

**AUGUST  
2025**



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# **FROM WASTE TO WORTH:**

## **BIOSOLIDS OPTIMIZATION AT THE HOWARD F. CURREN ADVANCED WASTEWATER TREATMENT PLANT**

**UNIVERSITY OF SOUTH FLORIDA**

**ADRIANA MAYR MEJIA  
ISABELLA GUZALDO  
ISAAC WASHINGTON  
OCHITHYA FERNANDO  
SCHUYLER JONES**

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## 2 Abstract and Team Effort

In response to tightening regulatory requirements in Florida and growing limitations on land application, the SustainaCore team at the University of South Florida conducted a comprehensive evaluation of biosolids treatment and end-use alternatives for the Howard F. Curren Advanced Wastewater Treatment Plant (HFC AWTP). Currently, HFC AWTP produces Class B biosolids through mesophilic anaerobic digestion, followed by dewatering via centrifuges or sludge drying beds. Final disposal primarily involves land application. Anticipated policy changes necessitated a shift toward technologies capable of producing Class A biosolids to enable broader beneficial reuse, reduce liability, and improve long-term environmental outcomes. The team assessed multiple biosolids management strategies based on key criteria including site footprint, operational complexity, technology maturity, capital and 25-year operations and maintenance costs, and overall sustainability performance. Of the ten technologies evaluated—including landfill disposal, lime stabilization, gamma irradiation, pyrolysis, and acid-gas phased anaerobic digestion—seven were ultimately deemed nonviable due to technical, regulatory, or economic constraints. Using a weighted decision matrix, the team identified composting, solar thermal pasteurization (STP), and temperature-phased anaerobic digestion (TPAD) as the top-performing alternatives. STP emerged as the recommended solution based on its proven success in Florida, compatibility with existing infrastructure, capacity for large-scale implementation, and its ability to produce a marketable Class A fertilizer product. To further enhance cost-effectiveness and regional sustainability, the team proposed a regional biosolids facility in partnership with Hillsborough County to support greater resource recovery at scale. This project serves as a model for utility-driven decision-making in biosolids management, emphasizing practical sustainability, regulatory resilience, and innovative reuse pathways.

### **Adriana Mayr Mejia – Project Manager, Solar Pasteurization Expert**

Adriana oversaw project coordination, scope management, and deliverable integration across all team members. She led the analysis of solar pasteurization as a Class A biosolids treatment option, evaluating its feasibility, performance, and implementation considerations specific to the Tampa Bay climate and the HFC AWTP context. She organized meetings and correspondence with Merrell Bros. and Hillsborough County.

### **Ochithya Fernando – Pyrolysis Expert**

Ochithya conducted technical and economic evaluations of pyrolysis as a thermal biosolids treatment method, with particular focus on PFAS destruction potential. She analyzed system scalability, energy recovery opportunities, and regulatory implications associated with emerging pyrolysis technologies. She was also the main point of contact for the vendors.

### **Schuyler Jones – TPAD Expert**

Schuyler led the assessment of Two-Phase Anaerobic Digestion (TPAD), focusing on its ability to enhance volatile solids reduction and pathogen destruction. He consulted with experts, energy estimates, and evaluated integration with the plant's existing mesophilic digestion system.

### **Isabella Guzaldo – Composting Expert**

Isabella evaluated composting for Class A biosolids production, examining operational requirements, integration, and end-use markets. She also analyzed the environmental trade-offs and land requirements of implementing composting at scale. She organized meetings and correspondence with Merrell Bros. and Hillsborough County.

### **Isaac Washington – Editor**

Isaac ensured consistency, clarity, and technical accuracy throughout the report. He coordinated document formatting, synthesized feedback, and supported quality control of all written materials and visual deliverables.

### **Acknowledgements**

The SustainaCore team would like to acknowledge Dr. Sarina Ergas for her guidance as capstone professor, Tom Cross, P.E. for his mentorship, and Dr. Karloren Guzman from the City of Tampa for providing project data and technical insight. We also thank Dr. Renan Dos Reis for his expertise in biosolids, George Dick, P.E. (FWEA) for his mentorship and biosolids knowledge, and Tim Ware, P.E. (FWEA) for his valuable input. Additional thanks are extended to the City of Tampa and Merrell Brothers representatives for facilitating the design project.

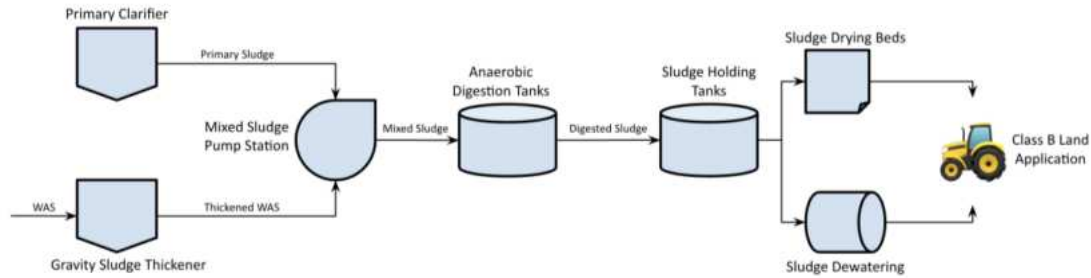
## **3 Background**

The Howard F. Curren Advanced Wastewater Treatment Plant (HFC AWTP) treats all the wastewater that is discharged into the City of Tampa’s wastewater collection system. The facility has a capacity of 96 million gallons per day (MGD), an average daily flow (ADF) of 55 MGD, and peak flows of 200 MGD. The effluent is either discharged into the Hillsborough Bay or pumped back into their reclaimed water distribution system for industrial or irrigation reuse.

Originally constructed in the 1950s, HFC AWTP has undergone multiple expansions and upgrades to increase efficiency, reliability, and resiliency. Its latest upgrade was completed in 2024, which included enhancements to the primary sedimentation tanks, biogas and digestion system, sludge drying beds, blowers, and dewatering facility (Garney Construction 2024). With these processes, the facility currently produces Class B biosolids, but due to emerging restrictions on Class B land application and increases in hauling costs, the City of Tampa has contracted SustainaCore to evaluate treatment and disposal methods to improve the plant’s operations.

SustainaCore conducted a preliminary analysis to understand how the current operations produce a Class B product. As shown in Figure 1, waste activated sludge (WAS) is collected from the high purity oxygen (HPO) reactors and final settling tanks and pumped into the gravity sludge thickeners. Sludge from the primary clarifier and thickened WAS enter the mixed sludge pump station as 60% primary sludge and 40% WAS. In this stage, the sludge is 5% total solids (TS), where it undergoes mesophilic digestion at 95°F for a solids retention time (SRT) of 15-20 days. Anaerobic digestion facilitates solids stabilization by reducing volatile solids content, pathogens, and odors through microbial activity that converts solids into biogas (Water Environment Federation, 2017). In 2015, the digester gas was being used as fuel at the existing combined heat and power (CHP) system to generate electrical power and heat water for the digested sludge heating system.

However, the CHP is out of service (OOS) and all biogas is currently being flared. After digestion, sludge enters the sludge holding tanks at 2% solids. After the sludge holding tanks, the sludge is treated one last time before being land applied as Class B biosolids.



*Figure 1. Process flow diagram for HFC AWTP sludge processing (Sustainacore, 2025).*

HFC AWTP has two methods of sludge dewatering via centrifugation and sludge drying beds. In January 2024, the City upgraded from belt presses to centrifuges. The current dewatering process primarily relies on centrifuges with drying beds as a backup, but neither significantly improves biosolids quality (McKim&Creed 2018). For the centrifuge sludge dewatering, the three-story centrifuge facility houses three centrifuges, where raw and diluted polymers are added to achieve the desired solids content to be transported into the loading trucks via auger conveyor and shaft for the trucks to park underneath. These polymers currently cost the City about \$1 million annually. The 32 drying beds are utilized when there is an excess of sludge that cannot be stored in the holding tanks, which spans 14.5 acres, involves a 2-3 month drying process and produces a product with 10-15% TS. The material from both final treatment systems is transported to the loading system, where trailers line up and are picked up by contractors that dispose of the sludge in landfills or agricultural lands. Sludge quantities from 2024 can be found in Table 1. Sludge production has remained relatively constant since 2019, which is why the design team will use these numbers through the report.

*Table 1. Summary of Sludge Data for Howard F. Curren AWTP from 2019-2024*

	<b>Annual Average</b>	<b>Annual Total</b>	<b>Per Day</b>
<b>Wet Tons per Month</b>	4,687	56,240	154.1
<b>Dry Tons per Month</b>	861	10,330	28.3

Furthermore, there are major upgrades to the mesophilic anaerobic digesters spanning from 2025 to 2028, which will need to be factored in with the alternatives explored and timeline (HFC AWTP 2016). Currently, there are 7 digesters, with 2 OOS (HFC AWTP 2016). By 2028, there will be two larger tanks remaining with two more being built for a total of four (HFC AWTP 2016). The operating volume in gallons is projected to be from 9,013,280 to 9,800,000 (HFC AWTP 2016).

An essential part of the project is understanding the classification of biosolids as specified by the Environmental Protection Agency (EPA) 40 CFR Part 503, Standards for the Use or Disposal of Sewage Sludge. Biosolids are divided into “Class A” or “Class B”, which is determined based on pathogen treatment methods, vector attraction reduction, and general requirements and management practices (Environmental Protection Agency 2025). Additionally, there is a third class, “Class A EQ”, which stands for Class A Exceptional Quality (EQ), and requires more stringent pathogen treatment and chemical pollution limits (Environmental Protection Agency 2025). Class A EQ is better known as Class AA according to the Florida Department of Environmental Protection (FDEP), which is the highest quality of biosolids and can be distributed

and marketed as a commercial fertilizer (Florida Department of Environmental Protection 2024). Biosolids qualities, class, and treatment are all under stringent regulations and codes, which is why it is important to understand the various regulations that impact the project. These can be found summarized in Table 2.

*Table 2. Pertinent Regulations and Ordinances from FDEP and EPA*

<b>Regulation</b>	<b>Relevant Standards &amp; Requirements</b>	<b>Impact on Project</b>
<b>EPA 503 Regulations</b> (40 CFR Part 503)	Defines Class A and B biosolids standards based on pathogen reduction, vector attraction reduction (VAR), and pollutant limits.	Should meet Class A or AA standards by implementing additional treatment processes for pathogen and VAR compliance.
<b>Pathogen Reduction Standards</b> (Method 1580)	- Class A: <1,000 most probable number (MPN) fecal coliforms per gram or below detectable Salmonella levels. - Class B: ≤2 million MPN fecal coliforms per gram.	Upgrading to Class A or AA requires additional treatment (e.g., thermophilic digestion, lime stabilization, or heat treatment).
<b>Florida Biosolids Rule</b> (62-640, F.A.C.)	State-specific requirements for land application, distribution, and disposal, with additional restrictions on nutrient loading and runoff prevention.	Imposes stricter requirements than federal regulations for land application and disposal in Florida. Only class AA qualifies for unrestricted use.
<b>Local Municipal Regulations</b> (Hillsborough County Municipal Code Section 6.11.53) (City of Tampa Fertilizer Ordinance)	Additional requirements including setbacks, zoning, minimum land areas, fertilizer application periods.	Constraints on biosolids disposal options, requiring compliance with regional nutrient management strategies.
<b>Domestic Wastewater Facilities</b> (62-600, F.A.C.)	Standards apply to domestic wastewater treatment, reuse, and biosolids management facilities.	Regulations must be met to determine a viable alternative that meets compliance.

## 4 Problem and Objective

The HFC AWTP currently produces Class B biosolids, which are minimally treated and consequently face the greatest restrictions on land application. According to the FDEP, the number of Class B land application sites has decreased significantly, from 140 in 2018 to 74 in 2025. (Florida Department of Environmental Protection 2024). This nearly 50% reduction in under a decade can be attributed to tightening regulatory constraints, the need for nutrient management plans, and increasing public opposition to biosolids reuse. In addition to general restrictions, 2010 Revised State Rule 62-640 limits Class B use in sensitive areas such as the Lake Okeechobee, Caloosahatchee, and St. Lucie River watersheds unless there is no net increase in phosphorus or nitrogen and sets stricter limits on how much material can be stockpiled at application sites (Merrell 2019). Class B

biosolids can only be land applied at sites that meet strict setback requirements and may not be used in areas with high public exposure, near wetlands, or in proximity to water bodies. These restrictions, combined with local bans in counties like Pasco County due to vulnerable spring watersheds, continue to diminish viable land application opportunities across the state.

Meanwhile, wastewater flows, and sludge production continue to be received by HFC, creating a growing gap between biosolids generation and disposal capacity. Maintaining the status quo introduces the risk of escalating costs and operational uncertainty. A continued decline in disposal market availability, or an abrupt tightening of regulations, could require longer hauling distances or a shift to landfilling, either of which would significantly increase overall disposal costs. Currently, the City of Tampa pays Manny's Bulk Express, a hauling contractor, \$2.1M in hauling fees every year.

At the same time, the facility is planning major renovations to its anaerobic digesters, presenting a timely opportunity to upgrade the biosolids treatment process. SustainaCore has been tasked with optimizing the treatment and disposal of biosolids. All the alternatives analyzed will be considering that the plant produces 10,400 dry tons/yr and 30 dry tons/day of biosolids. Per the client, options include the following:

- A. Continuing to the production of Class B biosolids using mesophilic anaerobic digestion, centrifuge dewatering, and sludge drying beds.
- B. Finding alternative treatment and disposal methods to produce Class A or Class AA biosolids.
- C. Investigating regional partnerships for treatment and disposal of digested biosolids.

## 5 Design Criteria

### 5.1 Evaluation Criteria

Through direct collaboration with the City of Tampa and in-depth conversations with operators Marcus McDougle and Rob Decker, and former plant operator Timothy Ware, SustainaCore crafted a tailored evaluation framework that reflects both technical goals and on-the-ground insights. The team identified seven key criteria to guide the selection of a biosolids solution.

1. **Class Achieved:** Evaluates the ability of each alternative to meet EPA 503 standards for biosolids classification, with higher scores awarded for achieving Class A or AA.
2. **Footprint:** Assesses the spatial requirements of the alternative, considering land availability and site constraints. Smaller footprints receive higher scores.
3. **Capital Costs:** Represents the total financial investment required over a 25-year planning period, including equipment, infrastructure, and installation. Lower costs are preferred.
4. **Operations and Maintenance (O&M) Costs:** Accounts for long-term operational and maintenance expenses over a 25-year planning period. Alternatives with lower ongoing costs receive higher scores.
5. **Ease of Operation:** Measures the complexity of daily operations, with a preference for alternatives requiring fewer personnel and less maintenance. Simpler, more automated solutions score higher.

6. **Proven Technology:** Evaluates potential uncertainties, with a focus on technologies already implemented at wastewater treatment plants in Florida. Lower-risk alternatives receive higher scores.
7. **Sustainability:** Considers resource efficiency, energy use, and the potential for beneficial reuse with attention to odor control, public acceptance, and sustainability. More sustainable options are prioritized.

### 5.1.1 Alternatives Analysis

During the execution of this project, SustainaCore explored 11 alternatives (Table 3): current operations, landfill disposal, heat drying, acid-gas phased anaerobic digestion (AGAD), gamma ray radiation, solar drying, lime stabilization, pyrolysis, solar thermal pasteurization (STP), composting, and temperature phased anaerobic digestion (TPAD). Phase 1 consisted in performing literature reviews for all 11 alternatives, analyzing and understanding where they would fit into HFC AWTP current operations HFC AWTP. This was done with information collected through the site visit, conversations with the client, the 2015 and 2018 Master Plans, and latest rule revisions to Chapter 62-640, F.A.C. Phase 2 further evaluates 4 alternatives that had the most potential to adapt to the current processes in HFC AWTP: pyrolysis, STP, composting, and TPAD. This phase included the design, cost estimation, vendor analysis, and other components to provide a more robust analysis to select a final alternative for recommendation.

*Table 3. Phase and Alternative Breakdown*

Phase	Alternative/Technology	Information Provided
Phase 1	Current Operations	<ol style="list-style-type: none"> <li>1. Literature review</li> <li>2. Design regulations and requirements</li> <li>3. Previous uses of technology in Florida</li> <li>4. Integration of Technology into HFC AWTP</li> </ol>
	Landfill Disposal	
	Heat Drying	
	Acid-Gas Phased Anaerobic Digestion	
	Gamma Ray Radiation	
	Lime Stabilization	
	Pyrolysis	
	Solar Thermal Pasteurization	
	Composting	
	Temperature Phased Anaerobic Digestion	
Phase 2	Pyrolysis	<ol style="list-style-type: none"> <li>1. Design and spatial requirements</li> <li>2. Cost Estimation</li> <li>3. Vendor Profiles and Analysis</li> </ol>
	Solar Thermal Pasteurization	
	Composting	
	Temperature Phased Anaerobic Digestion	

## 5.2 Phase 1

### 5.2.1 Current Operations

Current operations are described in Section 3. Briefly, HFC AWTP treats an average of 55 MGD of wastewater and generates approximately 56,240 wet tons (10,330 dry tons) of sludge annually. Sludge undergoes mesophilic anaerobic digestion (15–20 day SRT at

95°F), followed by dewatering via centrifuges and backup sludge drying beds, yielding a Class B biosolids product at 17% solids for land application. As stated above, SustainaCore is assessing treatment and disposal improvements in response to rising polymer and hauling costs, Class B land application constraints, and planned digester upgrades through 2028.

This option is the most aligned with current plant operations and carries the lowest short-term cost. However, it remains vulnerable to tightening biosolids regulations and lacks the capability to achieve Class A biosolids without significant temperature upgrades or integration with other technologies. This upgraded mesophilic digestion method represents the current baseline operation at HFC AWTP and serves as the reference point against which all alternatives were evaluated.

### 5.2.2 Landfill Disposal

Landfilling involves disposing of biosolids at designated landfill sites, either as a standalone material (monofil) or mixed with municipal solid waste (co-disposal). This method is typically used when biosolids do not meet land application standards or when more cost-effective reuse options are unavailable (Environmental Protection Agency 2003). Before disposal, biosolids are mechanically dewatered to reduce moisture content and overall transport weight. The material is then hauled by truck to a landfill, where it is either placed in a monofil or co-disposed to aid decomposition.

Landfilling presents several long-term drawbacks, such as high transportation and tipping fees, the permanent loss of valuable biosolid nutrients, and environmental concerns such as methane emissions and potential leachate mismanagement (Environmental Protection Agency 2003). Discussions with Hillsborough County, Kim Rogers and Luke Mulford, further revealed that local landfill space is limited and there is no current interest in accepting additional biosolids from HFC AWTP, rendering this option infeasible for the site. The primary options for biosolids handlers have become significantly costly due to competition from other counties' utilities.

Due to its high cost, wasted resource potential, environmental impact, and lack of local landfill availability, landfilling is considered an unsustainable long-term solution for biosolids management at HFC AWTP.

### 5.2.3 Heat Drying

Heat drying involves using a chamber fueled by natural gas to evaporate moisture from dewatered biosolids, producing a dry end-product that can be repurposed as fertilizer. The process, which uses direct or indirect dryers, reduces solids volume and can produce Class A biosolids when meeting 40 CFR Part 503 standards (EPA, Biosolids Technology Fact Sheet, Multi-Stage Anaerobic Digestion 2006). Direct systems expose solids to hot gases, while indirect systems use thermal conduction through surfaces like metal discs or paddles.

However, at HFC AWTP, a heat drying facility installed in 1988 was decommissioned in 2012 due to high operational costs, energy demands, and maintenance requirements. Heat-dried pellets were not sold, and the process proved financially unsustainable.

McKim & Creed estimated operating costs at approximately \$145 per dry ton, including parts, labor, and energy (McKim&Creed. 2016). The facility is scheduled for demolition.

While the technology remains viable with modern upgrades, the facility has opted not to revisit this option. As such, heat drying was not chosen due to its poor energy-to-profit ratio and prior operational challenges.

#### 5.2.4 Acid-Gas Anaerobic Digestion

AGAD is a two-stage mesophilic process consisting of acid-phase digestion followed by gas-phase digestion. The first stage promotes acidogenic organisms at a low pH (5.0–6.0), suppressing methanogens, while the second stage allows methanogenic organisms to convert volatile fatty acids to methane under longer detention times (V. G. Gomes 2016).

This process involves hydrolysis and volatile acid fermentation, operating separately from methane production and requiring dedicated digester tanks for each phase. AGAD can provide a 3% volatile solids reduction (VSR) and a 3% increase in biogas production (McKim&Creed 2018). While promising for energy recovery, concerns remain regarding the system's ability to consistently produce Class A biosolids, increased safety risks from chemical handling, and a required volume increase of 1.68 million gallons compared to baseline conditions.

According to McKim & Creed, and Hazen and Sawyer, this offers similar improvements in VSR and methane production with an estimated +3% increase (McKim&Creed 2018). This operates entirely in the mesophilic range, it presents more process stability than TPAD (EPA, Types of Anaerobic Digesters 2024), and hydraulic retention times (HRT) are expected to align with baseline mesophilic systems.

However, AGAD requires 1.68 MG more digester volume than the planned 9.8 MG, although this is less than TPAD's 6.18 MG increase (McKim&Creed 2018). Despite operational benefits, AGMD fails to meet EPA Class A standards due to insufficient operating temperatures (EPA, A Plain English Guide to the EPA Part 503 Biosolids Rule 1994). This limits reuse opportunities and increases regulatory requirements. This regulatory uncertainty, coupled with chemical handling risks and additional volume requirements, led the team to rule out AGAD as a feasible alternative for HFC AWTP.

#### 5.2.5 Gamma Ray Radiation

Gamma ray radiation radiates dewatered biosolids in a controlled chamber using high-energy gamma rays generated by radioactive sources such as Cobalt-60 or Cesium-137. The U.S. EPA recognizes this method as a Process to Further Reduce Pathogens (PFRP), meaning it has the potential to enable HFC AWTP to produce Class A biosolids (EPA, A Plain English Guide to the EPA Part 503 Biosolids Rule 1994). These rays disrupt microbial DNA, sterilizing the material and preventing pathogen regrowth (Ranković 2020). Once treated, the biosolids can be safely reused or disposed of.

Despite its disinfection effectiveness, there are considerable concerns regarding the feasibility of implementing gamma ray radiation at HFC AWTP. This technology has yet to be adopted by any advanced wastewater treatment facilities in Florida, introducing uncertainty about regulatory acceptance and permitting. Internationally, Gamma ray radiation has been proven to reduce bacteria and coliform to Class A standards from activated sludge in Saudia Arabia in a Riyadh wastewater treatment plant (Al-Ghoniem 2010).

High costs, radiation safety risks, regulatory delays, waste management issues, and uncertain scalability make this method operationally and economically unfeasible (Ranković 2020).

### 5.2.6 Lime Stabilization

Lime stabilization is a chemical treatment process that increases the pH of biosolids by adding hydrated lime and quicklime—specifically, calcium oxide (CaO) and calcium hydroxide (Ca(OH)<sub>2</sub>). This method is effective in producing Class A/AA biosolids, mitigating odors, and maintaining cost-effectiveness amid volume fluctuations (Association, Uses of Lime: Biosolids and Sludge. 2022).

Lime is produced by calcining limestone and hydrating it into its usable forms (Association, How is Lime Made 2023). The high pH (up to 12.4) inactivates pathogens and reduces vector attraction, while the exothermic reaction between CaO and water can raise the temperature of biosolids to 70°C (Association, Uses of Lime: Biosolids and Sludge. 2022). These conditions help meet EPA requirements for Class A biosolids—maintaining pH above 12 for 2 hours and above 11.5 for 22 more hours, with heat-aiding disinfection.

Additional benefits include lime’s ability to precipitate metals, reduce odor-causing compounds, and extend treatment effectiveness due to its low solubility. However, one of the primary drawbacks is limited volatile solids reduction, which results in an increased mass of biosolids requiring disposal (Farzadkia 2014). The elevated temperatures involved also necessitate adjustments in safety procedures for handling.

From a financial standpoint, lime is cost-effective compared to other treatment technologies. Vendors such as WeDoTanks estimate treatment costs around \$0.0025/gallon, increasing solids from <1.5% to 8% (WeDoTanks 2021).

An example of large-scale lime stabilization is the Southwest Water Reclamation Facility (SWWRF) in St. Petersburg, FL, where the Bioset process is used to produce Class A biosolids. Despite its success, this method increased solids volume, operational costs, and the number of truck trips for disposal (CH2M HILL Engineers 2015). Lime stabilization continues to be one of the primary Class A treatment methods used in Florida, but concerns arise about long-term soil imbalance and environmental risks from alkalinity leaching (FDEP 2024). Florida soils typically are in the slightly acidic range with the fine-grained soil known as Myakka being common across the state (EPA 2000). On average, the pH for Florida soils is 6.1 (Knox (n.d.)).

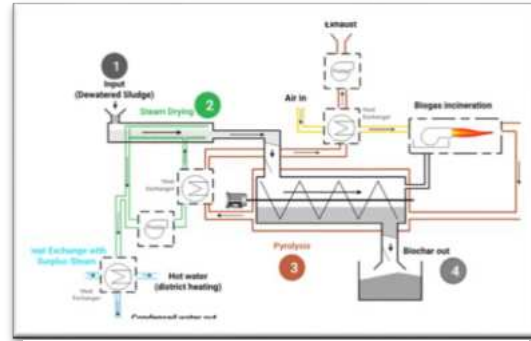
## 5.3 Phase 2

For Phase 2, 4 alternatives were selected for further evaluation: pyrolysis, STP, composting, and TPAD. These options were identified based on their compatibility with the existing process flow and their ability to build upon the City’s 2024 investment in centrifuge dewatering. Additionally, the sludge drying beds, which have been in use since at least 1995, continue to add operational redundancy to the biosolids process and were considered in identifying technologies that can integrate with both existing systems.

### 5.3.1 Pyrolysis

Pyrolysis is a process similar to incineration, using heat to break down biomass into useful products. Characterized by high temperatures, rapid heating rates, and an oxygen-free environment, pyrolysis leads to the thermo-chemical decomposition of biomass. This process can be applied to biosolids, irreversibly converting them into solid, liquid, and gas phase products called biochar, bio-oil, and biogas, respectively. The ratio of the production of the different phases is dependent on temperatures and heating rates, as well as the composition of the Biomass input into the system (Fahmy 2020).

Biochar is a solid carbon-rich residue that has many advantageous physical and chemical properties, that leads to bio char being an extremely versatile product with vast application potential (Patel 2020). Biogas can be used as a renewable fuel source for industrial combustion processes and internal combustion engines and bio oils have many uses, including power generation, heat generation, and transport fuels, and can also be used to make many chemical products such as fertilizers, resins, adhesives, and industrial feedstock (Patel 2020).



*Figure 2. AquaGreen process flow diagram with numbered steps (AquaGreen n.d.)*

In the process of pyrolysis, dewatered solids are taken in, dried, and then pyrolyzed. Figure 2 is a process flow used by the company AquaGreen (AquaGreen n.d.). The biogas and/or biofuel produced is generally reused to power the drying and pyrolyzing processes. It is a vendor specific process; parameters such as the dewatering requirements, drying methods and requirements, pyrolysis heating rates and temperatures, method of energy reclamation, etc., all depend on the vendor design selected.

Three vendors who have previous experience with biosolids pyrolysis in the United States, PYREG, AquaGreen, and BioForceTech, were contacted and details of their process flows and required parameters, were obtained (Table 4).

**Table 4. PYREG, AquaGreen, and BioForceTech Vendor Parameters**

<b>Vendor</b>	<b>TS % Required</b>	<b>Drying</b>	<b>Space (ft<sup>2</sup>)</b>
<b>PYREG</b>	20-30% TS	To 80-90% (Out of scope)	3,920
<b>AquaGreen</b>	18-28% TS	To 85-90% (Steam dryer)	21,400
<b>BioForceTech</b>	20-30% TS	To 70% (Biodryer)	3,230

The electricity and energy requirements of this process are dependent on the calorific value of the input sludge, since the products are used to fuel the process. According to brochures provided by Aquagreen and BioForceTech (Figure H 2, Appendix H, Section 10.8), operation is automated, and continuous, requiring minimal manpower, and can be controlled remotely through the Internet of Things (IoT). The belt drying facility is situated next to the dewatering facility and is not in use. It has an area of around 34,000 ft<sup>2</sup>. This would be the ideal location to situate the equipment.

As an emerging technology, the current commercial application references of pyrolysis are limited. In the United States, the Silicon Valley Clean Water facility (Silicon Valley Clean Water n.d.), and the municipal wastewater treatment plant in Lancaster County, Pennsylvania operated by Ephrata Borough Authority (Surti, Winslow and Landale 2023) have successfully partnered with BioForceTech to integrate this technology. There are currently no operating biosolids pyrolysis facilities in Florida.

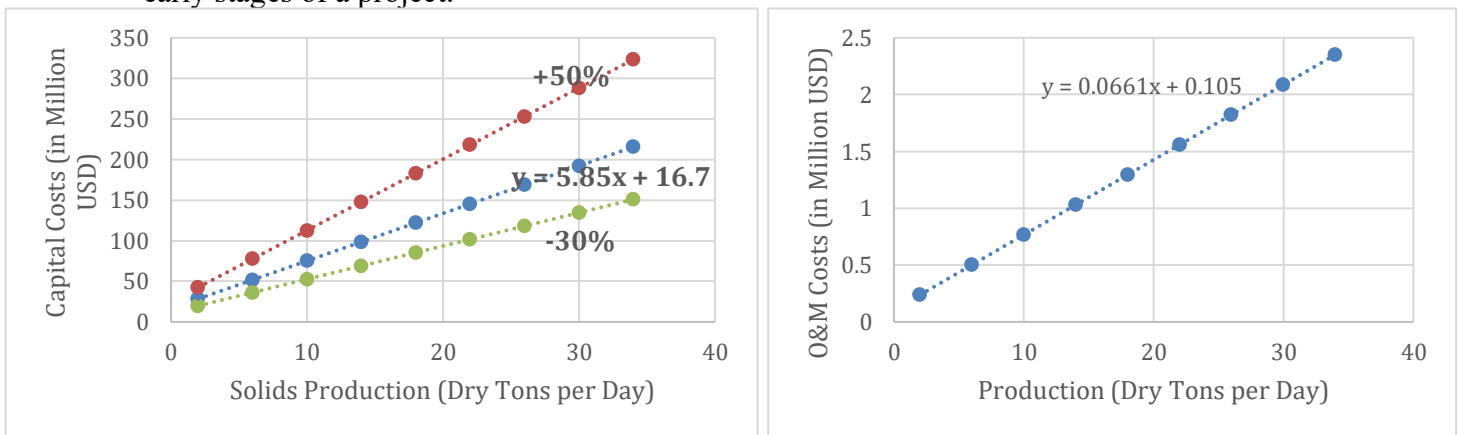
Pyrolysis of biosolids has a multitude of benefits. In addition to having versatile products, the biochar produced is free of per- and polyfluoroalkyl substances (PFAS) (Surti, Winslow and Landale 2023), and organic pollutants (Paz-Ferreiro, et al. 2018), and has proven to have the ability to adsorb PFAS, heavy metals and other organic pollutants

from soil (Sundaram and Jagadeesh 2023). Additionally, this process produces Class A biosolids (Biosolids Management that Creates Value n.d.). Further advantages include carbon sequestration, odor elimination, significant weight reduction leading to reduced disposal costs, energy recovery, and pollution control (e.g., reduction of pathogens, viruses, Polycyclic Aromatic Hydrocarbons (PAHs), and heavy metals) (Paz-Ferreiro, et al. 2018). Pyrolysis is also typically designed by most companies to be a continuous and fully automated process, requiring little to no operating and upkeep personnel.

Despite the benefits, this process comes with high initial installation costs, and some risks involved. There is a limited domestic track record, with current plants operating at a smaller scale, and if installed at HFC AWTP, it would be the first installation in Florida. Because biochar from sewage sludge does not meet EU standards by default, and that U.S. regulations are still evolving, there is regulatory uncertainty involved. Additionally, HFC AWTP only dries to 17-20% solids, thus, extra drying would be required, needing additional energy and infrastructure.

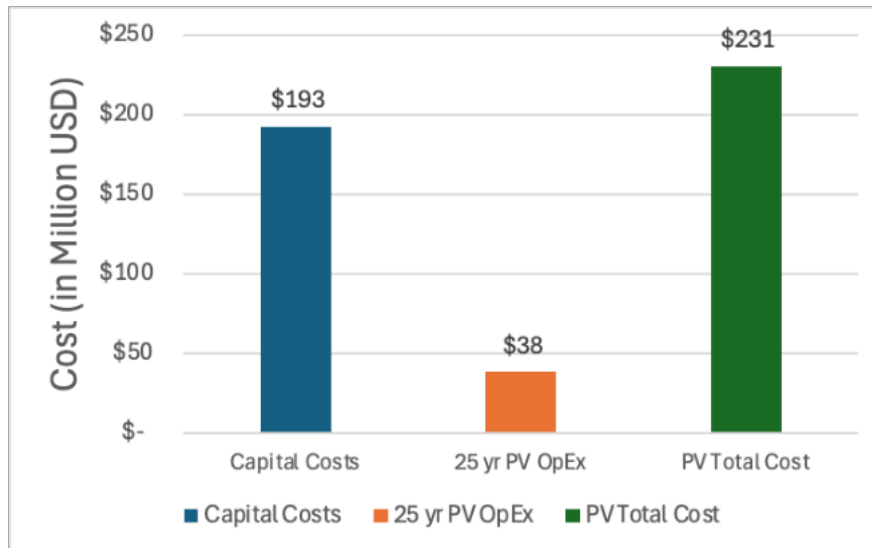
The costing for this design was established using costing curves shown in Figure 3 for capital and overhead expenditures created by the companies Hazen and Sawyer and Barr Engineering & Co. (Barr Engineering Co., & Hazen and Sawyer. 2023) for a cost analysis of solids production in dry tons per day (DTPD). A pyrolizer from the company Earth Care with a capacity of 40 DTPD was modelled for this cost calculation, and additional design parameters used can be found in Table H 1. Summary of Design Basis Assumptions For Pyrolysis Costing Table H 1 in Appendix H (Section 10.8). Several assumptions were made for the cost analysis in this study. For capital costs, the dryer and pyrolysis system were assumed to be provided as a complete equipment package by a single vendor, and biosolids feed piping, electrical and controls wiring, natural gas, and water connections were assumed to be provided by a contractor. Operational costs were assumed to include electricity, natural gas for startup, chemicals, operation labor, maintenance materials, but will vary depending on type of dryer and pyrolyzer.

The -30% and +50% cost curves in the capital cost chart were calculated in accordance to Class 4 of the AACE (Association for the Advancement of Cost Engineering) cost estimate classification system (Dysert 2016), which can be found in Table H 2 Appendix H (Section 10.8). This system accounts for variability in costs in the early stages of a project.



*Figure 3. Capital and Overhead cost curves for pyrolysis per dry tons per day.*

For 30 DTPD of solids production, the capital cost was calculated to be \$193M and annual operational costs to be \$2.22M. Costed over 25 years, the present worth of the annual costs have a value of \$38.2 Million. This cost calculation can be found Appendix H, Section 10.8). Figure 4 below represents the total present value costs for the next 25-years.



*Figure 4: Pyrolysis Present Value Costs*

### 5.3.2 Composting

The City of Tampa released the Climate Action and Equity Plan which outlines their vision for waste management: to decrease the waste going into their Waste to Energy (WTE) facility and landfills due to limited capacity and high costs (City of Tampa 2023). With yard trimmings being one of the largest contributors to landfill volume, there has been a shift toward composting (P.D. Millner n.d.).

Composting consists of three main methods such as aerated static pile, windrow, and in-vessel that can handle dewatered biosolids with bulking agents (EPA 2024). A few approved bulking agents are available, with yard trimmings being the primary focus of this project, as they are a significant waste concern in Florida (EPA 2024). Aerated static pile and windrow methods require a large volume of bulking agent and land area (EPA 2024). While a large volume of bulking agents, such as yard trimmings, could create a mutually beneficial partnership, HFC AWTP is a 96 MGD plant with significant material already being handled. Additionally, these composting methods may become infeasible due to land capacity limitations for managing all the biosolids. In-vessels can be more expensive; however, it requires less land and a higher amount of biosolids compared to bulking agents (EPA 2024). This could be further investigated because of the smaller land requirement; however, another type of partnership may be needed as there is a much higher use of biosolids. According to 40 CFR Part 503, achieving Class A biosolids in composting requires the methods to be at with the aerated static pile or in-vessel at least 3 days and windrow for at least 15 days with 5 turns (EPA 2024). There is also the potential to meet EQ biosolids when operating in these conditions, which would lead to further desirability of the product (EPA 2024).

Integrating composting into a facility requires approval of the chosen process, bulking agents, and time. Effective February 15, 2010, the following forms, permits, and reporting are required by the FDEP under the Chapter 62-709, F.A.C. for composting (Florida Department of Environmental Protection 2024).

- **62-709.901(3):** Application for Registration and Annual Report of a Yard Trash Transfer Station or a Solid Waste Organics Recycling Facility
- **62-709.901(1):** Application for a Permit to Construct/Operate a Solid Waste Management Facility for the Production of Compost
- **62-709.901(2):** Annual Report for a Solid Waste Management Facility Producing Compost Made from Solid Waste
- **62-709.901(4):** Application for a Permit to Operate an Organics Recycling Pilot Project

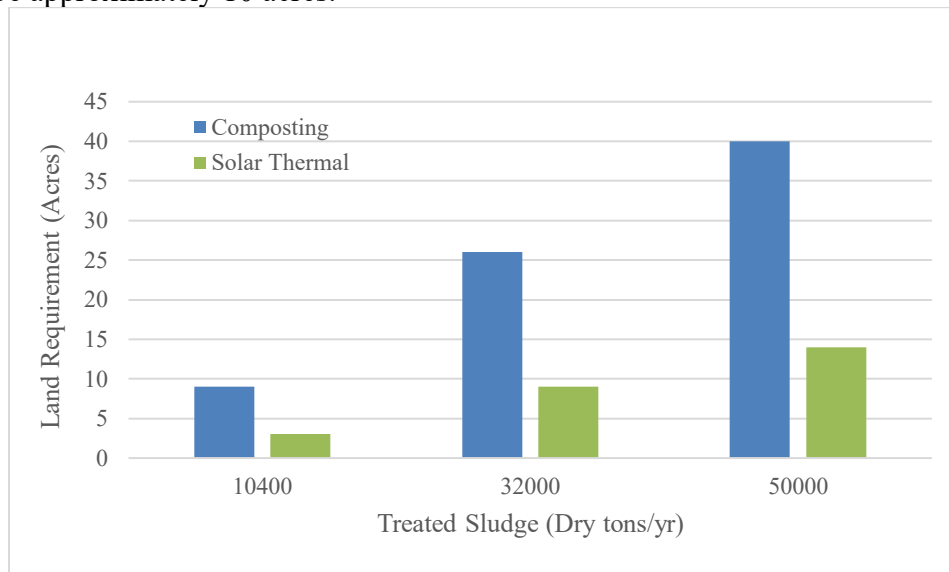
Hillsborough County's Falkenburg Road Advanced Wastewater Treatment Plant has a successful partnership with the Southeast Hillsborough County Landfill (Schinella and Clark 2016). This collaboration is expected to save \$1.5 million in five years and reduce biosolids and disposal operation costs by 36% (Schinella and Clark 2016). The technology used is a modified static aerobic pile (MSAP) which is a combination of static pile and windrow approved by FDEP and EPA to achieve Class A (Hillsborough County 2015). It began as a 3-acre pilot that then was increased to 7 acres after success in achieving Class AA compost (Schinella and Clark 2016). As of 2016, the capacity of both biosolids and yard trimmings is 29,000 tons/year (Schinella and Clark 2016). However, in 2022, the compost facility manager, Ron Wiesman, noted that the entire process could take between 70-90 days (Boyd 2022). It is crucial to consider that the Falkenburg Facility is significantly smaller than HFC AWTP at approximately 9 MGD reported in 2007 compared to HFC AWTP's 96 MGD (Hillsborough County 2007). HFC AWTP has also been reported to take on some of the flow from Falkenburg as they are struggling with their current capacity as of 2024 (Bruton 2024).

Composting could be a desirable solution as the plant could keep its current upgraded mesophilic operations while achieving at least Class A at a composting facility off-property. Additionally, hauling costs could be reduced by staying in-county. Contact was made with Hillsborough County to gauge their interest and capability in accepting biosolids from HFC AWTP. Luke Mulford was the primary contact with Kim Rogers as a point of further reference. There are major concerns with accepting more biosolids due to potential PFAS regulations in the future. Additionally, there is no interest in expanding composting operations with biosolids and there is currently not enough space to accept any more. Beyond capacity, there seems to be a decrease in biosolids handlers which is furthering this issue. This led to the investigation of this alternative to a private company specializing in biosolids management; Merrell Bros.

Through a meeting with Blake Merrell (notes found in 10.11.1), there was a discussion pertaining to their composting process as well as applications of this in the Johns Family Enterprises Facility, LLC (JFE) facility in Okeechobee, FL (New Markets Tax Credit Coalition 2022). This facility is approximately 80 acres and is a partnership with the Seminole Tribe as they are one of the largest cattle ranching landowners in the area. Merrell Bros uses a combination of the processes previously mentioned beginning with in-vessel then windrow (14 days above 101°F on a curing pad) then it is run through screens to get

finer before getting to farmers. This method was said to have been chosen as it is at least half the time as a MSAP and they use wood chips as the bulking agent.

Pasco’s facility that Merrell Bros. worked on was a source of comparison to a potential regional composting facility due to the sizing. A composting facility for the same intake would be about \$12 million. The long-term O&M costs associated with a composting facility are expected to be significantly higher, as well as more odor concerns. Considering Merrell Bros. process, a composting facility sized to serve 50,000 dry tons/yr like Pasco is expected to be approximately 40 acres (Figure 5), whereas HFC AWTP alone could be approximately 10 acres.



*Figure 5: Acreage required for Composting and Solar Thermal [Pasteurization] per dry tons/year.*

The information regarding potential build sites, ownership models, and regional partnership opportunities, gathered through ongoing discussions with Hillsborough County, will be explored in greater detail under the Section 5.5.1 as it is highly relevant to the feasibility of both composting and thermal processing options.

### 5.3.3 Temperature-Phased Anaerobic Digestion

HFC AWTP operates seven mesophilic digesters, maintaining temperatures between 95°F to 100°F. However, these digesters are in poor to moderate condition and will need extensive and costly upgrades. Given the need for investment, redesigning the digester system to incorporate TPAD presents a more advantageous alternative. In this system, biosolids are first processed in thermophilic digesters at temperatures of 122°F to 140°F before moving to the remaining mesophilic digesters, offering substantial benefits in biosolids quality and operational efficiency (EPA, Types of Anaerobic Digesters 2024).

The primary advantage of TPAD is its ability to produce Class A biosolids through enhanced pathogen reduction (R. Iranpour 2006). EPA 40 CFR Part 503 regulations require fecal coliform density to be below 1,000 MPN/gram dry solids or salmonella density to be under 3 MPN/4 grams dry solids at the time of hauling and application (EPA, A Plain English Guide to the EPA Part 503 Biosolids Rule 1994). Research indicates that most pathogens cannot survive above 131°F for more than four hours, making TPAD an effective method for meeting stringent pathogen limits (V. Riau 2010). Unlike

conventional mesophilic digestion, TPAD optimizes the digestion process by separating the acidogenesis stage from methanogenesis, leading to greater volatile solids reduction and consequently higher methane production (V. Riau 2010). The increased methane production can then be captured and reused to offset the energy requirements of heating and/or pumping using the CHP on-site if repaired. Thermophilic digestion followed by mesophilic digestion also improves dewatering properties which will lead to less biosolid mass and lower hauling costs (V. Riau 2010).

Estimates for volatile solids destruction and biogas production vary across studies. A technical memorandum of the HFC AWTP authored by McKim & Creed and Hazen and Sawyer estimated that converting to TPAD would increase volatile solids destruction from 58% to 60% (+ 3% increase) and biomethane production from 367 cubic feet per minute (cfm) to 378 cfm (+3% increase) (McKim&Creed 2018). A 2014 study comparing the biogas production between thermophilic and mesophilic digesters found that thermophilic digestion yielded 5% to 7% more biomethane when treating a mixture of cow manure and dog food, which was designed to mirror influent qualities of a wastewater treatment plant (R. Labatut 2014). Finally, a lab-scale study using wastewater from a treatment facility in Spain found that a TPAD system of 3 days thermophilic and 15 days mesophilic achieved 87% VSR (V. Riau 2010). Further study and analysis of existing full-scale TPAD operations will need to be conducted to better understand realistic VSR rates and biomethane production rates for HFC AWTP.

TPAD does have its drawbacks. Thermophilic digestion is more sensitive to fluctuations in temperature, volatile solids concentrations, and nutrient/metal concentrations compared to its mesophilic counterpart. Spikes in the influent of any of these variables can have severe inhibitory effects on the microbes that facilitate the digestive process (R. Labatut 2014).

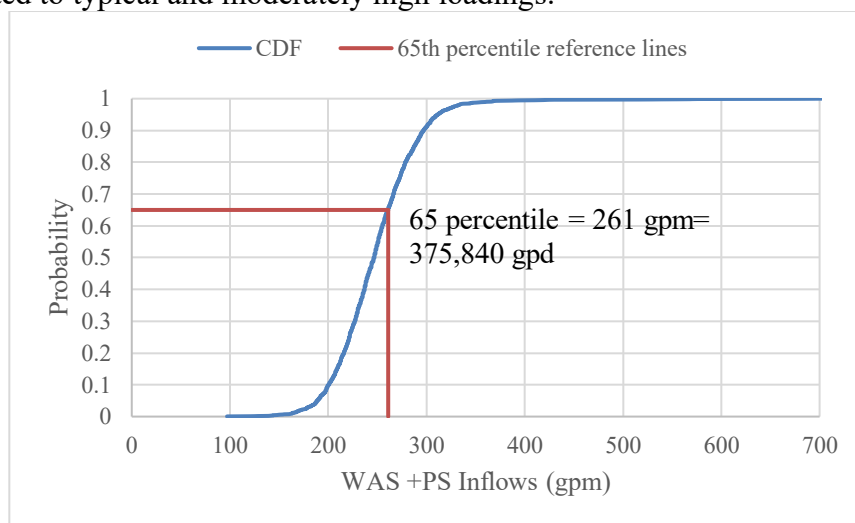
Another major concern with TPAD is ammonia inhibition and propionate accumulation. Thermophilic digestion releases high levels of free ammonia ( $\text{NH}_3$ ), which is toxic to methanogenic archaea (S. Sung 2003). In a two-phase system, methanogenesis is intentionally suppressed in the thermophilic stage to enhance hydrolysis and acidogenesis. However, if excessive ammonia carries over to the mesophilic phase, it can inhibit methanogenesis, preventing the breakdown of volatile fatty acids like propionate. This can lead to process instability, pH drops, and reduced methane production (J. Yang 2024).

Despite these challenges, TPAD remains a strategic long-term investment for HFC AWTP. Working within the plant's existing rehabilitation plans, TPAD could be implemented with an additional 2 MG of digester storage. While upfront costs are higher due to the need for additional digesters and increased maintenance, the long-term benefits may outweigh these expenses. Achieving Class A biosolids reduces regulatory restrictions, expands opportunities for reuse, and may lower disposal costs. Additionally, as biosolids regulations become more stringent, TPAD provides future compliance, preventing costly retrofits down the line. Given the inevitability of digester upgrades, investing in TPAD appears a prudent choice—one that enhances efficiency, sustainability, and regulatory readiness. For organization purposes, TPAD design and implementation is expanded upon on Section 5.4.

## 5.4 Implementation of TPAD

The first step in designing digester volumes for a TPAD system is to obtain flow data and set minimum HRTs. Monthly average digester inflow data from the HFC AWTP spanning January 2020 to December 2024 was analyzed. A cumulative distribution function (CDF) was developed from this dataset to assess the probability distribution of flows (Figure 6).

The 65th percentile flow value—261 gallons per minute (gpm) or 375,840 gallons per day (gpd)—was selected for design. This percentile represents a sustained high-flow condition, aligning with Metcalf & Eddy’s recommendation that “loading criteria are based generally on sustained loading conditions...typically peak 2-wk or peak mo[nth] sludge production” (Metcalf & Eddy 2014). A higher percentile was chosen over the median to strike a balance between realism and resilience: it is conservative enough to account for expected future increases in sludge production from population growth or stricter regulations yet avoids the unnecessary costs of designing for rare peak events (e.g., the 90th or 95th percentile). Selecting the 65th percentile supports a robust, cost-effective design suited to typical and moderately high loadings.



*Figure 6: Probability of digester flows using the 65th percentile.*

Next, appropriate HRTs must be selected for the TPAD process. Although TPAD has the potential to produce Class A biosolids, the U.S. EPA has not yet published specific HRT requirements for this configuration. As a result, HRT targets were selected based on a combination of related regulatory guidance, literature review, and precedent from comparable facilities.

HRT targets were selected based on a combination of regulatory guidance, literature review, and precedent from comparable facilities. For the thermophilic phase, EPA guidance for aerobic digestion recommends a minimum 10-day HRT to achieve sufficient pathogen reduction. While TPAD is an anaerobic process, this standard offers a conservative and widely accepted benchmark for the thermophilic stage.

The EPA recommends a 10-day HRT for thermophilic aerobic digestion (EPA, A Plain English Guide to the EPA Part 503 Biosolids Rule 1994). The mesophilic phase, while less critical for pathogen destruction, contributes to process stability and additional VSR. An EPA handbook on anaerobic digestion mentions a 10-day mesophilic HRT following a 5-day thermophilic HRT is theoretically sufficient to produce Class A biosolids

(EPA, Biosolids Technology Fact Sheet, Multi-Stage Anaerobic Digestion 2006). However, a broader literature review suggests an HRT of 15-25 days is more common.

To validate these assumptions, SustainaCore reviewed design plans from the East Central Regional Water Reclamation Facility in Palm Beach, Florida. This facility converted from aerobic digestion to TPAD in 2018 and selected a 10-day thermophilic and 20-day mesophilic HRT, for a total of 30 days at average flow. Given its geographic and operational similarity to HFC AWTP, it provides a valuable point of comparison.

Based on this evidence and to address potential concerns about underloading, SustainaCore recommends a 10-day thermophilic and 15-day mesophilic HRT. This approach balances regulatory confidence, operational flexibility, and improved volatile solids loading rates (VSLR) performance while reducing capital costs. It also preserves the ability to meet Class A biosolids standards and allows for future expansion, should sludge volumes increase over time.

With values for flow rate and HRT, the required total volumes for thermophilic and mesophilic digestion can be calculated according to equation 1.

$$V = Q\theta$$

*Equation 1.*

Where V=Volume, Q=Flow rate, and  $\theta$ = HRT (Equation 1) displays the calculated total volumes for thermophilic and mesophilic digesters.

*Table 5. Required Minimum Digester Volumes*

<b>Total Thermophilic Volume (gal)</b>	<b>Total Mesophilic Volume (gal)</b>
3,758,400	5,637,600

The HFC AWTP currently plans to demolish all existing digesters except Units 6 and 7, which are in better structural condition and have a combined capacity of 4.9 million gallons (MG). SustainaCore recommends supplementing this volume by constructing three new anaerobic digesters, each with a 35-foot sidewater depth. Minimum required volumes were calculated based on the 10-day thermophilic and 15-day mesophilic HRTs, then reverse-engineered to yield digester diameters. These calculations indicated that two 100-foot diameter thermophilic digesters and one mesophilic 60-foot diameter mesophilic digester would meet volume targets.

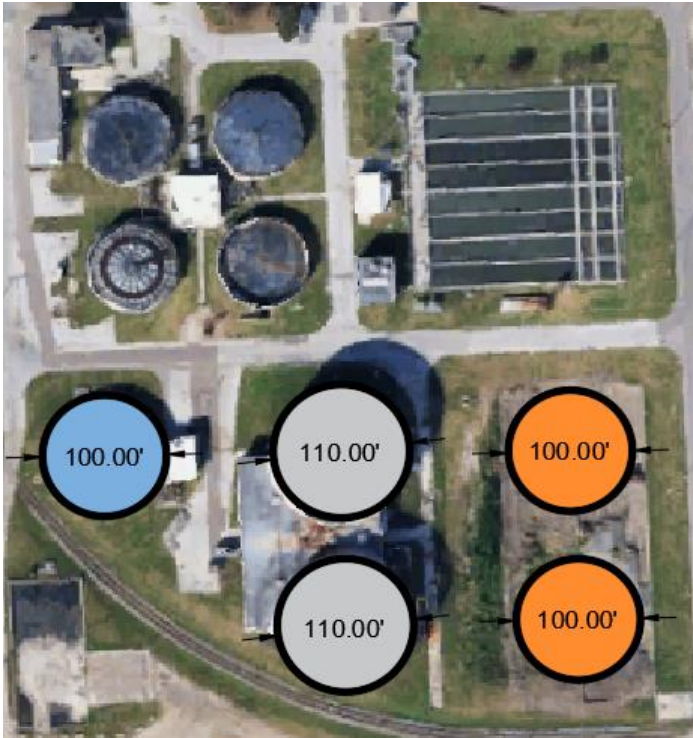
Despite the smaller theoretical requirement for the mesophilic stage, SustainaCore recommends constructing all three digesters at a consistent 100-foot diameter to simplify construction. The resulting volumes are listed in Table 6.

*Table 6. Thermophilic and Mesophilic calculated digester capacities.*

<b>Thermophilic Capacity (gal)</b>	<b>Mesophilic Capacity (gal)</b>	<b>Total Capacity (gal)</b>
4,112,345	6,956,172	11,068,517

The proposed layout for the new digesters is illustrated in Figure 7, which was developed in AutoCAD to provide accurate spatial dimensioning. The two thermophilic digesters (shown in orange) will be constructed adjacent to one another on the northern portion of the designated site. The new mesophilic digester (shown in blue) will be located west of the existing mesophilic digesters (Units 6 and 7, shown in grey). This layout

preserves the land east of the existing units for future expansion or alternative uses. The configuration aligns with existing utility corridors, maintains logical process flow direction, and minimizes the need for additional piping or site regrading. The color-coding in Figure 7 facilitates clear identification of digester function and staging.



**Figure 7: TPAD Layout**

Once design volumes are set, HRTs should be recalculated. HRTs are calculated by dividing the design volume of each stage by the median digester inflow of 355,680 gallons/day.

**Table 7. Calculated HRTs**

Calculated HRTs	Days
<b>Thermophilic</b>	<b>11.56</b>
1 Thermophilic OOS	5.78
<b>Mesophilic</b>	<b>19.56</b>
1 Mesophilic OOS	12.67
<b>Total</b>	<b>31.12</b>

To evaluate digester loading, the VSLR was calculated using 2024 sludge characteristics and median daily flow. Sludge samples averaged 4.48% total solids, with 83.37% volatile solids. Based on a median flow of 355,680 gpd, the volatile solids

mass input was estimated and divided by the digester volume to determine the organic loading rate.

For the mesophilic stage, the incoming volatile solids mass was adjusted to account for degradation in the thermophilic phase. Literature suggests that 45% VSR can be achieved in thermophilic digestion; meaning only 55% of the original volatile solids proceed to the mesophilic phase.

**Table 8. Volatile Solids Loading Rates for TPAD**

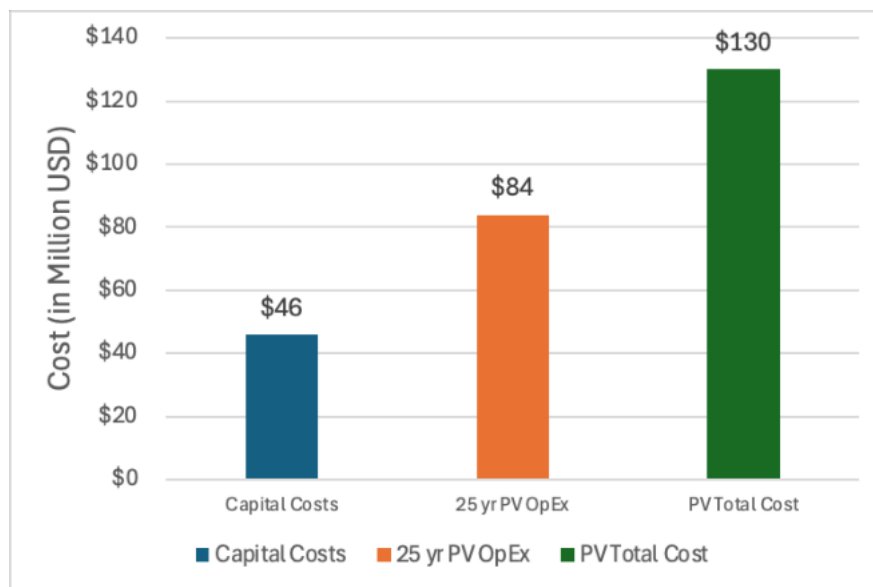
	VSLR lb. VS/ft <sup>3</sup> /day	VSLR lb. VS/1000ft <sup>3</sup> /day
Thermophilic	0.20135	201.35
Mesophilic (after 45% VSR)	0.06545	65.45

To further optimize the performance of the mesophilic digesters, SustainaCore recommends evaluating the feasibility of co-digestion with fats, oils, and grease (FOG). Given the currently low VSLR of 65.45 lb. VS/1000ft<sup>3</sup>/day in the mesophilic phase, the system has sufficient organic and hydraulic capacity to accommodate additional high-strength organic waste. Co-digesting FOG can significantly increase volatile solids loading and biogas production, helping to recover unused capacity and improve process economics. The TPAD configuration is particularly well-suited to FOG co-digestion, as the

thermophilic phase facilitates the breakdown of lipids, while the mesophilic phase provides stability. A phased approach to implementation, with careful monitoring of process parameters, would allow the facility to realize these benefits while minimizing operational risk.

### 5.4.1 Cost Estimation

Figure 8 presents the 25-year cost estimate for implementing the proposed TPAD system at HFC AWTP. Calculations are expanded upon in Appendix Table I 1.



*Figure 8: TPAD Cost Estimation*

The estimated total capital cost is approximately \$46 million. Over a 25-year lifecycle, present value operations and maintenance (O&M) are projected at \$84 million, bringing the total cost to approximately \$130 million. Cost estimates were adapted from a 2018 feasibility report by McKim & Creed and adjusted to reflect current digester sizing and layout. Consumer Price Index (CPI) inflation was applied for cost escalation instead of the ENR Construction Cost Index (CCI), as CPI yielded a more conservative estimate.

## 5.5 Solar Thermal Pasteurization

STP is a proprietary technology that was created by Merrell Brothers Incorporated (Merrel Bros.), who has been successfully managing and recycling biosolids since 1982. They have developed a patented system that integrates principles of greenhouse drying and oven/belt drying, ultimately producing a Class AA product that becomes FloridaGreen® Fertilizer, an approved State Class AA fertilizer. The company services 64 wastewater facilities in Florida, their biggest clients being Miami-Dade county and JEA, and offering various services such as dewatering, STP, composting, double drum drying, tracked biosolids transportation, and others.

To inquire about the services and products, SustainaCore conducted a meeting on March 31, 2025, with Blake Merrell, Chief Operations Officer at Merrell Bros. Blake

Merrell was able to inform the team more about their operations across the United States regarding STP and composting.

Merrell Bros. combines two proprietary technologies called solar-thermal pasteurization and double-drum drying, which prioritizes energy efficiency to obtain significant volume reduction in Class AA treatment levels. SustainaCore was advised to investigate into the company after one of its members witnessed their operations after visiting JEA’s Blacks Ford Water Reclamation Facility in St. Johns County; it was later mentioned by one of the mentors.



**Figure 9: Norris Thermal Technologies pasteurization building used by Merrell Bros (Merrell 2019).**

STP starts when biosolids are transported to the fully enclosed greenhouses, where conditions are controlled, and large ceiling fans stir the air to aid in removal of moisture. When biosolids arrive, they are expected to be at a 15-20% TS, which is suitable for HFC with their biosolids being at an average of 17% TS. In the greenhouse, the ultraviolet (UV) intensity and the

evaporation reduce volume, while the 8-to-12-inch layer of biosolids is tilled once a day to move the dry and crusted material underneath to promote further drying. The material is transferred from the greenhouse into the processing building, which is equipped with a belt conveyor system that moves the biosolids into a stainless-steel hopper. From there, the biosolids are conveyed into a two-part dryer (Figure 9) consisting of a heat up chamber and a pasteurization chamber. To meet pasteurization standards and PFRP, the material must maintain a temperature of at least 157°F for a minimum of 30 minutes, as shown in Figure 9 with data from the probes. The process begins with biosolids entering the dryer at

approximately 50% solids content. As they move through both chambers, the material is gradually heated and dried, reaching up to 75% solids by the end of the process. The heat up chamber serves to bring the temperature of the biosolids up to 107°F before it arrives to the pasteurization chamber, where temperature probes read the internal temperature of the material to ensure it is at 158°F. This controlled thermal treatment provides effective pathogen reduction and significantly reduces the



**Figure 10: Belt press probe testing to monitor temperature above 158°F (Merrell 2019).**

volume of the final product—resulting in only about one-fifth of the original input. For instance, 50,000 tons of raw biosolids can be reduced to approximately 9,000 tons of Class AA biosolids ready for beneficial reuse.

At the end of the process, the pasteurized material is discharged via conveyer belt into a covered fertilizer bunker, where the material can be stored for 21 days. Merrell Bros. has undergone the necessary patenting, regulation, and state registration for their technologies and Class AA fertilizer, FloridaGreen®. The fertilizer is part of the BioPreferred Program, which is managed by the U.S. Department of Agriculture (USDA) to promote the use of biobased products (United States Department of Agriculture 2018).

Additional processes can be added to improve product quality and efficiency. An extractor helps homogenize material for more consistent drying after the greenhouse. A pelletizer can transform the heat dried biosolids into pellets, preferred by large agricultural buyers using commercial spreaders.

The design for HFC AWTP draws on the Pasco County Biosolids Facility, detailed in Appendix L: Summary of Pasco County Biosolids Facility. Notably, the facility operates at a large scale with only five staff members—an appealing model for HFC AWTP given the client’s emphasis on minimizing staffing requirements. Additionally, because the facility processes digested WAS, odor generation is significantly lower than facilities handling raw sludge. As HFC has received multiple odor complaints recently (March and April of 2025), this is another benefit to integrate the technology (City of Tampa 2025) (Lynden 2025). Section 5.5.1 expands on the contracting of Merrell. Bros.

#### **5.5.1 Merrell Bros. Treatment Facility: Composting and STP**

Merrell Bros. can be contracted for the design/build (DB) of a facility, or the operations of either composting or STP operations. As the process to integrate these into HFC AWTP is similar, this section discusses the design and implementation of both. Additionally, a regional biosolids treatment facility refers to the option of creating a partnership between the City of Tampa and Hillsborough County to treat regional biosolids via composting or STP.

The first potential site for either STP or composting could be at the HFC AWTP drying beds, which comprises 14.5 acres (Figure A 1). While this could significantly reduce transportation costs, there is a higher concern for odor control that may not be able to sustain both options or more specifically composting. Additionally, this option would make the facility 100% plant owned. Another issue could be that it reduces the redundancy of the drying/dewatering process, however, there are three centrifuges with not all in use and Merrell Bros. offers a mobile dewatering service (belt press and centrifuge). This option would make the facility 100% plant-owned, having both benefits and drawbacks. HFC AWTP would be responsible for managing and operating the facility but would be able to offset costs by ‘leasing’ out the space in the facility to smaller neighboring municipalities such as Sarasota, Lakeland, or Plant City who would pay tipping fees.

For the second potential build site, South of the Southeast Hillsborough County Landfill, there is a property of 200 acres completely owned by Hillsborough County for the purpose of developing their One Water Campus (Hillsborough County Florida 2025). The main purpose is to create a regional wastewater treatment system to enhance resilience in the South-Central part of Hillsborough County. There is already an 18.5 MGD advanced wastewater treatment facility (AWTF) slotted to be operational in 2027. It is also known as the South County One Water Campus AWTF (SCOWC AWTF). This option would require the facility to be oversized to intake from neighboring facilities. This could be beneficial to HFC AWTP, as the other facilities would need to pay a fee to use it. Figure



**Figure 11: Map of Hillsborough County's site proposal for SCOWC AWTF and One Water Campus (Hillsborough County Florida 2022).**

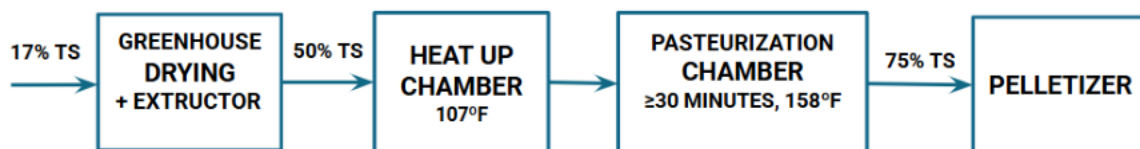
11 shows a map of the planned facility that was shared to the public, showing the proximity between the Southeast Hillsborough County Landfill, and the proposed location of the One Water Campus including SCOWC AWTF (Hillsborough County Florida 2022).

A meeting with Hillsborough County has been scheduled to discuss a proposal for a partnership with HFC AWTP and Merrell Bros.

Previously, they had been contacted regarding their existing composting site, however, the One Water Campus has potential to be a feasible location. Whether they would prefer an STP or composting facility at a regional scale has yet to be discussed. Composting may be better if there is more of a relationship with taking in yard waste as a bulking agent whereas STP may be more efficient at processing and operations.

## 6 STP Design

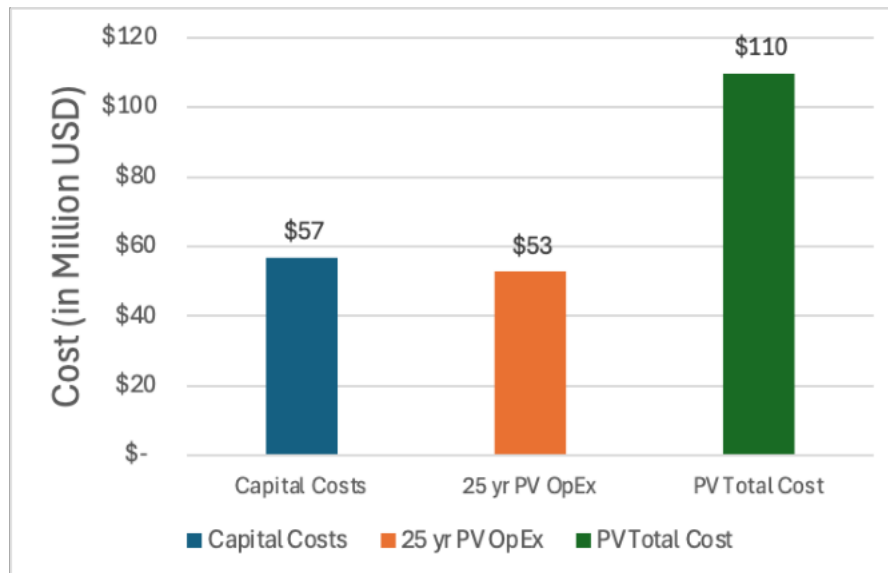
The STP implementation into HFC was designed using the process flow diagram in Figure 12, adding an extractor and a pelletizer. Figure 12: Solar Thermal Pasteurization system process.



**Figure 12: Solar Thermal Pasteurization system process.**

At HFC AWTP, the final design will be sized with a 20% increase in capacity as a buffer. That is a 5-acre facility to handle 67,671 wet tons per year (WTPY) and 11,504 dry

tons per year (DTPY). The following cost estimate was developed for 19 odor control towers, 2 tractors and tillers, 2 extractors, and 2 pelletizers.



*Figure 13: Costing for Solar Thermal Pasteurization.*

## 7 Evaluation of Alternatives

### 7.1 Comparative Analysis and Summary

Prior to evaluating the alternatives using a weighted sum model (WSM), fatal flaws were used as the method for elimination. The current biosolids management is unsustainable due to its lack of future compliance and was therefore moved from an alternative to a comparative baseline for the WSM. The next alternative evaluated was landfill disposal, which is hindered by limited availability in Hillsborough County, high costs, and reduced opportunities for beneficial reuse. Heat drying was another technology that was eliminated as it faces high operational and energy costs, with HFC AWTP's infrastructure decommissioned in 2012. Acid-gas phased anaerobic digestion was considered briefly, however, it struggles to consistently produce Class A biosolids and requires complex chemical handling. Gamma ray radiation was eliminated due to the high-energy exposure needed for disinfection and is impractical due to stringent U.S. regulations and significant risks. Solar drying has been redirected toward solar thermal pasteurization technology evaluated in the WSM. Lastly, lime stabilization, involving CaO and Ca(OH)<sub>2</sub> additions, increases biosolids mass, reduces volatile solids, elevates soil pH, and necessitates hazardous material transport.

### 7.2 Weighted Sum Model Evaluation

SustainaCore developed a WSM, (Table 9) to evaluate the remaining three alternatives against the current baseline with seven key criteria. Data was gathered for the numerical categories such as footprint (acres) and cost (\$) then interpolation was used as needed. The other categories had a clear ranking system used to define the appropriate rating. The weighting was determined by prioritizing cost for the plant but also the benefits that could offset this. The highest rating was reserved for cost, more specifically capital cost, as that

is what can really be the barrier to implementing a solution. One of the lowest rated is footprint as there are many options to remedy this and sustainability as it is incorporated into achieving a higher class of biosolids and the opportunities for reuse that arise from that. Criterion for the WSM is explained in Section 5.1, with more detail included in class achieved, ease of operation, proven technology, and sustainability as these are qualitative.

1. **Class Achieved:** The top rated in this category is Class AA as it would meet Florida’s standards. Then 5.5 is for Class A and Class B, the least desirable, is rated at 1.
2. **Ease of Operation:** Measures the complexity of daily operations, with a preference for alternatives requiring fewer personnel and less maintenance. Simpler, more automated solutions score higher. This rating system was done through the level of complexity of the technology. For example, solar thermal is a well-known technology and only requires 5 employees on staff.
3. **Proven Technology:** Ratings 1-3 were for those that have not been implemented in the U.S. with 1 not being successful and 3 being successful. Success in other states garnered a rating between 4-7 while success in other Florida facilities scored 8-10.
4. **Sustainability:** Ratings 1-3 were given to alternatives that had limited biosolids reuse and no byproduct reuse (flaring biogas). 4-7 signifies that biosolids and byproducts (biogas) are being re-used but not 100%.

The highest scoring is solar thermal as it has a proven track record of producing high quality biosolids with a low O&M cost. There is also a reduction in mass during this process that is desirable given that it reduces what is needed to handle. Composting closely follows; however, it is more it takes more to operate that kind of facility daily and requires a larger footprint. While TPAD is a few points below the baseline, due to the cost, the 0.5 difference could be justified due to the opportunities producing Class A could bring to the plant. Pyrolysis has been completely ruled out with the lowest score. It has extremely high costs overall and has the highest risk due to its limited proven implementation.

*Table 9. Weighted Sum Model*

Criteria	Class Achieved	Footprint	Capital Cost	25-yr O&M Cost	Ease of Operation	Proven Technology	Sustainability	
Alternative/Weight	25%	5%	25%	15%	10%	15%	5%	Score
Upgraded Mesophilic	1.0	10.0	9.1	6.6	10.0	10.0	3.0	6.7
Pyrolysis	5.5	9.3	1.0	10.0	5.0	4.0	10.0	5.2

TPAD	5.5	8.3	8.3	1.0	7.0	8.0	5.0	6.2
Composting	10.0	4.5	10.0	6.8	2.0	10.0	3.0	8.1
Solar Thermal	10.0	1.0	7.8	7.2	8.0	10.0	7.0	8.2

Based on the evaluation of WSM criteria, STP was selected as the preferred alternative for implementation.

## 8 Conclusions and Recommendations

### 8.1 Final Recommendation

SustainaCore suggests ensuring long-term sustainability, regulatory compliance, and Class AA biosolids production, by recommending the City of Tampa explore the implementation of Solar Thermal Pasteurization modeled after the FloridaGreen® Merrell Brothers Biosolids Fertilizer Facility. This method combines greenhouse drying and oven/belt drying to produce fertilizer-grade biosolids with significant odor control, hauling reductions, and marketable end-use opportunities. Proposed and design parameters are detailed in Table 10. Proposed Design Overview for HFC AWTP and Table 11. Scaled Design Overview for HFC AWTP.

The treatment process proceeds as follows:

- **17% Total Solids (TS)** → *Greenhouse Drying + Extractor*
- **50% TS** → *Heat-Up Chamber (107°F)*
- **≥158°F for ≥30 minutes** → *Pasteurization Chamber*
- **75% TS** → *Pelletizer*

This method achieves a **5:1 reduction ratio**, meaning five trucks of dewatered biosolids are converted into a single truckload of dry, pelletized fertilizer. This substantially reduces hauling demands and supports beneficial reuse goals.

The FloridaGreen®-style facility is designed to be modular, odor-controlled, and operator-light while processing up to 50,000 dry tons per year (DTPY). The system's footprint and operational requirements are suitable for Tampa's climate and biosolids output levels. A summary of the proposed design parameters is presented below:

*Table 10. Proposed Design Overview for HFC AWTP*

<b>Parameter</b>	<b>Design Value</b>
Treatment Capacity in Tons	32,000–50,000 DTPY
Land Requirement	14 acres
Odor Control Infrastructure	20 towers
Operational Staffing	5 trained operators

Final Product	Class AA biosolids pellets
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Our scaled design for HFC AWTP is based on projected biosolids output and a 20% capacity increase.

*Table 11. Scaled Design Overview for HFC AWTP*

Parameter	Design Value
Annual Wet Tons Processed	67,671 WTPY
Annual Dry Tons Processed	11,504 DPTY
Greenhouse Area Required	5 acres
Odor Control Towers	19 towers
Equipment	2 tractors + tillers, 2 extractors, 2 pelletizers

### **Potential Location Option 1: On-Site at HFC AWTP**

Located adjacent to existing operations, the Howard F. Curren site includes approximately 14.5 acres of available land, including underutilized drying beds. A FloridaGreen® system could be deployed within just 5 acres to treat 11,504 DPTY, with additional space available to scale capacity to approximately 34,000 DPTY. Merrell Brothers also offers mobile dewatering equipment, providing redundancy in the event of maintenance shutdowns or capacity fluctuations.

- Available Land: 14.5 acres
- Initial Treatment Footprint: 5 acres
- Expandable Capacity: Up to 34,000 DPTY
- Backup: Mobile dewatering available

### **Potential Location Option 2: Off-Site – One Water Campus (Opening 2027)**

The One Water Campus is a future regional advanced water treatment facility spanning 200 acres and designed to treat 18.5 MGD. A partnership between the City of Tampa, Hillsborough County, and Merrell Brothers positions the site to handle biosolids for multiple regional utilities. Oversizing the Solar Thermal Pasteurization facility would support broader Class AA adoption and cost-sharing across jurisdictions.

- Total Area: 200 acres
- Planned Operation Date: 2027
- Regional Partners: Tampa, Hillsborough County, Merrell Brothers
- Role: Oversized facility serving multiple utilities

The FloridaGreen® system produces a pelletized Class AA biosolids product that may be marketed as commercial or agricultural fertilizer. This creates a viable revenue stream and reduces reliance on landfilling or incineration. Pasco County receives 60% of all fertilizer sales.

In addition to internal use, the facility can accept biosolids from nearby municipalities or private haulers. These entities would pay tipping fees for processing, generating supplemental revenue for the City of Tampa or the regional operating authority.

The next critical steps are as follows:

- **Regional Solar Thermal Facility Development**

- Initiate formal discussions between the City of Tampa, Hillsborough County, and Merrell Brothers to pursue a shared regional facility.
- **Vulnerability Assessment**
  - Assess the operational impacts and resiliency considerations tied to removing or repurposing existing drying beds.
- **Community Engagement**
  - Develop public-facing educational materials and host town halls or facility tours to build community support and awareness.

## 8.2 Future Considerations

The implementation of a STP system modeled after the FloridaGreen® Merrell Brothers facility represents a forward-thinking approach to Class AA biosolids production. Unlike anaerobic digestion, this method does not produce biogas, which simplifies the process but also removes opportunities for energy recovery through systems like CHP. While this reduces operational complexity and capital intensity, it also places a greater emphasis on optimizing other aspects of resource recovery—specifically, the beneficial reuse of the final pelletized product and reductions in hauling costs due to the process’s 5:1 volume reduction ratio.

Future assessments should continue to monitor advancements in complementary biosolids technologies, such as thermal energy recovery or integration with co-located renewable infrastructure (e.g., solar panel arrays) to offset operational energy needs at the site. Potential enhancements to odor control, greenhouse ventilation, and drying efficiency could further improve the system’s environmental performance.

Emerging regulatory concerns, particularly PFAS, remain a critical consideration. While STP does not destroy PFAS compounds, it aligns with current EPA and FDEP guidelines for producing land-applicable Class AA biosolids. Should stricter PFAS regulations be implemented in the future, the land application of biosolids—even if treated to Class AA standards—could be limited. This would directly impact the marketability and distribution of the pelletized fertilizer product.

At present, no widely adopted biosolids treatment method effectively removes PFAS. Technologies such as pyrolysis and advanced oxidation show promise but remain in the early stages of full-scale adoption. As such, any long-term investment in STP should include planning flexibility for potential downstream PFAS treatment, storage contingency plans, and ongoing monitoring of both regulatory developments and pilot programs related to PFAS destruction.

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## 10 Appendices

### 10.1 Appendix A: Site Visit Summary

- Location: Howard F. Curren Advanced Wastewater Treatment Plant
- Address: 2700 Maritime Blvd, Tampa, FL 33605
- Date: January 27th, 2025
- Time: 9:30 am - 11:30 am

#### Summary:

On January 27th, 2025, SustainaCore toured the Howard F. Curren Advanced Wastewater Treatment Plant. Our group was accompanied by three mentors: Dr. Karloren Guzman and Daniel Rivera from the City of Tampa, and Timothy Ware from Hazen and Sawyer.

Rob Decker, an experienced operator, led the majority of the tour, providing detailed insights into the plant's operations. He began by describing the pump stations used for odor control, followed by an overview of the screen and grit systems, gravity settling tanks, high-purity oxygen stations, diffused air reactors, and chlorine tanks. Tim Ware pointed out the decommissioned heat drying facility, as well as the inclusion of drains in chlorine tanks, as a lesson to keep the end user in mind. Later, the tour was handed off to operator Marcus McDougle, who focused on areas for biosolids.

At approximately 10:40 AM, Marcus McDougle brought us to the sludge storage tank area. Here, we observed both older and recently poured drying beds. These drying beds are utilized when there is an excess of sludge that cannot be stored in the tanks, which involves a 2-3 month drying process. The plant currently has a storage capacity of 30 storage hours, with five tanks available. The contents of these tanks are sent to a centrifuge facility, which comprises three distinct floors designed to process the material efficiently.

The top floor of the centrifuge facility houses three centrifuges, typically operated one at a time. Raw and diluted polymers are added and adjusted with torque modifications ensuring the sludge achieves the desired cake-like texture. The processed material is then passed through the second floor, where a conveyor transports it to a loading system. This system drops the sludge into trailers, each capable of holding up to 60,000 lbs. We also observed five trailers lined up, ready to be picked up by contractors that dispose of the sludge in landfills or agricultural lands.



Figure A 1. Process flow diagram of HFC AWTP (SustainaCore, 2025).

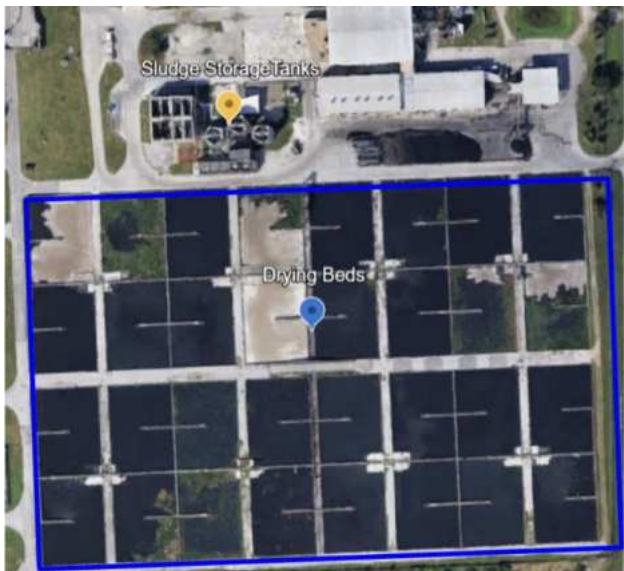


Figure A 2. Sludge Drying Beds (Google Earth, 2025)

## 10.2 Appendix B: Baseline Case: Mesophilic Digestion

Table B 1. Mesophilic Digester Upgrades

Mesophilic Digester Operational Volume (gal)		
Digester	2025	2028
1	837,760	X
2	837,760	X
3	837,760	X
4	X	X

5	1,600,000	X
6	2,450,000	2,450,000
7	2,450,000	2,450,000
8	X	2,450,000
9	X	2,450,000
<b>Total</b>	<b>9,013,280</b>	<b>9,800,000</b>



### Digesters

- 1 2 3 To be decommissioned 2028
- 4 Out of Service, 2025
- 5 To be decommissioned 2025
- 6 In use
- 7 To be rehabilitated 2025
- 8 9 To be completed 2028

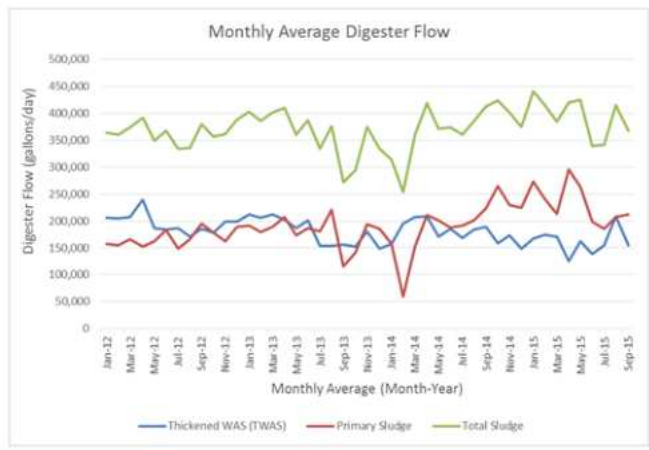
*Figure B 1. Upgrades from 2025-2028 to the Mesophilic Anaerobic Digestors (SustainaCore, 2025).*

*Table B 2. Existing Digester Volumes*

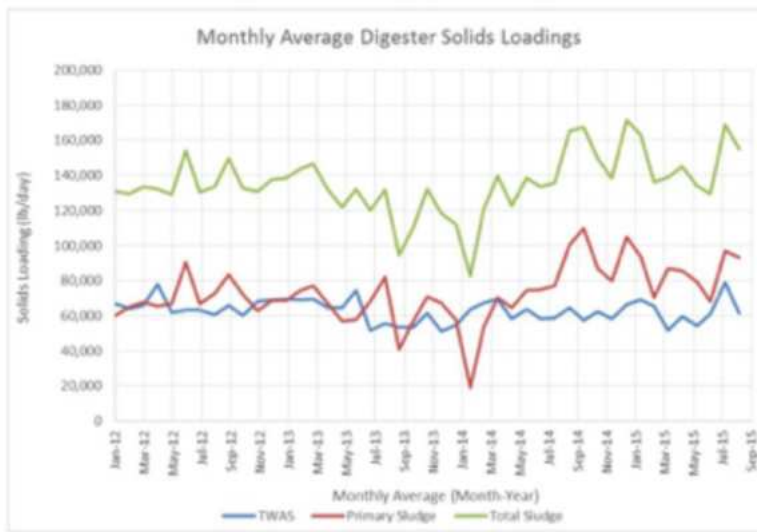
Digester	Volume (gallons)
1	837,760
2	837,760
3	837,760
4	860,000
5	1,600,000
6	2,450,000
7	2,450,000

*Table B 3. Present and Future Capacity*

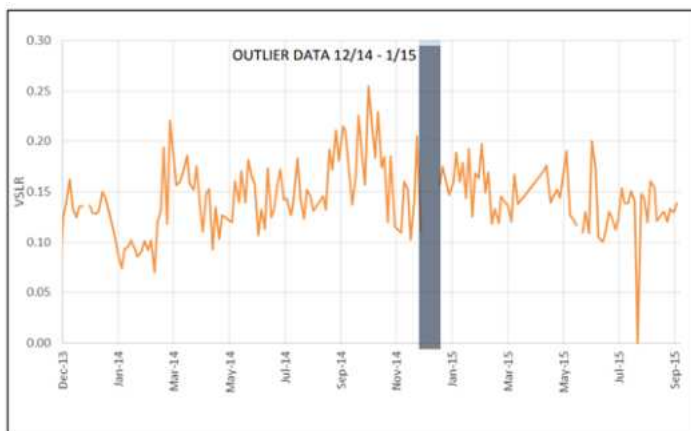
Present Max Capacity (gallons)	9,013,280
Future Planned Capacity (gallons)	9,800,000



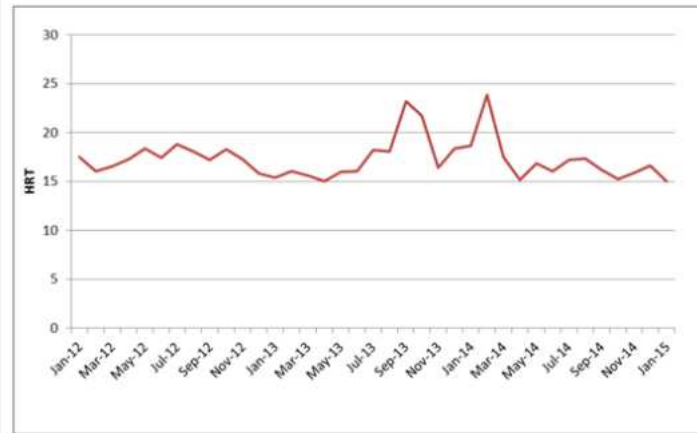
**Figure B 2. Historical volumetric solids production monthly data at the plant (HFC AWTP 2016).**



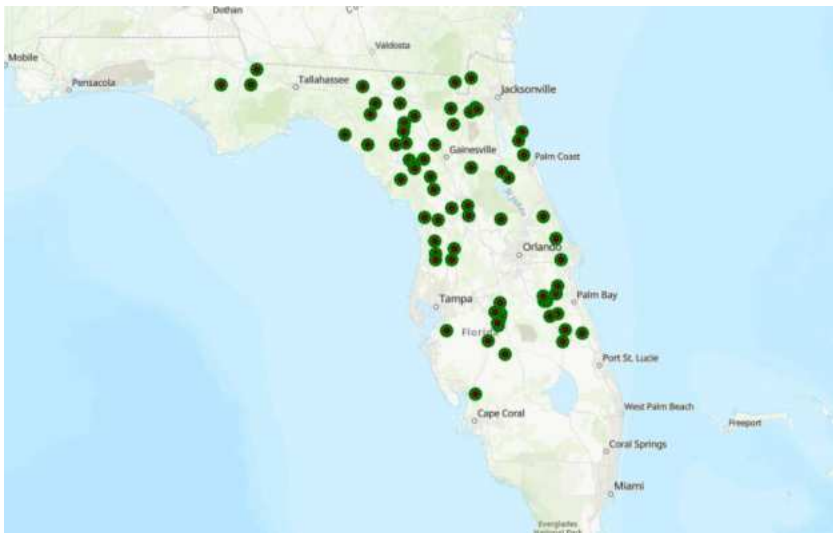
**Figure B 3. Historical mass solids production monthly data at the plant (HFC AWTP 2016).**



**Figure B 4. VSLR data for Digester (HFC AWTP 2016).**



*Figure B 5. HRT data for Digester 1 (HFC AWTP 2016).*



*Figure B 6. Sites throughout Florida that accepts Class B Biosolids (FDEP, 2023).*

### 10.3 Appendix C: Landfill Disposal



*Figure C 1. Landfill Disposal Process Flow Chart*

## 10.4 Appendix D: Acid-Gas Phased Anaerobic Digestion

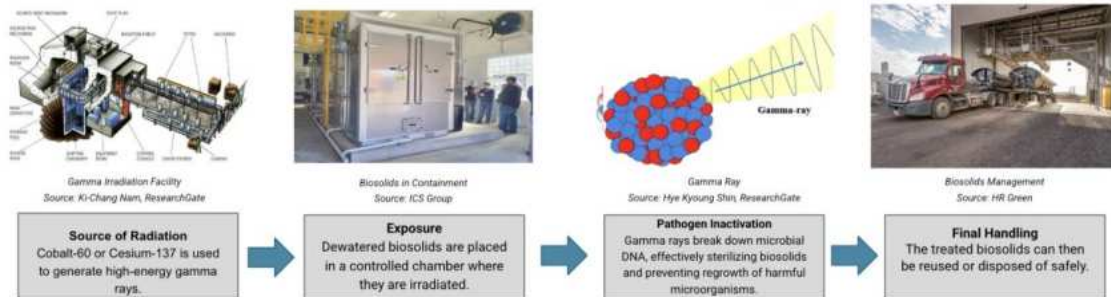


Source: Adapted from Google Earth 3/26/2023

1
4
5 Decommission    
 2
3 @ Acid-Gas  
6
7
8
9 @ Mesophilic

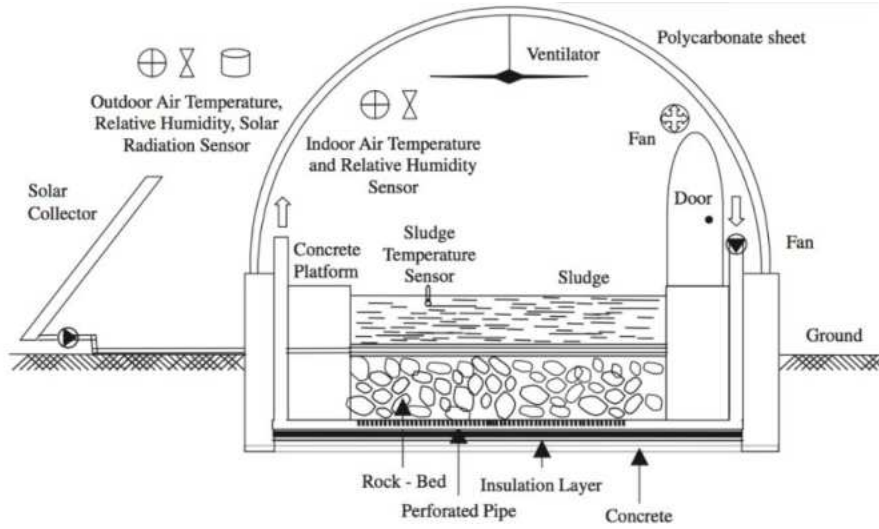
*Figure D 1. Potential Acid-Gas Digester Build Sites*

## 10.5 Appendix E: Gamma Ray-Radiation



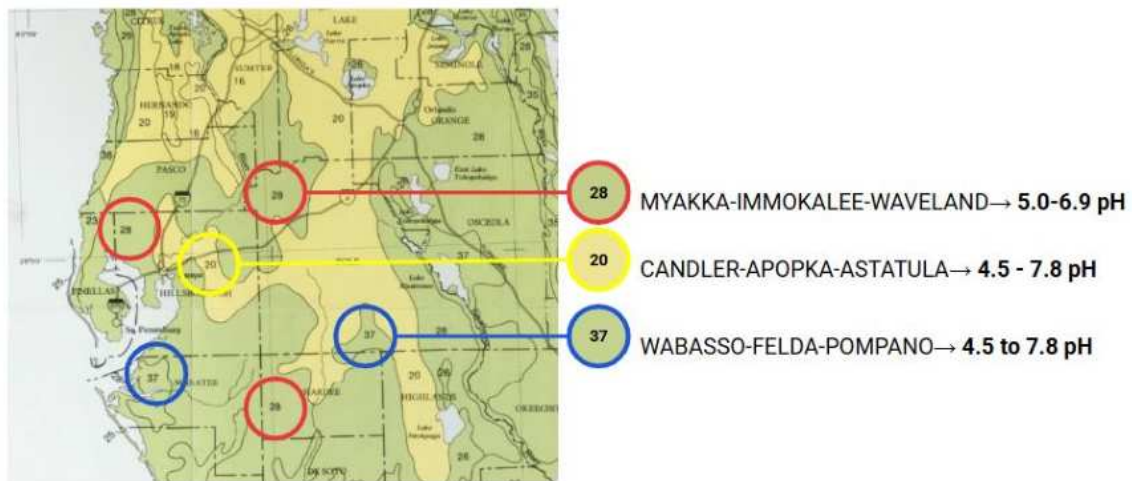
*Figure E 1. Gamma Ray Radiation Process Flow Chart*

## 10.6 Appendix F: Solar Drying



*Figure F 1. Typical solar drying system (Reis 2025) .*

### 10.7 Appendix G: Lime Stabilization



*Figure G 1. Potential Hauling Routes from Wastewater Facility to Landfill (SustainaCore, 2025).*

### 10.8 Appendix H: Pyrolysis

*Table H 1. Summary of Design Basis Assumptions For Pyrolysis Costing*

Design Parameter	Low	Mid	High
Dewatered biosolids load (dtpd)	2	6	10
Total solids (%TS)	25%	25%	25%
Evaporation rate (lb water/hour)	560	1,400	2,400
Number of dryers	1	1	1
Type of thermal dryer	Paddle	Paddle	Belt
Total solids of dried product (%TS)	90%	90%	90%
Pyrolysis/gasification unit capacity (dtpd each)	3	3	10
Number of pyrolysis/gasification units	1	2	1
Operating schedule	24 hours, 7 days/week		
Removal estimate for target PFAS	99.5%		

*Table H 2. AACE Cost Estimate Classification System*

ESTIMATE CLASS	Primary Characteristic	Secondary Characteristic		
	MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical variation in low and high ranges
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%




**Figure H 1. Pyrolysis Facilities in the US**


**Automation and Process Control**

The BioDryer machine integrates advanced industry 4.0 automation with IoT. With more than 40 sensors, the process is controlled with scientific precision in order to deliver maximum performance. The BioDryer's automated HMI can be accessed by a web-browser with secure local and remote access, allowing process control from any device like a smartphone, tablet, PC or Mac. The integrated data logging system records process data every second, generating charts and reports which can be used to analyze efficiency and perform predictive maintenance.


To facilitate integration with existing facilities, the BioDryer control system allows for SCADA connections with the most common protocols like ModBus and Profinet while also providing advanced and modern Restful API with JSON format.



**INDUSTRY 4.0**



© BioForce Corporation

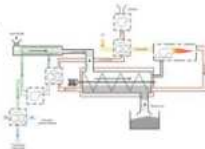


**Input:**

- Sludge is preferably dewatered to minimum 23% dry matter to obtain average balance
- After anaerobic digestion, the sludge dry matter is preferably >27%

**Output:**

- Raw bio biochar complying with Danish needs to soil fertil values
- Hot water 70-80°C to be used for local or district heating



**Capacity and size:**

HECLA® before 1000 treats ca. 1000 tonnes of sludge per year (on dry matter basis). The original single component measures approx. 3.5 x 9.5 m. The total size is 15.4 (2 x 4.2) m (L x W) x H including feeding and receiving systems. The total weight is 33 tonnes.

**Installation and access conditions:**

The process plant must be installed in a dry, frost-free, and closed room with fresh air ventilation, waterproof flooring with a load capacity of at least 1000 kg/m², and floor drains. The control cabinet must either be installed in a separate room or have independent ventilation for fresh air.

Ensure a free working space of approximately two meters around the entire facility. There must be access roads that allow the components of the system to be transported and mounted on the system.

**Key parameters (example):**

The system's capacity depends on the specific value and dry matter content of the biomass.

Parameter name	Value
Sludge	300 t/d
Feed rate, wet biomass	300 kg/d
Produced biochar	300 kg/d
Consumption	300 kg/d
Control panel	1 x 400 x 400

**Automation and operational monitoring:**

The process plant is automated with PLC control mounted in an independent control cabinet, with frequency conversions on all motor components. Via an internet connection, the system is monitored by AquaGreen with collection of all relevant sensor data and operating status parameters.

All operating data can also be made available via an interface to SCADA (Supervisory Control And Data Acquisition) systems.

**AquaGreen**

AquaGreen A/S  
Rise Huse 50, 8840 Rise, Denmark  
+45 53 640 888  
contact@aquagreen.dk  
www.aquagreen.dk

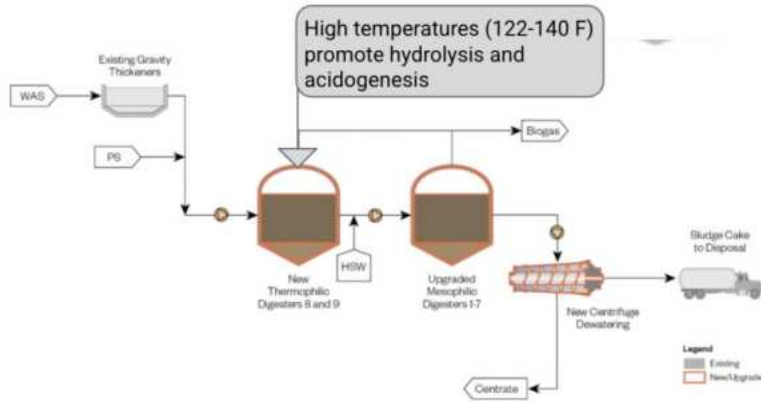
**Figure H 2. BioForceTech (Left) and AquaGreen (Right) Brochures Depicting Operational Details**

### 10.8.1 Calculation of Present Value of Operation Costs over 25 years

Using compound interest tables, with a discount rate of 3% over 25 years;

$$\begin{aligned}
 PV &= A \cdot (P/A, r, n) \\
 &= \$2.2M \cdot (P/A, 3\%, 25) \\
 &= \$2.2M \cdot 17.413 \\
 &= \mathbf{\$38.3M}
 \end{aligned}$$

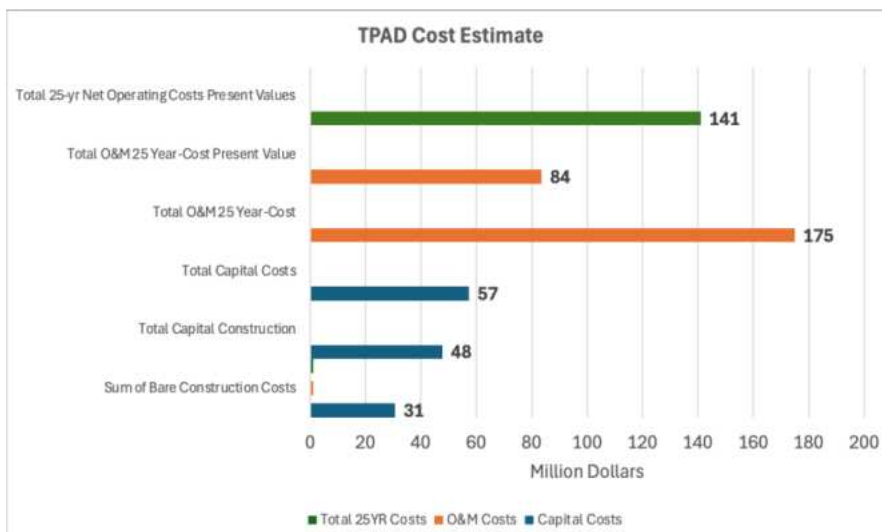
## 10.9 Appendix I: TPAD



*Figure I 1. TPAD Process Flow Diagram (Adapted from McKim and Creed and Hazen technical memorandum)*

*Table I 1. Capital and O&M Cost Breakdown for TPAD*

Item	Costs	Item	Life Cycle Costs
4 New 2 MG Digester Process Buildings	\$ 17,877,000.00	Anaerobic Digestion Costs	\$ 24,312,500.00
Total Capital Cost	\$ 6,706,000.00	Post Dewatering Cost	\$ 53,420,000.00
<b>Sum of Bare Construction Costs</b>	<b>\$ 24,583,000.00</b>	Hauling and Disposal Costs	\$ 58,665,000.00
30% Contingencies	\$ 7,374,900.00	O&M Labor Costs	\$ 38,450,000.00
Bare Construction Costs	\$ 31,957,900.00	Total O&M 25 Year-Cost	\$ 174,847,500.00
20% OH&P and GCs	\$ 6,391,580.00	<b>Total O&amp;M 25 Year-Cost Present Value</b>	<b>\$ 83,508,139.77</b>
<b>Total Capital Construction</b>	<b>\$ 38,349,480.00</b>		
20% Management and Engineering	\$ 7,669,896.00	<b>Total 25-yr Net Operating Costs Present Values</b>	
<b>Total Capital Costs</b>	<b>\$ 46,019,376.00</b>		<b>\$ 129,527,515.77</b>

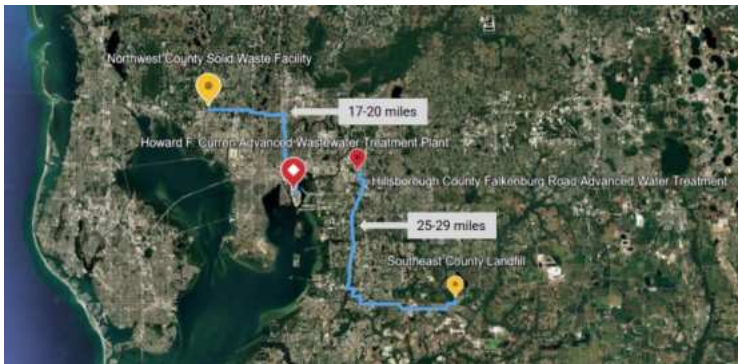


*Figure I 2. TPAD Capital costs estimated from McKim & Creed 2018 cost estimates and updated using CPI inflation.*

## 10.10 Appendix J: Composting

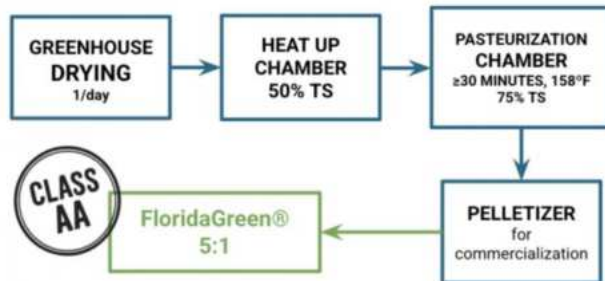
*Table J 3. Composting Methods*

Windrow	Aerated Static Pile	In-Vessel
<ul style="list-style-type: none"> <li>• Class A at 55°C for &gt;15 days/5 turns</li> <li>• Highly affected by weather</li> <li>• Proven at small scale</li> <li>• Large bulking agent needed</li> <li>• Adaptable to changes in biosolids/bulking agents</li> <li>• Low capital costs</li> <li>• Labor intensive</li> <li>• Large land area</li> </ul>	<ul style="list-style-type: none"> <li>• Class A at 55°C for &gt;3 days</li> <li>• Highly affected by weather</li> <li>• Proven at small/large scale</li> <li>• Large bulking agent needed</li> <li>• Adaptable to changes in biosolids/bulking agents</li> <li>• Wide-ranging capital costs</li> <li>• Moderate labor requirements</li> <li>• Large land area</li> </ul>	<ul style="list-style-type: none"> <li>• Class A at 55°C for &gt;3 days</li> <li>• Minimally affected by weather</li> <li>• Short operating history</li> <li>• Less volume of material needed</li> <li>• Sensitive to changes in biosolids/bulking agents</li> <li>• High capital costs</li> <li>• Not labor intensive</li> <li>• Small land area</li> </ul>



*Figure J 3. Potential Hauling Routes from Wastewater Facility to Landfill (SustainaCore, 2025).*

## 10.11 Appendix K: Solar Thermal Pasteurization



*Figure K 1. Solar Thermal Pasteurization Process Flow Diagram (Merrell Bros® proprietary biosolids treatment technologies)*

### 10.11.1 Meeting Notes with Blake Merrell from Merrell Brothers Incorporated

Meeting time and date: March 31, 2025, 4:00 PM - 5:15 PM EST

Attendees: Blake Merrel, Charles Vancura, Isabella Guzaldo, Adriana Mayr

Solar thermal process - Pasco

- 2-step process
- Greenhouse better than drying beds
- Evaporate more, percent solids improve
- Shed rain events
- Class A just solar drying, there is a plateau at 50 % with goal being 90 slow down way longer
- **1st step**
- Just like a drying bed, no additives, till with a tractor every morning
- 8 inches deep to 12 for the bed
- **2nd step**
- Belt oven
- Quiznos (pizza) sub oven basically to get to 107 degrees for like 30 min to meet pasteurization
- Gravity drops to 1st story and conveys pace no faster than 34 min
- Percent solids plateau in greenhouse, it's fine because 20-25%. 75% solids?
- **1/5 (1 truckload is exiting)**

Extractor (new material )

- After greenhouse
- Homogenize
- Cooks the same to be more efficient in the oven

Pelletizer

- Additional mill comparable to morganite
- **Buyers are agricultural if no pelletizer because sheets**
- **Sugar cane, citrus = big commercial spreader**
- Need for pelletization (in Pasco now to add customers) - open in april
- Can put additives more synthetic nutrients to balance

Map:

- Service area 64 wastewater facilities
- Trucks are tracked

Composting is different than what is going on in pasco

- Composting vs the cooking of a pelletized product
- 80 sum acre in a Seminole Tribe by florida - biosolids and wood
- Then put into a vessel (huge tunnel 15 of them)
- Vessel then windrow (14 days above 101 F on curing pad) then run through screens to get fines before getting to farmers
- Timeline doubles for modified static?? Likes in-vessel
- Has a before and after pic with land using composting in reservation (Natives) cattle ranching land
- Composting vs synthetic photos (composting is better)
- JFE Compost (renamed to brighton??)

WWTP Perspective

- Pick up biosolids, treat them, and distribute - depends on relationship with city
- Can just truck, or they handle everything, or completely contractor based, public-private relationship they pay a lesser fee because
- All private
- All municipal
- Mix
- Pasco paid for facility and then have lesser fees

- Reds in miami, part of their workflow 20 MGD

HFC

- Building facility itself contracting merrell bros
- Paying fee and making biosolids go away
- WANT MUNICIPAL PARTNERSHIP IN RIGHT ZONING DON'T WANT TO DEAL WITH BEING BY DEVELOPERS
- Southeast county landfill across street one water facility
- DRYER - capital cost is really high - emission issues
- Composting vs Solar thermal process
  - Cons solar thermal (more expensive upfront) 4-6 million for odor towers
  - Composting (whole place 7-9 million dollars)
  - Day to day more expensive in composting (more odor)
  - Solar thermal staffed by 5 people
  - 40 acres vs 10 acres in Pasco (less for solar thermal)
  - Compost no reduction
  - $\frac{1}{5}$  of what you started with it makes it easier to destroy PFAS

## 10.12 Appendix L: Summary of Pasco County Biosolids Facility

The following information was gathered during a meeting with Blake Merrell of Merrell Bros. regarding the Pasco County Biosolids Facility, located adjacent of Shady Hills Wastewater Treatment Plant in Pasco County. This regional facility processes approximately 32,000 dry tons of biosolids annually, collected from multiple Pasco County

treatment plants—Shady Hills, Wesley Center, Land O’Lakes, and Southeast—through the Pasco County Biosolids Program. While the current combined biosolids production across these facilities is about 32,000 dry tons per year, the Pasco County Biosolids Facility was intentionally oversized to handle up to 50,000 dry tons, allowing additional capacity for regional clients.

Pasco County funded the capital investment and benefits from lower operational costs while charging each non-county-owned facility a Host Community Fee at a minimum of \$150,000 annually per user, subject to annual escalation, for use of the additional capacity.

The facility occupies roughly 14 acres, including 4 acres of greenhouses and 4 acres of retention ponds, with 10 acres currently in active use. It was designed to scale up to 15 acres, allowing for economies of scale. Remarkably, this large-scale operation is staffed by only five operators. The site includes 20 odor control towers, 18 located at the greenhouses and 2 at the pasteurization area, representing a \$5 million investment. Odor control is a major cost component, making up roughly one-third of the total \$20 million facility cost, with overall O&M costs totaling approximately \$150,000 annually. However, since the process primarily treats digested waste-activated sludge (WAS), odors are significantly reduced, as most complaints typically stem from untreated or raw sludge.