
Tank materials:	10-12 weeks
Mixing equipment:	12-16 weeks

Dates are subject to confirmation upon receipt of written Purchase Order.

ITEM 11 WARRANTY

Tank: One (1) year from the equipment start up or six (6) months from tank erection

- Five (5) year warranty available upon request

Sub-systems- mixers, etc: One (1) year from the equipment start up or 18 months from delivery

ITEM 12 TERMS & CONDITIONS

All sales are subject to Centrisys' Terms & Conditions of sale found at the end of this document.

TERMS AND CONDITIONS OF PURCHASE

These terms and conditions apply to all quotations, proposals, orders acknowledgements or confirmations and contracts of Centrisys Corp. (hereinafter "Equipment"). As used in these terms and conditions of sale, the word "Equipment" includes all hardware, parts, components, software and options.

1. **ACCEPTANCE**: Our sale to you is limited to and expressly made conditional on your assent to the terms and conditions of sale herein and, if applicable, on the attendant quotation, both of which form a part of this order and which supersede and reject all prior agreements, representations, discussions or negotiations, whether written or oral, with respect hereto and any conflicting or additional terms and conditions of yours, or any statement therein, whether or not signed by you. We will furnish only the quantities and Equipment specifically listed on our quotations, proposals, or order acknowledgements or confirmations. We assume no responsibility for the terms or conditions of, or for furnishing other equipment or material shown in, any plans and/or specifications for a project to which the equipment quoted or ordered herein pertain or refer.
2. **PRICES**: Unless otherwise specified in writing, all quoted prices are firm for thirty (30) days from the date of offer. Stenographic, clerical and mathematical errors are subject to correction.
3. **DELIVERY**: Dates for the furnishing of services and/or delivery or shipment of equipment are subject to change. Quoted lead times are figured from the date of receipt of complete technical data and approved drawings as such may be necessary. We shall not be liable, directly or indirectly, for any delay in or failure to deliver caused by carriers or delays from labor difficulties, shortages, strikes or stoppages of any sort failure or delay in obtaining materials from ordinary sources, fires, floods, storms, accidents, or other acts of God or force majeure, by any statute, regulation, administrative order or decree or order or judgment of a court of law or other causes beyond our reasonable control. Unless otherwise agreed to in writing by us, in no event shall we be liable for any damages or penalties whatsoever, or however designated, resulting from our failure to perform or delay in performing due to any of the causes specified in this paragraph 3.
4. **SHIPMENT, RISK OF LOSS, TAXES**: Prices are in US Dollars, F.O.B. Centrisys shipping point, unless otherwise noted. Our prices do not include federal, state, municipal or other government excise, sales, use, occupational, processing, transportation or like taxes now in force or enacted in the future. You shall pay any taxes we may be required to collect or pay now or at any time in the future (including interest and penalties imposed by any governmental authority), or any taxes you may be required to pay, that are imposed on the sale, delivery or support of equipment purchased or licensed as a part of this order, or you shall provide us with a tax exemption certificate acceptable to the appropriate taxing authority.
5. **CREDIT AND PAYMENT**: Unless otherwise noted on our quotation, proposal, or order acknowledgement or confirmation payment for equipment shall be thirty (30) days net. Pro Rata payments shall become due with partial shipments. Any discount period which may be granted by us begins on the invoice date and all payments are due thirty (30) days after the invoice date. All payments should be made without deduction, deferment, set-off, lien, or counterclaim of any nature. All amounts due not paid within the thirty (30) days after the date such amounts are due and payable shall bear interest at the lesser of 1.5 percent per month or the maximum rate of interest allowed by law. We reserve the right at any time to suspend credit or to change credit terms provided herein, when, in our sole opinion, your financial condition so warrants. Failure to pay invoices when such invoices are due and payable, at our election, shall make all subsequent invoices immediately due and payable irrespective of terms, and we may withhold all subsequent deliveries until the full account is settled. We shall not, in such event, be liable for delay of the performance or nonperformance of contract in whole or in part subsequent to such event.
6. **CANCELLATIONS AND CHANGES**: Orders which have been accepted by us are not subject to cancellation or changes in specification except upon prior written agreement by us and upon terms that will indemnify us against all losses resulting from or arising out of such cancellation or change in specifications. In the absence of such indemnification, we shall be entitled to recover al damages and costs of whatever nature permitted by the Uniform Commercial Code.
7. **DEFFERED SHIPMENT**: If shipment is deferred at your request, payment of the contract price shall become due when you are notified that the equipment is ready for shipment. If you fail to make payment or furnish shipping instructions we may either extend the time for doing so or cancel the contract. In case of deferred shipment at your request, storage and other reasonable expenses attributable to such delay shall be payable by you.
8. **EQUIPMENT WARRANTY AND REMEDY**
   a. For new equipment only, we warrant to you that the equipment that is the subject of this sale is free from defects in design (provided that we have design responsibility), material and workmanship. The duration of this warranty is twelve (12) months from startup or eighteen (18) months from notification of equipment being ready for shipment ("Warranty Period"). If you discover within the Warranty Period a defect in design, material or workmanship, you must promptly notify us in writing, preserving the equipment for our inspection. Within a reasonable time after such notification we will correct any such defect with either new or used replacement parts, at our option. Such repair, including both parts and labor, is at our expense.
   b. For repairs, parts and service provided by us, we warrant to you that the repairs, parts and service we provide to you will be free from defects in material and workmanship. The duration of this warranty is ninety (90) days from as applicable (i) the date which the machine required the repairs, parts or service is returned to you by us, (ii) the date or your receipt of the part, (iii) the date of repair, if performed at your facility. If during this ninety (90) day period you discover a defect in the repairs, parts or service you must promptly notify us in writing.
   c. All warranty service is subject to our prior examination and approval and will be performed by us at your facility or at one of our service centers designated by us. All transportation to and from the designated service center will be at our expense. If we are unable to repair the equipment to conform to the warranty after a reasonable number of attempts, we will provide at our option, one of the following: (i) a replacement for such equipment, or (ii) a full refund of the purchase price. These remedies are your exclusive remedies for breach of warranty. Unless otherwise agreed in writing by us, our warranty extends only to you

and is not assignable to or assumable by any subsequent purchaser, in whole or in part, and any such attempted transfer shall render all warranties provided hereunder null and void and of no other further force or effect.

d. We will use all reasonable efforts to obtain for you any manufacturer's guarantees or warranties for any sub-assemblies included in the equipment. To the extent such warranties are assignable; we hereby assign to you all warranties that are granted to us by our suppliers of any sub-assemblies contained in the equipment.

e. The warranties set forth above are inapplicable to and exclude (i) any product, components or parts not manufactured by us or covered by the warranty of another manufacturer, (ii) damage caused by accident or the negligence of you or any third party, normal wear and tear, erosion, corrosion or by disasters such as fire, flood, wind and lightning, (iii) damage caused by your failure to follow all installation and operation instructions or manuals or to provide normal maintenance, (iv) damage caused by unauthorized or improper installation of attachments, repairs or modifications, (v) damages caused by a product or component part which we did not design, manufacture, supply or repair, or (vi) any other abuse or misuse by you or any third party.

f. EXCEPT AS SET FORTH IN SUBPARAGRAPHS (a) THROUGH (e) ABOVE, WE DISCLAIM ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO ANY IMPLLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

9. **LIMITATION OF LIABILITY**: In no event shall we be liable, and you hereby waive any claims against us and release us from liability to you, for any indirect, special, punitive, incidental, or consequential damages whatsoever based upon breach of warranty, breach of contract, strict tort, or any legal theory. Excluded damages include, but are not limited to, loss of profits, loss of savings or revenue, loss of use of the equipment or any associated equipment, cost of capital, cost of any substitute equipment, facilities or services, downtime, the claims of third parties including customers, and injury to property. This limitation does not apply to claims for personal injury. Some states do not allow limits on warranties, or on remedies for breach of certain transactions. In such states, certain of the limitations in this paragraph and subparagraph 8(c) do not apply.

10. **OWNERSHIP**: All drawings, designs, and specifications supplied by us have been prepared or assembled by us and is solely our property. Such drawings, designs and specifications have been furnished in order to provide full documentation and on the condition that they shall not be reproduced or copied in any manner whatsoever, in whole or in part, except for your internal use as necessary, and upon further condition that, as our sole property, they shall not be used, in whole or in part, for furnishing information to others or for any purpose not specifically authorized in writing signed by one of our corporate officers. These ownership provisions shall not be superseded by any printed form used in connection with or arising out of a sale induced by a proposal or otherwise.

11. **PATENT INFRINGEMENT**:

(a) We warrant that the equipment in the condition sold to you is free of the rightful claim of infringement of any apparatus claims of any third party U.S. patent issued as of the date of our acknowledgement and acceptance of your order, and we will defend, indemnify and hold you harmless from such claims, provided, however, we make no express or implied warranties of non-infringement and undertake no indemnification in respect to third party rights where the alleged patent infringement is based upon or related to (i) any method, process or product claims in third party U.S. patent, (ii) any combination of the equipment with other equipment not supplied by us, (iii) any modifications of the equipment made by you and not approved by us.

(b) You shall notify us within thirty (30) days of receipt of notice of an alleged third party patent infringement claim that would entitle you to patent infringement indemnification pursuant to paragraph 11(a), and we shall thereupon assume defense of the claim at our expense. We shall have the sole right to settle or otherwise compromise a third party claim, including but not limited to the right to either (i) modify the equipment to avoid infringement if you are agreeable to the modification, (ii) repurchase the equipment from you at a price equal to the then current fair market value of the equipment, (iii) secure rights by the assignment or license to permit continued use of the equipment.

(c) If a third party charges us with patent infringement relating to equipment sold by us to you, we shall have the right to either (i) modify the equipment to avoid infringement if you are agreeable to the modification, (ii) repurchase the equipment from you at a price equal to the then current fair market value of the equipment, (iii) secure rights by the assignment or license to permit continued use of the equipment. If a third party charges us with patent infringement on the basis set forth in paragraph 11 (a)(i), (ii) or (iii), you shall hold us harmless for all expenses and awards of damage against us, and we shall also have the right to modify or repurchase the equipment or to secure rights for continued use by way of assignment or license set forth in this paragraph.

12. **SAFETY AND HEALTH STANDARDS**: The equipment described herein (or on specifications provided herewith) complies with applicable safety and health standards issued pursuant to the Occupational Safety and Health Act of 1970 (the Act) and in effect on this date as such standards are interpreted and understood by us. These standards may be amended and/or their meaning may be clarified prior to shipment or performance, and if such changes or clarification requires changes in the equipment described herein, we shall make the necessary changes available to you. You shall pay for any and all changes at our prices therefore in effect at time of shipment or performance, as the case may be. Because actual compliance by employers with the Act is beyond our control, we cannot and do not represent that the use of the equipment described herein, nor the location, installation or maintenance thereof, will comply with the Act or regulations and standards issued pursuant thereto. We make no representation of compliance with safety and health standards contained in any statute, regulations or ordinance of any state or political subdivision thereof applicable to the equipment described herein unless you have notified us of the existence and contents of such standards and we have agreed in writing to the incorporation of such standards in the specifications relating to such equipment. Nothing in this provision shall operate to modify or affect in any manner whatsoever our disclaimer of any liability for consequential damages contained elsewhere in these terms and conditions of sale.

13. **INSPECTION**: Upon prior written notice, you may make reasonable inspections of equipment at our facility. We reserve the right to determine the reasonableness of the request and to select an appropriate time and location for such inspection. You agree to execute

appropriate confidentiality provisions upon our request prior to visiting our facility. All costs of inspection shall be solely determined by us and shall be payable by you. No inspection or expediting by you at the facilities of our suppliers is authorized.

14. **SOFTWARE PROVISIONS**: If software is provided hereunder, you are granted a nonexclusive, royalty free license only for your use of the software provided with our equipment. Under this license you may: (i) use our software in machine readable code only and only with the equipment provided, (ii) copy our software into any machine readable object code form for backup purposes in support of your use of our software on the equipment provided, and (iii) create one additional copy of the software for archival purposes only. This license may not be assigned, sublicensed or otherwise transferred by you with our prior written consent. You hereby recognize and acknowledge that the software provided to you hereunder comprises valuable trade secret and/or copyright property of Centrisys (or its licensor) and you covenant that you will take adequate precautions against access to the software by, or disclosure of the software to, anyone not authorized hereunder to use or have access to the software.
15. **TIME LIMIT FOR BRINGING SUIT**: Any action you file against us, whether for breach of contract, including but not limited to breach of warranty, or for negligence or strict tort, must be commenced within ninety (90) days following the expiration of the Warranty Period.
16. **MODIFICATION OF TERMS**: The terms and conditions set forth herein are an integral part of our quotation, proposal and/or order acknowledgement or confirmation. These terms shall not be deemed altered, modified or added to by printed or other "standard" terms in the purchase order, acceptance or similar document. Our confirmation or acknowledgement of any order is with the express understanding that all printed or other "standard" language on any such documents submitted by you will be entirely disregarded to the extent that it varies from the terms and conditions of this proposal/offer which may be modified only by typed or handwritten language in the body of you order, acceptance or similar document, together with a written acknowledgement and acceptance of such modification by us.
17. **LIMITATION ON WARRANTIES**: THE WARRANTES SET FORTH HEREIN ARE IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING AN IMPLIED WARRANTY IF MERCHANTABILITY, AN IMPLIED WARRANTY OF FITNESS FOR A PARTICULARPURPOSE, AND AN IMPLIED WARRANTYOF NONINFRINGEMENT. WE HERBY EXPRESSLY EXCLUDE FORM THIS CONTRACT THE IMPLIED WARRANTY OF MERCHANTABILITY, THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, AND THE IMPLIED WARRANTY OF NONINFRINGEMENT, OUR WARRANTIES AND LIABILITIES HEREUNDER ARE LIMITED AS STATED HEREIN.
18. **APPLICABLE LAW**: Any controversy or claim arising out of the contract or the breach thereof shall be finally decided with binding effect on both parties by the courts of Wisconsin and in accordance with the laws of the State of Wisconsin, without giving effect to the provisions thereof relating to conflict of laws. THE EQUIPMENT AND PARTS DESCRIBED IN THESE TERMS AND CONDITIOINS OF SALE MAY CAUSE INJURY IF NOT OPERATED PROPERLY AND FOR THIS REASON ALL OPERATORS SHOULD BECOME THOROUGHLY FAMILIAR WITH THE OPERATING INSTRUCTIONS BEFORE OPERATING THE EQUIPMENT.

TM 5 – Request for Proposals for Biosolids Granule Distribution and Marketing

Jacobs

Challenging today.
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2022 Biosolids Management Plan Update

TM 5 – Request for Proposals for Biosolids Granule Distribution and Marketing

Final

June 2022

Prepared for:

Encina Wastewater Authority

2022 Biosolids Management Plan Update

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Contents

Acronyms and Abbreviations

EWA	Encina Wastewater Authority
RAA	Ron Alexander and Associates
RFP	Request for Proposals
TM	technical memorandum

1. Introduction

As part of the implementation strategy outlined in Technical Memorandum (TM) 4, a short-term activity was identified to develop a Biosolids Market Broker Request for Proposals (RFP). The goal of this activity was to evaluate potential brokers, obtain a 5-year contract with a broker to increase local use of Class A biosolids, and gain insights on product marketability.

2. Request for Proposal Development

RFP development followed three main steps:

1) Develop a draft list of requirements and preferences.
2) Conduct market-sounding sessions with the four potential biosolids distributors that expressed interest during the market update conducted for TM 2
3) Draft RFP language, and develop evaluation criteria.

2.1 Draft List of Preferences and Requirements

Table 5-1 was prepared to summarize Encina Wastewater Authority's (EWA's) initial preferences and requirements and aid in discussions and development of the draft RFP. The table was shared prior to each market-sounding meeting with potential respondents to help communicate EWA priorities and guide the conversations.

Table 5-1. Encina Wastewater Authority Preferences and Requirements

EWA Respondent Requirements	EWA Respondent Preferences
3–5-year contract for the distribution of Class A granulated biosolids. *The goal is contract with 1 or 2 contractors to market and distribute 100% of the Class A granulated biosolids annual production volumes.*	Ability for a single contractor to manage the full production volume. If unable to initially, describe a path for it to occur over time.
Describe annual tonnage commitments.	Engage a single hauler to distribute all Class A product.
Provide EWA with forecasted monthly product tonnage requirements, and to assist in inventory management, will provide forecasted tonnage requests for the upcoming sales week.	EWA will provide a list of existing customers to the successful respondent to allow them to continue marketing to those entities. If arrangements cannot be made to continue sales to existing customers, then EWA retains the right to supply those customers.
Provide a purchase pricing bid, by year of contract. If EWA payments are required, then provide an annual price, with a plan to work to zero cost (or payment) to EWA within the term of the initial contract.	Market in Southern California, or describe a path to regional product marketing.
Continually provide names and locations of EWA customers for regulatory purposes. (monthly)	Have experience using or marketing a minimum of 1,000 tons of granulated biosolids annually.
Must be able to demonstrate experience developing markets, and distributing or using granulated biosolids.	Demonstrate experience with biosolids management and regulatory reporting.
Contractor will receive the product in bulk form, in 25-ton truckloads (with 20-ton minimum).	EWA to retain ownership of up to 5% of annual production for promotional and educational purposes.
Provide hauling services, with retention of two empty trailers onsite at all times.	EWA will not require contractor to distribute or market off-specification product.
Manage delivery of the product on its own; EWA will load trailers.	-
Contractor will be responsible for any regulatory registration, all fees, and reporting requirements for their distribution activities. EWA will only report amounts distributed to contractor.	-
Meet EWA insurance and bonds requirement.	-
Meet EWA trucking and trailer requirements.	-

- = not applicable

2.2 Market-sounding Meetings

The RFP was developed after initial market-sounding meetings conducted on September 23 and 30, 2021. These meetings provided valuable insight to EWA on the strengths, challenges, and interest of each of the firms. Some of the input received during these meetings included:

Factors for successful market development include:

- Commitment from top management down – Consistent and aligned approach through an organization.
- Approach it like a partnership rather than an owner and vendor relationship. Look for opportunities for both sides to share the upside and incentivize that. How do you align goals so both entities benefit?
- Longer terms of contract or at least identify renewal options and commitment to help justify the front-end loading of building a market in the area for the midsize market of 6,000 dry tons.
- Goal: Net positive revenue going back to EWA instead of net 0 – develop a clear model to attain that.

Specific feedback on terms in the RFP:

- Increase term of contract to more than 5 years, or define renewal options.
- Revise "zero cost" to "net positive revenue."
- Separate line item to identify monthly cost of two empty trailers so that is does not increase cost-per-ton pricing.
- Bond requirement – Clarify that that this is a "performance bond," and stipulate $100,000. Because if the intent is to work toward net positive revenue, how can you get a bond when the vendor may be paying EWA money?
- Branding – Consider whether you will allow entity to market under their own brand, rather than PURE GREEN. There are advantages and disadvantages to either approach. It is important and should be addressed.
- Add a requirement or expectation of regular communication: how often do you want meetings, updates, innovative ideas? Include this so everyone is proposing on the same thing.
- Establish process or protocol documenting how to handle problems. Who is responsible, what is the process to address it, what are the procedures?

2.3 Draft Request for Proposals Language

After completing the market-sounding sessions, Jacobs and Ron Alexander and Associates (RAA) developed a draft RFP and evaluation criteria for EWA review. The RFP was finalized and issued on December 2, 2021 as Admin 21-14842 and is included in Appendix 5-A.

3. Evaluation Criteria

Table 5-2 provides the criteria established to evaluate proposals for professional services.

Table 5-2. Evaluation Criteria

Evaluation Criteria	Weight (%)
1. Experience and Technical Competence	25
2. Project Organization and Key Personnel	25
3. Proposed Project Approach and Scope of Services	20
4. Proposed Cost Proposal	30
Total	**100**

4. Results and Discussion

Three proposals were received in response to the RFP, from the following vendors:

- Nutrients Plus
- Synagro – Agromin
- Upcycle

Unfortunately, after review of each of the proposals, EWA determined that none of the approaches met their needs at this time. An unexpected benefit of issuing the RFP and communicating a desire to expand the local biosolids market is an increase in Class A biosolids purchases in spring 2022. The Encina Water Pollution Control Facility continues to be open to partner with distributors and markets to develop a consistent, reliable, and local biosolids market.

Appendix 5-A
Request for Proposal

ENCINA WASTEWATER AUTHORITY
REQUEST FOR PROPOSALS
FOR BIOSOLIDS GRANULE DISTRIBUTION AND MARKETING

Ref: Admin. 21-14842

Encina Water Authority (EWA) is a Joint Powers Authority owned by the City of Carlsbad, City of Vista, City of Encinitas, Leucadia Wastewater District, Vallecitos Water District, and Buena Sanitation District. EWA operates the Encina Water Pollution Control Facility (EWPCF) in Carlsbad, California, where it operates a wastewater treatment plant and Andritz biosolids dryer and granulation system.

EWA is requesting proposals from qualified service providers (VENDORs) for the provision of a Class A dried and granulated biosolids product (granulated product) marketing and beneficial reuse contract for the distribution, sale, usage, and haulage of granulated product from the EWPCF in Carlsbad, California. The proposal shall be for the provision of hauling from the facility, beneficial reuse, and the ongoing management of the granulated product processed at this facility, with the goal of distributing or using as much of the granulated product as possible in Southern California (preferably San Diego County, then other counties in Southern California).

Interested firms may download a copy of the Request for Proposals (RFP) from the link to ebidboard located on the EWA website at https://www.encinajpa.com/work-with-us/procurement. EWA reserves the right to revise the RFP prior to the date that the Proposals are due. All interested contractors must register as plan holders to receive Addenda.

All questions relative to this project should be addressed in writing to the Owner's Project Manager:

Tucker Southern
Encina Wastewater Authority
tsouthern@encinajpa.com

Proposals will be received by the Owner at the Encina Water Pollution Control Facility, 6200 Avenida Encinas, Carlsbad, California 92011 until **2 p.m. (local time) on Tuesday, January 18, 2022.**

The EWA Board of Directors reserves the right to reject any or all Proposals and to waive any irregularities in the information contained therein.

Approved to Advertise as Written: ______________________

Date: December 2, 2021

ENCINA WASTEWATER AUTHORITY

REQUEST FOR PROPOSALS

for the

ENCINA WASTEWATER AUTHORITY

BIOSOLIDS GRANULE DISTRIBUTION AND MARKETING

Ref: Admin 21-14842

December 2, 2021

Proposals Due – Tuesday, January 18, 2022 at 2:00 p.m. (local time) via email: tsouthern@encinajpa.com

Attention: Tucker Southern, Director of Technical Services

Encina Wastewater Authority
6200 Avenida Encinas
Carlsbad, California 92011
(760) 268-8817

1. INTRODUCTION

Encina Water Authority (EWA) is a Joint Powers Authority owned by the City of Carlsbad, City of Vista, City of Encinitas, Leucadia Wastewater District, Vallecitos Water District, and Buena Sanitation District. EWA operates the Encina Water Pollution Control Facility (EWPCF) in Carlsbad, California, where it operates a wastewater treatment plant and Andritz biosolids dryer and granulation system.

EWA is requesting proposals from qualified service providers (VENDORs) for the provision of a Class A dried and granulated biosolids product (granulated product) marketing and beneficial reuse contract for the distribution, sale, usage, and haulage of granulated product from the EWPCF in Carlsbad, California. The proposal shall be for the provision of hauling from the facility, beneficial reuse, and the ongoing management of the granulated product processed at this facility, with the goal of distributing or using as much of the granulated product as possible in Southern California (preferably San Diego County, then other counties in Southern California).

This Request for Proposals (RFP) describes the project background, anticipated scope of services, project schedule, proposal requirements, presubmittal activities, submittal requirements, and the evaluation and selection process. Failure to submit information in accordance with the RFP's requirements and procedures may be cause for disqualification.

Attached to this RFP is a sample of the Agreement with EWA that the selected VENDOR will be expected to execute. Any exceptions that the VENDOR takes with this Agreement shall be identified in their proposal.

2. BACKGROUND INFORMATION

The EWPCF is a conventional activated sludge wastewater treatment plant with liquid capacity of 40.5 million gallons per day (MGD) and 43.3-MGD solids. The EWPCF employs chemically enhanced primary treatment to increase the volume of biogas produced in its anaerobic digesters by reducing the quantity of organic solids oxidized in secondary treatment. The EWPCF routinely achieves over 95% removal rates for influent suspended solids and carbonaceous biochemical oxygen demand.

The highly treated secondary effluent is either returned to the member agencies for recycling or is discharged to the Pacific Ocean through the Encina Ocean Outfall. Solid by-products are anaerobically digested, dewatered, and then dried and granulated (using an Andritz rotary drum dryer DDS-40) to produce approximately 5,000 tons per annum of a high-quality, U.S. Environmental Protection Agency (EPA) Certified Class A Exceptional Quality biosolids granule suitable for use as a fertilizer. The product is branded as “PURE GREEN” and is registered through the California Department of Food and Agriculture (CDFA) as a 5-5-0.2 fertilizer product. The product has a potential to reheat and the VENDOR is responsible for any necessary mitigation once it leaves EWPCF. Attachment 1 provides representative analytical testing data for the granulated product.

As part of the 2020 Biosolids Management Plan Update, EWA reviewed a biosolids market update, and considered short-term and long-term alternatives to provide necessary process capacity and to improve environmental sustainability of their biosolids program. One of the outcomes of this effort is to engage with a VENDOR to reduce their truck hauling distances, where possible, and maximize the beneficial reuse and value of the product produced.

3. SCOPE OF SERVICES

This section provides a brief description of the services to be provided by the VENDOR during execution of this project.

3.1 Beneficial Reuse

EWA desires beneficial reuse of the granulated product from the EWPCF. The VENDOR shall provide all related sales, marketing, end-use, and shipping activities. The VENDOR may market and sell EWA's granulated product under their own approved product label or may use EWA's brand. In this case, EWA will require that a licensing agreement be developed. EWA reserves the right to visit the VENDOR's facility at any time to review the facility operation and how EWA's granulated product is being managed.

3.2 Transportation and Loading

The VENDOR will receive the granulated product in bulk form, in 25-ton truckloads (with a 20-ton minimum). EWA will load and weigh all trucks. The VENDOR shall provide all related transportation and unloading of the product. The VENDOR shall provide daily and reliable removal of the granulated product from the EWPCF facility and all related coordination with the EWA EWPCF operations staff. The VENDOR shall confirm the trailers or containers used for these services are properly loaded per the volume and weight requirements of the Department of Transportation. EWA shall not be subject to penalization by the VENDOR for minimum or maximum loading provisions. Each trailer to be loaded will be weighed prior to loading on a certified scale located at the EWPCF. After loading, the tractor trailer will be weighed again. The differential weight in tons will be recorded. The VENDOR shall meet EWA truck and trailer requirements, with trailers under 13 feet 6 inches in height to allow loading. Specific dimensions of the VENDOR's proposed truck and trailer shall be submitted to EWA for approval.

3.3 Storage Trailers

The VENDOR shall provide and have two (2) trailers at the EWPCF at all times: one that is being loaded on an ongoing basis and one spare. Trailers shall be clean and free of debris and odors such that they do not create nuisance conditions at EWPCF. Trailers provided shall be capable of hauling approximately 20 to 25 tons of granulated product. EWA staff retains the ability to move trailers within the EWPCF.

3.4 Distribution and Marketing (Responsibilities)

The VENDOR shall provide all related marketing and sales information and provide end-use assistance to the end user. EWA will reserve the right to direct market 5% of the annual production of the granulated product.

EWA will provide a list of existing customers to the VENDOR to allow them to continue marketing to those entities. If arrangements cannot be made to continue sales to existing customers, then EWA retains the right to supply those customers at their sole discretion.

3.5 Pickup and Hauling Schedule

Loading of the granulated product from the EWPCF will only be allowed weekdays 8 a.m. through 4 p.m. (no weekends or holidays). Any deviations from the load schedule must be approved by EWA's designated contact 24 hours in advance.

3.6 Schedule Coordination and Forecasting

The VENDOR will provide EWA with product tonnage requirements on a monthly basis, and to assist in inventory management, will provide tonnage requests for the upcoming calendar week. This may be completed through verbal or written (email) communications. EWA will also require quarterly planning meetings with the VENDOR.

3.7 VENDOR Responsiveness

The VENDOR shall be able to adjust hauling schedules as needed within a 24-hour notice from EWPCF staff. The VENDOR shall provide a single point of contact for coordination of hauling schedules.

3.8 Reporting

The VENDOR will register the granulated product with the CDFA, complete all reporting paperwork, and pay fees associated related to the registration and sale of granulated product. EWA will only report amounts distributed to the VENDOR. The VENDOR will provide names and locations of customers to EWA on an ongoing basis (at least monthly) for regulatory purposes.

4. ADDITIONAL REQUIREMENTS AND PREFERENCES

4.1 EWA Preferences for VENDORs

- EWA prefers a single vendor to manage the full production volume. If unable to initially, outline a path for full production to be managed by one VENDOR over time.
- EWA prefers VENDORs that possess experience using or marketing a minimum of 1,000 tons of granulated biosolids annually.
- EWA prefers VENDORs that can demonstrate experience with biosolids management and regulatory reporting.
- EWA will not require the VENDOR to distribute non-Class A product.

4.2 TRUCKING

- Truck drivers shall always adhere to traffic regulations, both on the EWPCF site and offsite.
- Trucks and trailers must be appropriately registered with the State of California, insured, and maintained in good working order, without leakage, and in a good state of cleanliness. Trailers and containers shall be secured such that residuals spillage from the vessel does not occur. The VENDOR will be responsible for the cleanup and reporting of any spillage that occurs during transport.
- EWA reserves the right to request that drivers not adhering to safe practices and following all applicable policies and procedures be prohibited from granulated product hauling activities for EWA product.

- The VENDOR shall make every effort to avoid nuisance conditions to the community. Odor and noise mitigation measures shall be taken as needed. Use of jake brakes near plant sites and in adjacent neighborhoods will not be allowed.
- EWA prefers (not required) that the VENDOR use a single hauler to distribute all Class A product.

4.3 EWPCF Site Access

- EWA facilities are secured sites, and entrance and exit procedures shall be adhered to all times.
- The VENDOR will have access only to specified locations onsite.

4.4 Insurance and Bonding Requirements

The VENDOR will meet the insurance requirements identified in Attachment 2 - Sample Agreement.

The VENDOR, simultaneously with the execution of the contract, will be required to furnish a faithful performance bond in an amount equal to $100,000. The bond will be used for contract nonperformance, parameters of which will be negotiated with the VENDOR. The bond shall be executed by an admitted surety approved to conduct business in the State of California, pursuant to California Code of Civil Procedure Section 995.120.

All Bidders are notified that bonds required to be submitted relating to this contract must comply with California Code of Civil Procedure Section 995.630 and be executed by a person authorized by virtue of a valid Power of Attorney, which is in effect and on file with the County Clerk of the County of San Diego.

5. RFP PROJECT SCHEDULE

The following is the anticipated schedule for the selection and award of a contract related to the services described in this RFP. EWA may adjust the following schedule as needed. Note: All times shown as Pacific Standard Time (PST).

EVENT	ANTICATED DATE
Solicit Proposals	December 2, 2021
Optional Site Visit	To be scheduled and completed by VENDOR no later than December 22, 2021
Questions Due	December 23, 2021; 5:00 p.m.
EWA Responses to Questions	January 11, 2022; 5:00 p.m.
Proposal Due	January 18, 2022; 2:00 p.m.
Virtual Interview of VENDORs (if necessary)	Week of January 24, 2022
Issue Notice of Award	February 24, 2022

6. PROPOSAL REQUIREMENTS

Proposals shall be concise and well organized, and demonstrate the responder's experience applicable to the project and the project approach. Proposals shall be limited to 25 one-sided pages (8.5 inches by 11 inches), exclusive of resumes, dividers, and front and back covers. It is requested that resumes be limited to 2 pages each and that the use of standardized marketing literature be limited. Excessive marketing literature may not be reviewed.

EWA may reject any proposal or any part thereof that is incomplete, inadequate in its response, or departs in any substantive way from the required format as nonresponsive at its sole discretion. Proposals submitted in response to this RFP shall be in the order indicated in the following subsections.

6.1 Cover Letter and Letter of Intent

Introduction letter with intent as it may pertain to the RFP. The letter should include a clear, concise explanation as to why the EWA should select your firm for this work. The letter should also include the following:

- Legal name and address of company
- Legal form of company (for example, partnership, corporation, joint venture)
- Identification of any parent companies
- Addresses of offices in San Diego County and number of employees
- Name, title, address, and telephone number of person to contact concerning this RFP

6.2 Qualifications

The Qualifications Section of the proposal shall be concise and well organized, and shall demonstrate the responder's qualifications and experience applicable to the project and project approach. This section shall include background information on the organization and should give brief details of experience with similar projects in marketing dried biosolids or recycled organic materials.

6.3 Experience and Competence

A minimum list of three references (including contact persons with telephone numbers and email addresses) for which similar work has been performed shall be included, and the list shall include similar contracts (or projects) performed by the VENDOR in the past 5 years. Include a brief description of the project, date initiated, date ended (if applicable), project costs, name of owner and owner's project manager with phone number and email address. Failure to provide this list may result in the rejection of the VENDOR's proposal.

The selection committee may check with these sources to determine whether the VENDOR has appropriately listed similar work efforts. If the selection committee determines that references for other similar efforts were not listed, the Panel may contact these entities to make inquiry into the VENDOR's performance of those efforts, and the information obtained may be considered in evaluating VENDOR's proposal.

6.4 Project Organization and Key Personnel

Describe the proposed project organization, including identification and responsibilities of key personnel and subcontractors with an Organization Chart. Identify specialty contractors and their specific role. Identify role of the key personnel proposed for EWA's project, and their qualifications and experience for this project, including resumes citing experience with similar projects, the responsibilities to be assigned to each person, and their main work location. Describe the experience of any subconsultants.

6.5 Project Understanding, Approach, and Schedule

In this section, set forth in narrative, outline, or graphical form (or a combination of these), the VENDOR's approach to accomplish the tasks outlined in the Scope of Work section of this RFP. A description of each task and the schedule for accomplishing each shall be included.

6.6 Price Proposal

The Cost Proposal shall be submitted and outline costs and payments to EWA, as well as any cost-sharing options, on a per ton basis (as is weight), as shown in Table 1.

Table 1. Cost Proposal

Cost Item	Year Required				
Cost to EWA (per ton)	Year 1	Year 2	Year 3	Year 4	Year 5
Payment to EWA (per ton)	Year 1	Year 2	Year 3	Year 4	Year 5
Tonnage Commitment	Year 1	Year 2	Year 3	Year 4	Year 5

A separate quote for rental and usage of the storage trailers required as outlined in Section 3 should also be supplied or explained in a combined quotation.

VENDORs must provide a purchase pricing bid (by ton), by year of the contract. If EWA payments are required, then provide an annual price, with a plan to work to zero cost (or payment) to EWA within the term of the initial contract. Any cost-sharing concepts should also be included in this section.

6.7 Exceptions to the Request for Proposal

The VENDOR shall certify that it takes no exceptions to this RFP, including EWA's standard Agreement as attached. If the VENDOR does take exception to any portion of the RFP or Agreement, the specific portion of the RFP or Agreement to which exception is taken shall be identified and explained.

7. PRESUBMITTAL ACTIVITIES

7.1 Questions Concerning RFP

Upon review of the RFP documents, VENDORs may have questions to clarify or interpret the RFP to submit the best proposal possible. To accommodate the Proposal Questions process, VENDORs shall submit any such questions by the identified due date. EWA will not entertain any further questions after the due date. Questions shall be emailed to Mr. Tucker Southern at tsouthern@encinajpa.com by the date and time specified herein. VENDORs should enter "Biosolids Granule Distribution and Marketing Questions" as the subject of the email. Questions should include a reference to the applicable RFP section.

Questions received prior to the submission deadline date, EWA's response, and any additional terms deemed necessary by EWA will be emailed to all interested VENDORs in the form of an Addendum and shall become an Addendum to this RFP. No information, instruction, or advice provided orally or informally by any EWA personnel, whether made in response to a question or otherwise related to this

RFP, shall be considered authoritative or binding. VENDORs shall rely only on written material contained in an Addendum to this RFP.

7.2 Preproposal Site Visit

VENDORs are encouraged to schedule a site visit no later than December 22, 2021. Site visits will be allowed between 9 a.m. and 3 p.m. To schedule a preproposal conference or site visit or obtain samples of the granulated product, please send an email to Mr. Joe Cipollini at jcipollini@encinajpa.com, providing the name, organization, email address, title of individual who wishes to attend a site visit, along with proposed date and time for the site visit.

8. SUBMITTAL REQUIREMENTS

Proposal submittal will only be accepted electronically, submittal by email to Tucker Southern at tsouthern@encinajpa.com. Proposals must be clearly marked with name of the submitting company, the RFP title, “Biosolids Granule Distribution and Marketing.” VENDORs must submit one *electronic version, submitted as a viewable and printable Adobe Portable Document File (PDF), on or before the submittal due date and time*. Submissions that do not comply with the stated submission method will be deemed nonresponsive.

Failure to comply with the requirements of this RFP may result in disqualification. Proposals received subsequent to the time and date specified will not be considered.

EWA reserves the right to reject any or all proposals for any reason and to waive any informality it deems in its best interest. Any requirements in the RFP that cannot be met must be indicated in the proposal. VENDORs must respond to the entire RFP. Any incomplete proposal may be eliminated from competition at the discretion of EWA. Proposals must follow the format defined in Section 5.

All proposals, responses, inquiries, or correspondence relating to or in reference to this RFP, and all reports, charts, and other documentation submitted by VENDORs (other than materials submitted as and qualifying as trade secrets under California law) shall become the property of EWA when received; and the entire proposal shall be subject to the public records laws of the State of California, except where a proper trade secret’s exception has been made by the VENDORs in accordance with the procedures allowed by California law. EWA reserves the right to retain all proposals submitted and to use any ideas in a proposal regardless of whether that proposal is selected. Submission of a proposal indicates acceptance by the VENDOR of the conditions contained in this RFP.

9. VENDOR NOMINATING AND SELECTION PROCESS

9.1 Proposal Evaluation Process

EWA shall review all VENDOR responses to this RFP to confirm that they meet the specifications and requirements of the RFP. A Selection Panel (Panel) will be established for this project by the EWA. Using the established evaluation criteria, the Panel will evaluate the submissions based on the proposal’s completeness and content, the VENDOR’s personnel, project organization, experience with similar projects, approach, and Cost Proposal, and other information included in the proposal. EWA may choose to interview some short-listed firms.

EWA's pandemic policies may allow for in-person interviews, so interviews may be virtually or in person. At the time of short-listing, EWA will advise on the current policies. The interview will consist of a presentation of the VENDOR's qualifications, experience on similar projects, explanation of any ideas the firm has that may have a bearing on the overall project, and a question and answer period. VENDORs are cautioned, however, that the review committee is not required to request presentations or other clarification (and often do not). Therefore, all proposals should be complete and reflect the most favorable terms available from the VENDOR. EWA may request that the key project staff attend the interview.

VENDORs are cautioned that this is a request for offers, not an offer or request to contract, and EWA reserves the unqualified right to reject any and all offers at any time if such rejection is deemed to be in the best interest of EWA.

After the interviews, firms will be re-evaluated and ranked based upon the combined proposal and interview process. EWA reserves the right to eliminate the interview step of the procurement process and also reserves the right to cancel the RFP process.

The Panel may make a recommendation at the appropriate level for a contract award. Upon approval of this recommendation, EWA staff will coordinate with the selected firm to complete and execute the attached Agreement. Prices quoted must be held firm for 90 days after the RFP is due. EWA reserves the right to make an award without further discussion of the proposal submitted. EWA shall not be bound or in any way obligated until both parties have executed a contract. EWA also reserves the right to delay the award of a contract or to not award a contract.

10. CONTRACT TERM

The Contract shall have an initial term of 5 years, beginning on the date of contract award (the Effective Date). EWA shall have the option to renew the Contract on the same terms and conditions for up to a total of five additional 1-year terms. EWA will give the VENDOR written notice of its intent whether to exercise each option by a duly authorized amendment. Both parties would then have to agree to the terms of the extension.

11. COMPENSATION AND INVOICES

EWA shall submit monthly to the VENDOR an invoice for all biosolids distributed to or by the VENDOR. Payment shall be made to or from the EWA within 30 calendar days of receipt of invoice.

12. REVISIONS TO THE RFP

EWA reserves the right to revise the RFP prior to the date that proposals are due. Revisions to the RFP will be made available to all registered plan holders. EWA reserves the right to extend the date when proposals are due.

The RFP shall comprise the base RFP document, any attachments, and any Addenda released before Contract award. All attachments and Addenda released for this RFP in advance of any Contract award are incorporated herein by reference. All interested VENDORs shall register as plan holders to receive Addenda.

13. SIGNATURE PAGE

A signature must accompany the proposal response.

By submitting this proposal, the potential vendor certifies the following:

- This proposal is signed by an authorized representative of the firm.
- The potential VENDOR has read and understands the conditions set forth in this RFP, to include Standard Terms and Conditions, general conditions, service terms, any Addenda, and all attached exhibits, and agrees to them with no exceptions.

By: ____

Name: _____________________________________

(Signature) _________________________________

(Printed) ___________________________________

Title:_______________________________________

Date: ______________________________________

14. INSTRUCTIONS TO PROSPECTIVE VENDORS

Prospective VENDORS are **required** to register at eBidboard to receive Addenda and other project updates. EWA reserves the right to reject any and all proposals, to waive any informality in proposals, and unless otherwise specified by the VENDOR, to accept any item in the proposal. If either a unit price or an extended price is obviously in error and the other is obviously correct, the incorrect price will be disregarded.

14.1 Withdrawal of Proposal

A proposal may be withdrawn only in writing and actually received by the office issuing the RFP prior to the time for the opening of proposals identified on the cover page of this RFP (or such later date included in an Addendum to the RFP). A withdrawal request must be on VENDOR's letterhead and signed by an official of the VENDOR authorized to make such request. Any withdrawal request made after the opening of proposals shall be allowed only for good cause shown and in the sole discretion of EWA.

14.2 Informal Comments

EWA shall not be bound by informal explanations, instructions, or information given at any time by anyone on behalf of EWA during the competitive process or after award. EWA is bound only by information provided in this RFP and in formal Addenda issued through eBidboard.

14.3 Cost for Proposal Preparation

Any costs incurred by the VENDOR in preparing or submitting offers are the VENDOR's sole responsibility; EWA will not reimburse any VENDOR for any costs incurred prior to award.

14.4 VENDOR's Representative

Each VENDOR shall submit with its proposal the name, address, telephone number, and email address of the person with authority to bind the firm and answer questions or provide clarification concerning the firm's proposal.

14.5 Subcontracting

A VENDOR may propose to subcontract portions of the work to identified subcontractors, provided that its proposal clearly describes what work it plans to subcontract and that the VENDOR includes in its proposal all information regarding employees, business experience, and other information for each proposed subcontractor that is required to be provided for the VENDOR itself.

14.6 Inspection at VENDOR's Site

EWA reserves the right to inspect, at a reasonable time, the equipment or item, plant, or other facilities of a prospective VENDOR prior to Contract award, and during the Contract term as necessary, for EWA determination that such equipment or item, plant, or other facilities conform with the specifications and requirements and are adequate and suitable for the proper and effective performance of the Contract.

14.7 Notice to VENDORs Regarding RFP Terms and Conditions

It shall be the VENDOR’s responsibility to read the instructions, EWA’s terms and conditions, all relevant exhibits and attachments, and any other components made a part of this RFP and comply with all requirements and specifications herein. VENDORs also are responsible for obtaining and complying with all Addenda and other changes that may be issued related to this RFP.

Respectfully requested,

Scott McClelland
Interim General Manager

Attachments:

1. Example Product Characteristics
2. Sample Agreement

ATTACHMENT 1

EXAMPLE PRODUCT CHARACTERISTICS

REPORT DATE
Nov 08, 2021

SEND TO
20352

RECEIVED DATE
Oct 21, 2021

ISSUE DATE
Nov 08, 2021

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ENCINA WASTEWATER AUTHORITY
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6200 AVENIDA ENCINAS
CARLSBAD CA 92011

REPORT OF ANALYSIS

For: (20352) ENCINA WASTEWATER AUTHORITY
Sample Analysis

Analysis	Level Found As Received	Level Found Dry Weight	Units	Reporting Limit	Method	Analyst-Date	Verified-Date
Sample ID: **Encina Pellets**	Lab Number: **70012964**	Date Sampled: **2021-10-15 q**					
Ammonium nitrogen (total)	0.280	0.302	%	0.001	AOAC 920.03 (mod)	krg0-2021/10/22	eas2-2021/10/26
Bulk density (loose)	0.66		g/cm³	0.01	WC 069	Rpk5-2021/10/22	eas2-2021/10/26
Bulk density (packed)	0.70		g/cm³	0.01	WC 069	Rpk5-2021/10/22	eas2-2021/10/26
Humic acid	12.77		%	0.10	Calif HA4/JC (rev. 2:3-11-09)	eas2-2021/11/08	asl4-2021/11/08
Loss on ignition (OM)	67.2	72.4	%	0.01	MWL WC PROC 60	Mmg9-2021/10/26	eas2-2021/10/26
Nitrate-nitrogen	n.d.	n.d.	%	0.01	WC PROC 32	Rpk5-2021/10/26	eas2-2021/10/26
pH	6.92		S.U.	0.01	EPA 9045	Hgm9-2021/10/26	eas2-2021/10/26
Potash (K2O)	0.24	0.26	%	0.05	MWL ME PROC 26	Auto-2021/10/26	eas2-2021/10/26
Salt index	3			1	SOIL CH ANLY JACKSON P.245 *	jed2-2021/10/27	eas2-2021/10/29
Total organic carbon (TOC)	35.70		%	0.01	ASTM D 5373 (mod)	jmr5-2021/10/28	eas2-2021/10/29
Phosphate (P2O5)	7.30	7.88	%	0.10	MWL ME PROC 26	Auto-2021/10/26	eas2-2021/10/26
Water soluble nitrogen	0.26		%	0.01	Calculation	Auto-2021/10/27	Auto-2021/11/08
Chloride	0.15	0.16	%	0.01	Soil Sci. & Plant Anal. 1970	mrb3-2021/10/25	eas2-2021/10/26
Barium (total)	290	312	mg/kg	0.50	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Organic nitrogen	n.d.	n.d.	%	0.01	Calculation	Auto-2021/10/27	Auto-2021/11/08
Percent solids	92.8		%	0.01	SM 2540 G-(1997) *	Mmg9-2021/10/26	jdb5-2021/10/26
Silver (total)	n.d.	n.d.	mg/kg	1.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Arsenic (total)	n.d.	n.d.	mg/kg	10.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Boron (total)	15.6	16.8	mg/kg	5.00	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31

The result(s) issued on this report only reflect the analysis of the sample(s) submitted.

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CARLSBAD CA 92011

REPORT OF ANALYSIS

For: (20352) ENCINA WASTEWATER AUTHORITY
Sample Analysis

Analysis	Level Found As Received	Level Found Dry Weight	Units	Reporting Limit	Method	Analyst-Date	Verified-Date
Sample ID: Encina Pellets Lab Number: **70012964** (con't)							
Calcium (total)	31300	33730	mg/kg	20.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Cadmium (total)	n.d.	n.d.	mg/kg	0.50	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Cobalt (total)	n.d.	n.d.	mg/kg	1.00	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Chromium (total)	34.1	36.7	mg/kg	1.00	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Copper (total)	426	459	mg/kg	1.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Iron (total)	32770	35310	mg/kg	5.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Mercury (total)	0.21	0.23	mg/kg	0.05	EPA 7471	mrs3-2021/10/29	kkh9-2021/10/31
Potassium (total)	1573	1695	mg/kg	10.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Magnesium (total)	6265	6751	mg/kg	5.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Manganese (total)	181	195	mg/kg	1.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Molybdenum (total)	12.0	12.9	mg/kg	1.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Sodium (total)	1014	1093	mg/kg	5.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Nickel (total)	14.7	15.8	mg/kg	1.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Phosphorus (total)	29830	32140	mg/kg	5.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Lead (total)	6.7	7.2	mg/kg	5.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Sulfur (total)	19100	20600	mg/kg	10.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Selenium (total)	n.d.	n.d.	mg/kg	10.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Zinc (total)	793.5	855.1	mg/kg	2.0	EPA 6010	ery3-2021/10/25	kkh9-2021/10/31
Magnesium (water soluble)	5660		mg/L	10	MWL ME PROC 26	alm2-2021/10/29	eas2-2021/10/29

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REPORT OF ANALYSIS

For: (20352) ENCINA WASTEWATER AUTHORITY
Sample Analysis

Analysis	Level Found As Received	Level Found Dry Weight	Units	Reporting Limit	Method	Analyst-Date	Verified-Date
Sample ID: Encina Pellets Lab Number: **70012964** (con't)							
Potassium (soluble, as K2O/Potash)	0.17		%	0.01	AOAC 2015.18 *	alm2-2021/10/25	eas2-2021/10/26
Copper (water soluble)	237		mg/L	10	MWL ME PROC 26	alm2-2021/10/29	eas2-2021/10/29
Manganese (water soluble)	179		mg/L	10	MWL ME PROC 26	alm2-2021/10/29	eas2-2021/10/29
Zinc (water soluble)	600		mg/L	10	MWL ME PROC 26	alm2-2021/10/29	eas2-2021/10/29
Carbon nitrogen ratio C/N	5 : 1			0.1	Calculation	Auto-2021/10/27	Auto-2021/11/08
Carbon (total)	31.44	33.88	%	0.05	ASTM D 5373 (mod)	mdh0-2021/10/26	eas2-2021/10/26
Nitrogen (total)	5.75	6.20	%	0.01	MWL WC PROC 55	mdh0-2021/10/27	asl4-2021/11/01
Phosphorus (total)	3.19	3.44	%	0.05	MWL ME PROC 26	ras7-2021/10/22	eas2-2021/10/26
Potassium (total)	0.20	0.22	%	0.05	MWL ME PROC 26	ras7-2021/10/22	eas2-2021/10/26

n.d. = not detected , ppm = parts per million, ppm = mg/kg

For questions please contact:

Heather Ramig
Senior Account Manager
hramig@midwestlabs.com (402)829-9891

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REPORT OF ANALYSIS
For: (20352) ENCINA WASTEWATER AUTHORITY
Sample Analysis

Detailed Method Description(s)

ICP Analysis Fertilizers AOAC 985.01 (mod)

Analysis follows MWL ME 026 which is based on AOAC 985.01. Samples have been prepared using MWL WC 056. Total minerals in fertilizers have been prepared by AOAC 957.02 using mineral acids and heat. Water soluble manganese is prepared by AOAC 972.03 and the other water soluble by AOAC 977.01. Sample analysis involves moving the sample extract into the ICP where it is nebulized and introduced into the high temperature plasma which energizes the electrons of the dissolved minerals/metals. As the energized electrons of the minerals/metals return to ground state, energy is released as light. The emitted wavelength(s) and light intensities are used to identify and quantitate the minerals/metals in the sample

Ammonia (fertilizer/compost)

Analysis follows WC 015 which is based on AOAC 920.03. A sample is placed in a distillation tube and a standard base added to convert ammonium to ammonia. The ammonia is distilled into an acid solution. The acid solution is titrated with a standard acid.

Calculation

Analytical results are entered into applicable formulas to provide a calculated result which is reported.

Bulk Density

Method modified from USP <616> Method I

Carbon/nitrogen in coal ASTM D 5373 (mod)

Sample analysis follows MWL PR 263 which references ASTM D 5373 (modified). Samples are placed in a combustion instrument where carbon is oxidized in oxygen to produce carbon dioxide and nitrogen compounds are converted to elemental nitrogen and the levels determined. The modification indicated is the matrix analyzed is not part of the ASTM scope.

Elemental combustion Nitrogen, Carbon, Hydrogen

Analysis follows MWL WC 055 which is based on AOAC 993.13. Samples are ground to a fine, homogenous consistency and a small amount weighed and introduced into the instrument. The sample is burned in the presence of oxygen to release gases such as carbon dioxide, nitrogen, and hydrogen and the levels of a specific gas determined and reported.

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REPORT OF ANALYSIS

For: (20352) ENCINA WASTEWATER AUTHORITY
Sample Analysis

Humic Acid

Sample analysis follows MWL WC 059 which is based the California HA4/JC(revision 2: 3-11-09 procedure. Samples are dissolved by treatment with 1 N sodium hydroxide and then precipitated with hydrochloric acid. The resultant precipitate is dried and weighed and the result posted in %.

SM 2540 G

Analysis follows MWL WC 060 which is based on SM 2540 G. A sample is weighed and dried to a constant weight. The sample is then re-weighed and calculations are applied.

WC PROC 32

The extraction phase is based on ASA (American Society of Agronomy) chapter 38 and uses potassium chloride as the extracting solution. The extract is analyzed by automated cadmium reduction based on EPA 353.2

pH METER

Analysis follows MWL WC 061 which is based on EPA 9045. The sample is mixed with water and the pH of the resulting aqueous solution is measured.

Chloride by Soil Sci. & Plant Anal. 1970

Sample analysis follows MWL WC 054 which is based on a method published in the 1970 volume of Soil Science and Plant Analysis pp 1-6. The sample is extracted with dilute sodium hydroxide and a silver nitrate solution is used to titrate the extract to a potentiometric end point.

ME 042

Analysis follows MWL ME 042 which is based on EPA 6010b, Inductively Coupled Plasma (ICP). A light emission technique where prepared samples are injected into a high energy plasma that forces the elements in the injected sample to emit light energies which are proportional to the level of minerals and metals present. The light is then detected and correlated to the levels of minerals and metals in the original sample.

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REPORT OF ANALYSIS

For: (20352) ENCINA WASTEWATER AUTHORITY
Sample Analysis

ME 067

Samples are analyzed for mercury using MWL ME 067 which is based upon EPA 7471, cold vapor atomic absorption (CVAA).

Samples are prepared via MWL ME 037 that uses a series of digestion steps involving hot mineral acids and oxidizers so as to destroy organic matter and solubilize mercury. The mercury is reduced by use of stannous chloride to elemental mercury that is then aerated to the light path of a mercury light of an atomic absorption spectrometer (AAS). The absorption of the mercury light at 253.7 nm is then correlated to the level of mercury present in the original sample.

Fertilizer Prep AOAC 957.02

Samples are prepared using a combination of nitric acid and heat. The heating takes place in a block digestor

AOAC 957.02 (P2O5 preparation)

Samples are treated with hydrochloric acid and nitric acid on a hot plate to destroy organic material and dissolve phosphate.

ATTACHMENT 2

SAMPLE AGREEMENT

TECHNICAL SERVICES AGREEMENT

BETWEEN ENCINA WASTEWATER AUTHORITY

AND ______________________________

FOR BIOSOLIDS GRANULE DISTRIBUTION AND MARKETING PROJECT

This Technical Service Agreement ("Agreement") is made and entered into this_____day of _________, ____, ("Effective Date") by and between the ENCINA WASTEWATER AUTHORITY ("EWA") and ____, ("CONTRACTOR"), an independent contractor, with a principal place of business in _______________.

WITNESSETH

WHEREAS, CONTRACTOR has submitted to EWA a proposal to provide biosolids granule distribution and marketing services.

WHEREAS, it has been determined that it is in the best interests of EWA to enter into the Agreement hereinafter contained.

NOW, THEREFORE, in consideration of the mutual promises, conditions and covenants herein contained, the parties hereto agree as follows:

ARTICLE 1. SCOPE OF WORK

CONTRACTOR shall perform the services described in the Request for Proposals Re Biosolids Granule Distribution and Marketing, including any attachments and addendum, and CONTRACTOR's Proposal, incorporated and collectively referred to herein as the "Scope of Work." CONTRACTOR shall furnish all materials, equipment, supplies and incidentals necessary to perform the Scope of Work, except those which are expressly designated to be furnished by EWA. All work performed and materials supplied in the execution of this Agreement shall comply with applicable laws, standards, codes and regulations governing such materials, items and work. All material is guaranteed to be as specified in the Scope of Work. Any alteration or deviation from the specifications, which is material and/or involves extra costs, must be approved by in advance.

ARTICLE 2. TERM AND TERMINATION

A. Term. The Agreement will have a term of five (5) years beginning on the date of contract award (the Effective Date). At EWA's sole discretion, EWA may extend the term of this Agreement for up to five (5) additional one-year terms.

B. Termination. If EWA determines that CONTRACTOR's work is unsatisfactory or that CONTRACTOR has breached a term of this Agreement, EWA may notify CONTRACTOR in writing of such defect or failure to perform; which notice must give CONTRACTOR at least five (5) work days to perform said work or cure the deficiency. If CONTRACTOR has not performed the work or cured the deficiency within the time specified in the notice, EWA may terminate this Agreement immediately by written notice to CONTRACTOR. In lieu of termination, the Parties may negotiate a good faith adjustment of compensation. CONTRACTOR shall discontinue all affected work as of the date of termination. Thereafter, neither party shall have any further duties, obligations, responsibilities, or rights under this Agreement, except, however, any and all indemnification, hold harmless and defense obligations of CONTRACTOR shall remain in full force and effect. Upon termination of this Agreement, CONTRACTOR shall be entitled to the reasonable value of its services necessarily performed up to the effective date of termination, minus any offset from such payment representing EWA's damages from such breach. EWA reserves the right to delay any such payment, to allow for a full and complete accounting of costs. In no event, however, shall CONTRACTOR be entitled to receive in excess of the compensation quoted in its bid.

ARTICLE 3. TIME OF PERFORMANCE

CONTRACTOR shall not begin any of the work specified in this Agreement until authorized by in writing to proceed. CONTRACTOR agrees to complete said work according to the schedule contained in the Scope of Work and to the entire satisfaction of EWA before final payment is made. The time for performance of any work under this Agreement may be extended, or suspended, in the reasonable discretion of EWA, based on unavoidable disruption of work due to strikes, lockouts, government acts, epidemics/pandemics, acts of God and other similar conditions shown by CONTRACTOR or to be beyond their control.

ARTICLE 4. COMPENSATION

A. Fee Schedule. Compensation for all of the labor, equipment, materials and services which CONTRACTOR is obligated to perform under the terms and conditions of this Agreement, including all applicable taxes, shall not exceed the amount set forth in detail in the Scope of Work.

B. Payment. CONTRACTOR shall submit monthly invoices to EWA's Accounts Payable department (at accountspayable@encinajpa.com) and to EWA'S Project Manager. Such invoices shall represent the value of the items delivered or services provided during the billing period and any credits to which EWA is entitled under the Scope of Work. Prepayments will not be made, at any time, during the execution of this Agreement. Such invoices shall be prepared in such form and supported by documentation as may reasonably require including a brief narrative description of the work performed.

1. Payment shall be made by EWA to CONTRACTOR within thirty (30) days of receipt of an approved invoice. The amount of this payment will be less any amounts previously paid on the account.

2. EWA shall have the right to withhold payment from CONTRACTOR for any unsatisfactory services until such time service is performed satisfactorily or as otherwise provided for in this Agreement. EWA's acceptance of, or payment for any of CONTRACTOR's services, shall not operate as a waiver of any rights under this Agreement or of any cause of action or defense relating to the performance of this Agreement.

ARTICLE 5. CONTRACTOR OBLIGATIONS

A. Contractor's Qualifications. CONTRACTOR represents that it is skilled in the technical expertise necessary to provide the services required under this Agreement, including without limitation biosolids hauling. CONTRACTOR agrees to perform its work hereunder in a competent manner acceptable to and in conformity with the requirements of this Agreement and applicable industry standards. EWA's oversight and acceptance of reports, work or materials furnished hereunder, shall not relieve CONTRACTOR of responsibility for the technical adequacy of its work. CONTRACTOR will employ only competent workers to complete the work under this Agreement and shall be solely responsible for training, supervising and directing those workers.

B. Permits, Licenses and Certifications. CONTRACTOR shall at its sole expense secure and maintain in good standing for the term of this Agreement any and all permits, licenses and certifications required to perform the Scope of Work, including without limitation biosolids hauling. CONTRACTOR shall provide proof of any such permits and licensure upon request by EWA.

C. Subcontracting. CONTRACTOR shall not subcontract any work to be performed under this Agreement, except with the prior written approval of EWA. CONTRACTOR will be solely responsible for its subcontractors and for ensuring work performed by subcontractors conforms to this Agreement. No subcontractor shall be considered a beneficiary to this Agreement.

D. Employer Obligations. CONTRACTOR shall be solely responsible for paying all federal and state employment and income taxes for its employees, for carrying workers' compensation insurance and for otherwise complying with all other employment law requirements with respect to CONTRACTOR and its employee(s).

E. Safety. CONTRACTOR shall be solely and completely responsible for the safety of all CONTRACTOR employees, including employees of any subcontractors, during performance of the Scope of Work. CONTRACTOR shall ensure that such employees have adequate training on relevant safety matters and that they are issued any and all necessary personal protective equipment.

F. Compliance with Laws/Rules. In performing the Scope of Work specified in this Agreement, CONTRACTOR agrees to comply with all laws, rules, regulations and ordinances, whether federal, state or local, and any and all policies, procedures, departmental rules and other directives applicable to the goods and/or services to be furnished and provided by CONTRACTOR to EWA. Any changes to policies and procedures that relate to CONTRACTOR will be provided to CONTRACTOR in writing. CONTRACTOR agrees to review such policies, procedures, rules and directives the contents of which CONTRACTOR will be deemed to have knowledge.

G. Clean-Up and Remediation. CONTRACTOR shall be responsible for cleaning-up and removing any and all trash, grease, oil and debris that CONTRACTOR generates as a result of performing the Scope of Work. CONTRACTOR shall be responsible for the cleaning and remediation of any spills or discharge at EWA's facilities resulting from CONTRACTOR's performance of the Scope of Work. CONTRACTOR shall restore EWA's facilities to their pre-existing condition except as expressly allowed by the Scope of Work.

H. Hazardous Materials. CONTRACTOR shall not add to any EWA biosolids hauled, reused, disposed, or in any other way handled by the CONTRACTOR, any material considered hazardous or which creates byproducts or residues considered to be hazardous under Federal, California or other state or local laws. In the event CONTRACTOR adds any material to the biosolids that causes the biosolids to be allegedly hazardous, CONTRACTOR will be responsible for all costs incurred as a result therefrom, including any costs of treatment, disposal, defense and remediation, and any damages incurred due to improper disposal and/or handling. In the event any hazardous materials are allegedly generated or disposed of by CONTRACTOR under the AGREEMENT, CONTRACTOR shall promptly notify EWA.

ARTICLE 6. INDEMNITY

A. Duty to Indemnify and Defend. To the maximum extent allowable by law, CONTRACTOR agrees to indemnify, defend, protect, and hold , its Member Agencies (to include the City of Carlsbad, City of Encinitas, City of Vista, Buena Sanitation District, Leucadia Water District, and Vallecitos Water District), and each of their respective officers, officials, directors, agents, employees, and volunteers (collectively, "Indemnified Parties") from and against any and all losses, liabilities, claims, suits, actions, damages, costs and expenses (including attorney fees and costs to defend) and causes of action of every nature, including personal injury, bodily injury, loss of life, or damage to property, any violation of federal, state, or municipal law or ordinance resulting in penalties or fines, and environmental investigations, monitoring, containment, abatement, removal, repair, cleanup, restoration or remedial work (hereinafter, "Claims") that Indemnified Parties may incur that arise out of, pertain to or relate to the negligent, reckless or intentional acts or omissions of CONTRACTOR, including CONTRACTOR's officers, officials, directors, employees, subcontractors, agents, representatives, volunteers, successors, assigns or anyone for whom CONTRACTOR is legally responsible. CONTRACTOR's indemnification, hold harmless and defense obligation shall apply regardless of any negligence of Indemnified Parties. In the event the Indemnified Parties are made a party to any action, lawsuit, or other adversarial proceeding for which CONTRACTOR has a defense obligation pursuant to this section, CONTRACTOR shall provide a defense to the Indemnified Parties or at EWA's option reimburse the Indemnified Parties for their costs of defense, including reasonable attorneys' fees, incurred in defense of such claims.

B. Survival. CONTRACTOR's indemnification, hold harmless and defense obligation shall survive the termination of this Agreement.

ARTICLE 7. INSURANCE

A. CONTRACTOR shall carry all insurance required by federal, state, county and local laws, and such other and additional coverage adequate to protect CONTRACTOR and EWA from any liabilities and claims for injuries and damages to persons or property which may arise from, or in connection with, the performance of work hereunder by CONTRACTOR, its agents, representatives, employees or subcontractors. Specifically, CONTRACTOR and each of its subcontractors shall maintain throughout the term of this Agreement the following policies of insurance:

1. Commercial General Liability (CGL): Insurance Services Office Form CG 00 01, or equivalent, covering CGL on an "occurrence" basis, including products and completed operations, property damage, bodily injury and personal & advertising injury with limits no less than $2,000,000 per occurrence. If a general aggregate limit applies, either the general aggregate limit shall apply separately to this project (ISO CG 25 03 or 25 04) or the general aggregate limit shall be twice the required occurrence limit.

2. Automobile Liability: Insurance Services Office Form Number CA 0001, or equivalent, covering any auto (Code 1), or if Contractor has no owned autos, hired (Code 8) and non-owned (Code 9) autos, with limit no less than $1,000,000 per accident for bodily injury and property damage.

3. Workers' Compensation insurance as required by the State of California, with Statutory Limits, and Employer's Liability Insurance with limit of no less than $1,000,000 per accident for bodily injury or disease.

4. Pollution Liability applicable to the work being performed, with a limit no less than $2,000,000 per claim or occurrence and $2,000,000 aggregate per policy period of one year. If coverage is provided on a claims-made form, the following will also be provided to the extent possible:

a. The retroactive date must be shown, and must be before the date of the Agreement or the beginning of contract work.

b. Insurance must be maintained and evidence of insurance must be provided for at least five (5) years after completion of the contract of work.

c. If coverage is canceled or non-renewed, and not replaced with another claims-made policy form with a retroactive date prior to the contract effective date, CONTRACTOR must purchase an extended period coverage for a minimum of five (5) years after completion of contract work.

d. A copy of the claims reporting requirements must be submitted to EWA.

B. All policies of insurance required under this Section shall be from insurance providers who are either admitted or licensed to do business in California, or are Surplus Lines Carriers authorized to do business in California, and who have an A.M. Best Company rating of no less than A- and a financial size category of at least Class VII, unless otherwise acceptable to EWA.

C. All policies of insurance required under this Section, except for workers' compensation, shall be endorsed to name EWA, its Member Agencies (to include the City of Carlsbad, City of Encinitas, City of Vista, Buena Sanitation District, Leucadia Water District, and Vallecitos Water District), and their directors, officers, employees and representatives (the "Additional Insureds") as additional insureds under each such policy and an additional insured endorsement at least as broad as ISO Form CG 20 10 11 85 or both CG 20 10 and CG 20 37, or equivalent, shall be provided to EWA.

D. The Automobile Liability policy shall be endorsed to include Transportation Pollution Liability insurance, covering materials to be transported by CONTRACTOR pursuant to the contract. This coverage may also be provided on the Contractors Pollution Liability policy.

E. CONTRACTOR shall provide duly-authorized and, as applicable, executed original certificates and endorsements for all insurance required pursuant to this Agreement on forms approved by EWA in conformity with all requirements of this Agreement prior to commencement of any work hereunder. If any of the required coverages expire during the term of this Agreement, CONTRACTOR shall deliver renewal certificates to EWA at least ten (10) days prior to the expiration date.

F. For any claims related to this Agreement, CONTRACTOR's insurance coverage shall be primary insurance as respects the Additional Insureds. Any insurance or self-insurance maintained by the Additional Insureds shall be excess of the CONTRACTOR's (and its subcontractor's) insurance, and shall not contribute to such insurance.

G. Any self-insured retentions must be declared in writing and approved by EWA. At the option of EWA, either: the insurance provider(s) shall reduce or eliminate such self-insured retentions as respects EWA and its directors, officers, employees, and representatives; or the CONTRACTOR shall provide a financial guarantee satisfactory to EWA guaranteeing payment of losses and related investigations, claim administration and defense expenses.

H. CONTRACTOR hereby agrees to waive rights of subrogation against EWA and the Additional Insureds which any of CONTRACTOR's insurers may acquire from CONTRACTOR by virtue of the payment of any loss. CONTRACTOR agrees to obtain any endorsement that may be necessary to affect this waiver of subrogation.

I. CONTRACTOR shall provide thirty (30) days' advance written notice to EWA, of any cancellation or material alteration of any insurance policy required herein.

ARTICLE 8. WARRANTY OF WORK

A. Warranty of Work and Materials. CONTRACTOR guarantees all work pursuant to this Agreement against defective materials and workmanship for period of one (1) year from the date of completion of all work, except where longer warranty periods are specifically stated. Any defective material or workmanship which may be discovered before completion all work or within one (1) year thereafter shall be corrected immediately by CONTRACTOR at its own expense notwithstanding that it may have been overlooked in previous inspections and estimates. Any work to correct a defect in workmanship and/or replacement materials shall additionally be guaranteed by CONTRACTOR for a period of one (1) year from the date of completion of such corrective work or replacement of materials. Failure to inspect the work at any stage shall not relieve CONTRACTOR from any obligation to perform sound and reliable work as herein described. It is CONTRACTOR'S ultimate responsibility to complete all work as required by this Agreement. During the one (1) year warranty period, should CONTRACTOR fail to remedy defective material and/or workmanship, or to make replacements within five (5) days after written notice by EWA, it is agreed that EWA may make such repairs and replacements and the actual cost of the required labor or materials shall be chargeable to and payable by CONTRACTOR.

B. Non-Exclusive. The warranty provided herein shall not be in lieu of, but shall be in addition to, any warranties or other obligations otherwise imposed by this Agreement or by law. The remedies provided herein shall not be exclusive and EWA shall be entitled to any and all remedies provided by law.

ARTICLE 9. WORK DURING DISPUTES

In the event of a dispute between the parties as to the performance of the work, the interpretation of this Agreement, or payment or nonpayment for work performed, the parties shall attempt to resolve the dispute. If the dispute is not resolved, CONTRACTOR agrees to continue the work diligently to completion and will neither rescind this Agreement nor stop the progress of the work, but may submit such controversy for determination in accordance with applicable law. In the event any litigation is commenced with respect to this Agreement, such litigation shall not serve to suspend CONTRACTOR'S obligation to continue performance of the work hereunder.

ARTICLE 10. ASSIGNMENT

A. Assignment of Goods/Services. In entering into this Agreement to supply goods, services or material CONTRACTOR or subcontractor offers and agrees to assign to all rights, titles and interest in and to all causes of action it may have under Section 4 of the Clayton Act (15 U.S.C. Section 15) or under the Cartwright Act (Chapter 2 [commencing with section 16700] of Part 2 of Division 7 of the Business and Professions Code), arising from purchases of goods, services or material pursuant to this Agreement. This assignment shall be made and become effective at the time tenders final payment to CONTRACTOR, without further acknowledgement by the parties.

B. Non-Assignment of Agreement. CONTRACTOR shall not otherwise assign any of the work covered by this Agreement, and shall not assign this Agreement, except with the prior written approval of EWA.

ARTICLE 11. PREVAILING WAGE LAWS

CONTRACTOR shall comply with the requirements of this Section with respect to any installation, repair, maintenance or other work constituting a public works under California Labor Code sections 1720 et seq. and 1770 et seq., and California Code of Regulations, title 8, section 16000 et seq. (collectively, "Prevailing Wage Laws").

A. Registration. CONTRACTOR must be, and must require its subcontractors to, be registered with the California Department of Industrial Relations ("DIR") pursuant to Labor Code section 1725.5, prior to execution of this Agreement. No contractor or subcontractor may be listed on a bid proposal for a public works project, or may be awarded a contract for public work on a public works project, unless it registers with and pays an annual fee to the DIR. CONTRACTOR shall submit proof of current registration, and shall require subcontractors to submit proof of current registration, to EWA prior to commencing work on the project. This registration requirement does not apply to work performed on a public works project of twenty-five thousand dollars ($25,000) or less when the project is for construction, alteration, demolition, installation, or repair work or to work performed on a public works project of fifteen thousand dollars ($15,000) or less when the project is for maintenance work.

B. Prevailing Wage. CONTRACTOR agrees to comply with and require its subcontractors to comply with the requirements of Prevailing Wage Laws and any additional applicable California Labor Code provisions related to such work including without limitation payroll recordkeeping requirements. CONTRACTOR and its subcontractors shall pay not less than the prevailing rate of per diem wages as determined by the Director of the DIR for all services described in this Agreement and as required by law. The general prevailing wage determinations can be found on the DIR website at: http://www.dir.ca.gov. Copies of the prevailing rate of per diem wages may be accessed at EWA's administrative office, and shall be made available upon request. CONTRACTOR shall make copies of the prevailing rates of per diem wages for each craft, classification or type of worker needed to execute the services described in this Agreement available to interested parties upon request, and shall post and maintain copies at CONTRACTOR'S principal place of business and at all site(s) where services are performed. Penalties for violation of Prevailing Wage Laws may be assessed in accordance with such laws. For example, CONTRACTOR shall forfeit, as a penalty to EWA, Two Hundred Dollars ($200) for each calendar day, or portion thereof, for each workman paid less than stipulated prevailing rates for services performed under this Agreement by him, or any subcontractor under him, in violation of Prevailing Wage Laws. CONTRACTOR shall defend, indemnify and hold EWA, its Member Agencies (to include the City of Carlsbad, City of Encinitas, City of Vista, Buena Sanitation District, Leucadia Water District, and Vallecitos Water District) and each of their respective officials, officers, directors, employees, agents and volunteers free and harmless from any claims, liabilities, costs, penalties or interest arising out of the failure or alleged failure of CONTRACTOR or its subcontractors to comply with Prevailing Wage Laws.

C. Payroll Records. CONTRACTOR and each of its subcontractors shall keep accurate payroll records showing the name, address, social security number, work classification, straight time and overtime hours worked each day and week, and the actual per diem wages paid to each journeyman, apprentice, worker or other employee employed by CONTRACTOR or subcontractor in connection with the services performed pursuant to this Agreement. Each payroll shall be certified, available for inspection, and electronic copies thereof furnished directly to the Labor Commissioner (also known as the Division of Labor Standards Enforcement) (A) at least monthly or more frequently or (B) in a format prescribed by the Labor Commissioner, as prescribed in California Labor Code section 1776, including any required redactions. CONTRACTOR shall keep EWA informed as to the location of the records and shall be responsible for the compliance with these requirements by all subcontractors. CONTRACTOR shall inform EWA of the location of the payroll records, including the street address, city and county and shall, within five (5) working days, provide a notice of any change of location and address. Penalties for noncompliance include a forfeiture of One Hundred Dollars ($100) per calendar day, or portion thereof, for each worker until strict compliance is effectuated, which may be deducted from any moneys due CONTRACTOR.

D. Work Hours. Eight (8) hours of work shall constitute a legal day's work. CONTRACTOR and any subcontractors shall forfeit, as a penalty to EWA, Twenty-Five Dollars ($25) for each worker employed in the execution of services pursuant to this Agreement by CONTRACTOR or any of its subcontractors for each calendar day during which such worker is required or permitted to work more than eight (8) hours in any one (1) calendar day and forty (40) hours in any calendar week in violation of the provisions of the California Labor Code, in particular, sections 1810 to 1815, thereof, inclusive, except services performed by employees of CONTRACTOR and its subcontractors in excess of eight (8) hours per day at not less than one and one-half (1 ½) times the basic rate of pay, as provided in California Labor Code section 1815.

E. Apprentices. CONTRACTOR'S attention is directed to the provisions of California Labor Code sections 1777.5, 1777.6 and 1777.7 concerning employment of apprentices by CONTRACTOR or any of its subcontractors. If applicable to the services to be performed under this Agreement, CONTRACTOR shall comply with such apprenticeship requirements and submit apprentice information to EWA. Information relative to apprenticeship standards, wage schedules and other requirements may be obtained from the DIR or from the Division of Apprenticeship Standards. Knowing violations of section 1777.5 will result in forfeiture not to exceed One Hundred Dollars ($100) for each calendar day of non-compliance pursuant to section 1777.7.

F. Subcontractors. CONTRACTOR shall require any subcontractors performing services under this Agreement to comply with all of the above.

ARTICLE 12. GENERAL PROVISIONS

A. Notice. Any notices required to be given under this Agreement by either party to the other may be affected by personal delivery in writing or by mail, first class, registered or certified, postage prepaid with return receipt requested. Mailed notices must be addressed to the parties at the addresses below, but each party may change the address by giving written notice in accordance with this paragraph. Notices delivered personally will be deemed communicated as of actual receipt; mailed notices will be deemed communicated as of the day of receipt or the fifth (5th) day after mailing, whichever occurs first.

To : Encina Wastewater Authority
6200 Avenida Encinas
Carlsbad, California 92011
Attention: ___________________

To CONTRACTOR: ____________________________
____
____
____

B. Independent Contractor. CONTRACTOR is for all purposes an independent contractor. All qualified personnel provided by CONTRACTOR pursuant to this Agreement are to be employed by CONTRACTOR for its account only, and in no event shall CONTRACTOR or any personnel retained by it be deemed to have been employed by EWA. CONTRACTOR is free from the control and direction of in connection with the performance of the work, CONTRACTOR performs work that is outside the usual course of ’s business, and CONTRACTOR is customarily engaged in an independently established trade, occupation, or business of the same nature as that involved in the work performed.

C. Hazard Communications Standard. The "Hazard Communication Standard" requires that individuals (employees) working in an area where hazardous substances are being used must be informed of any potential dangers associated with working in that area. (29 C.F.R. § 1919.1220.) It is the responsibility of CONTRACTORS working at Encina Wastewater Authority to read and acknowledge receipt of the information packet prior to the start of any scheduled work. Furthermore, CONTRACTOR shall make available all applicable information regarding hazardous substances and conditions to all CONTRACTOR employees and subcontractors.

D. Audit. If this Agreement involves an expenditure of public funds in excess of ten thousand dollars ($10,000), the Agreement is subject to examination and audit of the State Auditor, at the request of or as a part of any audit of EWA, for a period of three (3) years after final payment under the Agreement. CONTRACTOR shall cooperate with regarding any such audit at no extra cost to EWA.

E. Non-Exclusive. This Agreement is not exclusive, and as such, CONTRACTOR is free to perform work for others during the term of this Agreement.

F. Modification. This Agreement may not be modified or altered except in writing and signed by both parties

G. Counterparts. This Agreement may be executed in counterparts, each of which shall constitute an original, but all of which together shall constitute one and the same agreement, and the signature of any party to any counterpart shall be deemed a signature to, and may be appended to, any other counterpart.

H. Provisions Required by Law. Each and every provision of law and clause required by law to be inserted in this Agreement shall be deemed inserted herein, and the Agreement shall be read and enforced as though they were included herein. If through mistake or otherwise any such provision is not inserted, or is not correctly inserted, then upon the application of either party, the Agreement shall forthwith be physically amended to make such insertion.

I. False Claims. In signing this Agreement, CONTRACTOR certifies that CONTRACTOR shall not submit a false claim in violation of the False Claims Act, section 12650 *et seq*. of the Government Code.

J. Severability. Each term, condition, covenant, or provision of this Agreement shall be viewed as separate and distinct, and in the event that any term, covenant, or provision be held by a court of competent jurisdiction to be invalid, the remaining provisions shall continue in full force and effect.

K. Waiver. A waiver by either party of a breach of any provision of this Agreement shall not constitute a general waiver or prejudice the other party's right otherwise to demand strict compliance with that provision or any other provisions in this Agreement.

L. Jurisdiction & Venue. This Agreement shall be construed and enforced under and in accordance with the laws of the State of California. Venue to any action or proceeding arising out of this Agreement shall be in San Diego County, California.

ENCINA WASTEWATER AUTHORITY:

____
Signature

____
Title

____
Date

CONTRACTOR:

____
Signature

____
Title

____
Date

____
Contractor's License No.

____
License Expiration Date

ENCINA WASTEWATER AUTHORITY
CARLSBAD, CALIFORNIA

ADDENDUM NO. 1
TO THE REQUEST FOR PROPOSALS
FOR
BIOSOLIDS GRANULE DISTRIBUTION AND MARKETING

January 10, 2022

Ref: Admin.21-14842d

THE PROPOSER SHALL SIGN AND EMAIL TO TUCKER SOUTHERN AT tsouthern@encinajpa.com THE CERTIFICATION AT THE END OF THIS ADDENDUM AND SHALL ATTACH THE CERTIFIED ADDENDUM TO THE DOCUMENTS SUBMITTED WITH THE PROPOSAL.

The following additions, modifications, corrections, deletions and clarifications are hereby made to the Request for Proposal of the subject Project:

RESPONSE TO QUESTIONS

ID	RFP Section	Question from Prospective Proposer(s)	Response from Encina Wastewater Authority
1	2. Background Information	What was the total tonnage of pellets produced annually in 2020 and 2021?	*Annual Totals of Class A (wet tons)* *2020: -6,541* *2021: Approximately 5,745*
2	2. Background Information	What was the total tonnage retained by Encina each year?	The tonnage amounts retained by EWA the past couple of years (2020 and 2021) were less than 1,000 wet tons each year.

ID	RFP Section	Question from Prospective Proposer(s)	Response from Encina Wastewater Authority
3	2. Background Information	Where were the pellets distributed in the past two years by tonnage?	The successful vendor will be provided with the locations of pellet distribution over the past two years, after the contract is fully executed.
4	2. Background Information	Who managed distribution for Encina in the past two years and what was the previous management fee charged?	*Denali Water Solutions* has managed the distribution contract and will be retained to handle non-Class A product through their contract term (ending July 30, 2024).
5	10. Contract Terms	Please clarify the extensions of the term beyond the initial five years. Section 10 Contract Term of the RFP states that it is at the sole discretion of EWA under the same terms and conditions (so does the sample contract), however the last sentence of Section 10 says that both parties would have to agree upon the terms of the 5 one-year extensions. This sounds as if the extensions are mutual.	Extension of the contract will be upon mutual agreement.
6	10. Contract Terms	Section 10 Contract Term – Would Encina amend to include the following language? "Encina will notify Vendor no less than 120 days, prior to the termination date of the agreement, of their decision to renew for the following 1-Year period, or not renew the agreement and let the contract expire on the termination date."	The proposer may include in their proposal any requested changes to the contract term for consideration by EWA.

ID	RFP Section	Question from Prospective Proposer(s)	Response from Encina Wastewater Authority
7	Attachment 2 – Sample Agreement	In Attachment 2 (Sample Agreement) would Encina agree to add or alter the descriptive of the language for uncontrollable circumstances to the following (or add the following as Section 3.A. Force Majeure)?	The proposer may include in their proposal any requested changes to the Sample Agreement for consideration by EWA.

* * * End of Addendum No. 1 * * *

DATE: January 10, 2022

ENCINA WASTEWATER AUTHORITY

Scott McClelland, General Manager

E-MAIL TO TUCKER SOUTHERN
tsouthern@encinajpa.com

PROPOSER'S CERTIFICATION

I acknowledge receipt of the foregoing Addendum No. 1 and accept all conditions contained herein. (A signed Proposer's Certification shall be provided with the Proposal.)

DATED: ______________________ PROPOSER: _______________________________________

Company

BY: ____

Signature

BY: ____

Printed Name

TM 6 – Enzymatic Hyperthermophilic Hydrolysis Summary

Challenging today.
Reinventing tomorrow.

2022 Biosolids Management Plan Update

TM 6 – Enzymatic Hyperthermophilic Hydrolysis Summary

Final

June 2022

Prepared for:

Encina Wastewater Authority

2022 Biosolids Management Plan Update

Project No:	W9Y30700
Document Title:	TM 6 – Enzymatic Hyperthermophilic Summary
Document No.:	PPS0326211244SCO
Date:	June 2022
Client Name:	Encina Wastewater Authority
Project Manager:	Mark Elliott, Jacobs
Author:	Yash Chaudhary, Corey Klibert, and Dave Parry, Jacobs

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Contents

Acronyms and Abbreviations

°C	degree(s) Celsius
µL	microliter(s)
C. bescii	*Caldicellulosiruptor bescii*
DSMZ	Leibniz Institute DSMZ, German Collection of Microorganisms and Cell Cultures GmbH
EHH	enzymatic hyperthermophilic hydrolysis
EWA	Encina Wastewater Authority
EWPCF	Encina Water Pollution Control Facility
FOS	free organic acids
L	liter(s)
lab	laboratory
LED	light-emitting diode
MAD	mesophilic anaerobic digestion
MOP 8	*Design of Water Resource Recovery Facilities, Manual of Practice Number 8*
PLC	programmable logic controller
RT	recuperative thickening
SRT	solids retention time
STP	standard temperature and pressure
TAC	total alkalinity content
TM	technical memorandum
TS	total solids
VAC	volt(s) alternating current
VS	volatile solids
VSR	volatile solids reduction
WAS	waste activated sludge
WWTP	wastewater treatment plant

1. Introduction

Caldicellulosiruptor bescii (*C. bescii*) is a hyperthermophilic anaerobic bacterium capable of hydrolyzing cellulosic and other recalcitrant biomass, such as waste activated sludge (WAS). *C. bescii* was first discovered in a geothermally heated freshwater pool in Russia in 1990 (Svetlichnyi et al. 1990; Yang et al. 2010). Subsequent research with *C. bescii* has focused on its potential for use in biofuel production and improving anaerobic digestion performance by hydrolyzing and fermenting recalcitrant biomass, such as cellulose and WAS that was not digested initially in anaerobic digestion.

Technical Memorandum (TM) 6 documents the evaluation of *C. bescii* enzymatic hyperthermophilic hydrolysis (EHH) of the Encina Wastewater Authority (EWA) digested sludge from the Encina Water Pollution Control Facility (EWPCF) in Carlsbad, California. Laboratory (lab)-scale testing of the EWPCF digested sludge was conducted at the Gresham Wastewater Treatment Plant (WWTP) in Gresham, Oregon. *C. bescii* EHH hydrolyzes recalcitrant biomass, enabling its conversion to biogas, thereby increasing digester performance.

The laboratory-scale testing evaluated the following digester performance parameters:

- Volatile solids reduction (VSR)
- Residual biosolids product
- Biogas production
- Process stability as measured by acid, alkalinity concentrations, and pH

TM 6 is organized as follows:

- Section 1, this section, provides background information.
- Section 2 describes the detailed testing procedure.
- Section 3 summarizes the results and discusses the findings.
- Section 4 provides the conclusions and next steps for the project.
- Section 5 provides the references used to develop this TM.

2. Testing Methodology

2.1 Cultivation and Inoculation

Jacobs staff used the following procedure to grow and cultivate *C. bescii* for EWPCF digested sludge treatability testing:

- The inoculum was sourced from frozen pellets acquired from the Leibniz Institute DSMZ, German Collection of Microorganisms and Cell Cultures GmbH (DSMZ) (DSMZ 2022), in Germany.
- At the Gresham WWTP laboratory, Media 516, as specified by DSMZ, was prepared to receive and sustain the frozen *C. bescii*. An anaerobic glove bag and gas delivery system were used to facilitate media preparation and microorganism setup.
- Once media was inoculated and sufficient growth of *C. bescii* was observed under a microscope, cultivated media were used to inoculate EWPCF digested sludge in the lab-scale reactors.

2.2 Laboratory-scale Reactor Setup

The Gresham WWTP lab-scale testing used a commercially available test system of anaerobic reactors procured from Anaero Technology (model Lobster-i). Figure 6-1 shows the basic Lobster-i reactor setup in the Gresham WWTP laboratory.

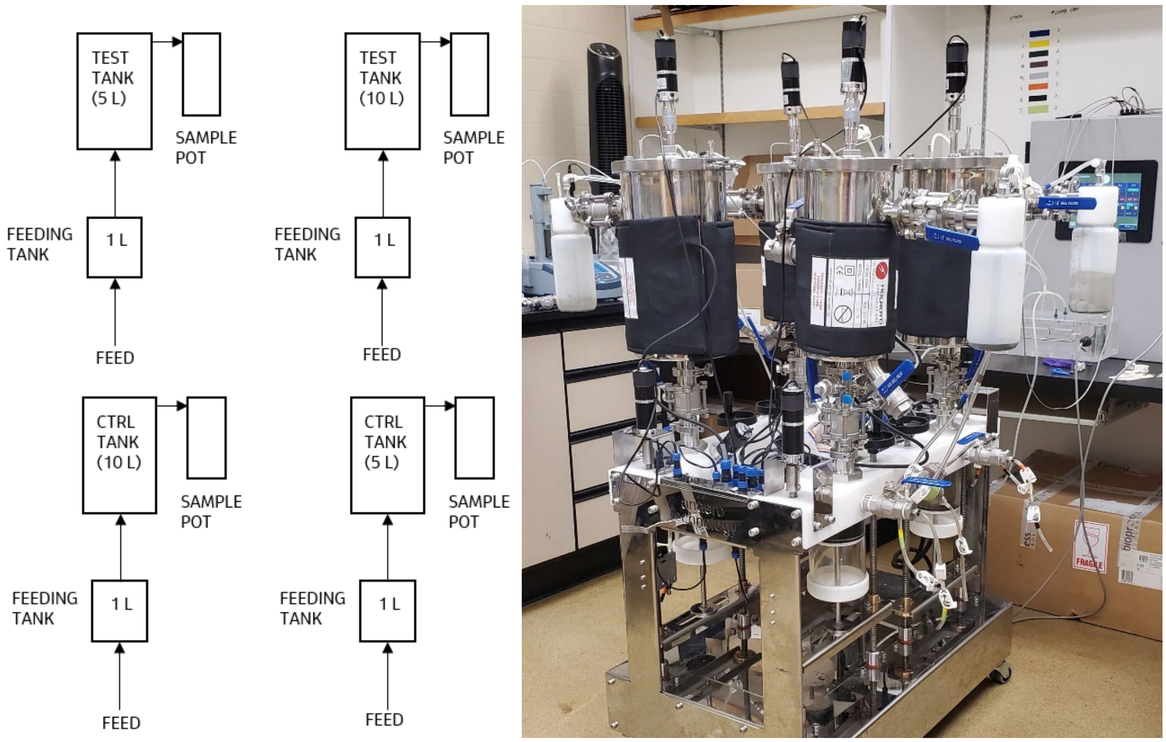


Figure 6-1. Laboratory-scale Reactor Setup at the Gresham Wastewater Treatment Plant

The Lobster-i reactor system consisted of the following components:

- Four reactor tanks: two 10-liter (L) and two 5-L tanks, sealed from atmosphere to provide anaerobic conditions, used as follows:
  - Test setup consisted of a 10-L anaerobic digestion tank and 5-L hydrolysis tank
  - Control setup consisted of a 10-L anaerobic digestion tank and 5-L hydrolysis tank
- Automatic feeder modules and intertank flow piping and valves
- Reactor mixing: automatically controlled paddle mixers
- Sample points for all tanks
- Heating jackets for all tanks to control temperature
- Gas flow meter: Real-time monitoring with automatic standard temperature and pressure (STP) conversion
- Programmable logic controller (PLC) control and monitoring: 110-volt-alternating-current (VAC) touchscreen PLC with software

2.3 Laboratory-scale Reactor Seeding

EWA provided an initial shipment of approximately 40 L of digested sludge, drawn from the Digester 6 heated recirculation loop. All four lab-scale tanks were initially heated to mesophilic temperatures (35 degrees Celsius [°C]) and filled from this source. The 5-L test hyperthermophilic hydrolysis reactor was then heated up to 80°C and inoculated by discharging active *C. bescii* growth media into a port on the reactor lid.

2.4 Laboratory-scale Process Flow and Feeding

In general, the EHH process can be integrated with anaerobic digestion in several ways. EHH can be installed prior to digestion: the hyperthermophilic reactor receives blended primary sludge and WAS. Alternatively, EHH can be used to treat sludge that has already been digested anaerobically as a sidestream treatment step. For EWA, the process configuration proposed would feature the EHH reactor operating as a sidestream reactor treating digested sludge from the mesophilic anaerobic digestion (MAD) digesters. The recirculation rate to the EHH reactors at EWPCF could vary based on operating conditions and available reactor volume.

The lab-scale reactors were then configured to test *C. bescii* activity on EWPCF digested sludge according to the process flow diagram shown on Figure 6-2.

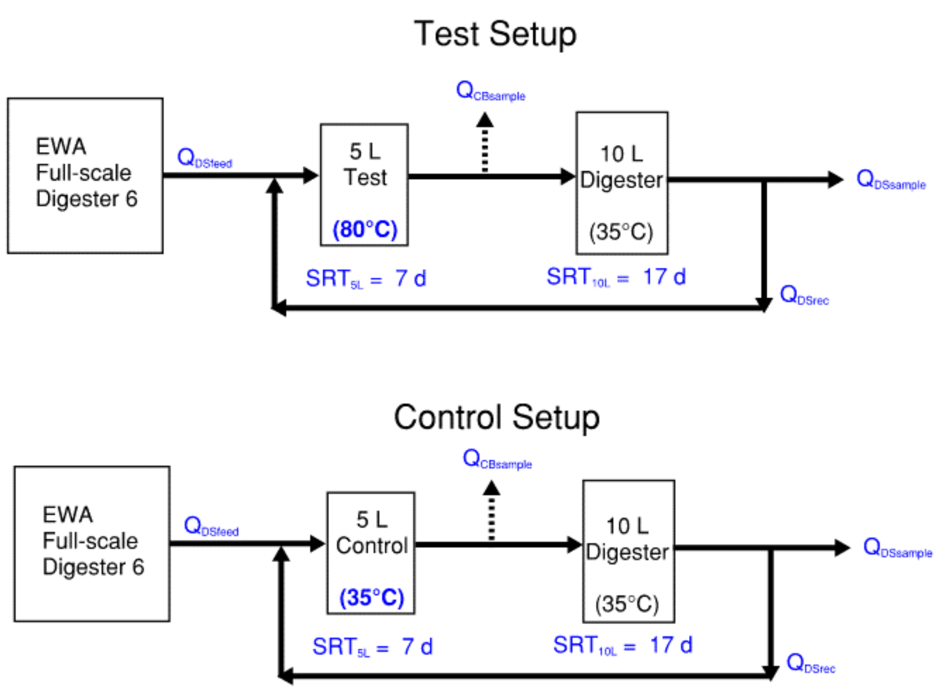


Figure 6-2. Laboratory-scale Reactor Process Flow

EWA collected digested sludge from Digester 6 to feed the lab-scale reactors and shipped it to Gresham WWTP every week for a total of 6 weeks, beginning on September 21 and ending on October 26, 2021. The digested sludge was stored in a refrigerator at Gresham WWTP at 4°C. Feed-digested sludge from refrigerated storage was manually pumped to the 1-L feed tanks of the 5-L reactors using hand syringes every day. An automated piston pushed the feed sludge from the feed tank into the reactor at 30-minute intervals throughout the day based on a user-specified feed rate setpoint in the system's PLC. The output from the 5-L reactors was then fed to the 10-L reactors to emulate the performance of a full-scale digester. A portion of the output from the 10-L reactors was then recycled back to the 5-L reactors. The same feed procedure was carried out for both the test and control reactors.

The test 10-L reactor, and control 5-L and 10-L reactors operated at a mesophilic temperature of 35°C. The test 5-L reactor operated at a hyperthermophilic temperature of 80°C. The 5-L test and control reactors had a solids retention time (SRT) of 7 days, and the 10-L test and control reactors had an SRT of 17 days.

Samples were manually drawn from the reactors, and the following parameters were measured at least three times per week during operation of the reactors:

- pH
- Free organic acids (FOS)
- Total alkalinity content (TAC)
- Total solids (TS)
- Volatile solids (VS)

Appendix 6-A provides the complete record of raw data collected from sampling.

TS and VS testing were used to evaluate the VSR of the test and control reactors, the main metric for comparison of reactor performance. Method 2540 G of the *Standard Methods for the Examination of Water and Wastewater* was used to determine the TS and VS content (American Public Health Association et al. 2018).

FOS, TAC, and pH measurements were obtained using Hach TitraLab AT1000 series automatic titrators. These data helped to determine the degree of *C. bescii* EHH, as well as the stability of the digesters.

2.5 Experimental Timeline

C. bescii was first cultivated from the frozen culture on September 10, 2021. Shipment of the initial batch of EWPCF digested sludge was delayed, leading to loss of the *C. bescii* culture. A second culture was prepared on September 17, 2021. The test and control reactors were seeded with the digested sludge on September 22, 2021. The test reactor was first inoculated with *C. bescii* on the same day as the sludge seeding.

The second *C. bescii* inoculation was carried out on September 24, 2021. The test and control digesters were fed with digested sludge starting from September 22, 2021.

Following final inoculation, a variety of operational factors (difficulty measuring gas production and FOS to TAC ratio) led the team to initially believe that methanogen populations had dropped due to sour conditions in the digesters. The team reseeded both the test and control 10-L reactors with the digested sludge from EWPCF on October 13, 2021, to definitively re-establish methanogen population. It was then realized that gas production had dropped due to a gas leak rather than poor digester performance, and pH results confirmed that the digesters had not gone sour.

On November 8, 2021, the lab-scale testing was completed, with the desired results obtained.

2.6 Microscopy

Light microscopy was used during cultivation and testing to confirm the presence of live *C. bescii* in the anaerobic growth media and to provide a visual indication of active hyperthermophilic bacteria in the test reactors. Light microscopy was conducted at the Gresham WWTP site using a Leica DM1000 light-emitting diode (LED) using the following procedure:

1) Pipette 500 microliters (μL) of sample onto a clean glass slide.
2) Place glass cover slip onto sample on a slide, checking that there are no trapped air bubbles or leaks.
3) Place slide on the microscope stage.
4) Select appropriate light phase filter to match the objective in use (20x, 40x, or 100x).
5) Apply immersion oil to slide cover for the 100x objective.

Figure 6-3 and Figure 6-4 show images of *C. bescii* in anaerobic growth media and in digester sludge taken at 400x magnification (10x eyepiece with 40x objective) at the Gresham WWTP. In both images, examples of the rod-shaped *C. bescii* are highlighted in red. Identification of *C. bescii* in anaerobic growth media is based on bacillus-shaped morphology (Yang et al. 2010). In the anaerobic growth media inoculated with a pure culture of *C. bescii*, the presence of viable, active bacilli is considered sufficient to confirm the presence of *C. bescii* because any other bacilli resulting from contamination would be inactivated by the high temperature of the growth medium.

In digested sludge, identification is approximate and based on observation of active bacillus-shaped organisms at 80°C, a temperature at which only hyperthermophilic bacteria such as *C. bescii* are active.

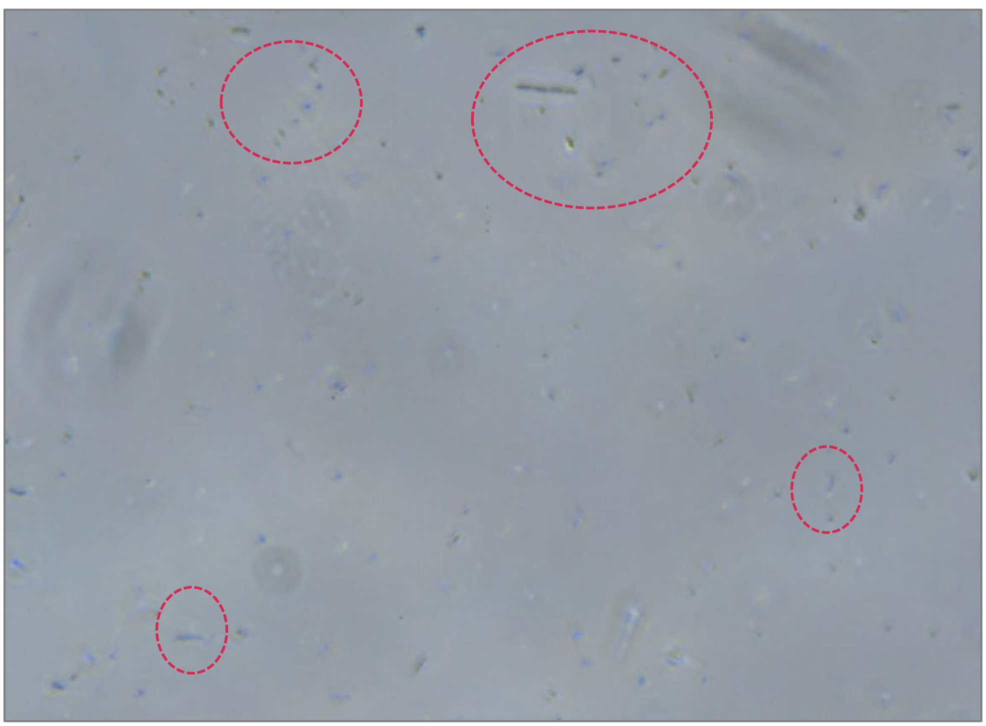


Figure 6-3. Light Microscopy of *C. bescii* in Anaerobic Growth Media (400x)

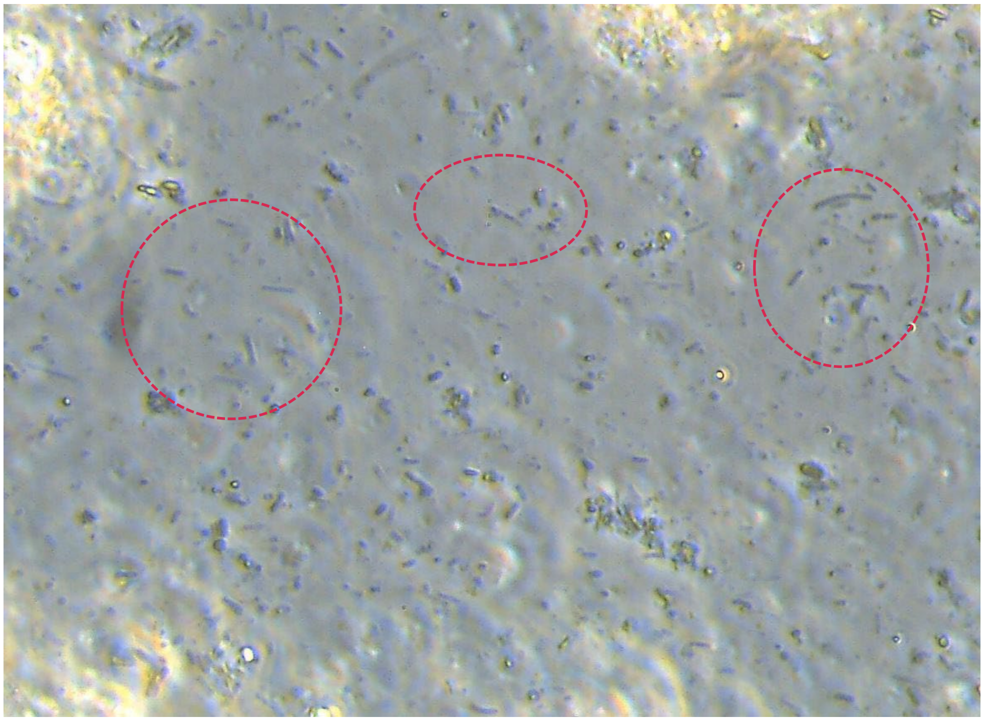


Figure 6-4. Light Microscopy of *C. bescii* in Digested Sludge (400x)

3. Results and Discussion

3.1 Volatile Solids Reduction

The primary parameter monitored to track the test system's digestion performance versus the control was overall system VSR. The VSR was determined using the mass balance method (EPA1995) (Equation 3-1), which is based on the VS concentration of the influent and effluent from the test and control systems.

$$VSR = \frac{(F * Y_f) - (B * Y_b)}{(F * Y_f)} \ (Eq. 3 - 1)$$

Where:

F = Volume of digested sludge feed from EWPCF
Y_f = VS concentration of digested sludge feed from EWPCF
B = Volume of waste digested sludge from lab-scale 10-L reactor
Y_b = VS concentration of waste digested sludge from lab-scale 10L reactor

System VSR was calculated by periodically sampling the TS and VS concentrations of the digested sludge fed to the reactors and the WAS produced by the reactors.

Figure 6-5 shows the actual VSR observed during the lab-scale testing, not including the VSR from the EWPCF full-scale digesters. Appendix 6-A provides the lab-scale VSR data.

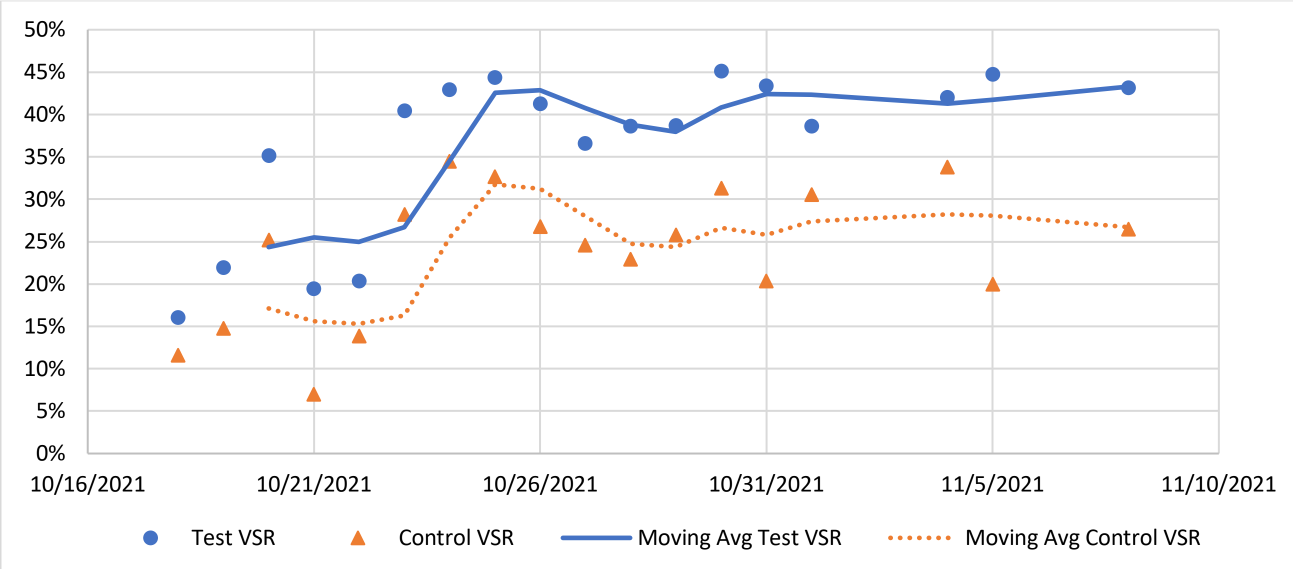


Figure 6-5. Additional Laboratory-scale Volatile Solids Reduction on Digester 6 Digested Biosolids

To calculate the overall VSR achieved by both the full-scale Digester 6 and the lab-scale systems, a full-scale VSR of 60% in Digester 6 was used based on historical performance. Figure 6-6 shows the overall VSR that was observed from the full-scale Digester 6 plus the test and control reactors.

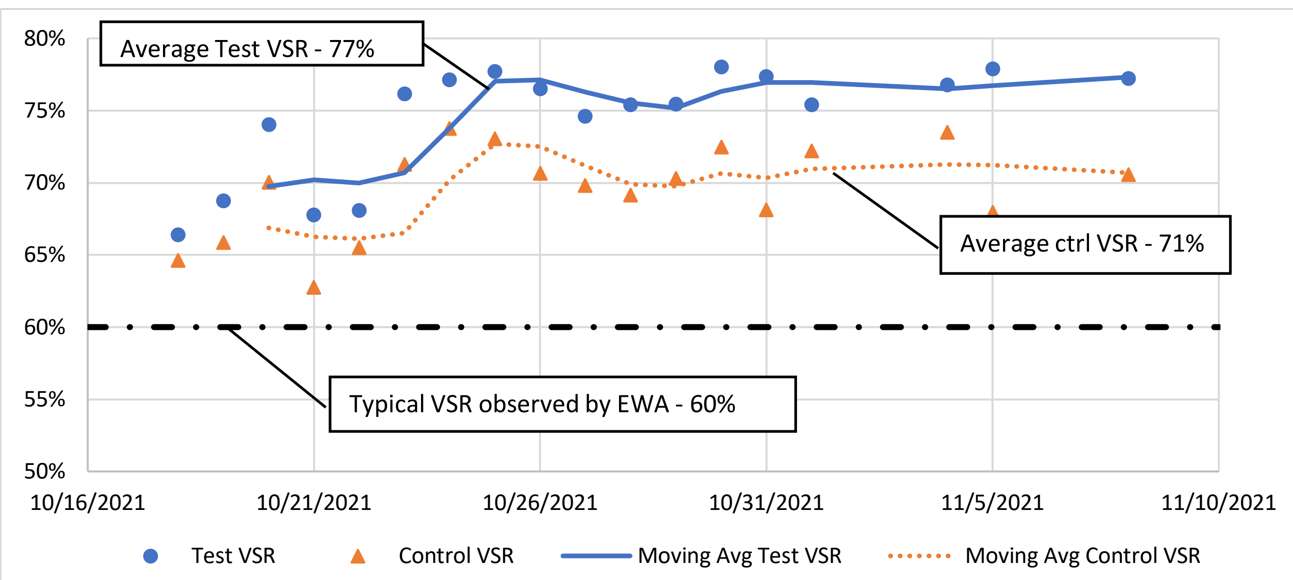


Figure 6-6. Overall Mass Balance Volatile Solids Reduction

The results show that both sets of reactors reached steady-state performance roughly 1 month after final inoculation of the 5-L reactors with *C. bescii* and 9 days after the 10-L reactors were reseeded with EWPCF digested sludge to stabilize reactors. Additional VSR was achieved both in the test reactors from *C. bescii* EHH and in the control reactors due to the additional residence time of 24 days at mesophilic temperatures. At steady-state conditions, the test EHH reactors exhibited an increase in VSR over continued MAD on the digested sludge. The overall mass balance VSR demonstrated that the *C. bescii* reactor outperformed the control setup and the full-scale EWPCF digester system.

An average VSR of 77% was obtained in the test reactors compared to the 71% achieved in the control reactors and 60% in the full-scale digesters. A VSR of 77% compared to 60% represents a 28% increase in VSR, with corresponding increases in biogas production and decreases in biosolids production. Due to limitations of the lab apparatus, the minimum SRT that could be maintained was 7 days. However, based on other tests, it is anticipated that a full-scale *C. bescii* digester would be able to achieve the same test VSR with a 2-day SRT. If the control reactors' VSR of 71% is to be achieved in a full-scale MAD digester system, an additional 24 days of SRT would be required.

3.2 Total Solids

Figure 6-7 shows the TS concentrations of the EWPCF digested sludge feed and the test and control reactors. TS in the test hyperthermophilic 5-L reactor was significantly greater than in other reactors, which is hypothesized to be a result of the growth of *C. bescii* in the test 5-L reactor. The TS concentration of the test 10-L mesophilic digester (from which sludge was wasted) was less than in the control 10-L reactor, corresponding to the greater VS of the test system.

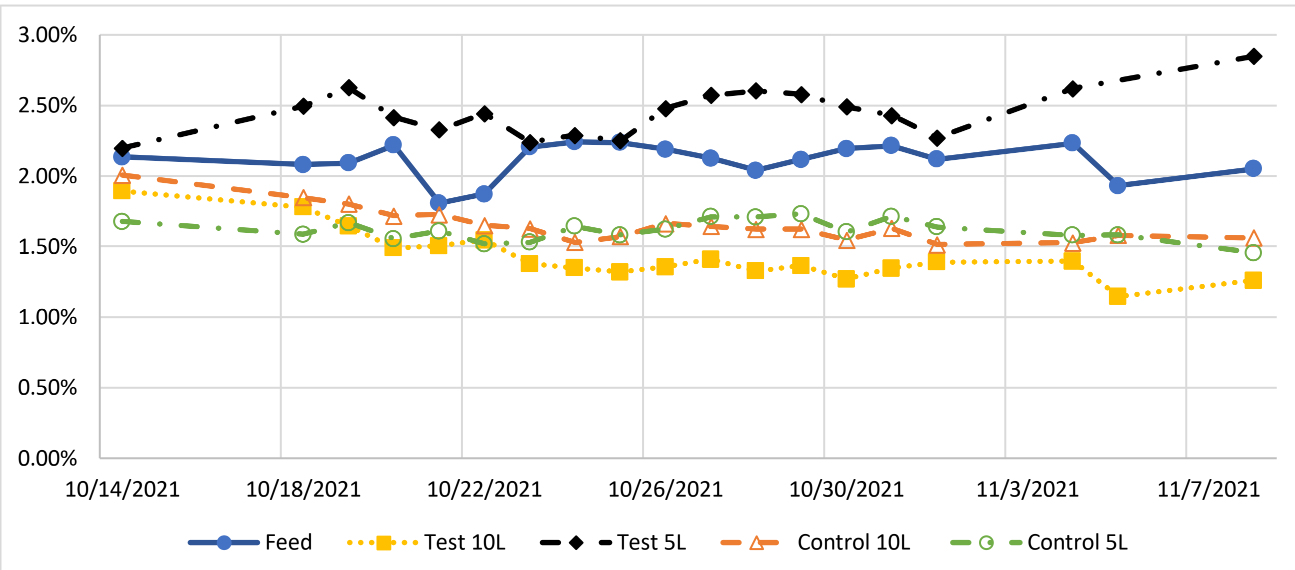


Figure 6-7. Total Solids Concentration of Feed and Reactor Solids

3.3 Process Stability

In addition to VSR, the stability of the digesters was continuously monitored by measuring volatile acids, alkalinity, and pH. Figure 6-8 shows the results collected during the lab-scale testing. Alkalinity results were within the normal range of 2,500 to 5,000 milligrams of alkalinity per liter, according to the *Design of Water Resource Recovery Facilities, Manual of Practice Number 8* (MOP 8) (WEF 2018). The results also illustrated reactor pH levels between 7 and 8, which are well above the recommended minimum pH of 6.8 per MOP 8.

Increased acid concentrations were observed in the test 5-L reactor compared to the feed and other reactors, indicating *C. bescii* hydrolysis. Despite the elevated acid production, the pH and alkalinity were relatively constant and within normal range. This showed that *C. bescii* EHH did not result in instability in the digester performance. The remaining test 10-L, control 10-L, and 5-L reactors exhibited acid and alkalinity and pH values close to what was observed in the feed sludge. Attachment 1 provides the lab-scale data for the different process stability parameters.

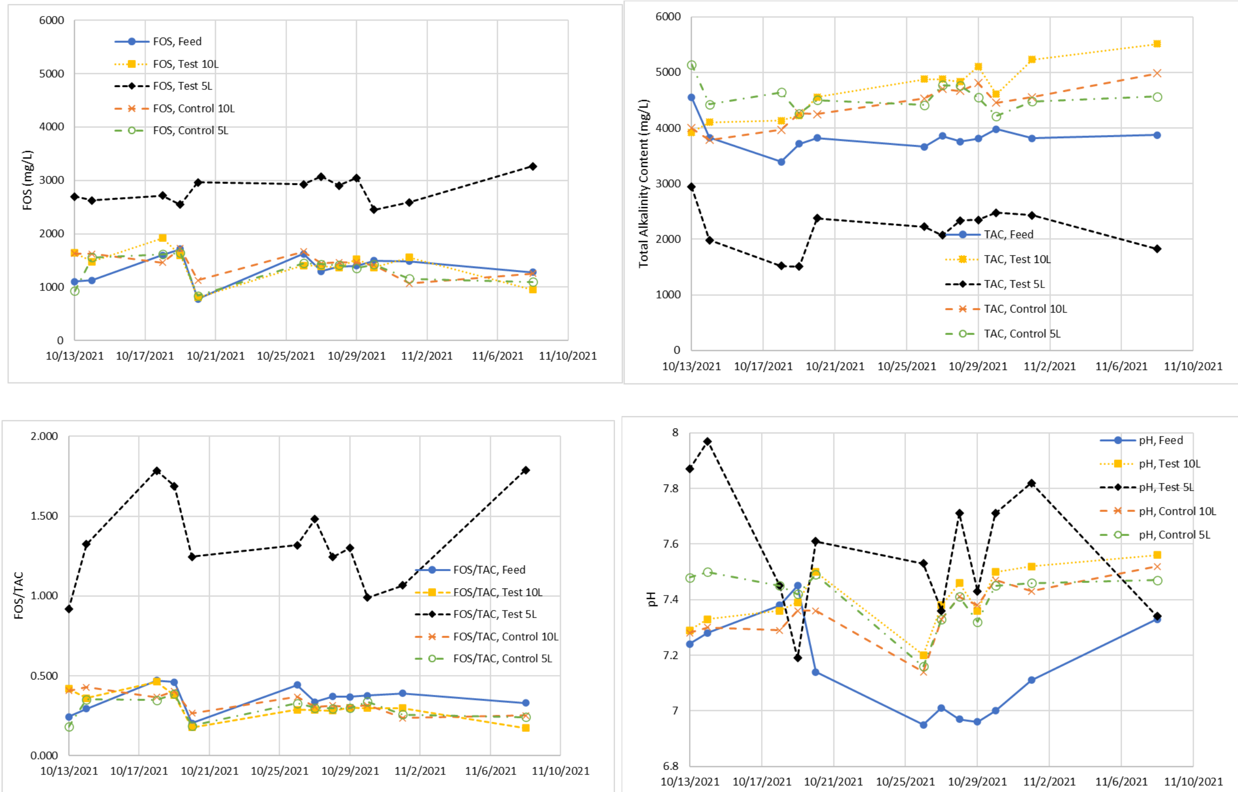


Figure 6-8. Laboratory-scale Testing Acid and Alkalinity and pH Results

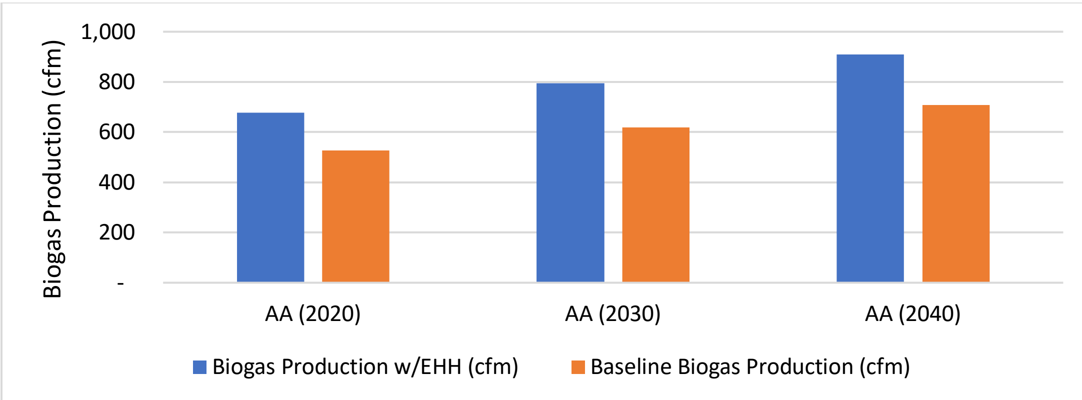
3.4 Biogas Production

Biogas production rates were monitored as part of the experiments, but persistent small gas leaks that appeared in both test and control sides of the lab-scale system rendered the data unsuitable for analysis. The anticipated biogas production was determined from the VSR.

3.5 Potential Full-scale Impacts

Achieving an overall VSR of 77%, as demonstrated in the test system, would result in a significant increase in biogas production and a decrease in digested biosolids production relative to the rates observed at a VSR of 60%, the typical value achieved in EWPCF's digesters. These benefits would result in more energy recovery and less sludge production at the plant, increasing a valuable resource, while reducing load on downstream solids processes.

Figure 6-9 shows the projected increase in biogas and decrease in biosolids from EHH compared to baseline conditions for annual average operation in 2020, 2030, and 2040.



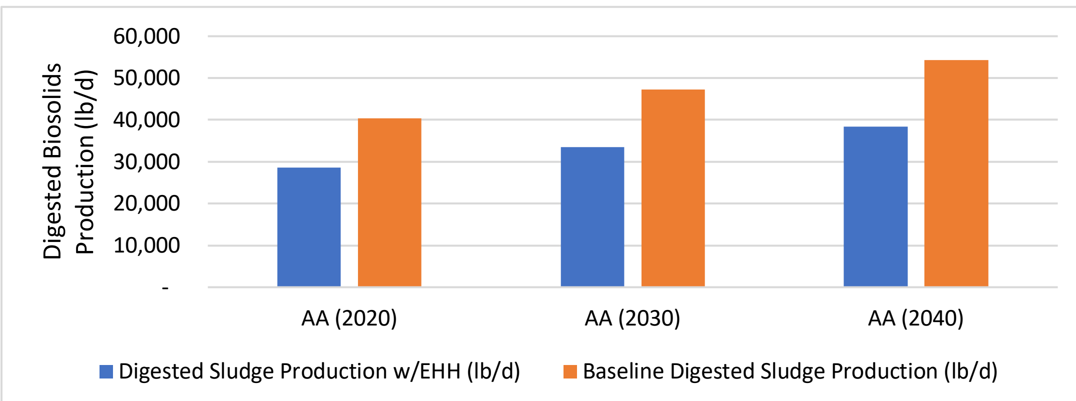


Figure 6-9. EHH and Conventional MAD Comparison of Current and Projected Biogas and Digested Biosolids Production

4. EHH Laboratory Test Conclusions

Results from the lab-scale experiments demonstrated that *C. bescii* EHH can enhance the MAD digesters to increase the VSR and consequently the biogas production of the system. Increased VSR also reduces the residual biosolids production. Stable digester performance was observed, even with elevated acid concentrations.

Realizing a VSR of over 75% in a full-scale operation could increase biogas production by more than 25%. The residual biosolids production could decrease by more than 25%, resulting in less demand on the dryers. Increased biogas production and decreased biosolids production could result in operating savings.

5. Application of EHH at EWPCF

Given the encouraging results of the lab-scale EHH tests, consideration for full-scale implementation at the EWPCF is warranted. Repurposing digesters 1, 2, and 3 for increased digestion capacity is discussed in TM 4. With demonstrated success of EHH, digesters 1, 2, and 3 would be operated as EHH tanks, with digesters 4, 5, and 6 continuing to operate as MAD digesters.

A pilot-scale demonstration of EHH at EWPCF would provide additional confidence in the operation and benefits of EHH. A trailer digestion facility with a test and control digester and EHH tank could be brought to EWPCF for demonstration. Even before the pilot demonstration, a conceptual design of the digestion system with EHH could be conducted to determine capital and operating costs of the full-scale system. To improve digestion performance and capacity, EHH can be combined with recuperative thickening (RT). Figure 6-10 is a process flow diagram of EHH combined with RT.

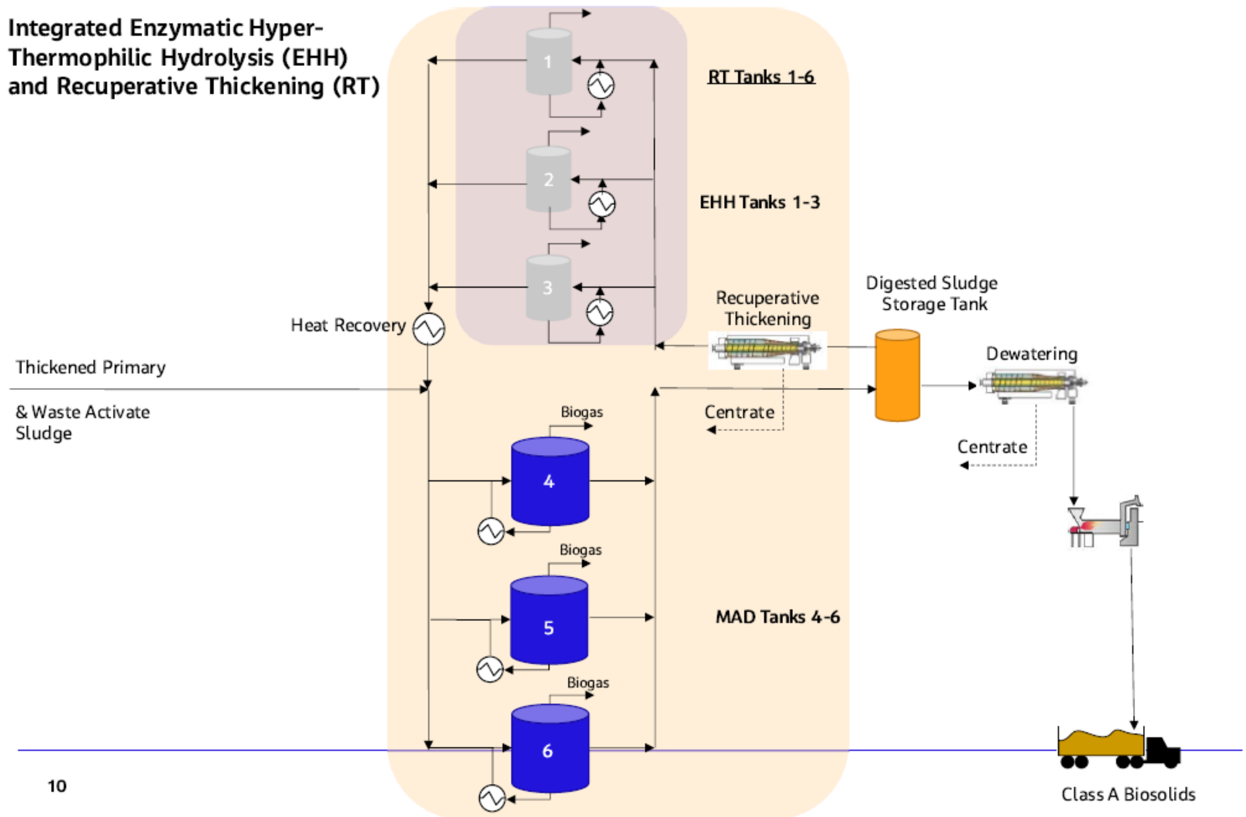


Figure 6-10. Integrating EHH and Recuperative Thickening

With the higher VSR from EHH, RT can be applied to all six digesters instead of just digesters 1, 2, and 3. The higher VSR results result in the TS concentrations less than 3% in digesters 4, 5, and 6, allowing the existing digester mixing system to be used. Digesters 1, 2, and 3 would be repurposed and optimized with new covers, mixing, and heating. Digesters 4, 5, and 6 would not require any modifications and would continue to operate as MAD digesters.

A new digested sludge storage tank would be installed to feed the existing dewatering system and new RT system. The integrated EHH and RT system would increase the capacity of the digestion system to handle loads to 2045 with acceptable loading rates and SRTs (Figure 6-11). Biogas production would be increased more than 25%, and biosolids production would be decreased more than 25%. Operating costs would be reduced, with more biogas for the cogeneration system and dryer, and less biosolids for the dryer and distribution.

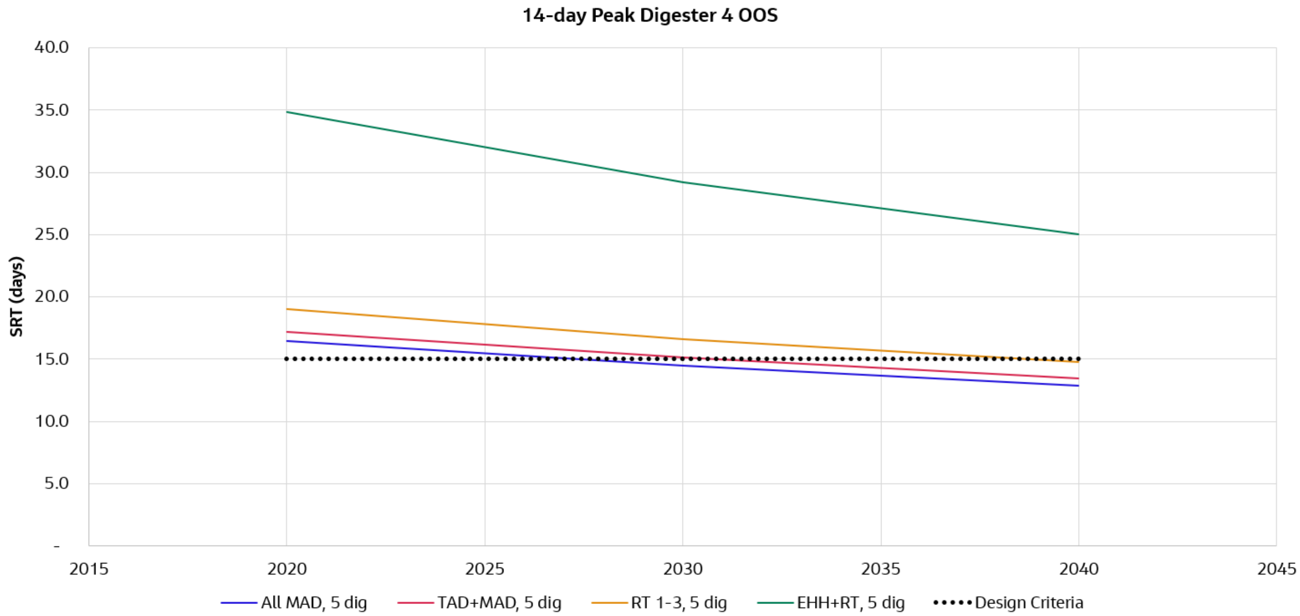


Figure 6-11. Capacity Evaluation of Integrated EHH and Recuperative Thickening

In conclusion, the potential benefits from an integrated EHH and RT solution include:

- Increased capacity and performance of the digestion process by providing more than 15-day SRT during peak 2-week loading with large digester out of service beyond 2040
- Increased VSR from 60 to 75%, resulting in potentially less biosolids to process in the dryers, less biosolids to distribute, and increased biogas produced
- Increased VSR achieved with EHH allows EWPCF to add RT to all six digesters using existing mixing systems because TS will be maintained at less than 3%
- Continued operation of digesters 4, 5, and 6 in mesophilic mode, and maximizing efficiency and use of digesters 1, 2, and 3
- Potential operations cost savings, with more biogas produced and less biosolids to manage

6. References

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Appendix 6-A
Summary of Testing and Results from the Enzymatic Hyperthermophilic Hydrolysis Laboratory Testing

Date	Feed							Test 10L							Test 5L						
	Wt. Pan	Wt. Pan + sample, pre-oven (g)	Wt. Pan + Residue, post-oven (g)	Wt. Pan + Residue, post-furnace (g)	TS%	VS %	VS/TS	Wt. Pan	Wt. Pan + sample, pre-oven (g)	Wt. Pan + Residue, post-oven (g)	Wt. Pan + Residue, post-furnace (g)	TS%	VS %	VS/TS	Wt. Pan	Wt. Pan + sample, pre-oven (g)	Wt. Pan + Residue, post-oven (g)	Wt. Pan + Residue, post-furnace (g)	TS%	VS %	VS/TS
10/14/2021	1.2814	17.8998	1.6361	1.3879	2.13%	1.49%	70.0%	1.2747	13.1148	1.4988	1.3407	1.89%	1.34%	70.5%	1.2765	14.0351	1.557	1.3641	2.20%	1.51%	68.8%
10/18/2021	1.2785	15.1669	1.5676	1.3636	2.08%	1.47%	70.6%	1.2786	13.2297	1.4911	1.3437	1.78%	1.23%	69.4%	1.2763	12.7448	1.5625	1.3667	2.50%	1.71%	68.4%
10/19/2021	1.2725	17.2357	1.6066	1.3732	2.09%	1.46%	69.9%	1.2878	15.1217	1.5156	1.3577	1.65%	1.14%	69.3%	1.2714	15.3212	1.6405	1.3863	2.63%	1.81%	68.9%
10/20/2021	1.2788	16.5101	1.6169	1.3749	2.22%	1.59%	71.6%	1.2725	13.9468	1.4612	1.3305	1.49%	1.03%	69.3%	1.278	15.2268	1.615	1.3825	2.42%	1.67%	69.0%
10/21/2021	1.2697	12.493	1.4726	1.3299	1.81%	1.27%	70.3%	1.2744	12.4018	1.4418	1.3278	1.50%	1.02%	68.1%	1.2786	12.5129	1.5401	1.3615	2.33%	1.59%	68.3%
10/22/2021	1.2672	11.6921	1.4623	1.3255	1.87%	1.31%	70.1%	1.2724	12.1231	1.4402	1.3267	1.55%	1.05%	67.6%	1.2765	12.4853	1.5503	1.3629	2.44%	1.67%	68.4%
10/23/2021	1.266	12.878	1.522	1.3412	2.20%	1.56%	70.6%	1.2811	12.0552	1.4295	1.3295	1.38%	0.93%	67.4%	1.286	11.9534	1.5249	1.3617	2.24%	1.53%	68.3%
10/24/2021	1.2848	13.1866	1.5516	1.3618	2.24%	1.59%	71.1%	1.2752	11.9742	1.4195	1.3221	1.35%	0.91%	67.5%	1.2811	11.887	1.5239	1.3587	2.29%	1.56%	68.0%
10/25/2021	1.2831	12.1415	1.5259	1.3545	2.24%	1.58%	70.6%	1.2846	12.7557	1.4359	1.3351	1.32%	0.88%	66.6%	1.2811	11.7071	1.5158	1.356	2.25%	1.53%	68.1%
10/26/2021	1.2786	11.6462	1.5055	1.3462	2.19%	1.54%	70.2%	1.2805	11.6086	1.4204	1.3272	1.35%	0.90%	66.6%	1.2811	12.4136	1.5572	1.3689	2.48%	1.69%	68.2%
10/27/2021	1.2567	12.3718	1.4929	1.3266	2.13%	1.50%	70.4%	1.2735	11.5624	1.4186	1.3209	1.41%	0.95%	67.3%	1.2608	12.647	1.5536	1.3575	2.57%	1.72%	67.0%
10/28/2021	1.2833	12.5793	1.5137	1.3526	2.04%	1.43%	69.9%	1.2757	11.8134	1.4155	1.3232	1.33%	0.88%	66.0%	1.2796	11.9446	1.5574	1.3669	2.60%	1.79%	68.6%
10/29/2021	1.2815	12.4981	1.519	1.3531	2.12%	1.48%	69.9%	1.2825	11.5884	1.4232	1.3297	1.37%	0.91%	66.5%	1.2827	11.7399	1.5523	1.368	2.58%	1.76%	68.4%
10/30/2021	1.2824	11.4318	1.505	1.3496	2.19%	1.53%	69.8%	1.2783	11.7983	1.4118	1.3234	1.27%	0.84%	66.2%	1.2816	11.5125	1.5365	1.3624	2.49%	1.70%	68.3%
10/31/2021	1.2761	11.8261	1.5097	1.3451	2.21%	1.56%	70.5%	1.2802	12.2916	1.4285	1.3312	1.35%	0.88%	65.6%	1.277	11.7004	1.5303	1.3183	2.43%	2.03%	83.7%
11/1/2021	1.276	11.9719	1.5027	1.3449	2.12%	1.48%	69.6%	1.2754	12.51	1.4315	1.3297	1.39%	0.91%	65.2%	1.2756	11.8717	1.5163	1.354	2.27%	1.53%	67.4%
11/4/2021	1.2729	11.4625	1.5003	1.3409	2.23%	1.56%	70.1%	1.2782	12.3067	1.4323	1.3322	1.40%	0.91%	65.0%	1.2797	11.8117	1.5556	1.3704	2.62%	1.76%	67.1%
11/5/2021	1.2794	11.116	1.4693	1.3361	1.93%	1.35%	70.1%	1.2737	11.4845	1.3907	1.3143	1.15%	0.75%	65.3%	1.2767	12.3618	1.3444	1.2996			
11/8/2021	1.2791	11.6311	1.4914	1.3423	2.05%	1.44%	70.2%	1.281	11.7693	1.4131	1.3272	1.26%	0.82%	65.0%	1.2791	12.2532	1.5917	1.3814	2.85%	1.92%	67.3%

Summary of Testing and Results from the Enzymatic Hyper-Thermophilic Hydrolysis (EHH) Lab Testing
Appendix A - Lab Testing Data

Date	**Control 10L**							**Control 5L**							**Test VSR**	**Control VSR**
	Wt. Pan	Wt. Pan + sample, pre-oven (g)	Wt. Pan + Residue, post-oven (g)	Wt. Pan + Residue, post-furnace (g)	TS%	VS %	VS/TS	Wt. Pan	Wt. Pan + sample, pre oven (g)	Wt. Pan + Residue, post-oven (g)	Wt. Pan + Residue, post-furnace (g)	TS%	VS %	VS/TS	**Approx Mass Balance Method**	**Approx Mass Balance Method**
10/14/2021	1.278	15.358	1.5605	1.3613	2.01%	1.41%	70.5%	1.2809	14.3048	1.4994	1.3509	1.68%	1.14%	68.0%	64%	62%
10/18/2021	1.2716	13.7145	1.5015	1.3399	1.85%	1.30%	70.3%	1.2749	12.8394	1.4584	1.3319	1.59%	1.09%	68.9%	66%	65%
10/19/2021	1.2758	13.8922	1.5031	1.3458	1.80%	1.25%	69.2%	1.2859	16.216	1.535	1.3666	1.67%	1.13%	67.6%	69%	66%
10/20/2021	1.2765	16.8013	1.5433	1.3586	1.72%	1.19%	69.2%	1.2758	14.5904	1.4829	1.3406	1.56%	1.07%	68.7%	74%	70%
10/21/2021	1.273	11.7527	1.454	1.33	1.73%	1.18%	68.5%	1.2707	12.8746	1.4575	1.3312	1.61%	1.09%	67.6%	68%	63%
10/22/2021	1.2756	13.0393	1.4698	1.3368	1.65%	1.13%	68.5%	1.2713	12.1626	1.4367	1.3239	1.52%	1.04%	68.2%	68%	66%
10/23/2021	1.2879	12.3222	1.4675	1.3441	1.63%	1.12%	68.7%	1.2728	12.3881	1.4429	1.3266	1.53%	1.05%	68.4%	76%	71%
10/24/2021	1.2957	12.4783	1.4669	1.35	1.53%	1.05%	68.3%	1.2724	12.3913	1.455	1.3299	1.64%	1.13%	68.5%	77%	74%
10/25/2021	1.2759	11.7901	1.441	1.3292	1.57%	1.06%	67.7%	1.282	12.6011	1.461	1.3399	1.58%	1.07%	67.7%	78%	73%
10/26/2021	1.2817	12.3292	1.4655	1.3411	1.66%	1.13%	67.7%	1.2796	11.8158	1.4506	1.3351	1.62%	1.10%	67.5%	77%	71%
10/27/2021	1.2786	12.4017	1.4613	1.3357	1.64%	1.13%	68.7%	1.2746	12.5637	1.4679	1.3363	1.71%	1.17%	68.1%	75%	70%
10/28/2021	1.2809	12.2372	1.4587	1.3382	1.62%	1.10%	67.8%	1.2827	13.409	1.4899	1.3492	1.71%	1.16%	67.9%	75%	69%
10/29/2021	1.2761	12.5684	1.4594	1.3354	1.62%	1.10%	67.6%	1.2822	12.2502	1.4722	1.3432	1.73%	1.18%	67.9%	75%	70%
10/30/2021	1.2802	12.2627	1.45	1.3344	1.55%	1.05%	68.1%	1.276	12.9212	1.4625	1.336	1.60%	1.09%	67.8%	78%	73%
10/31/2021	1.2782	11.658	1.4473	1.3183	1.63%	1.24%	76.3%	1.2791	11.3413	1.4515	1.3352	1.71%	1.16%	67.5%	77%	68%
11/1/2021	1.2825	12.2061	1.448	1.336	1.52%	1.03%	67.7%	1.2745	12.3455	1.456	1.3329	1.64%	1.11%	67.8%	75%	72%
11/4/2021	1.2879	11.2205	1.4397	1.3368	1.53%	1.04%	67.8%	1.2767	11.8983	1.4444	1.33	1.58%	1.08%	68.2%	77%	74%
11/5/2021	1.2706	11.5944	1.4338	1.3219	1.58%	1.08%	68.6%	1.2764	13.3563	1.4675	1.3372	1.58%	1.08%	68.2%	78%	68%
11/8/2021	1.2822	11.3109	1.4389	1.3327	1.56%	1.06%	67.8%	1.278	12.1201	1.4359	1.3286	1.46%	0.99%	68.0%	77%	71%

Summary of Testing and Results from the Enzymatic Hyper-Thermophilic Hydrolysis (EHH) Lab Testing
Appendix A - Lab Testing Data

Date	Feed					Test 10L					Test 5L					Control 10L					Control 5L				
	pH	TAC (mg/L)	B	FOS (mg/L)	FOS/TAC	pH	TAC (mg/L)	B	FOS (mg/L)	FOS/TAC	pH	TAC (mg/L)	B	FOS (mg/L)	FOS/TAC	pH	TAC (mg/L)	B	FOS (mg/L)	FOS/TAC	pH	TAC (mg/L)	B	FOS (mg/L)	FOS/TAC
10/13/2021	7.24	4548	0.356	1108	0.244	7.29	3920	0.517	1640	0.418	7.87	2942	0.84	2698	0.917	7.28	3999	0.514	1630	0.408	7.48	5138	0.303	930	0.181
10/14/2021	7.28	3829	0.362	1127	0.294	7.33	4100	0.409	1481	0.361	7.97	1983	0.81	2624	1.323	7.30	3784	0.512	1625	0.429	7.50	4422	0.491	1556	0.352
10/18/2021	7.38	3392	0.504	1597	0.471	7.36	4134	0.6	1918	0.464	7.45	1520	0.84	2714	1.786	7.29	3969	0.462	1459	0.368	7.45	4641	0.51	1617	0.348
10/19/2021	7.45	3716	0.539	1713	0.461	7.39	4228	0.504	1599	0.378	7.19	1510	0.79	2550	1.689	7.36	4267	0.542	1726	0.404	7.42	4258	0.518	1643	0.386
10/20/2021	7.14	3819	0.257	777	0.203	7.50	4555	0.266	808	0.177	7.61	2380	0.92	2964	1.245	7.36	4251	0.362	1127	0.265	7.49	4501	0.276	842	0.187
10/26/2021	6.95	3665	0.511	1622	0.443	7.20	4875	0.446	1406	0.288	7.53	2222	0.91	2930	1.319	7.14	4529	0.524	1665	0.368	7.16	4412	0.458	1447	0.328
10/27/2021	7.01	3857	0.413	1297	0.336	7.38	4877	0.443	1396	0.286	7.36	2074	0.95	3070	1.480	7.33	4701	0.457	1443	0.307	7.33	4772	0.453	1428	0.299
10/28/2021	6.97	3756	0.442	1391	0.370	7.46	4831	0.434	1365	0.283	7.71	2336	0.9	2905	1.244	7.41	4667	0.464	1466	0.314	7.41	4761	0.447	1410	0.296
10/29/2021	6.96	3806	0.445	1402	0.368	7.36	5107	0.483	1530	0.300	7.43	2346	0.94	3048	1.299	7.38	4805	0.445	1462	0.304	7.32	4546	0.432	1360	0.299
10/30/2021	7.00	3979	0.473	1496	0.376	7.50	4604	0.436	1373	0.298	7.71	2476	0.76	2452	0.990	7.47	4457	0.448	1413	0.317	7.45	4214	0.452	1425	0.338
11/1/2021	7.11	3817	0.471	1488	0.390	7.52	5228	0.492	1558	0.298	7.82	2432	0.8	2592	1.066	7.43	4553	0.345	1070	0.235	7.46	4480	0.371	1158	0.258
11/8/2021	7.33	3873	0.408	1281	0.331	7.56	5509	0.311	957	0.174	7.34	1825	1.07	3264	1.788	7.52	4984	0.4	1254	0.252	7.47	4565	0.354	1102	0.241

Workshop Materials

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Challenging today.
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TM 1 - PowerPoint Presentation and Meeting Minutes

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2020 Biosolids Management Plan Update Study

Encina Wastewater Authority

Criteria Setting Mtg

November 17, 2020; 9:30-11:00 am Pacific Time

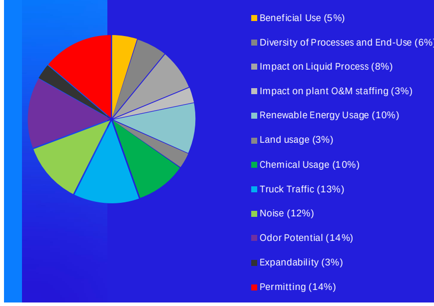
1

Goal: Update Encina Specific Selection Criteria and Priorities

Sustainability	Infrastructure	Economic
• Resource recovery • Energy use • Greenhouse gas emissions • Regulatory issues • Air pollutant emissions • Trucking distance for distribution	• Reliability • Flexibility • Ease of Implementation • Available footprint • Ease of O&M • Impacts on liquid treatment • Level of complexity • Level of intensity	• Reliability • Life cycle cost • Capital cost • O&M cost • Sensitivity to variable energy costs and biosolids product value

Information from proposal and example from another utility

Benefit Evaluation/Qualitative Criteria Weighting Used at another Utility



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2008 BMP Evaluation Criteria

Objective	Criteria	Comments/Considerations
Reliability	1. Seasonality 2. 5-10 Year Outlook 3. Competing Products	Focused on markets
Flexibility	4. Adaptability to Product Changes 5. Delivery Schedule 6. Onsite Processing Needs 7. Product Form	Focused on markets
Regulatory Issues	8. Ability to Permit 9. Environmental Compliance 10. Public Health 11. New Regulations	Focused on process
Risk Exposure	12. Safety 13. Litigation/Liability 14. Product Handling	Combination of market and process.
Implementation Issues	15. Regulatory Hurdles 16. Public Acceptability 17. Schedule	The criteria in this objective overlap with "Regulatory Issues" criteria.

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Key Drivers Discussed with Encina as part of 2020 Update

- Reliability and Redundancy –With process equipment (digestion, dewatering, drying, Class A/B) and the 200% distribution (Class A, Class B, subclass B).
- Regulatory Outlook and Future Restrictions -PFAS, Bans of organics going to landfill, restrictions of specific counties to limit Class B, understand limitations
- Safety – Assumes all options are safe, but ranking based on relative safety measures required to implement alternative.
- Sustainability – Criteria focuses on environmental sustainability with respect to carbon footprint and carbon sequestration.
- Flexibility – This criteria is captured both for market distribution options and equipment flexibility as two separate criteria.
- Regional Solution – This is seen more as an alternative than a criteria.
- Clarity on path forward with key triggers identified - Providing timeframes and triggers to evaluate options: short term, mid-term, long term. Triggers could include: regulations, equipment capacity, equipment life. This driver is not a criteria, but a framework to evaluate.
- Local Use – Captured under reliable distribution criteria. Provide documentation of available large scale local outlets and organize a public outreach event (consider what next steps would be to provide public with access to product)

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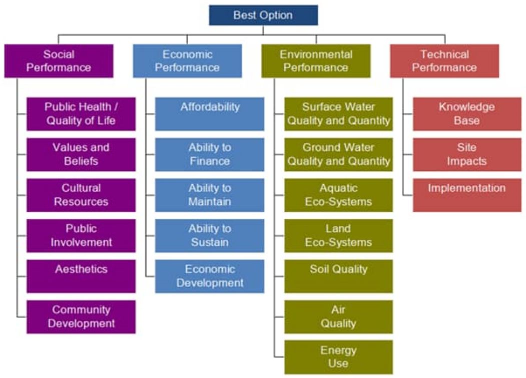
Different Approaches to View Setting Criteria



Proposed new set of Criteria, Definitions, and Ranking Approach

	Criteria	Description	Comparative Scoring Criteria
1	Future Regulatory Risk	Ability to adapt to potential changes in regulation. The challenges associated with permitting new processes or management methods.	An uncertain permitting scenario outcome is a negative. (lower score)
2	Reliable and Redundant Biosolids Product Distribution	Marketability and value of biosolids product and the ability to diversify outlets locally and to provide 200% outlet capacity.	Higher score for processes that support local use and that has multiple potential uses/outlets to provide 200% outlet capacity.
3	Environmental Sustainability	Ability of the alternative to reduce energy consumption or produce clean or renewable energy to reduce greenhouse gas emissions. (carbon footprint and carbon sequestration)	Higher score for alternatives with lower carbon footprint and increased resource recovery.
4	Operational Complexity and Serviceability and Flexibility	Impact on plant operations and maintenance staff as a result of increasing system complexity. Incorporates serviceability and proven technology.	Higher score for processes that are known or have been operated without significant specialization.
5	Reliable and Redundant Equipment	Ability of alternative to provide the required capacity and quality of product. This includes longevity of the equipment.	Higher score for process that can be sustained or adapted to provide effective solution over time.
6	Potential Public Impacts	Potential of the process and biosolids product to cause a public nuisance. This includes at the plant site, during transport of material, and at final product usage.	More noise, traffic, visual impacts, and odor results in a lower score.
7	Safety Aspects	Safety measures required for process to maintain safety of EWA staff, safety of process, safety of product.	More safety mitigations result in a lower score.

Considerations and Next Steps

- Distribute list of possible criteria to team
- Workshop with Team to Establish Criteria – Dec. 2/3
  - Develop clear definition of each selected criteria
  - Force-Weighting of Criteria
  - Conclusion of Criteria Weighting
  - Example application of criteria to Status quo (current operation)

Forced-Weighting of Criteria

- The goal – to represent the EWA's priorities reflected in the selected criteria
- The approach – Compare all criteria and select the preferred one

Criteria Prioritization

		Future Regulatory Risk	Reliable /Redundant Biosolids Distribution	Environmental Sustainability	Operational Complexity/ Serviceability/Flexibility	Reliable and Redundant Process Equipment	Potential Public Impacts	Safety Aspects	Other	Score
		1	2	3	4	5	6	7	8	
1. Future Regulatory Risk	1									0
2. Reliable /Redundant Biosolids Distribution	2									0
3. Environmental Sustainability	3									0
4. Operational Complexity/Serviceability/Flexibility	4									0
5. Reliable and Redundant Process Equipment	5									0
6. Potential Public Impacts	6									0
7. Safety Aspects	7									0
8. Other	8									0

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Meeting Minutes

Subject **TM 1 Evaluation Criteria Discussion**

Project Encina Biosolids Management Plan Update

Prepared by Renee Groskreutz, Jacobs

Location Microsoft Teams **Date/Time** Tuesday, November 17, 2020
9:30-11:00 a.m.

Participants **Encina Wastewater Authority (EWA):** Doug Campbell, Scott McClelland, Tucker Southern
Jacobs: Mark Elliott, Renee Groskreutz, Dave Parry, Todd Williams

Notes		Action
1	**Purpose of Meeting** To update the 2008 Biosolids Master Plan (BMP) evaluation criteria to include sustainability and capture the nonmonetary considerations in evaluating the alternatives.	
2	**Approach to Setting Criteria** ▪ Independent variables – Limit overlap ▪ Focused on comparing the nonmonetary factors of the BMP alternatives ▪ Simplified – So that important factors do not get hidden or minimized by too many criteria; goal is to have 6-8 critical criteria	
3	**Key Drivers** ▪ Reliability and Redundancy – With process equipment (digestion, dewatering, drying, Classes A and B) and the 200% distribution (Class A, Class B, subclass B). Currently only have a primary hauling contract (Denali), but no secondary contract. Closest landfill that will take solids is in Arizona – same hauler. Option: Take more control of where biosolids are sent (purchase land or larger regional solution). ▪ Regulatory Outlook and Future Restrictions - Per- and polyfluoroalkyl substances (PFAS), ban of organics going to landfill, restrictions of specific counties to limit Class B, understand limitations. ▪ Safety – Assumes all options are safe but ranking based on relative safety measures required to implement alternative. ▪ Sustainability – Criteria focuses on environmental sustainability with respect to carbon footprint and carbon sequestration. ▪ Flexibility – This criterion is captured both for market distribution options and equipment flexibility as two separate criteria. ▪ Regional Solution – This is seen more as an alternative than a criterion. ▪ Clarity on path forward with triggers identified - Provide time frames and triggers to evaluate options: short term, midterm, long term. Triggers could include regulations, equipment capacity, and equipment life. The timeframes and triggers are not a criterion, but a framework to evaluate. ▪ Local Use – Included under reliable distribution criteria. Provide documentation of available large-scale local outlets, and organize a public outreach event (consider what next steps would be to provide the public with access to the product).	

<table>
<tr><th colspan="2">Notes</th><th>Action</th></tr>
<tr><td>4</td><td>New Criteria Proposed
1) Future Regulatory Risk
2) Reliable and Redundant Biosolids Product Distribution
3) Environmental Sustainability
4) Operational Complexity, Serviceability, and Flexibility
5) Reliable and Redundant Equipment
6) Potential Public Impacts
7) Safety Aspects</td><td></td></tr>
<tr><td>5</td><td>Next Steps
▪ Review wording of descriptions and rating criteria. Provide feedback prior to larger meeting.
▪ Present criteria and force-weight them with larger group on December 3.
▪ Using the weighted criteria, look at the status quo (current operation) and give that an evaluation.</td><td>Jacobs to update Microsoft PowerPoint slides and share with EWA.
Jacobs to send meeting notice for workshop on December 3.</td></tr>
</table>

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2020 Biosolids Management Plan Update Study

Encina Wastewater Authority

TM1 Workshop

December 14, 2020; 3:00-4:30 pm Pacific Time

1

Agenda

- Goals and Purpose of Meeting
- Review the current biosolids management practices and biosolids quality as presented in TM1
- Discuss the regulatory outlook
- Confirm the nonmonetary evaluation criteria and confirm approach for safety evaluation
- Next Steps and Discussion
  - Updates on Task 2 effort to date
  - Regional Solutions Approach
  - Task 3 look ahead

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Goals and Purpose of Today's Meeting

- Discuss EWA's current biosolids management practices
- Confirm information presented in TM1 and receive initial comments and operations clarifications from EWA
- Clarify outlook for future
- Confirm evaluation criteria

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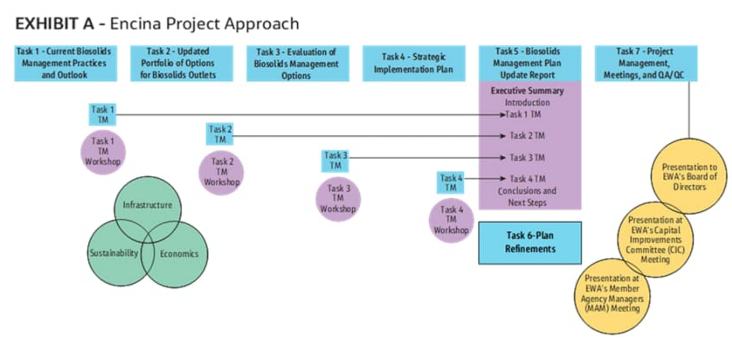
Project Scope Review



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Current Biosolids Practices and Comments to TM 1

5

5

TM 1 Review – Major Components

Section 3 captures current and projected flows and loads to the Biosolids Process.

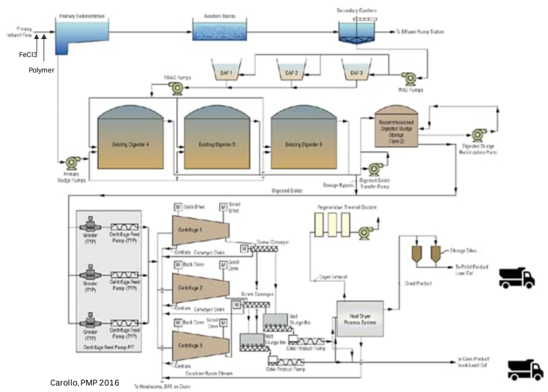
Section 4 provides the regulatory outlook, PFAS updates, and new initiatives in Encina's interest.

Section 5 introduces the nonmonetary evaluation criteria

6

Current Biosolids Process

- Thickening
- Digester
- Updates to this process flow
- Current thinking of planned upgrades
  - Rotary Drum Thickeners
  - Use of Digesters



Carollo, PMP 2016

7

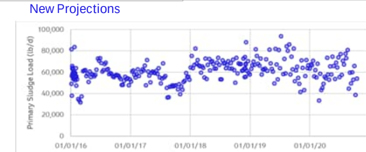
Primary Sludge Projections

- Current average annual PS production has exceeded projections from the BEE report by roughly 15 percent.
- Jacobs revised the BEE projections to incorporate recent data by increasing the 2020 baseline
- 2020 = average annual recorded production from 2017 to 2019
- Assume 4.1% solids

Table 1. Primary Sludge – Current Production and Biosolids, Energy and Emission Plan-projected Rates

Year	Observed		Projections (reproduced from BEE [Brown and Caldwell 2018])	
	PS Flow, gpd	PS Loading, lb/d	PS Flow, gpd	PS Loading, lb/d
2016	159,729	51,639	--	--
2017	166,575	55,224	--	--
2018	183,228	65,695	130,000	47,500
2019	174,821	66,737	--	--
2020	175,000	62,600	140,000	50,600
2030	202,000	72,300	170,000	60,800
2040	229,000	82,000	200,000	71,100

New Projections



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WAS Projections

- Average annual WAS production from 2016 to the present has exceeded projected loads from the BEE report by roughly 20 percent.
- Jacobs revised the projections to incorporate recent data by increasing the 2020 baseline of the projections
- Average from 2017 to 2019 was set as the baseline for the revised projections
- Avg TWAS: 5% solids

	Observed		Projections (Reproduced from the BEE [Brown and Caldwell 2018])	
Year	WAS Flow, MGD	WAS Loading, lb/d	WAS Flow, MGD	WAS Loading, lb/d
2016	0.74	39,400	--	--
2017	0.76	43,300	--	--
2018	0.56	39,300	0.71	29,400
2019	0.59	39,700	--	--
2020	0.64	40,800	0.76	31,600
2030	0.78	49,900	0.94	39,000
2040	0.92	58,900	1.11	46,300

New Projections

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Summary of Recommended Projections

- 2030 and 2040 projections were calculated by assuming the same annual percent growth rate presented in the BEE report.
- Note: Adjusting the projections will impact the timing of capacity constraints for the different processes

Table 5. Projected Average Annual Future Solids Loadings

Loading		2020	2030	2040
Primary Sludge	lb/d	62,600	72,300	82,000
	gpd	175,000	202,000	229,000
Waste Activated Sludge	lb/d	40,800	49,900	58,900
	gpd	636,000	779,000	919,000
FOG	lb/d	4,000	4,000	4,000
	gpd	7,300	7,300	7,300
Brewery Waste	lb/d	[TBD]	[TBD]	[TBD]
	gpd	7,200	7,200	7,200

% Solids:

PS = 4.1%

TWAS=5%

FOG = 5.5%

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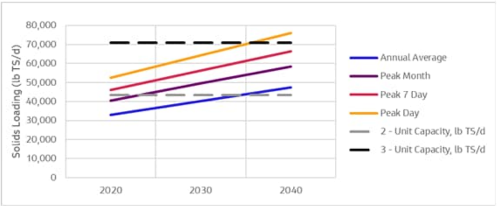
Process Capacity – DAF Thickening

Technology	Total Units	Firm Units	Design Loading Rate[a]	Total Service Capacity (lb/d)	Firm Service Capacity (lb/d)
DAF Thickening	3	2	0.72 lb/h/ft²	70,900	43,400

Assume TWAS 5% solids



- Jacobs typically uses Peak 7 day for sizing thickening, but can adjust per EWA preference.
- Need to understand redundancy approach for EWA.

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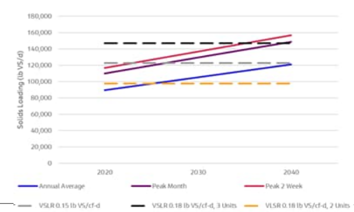
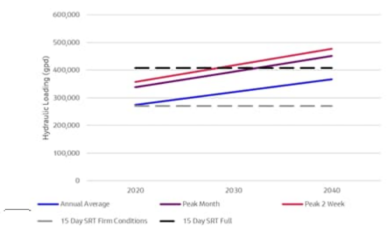
Process Capacity - Digesters

Total Units	Firm Service	Condition	Design Criteria[a]
3	2	Average Volatile Solids Loading; All units in service	0.15 lb VS/ft³/d
		Average Volatile Solids Loading; Two units in service	0.18 lb VS/ft³/d
		Peak 2-week Volatile Solids Loading; All units in service	0.18 lb VS/ft³/d
		Hydraulic Loading (all conditions)	15-day minimum

Note: Avg Solids Conc. of Combined primary and TWAS ~4.7%





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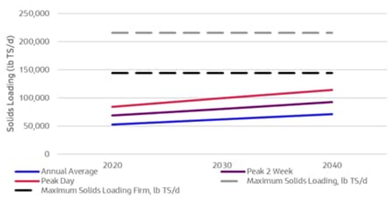
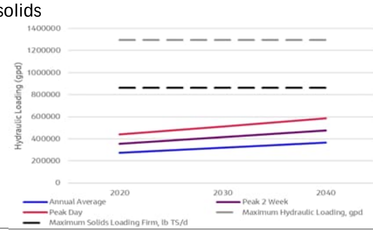
12

Process Capacity - Dewatering

Technology	Total Units	Firm Units	Solids Design Criteria, lb/h/d	Total Service Capacity, lb/d	Firm Service Capacity, lb/d	Hydraulic Design Criteria, gpm	Total Service Capacity, gpm	Firm Service Capacity, gpm
Centrifuge	3	2	3,000 lb/h/d	216,000	144,000	300	900	600

- Solids Concentration of Dewatered Cake: 22%
- Operations Insights on Operation and optimal % solids





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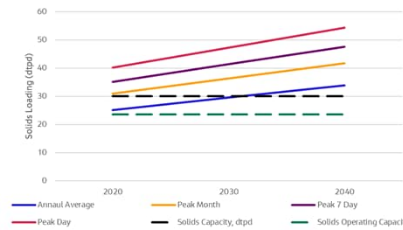
Process Capacity: Dryer

Technology	Total Units	Design Criteria, dtpd	Total Service Capacity, dtpd	Total Operation Capacity, dtpd
Dryer	1	30	30	23.5

- DDS-40 dryer has a water evaporation capacity of 8800 lb/hr
- Based on 22.2%TS cake feed on average, the dryer's 24 hr/day capacity is 30 dry tons to achieve 94%TS
- With scheduled down time (11 days on, 3 off, 2 weeks down) the average capacity is 23.5 dtpd or 6500 dry tons per year
- Capacity on a per ton basis can be increased by increasing the feed solids concentration



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Energy Use

- EWA's point of view: how is energy management at plant now?
- Integrated management of digester gas and natural gas to the dryers and cogeneration units.
- Dynamically load the digesters to produce more gas during on-peak power periods and less gas during the off-peak (evenings and weekends). Link to overall treatment process.
- Is it possible to use more digester gas in dryers?

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Biosolids Quality

- Pollutant concentrations (metals) are well below EPA Exceptional Quality PC limits
- Guaranteed N-P-K is 5-6-0
- High P content is not a benefit in current regulatory climate
- Particle size
- Dust level
- Reheating in storage is ongoing issue (carries stigma in marketplace)

Constituent or Parameter	EPA EQPC Limit	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Avg.
% Solids Granules	--	93	94	94	94	94	94	94
Wet U.S. tons	--	354	591	117	121	383	400	328
Dry U.S. tons	--	331	558	110	113	361	363	306
Arsenic (mg/kg)	41	--	3.1	--	4.3	--	--	3.7
Cadmium (mg/kg)	39	--	1.3	--	0.7	--	0.6	0.9
Copper (mg/kg)	1,500	--	390	--	380	--	320	363
Lead (mg/kg)	300	--	6.2	--	1.8	--	6.2	4.7
Mercury (mg/kg)	17	--	0.8	--	1.0	--	0.7	0.8
Nickel (mg/kg)	420	--	13	--	13	--	13	13
Selenium (mg/kg)	100	--	6.3	--	7.4	--	4.7	6.1
Zinc (mg/kg)	2,800	--	660	--	690	--	580	643
TKN (mg/kg)	--	--	16,000	--	63,000	--	50,000	43,000
Ammonia - N (mg/kg)	--	--	2,200	--	1,600	--	1,000	1,600
Organic - N (mg/kg)	--	--	1,380	--	61,400	--	49,000	37,260
NO_2/NO_3-N (mg/kg)	--	--	2.0	--	6.0	--	2.0	3.0

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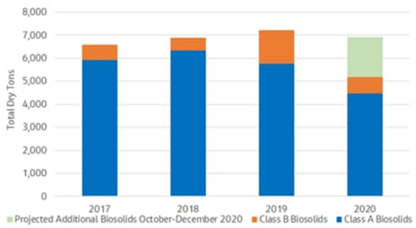
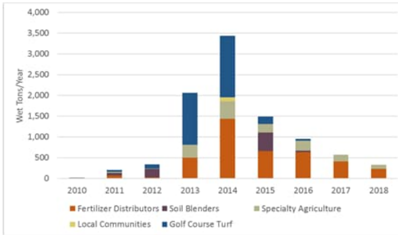
Biosolids Production by Class



Biosolids Class A Sales History



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Process and Distribution – Current Operation and Outlook

- Have we captured the current operations effectively?
- Any clarifications or nuance that may have been missed?
- What additional information is important to EWA?
- Status of Planned Projects
  - Use of Digester 2?
  - RDT replacing DAFs?
  - Anything else

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Regulatory Outlook

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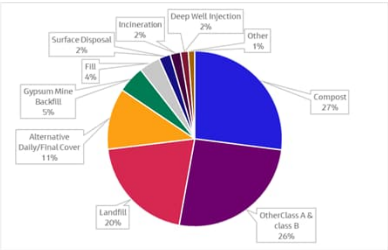
Regulatory Outlook

- Biosolids federal regulations
- Emerging pollutants of concern
  - PFAS
- County, state, and regional regulations
  - SB 1383 comes into play in 2025, 75% reduction in landfilling of organics including biosolids (eliminates landfilling of biosolids)
  - Digested or composted biosolids can be land applied and County's cannot prohibit this after January 1, 2022 (from SB 1383, Chapter 2, Section 18990.1)
- New initiatives
  - Healthy Soils
- Agricultural considerations



Ultimate destination of the biosolids produced in California (CASA 2019).

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20

Confirm Evaluation Criteria

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Proposed new set of Criteria, Definitions, and Ranking Approach

	Criteria	Description	Comparative Scoring Criteria
A	Future Regulatory Risk	Ability to adapt to potential changes in regulation. The challenges associated with permitting new and existing processes or management methods.	An uncertain permitting scenario outcome is a lower score. While process flexibility would provide higher score.
B	Reliable and Redundant Biosolids Product Distribution	Marketability and value of biosolids product and the ability to diversify outlets locally and to provide 200% outlet capacity. (Class A or Class B or subclass B)	Higher score for processes that support local use and that has multiple potential uses/outlets to provide 200% outlet capacity.
C	Environmental Sustainability	Ability of the alternative to reduce energy consumption or produce clean or renewable energy to reduce greenhouse gas emissions. (carbon footprint and carbon sequestration)	Higher score for alternatives with lower carbon footprint and increased resource recovery.
D	Operational Complexity and Serviceability and Flexibility	Impact on plant operations and maintenance staff as a result of increasing system complexity. Incorporates serviceability and proven technology.	Higher score for processes that are known or have been operated without significant specialization.
E	Reliable and Redundant Process	Ability of alternative to provide the required capacity and quality of product. This includes longevity of the process.	Higher score for process that can be sustained or adapted to provide effective solution over time.
F	Potential Public Impacts	Potential of the process and biosolids product to cause a public nuisance. This includes at the plant site, during transport of material, and at final product usage.	More noise, traffic, visual impacts, and odor results in a lower score.
G	Safety Aspects	Safety measures required for process to maintain safety of EWA staff, safety of process, safety of product.	More safety mitigations result in a lower score.

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Results - Conclusion of criteria weighting

- Forced-weighting results

Criteria Prioritization

		Future Regulatory Risk A	Reliable and Redundant Biosolids Product Distribution B	Environmental Sustainability C	Operational Complexity and Serviceability D	Reliable and Redundant Equipment E	Potential Public Impacts F	Safety Aspects G	Score	Weight
Future Regulatory Risk	A		B	C	D	E	A		1	10%
Reliable and Redundant Biosolids Product Dist	B			B	B	E	B		4	25%
Environmental Sustainability	C				D	E	F		1	7%
Operational Complexity and Serviceability	D					E	D		3	20%
Reliable and Redundant Equipment	E						E		5	33%
Potential Public Impacts	F								1	5%
Safety Aspects	G								0	0%
									Sum of Weights	100%

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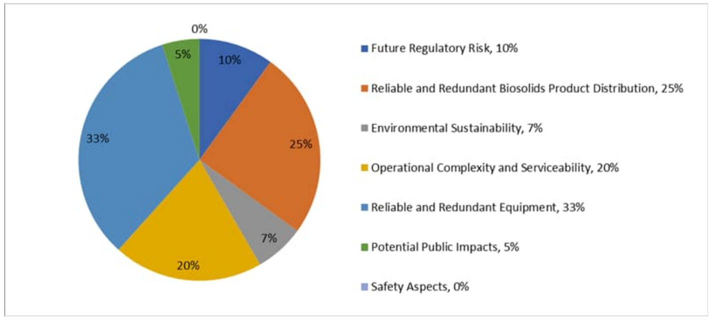
Results - Conclusion of criteria weighting

- Forced-weighting results



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Clarification on purpose of Nonmonetary Evaluation criteria

From the Scope of Work

- Task 3.1 - Screen Options
  - We will screen the long-list of options using the prioritized evaluation criteria. The initial screening will be with non- economic (sustainability and infrastructure criteria) and look for any "fatal flaws."
    - A. Use the weighted non-monetary criteria developed in Task 1
    - B. Further clarify Safety Aspects of the screened options – provide safety ranking of those options
    - C. Move forward with 3 viable options to develop conceptual costs in Task 3.2
- Task 3.2 – Evaluate Options
  - We will further develop and evaluate two to three options. Each option will be described with a description of the product(s) characteristics, process flow diagram, layout of major equipment on a site plan, and details of operation. Conceptual cost estimates (capital and O&M) will be prepared.
- Task 3.3 Compare Options
  - We will compare the evaluated options using all the prioritized criteria including economic metrics. We will summarize the comparisons using benefit: cost ratios where the highest number is the highest ranking. We will recommend the highest ranked biosolids management option for further development in Task 4.

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Next Steps and Discussion

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Next Steps

- Provide update on Marketing Efforts
- Regional Solutions Approach – Jacobs will provide input and list of questions for EWA to have conversations with nearby agencies.
- Look at potential processes and alternatives in Task 3 for Encina to consider.
  - Focus on alternatives to a second dryer
  - Optimize WW treatment and digester performance
  - Dryer/Digester provide redundancy for each other

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Market Research Update

- Efforts were re-focused by EWA, to concentrate on large volume customers (500-1,000 t/a minimum)
  - Product can be distributed to customer for free, or even pay a management fee (as long as is it lower than $51.50/t), local/regional usage is preferred
- Completed over half of the market contacts and have distributed samples
  - Soil blenders received a truckload of product (Great Soils, San Marcos)
- In discussions with 3 companies (Agromin, Mannco, Nutrients-Plus) regarding off-take agreements
- Various end users being contacted (composters, soil blenders, spreaders)

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Meeting Minutes

Subject	TM 1 Workshop Summary
Project	Encina Biosolids Management Plan Update
Prepared by	Renee Groskreutz, Jacobs
Location	Microsoft Teams
Date/Time	Monday, December 14, 2020 3:00-5:00 p.m.
Participants	Encina Wastewater Authority (EWA): Joe Cipollini, Scott Goldman (W&C). Scott McClelland, Octavio Navarrete, Lindsey Stephenson, Tucker Southern, Jacobs: Mark Elliott, Renee Groskreutz, Corey Klibert, Dave Parry, Todd Williams RAA: Ron Alexander

Notes	Action
1 **Goals and Purpose of Meeting** Provide an overview of TM 1 – *Current Biosolids Management Practices and Regulatory Outlook*. Clarify information and projections presented, and gather initial comments and additional Operations input. Provide an update on Task 2 marketing efforts and potential clients.	Jacobs to provide meeting summary.
2 **TM 1 Review** The current solids loading and projections, and the impact to solids process capacity over the next 20 years were discussed assuming those projections. <u>Projections Discussion</u> In the original scope of work, Jacobs assumed hydraulic and solid loading projections presented in recent master planning efforts would be used as part of the capacity review in TM1. As Jacobs compared the current operational data to these projections, there was a 15% discrepancy in the primary sludge production numbers and 20% discrepancy in the waste activated sludge (WAS) production numbers. When this was observed, Jacobs reached out to EWA and recommended updating the 2020 starting point with a 3-year annual average using 2017-2019 and then using the same escalation for both primary sludge and WAS. During the workshop, Operations shared two historical events that impacted the influent data: 1. Influent Junction Rehab Project shifted the sampling locations in 2016, which resulted in improved data and subsequent greater primary solids concentration and load. 2. There was a plant upset from April-November 2018; one of the mitigations was to increase primary solids pumping, resulting in an overinflated primary hydraulic loading rate that was not consistent with normal operations. Although the EWA service area is primarily residential, there is a large tourism component as well. With the COVID-19 pandemic in 2020, there have been some increased flows but reduction in solids overall. Jacobs will relook at the operational data, removing 2018 data and considering either 2017, 2019, or 2020 or an average of 2019 and 2020 data to see how that impacts the 2020 starting point. The percent solids of each flow stream was discussed. • Primary solids at 4.1% was appropriate.	Jacobs to update projections to remove 2018 data in annual average. Use 2017, 2019, or 2020 data.

- Thickened waste activated sludge (TWAS) was assumed at 5% and should be increased to 5.5% on average. The plant often sees between 6 and 7%; however, the dissolved air flotation thickening (DAFT) units are limited by percent solids that can be pumped through the pipes to the digesters.
- Fat, oils, and grease (FOG) is thickened since June 2020. Assume 5.5%, and biochemical oxygen demand (BOD) and chemical oxygen demand (COD) loadings vary from 50,000 to 200,000 milligrams per liter (mg/L) for the brewery waste.

Jacobs to update TWAS to 5.5% solids.

Dissolved Air Flotation Thickening

Normal Operations: Operate one DAFT unit (number [No.] 3) at 500 gallons per minute (gpm). If flow increases to 560 gpm, then Operations brings a second DAF unit online. The hydraulic loading rate is much higher than is shown in our report. DAF units consistently produce 5.5% solids using 40-50 gallons of polymer per day.

Limitations: TWAS pumps and discharge piping limits the percent solids that can be sent to digesters.

Jacobs to update DAFT process table based on EWA Operations input.

Digestion

Normal Operations: Normally, 2 digesters are in operation at 16-19 days. With 3 digesters in operation, all master planning efforts to date have shown they can meet the required 15 days. Need to relook at projections and remove 2018 data to see the impact. Significant work was completed to determine the optimal hydraulic retention time (HRT), and it was determined that 15 days is the minimum Operations will agree to for planning purposes. The minimum required capacity for EWA is: 15 days at Peak 2 week, with all 3 digesters in service. Can they meet the hydraulic and solids loading within these parameters with updated projections?

Limitations: Need to consider capacity and redundancy requirements for the digesters during digester maintenance and with future loadings. The original plan was to add a second dryer to help provide redundancy for digesters. If that does not proceed, need to look at the operational redundancy of the process without the second dryer.

Jacobs to update digestion projections with updated loading criteria, Peak 2 week, and 15-day HRT.

Dewatering

Normal Operations: Initial input is to cut all the hydraulic capacity numbers by half. EWA typically operates with two Alfa Laval centrifuges in service to treat 230 gallons pr minute (gpm). Octavio shared that, operationally, each centrifuge is hydraulically limited to 125 gpm at 95% capture; and this was confirmed with other nearby agencies with Alfa Laval centrifuges. The equipment literature is a hydraulic design rate of 300 gpm. Jacobs to update hydraulic loading capacity and regenerate curves based on EWA operational performance.

Limitations: Hydraulic loading of the centrifuges and dewatering to only 22% total solids (TS) on average.

Jacobs to update dewatering projections with updated hydraulic loading capabilities of 125 gpm (instead of 300 gpm).

Dryer

Normal Operations: The report assumes the DDS-40 dryer has a water evaporation capacity of 8,800 pounds per hour (lb/h) and converts that to dry tons per day (dt/d) capacity.

Scott Goldman expressed concerns about expressing capacity of the dryer in these terms. Normally, the dryer runs at approximately 8,000 lb/h of water evaporation. The normal operation needs to be updated in the report. It should say 10 days fully loaded

Jacobs to update dryer capacity with operating times and clarify water evaporation capacity.

and 4 days for maintenance every 2 weeks. Plus, in each year, there are 2 weeks of planned downtime and an additional 2 weeks of unplanned downtime that should be included in the calculations.

Dryer Improvements Planned or Ongoing:

- Reviewing sludge strainer to remove hair and fibrous materials
- Implement new bar screening to reduce trash
- Improve gas pretreatment upstream of regenerative thermal oxidizer (RTO) to remove particulates using a bag filter.

Limitations: RTO

Energy Usage and Digester Gas

Octavio provided an overview of current operations of the digester gas usage:

- Two engine generators operate on digester gas
- Third engine on digester or natural gas during peak hours (4-10 p.m.)
- Excess digester gas is used in heat drying process

Limitations: Size of burner for dryer; RTO; tank storage for FOG

For the dryers, need to keep digester gas less than 5,000 cubic feet per hour (ft^3/h), or Operations sees elevated exhaust temperatures at the RTO. Manufacturer is tuning burners to confirm true capacity.

Adding FOG increases digester gas production directly. The limiting factor is FOG storage, as there are only 2 storage tanks for FOG, each with a capacity of 19,500 gallons. Operations attempts to keep storage tanks full to augment during peak hours, but must adjust for FOG deliveries. Adequate storage capacity is also problematic for weekends, as by Saturday evening, FOG storage tanks are empty and will not be refilled until Monday.

Biosolids Quality

The PURE GREEN label was updated in 2019 to indicate 5-5-0.2 %. This needs to be updated in the report. From a marketing perspective, the particle size is acceptable. The major concern that EWA is fully aware of is the reheating issue.

Regulatory Outlook

Todd summarized the regulations outlook, with particular importance on digestion to meet State Bill (SB) 1383. This may impact options considered under Task 3. And per- and polyfluoroalkyl substances (PFAS) is a contaminant of concern that should be watched for impact in both California and Arizona.

Other Solids Processing Updates and Plans

EWA updated Jacobs that the rotary drum thickeners (RDTs) are currently on hold, and the team should proceed with DAFTs to understand the loadings to the digesters.

Digesters 1 and 3 are abandoned, and there are currently no plans for those. A report is available with what structural and mechanical improvements would be necessary to bring them back into service in some capacity. This report was already shared with Jacobs.

Jacobs to update discussion of digester gas usage in report.

Jacobs to update biosolids quality discussion in report.

3	**Task 2 – Marketing Update** Ron provided an update of the marketing effort to date. MANNCO has provide a written proposal to take some material. Jacobs will be sharing that with EWA.	Jacobs to share the first proposal received as part of Task 2.

Action Items:

1. EWA to provide consolidated comments to Jacobs by Monday, December 21.
2. Jacobs to update the TM 1 *Current Biosolids Management Practices and Regulatory Outlook* and provide a final version by the end of the year.
3. RAA to continue marketing efforts.
4. Jacobs to begin Task 3 Biosolids Options effort in January.

TM 2 - PowerPoint Presentation and Meeting Minutes

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Regional Biosolids Management Exploratory Discussion

January, 2021

1

AGENDA

- Introductions and Purpose
- What are the Drivers for a Potential Regional Biosolids Option?
- What are the Benefits to Utilities for a Regional Solution?
- What information is needed for EWA to evaluate this option?
- Options for siting/hosting a Regional Facility
- Next Steps

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2

What are the Drivers for a Potential Regional Biosolids Option

- SB 1383 eliminating landfilling of sludge/biosolids in 2025 in CA
- Escalating costs of third-party management contracts
- Hauling distances to useable agricultural sites keep increasing

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3

What are the Benefits to Utilities for a Regional Solution

- Reduced hauling distance for Class B or possibly unclassified solids
- Reduced operating cost for larger regional plant vs. independent smaller ones
- Reduced asset management costs (processing equipment owned and operated by a third party)
- Simplifies biosolids management operations
  - Only dewatering may be required
  - Regional hauler instead of multiple entities with own haulers

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Options for Siting or Hosting a Regional Facility

- At an existing WRRF site
- At a geographically centralized site
- Lead or host agency/community commitment
- Future discussions with 3rd party for potential PPP

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5

What information is needed for EWA to evaluate this option?

- Quantity and quality information of sludge/biosolids
- Current contract pricing with contractor and term conditions
- Existing utility policy drivers such as reduction in GHG impacts or Recycling goals
- Interest in specific biosolids management technologies
- Ability to commit long term if a regional facility is developed

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6

Next Steps

- If interested….
- Fill out basic information survey form and return to EWA
- Follow-up discussions and timing

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7

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Meeting Minutes

Subject	**TM 2 Coordination Meeting**
Project	Encina Biosolids Management Plan Update
Prepared by	Renee Groskreutz, Jacobs
Location	Microsoft Teams
Date/Time	Thursday, October 22, 2020 1:00-2:00 p.m.
Participants	**Encina Wastewater Authority (EWA):** Doug Campbell, Scott McClelland, Octavio Navarrete, Tucker Southern **Jacobs:** Mark Elliott, Renee Groskreutz, Dave Parry, Todd Williams **RAA**: Ron Alexander

Notes	Action
1 Overview of Schedule and Overlapping Efforts Jumpstarting Task 2 and overlapping efforts to meet deadline of early April 2021 for project cost information and clarity with markets.	Jacobs to finalize project schedule – showing overlap of tasks.
2 Type of Products being Considered Now and in the Future Mission: 1) Identify 200% biosolids management capacity: Class A Granules, Class A, Class B, and sub-Class B 2) Create opportunities for Marketing or Revenue Generation; however, revenue generation is not as important as local beneficial use 3) Find local use of biosolids, and minimize cost of final product distribution would be favorably seen by Board 4) Look for land opportunities for storage and potential composting (local beneficial use is more important than reducing truck traffic); this can also serve as a potential regional solution for multiple plants to deliver biosolids to a third-party contractor or similar	Ron to follow up directly with Octavio regarding 2-gallon sample.
EWA's perspective on the markets is that they are similar when it comes to public acceptance: often the public is willing to use biosolids, or they are not. EWA's experience is the market prefers a Class A granule product. There is a difference between Class A granules and biochar when it comes to markets. Biochar is a new market and might be viable. This will be clarified further in our report. Scott M: Is there a reason to stay with Class A product, or a reason to shift to Class B? EWA understands the long-haul distribution process. A Class B product has to go to a land application purpose. With a Class A product, you may be able to find different markets. This must be tempered by the regulatory outlook. Note: The Biosolids, Energy and Emission Plan (BEE) ruled out Class A cake from a thermal hydrolysis process (THP). Jacobs agrees that THP would require major changes to the Water Purification Control Facility (WPCF). There are other technologies that are less disruptive (e.g., pre-pasteurization) and can produce a Class A cake. Scott M. acknowledged that more trucks of a Class A cake would be preferred over a second dryer.	Jacobs will clarify the differences among the different products for final product distribution: dried granules, biochar, Class A, and Class B.

	Notes	Action
	Tucker clarified that EWA wants to understand the market's preference for a Class A cake (over a pellet) if there is one, as well as the regulatory reason for Class A moving into the future. Todd: Class B is a non-starter - going to agriculture, it will be a haul and land application cost. You won't move Class B to other markets. It would be a short term, short-lived option. Doug: Only income received from Class A pellet is when EWA had a full time marketing staff member. His salary was about the same as the amount made. It was also noted that one full-time member is not enough: a team is required. Octavio: Currently, biosolids is a disposition effort - revenue sources have come with other costs (bagging, marketing, managing revenue). Scott M.: Would prefer to secure land and ship all biosolids (Class A granule or cake, Class B) to a composting facility to process.	Jacobs to document options that would require a full-time biosolids marketer and include it in the total cost for distribution.
3	**Quantities and Storage, and Reheating Discussion** *Quantities:* Confirmed production of 18.8 wet tons per day (wt/d) or 6,800 wet tons per annum (wt/a). *Cost to haul and land apply by Denali:* $51.50/ton for dewatered cake, $48.50/ton for Class A pellets. Jacobs requested a copy of the current contract. *Storage silos typical operation*: Pellets are stored in one silo up to 24 tons (one truck) and then offloaded and move to another silo for storage until the next truck is ready to fill. This is a small portion of the design capacity of each silo (90 tons per silo), but storage is operated this way to reduce the risk of reheating pellets. *Reheating Issue*: Will be addressed in Task 3 – Biosolids Options. Black & Veatch (B&V) prepared a study on the reheating issue, and the report will be provided to Jacobs for review.	Renee to follow up with Octavio for current contract with Denali. Tucker to forward B&V Pellet Reheating memo.
4	**In-house Marketing Effort** Based on past experience, it is not planned to hire in-house staff to market biosolids. Need to capture metrics on this. An in-house marketing team would only be considered if it made economic sense and helped with local distribution. Octavio: Often need more than one marketing person – it requires a team for bagging, coordination with outlets, distribution, management, and related tasks. The staff time to manage marketing and distribution can be significantly more than one person.	
5	**List of Contacts** List of entities that can be contacted or not – EWA confirmed that everything is available and open; there are no current strained relationships that should be avoided. Jacobs can use the spreadsheets provided to guide contact efforts.	Ron to initiate contacts and marketing effort in light of discussion.

Notes	Action
6 Regional Solution ▪ Partnering with others to create a solution (larger volume). ▪ Recent South Orange County Wastewater (SOCWA) discussions - They are interested in a regional solution and have similar volumes of biosolids from their plants. ▪ Irvine Ranch Water District (IRWD) Heat Dryer Project - Not interested in hauling to another dryer, but interested in conversations about regional solutions. The focus here was on a partnership for disposal options; for example, cement kiln or composter. ▪ Public-Private Partnerships (P3) - Open but would need good economical justification for an onsite third party. EWA would consider participating in P3 or similar arrangements with merchant (third-party) operations that takes Encina Water Pollution Control Facility (EWPCF) biosolids offsite for further processing. ▪ Potential to purchase or secure land for composting, land application, or storage. ▪ Discussion with Tucker after the meeting: If EWA becomes a regional facility, it would require taking biosolids from outside of the service area, which would require modifications to the Revised Basic Agreement and unanimous approval from the Board. This would be difficult. Therefore, refocus effort to explore an offsite regional solution (not located at an EWA site).	
7 Data Needs ▪ Data request from October 12 ▪ Current contract with Denali ▪ B&V study on pellet reheating issue	Tucker to provide data needs from October 12 request by next week.

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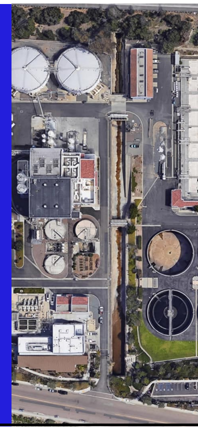
2020 Biosolids Management Plan Update Study

Encina Wastewater Authority

Task 2 Workshop

February 11, 2021



1

Agenda

- Meeting Purpose
- Market Survey Findings
  - Potential Large Bulk User Feedback
- Suggested Distribution Options
  - SWOT comparison of these options

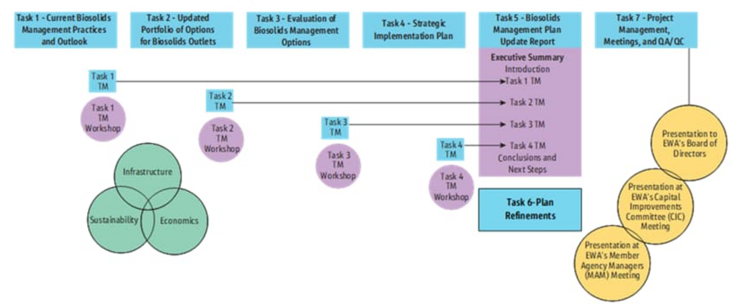
2

Meeting Purpose

3

Project Scope Review

EXHIBIT A - Encina Project Approach



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Market Survey Findings

5

Findings of Task 2 – Biosolids Class A Granule Market Analysis

- Select Horticulture and Fertilizer Market Demographics

Businesses (within 75- miles of Carlsbad)	Landscape Suppliers	Topsoil Blenders	Sod Producers	Fertilizer Wholesale	Fertilizer Retail
	166	54	52	54	22

- Market Research Contact Categories and Counts

Agriculture	2	Fertilizer Blenders & Packagers	4
Composters	4	Bulk soil blenders	3
Energy	3	Soil packagers	1
Fertilizer Brokers / Sales	5	Total	22

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6

General Product Feedback from Surveys

Characteristic	Survey Feedback
Nutrient Content	+++++
Particle Size	++++
Bulk Density	++++
Odor Content	++++
Pathogen Reduction	+++++
Metal Content (EQ)	+++++
Potential to Reheat	-----
Flexibility on Availability and Pricing	---

- Need to address reheating issue

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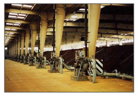
7

Comments by Market Categories on Class A EQ Granule Product

- Agriculture – opportunity exists for direct sale of product to farmers, but that would require dedicated sales staff. Instead, farmers may be accessed by working through agricultural spreading companies (e.g., ET, Inc), who would act as a product distributor.
- Cement Kilns - although successfully used as an alternative energy source in industrial applications, the regional cement companies did not express interest in an EWA product. Product volumes are too small, perceived Hg issue.
- Composters – interest was not identified for the use of the biosolids granules as an additive to composting (for nutrient enhancement).
  - However, Agromin (a LA area composter and packager) showed interest in using the product in some of their blended soil products.
  - Imperial Valley Compost, located in Brawley, showed some interest in distributing the product.



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Comments by Market Categories on Class A EQ Granule Product

- Fertilizer Blenders / Packagers – limited interest was identified with new fertilizer blenders and packagers.
  - However, Nutrients-Plus and Upcycle & Company showed continued interest in working with the EWA product.

- Fertilizer Brokers/Biosolids Managers – companies such as MANNCO and WeCare/Denali showed significant interest in working with the EWA fertilizer.
  - Both companies experienced at marketing granulated biosolids
  - Would likely offer a distribution agreement in which they would be paid a fee to distribute the product, potentially reducing over time
- Soil Blenders – limited interest was shown by bulk soil blenders
  - However, interest was shown by Agromin, a large packaged soil producer.
  - Great Soils, LLC, a local bulk soil blender was initially enthusiastically interested in using 1,000 tons per year of the product. However, when they received a trial 20-ton truck load of the product, it was very hot and looked to be smoldering so they have lost interest.

9

Large (> 1,000 TPY) Potential Users Identified

Agromin+	Interested in the potential use of the granules. Obtained a trial load from Encina. Has some interest in using the product if EWA ships the product to their Oxnard facility for free. May have interest in marketing the product in the future.
MANNCO*	Experienced biosolids granule marketing company, but not currently operating in California. Provided a draft marketing agreement to EWA for consideration.
Nutrient PLUS*	Open to marketing and/or using larger volume of product. Provided a draft marketing agreement to EWA for consideration. (Had difficulties obtaining larger volumes of EWA product in 2020)
Upcycle & Co	Been packaging and selling the EWA product for some time. They sell in 4 lb bags, with usage of 20-30 tons (total) over the past few years. They want to be using larger volumes of product on a more consistent basis. They are interested in managing product for EWA, and being one of the companies taking 1,000 tons. They are working on a plan and potential proposal for EWA.
WeCare/Denali LLC+	Open to managing granule through creative distribution option, open to an introductory call. Their plan would be for EWA to pay them to move the granules while developing markets, leading to a cost neutral (or pay) service; 5 year contract.

* Provided proposals + Open to meeting and providing proposals

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Survey of Other Biosolids Dryers/Granulators

Facility	Product data	Market data
City of Corona Corona, CA	Produce 8,000 t/a, of a 6-6-0 % product, using a Siemens Water Technologies rotary drum dryer. Facility experienced a fire in 2020. Expect to rebuild and start production again; likely taking 1-2 years.	Had been selling all product to / through Nutrients-Plus (N-P), whose management thought that they had done well. N-P purchased the product that they used in fertilizer blending ($10/ton), and received the product distributed to farmers for free.
Irvine Ranch Water District (IRWD) Irvine, CA	New Andritz belt dryer system to start spring 2021, producing approx. 3,600 t/a of a 4-3-0 % or 5-3-0 % product. Will have some spare processing capacity.	They will not have internal sales staff for the product, but are looking for off-take agreements. Unknown if they will be paid for the product in the short-term.
Milorganite Milwaukee, WI	Produce 46,000-48,000 t/a, of a 6-4-0, 2.5 % Fe (150 SGN) product. Currently selling out, and have some interest in the sale of product that they do not produce, to gain distant supply and help the industry.	Could use 5,000-10,000 t/a source, west of the Rockies. Said the product does not have to have the same particle size or nutrient content. The efficacy of the product, consistency and long-term stability of the program is key.
Pierce County Public Works, University Place, WA	Produce 2,400 t/a of a 5-5-0 % fertilizer product, using the Andritz rotary drum dryer technology. Call product "SoundGro". Sell product in bulk, 1 ton totes and 50 lb bags (in pallet quantities only).	All product is now ordered on-line with 9 companies reselling bags in WA. Pricing: loose tons - $66.36, totes - $85.95, pallet of bags - $300.38. After struggling to expand sales, with no dedicated sales staff, they report to be currently 'selling out'.
Sacramento Regional County Sanitation District (SOFCO - operated by Synagro) Elk Grove, CA	Produce 7,300 t/a of a 5-3-0 % using an Andritz rotary drum dryer. Have 100 tons of silo storage, but try not to use because of reheating. Coat granules sold to fertilizer blenders with oil.	Fertilizer blenders pay @$60-65/ton and farmers pay $20-25/ton, FOB. Facility does not run every week, so need to give lead time for orders. Their sales guy is located in Bakersfield.

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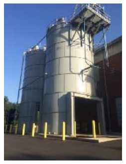
Lessons Learned from Survey of other Drying Facilities



- Branding is helpful, but primarily when marketing to the retail and smaller commercial sectors
- Product consistency and communication about shutdowns are important to buyers / brokers
- Reheating is a problem for many dried biosolids products
- Designating staff responsibility for sales and distribution is key
  - Understand roles and objectives
- Concerted sales / marketing efforts raise product value and improve sales / marketing success
- Successful market development takes time (and effort)

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Suggested Biosolids Granule Marketing Options for EWA

Options	Pros	Cons
Develop in-house marketing program	Can generate the greatest income and publicity. Provides EWA with the greatest control.	Requires staffing, most internal effort. Leaves EWA with the greatest amount of responsibility.
Contract with broker and/or biosolids management firm	Large volumes are contracted or committed to one or a few companies, reducing EWA management requirements. Reduced EWA market risk.	Product often becomes commoditized, and the producer typically loses the ability to brand the product (internal). The producer may be paying a fee for distribution.
RFP for purchase of product	Can cast a broad net, identifying potential interested parties.	Often poorly executed (advertised to the wrong organizations). Typically reduces value of the product.

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SWOT Analysis Comparison Discussion

- In-House Marketing/Distribution Option
- External Broker Marketing/Distribution
- Strengths and Weaknesses are generally internal issues
- Opportunities and Threats are generally external issues
- Present draft list/comparison

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In-House Distribution / Marketing Option

STRENGTHS	WEAKNESS
• Existing staff knowledge • Past product branding • Product possesses good physical and chemical characteristics • Understanding of trucking logistics	• Sales approach to marketing has inconsistencies • Maybe 'too many cooks in the kitchen', with no chef leading the way • Reheating issue is known to fertilizer blenders (highest value commercial buyers) • Additional staff time/resources potentially needed
OPPORTUNITIES	**THREATS**
• Solve product reheating issue • Large number of packaged fertilizer users in the region (retail market / true highest value) • Many fertilizer companies located in region • Large acreage of agricultural crops and sod production within the region	• Regional competition • Negative biosolids product(s) stigma • Continued product reheating issues • Negative stigma around EWA and Pure Green • Lack of end user storage capacity • Initiative to reduce turf in California • Future changes in regulations

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External Broker Distribution / Marketing Option

STRENGTHS	WEAKNESSES
• Experienced in sales and marketing • Have adequate sales and marketing staff • Experienced in selling biosolids granules • Experienced in managing logistics (shipping) to leverage lowest haul cost • Existing contacts within end user groups	• Little interest in using large volumes in the short-term without compensation • May not be sympathetic about production problems • A single EWA staff member will have to manage the relationship with broker
OPPORTUNITIES	**THREATS**

• More timely removal of product
• Pay lower management fees (per ton)
• Ability to reduce cost or payment for product sales over time
• Long term contracting possible
	• Future changes in regulations
	• Lower market penetration due to:
	  • Continued product reheating issues
	  • Lack of use by fertilizer blenders
	  • Negative stigma of EWA and Pure Green

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Next Steps

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Next Steps

- Receive EWA comments on draft TM2
- Complete conversations with potential Regional Partners
- Finalize TM 2
- Implement Recommendations (Future Efforts):
  - Negotiate with potential brokers/end users in near term
  - Address reheating issue
  - Identify and remove distribution limitations
    - Scale must be in working order
    - Determine direction on diversifying market partners or continue with current contractor
    - Develop a process to respond to market needs

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Meeting Minutes

Subject	**TM 2 Workshop**		
Project	Encina Biosolids Management Plan Update		
Prepared by	Renee Groskreutz, Jacobs		
Location	Microsoft Teams	**Date/Time**	Thursday, February 11, 2001 9:00-10:30 a.m.
Participants	**Encina Wastewater Authority (EWA):** Doug Campbell, Scott Goldman (W&C), Scott McClelland, Octavio Navarrete, Tucker Southern **Jacobs:** Mark Elliott, Renee Groskreutz, Dave Parry, Todd Williams, **RAA:** Ron Alexander		

Notes	Action
1 Introduction Draft TM 2 was submitted on Friday, February 5, 2021. The purpose of this meeting is to provide an overview of TM 2 and gather initial comments.	
2 Market Survey Findings Ron provided an overview of the feedback during his market survey. Overall, positive feedback on Class A biosolids quality (nutrient levels, size). Concerns were raised about 2 items: 1) Reheating Issue – Risk of smoldering and storage 2) Availability and Price – Inconsistent There was no interest in Class B dewatered cake in the local market among those surveyed. Some interest does exist in biochar with soil blenders. Scott G.: What is knowledge of biochar in the local markets? The EWA pilot with biochar resulted in a very hard pellet that was not dissolvable. Dave: Clarified that the technologies now create a finer material, and it is a fully integrated process. Scott M.: Question about the cement kilns' response of preferring larger volume– what constitutes a large volume? Ron: Tens of thousands of tons. Also, a cement kiln may take care of transport costs but would not purchase the biosolids. Additional concerns of permitting, mercury content, and consistent volumes for this market. Tucker: Is there an interest in Class B for offsite composting? Inland Empire Composter is full, and Synagro facility has capacity issues. For Composters, there are two sides of the issue: tip fee to take the product, and haul cost to get it there. Inland Composter may take Class A pellets to distribute and provide other blended products, but would likely not use them in the composting process.	Jacobs to add discussion about Class B options in TM 2.
3 Recommended Distribution Options Contract with Broker or Biosolids Management Firm to provide the 200% distribution capacity. There are 5 interested parties: 1) Agromin - Main operation in Oxnard, which has similar haul cost to Yuma, but could develop market locally in the future. 2) MANNCO - Provided proposal, EWA commented, and they revised the proposal. 3) Nutrients Plus (NP) - Currently purchases, and would like to increase share. Has voiced some product availability concerns. EWA voiced concerns that NP did not take	Jacobs to send list of contacts and updated contracts.

	Notes	Action
	product when available. Could be an issue for seasonal supply and demand. Provided proposal, but did not update from comments yet. 4) Upcycle & Co. - Octavio: Upcycle has requested 500 tote sacks. Operations does not have the equipment and staff to provide that many tote sacks. 5) WeCare/Denali LLC - This is the marketing arm of Denali. Would recommend introductory conversation with WeCare/Denali. Great Soils was initially interested but had major concerns about reheating and safety issue. They may be interested if reheating issue is fully addressed.	
4	**Discussion** **Reheating Issue –** Clarify all 5 entities identified can handle current issues. Highest bulk market cannot take it (which reduces the potential value). Recommendation: Be transparent on reheating issue – understand it will impact volume and price in discussions with distributors. If everyone understands the issue, then it boils down to risk, cost of solution, flexibility, and perceived value of product. Doug: Need to have a clear plan to address reheating. **Managing Multiple Distributors –** Scott M.: Jacobs has brought potential distributors to the table, but EWA will need to decide ultimately who to work with because it is too difficult to serve multiple contracts. The goal needs to be securing 200% capacity and understanding seasonal fluctuations. **Contract Process –** Tucker: Need to understand process to negotiate deals, requirements of contracts, and purchasing policy. Scott M.: There is precedence with alternative fuel contracts. Need to present to Board path forward and have them authorize, but can begin conversations. Scott M.: Any contract must include a bottom line of the minimum product that must be taken. Need to include a schedule to balance out seasonality of product. **Decision Tree –** Scott M.: It would be helpful to have a decision tree to present to Board. Net cost versus net savings. **Timing of Negotiations –** Scott M.: What happens if we wait to negotiate until after results of study in April? The longer the initial discussion wait, the loss in interest from the potential distributors increases. Develop interim approach to meet demand and build market, but not have a contract. Contracts require Board approval.	Jacobs to create decision tree. EWA to initiate conversations.
5	**Regional Solution** ▪ Follow up with agencies for data request. ▪ Need to initiate conversation with South Orange County Wastewater (SOCWA) and Escondido (need contact – Mark to provide possible contact; Doug to find out who manages biosolids).	Renee to follow up on data request from regional partners Tucker to schedule conversations with other regional partners

Notes	Action
6 Next Steps 1) Reheating Strategy: Determined by discussions with potential users. If goal is to distribute to local markets, then product will be valued less by end users if reheating issue is not addressed. 2) Initiate Conversations with 5 Distributors: Distributors who do not have issue with reheating would score more positively. In the interim, provide product to develop markets. 3) Understand contractual opportunities and limitations. 4) Address equipment limitations for loading sacks, and coordinate potential users. 5) Fix scales so efficient distribution can be completed. 6) Board meeting to present results of overall project in April.	
7 Action Items 1) Ron to provide list of contacts and updated proposals (completed February 11). 2) EWA to provide comments to draft TM 2 to Tucker to consolidate and share with Jacobs by February 26. 3) Scott M. to schedule a special meeting with Board to review overall BMP Update results in April. 4) Scott M. and Tucker to set up calls with 5 potential distributors to initiate discussions. 5) Doug to provide initial per- and polyfluoroalkyl substances (PFAS) results from Encina Water Pollution Control Facility (EWPCF) (completed February 12). 6) Doug to provide contact at Escondido. 7) Mark to provide contact at Escondido. 8) Renee to follow up on data request from Oceanside and San Elijo. 9) Renee to provide a type of decision tree for both biosolids markets and technologies.	

TM 3 - PowerPoint Presentation and Meeting Minutes

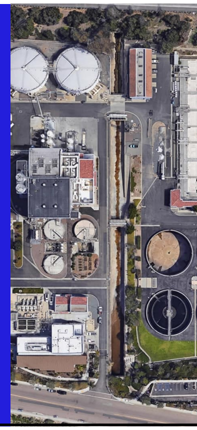
Jacobs Challenging today. Reinventing tomorrow.

2020 Biosolids Management Plan Update Study

Encina Wastewater Authority

Task 3 Pre-workshop

January 28th, 2021



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Agenda

- Goals and Purpose of Meeting
- Preliminary Screening
- How Key Technologies support EWA's Management Strategy
- Biosolids Processing Solution Alternatives
- Next Steps and Discussion

2

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Goals and Purpose of Today's Meeting

Present solutions fitting EWA drivers for biosolids processing and discuss EWA's preferences in terms of management approaches.

3

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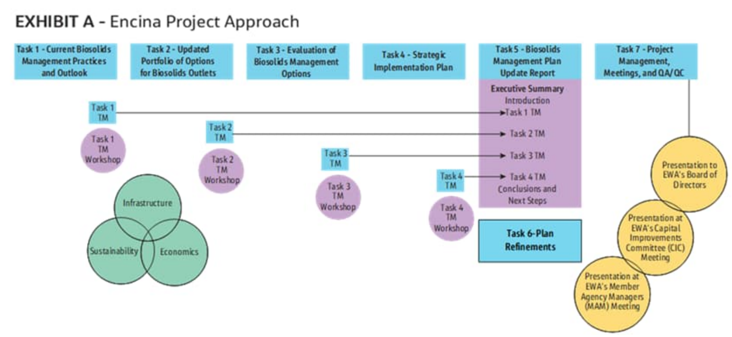
Project Scope Review



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Preliminary Screening

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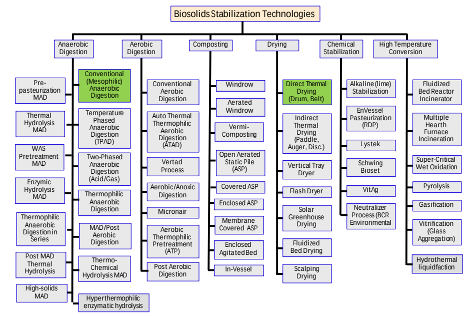
Encina Criteria Will Drive the Selection of Process Technology Options

Universe of technology options



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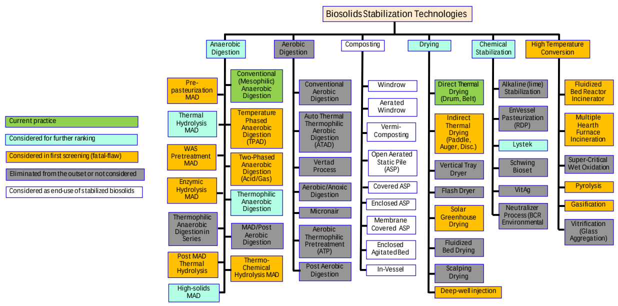
EWA Alternatives Considered in the 2018 BEE



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2020 BMP Update - Initial Screening "Fatal-flaw"

- Eliminated:
  - Aerobic Digestion
  - Chemical Stabilization
  - Incineration
  - Thermal Hydrolysis Process (THP)
  - Composting technologies

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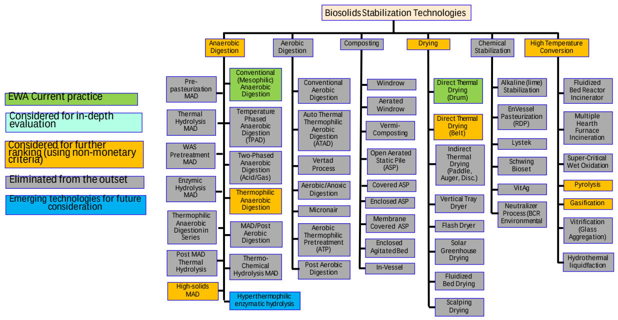
Encina Criteria Will Drive the Selection of Process Technology Options



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Key Drivers in EWA Management Approach

- Solids Processing Redundancy
  - Digestion provides backup to Dryer
  - Dryer provides backup to Digestion
- Digester performance impacts dryer operation
  - Increased VSR increases dewatering performance
  - Higher cake solids reduce dryer evaporative demand
- Product Marketability
  - Limited market for Class A and Class B cake
  - Saving incentive from volume reduction

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General Product Feedback from Surveys

Characteristic	Survey Feedback
Nutrient Content	+++++
Particle Size	++++
Bulk Density	++++
Odor Content	++++
Pathogen Reduction	+++++
Metal Content (EQ)	+++++
Potential to Reheat	-----
Flexibility on Availability and Pricing	---

- Need to address reheating issue

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How Key Technologies support EWA's Management Strategy

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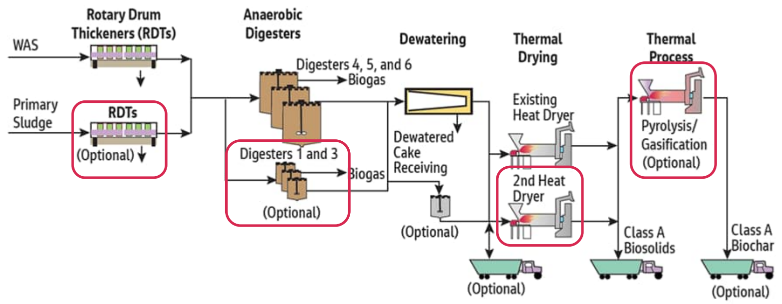
Technologies Working Together – Solutions



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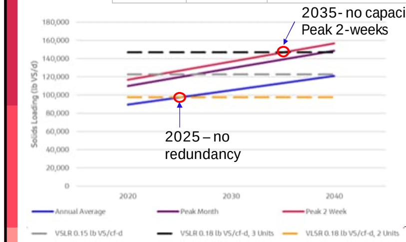
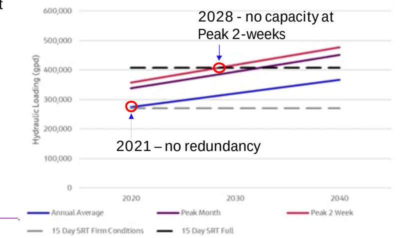
Anaerobic Digestion – Why and When?

Total Units	Firm Service	Condition	Design Criteria[a]
3	2	Average Volatile Solids Loading; All units in service	0.15 lb VS/ft³/d
		Average Volatile Solids Loading; Two units in service	0.18 lb VS/ft³/d
		Peak 2-week Volatile Solids Loading; All units in service	0.18 lb VS/ft³/d
		Hydraulic Loading (all conditions)	15-day minimum





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Optimized Anaerobic Digestion – How?

Increase digestion volume

- Utilize Digester 3
- Build fourth digester of similar size of Dig 5 and 6

High-solids anaerobic digestion

- Thickened feed
- Recuperative thickening

Thermophilic Anaerobic Digestion

THP-MAD: Screened out

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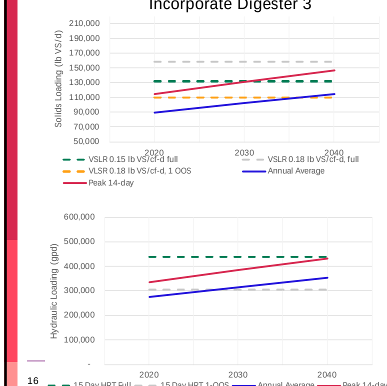
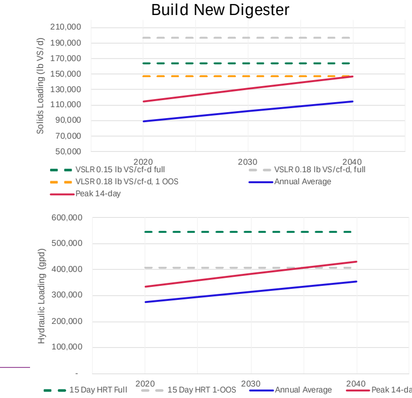
Optimized Anaerobic Digestion – Increase Volume

Incorporate Digester 3



Build New Digester



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Optimized Anaerobic Digestion – High-solids

- Digestion operated at 3.5% solids in digester
- Operating considerations and equipment updates
  - Thickened feed – 7% TS
    - RDT
  - Mixing modifications
  - Feeding modifications (feed pumps)

			Design Criteria	
Total Units	Normal Service	Condition	Volumetric (BEE 2018)	Specific
3	2	Average Volatile Solids Loading; All units in service	0.15 lb VS/ft^3/d	0.15 lb VS/lb VS dig/d
		Average Volatile Solids Loading; Two units in service	0.18 lb VS/ft^3/d	0.19 lb VS/lb VS dig/d
		Peak 14-day Volatile Solids Loading; All units in service	0.18 lb VS/ft^3/d	0.19 lb VS/lb VS dig/d
		Hydraulic Loading (Peak 14-day conditions)	15-day minimum	15-day minimum

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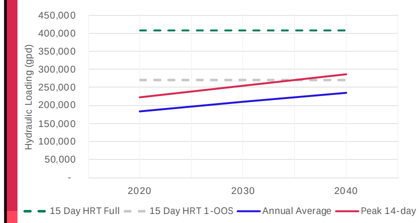
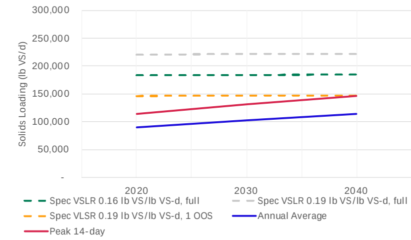
Optimized Anaerobic Digestion – High-solids – Feed at 7% TS





Capacity and Redundancy can be met in 2040 if management strategy incorporates Digester 3

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Optimized Anaerobic Digestion - Thermophilic Digestion

- Existing Digester Capabilities
- Increase organic loading rate to 0.3 lbVS/ft^3/d
- HRT 12 days at average 8 days at peak conditions
- Class A Cake
- Considerations to implement with current assets
  - Structural
  - Heating Supply
  - Equipment
  - Additional biogas production
  - Sidestream return ammonia

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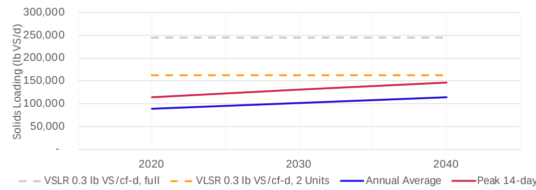
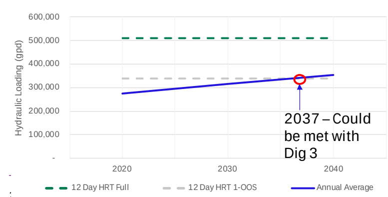
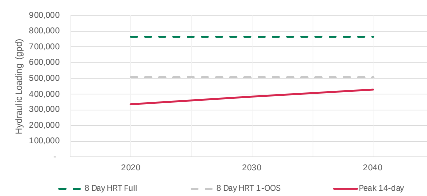
Optimized Anaerobic Digestion - Thermophilic Digestion







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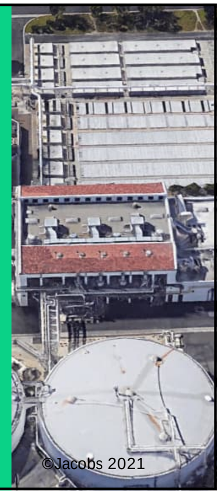
Post-digestion – How?



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Post-digestion – The Second Dryer - Direct Thermal Dryer

- Drum Dryer
- Belt Dryer
  - Lower temperature drying
  - Can work along CHP
  - Larger footprint

Biocon Belt Dryer Enclosure

Biocon Dried Product (Belt Dryer)

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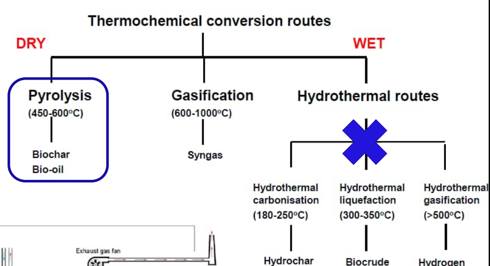
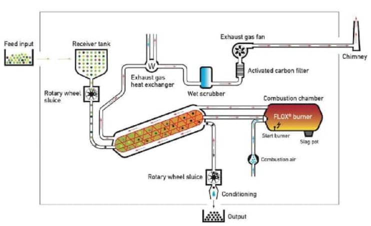
Post-digestion - Pyrolysis

- Volume reduction (90%)
- May address potential <u>regulatory</u> issues (PFAS)
- Low energy input
- Requires drying capacity to be expanded





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Post-digestion - Gasification

- Volume reduction (>90%)
- May address potential <u>regulatory</u> issues (PFAS)
- Low energy input
- Solution may already include drying capacity

Ecoremedy gasification and drying system

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Relative Tonnages and # Trucks per week for various options

Option	2020 Production (7,000 Dry Tons/Year)		2040 Production (9,000 Dry Tons/Year)	
	Wet tons per day	Trucks per week	Wet tons per day	Trucks per week
No drying	87	28	112	36
Current operation	27	9	36.6	12
Second Dryer	20	7	26.8	9
Pyrolyzed Char Product	2.7	<1	3.5	<2

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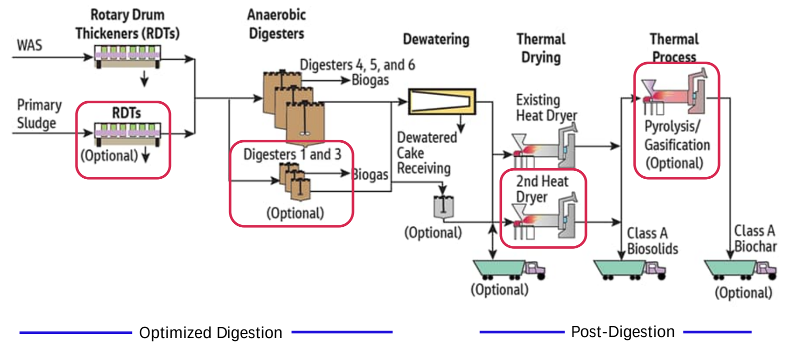
Discussion



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Next Steps

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Next Steps in Task 3

- Develop Alternative Solutions based on today's feedback.
- Apply non-monetary criteria to select up to 3 solutions
  - Scoring meeting
- Develop cost estimate for the 3 solutions and compare alternatives
- Draft TM
- Workshop

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List of alternatives

Biosolids Management Alternatives - Implementation timeline

	Short-term	Mid-term	Long-term
1	Reheating/Marketing	Optimized Digestion	Optimized Digestion
2	Reheating/Marketing	Add Dryer Carbonization	Optimized Digestion
3	Reheating/Marketing	Optimized Digestion	Add Dryer Carbonization
4	Reheating/Marketing	Carbonization	Optimized Digestion

Optimized Digestion (all options to achieve Class B as minimum)

A. Increase Volume
1. Add Digester 1 and 3
2. Add Dig 1, 2 and 3.
3. Build new digester (not really feasible)

B. High-solids
1. Improve thickening system
2. B1 and add Dig 1 and 3
3. Recuperative Thickening in Digester 1 and 3
4. B3 and add Dig 2.

C. Thermophilic
1. Operate Dig 4, 5 and 6 Thermophilic
2. Same as C1 with Dig 1 and 3 Thermophilic
3. Incorporate Digester 1, 2 and/or 3 Thermophilic as needed. Dig 4, 5 and 6 mesophilic (current operation)

D. Enzymatic hyperthermophilic hydrolysis
1. Implementation in 2030 using Dig 1 and 3

Post-digestion (assume Class B solids is met at all times)

A. Drying
1. Status quo – 55-60% drying capacity. Class B cake production
2. No drying – All class B cake
3. Status quo (A1) to 2030 then abandon dryer to 100% Class B cake
4. Add second dryer in 2025 to meet 100% drying capacity under max month
5. Add second dryer in 2030 to meet 100% drying capacity under max month

B. Carbonization
1. Same as A4 with all dried product to pyrolysis
2. Same as A5 with all dried product to pyrolysis
3. Same as A1 and add Ecoremedy type solution. Gasification on what's not processed by current dryer. Produces dry product and syngas.

Jacobs

Meeting Minutes

Subject	**TM 3 Pre-Workshop Summary**
Project	Encina Biosolids Management Plan Update
Prepared by	Renee Groskreutz, Jacobs
Location	Microsoft Teams
Date/Time	Thursday, January 28, 2021 11:00 a.m.-12:30 p.m.
Participants	**Encina Wastewater Authority (EWA):** Scott Goldman (W&C), Jimmy Kearns, Scott McClelland, Octavio Navarrete, Lindsey Stephenson, Tucker Southern, **Jacobs:** Mark Elliott, Adrian Romero-Flores, Renee Groskreutz, Dave Parry, Todd Williams

<table>
<tr><th colspan="2">Notes</th><th>Action</th></tr>
<tr><td>1</td><td>Goals and Purpose of Meeting
Provide a preview of Task 3 technologies being considered in management approach and develop list of alternatives to consider based on results of TM1 and TM2.</td><td></td></tr>
<tr><td>2</td><td>Preliminary Screening and Drivers
Start with a large list of biosolids stabilization technologies. Take the results of the Biosolids, Energy and Emission Plan (BEE), which looked in depth at each of technologies in 2018, and take a fresh look at what technologies are relevant in the management strategy moving forward. Then Jacobs conducted a fatal flaw evaluation. Based on this strategy, the technologies that will be integrated into the alternatives to evaluate include:
Optimizing current operation of mesophilic anaerobic digestion (MAD) and direct thermal drying
Technologies to further consider:
Improved thickening and recuperative thickening (RT) (high-solids MAD)
Thermophilic anaerobic digestion (TAD)
Direct thermal drying, including by belt, pyrolysis, and gasification
Emerging technologies (to stay informed and ahead of curve): Enzymatic hyperthermophilic enzymatic hydrolysis (EHH)
Review of drivers and potential triggers to consider these technologies:
Solids processing redundancy (digestion and dryer synergy)
Digester performance impacts dryer operation (one improvement impacts the other)
Product marketability, including:
Limited options for cake locally
Considerations of product quality (reheating) and availability (contract terms)
Incentives for volume reduction to reduce cost and number of trucks
Regulatory drivers include State Bill (SB)1383 and per- and polyfluoroalkyl substances (PFAS) regulations
Scott G.: EWA participated in a full-scale pyrolysis evaluation with Anaergia for 2 years with unfavorable results. Jacobs should clarify the differences of the technologies proposed compared to the Anaergia pilot test.</td><td>Jacobs will make note of previous experience with pyrolysis.
Jacobs to clarify the time to market for emerging technologies.
Jacobs to address enzyme addition as fatal flaw screening.</td></tr>
</table>

Notes		Action
	Dave: To clarify, there are successful applications of this technology by BioForceTech in Redwood City, California and at Silicon Valley Clean Water and Eco-Remedy in Morrisville, Pennsylvania. It should be considered as a possible solution to meeting future regulations for PFAS. Scott M.: Need to consider time to market for emerging technologies. EWA would consider pilot testing opportunities for emerging technologies. Dave: Pilot unit is on semi-trailer and could be available as early as June. Octavio: Should we consider enzymatic addition? Vendors have been marketing this strategy, and City of Oceanside is considering it. Need to capture the cost versus improvement and experience that these additives have not proved cost-effective in the long term to document that it was evaluated. Dave: EHH does not add enzymes but creates them naturally. Jacobs is not suggesting or evaluating the addition of enzymes to the digestion process. Scott M.: Is reheating issue a deal killer for local markets? Todd: We have gotten direct feedback from one of the possible markets that it is. We have also gotten direct feedback that it is not from another. General sentiment is that it is looked on as unfavorable.	Jacobs will clarify extent of reheating issue in Task 2 Workshop.
3	**How Key Technologies support EWA's Management Strategy** The discussion of key technologies is categorized as Digestion and Postdigestion, and they work together to provide viable management solutions. *Digestion Options:* (Address capacity issue and optimize current operation) ▪ Add volume from digesters 1 and 3. ▪ Construct fourth larger digester in place of digesters 1, 2, and 3. This option needs to clarify the site impacts and use of Digester 2 as a holding tank for centrifuge. ▪ Convert digesters 1 and 3 to RT. ▪ Covert digesters 1, 3, 4, 5, and 6 to RT. Be aware of the limit of mixing digesters 4, 5, and 6 with thicker solids (greater than 3.5% in digesters). ▪ Convert to TAD. Lindsey: Confirmed there is room for heat exchangers by each of digesters 4, 5, and 6. ▪ High-solids digestion, improved thickening with rotary drum thickeners (RDTs) (waste activated sludge [WAS] and primary sludge) RT: Dave suggested thickening of all the digesters, but there is a limitation in mixing equipment in digesters 4, 5, and 6. Previous studies have looked at RT of digesters 1 and 3 only to address these limitations. *Postdigestion Options:* Consider life of current dryer and how it will be handled until then. ▪ Use of Existing Dryer: Compare current operation versus design loading, then take a percentage of that to accommodate aging of equipment and escalating downtime because of maintenance requirements. ▪ Add second Dryer: Drum or belt dryer	Jacobs to revise discussion to include both digesters 1 and 3. Add recuperative thickening of Digesters 1 and 3 only as an option.

<table>
<tr><th colspan="2">Notes</th><th>Action</th></tr>
<tr><td></td><td>Pyrolysis: What is the benefit or drawbacks, and what are the triggers?
Gasification: Initial reactions to this to potentially address PFAS regulations.
Do Nothing option: Understand impact to number of trucks, how to stage them, what to do with sub-class B quality. Need to bookend possible options with this.
Octavio: For the Do Nothing option, need to understand the range of management options. Note that previous experience with dewatering using the belt presses resulted in 5 trucks per day, so the trucking slide is in line with this and the use of centrifuges.
Tucker: It is important that Jacobs provide input on the issues of the different options and advantages and disadvantages of the different strategies.
Octavio: Is there a trigger for not considering the existing dryer in the long-term strategy?
Scott M.: We may need to relook in 5-10 years as the economics of maintaining the existing dryer shifts, but the short- and midterm options must include the existing dryer.</td><td></td></tr>
<tr><td>4</td><td>Biosolids Processing Solution Alternatives
Based on discussion during this workshop, Jacobs will develop a preliminary list of alternatives for EWA to consider and schedule a criteria weighting meeting to get input on each alternative.</td><td>Jacobs to develop list of alternatives to further evaluate.</td></tr>
<tr><td>5</td><td>Next Steps and Discussion
Develop alternative solutions based on today’s feedback.
Apply nonmonetary criteria to select up to 3 solutions, and hold a scoring meeting.
Develop cost estimate and layout requirements to compare alternatives with monetary criteria for 3 alternatives.
Draft the TM 3 Evaluation of Biosolids Management Options.
Hold the TM 3 Workshop.</td><td></td></tr>
</table>

Jacobs

Meeting Minutes

Subject	**TM 3 Workshop**
Project	Encina Biosolids Management Plan Update
Prepared by	Renee Groskreutz, Jacobs
Location	Microsoft Teams
Date/Time	Thursday, March 18, 2021 8:30-10:00 a.m.
Participants	**Encina Wastewater Authority (EWA):** Joe Cipollini, Scott Goldman (W&C), Scott McClelland, Octavio Navarrete, Tucker Southern, **Jacobs:** Peter Burrowes, Mark Elliott, Adrian Romero-Flores, Renee Groskreutz, Dave Parry, Todd Williams

Notes		Action
1	**Meeting Goals** The team has conducted two pre-workshops (January 28 and February 12) to establish the alternatives to consider and provided nonmonetary weighting; this workshop further clarifies the three alternatives and bookend scenarios, and discusses safety considerations, greenhouse gas (GHG) analysis, and monetary evaluation. The goal is to review the data and approach for Task 4 – Implementation Schedule.	Jacobs to prepare and distribute meeting minutes.
2	**Summary of Pre-workshops: Alternatives and Nonmonetary Criteria Evaluation** Based on the discussion during the February 12 meeting, the following three alternatives were chosen for further evaluation: 1) Digestion improvements using digesters 1, 2, and 3, operating in thermophilic mode, with opportunity to add enzymatic hyperthermophilic hydrolysis (EHH) (Alternative 8). 2) Install a new rotary drum dryer, sized at DDS-60 (Alternative 9a). 3) Install a new belt dryer, sized at BDS-60 (Alternative 9b). Jacobs recommended including two bookend scenarios to understand both the benefits and costs of continuing current operations and implementing an integrated dryer, pyrolysis, and gasification process now: 4) Base Case Scenario (Alternative 0) 5) Integrated System (Alternative 18)	
3	**Sensitivity Analysis of Solids Loading based on Plant Data versus Hauling Data** The capacity of the existing system and the sizing of future equipment is dependent on having accurate hydraulic and solids loading data. In discussions with Tucker on February 25, it was determined that the hauling data, which is based on what leaves the plant, is considered more accurate than the flow readings and grab samples of percent solids. Jacobs provided both as a sensitivity analysis of the capacity triggers for digestion, and assumed the hauling data for sizing the future dryer alternatives.	Jacobs to update discussion in TM 3 to clearly indicate the impact of the data on the triggers for digestion and drying capacity.

Notes	Action
4 GHG Evaluation Jacobs provided a GHG evaluation as a means of quantifying the sustainability criteria. The following discussion resulted: ▪ Scott M. asked what is meant by "incomplete combustion" on Slide 21? Adrian clarified that it refers to the digester gas that is not fully combusted. It will be clarified in TM 3, but wording will be removed from this presentation as it confuses the issue. Also, remove the purple line (digester gas incomplete combustion). ▪ Tucker clarified that although the dryer could reduce its GHG contribution if more than 20% digester gas could be used, based on the Biosolids, Energy and Emission Plan (BEE), there are 3 tiers of usage for the digester gas: – Pipeline credits – Electricity production – Offsets from other natural gas usage in the dryer	Jacobs to clarify the GHG analysis and what is incomplete combustion in TM 3 and remove this reference in presentation.
▪ Adrian clarified that an regenerative thermal oxidizer (RTO) was not included in the belt dryer GHG evaluation. ▪ Scott M. asked whether Alternative 8 included the potential benefits of EHH in the GHG analysis. Adrian clarified the EHH benefits are not included at this time, as they are still being quantified in trials.	Jacobs to add the RTO to the belt dryer alternative for GHG analysis.
5 Monetary Evaluation Tucker: Does the monetary evaluation assume any income for the product? Adrian clarified that it does not. But Class A hauling distance is reduced in the GHG analysis. Adrian reviewed the assumptions of the capital, operations and maintenance (O&M) costs, and net present worth evaluation (20-year period). Impacts of these assumptions on each alternative and overall evaluation were discussed and are summarized in the next section. The Andritz costs were just received on March 17, 2021 and are included in the presentation. The difference in capital cost between rotary dryer and belt dryer is minimal.	
6 Discussion **Reheating Discussion** ▪ Tucker asked how we include "addressing reheating issue" in the costs? The costs of addressing the reheating issue are not included in the evaluation, as it was assumed that all options would address these costs. The costs impact the nonmonetary analysis by providing a redundant local outlet for Class A biosolids and the GHG analysis.	
▪ Based on meetings with the Biosolids Brokers on March 11, EWA does not feel the necessity to address the reheating issue yet. Jacobs will include our observations and recommendations if EWA would like to address the reheating issue in the future.	Jacobs to remove "Address Reheating Issue" description from Alternatives 8, 9A, 9B.

Notes	Action
Digestion Alternative ▪ Tucker requested specific metrics be identified for the thermophilic option for digesters 1, 2, and 3. What additional capacity does the thermophilic process provide, and how will that impact the triggers? ▪ Octavio asked whether EHH can be run on mesophilic digesters? Dave responded that, typically, EHH is a supplemental process to either thermophilic or mesophilic processes.	Jacobs to update TM3 providing clarit for Alternative 8 on how this option impacts the process capacity.
▪ Scott G. asked whether there are any issues operating digesters 1, 2, and 3 in thermophilic mode, and digesters 4, 5, and 6 in mesophilic mode; and what will the impact be to dewatering? Dave responded that there would be one single digested storage tank prior to the dewatering process. The implementation strategy will be further developed in Task 4. **Rotary Drum Dryer Alternative** ▪ Scott G. asked why we did not size the second drum dryer as a DDS-40, as that is what is preplumbed in the Dryer Building. Tucker shared that the evaluation of the existing building showed that there is not enough space to maintain the equipment if a DDS-40 were installed in the available space. If the Dryer Building will need to be expanded, then it makes sense to install a larger unit that can handle the full load to provide redundancy. ▪ The sizing of the dryer assumes mesophilic digestion to estimate dryer loadings, as each alternative was evaluated for its own benefits and costs. In Task 4, an implementation schedule will be developed, and digestion improvements will impact dryer capacity requirements. Dave indicated that thermophilic digesters would reduce dryer capacity requirements, and EHH may reduce both dryer capacity needs and overall solids production. ▪ Does it make sense to build a new wing, rather than extend the Dryer Building to allow enough room for maintenance and continuous operation during construction? For planning, it is assumed that we are extending the existing building. **Belt Dryer Alternative** ▪ Tucker: Why did Jacobs assume the Andritz belt dryer? In our conversations, the other belt dryer vendors can provide a serpentine design to reduce the overall footprint. Peter replied that Andritz is the only manufacturer that has an operational belt dryer of this size. The other manufacturers would have to provide two, which would increase the footprint. The other manufacturers are limited to about a 10,000-pound-per-hour (lb/h) evaporation rate. Andritz is a single deck dryer with a wider belt and increased air circulation. The overall footprints would be similar. ▪ In general, the belt dryer operates at a lower temperature. ▪ The product quality and look is different for a belt dryer. The particle size and granule is different – it is not as dense or hard as EWA's current pellet. The Andritz	The cost of a digested storage tank prior to dewatering has not been included in the cost estimates for this option. Jacobs to update TM3 to include the cost.

Notes	Action
belt produces the best product of the belt manufacturers, but not equivalent to pelletized product.	
▪ Scott M. asked whether there are dust issues with belt dryers? Peter responded they are low because air flow does not pick up as much product. There is typically more product dusting than for drum dryers, as belt product is not as hard.	
▪ Tucker summarized the major differences: – Addition of a belt or drum dryer will provide 100% redundancy. – Belt dryer would result in 2 different products. – Belt dryer is half the height of the current dryer but has a larger footprint. – Belt dryer is a simpler system with respect to equipment and process, and results in less O&M labor. – Belt dryer typically has fewer safety issues. Peter clarified that some belt facilities have had fires, so there are still considerations.	Jacobs to include a clear summary of the major benefits o each alternative anc clearly define the differences.
▪ Octavio asked what is the typical operating temperature for a belt dryer? Peter responded that air typically goes in at 200-350 degrees Fahrenheit (°F) and leaves 160-180°F.	
▪ Scott M. asked whether an RTO is required for a belt dryer? Peter responded that most belt dryer installations do not include an RTO; however, California air district will likely require one, so the cost should be added in. It is not currently included in the cost or GHG evaluation.	Jacobs to add the capital cost and GHG impact of adding an RTO to the belt dryer alternative.
▪ EWA would prefer a separate load-out facility for the belt dryer, as there are two different products. It is a different market because of the density issue. Will need to relook at potential markets prior to implementation. Need to consider that management of two different products will increase operator complexity, and this may result in a different nonmonetary rating for belt dryers.	Jacobs to add a load-out facility for the belt dryer.
▪ Tucker asked about the potential of using the waste heat from the Cogeneration (Cogen) Facility for the belt dryer. Peter clarified that, depending on the location of the Cogen Facility and the distance the heat would need to travel, that a water or oil loop would need to be constructed to convey the heat.	Jacobs to evaluate feasibility of using cogen waste heat for the belt dryer.
Bookends	
▪ The Base Case alternative is not a viable option moving forward because EWA will run out of digester capacity in the planning period. By including the Base Case, the existing management approach will be evaluated with respect to GHG and operating costs: – The comparison between producing Class B cake only and operating the dryer to produce both Class B cake and Class A dried product indicated that the cost of operating the dryer is slightly lower than disposal of Class B cake. – However, due to combustion of natural gas required to operate the dryer, the GHG emissions are considerably higher when the dryer is online.	

Notes	Action
▪ The Have it All alternative is also not a viable option at this time because of the very high cost, but will be included in the evaluation to capture the most environmentally sustainable option. ▪ The purpose of the bookend alternatives are to bound the extremes and provide context for the 3 alternatives considered and staged approach that will be developed in Task 4 – Strategic Implementation Plan. **Recommendations** Summarize the implications of the nonmonetary and monetary criteria, and provide a big picture roadmap of what is needed now, including: 1) Address the digestion capacity now. 2) Identify the triggers to add dryer capacity in the future. As those triggers gets closer, reconsider the drum dryer versus the belt dryer, and specifically look at market conditions for rotary drum granules versus the belt dried product. In TM 3, summarize main differentiators of the two types of dryers:	Jacobs to add a clear summary of each alternative and recommendation moving forward.

Rotary Drum Dryer	Belt Dryer
Consistent product	Fewer safety considerations
Operator knowledge	Potential use of waste heat
Smaller footprint	Less-complicated system

Notes	Action
7 **Next Steps and Action Items** ▪ Prepare and distribute meeting minutes. ▪ Update TM 3 with workshop discussion. Specifically: – Update discussion to clearly indicate the impact of the plant data versus hauling data on the triggers for digestion and drying capacity. – Remove “address reheating” from Alternative 8, 9A, and 9B. – Clarify “incomplete combustion” in GHG discussion. – Add cost for a digested storage tank prior to dewatering for the digester alternative. – Add RTO to the belt dryer alternative (cost and GHG analysis). – Add cost for a second load-out facility for the belt dryer product. – Evaluate whether the excess cogen heat can be used for the belt dryer and whether this offsets the natural gas requirement. If feasible, add capital cost for a heat recovery system, reduce O&M costs, and reduce GHG (in the total cost and GHG analysis). – Provide a clear synopsis of each alternative and the main advantages and disadvantages of each. ▪ Start developing Task 4 – Strategic Implementation Plan.	

TM 4 - PowerPoint Presentation and Meeting Minutes

Jacobs Challenging today. Reinventing tomorrow.

2020 Biosolids Management Plan Update Study

Encina Wastewater Authority

Task 4 Strategic Implementation Workshop

May 13, 2021

1

Agenda

- Goals and Purpose of Meeting
- Recap from Task 3
- Implementation Strategy – decision tree, PFD, benefits, sequencing options
- Fine tuning the Cost Estimates – revisions from Task 3 to Task 4
- Next Steps and Discussion

2

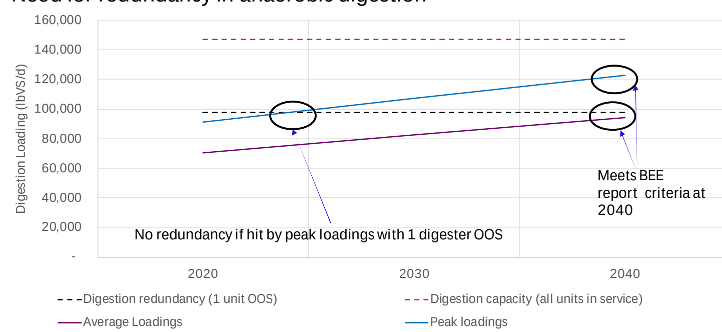
2

Recap from Task 3 Biosolids Management Options

3

Solids Production Projections - Digester loadings

- Need for redundancy in anaerobic digestion



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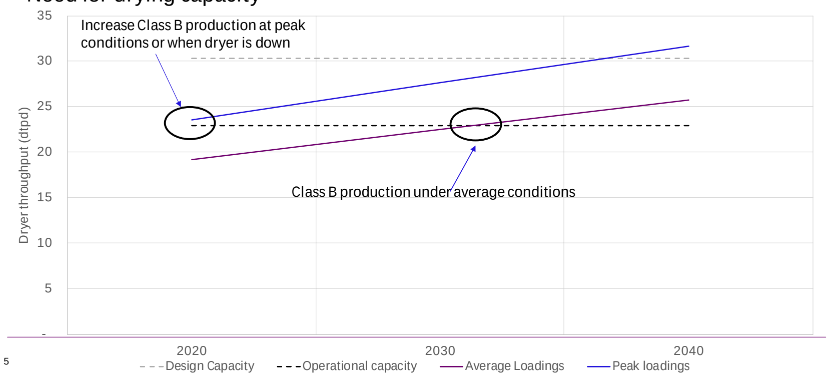
Solids Production Projections - Dryer loadings

- Need for drying capacity



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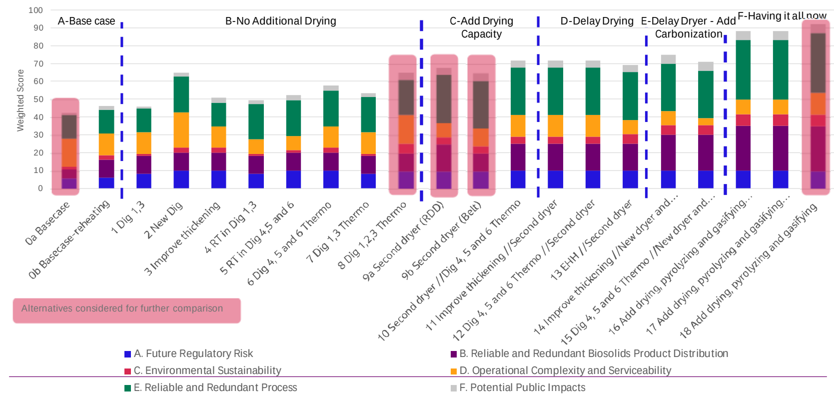
Non-Monetary Criteria Screening



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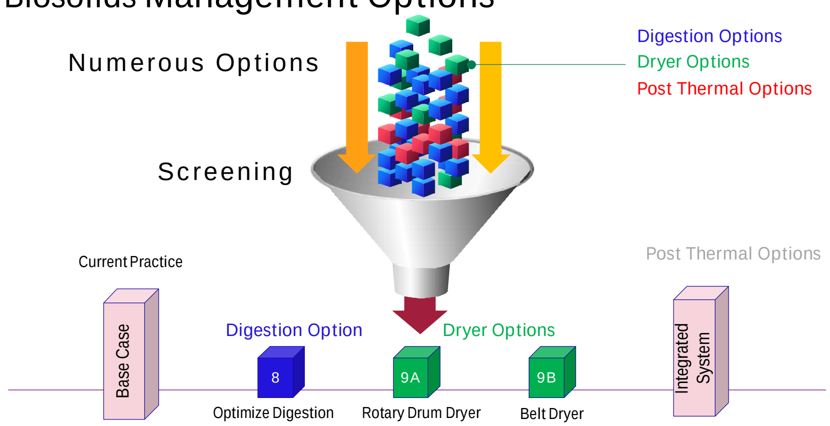
Biosolids Management Options



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Where do we go from here?

8

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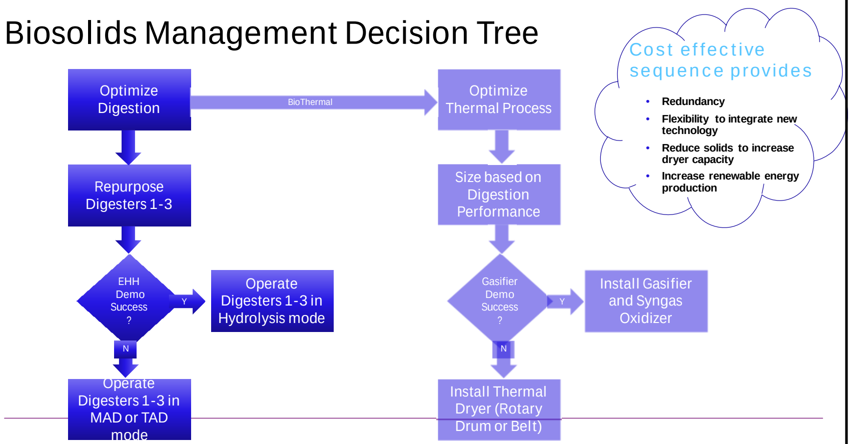
8

Biosolids Management Decision Tree



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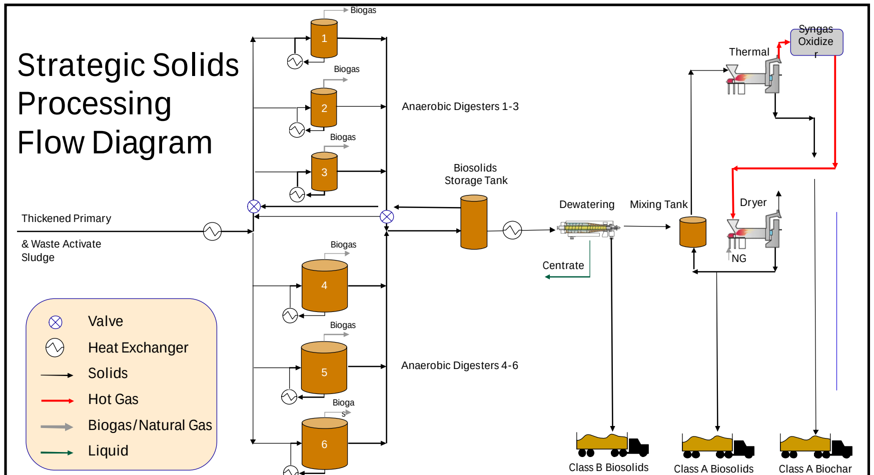
Strategic Solids Processing Flow Diagram



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Benefits of Strategic Solids Processing

Infrastructure
- Maximizes Existing Assets
- Flexibility for Emerging Technologies

Sustainability
- Increases Biogas
- Reduce Energy Demand
- Balance Dryer GHG with Hauling GHG

Economics
- Decrease Cost Distribution
- Develops Markets
- Optimize Capital Expenditures

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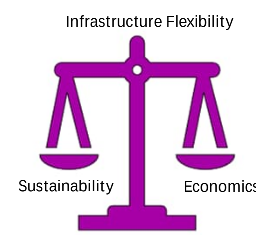
Operational Flexibility is key

The outcome of this biosolids management approach is increased <u>operational flexibility</u> using existing infrastructure.



While balancing the environmental sustainability considerations and financial responsibility of EWA board members.

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Strategic Sequenced Implementation

	Existing	Near-term	Mid-term	Long-term	Long-term
Digester 1	OOS	TAD	EHH	EHH	EHH
Digester 2	BST	TAD	EHH	EHH	EHH
Digester 3	OOS	TAD	EHH	EHH	EHH
Digester 4	MAD	MAD	MAD	TAD	TAD
Digester 5	MAD	MAD	MAD	TAD	TAD
Digester 6	MAD	MAD	MAD	TAD	TAD
Storage Tank	DNE	BST	BST	BST	BST
Thermal Process 1	RDD	RDD	RDD	RDD	RDD
Thermal Process 2	DNE	DNE	DNE	RDD	FLG

BST	Biosolids Storage Tank	MAD	Mesophilic Anaerobic Digester
DNE	Does Not Exist	OOS	Out of Service
EHH	Enzymatic Hyper-thermophilic Hydrolysis	RDD	Rotary Drum Dryer
FLG	Fluid Lift Gasifier	TAD	Thermophilic Anaerobic Digester

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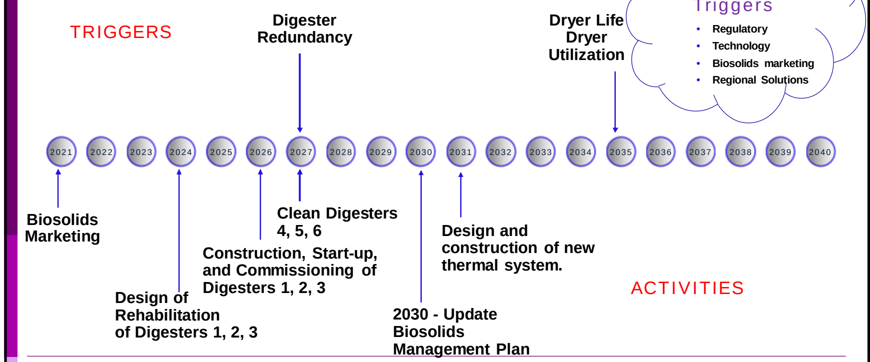
Strategic Implementation Schedule



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Revision of Cost Estimate

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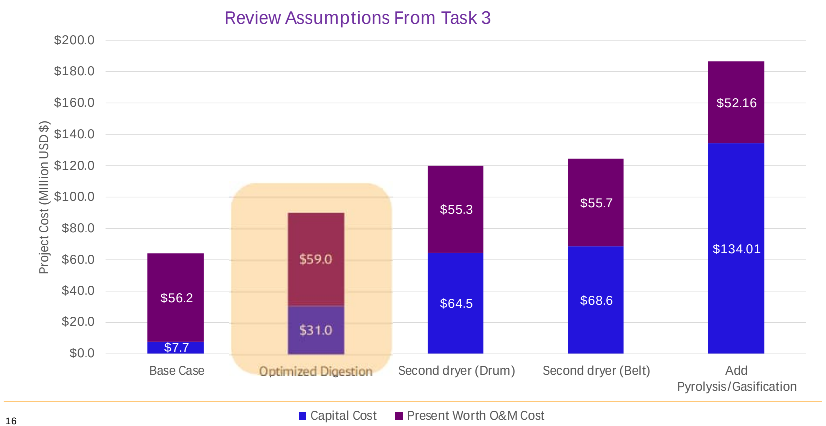
Total Project Cost (NPV) - (based on hauling data loading)



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Capital cost clarifications, before mark-ups

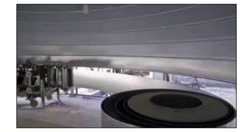
- Task 3
  - Digester 1-3 rehab (per digester, equipment costs only)
    - Reported in TM3: $2.19M
    - Corrected: $1.19M
  - Assumed Sludge storage tank (similar size as digester 1-3): $1.56M
  - Total before markups: $8.13M ($5.13M corrected)
  - Recuperative Thickening in 1 and 3 (B&C TM): $2.79M per digester ($5.58M total)
- Task 4 – Revised estimates
  - Digester 1-3 rehab (per digester)
    - Increased to $1.27M before markups (revised heat exchangers and added 4, 5, 6)
  - Sludge storage tank (60,000 gallons; LIPP technology): reduced to $0.32M
  - Total before markups: $4.13M

LIPP Technology

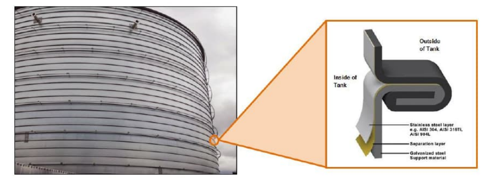
THE DOUBLE-FOLD SYSTEM

The *Double-Fold System is* the process by which Lipp Tanks are mechanically manufactured on-site from coiled steel using stationary machine temporarily mounted to the foundation floor to implement a two-stage folding process resulting in the *Double-Fold seam.*

With use of the *Double-Fold System*, the need for bolts is virtually eliminated from the structure, with the exception of appurtenances, etc.

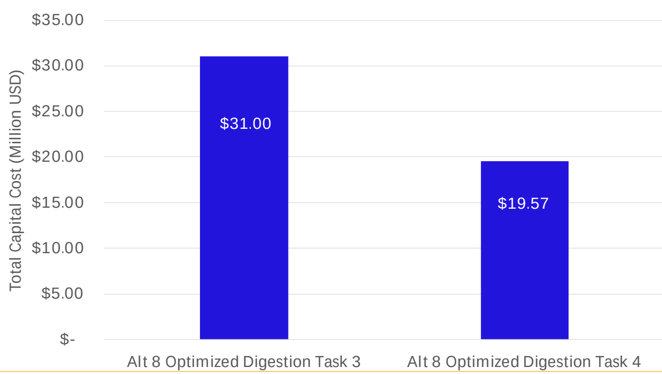


Lipp Machine at Work



Detail on the Double-Fold System and the Verinox System

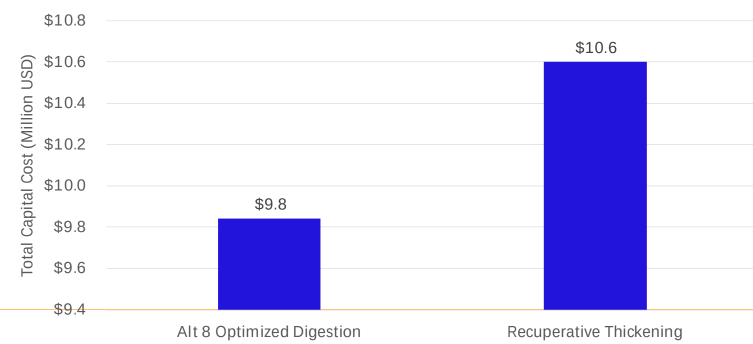
Revised total capital cost – from TM 3 to TM 4 for Optimized Digestion



Both options include dryer repair and construction and non-construction markups

Comparing Thermophilic to RT

- Without the dryer repairs – just this process- and without non-construction markups.



Other Considerations of Optimized Digestion Recommendation

- Structural Evaluation of Existing Digesters 1, 2, 3 may impact construction costs
- Sequencing for the new holding tank
- EHH bench scale testing

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DISCUSSION

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Next Steps

- EWA to request any specific clarifications on costs for 5-year CIP planning.
- Meet to discuss revisions to TM3.
- Await MAM and Board meetings in early June before preparing TM4 and Executive Summaries.
- Prepare scope of work
  - to develop RFQ/RFP for market brokers.
  - to conduct EHH bench scale pilot testing.

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23

Thank you

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Jacobs

Meeting Minutes

Subject	TM 4 Workshop
Project	Encina Biosolids Management Plan Update
Prepared by	Renee Groskreutz, Jacobs
Location	Microsoft Teams
Date/Time	Thursday, May 13, 2021 9:00-10:00 a.m.
Participants	Encina Wastewater Authority (EWA): Doug Campbell, Scott McClelland, Tucker Southern Jacobs: Mark Elliott, Adrian Romero-Flores, Garrett Geer, Renee Groskreutz, Dave Parry

<table>
<tr><th colspan="2">Notes</th><th>Action</th></tr>
<tr><td>1</td><td>Meeting Goals
The purpose of this meeting is to review the Task 4 recommendations, implementation schedule, and cost adjustments from Task 3.</td><td>Jacobs to prepare and distribute meeting minutes.</td></tr>
<tr><td>2</td><td>Recap of Task 3 Nonmonetary and Monetary Evaluation
Renee reviewed that Task 3 evaluated the following three alternatives:
1. Digestion improvements using digesters 1, 2, and 3, operating in thermophilic mode, with the opportunity to add enzymatic hyperthermophilic hydrolysis (EHH) (Alternative 8).
2. Install a new rotary drum dryer, sized at DDS-60 (Alternative 9a).
3. Install a new belt dryer, sized at BDS-60 (Alternative 9b).
The two bookend scenarios were evaluated to provide greenhouse gas (GHG) and cost clarity with respect to solids management:
4. Base Case Scenario (Alternative 0)
5. Integrated System (Alternative 18)
After the workshop, Tucker and Renee discussed the EWA comments on the Evaluation of Biosolids Management Options report . It was decided to keep the sensitivity analysis on the plant data versus the hauling data at the beginning, but to conclude that hauling data would be used in the Task 4 evaluation. Also, Jacobs should consider the evaluation of waste heat for the belt dryer at a very high level for feasibility, incorporate the potential use as a nonmonetary benefit (sustainability), and assume a certain amount of piping to extend the hot water recovery system to the new Dryer Building. The main point was to make sure the nonmonetary and monetary evaluations are based on the same process and sizing criteria. Consistency is the end result.</td><td>Jacobs to update TM3 based on discussion.</td></tr>
<tr><td>3</td><td>Implementation Schedule and Recommended Process Flow Diagram
Dave presented the implementation schedule and process flow diagram prepared for the Board meeting on May 5. The team agrees to focus on the following items:
- Near term (2021-2026): Marketing of products and digestion improvements
- Midterm (2027-2031): Considering results of marketing effort and technology advancements, and updating the Biosolids Management Plan (BMP)
- Long-term (2031-2040): Improving the thermal process</td><td></td></tr>
</table>

Notes		Action
	Tucker: Is the storage tank needed? If yes, what size? Dave: The storage tank provides a wide spot in the line; increases operator flexibility when bringing on digesters 1, 2, and 3; and allows for dewatering operation flexibility. This approach is consistent with providing flexibility in operation and redundancy in capacity. A 60,000-gallon storage tank will provide 4.4 hours of storage time during 2040 production levels and is appropriate for this initial planning effort. Tucker: Please provide clarity in TM 4 of size, partially below ground, and other siting considerations for space planning. Tucker: In the TM 4, it will be important to clarify specific time frames for short-term, midterm, and long-term. Scott M.: Furthermore, clarify whether improvement is needed to be completed or initiated in each time frame. Suggested adding, "Due by date 2027, 2031, and 2040" to the sequencing table.	
4	Cost Evaluation Update Adrian provided an update on the cost estimates in TM 3 and additional refinements for TM 4. Implementing thermophilic mode on all 3 digesters is less expensive than recuperative thickening based on known equipment costs, but EWA should consider the structural integrity of the existing digesters when considering increasing the temperatures. Note: Structural evaluation of the domes of digesters 1, 2, and 3 were conducted assuming mesophilic temperatures. This should be re-evaluated with the higher temperatures and conditions of thermophilic mode and EHH.	Jacobs to provide updated costs for TM 4 in a memo to EWA within the next 2 weeks.
5	Wrap-up Overall, Scott M., Tucker, and Doug are pleased with the recommendations of the BMP update. Doug shared that the recommendations do not impact the regulatory approach for EWA, and he sees this as best option moving forward. Scott M. is pleased with the plan results and estimated costs. In response to whether additional work was needed on the regional solution, Tucker responded that EWA will plan to remain in communication with other agencies and revisit the potential for a regional solution during the 2030 update.	
6	Next Steps and Action Items • Jacobs to finalize TM 3 with comments received from EWA and clarifications from Tucker today. • Jacobs to send updated cost estimates and assumptions to Tucker • Jacobs to provide scope and level of effort to develop a Request for Qualifications (RFQ) and Request for Proposals (RFP) for Marketing Brokers to market EWA's biosolids. Jacobs will request a project time extension at the same time. • Jacobs to provide scope and level of effort for bench-scale testing of EHH using EWA's samples. • Wait to prepare TM 4 until after the Member Agency Manager committee meetings in early June. EWA will share comments and input after the meeting.	

Jacobs

Meeting Minutes

Subject	TM 4 Review Workshop		
Project	Encina Biosolids Management Plan Update		
Prepared by	Renee Groskreutz, Jacobs		
Location	Microsoft Teams	Date/Time	Tuesday, September 28, 2021 11:00 a.m. - noon
Participants	Encina Wastewater Authority (EWA): Doug Campbell (until 11:30 a.m.), Scott McClelland (until 11:30 a.m.), Octavio Navarette, Tucker Southern Jacobs: Mark Elliott, Todd Williams, Adrian Romero-Flores, Renee Groskreutz		

	Notes	Action
1	Meeting Purpose The purpose of this meeting is to review the TM 4 draft Strategic Implementation Plan and receive initial comments from EWA.	Jacobs to prepare and distribute meeting minutes.
2	Project Update and Overview of Strategic Implementation Plan Renee provided an update of the overall project and an overview of TM 4 Strategic Implementation Plan. TM1 *Current Biosolids Management Practices and Outlook* and TM 2 *Updated Portfolio of Biosolids Outlets* have been finalized. TM 3 *Evaluation of Biosolids Management Options* was updated and submitted addressing EWA's comments. The discussions from the Task 4 Workshop (May 13, 2021) guided updates in both TM 3 *Evaluation of Biosolids Management Options* report and writing of the draft TM 4 *Strategic Implementation Plan,* specifically about the following: • Definition of schedule and time frames • Use of hauling data • Sizing of the 60,000-gallon storage tank • Cost assumptions	
3	Initial Comments from EWA Comments will be consolidated and sent to Jacobs by next Friday, October 8. The Strategic Implementation Plan was clear and provides a straightforward plan to implement. Tucker: Jacobs to clarify whether digesters 1, 2, and 3 operate in mesophilic anaerobic digestion (MAD) mode, do they provide enough capacity through 2037? Adrian: Yes, additional capacity of all 3 digesters provides capacity at the hauling loading rates. Tucker: Jacobs to clarify what the potential considerations and implications are for coatings, equipment, and materials of running digesters in MAD, thermophilic anaerobic digestion (TAD), and enzymatic hyperthermophilic hydrolysis (EHH) modes? Please respond to the feedback from Brown and Caldwell that there is no single coating that can handle both mesophilic and thermophilic conditions. Tucker: Update Table 1 – add digesters 1, 2, 3, 4, 5, and 6 in TAD mode to understand the heat demand. Clarify in the discussion why the heat demand is less for EHH and MAD option versus TAD and MAD option because of parallel versus series operation and the heat recovery potential from running in series.	Jacobs to review and respond to comments received on TM 4. Jacobs to follow up on suitability of TAD equipment to run at mesophilic temperatures and operation. Identify potential conflicts or concerns.

<table>
<tr><th colspan="2">Notes</th><th>Action</th></tr>
<tr><td></td><td>Octavio: Clarify whether there are any operating considerations of running different temperatures in different digesters. Can we estimate impacts to biology and maintaining healthy microbes in both? What is the impact in the blending tank as well as the dewaterability. For the series operation from EHH or TAD to MAD, what is the feed ratio? How does that impact health of digesters 4, 5, and 6?
Scott M.: Clarify the assumptions of how the storage tank was sized.
Tucker: Add a brief discussion in text about lifecycle costs of the different operating strategies and how they could be impacted should conditions or plant operation change. What are some considerations?
Two insights (not necessarily to be included in TM 4):
• Air Pollution Control District is pushing for more stringent exhaust limits, which will require SCR on cogeneration (cogen).
• Energia has approached EWA with a new cost model to capture extra gas, and they are willing to provide upfront capital, including recuperative thickening (RT) to capture excess digester gas.
It will be helpful to understand criteria that may impact lifecycle costs in this discussion (i.e., impact of heat from cogen).</td><td></td></tr>
<tr><td>4</td><td>Considerations
Note: Structural evaluation of the domes of digesters 1, 2, and 3 were conducted assuming mesophilic temperatures. This should be re-evaluated with the higher temperatures and conditions of thermophilic and EHH modes.
Adrian: Was there a structural evaluation of concrete for digesters 4, 5, and 6 as part of digester improvement project? Tucker: Yes, the concrete is acceptable for thermophilic conditions.</td><td></td></tr>
<tr><td>5</td><td>Wrap Up
Overall, the Strategic Implementation Plan is clear and concise. There may be additional comments from Woodard & Curran after their review, and Jacobs should plan to update and clarify once all comments are received.
In the meantime, Jacobs will check with corrosion experts to inquire about coatings applicability to mesophilic and thermophilic temperatures.</td><td></td></tr>
<tr><td>6</td><td>Next Steps and Action Items
• Jacobs to finalize TM 4
• Jacobs to prepare Executive Summary (ES) (Task 5) with all finalized TM 1, 2, 3, and 4 behind the ES.
• Jacobs and EWA to attend vendor meetings on Thursday with Agromin, NutrientsPlus, and Upcycle.
• Jacobs to provide initial results of bench-scale testing in 2 weeks.</td><td></td></tr>
</table>

TM 5 - PowerPoint Presentation and Meeting Minutes

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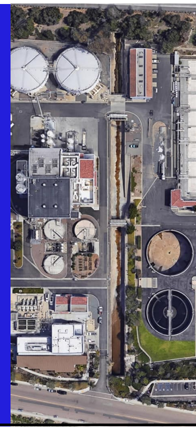
BMP Update

Encina Wastewater Authority

Task 6 – Biosolids Broker RFP/RFQ Development – Kick Off Meeting

June 29, 2021



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Agenda

1. Introduction of Task: Goals and Purpose of Meeting
2. Past Encina RFP/RFQs Examples
3. RFP vs RFQ
4. General Approach – understanding key parameters to Encina
5. Key Criteria from other Industry RFPs
6. Schedule – Timing for Board Approval

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2

Purpose of the Meeting – Goals/Objectives

- Engage Encina staff to capture key objectives of this RFP/RFQ.
- What is the end goal that staff want to achieve with this contract?
- Identify limitations or restrictions to capture in the RFP/RFQ.

- ACTION ITEM: *Ask everyone for input on goal/objective of this RFP/RFQ, and ultimately the contract with the Market Broker.*

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Past Encina RFP, RFQ, Rating Forms

- Biosolids Hauling and Reuse (Disposal) Bid RFP
- 21-14558 – Digester Improvements Project – Contract RFQ
- CM Services for Digester Improvements – Rating Form

- ACTION ITEM: *Are there other examples, wording that are relevant to this task?*

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4

Previous Encina RFQ and RFP Content

The example RFQ and RFP sections have a very different approach:

Section	RFQ	RFP
Cover Page	Title, Admin # General Timing Encina Point of Contact	Title, Specification #, Board of Directors, Mgmt, Bid Opening, Location
1.0	Introduction	Notice Inviting Bids
2.0	Brief Description of Work	General Bid Terms and Conditions
3.0	Prequalification Required to Bid	Special Bid Terms and Conditions
4.0	RFQ and Project Bid Schedule	Bid Specifications
5.0	Pre-submittal Activities	Bid Submission Form
6.0	Revisions to the RFQ	Statement of Qualifications and References
	Instructions to Bidders Prequalification Requirements Evaluation Procedure	Statement of Bidder's Past Contract Disqualifications
	PreQualification Questionnaire (6 parts)	Agreements

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RFP vs RFQ for Encina

- What is the intent of this exercise? Can we capture it all in RFP?
- Can we have Brokers just submit one time and make an informed decision based on one submittal? Does there need to be both a RFQ and RFP?

ACTION ITEM: *Need to balance complexity of process (both bidding and contractual), and value obtained from the Broker service.*

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6

General Approach for RFP

1. Main Criteria
2. Limitations
3. Performance
4. Nomenclature to use in this new "Biosolids Market" RFP/RFQ

ACTION ITEM: *Provide clarity on approach and answer these questions:*

What is not OK based on proposals or NOI received during planning phase in December?

Can we leave space for creativity for the Brokers to be innovative? Or an alternative response?

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7

Key Criteria from other Industry RFP/RFQs

- Product quality / characteristics - minimums
- Production volumes (monthly/weekly) and storage expectations
  - Volume commitments
- Fee and Product Pricing Schedules
- Contract length
- Required insurances
- Trucker requirements

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Schedule

- Draft RFP/RFQ language for Encina's review by mid-July
- Timing for review and finalization for Board adoption
- When would it be possible to advertise?
- How long to allow them to respond? (Standard timeframe?)
- When would the Period of Performance be? (5-years?)

9

Wrap-Up and Next Steps

Market Broker RFP/RFQ Kick-Off

10

Large (> 1,000 TPY) Potential Users Identified

Agromin	Interested in the potential use of the granules. Obtained a trial load from Encina. Has some interest in using the product if EWA ships the product to their Oxnard facility for free. May have interest in marketing the product in the future.
MANNCO*	Experienced biosolids granule marketing company, but not currently operating in California. Provided a draft marketing agreement to EWA for consideration.
Nutrient PLUS*	Open to marketing and/or using larger volume of product. Provided a draft marketing agreement to EWA for consideration. (Had difficulties obtaining larger volumes of EWA product in 2020)
Upcycle & Co	Been packaging and selling the EWA product for some time. They sell in 4 lb bags, with usage of 20-30 tons (total) over the past few years. They want to be using larger volumes of product on a more consistent basis. They are interested in managing product for EWA, and being one of the companies taking 1,000 tons. They are working on a plan and potential proposal for EWA.
WeCare/Denali LLC	Open to managing granule through creative distribution option, open to an introductory call. Their plan would be for EWA to pay them to move the granules while developing markets, leading to a cost neutral (or pay) service; 5 year contract.

11

Jacobs

Meeting Minutes

Subject	**TM 5 - Market Broker Request for Proposal Development**
Project	Encina Biosolids Management Plan Update
Prepared by	Renee Groskreutz, Jacobs
Location	Microsoft Teams
Date/Time	Tuesday, June 29, 2021 8:00-9:00 a.m.
Participants	**Encina Wastewater Authority (EWA):** Doug Campbell, Scott Goldman (W&C), Scott McClelland, Octavio Navarrete, Tucker Southern **Jacobs:** Ron Alexander, Mark Elliott, Renee Groskreutz

Notes		Action
1	**Task Goals and Purpose of Meeting** The purpose of this meeting is to kick off the development of the Biosolids Market Broker Request for Proposal (RFP). The goal is to facilitate discussion and understand EWA's expectations and contract limitations, and help simplify the process so that EWA will get the best response and value from the Market Brokers. Tucker: The goal of this task is to obtain real proposals to address the specific requirements identified (i.e., full trucks, reheating potential, flexibility with supply fluctuations, local solution), all to eventually reduce cost of distribution. Scott M.: We conducted the 5 interviews and prequalifications of the potential proposers, and there are three different approaches: ▪ Biosolids blended fertilizer ▪ Engineered soils ▪ Land application It would be helpful to have a clear understanding of how we will compare different approaches and address the Board's concerns on economics and sustainability. The goal is to build a market now, which may initially require longer hauls, but will eventually provide a pathway to local beneficial use. Octavio: Clarify what local beneficial use means. Ideally, it means to redistribute or use within Southern California, but focus on hauling from Encina Water Pollution Control Facility (EWPCF), and reduce both cost and greenhouse gases (GHGs) for this first part of distribution.	Jacobs to provide meeting summary. Ron to check with how Assembly Bill (AB) 1383 will be interpreted for "engineered soils."
2	**Past Encina RFQ and RFP Examples** Requested Microsoft Word documents for the Adobe Portable Document Format (PDF) examples received from EWA, including: ▪ Biosolids Hauling and Reuse (Disposal) Bid RFP ▪ 21-14558 – Digester Improvements Project – Contract RFQ ▪ CM Services for Digester Improvements – Rating Form	Octavio emailed the Microsoft Word document for the Biosolids Distribution RFP during the meeting.
3	**RFQ versus RFP** ▪ The original reason that Request for Qualifications (RFQ) and RFP were both stated was to allow EWA to competitively select a partner to negotiate a contract. But because much of the normal prequalification effort has already been completed, EWA will proceed with an RFP and include qualification-based criteria in the RFP.	Jacobs to proceed with RFP development only (rather than RFQ and RFP development).

Notes		Action
4	**General Approach** Great discussion of desires and priorities of the RFP that are focused on goals to build a local market, reduce unnecessary strain on operations to manage contract requirements, while manage the constant biosolids product supply regardless of seasonal demand. To focus the RFP, the first step is for Jacobs to develop a clear list of requirements versus preferences. The purpose is to document EWA's needs while balancing what the market will support. If language in the RFP is too restrictive or detailed, then it will result in limited proposers or drive up the price. Overall goal is to not unnecessarily limit RFP responses. Tucker shared a component to this task is outreach: to engage the potential proposers to help shape the RFP responses to requirements and preferences. Tucker requested that the team consider how to handle multiple requests. Will there just be two contracts: Denali for disposal, and Market Broker for reuse? What happens if there is excess? Need to determine approach for handling excess biosolids as Broker is ramping up because there is no storage onsite. Perhaps a first right of refusal to negotiate terms? Need to be mindful not to undermine market development. Tucker thinks it will be necessary to work collaboratively with the proposers to develop a proposal that is mutually beneficial to both EWA and the hauler and soil blender and market development effort. Just putting an RFP out will likely result in no response and further delay our efforts.	From the discussion and from Industry experience, Ron to develop a draft list of recommended requirements and preferences. Jacobs to share with EWA.
5	**Criteria from other Industry RFPs** ▪ Product quality and characteristics - minimums ▪ Production volumes (monthly and weekly), and volume commitments ▪ Fee and product pricing schedules ▪ Contract length ▪ Required insurances ▪ Trucker requirements These criteria will be further developed and included in the draft RFP once the requirements versus preferences list is discussed and agreed upon. Ron noted that it is a buyers' market for biosolids. It will be important to balance the complexity of the process (both bidding and contractual), and the value obtained from a Market Broker service.	
6	**Schedule** Scott M.: Work toward providing recommendation to Board in December for a Market Broker. Back up the schedule from there.	

Notes	Action
7 **Previous Interviews and Discussion with Potential Proposers:** 1) Agromin - Main operation in Oxnard, which has similar haul length to Yuma, but could develop market locally in the future. 2) MANNCO - Provided proposal, EWA commented, and they revised proposal; but EWA has not seen the revised proposal. 3) Nutrients Plus (NP) - Currently purchases, but would like to increase share. Has voiced some product availability concerns. EWA voiced concerns that NP did not take product when available. Could be an issue regarding seasonal supply and demand. Provided proposal, but did not update from comments. It appears that NP is planning on hauling to a blending facility near Phoenix. 4) Upcycle & Co. - Octavio: Upcycle has requested 500 tote sacs or ~1,000 tons/year that they can take in bulk loads. Operations does not have the equipment and staff to provide that many tote sacs. 5) WECare/Denali LLC is the marketing arm of Denali.	

TM 6 - PowerPoint Presentation and Meeting Minutes

Jacobs

Meeting Minutes

Subject	**TM 6 Enzymatic Hyperthermophilic Hydrolysis Bench Scale Testing Coordination**
Project	Encina Biosolids Management Plan Update
Prepared by	Renee Groskreutz, Jacobs
Location	Microsoft Teams
Date/Time	Tuesday, August 31, 2021 3:00-4:00 p.m.
Participants	**Encina Wastewater Authority (**EWA): Scott McClelland, Octavio Navarrette, Tucker Southern **Jacobs:** Renee Groskreutz, Corey Klibert, Petra Liskova, Dave Parry, Todd Williams

Notes		**Action**
1	**Introductions and Purpose of Meeting** ***Introductions***: Jacobs and EWA teams were introduced. ***Purpose:*** The purpose of this meeting is to kick off TM 6 by reviewing the scope, responsibilities, timeline, and expectations for the enzymatic hyper-thermophilic hydrolysis (EHH) bench-scale testing. EHH is also known as the *C. bescii* hydrolysis process (CBHP) or more generally known as microhydrolysis process (MHP). The sludge sampling plan and draft testing plan will be discussed.	Jacobs will prepare meeting minutes and share with team.
2	**Scope of Testing** Petra reviewed the overall task scope. The sludge sampling and CBHP testing_plan will be developed from today's conversation and clarifications. In mid-September, EWA will send requested digested solids to Jacobs to begin the 4-week test in their lab; and each week for 3 more weeks, EWA will send another sample from the same digester to be added to the bench-scale test. Jacobs will outline the requirements of the plant and lab team in the plan.	
3	**Process Flow Diagrams** Dave shared the process flow diagram (PFD) of a typical MHP and the potential application at Encina Water Pollution Control Facility (EWPCF) of using CBHP after digesters 4, 5, and 6, and then returning to digester 4, 5, and 6 for further volatile solids reduction (VSR). This is important to keep in mind as we set up the bench-scale test to try to imitate the recommended approach in the lab. Scott asked for clarification on the heat exchanger on the return line, and Dave clarified this is to cool down the solids (from 75 to 35 degrees Celsius [°C] for mesophilic mode) after the MHP. The lab test will take digested solids from Digester 6, and feed a control digester (with no *C. bescii*) and a CBHP digester (with the *C. bescii*). The difference in performance between the control and the data collected by EWA will account for impacts to the solids during shipping, and to discount any additional VSR in the control digester.	Jacobs to update the PFD to better show MHP feed to be more of a recuperative digestion process.
4	**Existing Anaerobic Digestion Process Information** EWA shared the current operating data for digesters 5 and 6 (Digester 4 is offline for maintenance). In general: ▪ VSR is running 54% ▪ pH is 6.98 ▪ Alkalinity is 4,222 milligrams per liter (mg/L) ▪ Volatile solids (VS) are 153 mg/L	

Notes		Action
	▪ Total solids (TS) is 2.0% ▪ The VS to TS ratio is 72% Octavio confirmed this is current operations because they are only running 2 digesters, so they are closer to the 15-day solids retention time (SRT). They typically achieve closer to 60% VSR with all 3 digesters online. For the testing, it is critical to maintain steady operations during the month and draw consistent samples from the same digester.	
5	**Sludge Sampling Plan** Petra and Corey reviewed the considerations for plant sampling. The details will be included in the plan. It was clarified that the plant will need a total of 42 liters (L) for the first sample and 12-L batches for the following 3 weeks. Octavio provided feedback that the plant takes samples on Tuesdays typically, and FedEx arrives at the plant around noon. Octavio requested that Jacobs send the required sampling containers for the plant to use. They have experience sending digested solids samples, but it would be helpful to have correctly sized containers.	Petra will share draft sampling and testing plan with EWA for review and comment.
6	**Task Schedule** The sampling plan will be drafted and finalized the first 2 weeks of September; the test period is currently scheduled to begin September 16, running 4 weeks through October 14. A progress report will be shared at the end of September, and the results of the test will be summarized in a report by early November.	
7	**Discussion** ▪ Octavio: How will alternative fuels impact MHP? Dave: MHP has flexibility, but first we need to see how it performs on EWA solids. This bench-scale test is the first step. ▪ Tucker: Is there a pilot size between bench and full scale? Dave: Yes, a trailer pilot can be considered if the bench-scale test shows merit. The EWA budget is processed in January, so we want to anticipate the cost of pilot- and full-scale testing; having results this fall would be very helpful. ▪ Octavio and Corey: Discussion of plant sampling, testing, and shipment. Ideally, if operators can sample and send Tuesday, and sample a small amount for the lab to test pH, alkalinity, and the other parameters, that would be ideal. If sample must wait to ship to Wednesday, just make sure to cool down the sample on ice immediately after taking it.	

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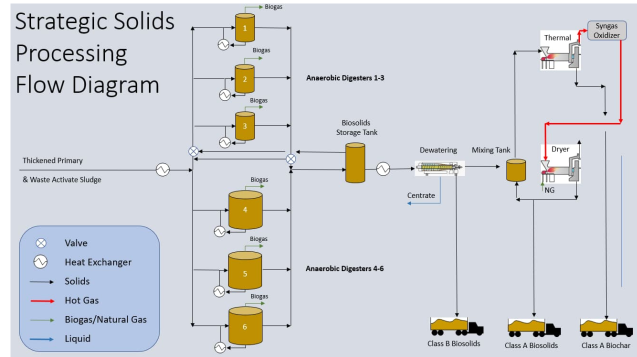
Encina Enzymatic Hyper-Thermophilic Hydrolysis (EHH) Lab-Scale Testing

December 2nd, 2021

1

Strategic Solids Processing Plan



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Encina Lab-Scale EHH Testing Objectives

- Evaluate lab-scale performance of *C. bescii* enzymatic hyper-thermophilic hydrolysis (EHH) on Encina digested sludge
  - What key aspects of digester performance can EHH achieve on Encina sludge?
    - Increase in VSR
    - Increase in biogas
    - Decrease in biosolids
  - Is the process stable?
    - Acid/alkalinity balance
    - pH

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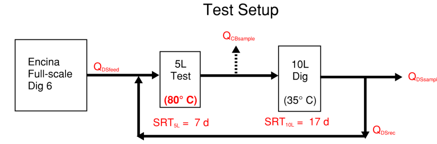
3

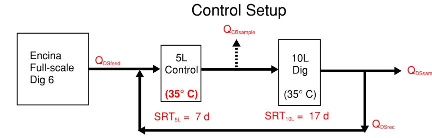
Encina Lab-Scale EHH Testing Process Flow Schematic

- Encina provided digested biosolids from Dig 6 for testing
- Dig 6 biosolids fed to lab-scale 5L test and control reactors
- Lab-scale 10L reactors (meso temperature) emulated full-scale digesters

Test Setup



Control Setup



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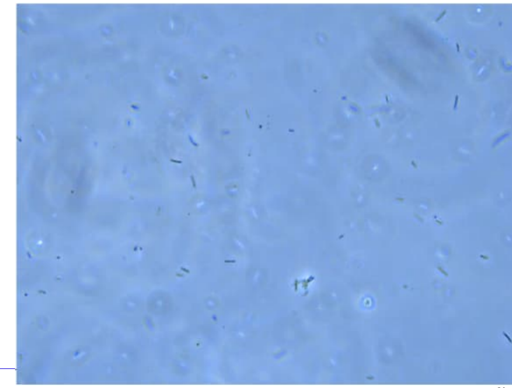
Encina Lab-Scale EHH Testing Apparatus

- Reactor setup consists of 4 stand-alone reactors (2x 5L, 2x 10L)
- Each reactor is fed from a 1L feed tank
- Feed tank was manually filled with appropriate feed on a daily basis
- Automatic piston feeder slowly metered feed tank contents into reactors over the course of the day
- Samples were manually drawn from the main reactor

5

C. bescii growing in pure culture

- Hyper-thermophilic rod-shaped (bacillus) gram-positive bacteria
- 100x magnification visible light
- Anaerobic growth media



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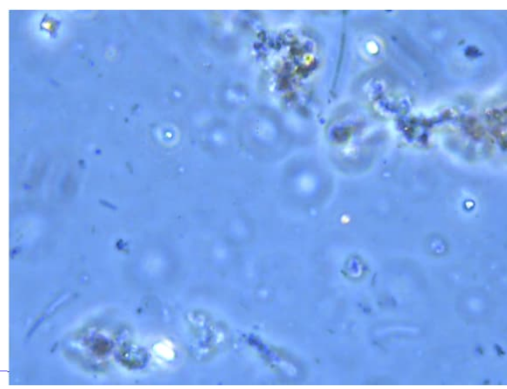
C. bescii growing in Encina digested biosolids

- 100x magnification visible light



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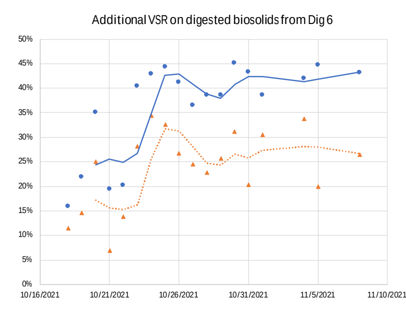
VSR results from lab-scale testing

- Results show the additional VSR achieved from EHH digestion (test) and continued mesophilic digestion (control) of biosolids from Digester 6
- At steady-state conditions, EHH digestion exhibited a significant increase over continued mesophilic digestion on digested biosolids



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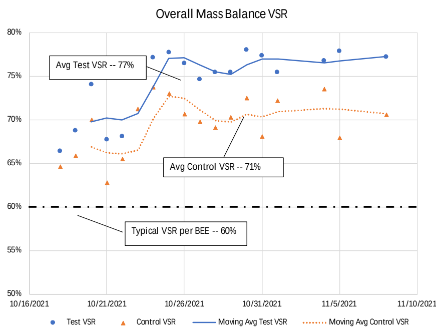
VSR results from lab-scale testing

- Overall VSR – incorporating Dig. 6 VSR with additional VSR from lab
- Overall VSR of 77% achieved in test reactors
  - Lab apparatus limited EHH reactor SRT to a minimum of 7 days
  - In real-world application, test VSR is anticipated to be achieved with 2-day SRT
  - EHH VSR plateaus after 2 days
- Full 24 days of additional SRT would be required to meet 71% VSR at mesophilic temperatures without EHH
  - SRT of 5L+10L control reactors



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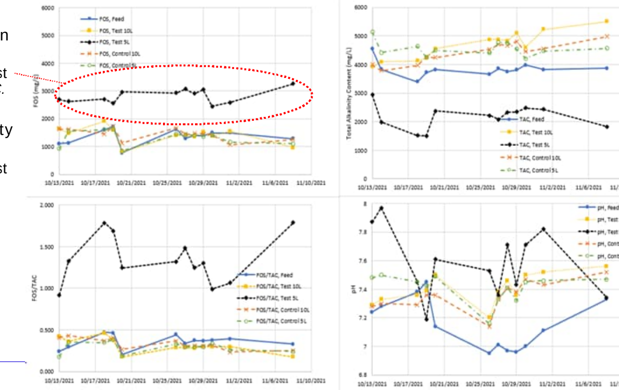
Process Stability: Acid/Alkalinity results from lab-scale testing

- Elevated volatile acid production observed in test 5L reactor
  - Acid production in test 5L reactor indicates *C. bescii* hydrolysis
- Stable pH and alkalinity in test 5L reactor
  - Acid production in test 5L did not result in instability in digester performance



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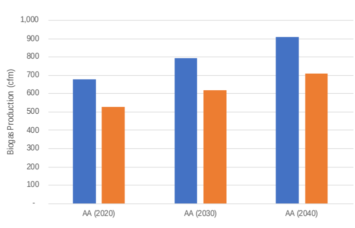
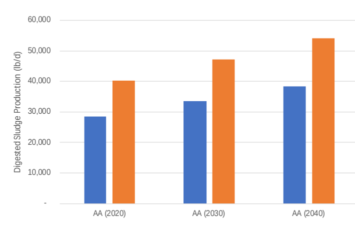
Potential Full-scale Impacts

- If achievable, full-scale VSR of 77% would result in:
  - increased biogas production (~22%)
  - reduced digested sludge production (~29%)





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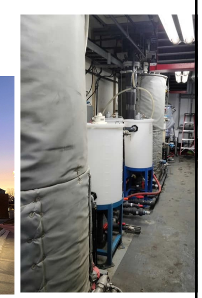
11

Discussion

- Test reactors exhibited:
  - Over 75% VSR is possible
  - Stable pH
  - Healthy buffering capacity
- Possible full-scale impacts could be significant
  - Increase biogas production (~22%)
  - Decreased sludge production (~29%)
- Next steps:
  - Onsite Pilot
  - Mass/Energy Balance
  - Conceptual Full-Scale Design



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Jacobs Challenging today. Reinventing tomorrow.

2020 Biosolids Management Plan Update Study

Encina Wastewater Authority

Progress Update

May 31, 2022

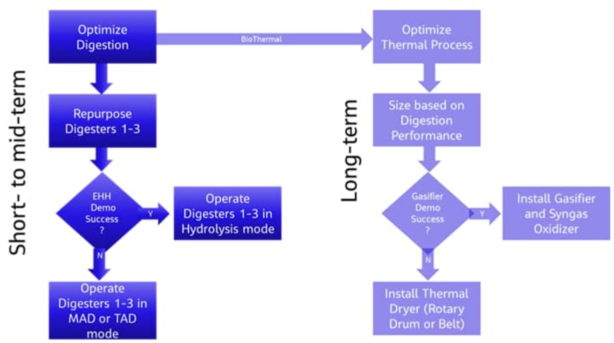
1

Agenda

- Status of Biosolids Management Plan
- Analysis of Integrated EHH and Recuperative Thickening
- Wrap-up of Report – discuss comments to TMs
- Next Steps of project

2

Overview of EWA's Biosolids Management Plan



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3

Impact of Integrated

Enzymatic Hyper-Thermophilic Hydrolysis (EHH) and Recuperative Thickening (RT)

for increasing capacity and performance

4

4

Overview of Capacity and Performance Analysis

- Encina's Update on Recuperative Thickening (RT) with Anaergia
- Jacobs' Update on Status of Enzymatic Hyper-Thermophilic Hydrolysis (EHH)
- Goal of this analysis:
  - Evaluate potential and benefits of integrating EHH and RT for EWA's biosolids management to increase capacity and performance
  - Compare RT on digesters 1-3 against EHH in digesters 1-3 with RT on digesters 1-6.

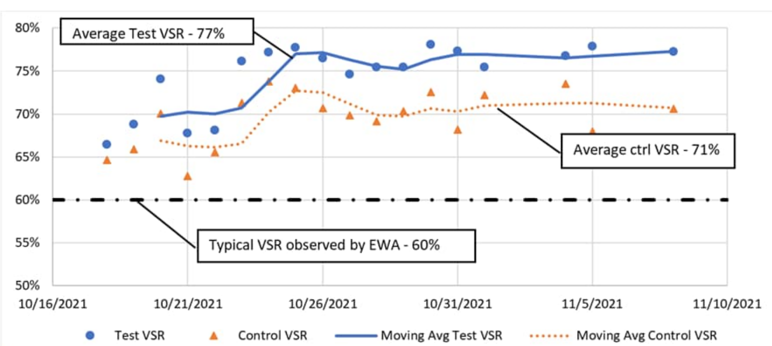
5

Status of EHH

- Process model
- Lab-scale
- Pilot-scale
- Full-scale
- Digestion performance: greater than 75 percent
- Capacity increase: greater than 50% with recuperative thickening

6

Overall Mass Balance Volatile Solids Reduction



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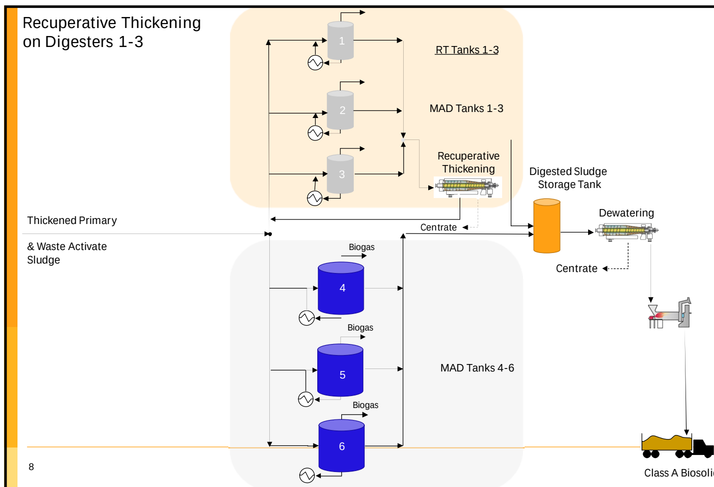
Recuperative Thickening on Digesters 1-3



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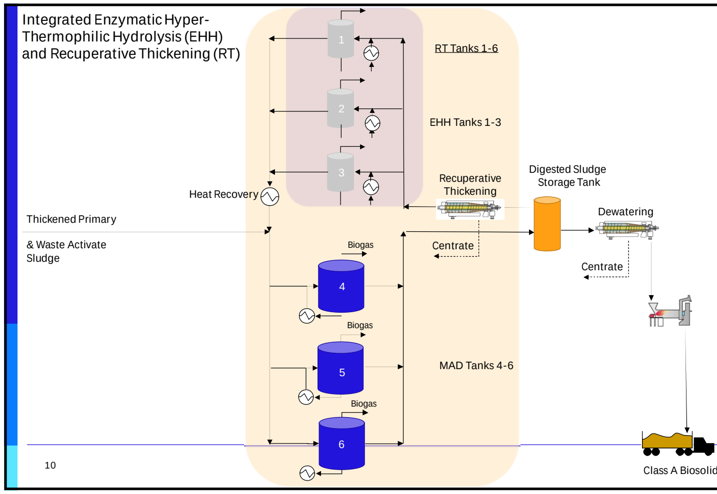
Key inputs and assumptions – RT on Digesters 1-3

- Meets minimum of 15 days HRT in digester 4-6
  - Additional feed goes to digesters 1-3
- Recuperative thickening on digesters 1-3
  - Maximum circulation rate set at 100% flow
  - Maintain digesters 1-3 TS at 3.5% maximum
    - Confidence in mixing with new system designed for higher solids
  - Thicken solids concentration needed to meet 15 days SRT
- Volatile solids reduction in digester 1-6: 60%

9

Integrated Enzymatic Hyper-Thermophilic Hydrolysis (EHH) and Recuperative Thickening (RT)



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Key inputs and assumptions – EHH + RT

- Target solids in digester 1-3: 4% TS
  - Hyper-thermophilic temperatures changes rheology (lowers viscosity)
  - Confidence in mixing with new system
- Solubilization of solids, volatile solids content remains the same
- Minimum HRT in EHH at 3 days
- Target solids in digester 4-6: below 3% TS
  - Confidence in mixing with existing system
- Maximum circulation rate at 100% flow
- Volatile solids reduction in digester 4-6: 75%

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Key Operating Conditions and Results

Parameter	RT 1-3	EHH+RT
Thickened solids fed to Digesters 1-3, %	5.1	4.0
Solids concentration in Digesters 1-3, %	3.5	4.0
Solids concentration in Digesters 4-6, %	1.9	2.7
Solids concentration to dewatering, %	2.1	2.7
Solids to Recuperative Thickening, lb/h (2040 Peak-14 day)	2,300	4,800
Solids to dewatering, dtpd (2030 AA)	24	17

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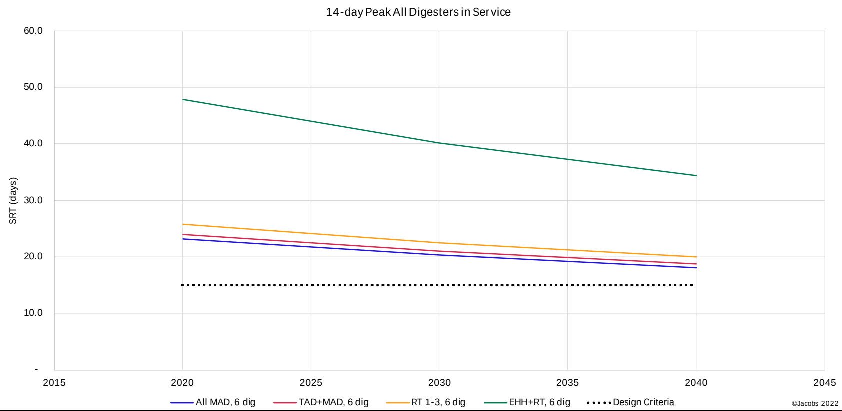
Capacity evaluation of integrated EHH and RT



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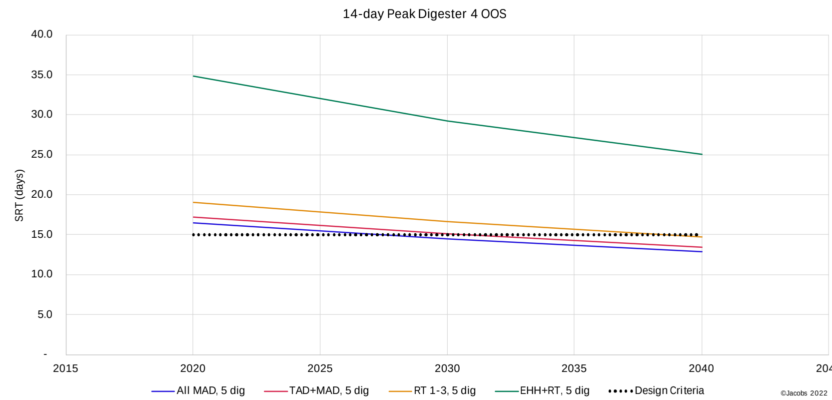
Capacity evaluation of integrated EHH and RT



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Benefits of EHH + RT – Increase Capacity and Performance

- Provides more than 15 days SRT (25 days) during peak 2-week loading with large digester OOS
- Increased VSR enables RT on entire digestion system
  - No risk of mixing less than 3 percent TS in digesters 4-6 with existing system
- VSR increased from 60 to over 75 percent
- Greater than 25 percent increase in biogas production
- Greater than 25 percent decrease in biosolids production
  - Reduced solids feed to dryer
  - Reduced biosolids to distribute
- Effective use of digesters 1-3
- Non-proprietary upgrade of digesters 1-3
  - Mixing
  - Covers
- Continued operation of digesters 4-6
- Operating savings with more biogas and less biosolids

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What is Next?

- Pilot of EHH on-site (transition from bench scale – to larger pilot-scale)
- Preliminary Design of Integrated EHH + RT
- Business Case Evaluation of EHH + RT at Encina WPCF

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Wrap-up of Report
Discussion of Remaining Comments

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Executive Summary Comments

- Several areas were highlighted without a comment – look at document to clarify.
- TM 1 – Athena requested "Reference for items below for where they were evaluated. Consistently add a graph or a reference to a TM" – The purpose of the Executive Summary was to provide a reader digest of the TMs, not to repeat all the data. Would EWA prefer additional graphs and information included in the ES? This comment is unclear.
- TM2 – Should the results of the RFP process be included in the report?
- TM 3 – Question on how the 3 alternatives were determined and the purpose of the nonmonetary criteria. The purpose of the evaluation is to understand the range of alternatives possible, understand the nonmonetary benefits and challenges and to rank them. Based on the discussion and nonmonetary evaluation, EWA staff selected three alternatives to further evaluate costs.
- TM4 – Athena commented, "Section to be updated per EWA comments on TM-4." The Executive Summary was written after EWA comments were reviewed and incorporated. This comment is unclear.
- Recommendations and Considerations: State of California, SB 1383 – not sure how this will increase potential outlets.
- Any other items to highlight? Should we elaborate on potential of EHH and Recuperative Thickening. It is just mentioned as an option here.

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TM-6 Comments

- Include TM6 in the overall report or as a stand-alone document?
- Major Comment Summary
  1. State primary goal of testing EHH and how that fits into the BMP goals.
  2. Where do we envision EHH in the process at EWPCF? What percentage of sidestream?
  3. Define steady-state operation of bench scale test and time to reach – 1 SRT, 2 SRT, 3 SRT?
  4. Normal ranges for pH, FOS, and TAC and the FOS/TAC ratio – establishing stable operation:
     - *Alkalinity results within 2,500 to 5,000 milligrams of alkalinity per liter*
     - *pH levels between 7 and 8*
     - *Increased acid concentrations were observed in the test 5-L reactor compared to the feed and other reactors, indicating C. bescii hydrolysis*
  5. Acid/alkalinity ratio for the test 5L reactor of >1 is much higher than the target range of 0.1 to 0.35 for a typical anaerobic digester.
  6. Concern for assumption that biogas production is proportional VS destruction, given the relatively high FOS/TAC feed from EHH which may impact methanogenesis in the meso reactor
  7. 77% compared to 60% of full-scale digesters or to 71% of the control digester?

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Final Wrap-up Schedule

- Jacobs will issue following by June 8th:
  - Word - comments/responses
  - PDF of complete Report with updated TMs accepted comments.
- Encina final review of PDF – June 9-June 17
- Jacobs prepare final Report and issue by June 30th.

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Jacobs

Meeting Minutes

Subject	**TM 6- Enzymatic Hyperthermophilic Hydrolysis and Recuperative Thickening Analysis**
Project	Encina Biosolids Management Plan Update
Prepared by	Renee Groskreutz, Jacobs
Location	Microsoft Teams
Date/Time	Tuesday, May 31, 2022 3:00-4:30 p.m.
Participants	**Encina Wastewater Authority (**EWA): Alicia Appel, Scott Goldman (W&C), Scott McClelland, Octavio Navarrette **Jacobs**: Mark Elliott, Adrian Flores-Romero, Renee Groskreutz, Dave Parry

Notes		Action
1	**Introductions and Purpose of Meeting** ***Introductions***: Alicia Appel recently joined EWA and joined the call. ***Purpose:*** The purpose of this meeting is to provide a status update on the Biosolids Management Plan (BMP) and provide the results of the integrated enzymatic hyperthermophilic hydrolysis (EHH) and recuperative thickening (RT) analysis.	Jacobs will prepare meeting minutes and share with team.
2	**Overview of EWA's Biosolids Management Plan** In the near term, optimize digestion; in the long term, optimize the thermal process. As part of the near-term improvements, evaluate new technology that may provide improved efficiency. The bench-scale testing was the first step in evaluating this potential.	
3	**Integrated EHH and RT Analysis** Dave shared the impact of integrated EHH and RT for increasing capacity and performance. The analysis compared RT on digesters 1, 2, and 3 versus EHH on digesters 1, 2, and 3 and RT on digesters 1, 2, 3, 4, 5, and 6. The increased capacity evaluated by the solids retention time (SRT) in days was plotted with all digesters in service and with Digester 4 out of service. Both results indicate that EHH and RT provide higher capacity through the planning period. The benefits of integrated EHH and RT include: ▪ Provides 25 days of SRT during peak 2-week loading with the larger digester out of service ▪ Increased volatile solids reduction (VSR) enables RT on entire digestion system, with no risk of mixing ▪ Potential VSR increase from 60 to 75% ▪ Potential 25% decrease in biosolids production, resulting in reduced solids feed to dryer and reduced biosolids to distribute ▪ Potential 25% increase in biogas production (must be validated during piloting) ▪ Nonproprietary upgrade of digesters 1, 2, and 3 – conventional mixing system and competitive selection of equipment ▪ Continued mesophilic operation of digesters 4, 5, and 6 ▪ Maintain independence on process and energy production	

Notes		Action
	Next steps for EHH at Encina Water Pollution Control Facility (EWPCF): ▪ Consider piloting of EHH onsite – Semi-trailer is available for next 6 months prior to going to Wilmington. EWA has multiple pilots onsite right now for membrane bioreactor (MBR), odor control, and others. There is not currently staff availability to support another pilot test at this time. Open to considering after July 2023. ▪ Visit a full-scale operation in Indiana – 2.5-million-gallon (MG) digesters. ▪ Preliminary design of digester 1, 2, and 3 improvements with potential to add EHH in the future.	
4	**Wrapping up the BMP Report** Renee provided a summary of comments received on the Executive Summary and TM 6. Jacobs will provide written responses to comments and submit as part of finalizing the report. Additional updates to the overall report: ▪ Revise title of report from 2020 *Biosolids Management Plan Update to 2022 Biosolids Management Plan Update*. Keep same data that was evaluated. ▪ Include the workshop slides and meeting minutes at the end of the report. ▪ Add Market Broker Request for Proposal (RFP) results – who submitted, brief summary, and state that: "No broker met the needs of EWA at this time, and there is no clear path identified to develop a consistent, reliable local biosolids market." ▪ Add conclusion of smaller projects that pave the way, and potentially integrate EHH and RT, or move forward with larger expenditure now.	
5	**Updates on Biosolids Marketing** Octavio shared that although EWA chose not to proceed with a Market Broker, advertising the RFP has resulted in an increase in local interest and demand for the Class A granules. Octavio will provide an update about biosolids distribution for the end of 2021 and 2022. Octavio requested that Jacobs send the required sampling containers for the plant to use. They have experience sending digested solids samples, but it would be helpful to have correctly sized containers.	Jacobs to send request for biosolids distribution. Octavio to share 2022 distribution volumes.
6	**Project Schedule** Jacobs will target submitting a draft of the overall report by June 8. EWA to provide final review and comment June 9-17. Jacobs will prepare final report and issue by June 30.	Jacobs to submit on June 8 and 30.
7	**Discussion - Integrated EHH and RT** ▪ Scott G. asked whether we could plot RT on only digesters 4, 5, and 6 during our analysis. The anticipated projection can be added for information. ▪ Scott M. asked about the relative size of the RT system between the two scenarios. Dave confirmed that RT for all the digesters would be larger, and the plant would realize more benefits from the increased capacity.	

Notes	Action
▪ Scott M. indicated that the incremental cost will drive the decision. If they are out of capacity by 2025-2026, then what should they focus on getting into design now? Specifically, budgetary costs for: – Digester 1, 2, and 3 improvements – Add RT to digesters 1, 2, and 3 – Add EHH – Add RT to digesters 4, 5, and 6 • Delivering this incrementally will be one cost, providing all options now will be another. Relative costs are important to make this decision. Need to understand this staging. ▪ Scott M.: Another benefit of the increased capacity with EHH and RT is there is more capacity to take in additional high-strength wastes and create another revenue stream. ▪ Scott M. asked: Are results consistent across enough platforms to warrant proceeding with design, or should we wait to pilot? Dave shared that he feels there is consistent data across multiple platforms to recommend proceeding.	