West Basin Facility Plan Project 7054

TECHNICAL MEMORANDUM 6

Rock Creek Digester Capacity Evaluation

FINAL / September 2025

Produced by: carollo

Clean Water Services

Clean Water Services

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Rock Creek Digester Capacity Evaluation

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REGISTERED PROFESSIONAL
ENGINEER
66976
OREGON
JULY 9, 2001
BRIAN ROSS MATSON
EXPIRES: 12/31/26

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Abbreviations

°F	degrees Fahrenheit
AACE	Association for the Advancement of Cost Engineering
ADW	average dry weather
ATAD	autothermal thermophilic aerobic digestion
AWW	average wet weather
CAMP®	concentrated, accelerated, motivated, problem-solving
Carollo	Carollo Engineers
District	Clean Water Services
DRA	draft risk assessment
ELA	engineering, legal, and administration services
HRT	hydraulic retention time
MG	million gallons
MMBTu	million British thermal units
MMDW	maximum month dry weather
MMWW	maximum month wet weather
O&M	operations and maintenance
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
ppd VS/cf	pounds of volatile solids per day per cubic foot of digester volume
SRT	solids retention time
THP	thermal hydrolysis process
TM	technical memorandum
TPS	thickened primary solids
TS	total solids
TTWAS	twice-thickened waste activated sludge
USEPA	United States Environmental Protection Agency
VSLR	volatile solids loading rate
WAS	waste activated sludge
WRRF	Water Resource Recovery Facility

TM 6 ROCK CREEK DIGESTER CAPACITY EVALUATION

6.1 Introduction

Clean Water Services (District) authorized Carollo Engineers (Carollo) to develop an integrated master plan for the West Basin, which includes the Rock Creek Water Resources Recovery Facility along with other regional treatment plants. A primary objective of this master plan is to ensure that the facilities can meet future demands and stay compliant with regulations. As part of this effort, Carollo conducted a capacity analysis of all major unit processes at Rock Creek. The analysis revealed that, based on projected future solids flows and loads, the Rock Creek digesters are expected to reach capacity limits within the planning period of 20 years.

This finding is in line with the 2009 evaluation of the digestion system at Rock Creek, which identified significant capacity, performance, and maintenance challenges.[1] The digesters, constructed in phases since the 1970s, were found to have outdated equipment, limited mixing capabilities, and inefficiencies in sludge processing. The 2009 study assessed improvements to existing digesters and evaluated options for new digester configurations, focusing on constructability, cost, and site efficiency. The preferred solution at the time was to add new conventional digesters near the existing units, offering a balance of operational feasibility and cost-effectiveness. Since the 2009 study, the digestion process has undergone various upgrades and improvements as needed, but the digestion capacity has remained the same.

The purpose of this technical memorandum (TM) is to build on the previous analysis by exploring additional alternatives that ensure adequate capacity throughout the planning period. This effort leverages insights and findings from the 2009 evaluation, aiming to address both current and projected demand while considering updated technology and improved operational efficiency, while still addressing cost-effectiveness. By assessing a broader range of options, the study seeks to identify solutions that not only meet capacity requirements but also enhance system reliability and flexibility, accommodating potential growth and changes in regulatory requirements.

6.2 Basis of Analysis

This section includes a description of the existing anaerobic digesters, the projected digester feed flows and loadings used in this analysis, along with an assessment of the existing anaerobic digestion capacity. Operational and design criteria are established to confirm that this analysis aligns with the District's goals.

6.2.1 Existing Plant Operation and Design Criteria

The anaerobic digestion system at Rock Creek consists of six tanks. Five of these tanks operate as digesters, but Digester 2 is not heated and currently acts as a digested solids storage tank. Table 6.1 provides a summary of the digesters, outlining their volumes, construction years, and specific design

[1] Carollo Engineers, Inc. (March 2009). Project Definition. Technical Memorandum 1. Predesign for Solids Processing Facilities Improvements. Also see Carollo Engineers, Inc. (November 2008). Existing Facilities Condition Assessment. Technical Memorandum 2.1. Rock Creek Advanced Wastewater Treatment Facility Plan.

components. With all units in service (excluding Digester 2), three small digesters (1, 3, and 4) and two large digesters (5 and 6) are operated to provide a total digestion volume of 4.8 million gallons (MG).

Table 6.1 Anaerobic Digestion Design Criteria

Digester	Digester Volume (MG)	Construction Year	Mixing System	Heating System	Cover Type
Digester 1	0.67	Early 1970s	Vertical Shaft	External, Spiral, Hot Water	Fixed Concrete Cover
Digester 2(1)	0.67	Early 1970s	Submersible	N/A(2)	Fixed Concrete Cover
Digester 3	0.67	1987	Draft Tube	External at Draft Tubes	Fixed Steel Cover
Digester 4	0.67	1987	Draft Tube	External at Draft Tubes	Fixed Steel Cover
Digester 5	1.45	Early 1990s	Pump mixing	External, Spiral, Hot Water	Fixed Concrete Cover
Digester 6	1.45	Early 1990s	Pump mixing	External, Spiral, Hot Water	Fixed Concrete Cover

Notes:
(1) Digester 2 is currently used as a digested solids storage tank.
(2) Not equipped with heating.

The anaerobic digestion capacity design criteria were previously documented in *TM 2 - Rock Creek Water Resource Recovery Facility (WRRF) Capacity Assessment* (Carollo, 2023). Digester capacity is evaluated using both hydraulic and volatile solids loading criteria. A minimum solids retention time (SRT) of 15 days is required to ensure biosolids satisfy United States Environmental Protection Agency (USEPA) Class B biosolids requirements for pathogen reduction. A maximum volatile solids loading rate (VSLR) of 0.2 pounds of volatile solids per day per cubic foot of digester volume (ppd VS/cf) is used based on the District's historical operating experience. Digester capacity is evaluated with all units in service for the maximum month dry weather (MMDW) and maximum month wet weather (MMWW) conditions. Redundancy is provided under average loading conditions, with provisions for one small digester taken out of service in the average annual dry weather (ADW) season and one large digester taken out of service in the average annual wet weather (AWW) season.

6.2.2 Flows and Loads Projections

The flows and loads used in this TM are summarized previously in *TM 2 - Rock Creek WRRF Capacity Assessment*.[2] Briefly, digester feed flow and volatile solids load projections were developed from process modeling using collection system flow and load projections updated for this project. Figures 6.1 and 6.2 depict the flow and volatile solids load projections, respectively. As shown, digester feed flow and volatile solids load projections were found to generally align with observed values up to 2020, which was the last year included in the historical data set used to develop the collection system flow and load projections. From 2020 through 2024, observed digester feed flow and loads have not increased. Therefore, the projections were shifted by four years in the Rock Creek WRRF Capacity Assessment to develop a trigger year range to better reflect the uncertainty in the projections. For the present alternatives analysis, the modeled unshifted projections were used to establish the expected capacity limitation timelines.

[2] Carollo Engineers, Inc. (February 2023). TM 2 - Rock Creek WRRF Capacity Assessment. West Basin Facility Plan Project 7054.

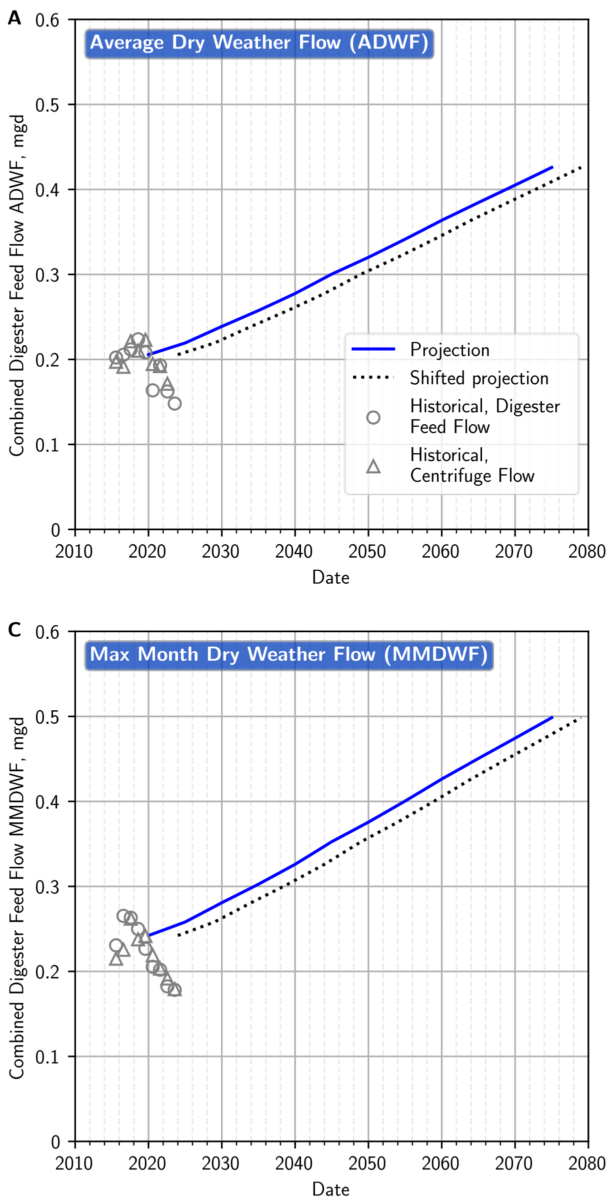

Figure 6.1 Rock Creek Digester Feed Flow Projections

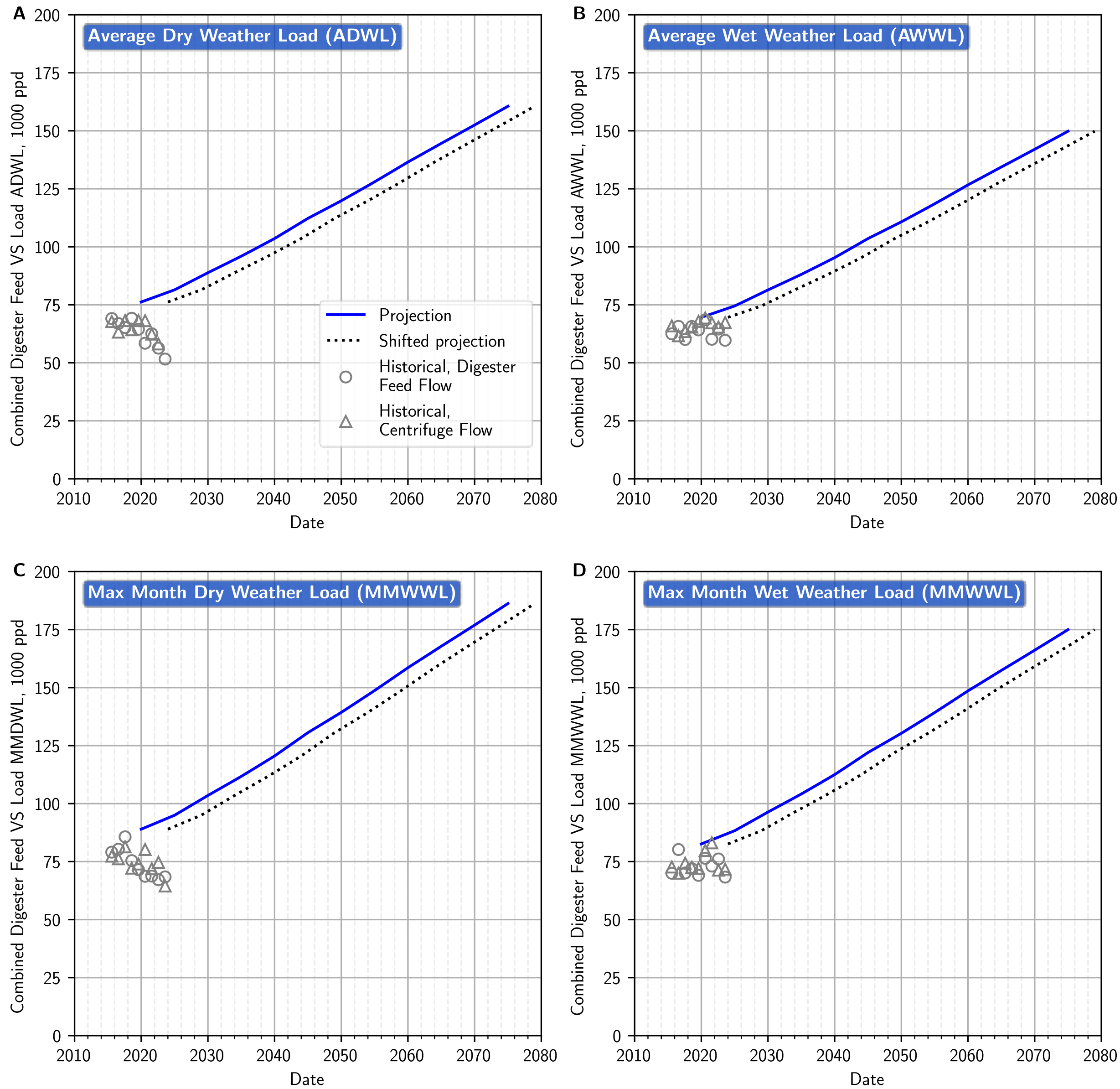

Figure 6.2 Rock Creek Digester Feed Volatile Solids Load Projections

6.2.3 Existing Anaerobic Digestion Capacity

Digestion capacity at Rock Creek has previously been documented in *TM 2 - Rock Creek WRRF Capacity Assessment* (Carollo, 2023). Figures 6.3 and 6.4 show the digester hydraulic and volatile solids loading trigger plots. The digesters are hydraulically limited and are projected to reach capacity between 2034 and 2038 under the average annual wet weather condition with one large digester out of service.

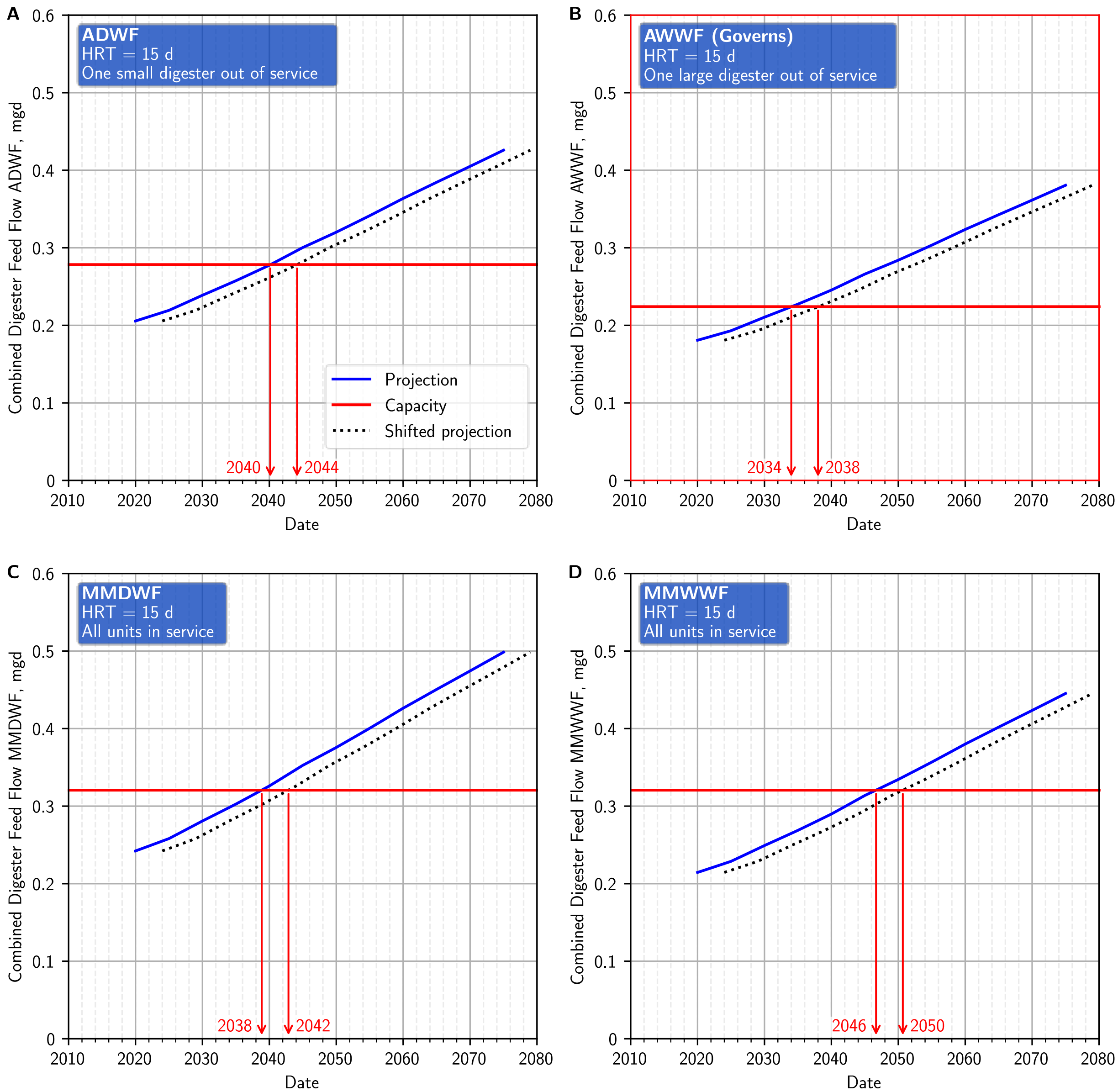

Figure 6.3 Digester Hydraulic Loading Trigger Plots

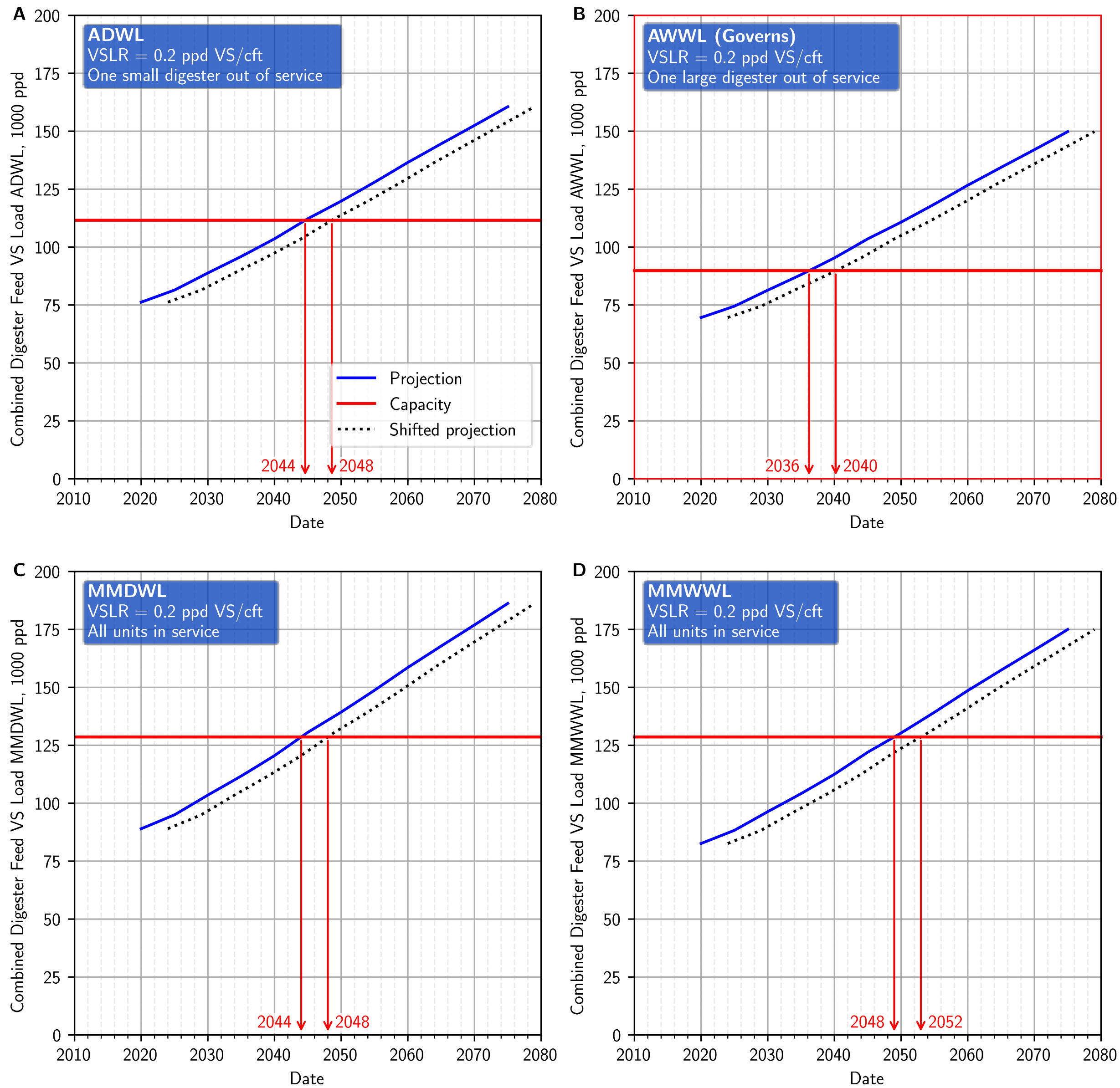

Figure 6.4 Digester Volatile Solids Loading Trigger Plots

6.3 Evaluation Criteria

The evaluation of alternatives is based on both monetary and non-monetary criteria to provide a comprehensive assessment of costs, feasibility, and operational impacts. The following sections provide more detailed explanations of each evaluation criterion.

6.3.1 Non-Monetary Evaluation Criteria

The non-monetary evaluation criteria focus on operational and regulatory factors that impact the feasibility and performance of each alternative beyond financial considerations. These criteria include proven solids treatment performance, technology familiarity, process compatibility, digester gas beneficial use, and adaptability to future regulatory changes such as per- and polyfluoroalkyl substances (PFAS) limits. Additionally, factors like sidestream impacts, odor concerns, constructability, and site requirements are evaluated to assess how each alternative integrates with existing systems and addresses operational challenges. The following sections provide detailed insights into these criteria, highlighting their role in selecting the most suitable alternative.

6.3.1.1 Proven Technology

Technologies with a history of successful solids reduction, pathogen reduction, and stable operation are favored under this criterion, as they provide confidence in achieving desired outcomes and long-term reliability in managing biosolids. For the purposes of this alternatives analysis, proven technologies:

- Have been demonstrated to work at a similar scale and application within the United States and worldwide.
- Provide consistent and reliable treatment that meets the District's stated requirements.

6.3.1.2 Technology Familiarity

Technology familiarity assesses how well-versed operations and maintenance staff are with the proposed technology. Introducing new technology would require training to effectively manage the new system. Staff familiarity can directly affect system reliability, safety, and long-term success, making it a key factor in the decision-making process. For the purposes of this alternatives analysis, familiar technologies:

- Do not require significant, additional labor and training.

6.3.1.3 Process Compatibility

Process compatibility evaluates how well the proposed technology integrates with Rock Creek's existing infrastructure, treatment processes, and overall operational framework. It considers the complexity of connecting new systems with existing solids handling, dewatering, and energy recovery systems. For the purposes of this alternatives analysis, compatible processes:

- Do not require significant modification or disruption to existing process units.
- Minimizes integration risks.

6.3.1.4 Digester Gas Beneficial Use

This criterion evaluates enhancements to digester gas production, digester gas quality, and how well the technology aligns with energy recovery strategies. For the purposes of this alternatives analysis, alternatives are favored when they:

- Maximize digester gas production.
- Require less energy for operation.

6.3.1.5 Future Regulations (e.g., PFAS Limits)

This criterion refers to the ability to meet or mitigate impacts of potential new regulatory requirements for biosolids. One of the most pressing concerns in wastewater treatment, and specifically biosolids management, is the increasing scrutiny and potential new regulations for contaminants of concern, such as PFAS. PFAS are persistent in the environment and have been detected in biosolids, raising concerns about the long-term viability of biosolids land application. As regulations around PFAS and other contaminants evolve, there may be stricter limits on or restrictions of biosolids land application. Because perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) have been designated as hazardous compounds under the Comprehensive Environmental Response, Compensation, and Liability Act and PFAS are also present in landfill leachate, acceptance of biosolids by landfills may also be endangered due to concerns about liability. For the purposes of this alternatives analysis, alternatives are favored when they:

- Provide flexibility to meet potential future regulations.

6.3.1.6 Sidestream Impacts

Sidestream impacts consider effects on sidestream flows that are returned to the secondary treatment processes, particularly the nutrient-rich liquid stream generated during digestion and dewatering. These sidestreams often contain high concentrations of nitrogen, phosphorus, and other dissolved compounds that can increase the nutrient load on the secondary treatment system or sidestream treatment system. For the purposes of this alternatives analysis, alternatives are favored when they:

- Minimize the impact of sidestreams on existing treatment processes.

6.3.1.7 Odor Concerns

Odors can negatively affect both plant operations and the surrounding community. Odor issues typically arise from volatile organic compounds, hydrogen sulfide, and ammonia, which are by-products of processes like fermentation, digestion, and drying. Uncontrolled odors can lead to complaints from nearby residents, increased regulatory scrutiny, and the need for costly odor control measures. For the purposes of this alternatives analysis, alternatives are favored when they:

- Do not significantly increase odor control requirements.

6.3.1.8 Constructability/Site Impacts

When assessing constructability, considerations include the timeline for construction, ease of installation, and proximity to sensitive areas, such as areas that are prone to liquefaction. Because there are site constraints and limited land available at the site, land requirements of the treatment options are important to consider. For the purposes of this alternatives analysis, alternatives are favored when they:

- Reduce construction complications.
- Minimize footprint and preserve space for future expansion or modifications.

6.3.2 Monetary Evaluation Criteria

Planning level capital, operations and maintenance (O&M), and life cycle costs are used for this evaluation. The expected level of accuracy for the planning-level capital cost estimate follows the Recommended Practice 18R 97 Cost Estimate Classification System for the Process Industries (AACE, 1998) designation as a “Class 5” estimate with an expected level of accuracy at bid of -50 percent to +100 percent of the cost presented. Operations and maintenance costs, and subsequent life cycle costs, are estimated based on unit costs for labor, energy, and solids management provided by the District, as well as a percentage of capital to account for maintenance material costs. The relative costs for each alternative are considered sufficient for comparative purposes. Cost estimates are subject to change. The cost of materials and equipment may vary as the project matures or scope is modified.

6.3.2.1 Capital Cost

Construction cost estimates include materials, labor, equipment involved in the installation, subcontractor costs, and indirect costs (i.e., contractor mobilization, demobilization, startup, commissioning, and warranties). The planning level construction costs for the options considered are estimated with one or more of the following:

- Historical costs of similar systems.
- Vendor-supplied costs for major equipment.
- Major-item quantity estimates with percentage allowances.

Estimated construction costs are in 2024 dollars. Escalation was not included due to uncertainty in project timing; however, escalation to project mid-point should be included in subsequent construction cost estimates for projects that the District selects once project timing is defined. A material pricing uncertainty allowance was added to account for recent market volatility that result in increased pricing.

The overall capital cost for a project includes the construction cost as well as the cost for engineering (design and construction management), legal, and administration services (ELA). The cost factor for ELA and indirect construction cost factors are shown in Table 6.2. Additional information about how these factors are applied can be found in Appendix 6B.

Table 6.2 Basis of Capital Cost Estimates

Capital Cost Parameter	Value
Contingency	30%
Material Pricing Uncertainty Allowance(1)	10%
General Conditions	10%
Contractor Overhead and Profit	12%
Engineering, Legal, and Administration	20%

Notes:
(1) A material pricing uncertainty allowance was used for the comparative cost estimate presented in this TM. The cost estimate for digester improvements presented in the Rock Creek Implementation Plan and CIP does not include this markup and uses markups that are consistent with other costs developed for the CIP.

6.3.2.2 Operation and Maintenance

O&M costs were developed for O&M labor, power, energy consumed or generated, solids management, and equipment maintenance in 2024 dollars from the values provided by the District as part of the East Basin Master Plan.[3] The basis of the cost estimates for O&M is presented in Table 6.3.

[3] Carollo Engineers, Inc. (June 2021). TM 1 - Project Goals and Planning Criteria. East Basin Master Plan Project.

Table 6.3 Basis of O&M Cost Estimates

Operating Cost Parameter	Value
O&M Labor (burdened)(1)(2)	$59 per hour
Power(2)	$0.06 per kilowatt-hour
Natural Gas(2)	$8.5/MMBTU
Solids Management(2)	$17 per Wet Ton
Equipment and Facilities Maintenance(3)	1% of capital cost per year

Notes:
(1) O&M labor estimates reflect only the additional labor required for each alternative compared to the current conditions.
(2) Data provided by District in 2020 dollars.
(3) Assumed value.
MMBTU - million British thermal units

6.3.2.3 Present Worth

Net present worth costs include estimated capital costs and the present worth of annual O&M costs, assuming a 20-year life cycle and a net discount rate of 2 percent to be consistent with previous analyses performed for this facility.

6.4 Alternatives Description

This analysis considered mesophilic digestion, thermophilic digestion, high-solids digestion, thermal hydrolysis process (THP), and solids drying. The following sections provide a description of each alternative, including typical process flow diagrams, alternative-specific trigger charts, site layouts, and a summary of the advantages and disadvantages associated with each option.

6.4.1 Alternative A - Mesophilic Digestion

Anaerobic digestion is the biological stabilization of organic materials in a heated, anaerobic environment. During this process, biodegradable organic matter undergoes several biochemical processes including hydrolysis, fermentation (acidogenesis and acetogenesis), and methanogenesis, with much of the matter ultimately being converted into methane, carbon dioxide, and other gases. The methane-rich biogas produced can be used as a renewable fuel. The remaining solids are stabilized with reduced biological activity. Mesophilic digesters are currently in operation at Rock Creek. Therefore, this alternative is a continuation of the existing solids stabilization technology.

Mesophilic anaerobic digestion is the most widely used digestion process in the US due to its relatively low operating temperatures, ease of operation, and proven track record. Mesophilic digesters typically operate within a temperature range of 95 to 102 degrees Fahrenheit (°F) and at SRTs of 15 days or more. The resulting digested solids are a nutrient-rich soil amendment that can be beneficially used as a fertilizer. The USEPA Part 503 regulations define mesophilic digestion as a biosolids technology that meets Class B pathogen reduction when the process provides a minimum of 15-days mean cell residence time at 35-55 degrees Celsius (°C). Vector attraction reduction requirements for land application under Part 503 are met if the volatile solids reduction is 38 percent or higher. Biosolids that meet the Class B pathogen reduction, vector attraction reduction, and pollutant (metals) limits included in Part 503 are suitable for most large-scale agricultural, forestry, and mine reclamation applications.

The digester hydraulic and volatile solids loading capacity projections are shown in Figure 6.5 and Figure 6.6, respectively. An additional 1.45 MG mesophilic digester would be required by 2034 to provide solids stabilization capacity through the planning period. Additional mesophilic digestion capacity may be required beyond the end of the current planning period and before buildout. With the current projections and design criteria, the six digesters would be hydraulically limited under the MMDW condition by 2058.

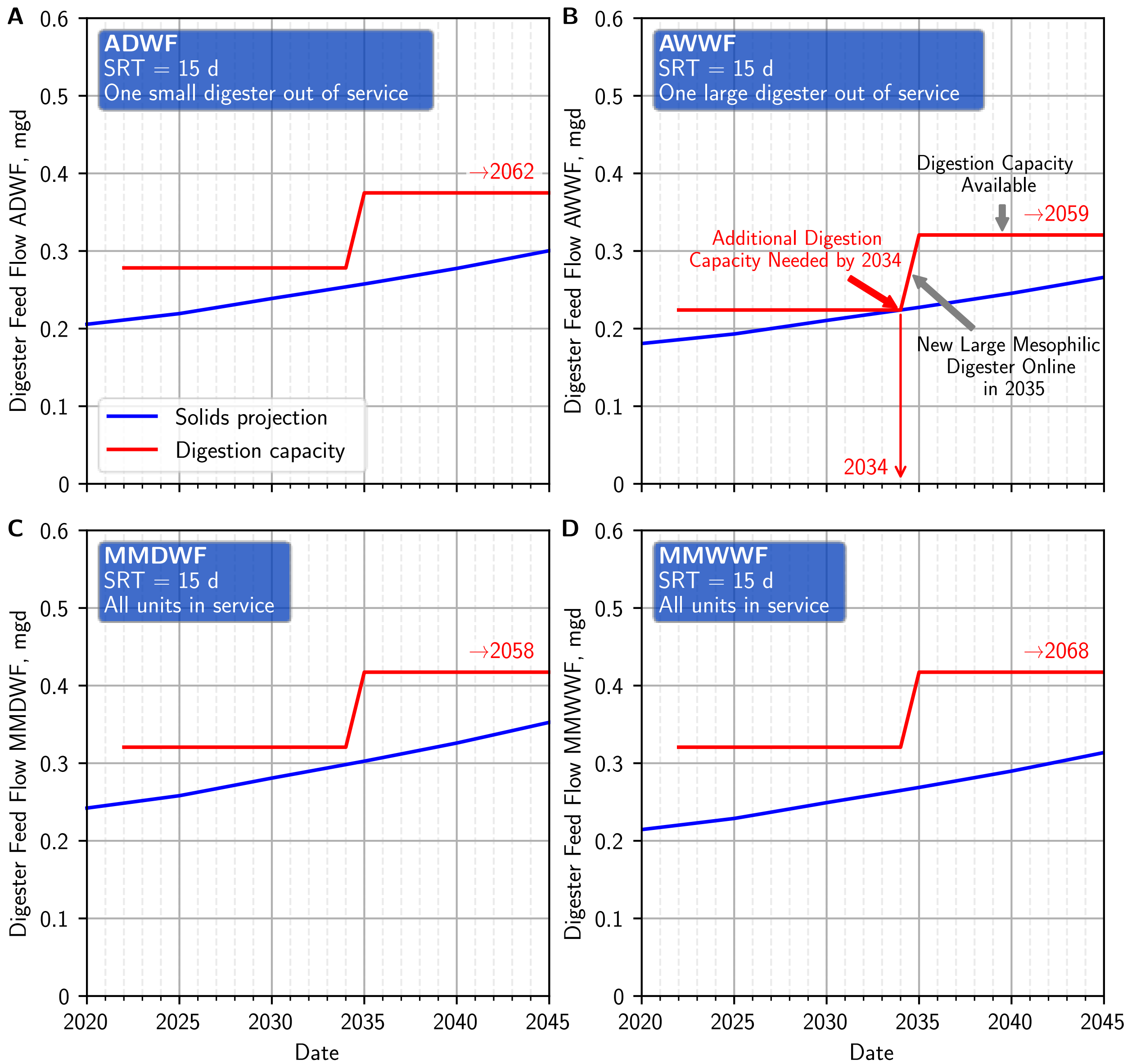

Figure 6.5 Mesophilic Digestion Hydraulic Loading Capacity Projections

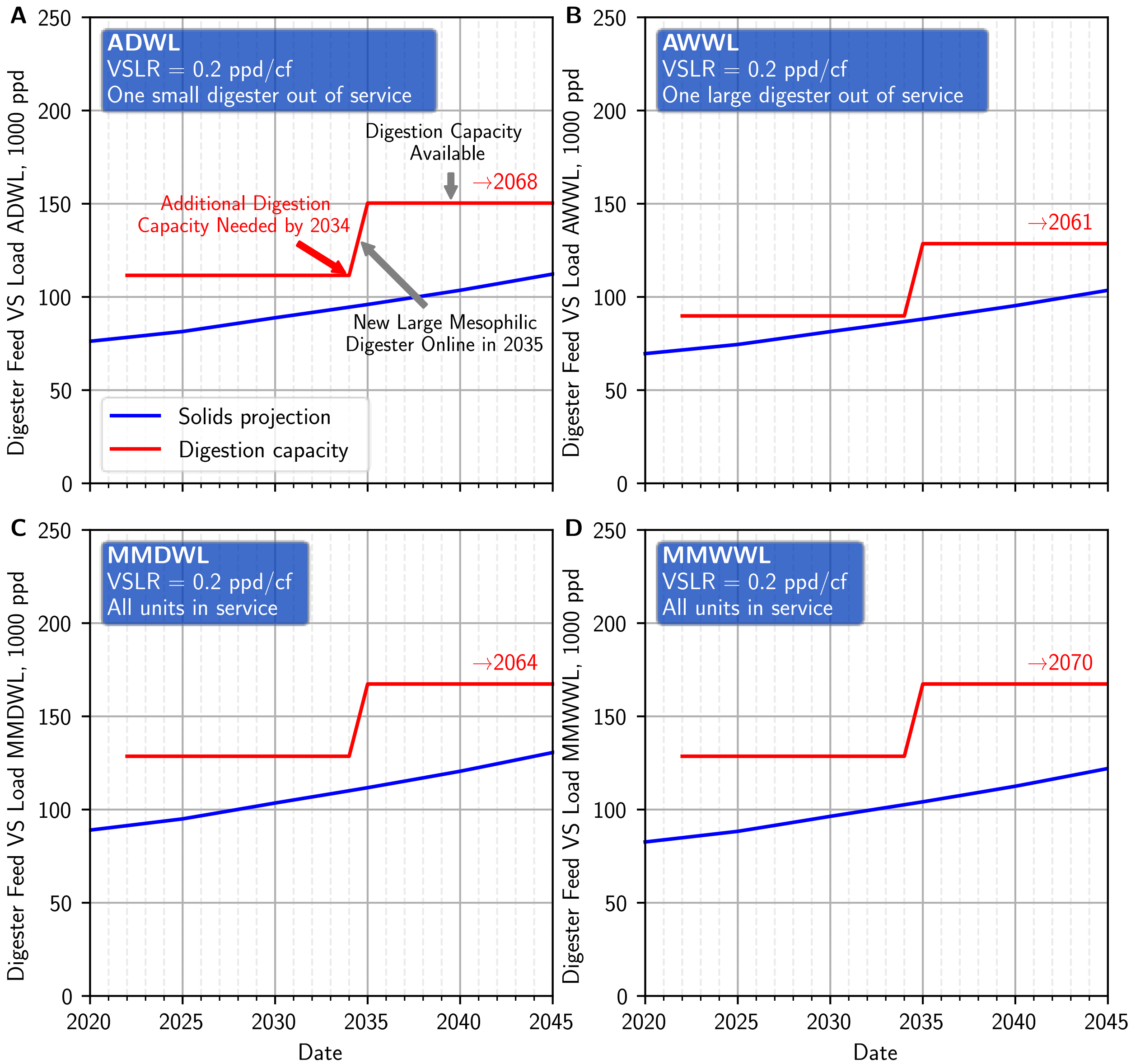

Figure 6.6 Mesophilic Digestion Volatile Solids Loading Capacity Projections

A process flow diagram of the existing and future mesophilic anaerobic digestion process is shown in Figure 6.7. The existing processes are shown in black lines and text, while the new processes are highlighted in red.

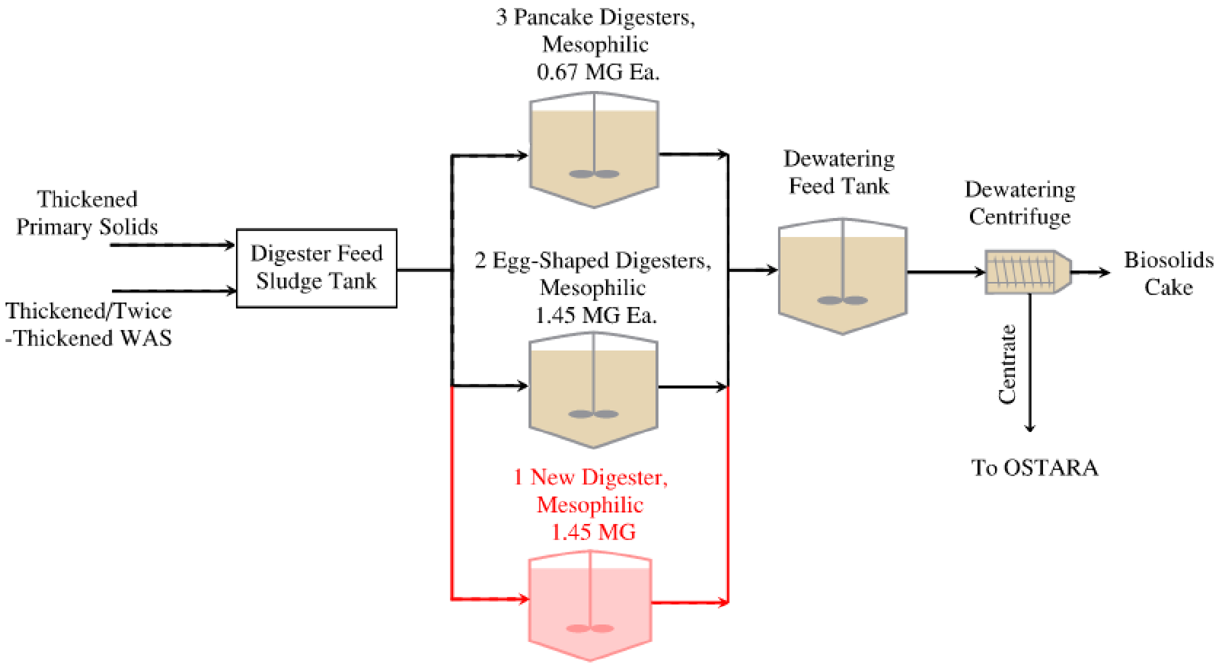

Figure 6.7 Mesophilic Anaerobic Digestion Process Flow Diagram

A potential site layout for the mesophilic alternative is shown in Figure 6.8. Locating the new digester on the east side of the existing egg-shaped digesters would optimize process flow by grouping similar processes together. However, there are expected to be construction challenges in this area, including the potential need for shoring to protect nearby facilities and traffic re-routing during construction.

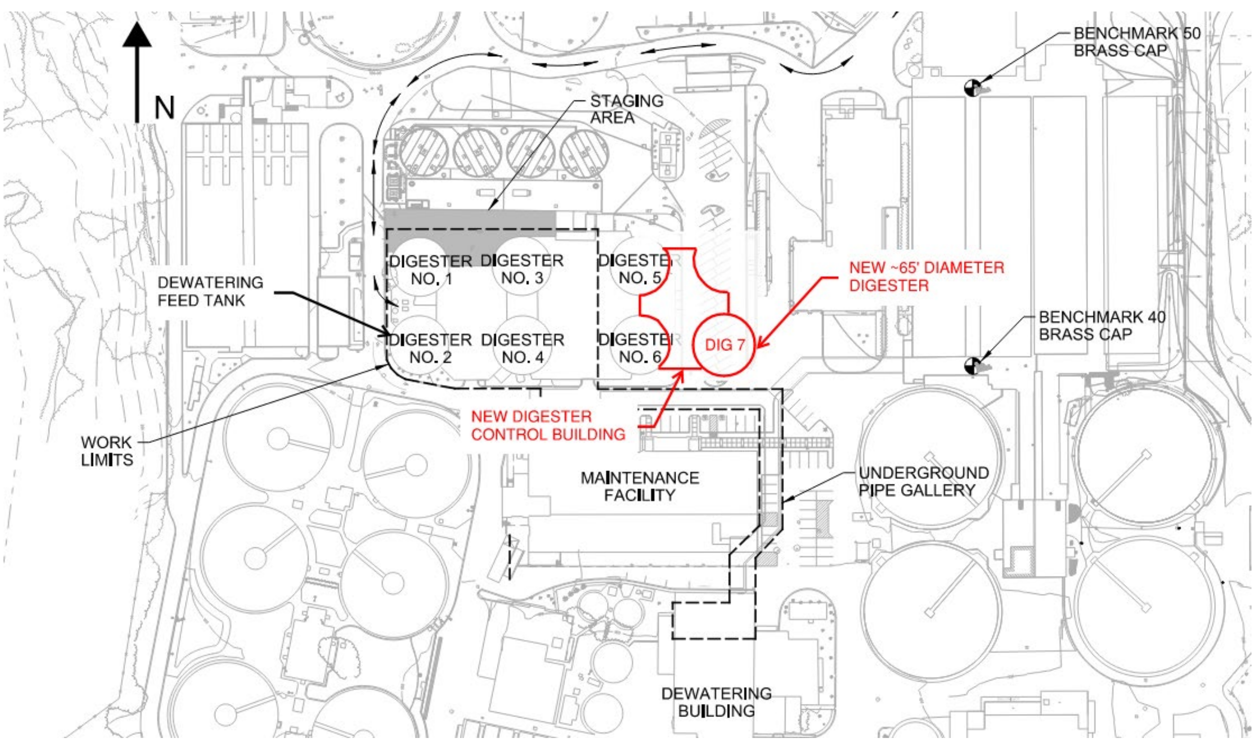

Figure 6.8 Mesophilic Digestion Layout

The advantages and disadvantages of mesophilic digestion are shown in Table 6.4. Mesophilic digestion has been a reliable and effective technology for Rock Creek, with minimal disadvantages. Therefore, mesophilic digestion was selected for further evaluation.

Table 6.4 Mesophilic Digestion Advantages and Disadvantages

Advantages	Disadvantages
Proven Technology ▪ Most common digestion technology used in municipal wastewater applications. ▪ Long history of successful performance at Rock Creek. **Technology Familiarity** ▪ O&M staff are familiar with the process – no additional training required. **Process Compatibility** ▪ Same as existing operation. **Digester Gas Beneficial Use** ▪ No impact to digester gas beneficial use. **Side-Stream Impact** ▪ Minimal side-stream impact expected. **Odor Concerns** ▪ Same as existing operation. **O&M** ▪ Simple operation. ▪ Class B biosolids produced.	**Future Regulations** ▪ Does not affect PFAS removal. **Constructability/Site Impacts** ▪ Footprint for additional digester required. **O&M** ▪ Class A biosolids more difficult to achieve in future.

6.4.2 Alternative B - High Solids Digestion

Typical anaerobic digesters operate at a total solids (TS) concentration of 3.5 percent TS or lower within the tanks. High solids digestion increases the TS concentration above 3.5 percent to reduce the required digester tank volume. Rock Creek currently targets a digester TS concentration of approximately 3 percent with a combined digester feed TS concentration between 5 percent and 6 percent. This is achieved by thickening the thickened primary solids (TPS) to approximately 5 percent TS and the twice-thickened waste activated sludge (TTWAS) to approximately 6 percent TS. The District has observed impaired mixing and foaming issues when operating at digester TS concentrations greater than 3 percent, particularly in the small digesters due to inefficient mixing. To increase the solids concentration in the digesters above 3.5 percent TS and maintain performance, proprietary propeller mixers are recommended.

Two options are available to increase the digester TS concentration and achieve high-solids digestion:

- Recuperative thickening, which uses a dedicated thickener on a recirculation loop where digested solids are withdrawn, thickened, and returned to the digester. Recuperative thickening decouples the digester hydraulic and solids retention times (HRT and SRT, respectively), which allows the digesters to operate at the minimum SRT of 15 days and an HRT less than 15 days.
  - This option requires additional mechanical equipment, increases polymer demand, and produces an additional return stream which would require further integration with the nutrient recovery system.
- Enhanced pre-thickening, which increases the TS concentration of the digester feed. This option reduces the digester heat demand compared to recuperative thickening, but cannot usually achieve the high solids concentrations possible with recuperative thickening.

▪The maximum sustained VSLR that has been proven with long-term operating data at full-scale for high-solids digestion is 0.25 ppd VS/cf. However, that loading rate was achieved using digesters performing co-digestion, not operated on wastewater solids only. Co-digestion involves substrates that are often easier to digest than some municipal sludges, so it is possible that such VSLRs may not result in stable operation with sludge-only digestion. Furthermore, operating data has not shown that operating at 0.25 ppd VS/cf only on wastewater solids can reliably result in stable operation. The maximum loading rate proven for a high-solids digester operating only on wastewater solids is 0.21 ppd VS/cf. This loading rate is approximately the same as the maximum VSLR used for mesophilic digestion. Limited data on high-solids mesophilic digestion are available and operation at higher volatile solids loading rates may be possible, but has not yet been proven in a sustained fashion with a sludge-only feed. To avoid overlap with the mesophilic digestion option and present the maximum possible high-solids digester capacity, this analysis used a maximum VSLR of 0.25 ppd VS/cf, but it should be noted that this loading rate may not be stable and there is a high risk of digester instability at that loading rate.

▪To eliminate the hydraulic limitation in the digesters at the design loading rate, the digester solids concentration within the tanks would need to be at least 4 percent TS. It is unlikely that the existing thickening system would be able to reliably achieve and pump a feed concentration high enough to result in 4 percent TS within the digester. Therefore, this analysis assumed that recuperative thickening would be used. However, many of the conclusions would be the same for an enhanced pre-thickening process.

Figure 6.9 shows the volatile solids loading capacity projections for the high-solids digestion option assuming all of the existing digesters would be converted to high-solids operation. Note that a hydraulic loading chart is not provided because the solids concentration in the digester would be increased to eliminate a hydraulic loading limitation. The capacity projection was developed with the following assumptions:

- Conversion to high-solids digestion would occur on the smaller digesters before the larger digesters and the digesters would be converted individually. This sequencing is intended to offset the significant capacity reduction that occurs when the large digesters are taken offline for conversion.
- Each digester would require one year to convert to high-solids digestion and the digester would be out of service for that year. This may be an aggressive schedule depending on the work required to convert each digester.

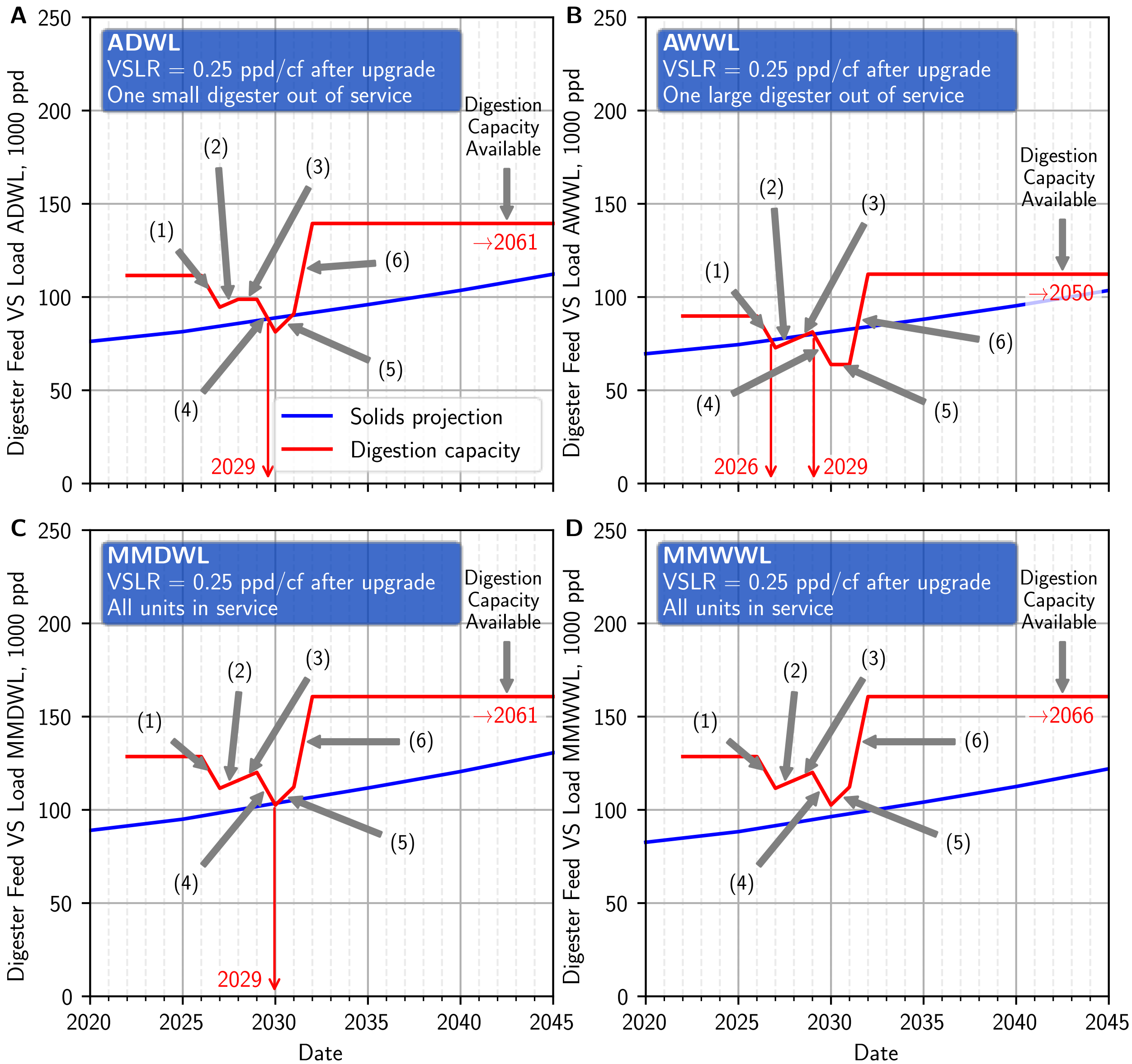

Figure 6.9 High-Solids Digestion Hydraulic Loading Capacity Projections Assuming Conversion of Existing Digesters

Notes:
(1) Start AD1 conversion in 2027.
(2) AD1 converted in 2028. Start conversion of AD3.
(3) AD3 converted in 2029. Start conversion of AD4.
(4) AD4 converted in 2030. Start conversion of AD5.
(5) AD5 converted in 2031. Start conversion of AD6.
(6) AD6 converted in 2032.

Converting the existing digesters to high-solids digestion would not allow the District to maintain sufficient solids stabilization capacity, even if the conversion process begins immediately. Digester capacity during the average dry weather and average wet weather loads is less than the solids projections when the digester are converted, resulting in digester overload. Therefore, converting the existing digesters to operate as high-solids digesters does not meet the objectives of this study. A new high-solids digester would be required.

Figure 6.10 shows the volatile solids loading capacity projection for high-solids digestion if a new digester is constructed. Construction may be delayed until the existing mesophilic digesters reach capacity in 2034. Once the new digester is online, the existing digesters may be taken offline and converted to high-solids digestion.

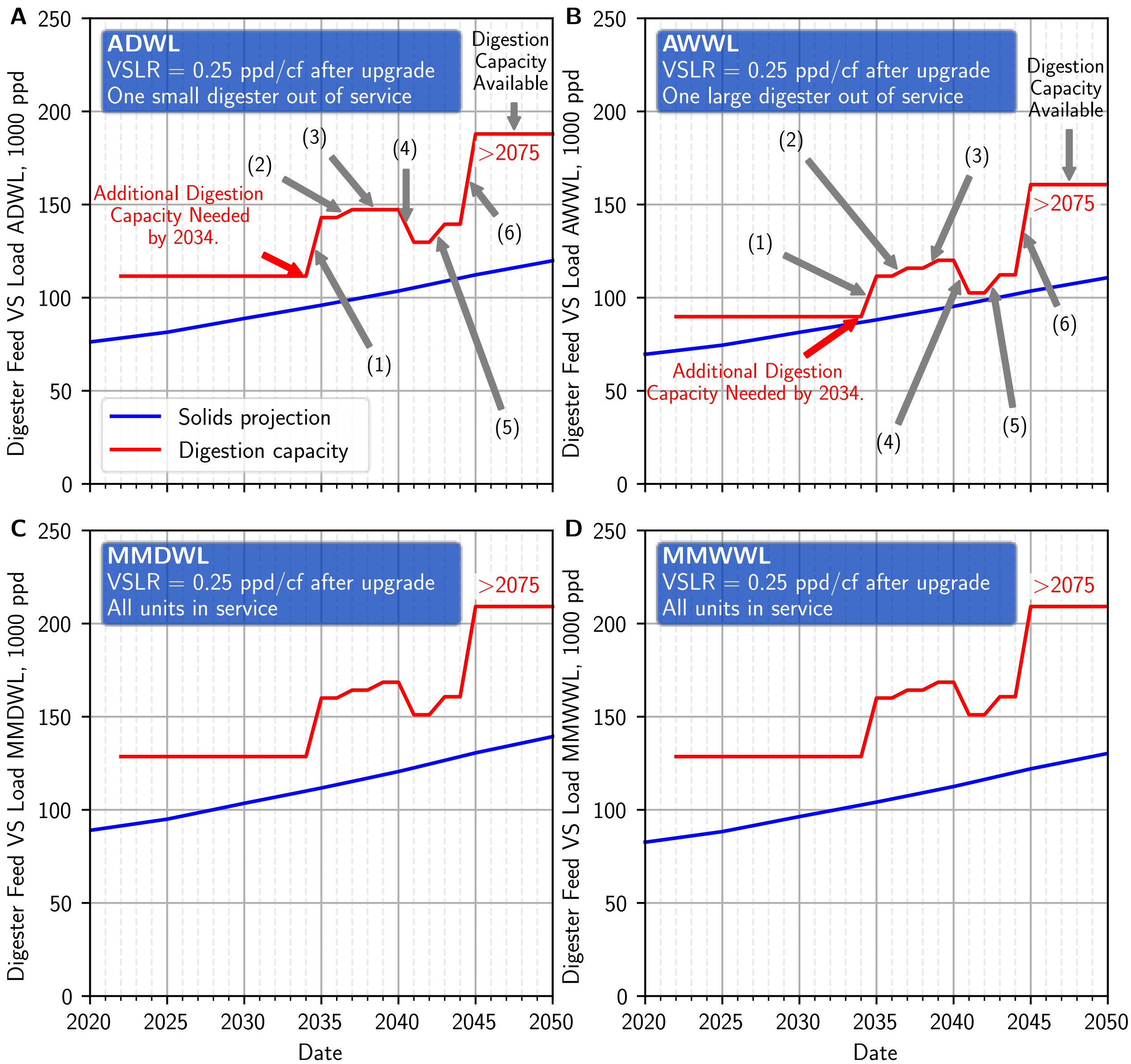

Figure 6.10 High-Solids Digestion Hydraulic Loading Capacity Projections Assuming a New Digester is Constructed

Notes:
(1) New large high-solids digester online in 2035. Start AD1 conversion.
(2) AD1 converted in 2037. Start AD3 conversion.
(3) AD3 converted in 2039. Start AD4 conversion.
(4) AD4 converted in 2041. Start AD5 conversion.
(5) AD5 converted in 2043. Start AD6 conversion.
(6) AD6 converted in 2045.

A representative process flow diagram for this option is shown in Figure 6.11.

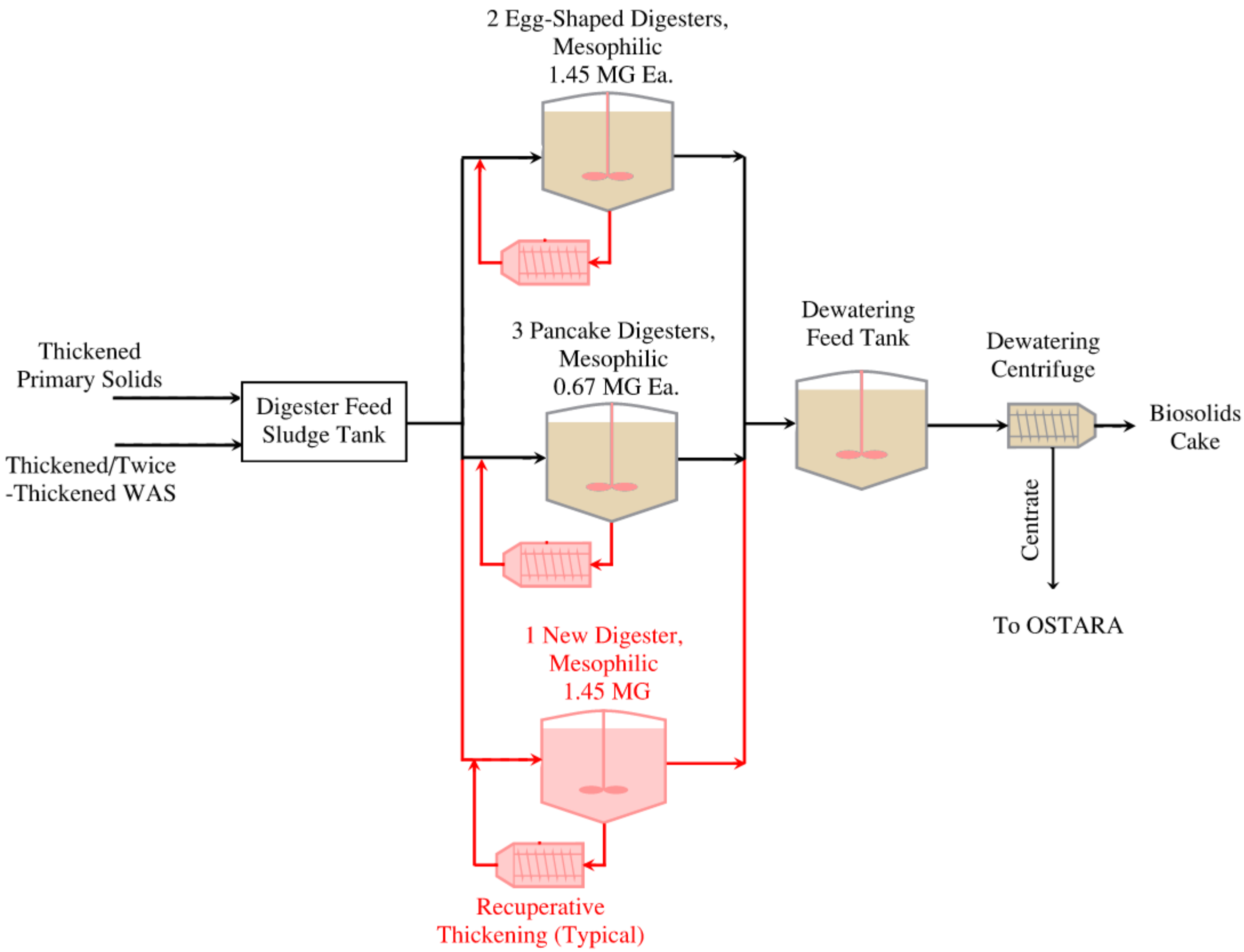

Figure 6.11 High-Solids Digestion Process Flow Diagram

A representative site layout for high-solids digestion with recuperative thickening is shown in Figure 6.12. The new high-solids digester is located on the east side of the existing digesters. Additional space for recuperative thickening equipment is shown north of Digester 7. If space for Digester 8 is needed in that location, it may be possible to locate recuperative thickening equipment in the existing dewatering building or consider replacing the existing thickening equipment with thickening centrifuges. Care should be taken to ensure that thickened sludge can be pumped between the thickeners and digesters. In general, it is best to locate thickeners as close to the digesters as possible.

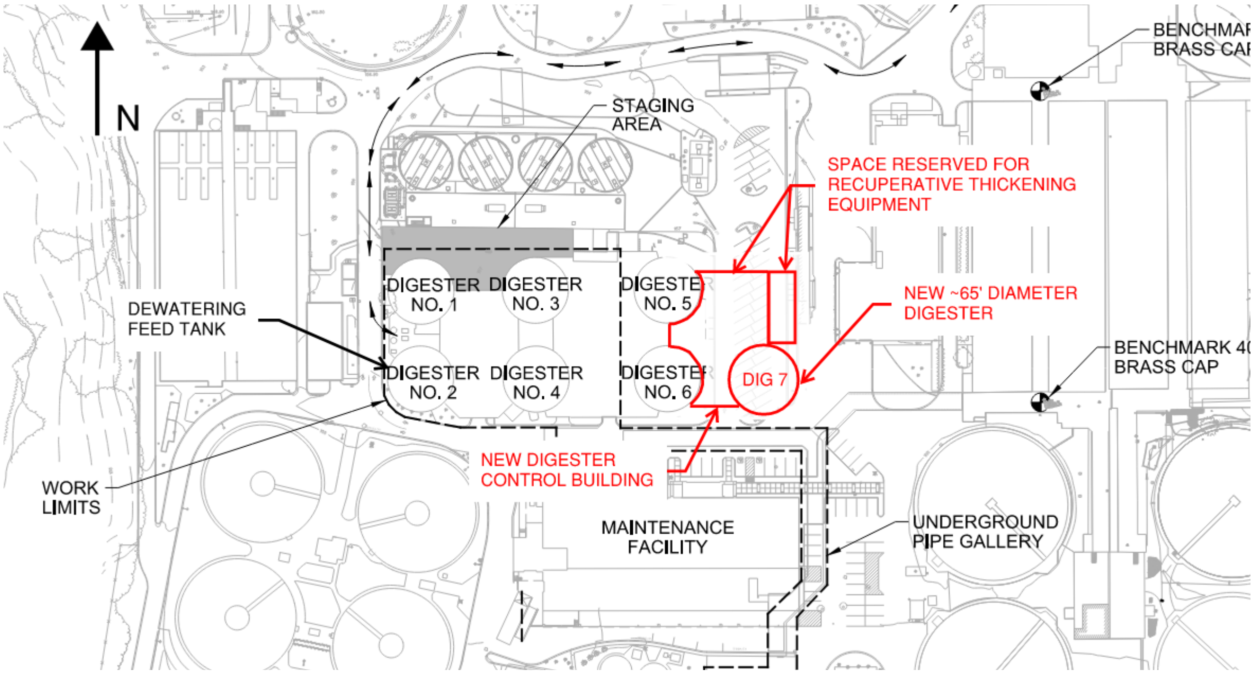

Figure 6.12 High-Solids Digestion Site Layout

Table 6.5 summarizes the advantages and disadvantages of high-solids digestion.

Table 6.5 High-Solids Digestion Advantages and Disadvantages

Advantages	Disadvantages
Digester Gas Beneficial Use ▪ No impact to digester gas beneficial use. **Odor Concerns** ▪ Similar to existing process. **O&M** ▪ Class B Biosolids.	**Proven Technology** ▪ Less industry experience than other technologies. **Technology Familiarity** ▪ Need additional training and O&M. **Process Compatibility** ▪ May impact dewaterability of biosolids, polymer incorporation, recycle streams, and pumping systems. **Sidestream Impact** ▪ Would require a change in thickening process (enhanced pre-thickening) or would generate an additional sidestream to be routed to Ostara. **Future PFAS Regulation** ▪ Does not affect PFAS removal. **Site Impacts** ▪ Larger footprint required for recuperative thickening equipment. **O&M** ▪ Higher complexity. ▪ Increased polymer use and additional polymer injection locations. ▪ Digester mixer access and maintenance considerably more complicated. ▪ Higher potential for digester gas entrainment and foaming. ▪ Aggressive design criteria may not be possible long-term. ▪ Similar to mesophilic alternatives, Class A biosolids more difficult to achieve in future.

This option has many of the same advantages of mesophilic digestion, but requires significantly more mechanical equipment, does not alleviate the need for an additional digester past the planning period, and the aggressive volatile solids loading criterion of 0.25 ppd VS/cf may not result in stable operation. If recuperative thickening is used, it would generate an additional sidestream that would need to be routed to the Ostara system. Furthermore, the high solids mixers used for the Anaergia Omnivore process have not been installed in tall, silo-type or egg-shaped digesters and there is concern about the stability and reliability of the mixer shafts at very long lengths as well as the requirements and accessibility for installation of the mixers' service boxes on top of tall digesters. While the mixers may be stable and easy to operate and maintain on the shorter pancake digesters, the units on Digesters 5 and 6 could be unstable and would be difficult to access from atop the digesters. For these reasons, this option was not selected for further evaluation.

6.4.3 Alternative C - Thermophilic Digestion

Thermophilic anaerobic digestion typically operates at temperatures from 120°F to 135°F. Biochemical reactions in anaerobic digestion increase with temperature, making microbial activity significantly faster compared to mesophilic digestion. As a result, thermophilic systems can handle higher loading rates. For this analysis, design criteria for a thermophilic digester include a minimum SRT of 8 days and a maximum volatile solids loading rate of 0.35 ppd VS/cf. Operating at an SRT less than 15 days would require sampling to prove that the biosolids meet Class B requirements for pathogen reduction. For comparison, the current mesophilic digestion process automatically achieves pathogen reduction requirements for Class B biosolids by operating at an SRT longer than 15 days. In addition, thermophilic digestion can be adapted to meet the USEPA Part 503 pathogen reduction requirements for Class A biosolids by adding batch tanks that achieve a batch holding time of at least 24 hours at 131°F. The size and location of batch tanks was not determined as part of this analysis.

To convert a digester from mesophilic to thermophilic operation, several items may need to be checked or revised.

- Check the digester structure to confirm that it can handle a higher temperature differential across the walls. If needed, install insulation on digester walls.
- Check digester coatings to ensure they will not fail at higher operating temperatures. If needed, remove and re-install coatings.
- Check pipe insulation to confirm that higher sludge temperatures do not pose a risk to operations personnel. If needed, install additional insulation.
- Revise heating system to supply more heat to digester. If the volumetric feed to the digesters remains the same for either mesophilic or thermophilic operation, thermophilic operation may require 2.0 to 2.8 times the heat as mesophilic operation to bring an incoming digester feed sludge temperature of 60- 75 deg F up to the digester operating temperatures. Most of the digestion process's heat demand is associated with the load to bring incoming cold digester feed up to operating temperatures. However, thermophilic digesters will also lose more heat to atmosphere than mesophilic digesters, so the overall increase in heat demand would slightly exceed the 2.0 to 2.8 times increase noted. If needed, install new or larger boilers, heat exchangers, heating loop piping, and digester heating controls.

- Check digester gas conveyance and conditioning system to ensure that it can process additional digester gas flows generated from higher digester loading rates to each digester, greater moisture, and higher concentrations of gaseous pollutants (H2S, ammonia, and possibly siloxanes). If thermophilic digesters were operated at the same SRT as mesophilic operations, overall digester gas production could also increase by 10 to 20-percent. However, if thermophilic digesters are operated at shorter SRTs as suggested here, the overall gas production may not show a significant comparative increase in total flow. Nevertheless, the higher feed to each digester will generate more digester gas from each digester and that must be considered.
- Consider impacts of process revision on digester polymer dose, dewaterability, and odors. Thermophilic digestion has been associated with adverse impacts to each of these parameters, although there are several full-scale operations that successfully operate thermophilic digestion with minimal negative impacts.

Three options were considered for implementing thermophilic digestion:

- Convert the two existing large digesters to operate at thermophilic temperatures.
- Convert the three existing small digesters to operate at thermophilic temperatures
- Build one new large thermophilic digester.

▪Converting the existing large or small digesters to operate at thermophilic temperatures does not result in enough digester capacity through the design period, as discussed below. Therefore, those alternatives were not fully developed. Only a new thermophilic digester meets the requirements for this project, thus that option was developed further.

▪Thermophilic digestion provides a large capacity increase for a given digester volume, thus it would not be necessary to convert all the digesters to operate at thermophilic temperatures to achieve the digester capacity requirements of this project. However, this approach would require thermophilic and mesophilic digesters to be operated in parallel, which may be operationally challenging due to changes in digester gas composition, digester heating requirements, dewatering temperature and polymer changes, etc. If operational challenges are observed, the District may prefer to convert all digesters to operate at thermophilic temperatures.

6.4.3.1 Convert the Two Existing Large Digesters to Thermophilic

Figure 6.13 and Figure 6.14 show the thermophilic digestion capacity charts if digesters 5 and 6 are converted to operate at thermophilic temperatures. It was assumed that it would take up to two years to convert an existing digester to operate at thermophilic temperatures. Removing a digester from operation for a year or more may not be possible given the design criteria of this project because the digesters would be overloaded under all design conditions. Depending on the specific modifications required, it may be possible to convert the digesters to thermophilic operation in a shorter time period. If a digester does not need a prolonged out-of-service period, converting the existing digesters to operate at thermophilic temperatures may be a viable option because a capacity deficit caused by taking a digester out of service would not occur. Further study should be performed to determine the expected upgrades, conversion sequencing, and equipment revisions needed for this option.

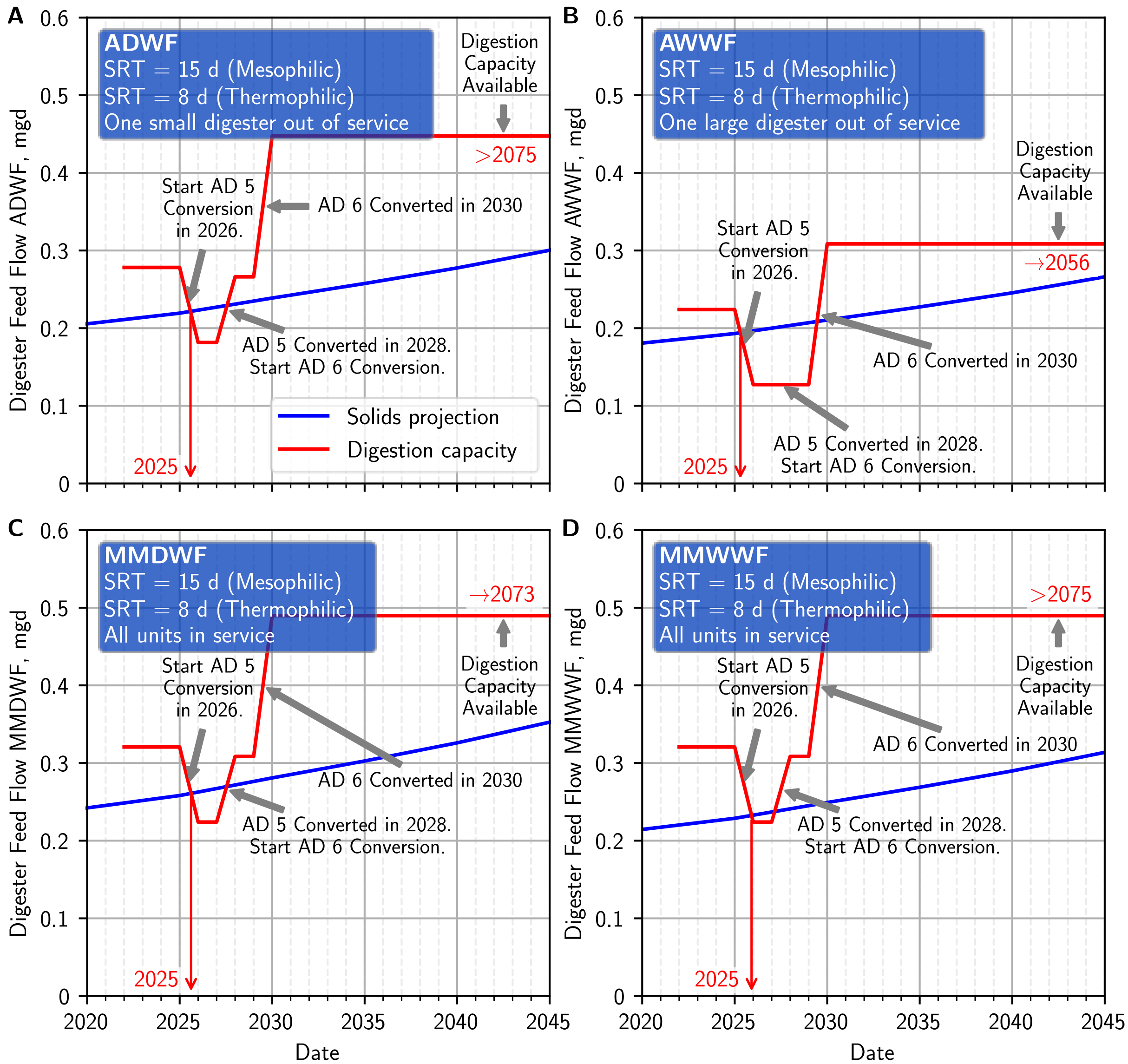

Figure 6.13 Thermophilic Digestion Hydraulic Loading Capacity Projections if Large Digesters are Converted

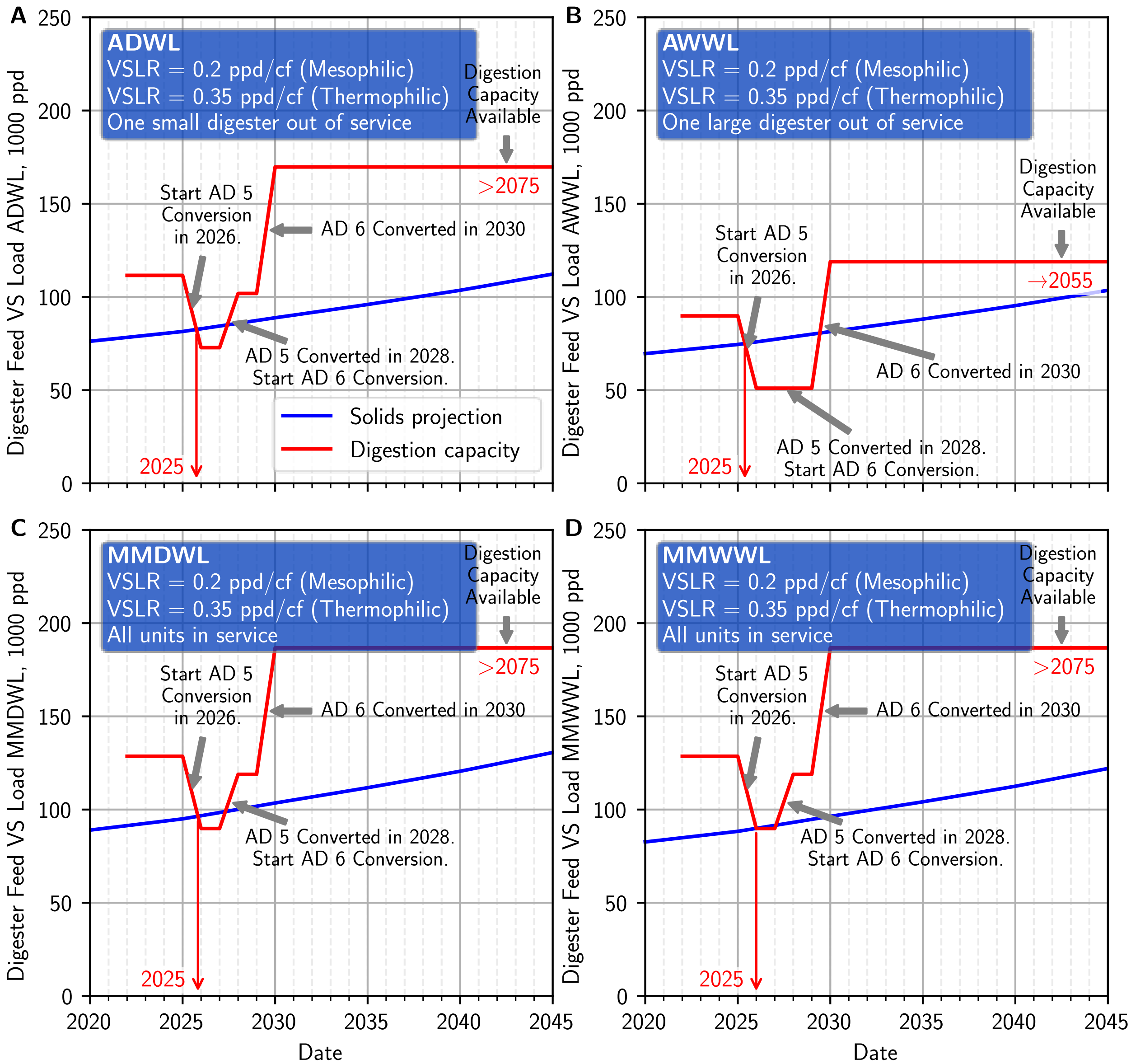

Figure 6.14 Thermophilic Digestion Volatile Solids Loading Capacity Projections if Large Digesters are Converted

6.4.3.2 Convert the Three Existing Small Digesters to Thermophilic

Figure 6.15 and Figure 6.16 show the thermophilic digestion capacity charts if digesters 1, 3, and 4 are converted to operate at thermophilic temperatures. It was assumed that it would take up to two years to convert an existing digester to operate at thermophilic temperatures. Removing a small digester from operation for a year or more may not be possible because the remaining digesters would be overloaded under the average wet weather flow condition with one large digester out of service. However, it may be possible to convert the digesters to operate at thermophilic temperatures over a shorter time period. If a digester does not need a prolonged out-of-service period, converting the existing digesters to operate at thermophilic temperatures may be a viable option. Further study should be performed to determine the expected upgrades, conversion sequencing, and equipment revisions needed for this option.

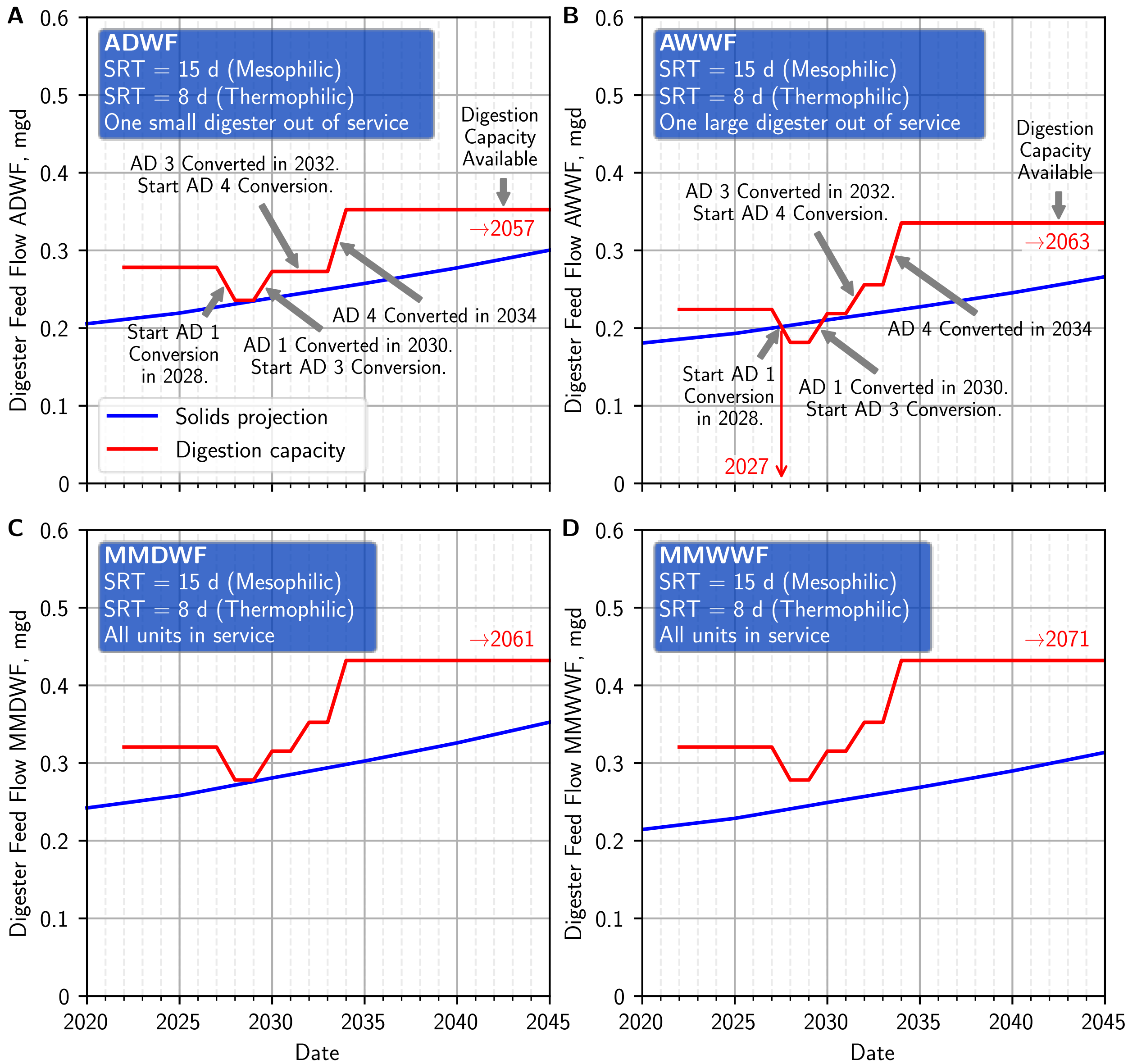

Figure 6.15 Thermophilic Digestion Hydraulic Loading Capacity Projections if Small Digesters are Converted

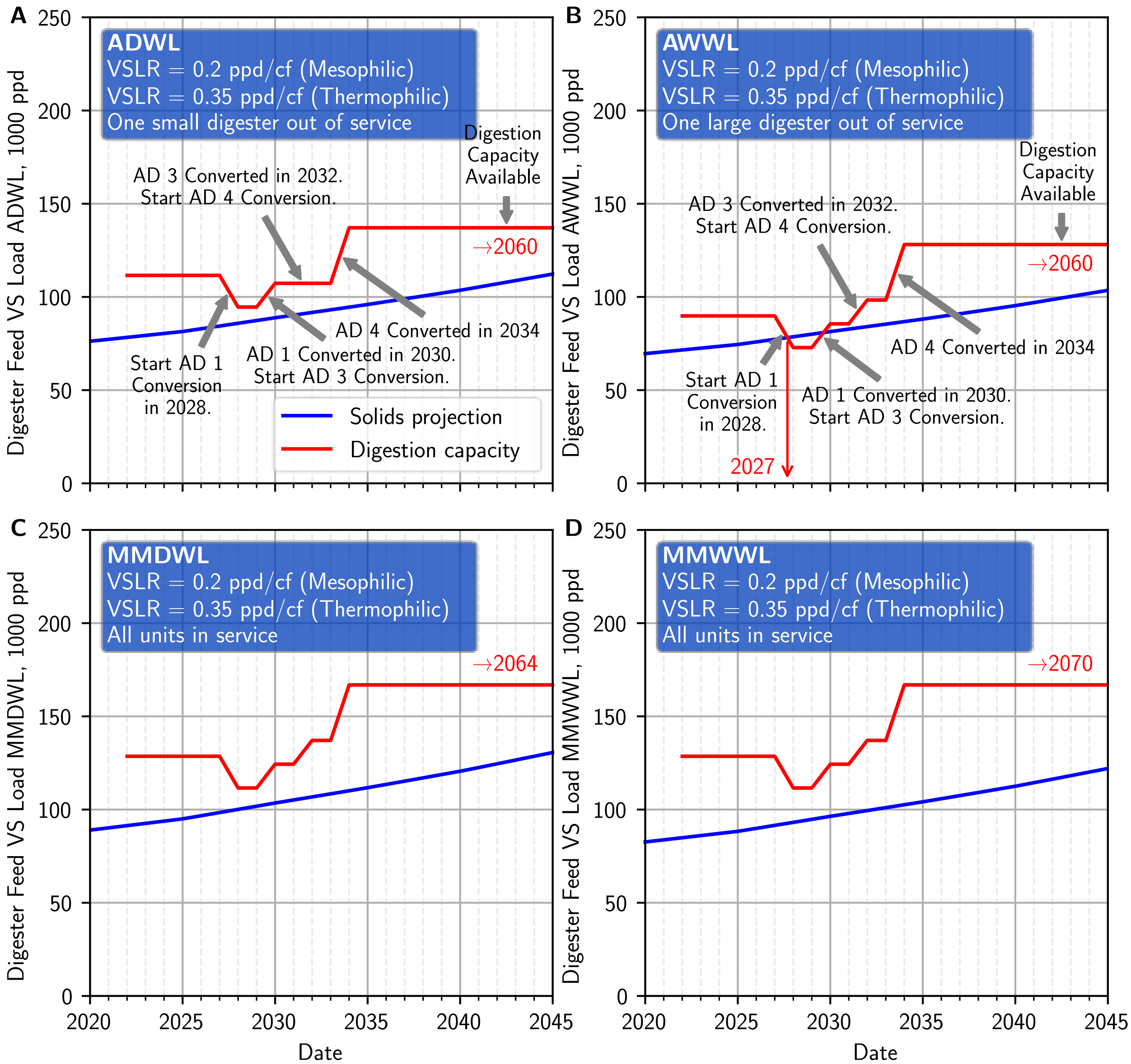

Figure 6.16 Thermophilic Digestion Volatile Solids Loading Capacity Projections if Small Digesters are Converted

6.4.3.3 Construct One New Thermophilic Digester

One new 1.45 MG thermophilic digester may be needed to provide solids stabilization capacity through the planning period while maintaining the required level of redundancy, as shown in Figures 6.17 and 6.18. Because thermophilic digestion can be operated at a shorter SRT than mesophilic digesters, the new digester could potentially be smaller than 1.45 MG, but keeping digester sizes consistent with the existing digesters is a good design and operational practice. Note that the firm digestion capacity for thermophilic digestion is the same as mesophilic digestion (Alternative A) because the new thermophilic digester will be the largest capacity unit.

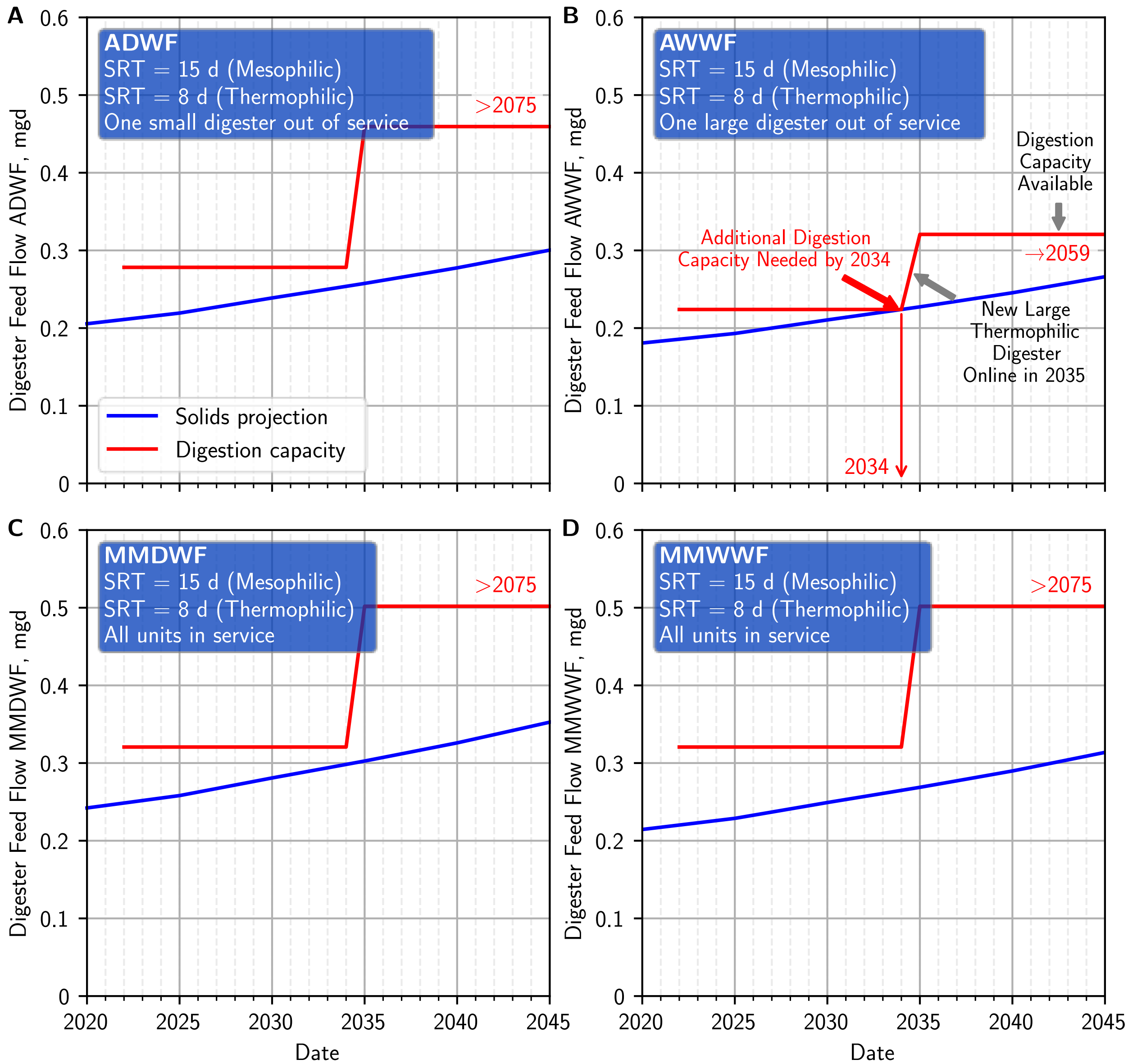

Figure 6.17 Thermophilic Digestion Hydraulic Loading Capacity Projections if One New Digester is Constructed

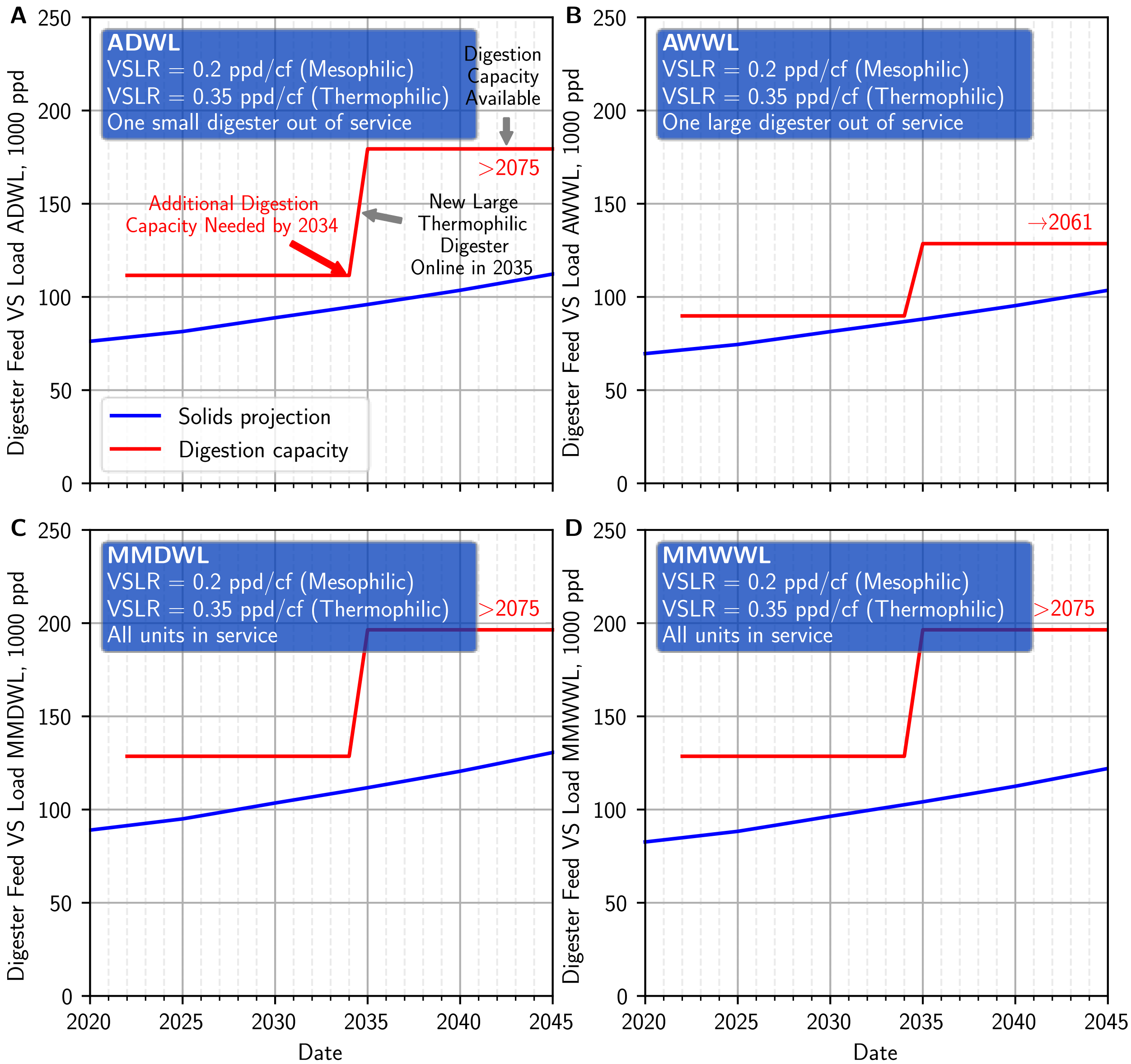

Figure 6.18 Thermophilic Digestion Volatile Solids Loading Capacity Projections if One New Digester is Constructed

Constructing a new thermophilic digester would be required for this alternative unless further study confirms that the existing digesters could be converted to operate at thermophilic temperatures on a shorter timeline.

A representative process flow diagram for this alternative is shown in Figure 6.19.

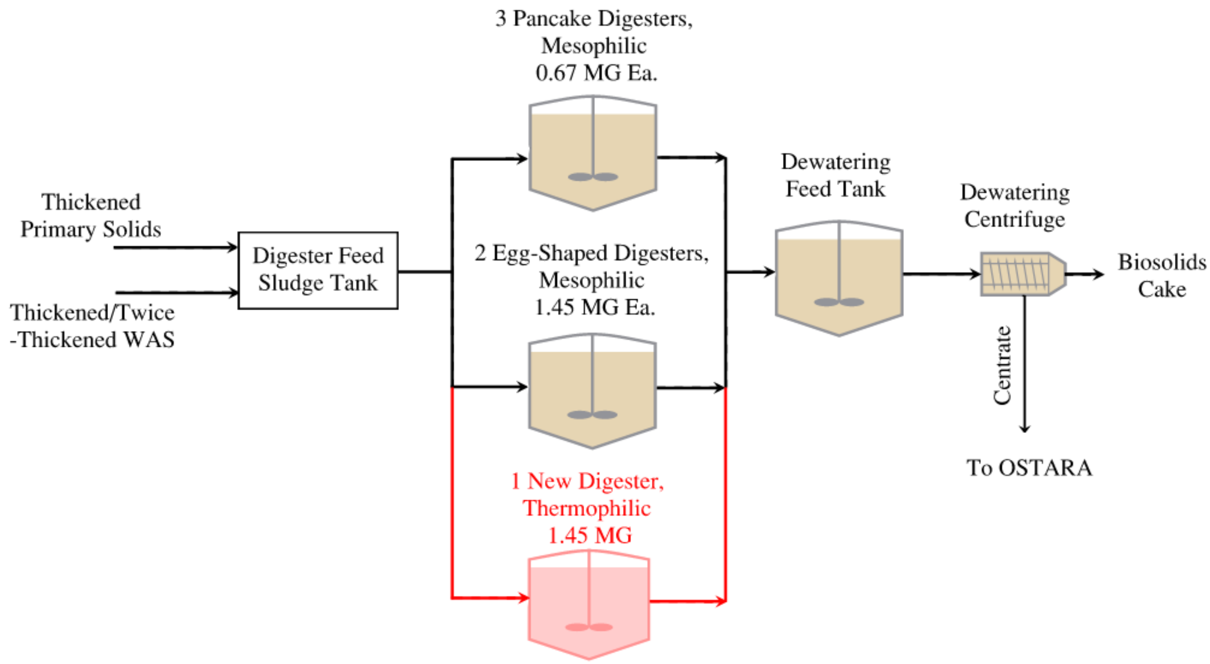

Figure 6.19 Thermophilic Digestion Process Flow Diagram

A representative thermophilic alternative site layout is shown in Figure 6.20.

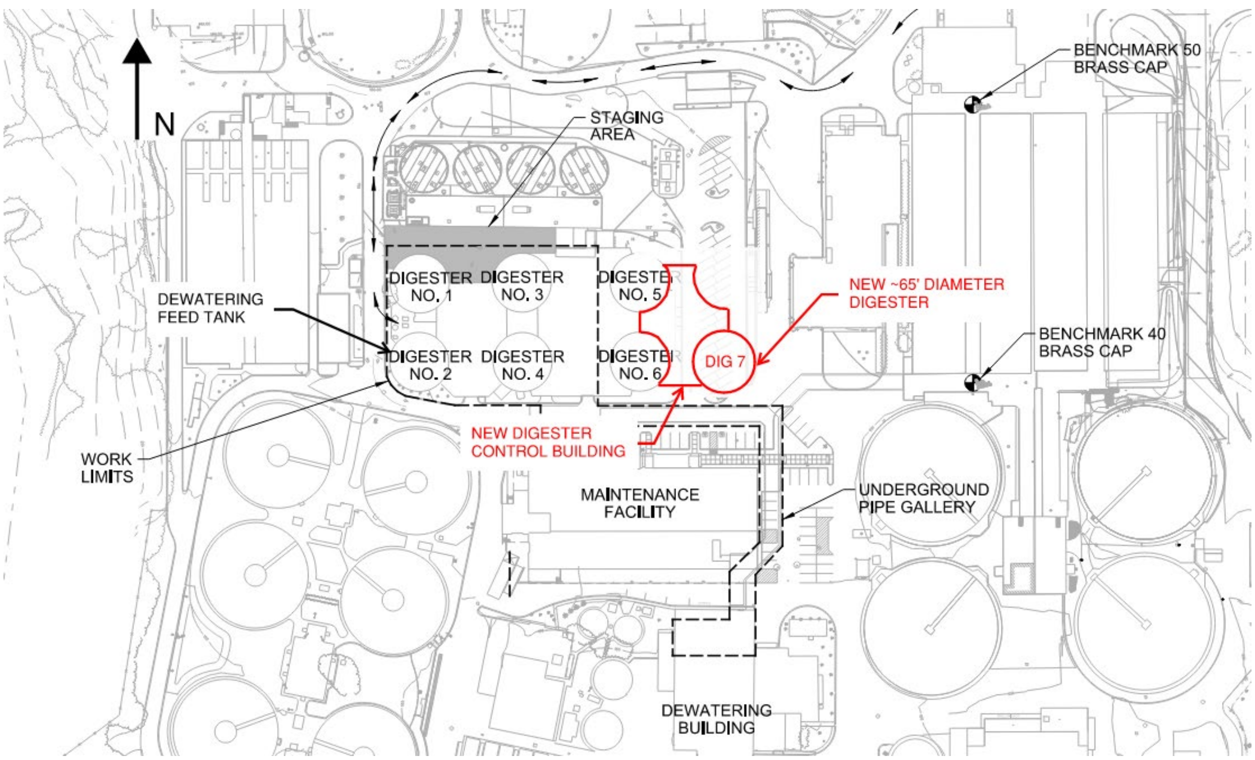

Figure 6.20 Thermophilic Digestion Layout

Table 6.6 summarizes the advantages and disadvantages of thermophilic digestion. If a new digester is needed for this alternative, it may not provide an immediate advantage over the other alternatives. However, designing a new mesophilic digester to safely operate at thermophilic temperatures would provide the benefits of faster biokinetics while preserving flexibility to use other solids stabilization technologies in the future. Further study should be performed to determine how to convert the existing digesters to operate at thermophilic temperatures.

Table 6.6 Thermophilic Digestion Advantages and Disadvantages

Advantages	Disadvantages
Proven Technology ▪ Proven digestion technology. **Constructability/Site Impacts** ▪ May avoid the need for additional digester. **O&M** ▪ Relatively simple operation compared to other more mechanically intensive processes and systems. ▪ Class A biosolids achieved with addition of batch tanks.	**Technology Familiarity** ▪ Requires operational changes from current operations. **Process Compatibility** ▪ May result in changes to digester heating system, operational controls, digester gas characteristics, biosolids dewaterability, polymer demand, etc. **Digester Gas Beneficial Use** ▪ Requires more digester gas for process heating, which leaves less digester gas for beneficial reuse. **Future Regulations** ▪ Does not reduce PFAS. **Sidestream Impacts** ▪ Increased sidestream temperature, nutrient loading, and changes to other characteristics. **Odor Concerns** ▪ Potential increase to biosolids odor. ▪ Potential increase in nuisance struvite precipitation in digesters compared to current operations. **O&M** ▪ Operating thermophilic and mesophilic digesters in parallel may be challenging.

6.4.4 Alternative D - Thermal Hydrolysis Process

Thermal hydrolysis processes involve applying heat, pressure, and/or chemicals to facilitate the release and solubilization of particulate organic material. THP can be integrated into a treatment system upstream of anaerobic digestion, between digestion stages, or downstream of digestion. For this project, only pre-digestion THP was evaluated. Intermediate and post-digestion THP were not considered because they would not increase overall solids processing capacity. THP can also be applied exclusively to waste activated sludge (WAS). Using WAS-only THP systems can lower capital costs while still achieving most of the digestion capacity and dewaterability benefits. However, Class A biosolids would not be produced.

THP systems vary by manufacturer and may operate as either batch or continuous flow processes. Cambi's thermal hydrolysis process is representative of most full-scale THP systems in operation. Other manufacturers have already or are developing comparable processes with different configurations. THP systems require relatively large buildings and equipment footprints, including solids screening, pre-dewatering centrifuges with polymer addition, pre-dewatered cake storage and pumping, solids dilution and cooling systems, steam boilers, and THP reactor tanks. However, THP can often reduce the number of digester tanks needed due to higher allowable digester loading rates and increased SRT from thicker digester feed.

THP is a mature technology, with over 20 years of commercial operation in both Europe and North America. Each manufacturer's operating process differs. Cambi uses a high temperature/high pressure system, while Lystek and Pondus offer low-temperature thermo-chemical hydrolysis. Lystek is generally used as a post-digestion process to create a Class A liquid fertilizer from digested sludge and Pondus has been used primarily to lyse WAS cells for enhanced dewatering but does not generally produce Class A biosolids directly. The Cambi process was assumed for this analysis.

Figure 6.22 shows the THP option capacity projection. The design criteria assumed for THP is a maximum volatile solids loading rate of 0.35 ppd VS/cf, although other design criteria could be evaluated in subsequent phases. Hydraulic loading limitations are not considered for THP because solids are pre-dewatered prior to digestion. Because of the hydrolysis that occurs within the THP process, sludge viscosity changes allow conventional mixing equipment to work well even with high solids concentrations so changes in digester mixing technology should not be required. Installing THP would avoid the need to construct another digester due to the increased solids loading capacity of the digesters.

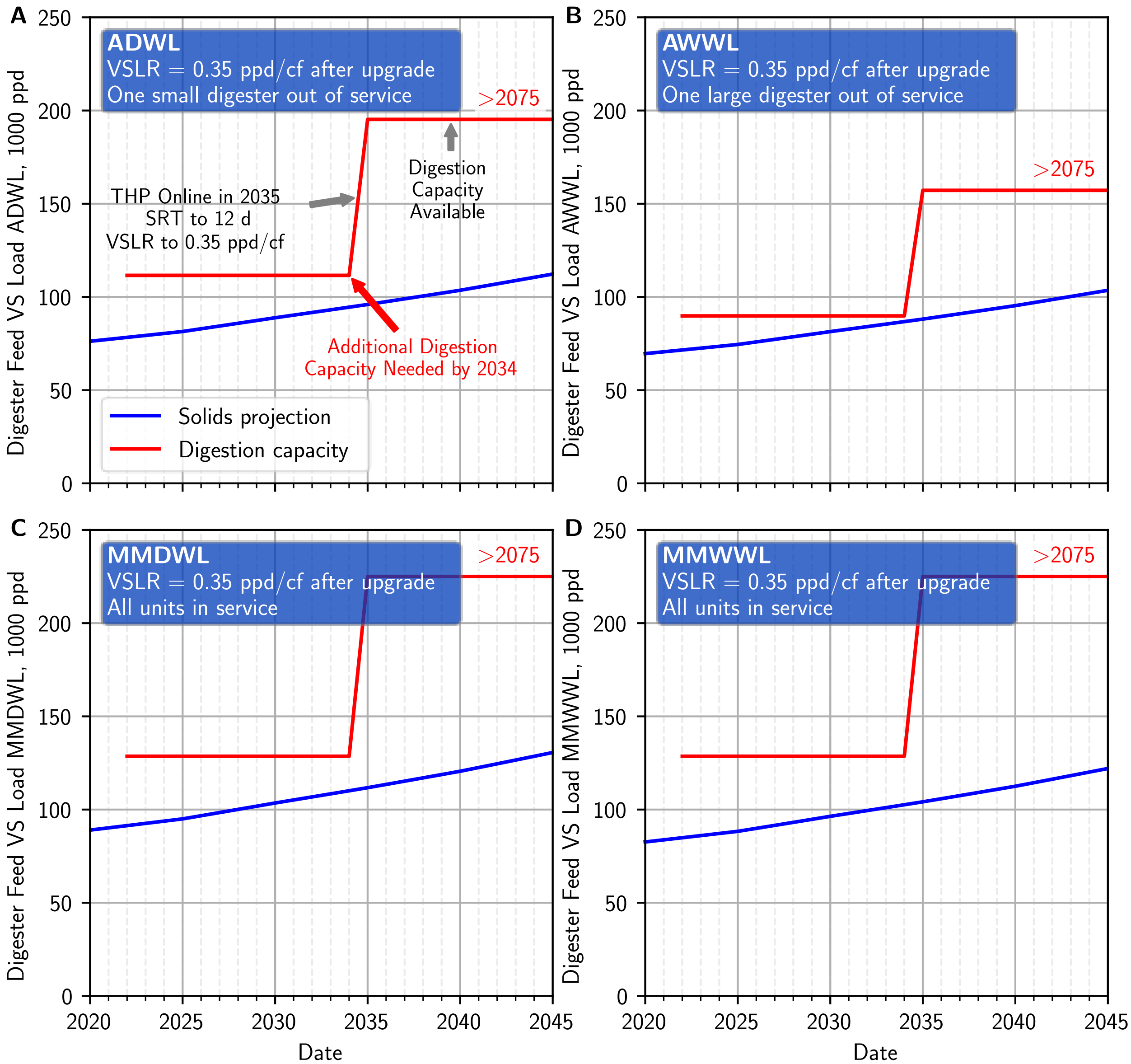

Figure 6.21 THP Volatile Solids Loading Capacity Projections

A representative THP layout is shown in Figure 6.23. The Cambi THP process consists of four main stages:

1. **Sludge screening** removes large debris (plastic, rags, grit) to protect downstream equipment. Screening is usually accomplished using a sludge screen with 3-6 millimeter perforations.
2. **Pre-THP dewatering** uses thickening centrifuges to increase the solids concentration to 16-20 percent total solids. Dilution water is added directly downstream of pre-THP dewatering to reduce the solids concentration to 14-18 percent total solids.
3. **Thermal hydrolysis** consists of three main steps (see Figure 6.24):
   a. **Sludge heating (steam injection)** in the pulper forms a homogenous mix and heats to approximately 100°C in preparation for high-pressure treatment.

b. **High-pressure reactors** heat the sludge to approximately 160°C and 6 bar(g) pressure for 20-30 minutes. This process breaks down cell walls, solubilizing organic material for digestion.
c. **Flash tank** creates a rapid depressurization and cooling effect to the sludge, further enhancing biodegradability and significantly reducing sludge viscosity.

4. **Sludge cooling** reduces the sludge temperature to the operational temperature of the digester, usually 95-100°F for mesophilic digestion. A heat exchanger is used to reduce the temperature first, followed by dilution water. In some cases, dilution water is added upstream of the heat exchanger.

After THP, sludge is digested, stored, and dewatered similar to the other digestion alternatives described above.

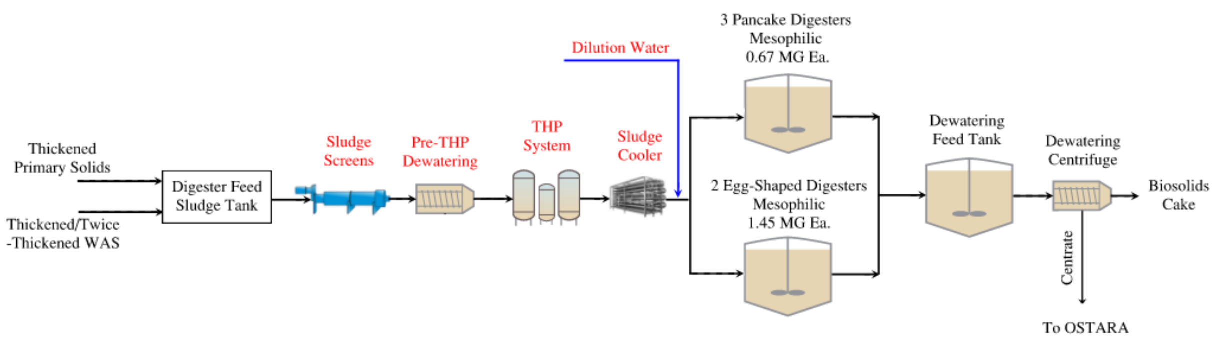

Figure 6.22 THP Process Flow Diagram

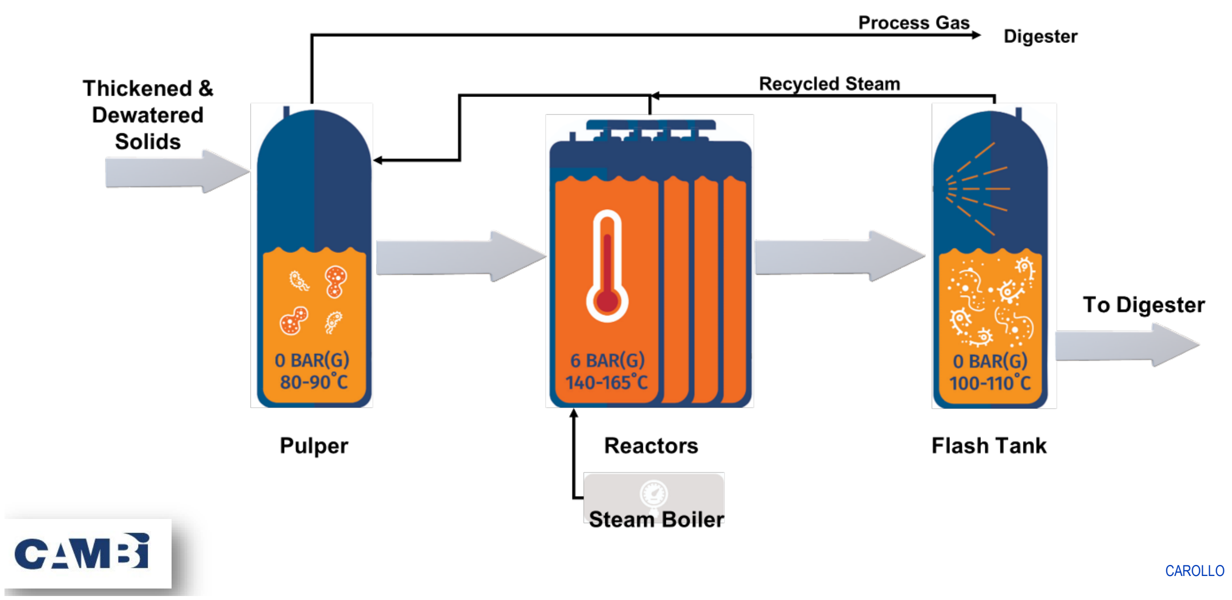

Figure 6.23 Cambi THP Process Schematic

A representative THP alternative site layout is shown in Figure 6.24. Although this location has many of the same constructability issues as the mesophilic digestion alternative, the THP system would not require as much shoring because the equipment can be built at grade and would result in lower seismic loads.

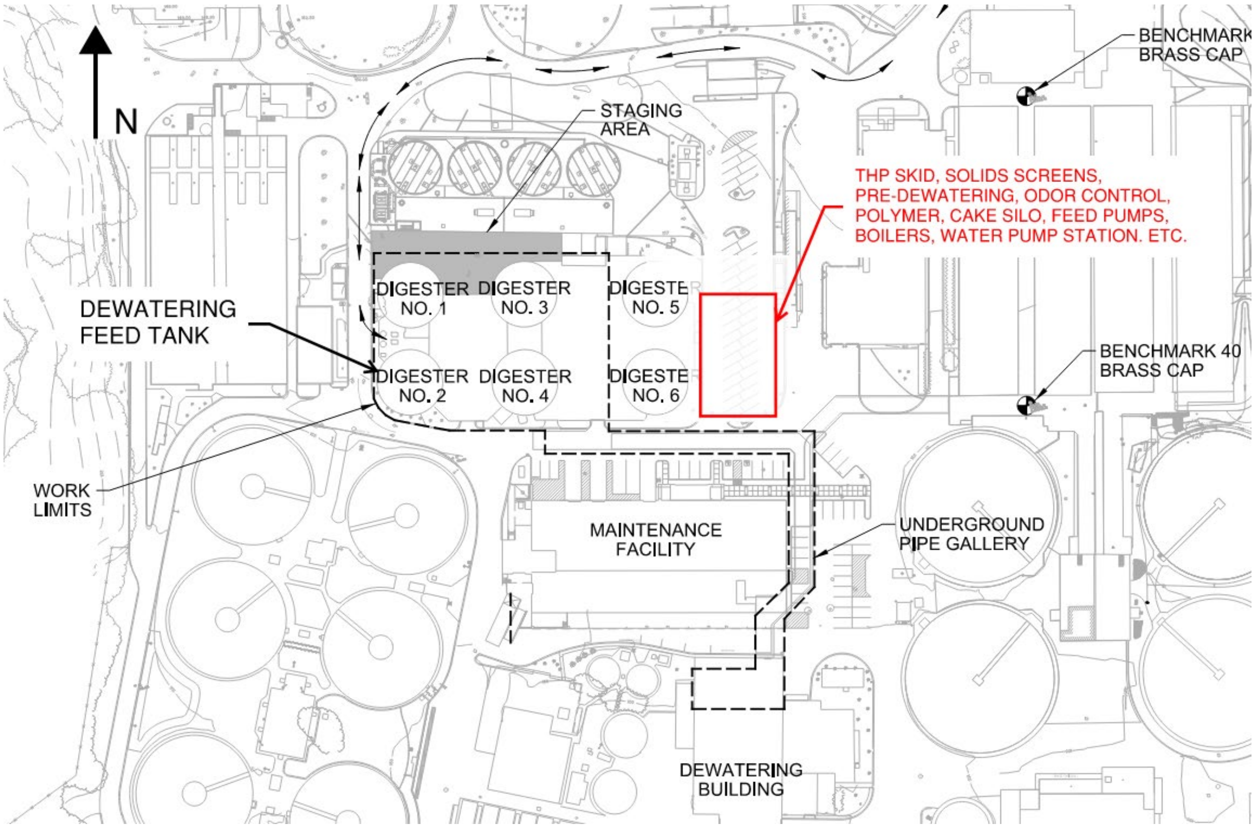

Figure 6.24 THP Layout

Advantages and disadvantages of the THP alternative are shown in Table 6.7. THP is an established technology with significant benefits in reduced digester volume needs, dewaterability, Class A biosolids production, and reductions in digester foaming. The process can also produce biosolids that can be cured to form an aesthetically pleasing soil-like material that has been successfully marketed as soil amendments in other parts of the country. However, the footprint of a THP facility is similar to single new digester and associated elements that would be required for Rock Creek without THP, THP also includes significantly more mechanical equipment than other alternatives, including steam boilers that may require specialized staffing. The added complexity and cost of that equipment is unlikely to outweigh the advantages of THP, especially without the quantity reduction benefits that other Class A options like drying could provide. Furthermore, the cost of the overall modifications necessary to implement THP will likely be higher than the addition of a single new digester. For these reasons, THP was not selected for further evaluation for Rock Creek.

Table 6.7 THP Advantages and Disadvantages

Advantages	Disadvantages
Proven Technology ▪ Established technology. **Odor Concerns** ▪ Minimal odor concerns with process or biosolids; may be slightly different odor than current biosolids. **Constructability/Site Impacts** ▪ Additional digesters may not be needed. ▪ Reduced truck traffic due to enhanced dewaterability. **O&M** ▪ Class A biosolids guaranteed (when both primary and secondary solids are processed with THP). ▪ Valuable Class A biosolids product can be produced with post-processing and curing.	**Technology Familiarity** ▪ Need additional training and O&M. ▪ Increased system complexity. **Process Compatibility** ▪ Additional mechanical equipment required. ▪ Requires steam (safety and operational concern). ▪ Large cooling and dilution water demand. **Digester Gas Beneficial Use** ▪ Reduced digester gas availability for beneficial use due to increased heat demand compared to mesophilic digestion. **Future Regulations** ▪ No impact to PFAS removal. **Sidestream Impacts** ▪ Additional side stream likely created with pre-dewatering, depending on sludge characteristics. ▪ Pre- and post-dewatering sidestreams have increased nutrient loads. ▪ Sidestream impacts have negative impacts on UV disinfection (if implemented in the future). ▪ Additional solids screening waste stream.

6.4.5 Alternative E - Solids Dryer

Thermal drying is used to evaporate water from wastewater solids and reduce pathogens. Moisture is removed in the exhaust gas. Particulate removal is often performed prior to releasing exhaust air. There are two basic types of thermal dryers: indirect and direct.

- Indirect dryers use steam or thermal oil as a heating medium and indirectly heat wastewater solids across a conductive boundary. Indirect dryers include paddle, rotary screw, tray, and others.
  - Paddle, rotary screw, and tray dryers operate in a similar fashion. Dewatered solids are heated by hollow rotating paddles/screws/shelves and a heated jacket using steam, hot oil, or gas at 300-600°F. These dryers produce a dusty product that is difficult to handle. Therefore, they were not considered for this analysis.
  - Solar dryers are also available, but require significantly more land area than available at Rock Creek, thus they were not considered for this analysis.
- Direct dryers evaporate moisture in wastewater solids via convective contact with hot gases. Direct dryers include rotary drum and belt dryers.
  - Rotary drum dryers are large rotating drums that slowly tumble and mix the solids for even drying. Heated air from 400 to 1,100°F causes evaporation.
  - Belt dryers consist of a slow-moving, porous belt inside a heated, enclosed chamber. Dewatered solids are distributed on the belt and warm air (180-320°F) is blown through the belt. Some systems use multiple stacked belts for energy- and space-efficient drying.

Rotary drum dryers are relatively tall, but produce a high-quality product and are viable for Rock Creek. However, they have a smaller footprint and operate at higher temperatures than belt drying. To be conservative, belt drying was selected for this analysis.

A typical dryer is operated to produce dried product that is at least 90 percent solids, which automatically achieves Class A biosolids and significantly reduces the mass of solids hauled from the facility. It may be possible to operate a thermal dryer to achieve less than 90 percent solids, which may reduce the size, cost, or fuel demand of the dryer. However, the biosolids would not achieve Class A and would need to be sampled to prove that they meet the pathogen and vector attraction reduction requirements for Class B biosolids prior to land application. Additionally, wastewater solids experience a glue-like plastic phase in the 55 to 75 percent solids range. To avoid this phase and improve final product quality, dried product is often back-mixed with wet solids. The dried solids content would need to be managed to avoid the plastic phase and facilitate solids handling.

This alternative includes a new thermal dryer following digestion and dewatering. Because dryers produce Class A biosolids, the digesters would not need to be operated to produce Class B biosolids if the digested solids are dried. This alternative assumes that the existing digesters can be operated with an SRT as short as 12 days while maintaining stability. Mesophilic digesters can generally be operated with an SRT as short as 12 days before digester instability occurs. Shorter than 12 days often results in digester instability due to a loss of methanogenic microorganisms. Importantly, operating the digesters at an SRT of 12 days requires the dryer to be online. If the dryer was offline, the digested solids would not meet Class B. Given this risk, it was assumed that the reduced SRT of 12 days would apply for the redundancy conditions and that an SRT of at least 15 days would be maintained under normal operation.

This alternative is both hydraulically and organically limited, as shown in Figure 6.25 and Figure 6.26. An additional digester would be required by 2034 due to the hydraulic loading limitation.

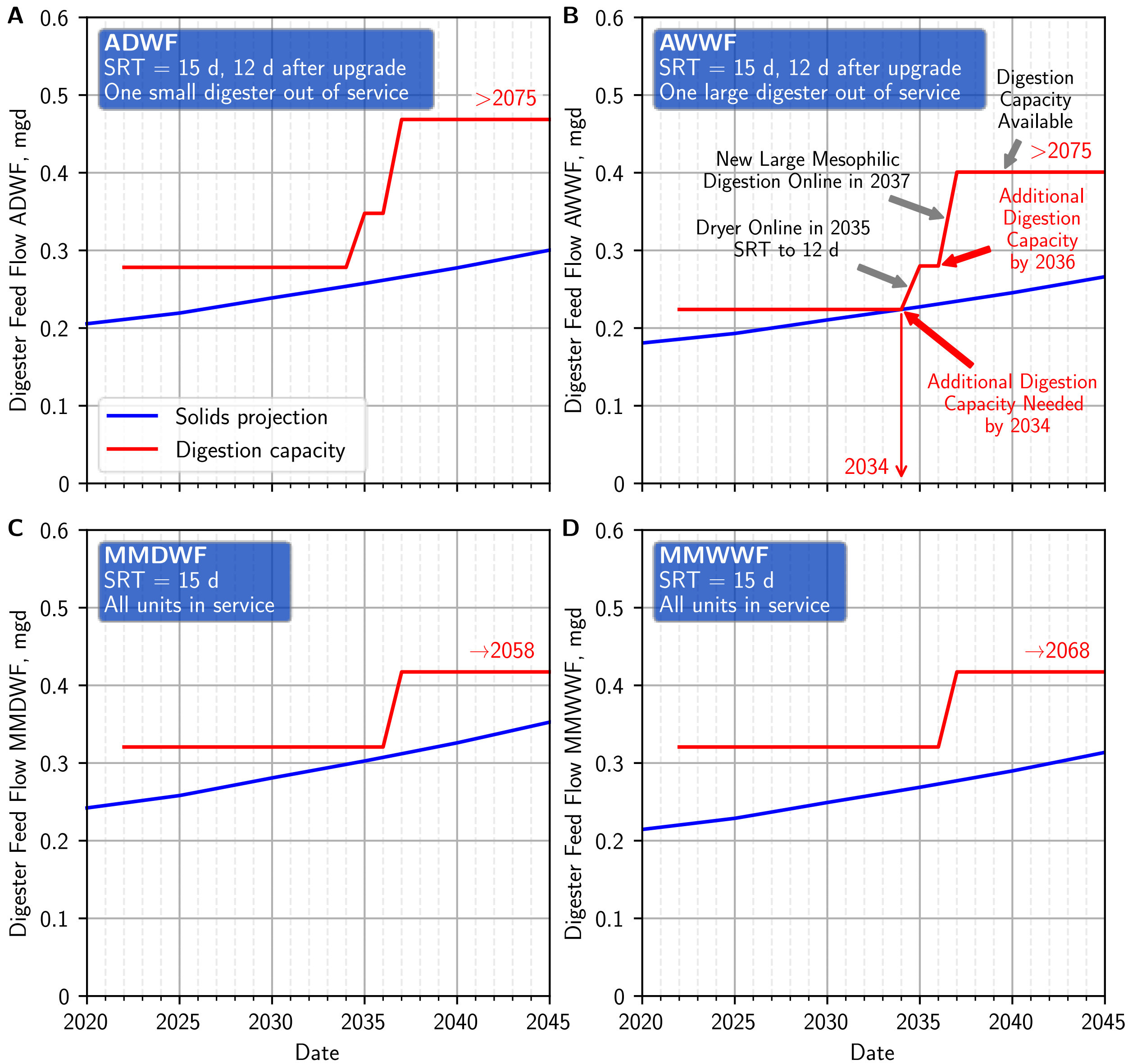

Figure 6.25 Thermal Dryer Hydraulic Loading Capacity Projections

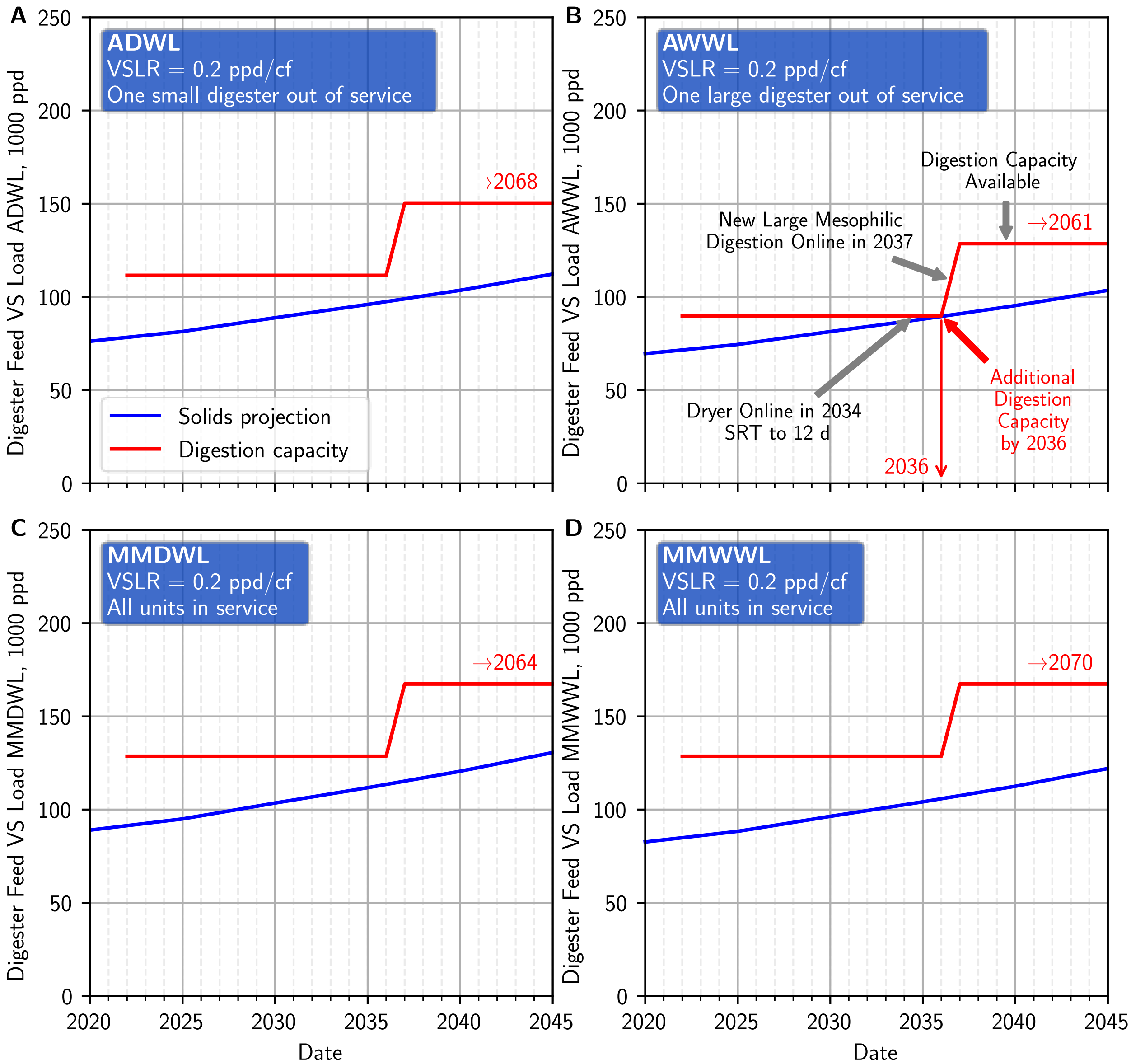

Figure 6.26 Thermal Dryer Volatile Solids Loading Capacity Projections

It may also be possible to bypass digestion with a portion of raw solids and dry them directly. This approach would allow the digesters to maintain the mesophilic design criteria stated above while guaranteeing Class A biosolids. However, raw solids drying is possible but is not generally recommended by dryer manufacturers. In particular, drying primary solids can create significant odors and the high volatile content of raw solids can increase the risk of thermal events. Therefore, this approach is not recommended.

A representative process flow diagram is shown in Figure 6.27, showing both a new dryer and a new digester.

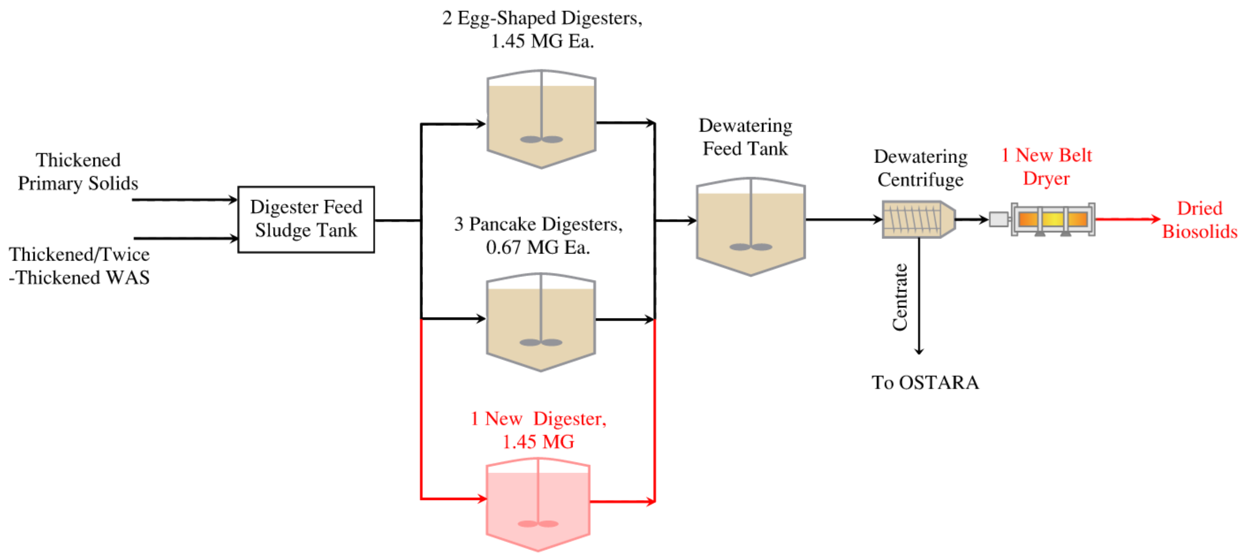

Figure 6.27 Thermal Dryer Process Flow Diagram

A representative layout for a new digester and thermal drying facility is shown in Figure 6.28. The thermal dryer facility could potentially be located south of the dewatering building make sense from a process adjacency standpoint, although this location may require pipe relocation and would consume space that is currently needed for future tertiary treatment processes. It should also be noted that this area is within the lateral spread zone, adding to the complexity and cost of any new development. The planning team discussed other potential locations for the dyer facility (e.g., northeast of the site adjacent to Southeast River Road); however, the facility should be located as close as possible to the dewatering building to reduce the complexity of conveying dewatered sludge cake to the dryer. Further evaluation of site layout should be performed in subsequent phases.

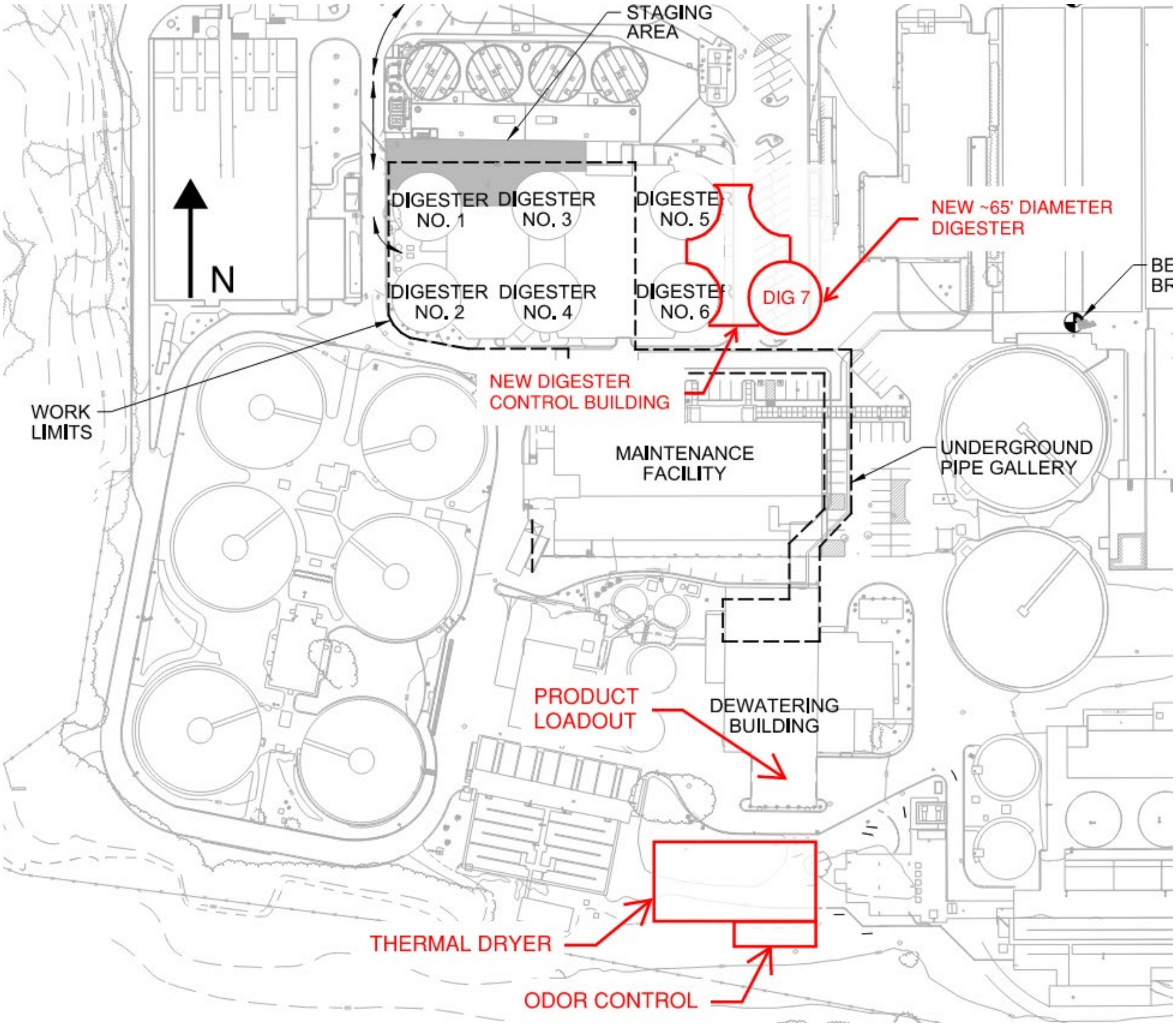

Figure 6.28 Thermal Dryer Site Layout

Advantages and disadvantages of the solids drying alternative are shown in Table 6.8. Solids drying is a reliable and proven technology for solids stabilization selected for further evaluation. Adding solids dryers is not expected to significantly increase the capacity of the existing digestion system, however, it is prudent to continue evaluating drying because it significantly reduces the quantity of material requiring management and is necessary upstream of gasification and pyrolysis, which are two thermal processes being studied for their ability to possibly destroy PFAS in biosolids. Therefore, solids dryers were selected for further evaluation.

Table 6.8 Thermal Dryer Advantages and Disadvantages

Advantages	Disadvantages
Proven Technology ▪ Established technology. **Process Compatibility** ▪ Minimal impacts expected to existing process. **Future Regulations** ▪ Necessary as part of a thermal treatment train comprised of drying+gasification or drying+pyrolysis, which may be options to meet future PFAS regulations. **Sidestream Impacts** ▪ Minimal impact from drying sidestreams. **O&M** ▪ Significantly reduces hauling costs. ▪ Can achieve Class A biosolids. ▪ Reduced truck traffic due to decreased biosolids volume.	**Technology Familiarity** ▪ Increased system complexity. ▪ Need additional training and O&M. **Digester Gas Beneficial Use** ▪ Drying will consume most produced digester gas. **Odor Concerns** ▪ Significant odor control requirements. **Constructability/Site Impacts** ▪ Construction challenges, including large-diameter pipe relocation and building within the lateral spread zone, associated with the proposed dryer location. ▪ Locations adjacent to existing dewatering facilities (which are preferred) are currently planned for other critical plant processes. **O&M** ▪ Additional mechanical equipment required. ▪ Does not eliminate the need for additional digesters.

6.4.6 Other Available Technologies

PONDUS and autothermal thermophilic aerobic digestion (ATAD) were briefly reviewed, but were not selected for further evaluation due to several factors, including site-specific constraints and non-alignment with project objectives. As a result, site layout and conceptual design information were not developed for these technologies. The following sections provide a brief description of these two alternatives.

6.4.6.1 PONDUS

The PONDUS thermal hydrolysis process is an anaerobic digestion pre-treatment method that enhances sludge hydrolysis and improves dewaterability using low-grade heat and sodium hydroxide. The process can improve digester volatile solids destruction and gas production, increase cake dryness in dewatering, and reduce polymer demand. This process is particularly effective when applied to WAS, although it can be applied to primary and secondary sludge to achieve Class A biosolids. The PONDUS process begins with sludge feeding, where WAS or a combination of sludge types is introduced into the system. Sodium hydroxide is then added to raise the pH of the sludge to at least 11, which facilitates the breakdown of complex organic molecules, including cell walls and extracellular polymeric substances.

Unlike conventional thermal hydrolysis, which operates at high temperatures of 320–360°F, the PONDUS system uses moderate heat ranging from 180–210°C. The sludge remains in the hydrolysis reactor for one to two hours. After pre-treatment, the sludge is transferred to anaerobic digesters. While there are a number of potential benefits from this process, it does not allow for increased digester loading or reduce SRT requirements, so it does not reduce overall digester capacity needs.

A representative process flow diagram for a PONDUS system is shown in Figure 6.29. The process flow assumes WAS-only THP treatment.

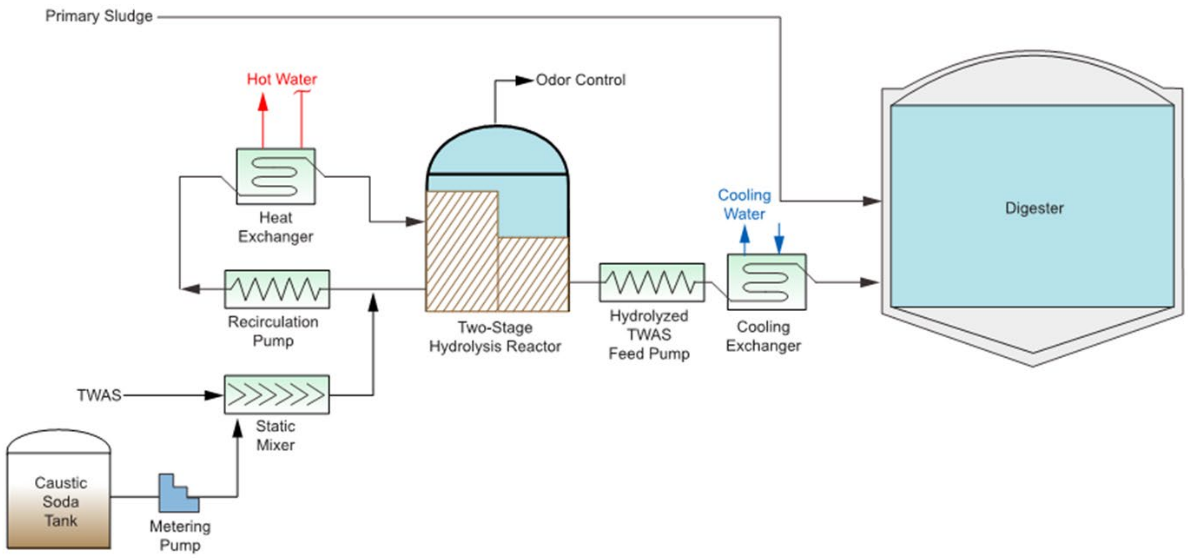

Figure 6.29 PONDUS Schematic

PONDUS has not been shown to significantly impact the capacity of the digesters, thus it does not address the need for solids stabilization capacity at Rock Creek and was not selected for further evaluation.

6.4.6.2 Autothermal Thermophilic Aerobic Digestion

ATAD is an aerobic digestion process that is operated at thermophilic temperatures to achieve solids stabilization and pathogen reduction. The process is operated at a thermophilic temperature from 110°F to 150°F. The temperature is achieved by leveraging the exothermic microbial oxidation process. With sufficient insulation, appropriate hydraulic retention time, adequate solids concentration, and mixing, the process can be controlled to maintain thermophilic temperatures and achieve high volatile solids destruction. When controlled to a temperature between 122°F and 140°F and maintained for a 10-day SRT, the process meets USEPA 40 CFR Part 503 Class A designation. A representative ATAD process flow diagram is shown in Figure 6.30.

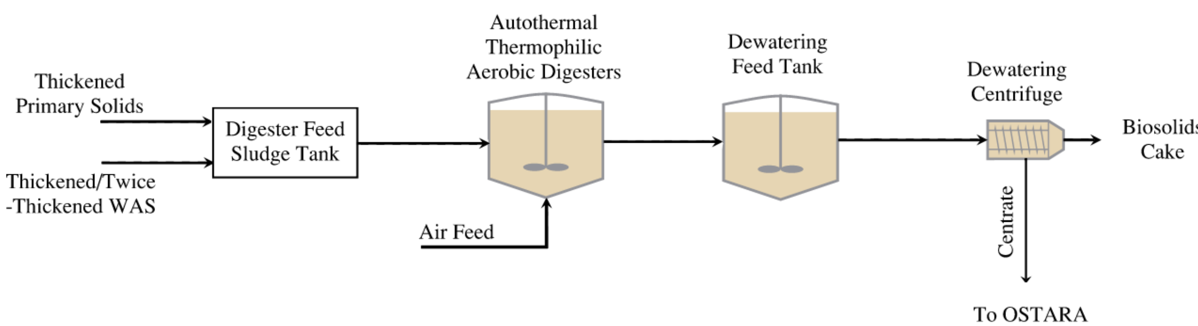

Figure 6.30 Autothermal Thermophilic Aerobic Digestion Process Flow Diagram

The status of ATAD is in decline in North America, although recent innovations may be promising for future applications. Few historical ATAD installations operated at large facilities. Major operating issues with nearly all ATADs included serious odor problems, foaming, and temperature control. Product odor issues often prevented or impaired the beneficial use of the final product. Because ATAD is not common industry practice, would require significant process revisions, and would significantly increase power demand, it is unlikely to provide value for the District and was not selected for further evaluation.

6.4.7 Alternatives Screening

Table 6.9 summarizes the initial screening exercise.

Table 6.9 Alternatives Screening

Alternative	Decision	Comment
Alternative A - Add Mesophilic Digestion Capacity	Selected for further evaluation	Reliable technology with operator familiarity
Alternative B - High Solids Digestion	Eliminated	Significant increase in mechanical equipment, higher recuperative thickening cost, and limited information supporting stable operation for sludge-only digestion at claimed high volatile solids loading rates.
Alternative C - Add Thermophilic Digestion Capacity	Selected for further evaluation	Further study needed to evaluate conversion of existing digesters to thermophilic operation. Option to operate one new digester at thermophilic temperatures.
Alternative D - Add THP	Eliminated	Need for additional equipment, steam, and concerns about sidestream load and overall system complexity
Alternatives E - Add Solids Dryer	Selected for further evaluation	Potentially needed as part of post-digestion treatment train to address future PFAS limits in biosolids.

6.4.8 Economic Evaluation

The solids stabilization alternatives were evaluated using the cost criteria defined above. The capital and O&M costs for each alternative are summarized in Table 6.10. Details for the capital costs are included in Appendix 6B.

Of the alternatives considered, solids drying has a substantially higher capital cost. However, annual O&M cost is lower due to lower biosolids hauling costs. While adding a solids dryer is a significant investment, this alternative is an important step to a future technology train that may address PFAS.

Table 6.10 Solids Stabilization Alternatives Cost Estimate

Digestion Alternatives	Capital Cost of Digestion	Capital Cost of Drying	Annual O&M Cost	Net Present Cost(1)
Alternative A - Add Mesophilic Digestion Capacity	$41M	$0M	$160,000	$44M
Alternative C - Add Thermophilic Digestion Capacity	$44M	$0M	$230,000	$48M
Alternative E - Add Solids Dryer	$41M	$91M	$110,000	$134M

Notes:
(1) Over 20-year planning period.

6.5 Recommendations

A primary benefit of thermophilic digestion – reduced tankage relative to mesophilic digestion – cannot be realized at Rock Creek due to the need to maintain reliable digestion capacity while taking existing digesters out of service for thermophilic conversion (given the load projections, a new digester would need to be constructed before existing digesters could be taken out of service for the required structural and mechanical retrofits). Converting Digesters 1 through 4 to thermophilic digesters is not recommended, as these digesters are older, located in an area that is subject to seismic instability, and not designed to withstand a significant seismic event. Making a significant investment in process tanks that are not seismically resilient is not consistent with the District's long-term plan to maintain reliable operation after a hazard event. The thermophilic conversion alternative also presents process risks that are avoided if mesophilic digestion is maintained

Constructing one new 1.45 MG mesophilic digester by 2034 is recommended. During preliminary design, features that would allow the digester to operate at either mesophilic or thermophilic temperatures should be evaluated, and implemented if possible to preserve the flexibility to convert the new digester to thermophilic operation at some point in the future.

Although the District does not currently plan to reserve capacity for codigestion of high strength waste, compatibility with codigestion is a benefit of the recommended alternative and, following expansion, any spare capacity can be used for codigestion.

The solids drying alternative is more expensive, requires considerably more mechanical equipment, does not significantly extend the timeline before a new digester is needed, and is very difficult to locate at the existing Rock Creek site. Drying may be needed in the future to respond to biosolids PFAS regulations. While solids drying is not recommended as part of this project, it may be prudent to reserve space on the site for future drying, which would be a necessary step in a post-digestion process train to destroy PFAS. Alternately, dewatered sludge from the Rock Creek digesters could be hauled to a regional post-digestion facility that could include comprehensive (e.g., drying and gasification or pyrolysis) post-digestion facilities.

6.5.1 USEPA Draft Risk Assessment

In January 2025, the USEPA released a draft risk assessment (DRA) evaluating the potential human health risks associated with PFOA and PFOS in land applied, surface disposed (monofilled), or incinerated biosolids. The DRA indicated potential risks associated with each of these three management approaches, with risks quantified through the USEPA's modeling methodology for land application and surface disposal and only indicated qualitatively for incineration due to a lack of data.

It should be noted that the risk assessment is in draft form and is not a regulatory guideline. Nevertheless, once finalized, it may inform future regulations. Before that happens, the USEPA will receive comments on the draft assessment and will determine those comments that they feel should be addressed. That may result in changes to the assessment. Furthermore, past regulatory action included both a risk assessment and an evaluation of risk management approaches in which risk mitigation measures, costs, benefits, and technical feasibility are considered. If the USEPA follows this past pattern, that risk management evaluation must be completed prior to regulatory promulgation.

The DRA relative to land application of biosolids was conducted for a hypothetical “farm family” and does not evaluate risks to the general population. The “farm family” represents a group exposed to a concentrated risk due to the assumptions made by the USEPA. They assumed that the “farm family” applies biosolids for 40 years to their land and subsists almost entirely for 10 years on the meat, milk, eggs, crops, and drinking water from a well on the farm site. Eighteen different consumption-based exposure pathways were studied for the farm family based on a variety of fate and transport models used by the USEPA. Through this assessment, at a concentration of 1 part per billion of PFOS or PFOA in the biosolids, the USEPA’s thresholds for cancer and/or non-cancer risks were exceeded under some of the modeled scenarios for the farm family.

As academic and industry experts review the DRA, they have already raised a number of questions regarding the methodology used and the very limited data/sources used by the USEPA for fate and transport. The comments they submit during the comment period may result in changes to the DRA. Federal administration changes also make future actions uncertain. Nevertheless, the DRA released as it was and misunderstandings about what it represents have already led to some state-level pushes to limit land application and other practices. In addition, farmers and some agricultural partners who use biosolids for land application are also concerned about potential risks and liability. Hence, it is prudent to consider alternative forms of biosolids management to diversify biosolids management options. The suggestion in this evaluation includes planning for space to install a thermal dryer that would be necessary ahead of advanced thermal processes like pyrolysis or gasification. Research of pyrolysis and gasification has indicated promising results for reduction or destruction of those PFAS currently analyzed for in the solids products from the processes, but the levels of PFAS in condensate and exhaust from these processes are still being studied. Nevertheless, these technologies paired with systems like regenerative thermal oxidizers for exhaust may be options in the future if PFAS destruction in biosolids is required. We recommend continuing to track PFAS regulations and preserving the option to install thermal drying and thermal decomposition technologies in the future.

APPENDIX 6A ROCK CREEK WRRF DIGESTION ALTERNATIVES - WORKSHOP 3

Clean Water Services

Rock Creek WRRF Digestion Alternatives Workshop - 3

West Basin Master Plan

August 19, 2024

carollo

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Agenda

- Review of Prior Work
- Solids Processing Alternatives
  - » Alternative A – Add Mesophilic Digestion Capacity
  - » Alternative C – Add Thermophilic Digestion Capacity
  - » New Alternative – Add Thermal Drying
- Initial Conclusions and Recommendations
- Next Steps

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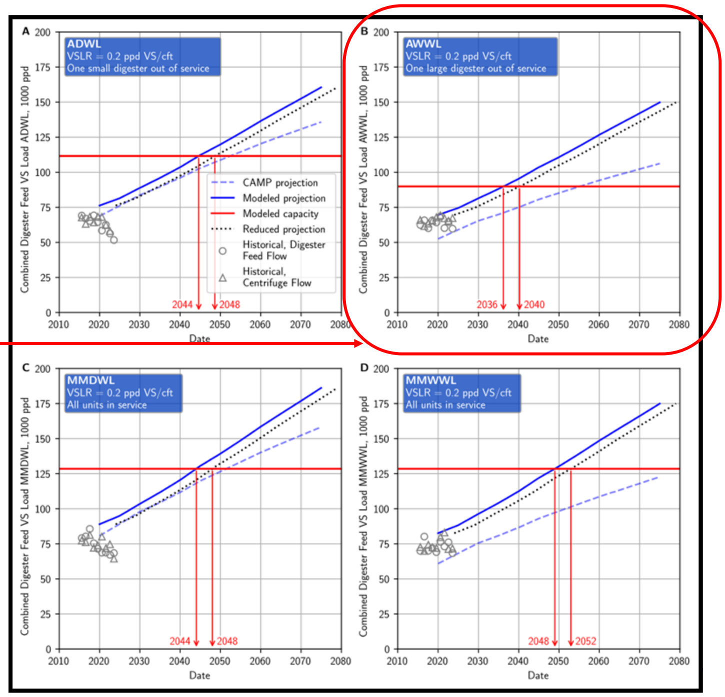
Review of Prior Work

Trigger Plots (Organic Loading)

Organic Loading Limitation: AWWL, Year 2036



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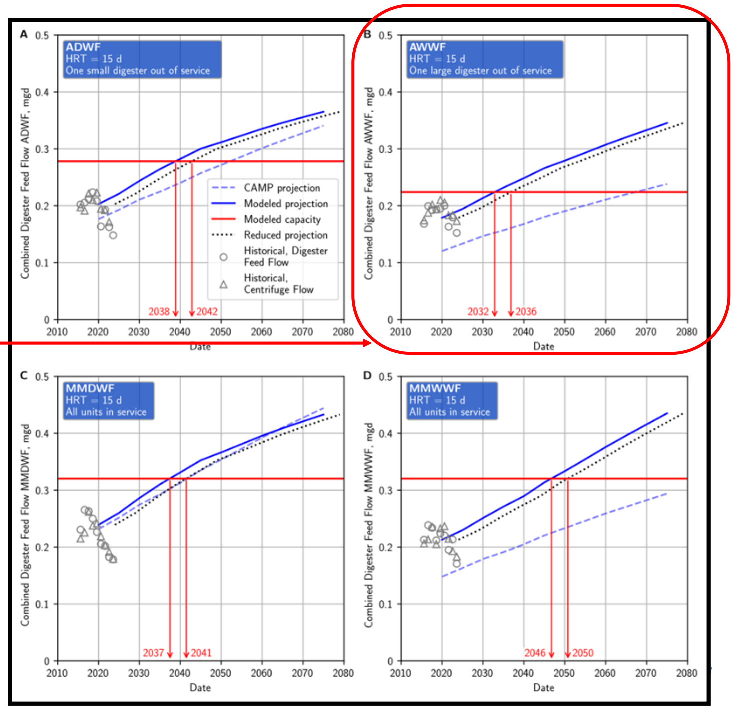
Trigger Plots (Hydraulic Loading)

Limiting Condition: AWWF, Year 2032



Summary of Initial Alternative Screening

- Alternative A: Add Mesophilic Digestion Capacity – Kept for Further Evaluation
- Alternative B: High Solids Digestion (Anaergia/Omnivore) – Eliminated: higher risk of gas entrainment and RVE, high recuperative thickening cost, unproven design criteria
- Alternative C: Add Thermophilic Digestion Capacity – Kept for Further Evaluation
- Alternative D: THP – Eliminated: additional mechanical equipment, requires steam, sidestream load concern, overall system complexity
- Other Ideas
  - » PONDUS – Eliminated: does not increase digester capacity
  - » ATAD – Eliminated: net energy expenditure, extensive process change
  - » Solids Dryers – Added as a potential step towards future PFAS regulation

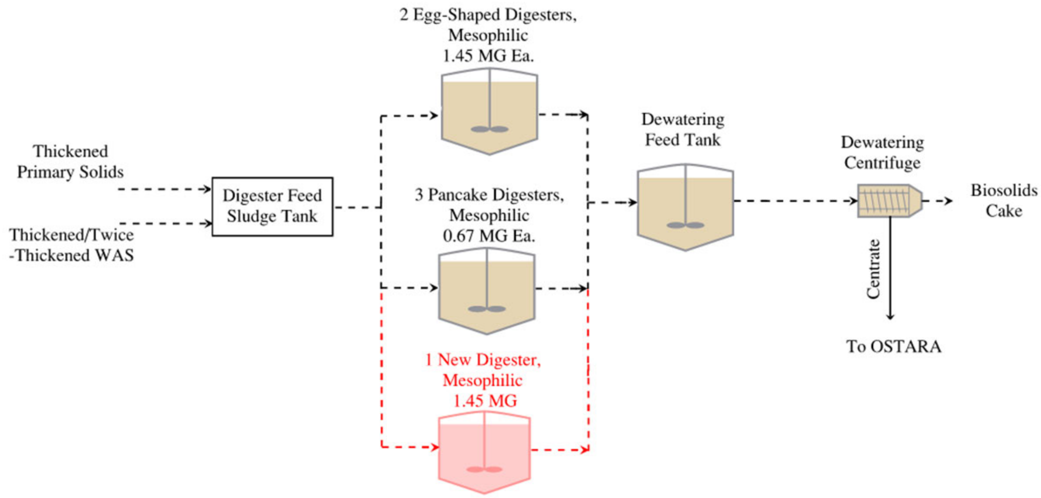
Cost Estimate Assumptions

Capital Cost Parameter	Value
Contingency	30%
Material Pricing Uncertainty Allowance	10%
General Conditions	10%
Contractor Overhead and Profit	12%
Engineering, Legal, and Administration	20%

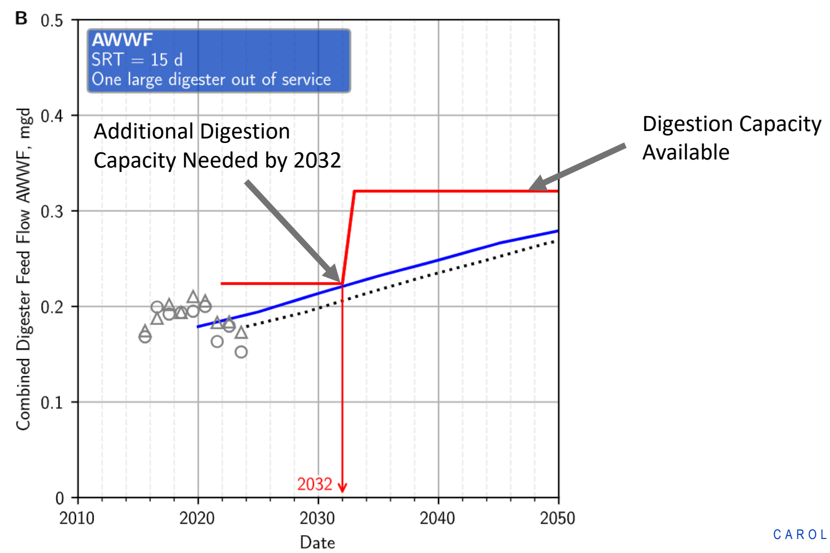
Operating Cost Parameter	Value
O&M Labor	$59/hour
Power	$.06/kWh
Natural Gas	$8.5/MMBTU
Solids Disposal	**$17/wet ton**

Alternative A – Mesophilic Digestion

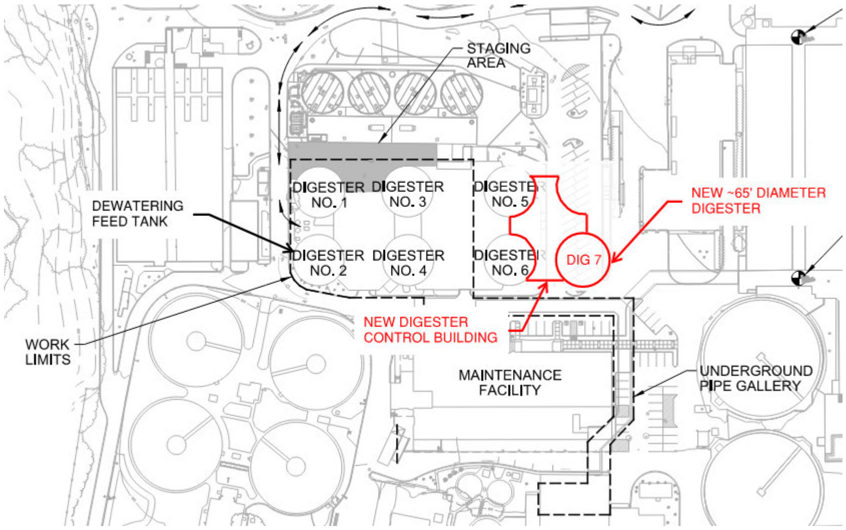
Alternative A – Mesophilic Digestion Schematic



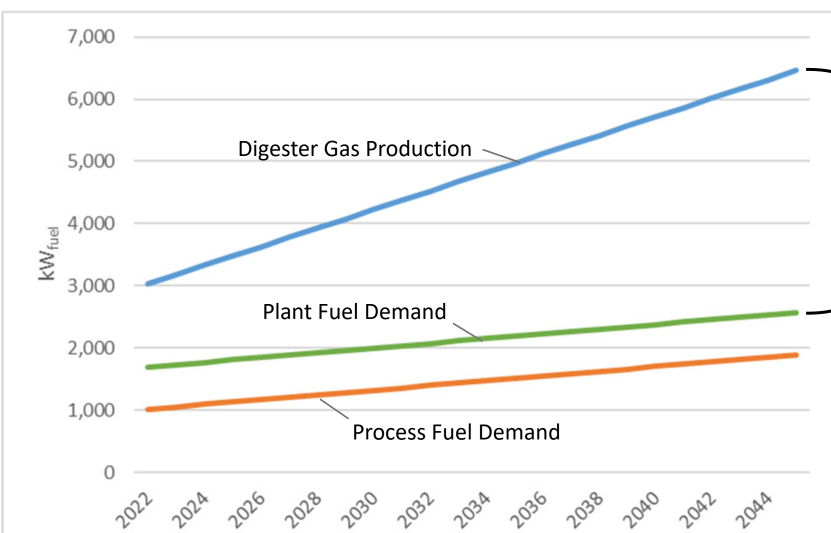
Alternative A – Mesophilic Digestion Trigger Plot



Alternative A – Mesophilic Digestion Preliminary Site Layout



Alternative A – Mesophilic Digestion Heat Balance



Digester Gas Available for Other Uses

Assumes all gas is used in boilers

Alternative A – Mesophilic Digestion Preliminary Cost Estimate

1	New Anaerobic Digester and Control Building		$11,404,540
2	Excavation and Dewatering		$1,400,000
3	Shoring		$500,000
4	Piles		$371,429
6	Site Work Allowance	20%	$2,280,908
7	E&IC	30%	$3,421,362
	Subtotal		*$19,378,239*
	Contingency	30%	$5,813,472
	Material Pricing Uncertainty Allowance	10%	$1,937,824
	Total Direct Cost		**$27,129,534**
	General Conditions (mobilization, permits, bonds/insurance, etc	10%	$2,712,953
	Subtotal		*$29,842,487*
	General Contractor Overhead and Profit	12%	$3,581,098
	Subtotal		*$33,423,586*
	Tax	0%	$0
	TOTAL ESTIMATED CONSTRUCTION COST		**$33,423,586**
	Engineering, Legal & Administration Costs	20%	$6,685,000
	TOTAL ESTIMATED PROJECT COST		**$41,000,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

[1] *Total in Q3 2024 Dollars*

Alternative A - Mesophilic Digestion Preliminary Annual Cost Estimate

Parameter	Alt A - Mesophilic
Power	$41,000
Parts and Maintenance	$114,000
Natural Gas	$0
Labor (1)	$0
Hauling Savings	$0
Annual Cost	**$160,000**

(1) Additional labor (over and above labor to run existing mesophilic digester process)

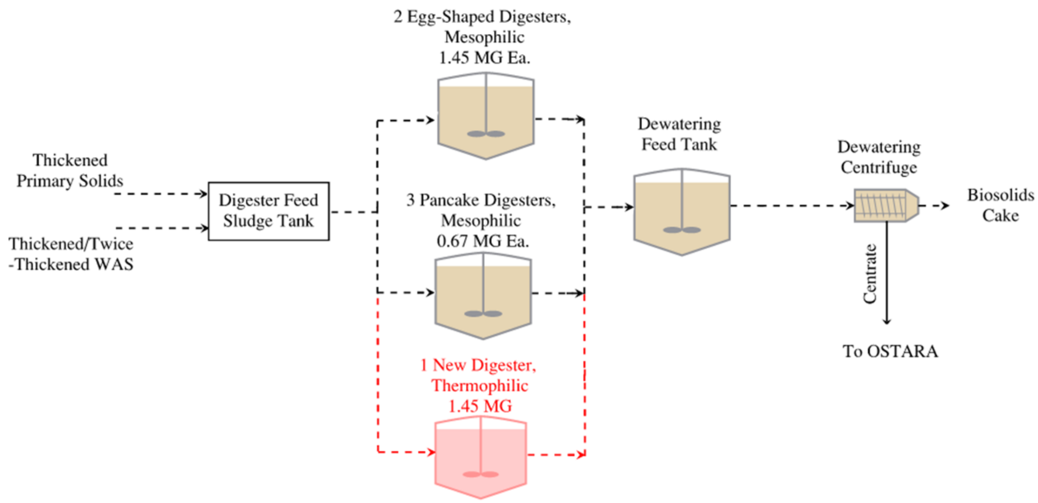
- Costs in 2024 dollars
- Assumes digester gas is used for plant heating

Alternative A – Mesophilic Digestion Non-Cost Considerations

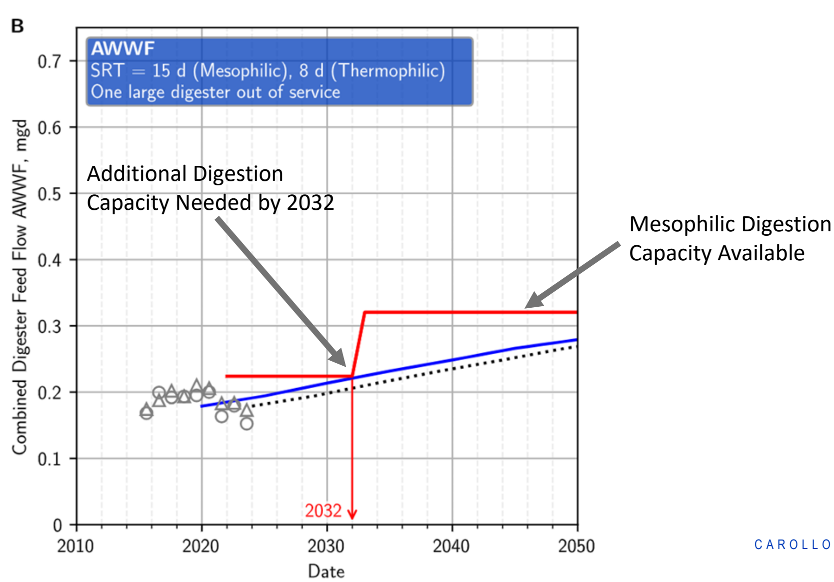
Consideration	Comment	
Proven Solids Process Performance	●	Most proven, very common
O&M Staff Familiarity	●	Very familiar
Overall Process Compatibility	●	Most compatible
Digester Gas Beneficial Use	●	Maximizes digester gas available for cogeneration or other uses
Biosolids Classification	●	Class B
Future Regulations (e.g., PFAS)	●	Compatible with a future plan to address PFAS, which would include dryers and additional thermal treatment on/off site.
Sidestream Impacts	●	Minimal (status quo)
Odor Concerns	●	Minimal (status quo)
Constructability/Site Impacts	●	Consistent with prior plans, does not require modifications to existing digesters

Alternative C – Thermophilic Digestion

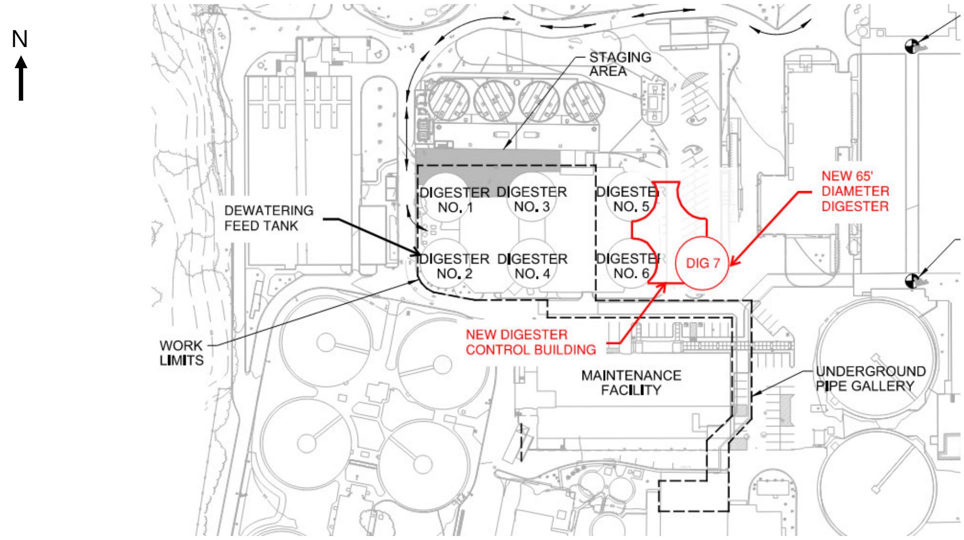
Alternative C – Thermophilic Digestion Schematic



Alternative C – Thermophilic Digestion Trigger Plot

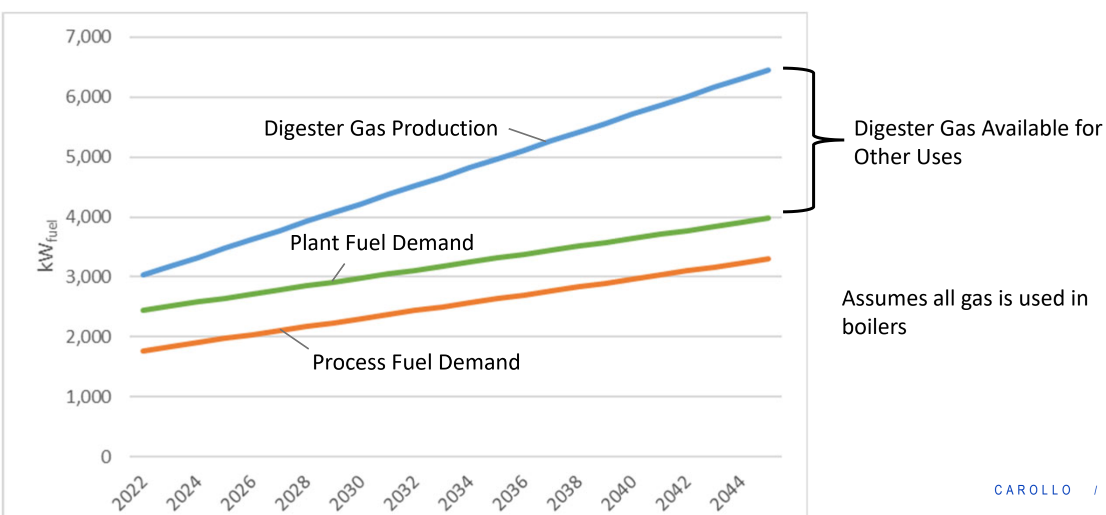


Alternative C – Thermophilic Digestion Preliminary Site Layout



Alternative C – Thermophilic Digestion Heat Balance

NOTE: Assumes ALL Thermophilic Digesters



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Alternative C – Thermophilic Digestion Preliminary Cost Estimate

1	New Anaerobic Digester and Control Building		$12,544,994
2	Excavation and Dewatering		$1,400,000
3	Shoring		$500,000
4	Piles		$371,429
5	Site Work Allowance	20%	$2,508,999
6	E&IC	30%	$3,763,498
	Subtotal		*$21,088,920*
	Contingency	30%	$6,326,676
	Material Pricing Uncertainty Allowance	10%	$2,108,892
	Total Direct Cost		**$29,524,487**
	General Conditions (mobilization, permits, bonds/insurance, etc.)	10%	$2,952,449
	Subtotal		*$32,476,936*
	General Contractor Overhead and Profit	12%	$3,897,232
	Subtotal		*$36,374,168*
	Tax	0%	$0
	TOTAL ESTIMATED CONSTRUCTION COST		**$36,374,168**
	Engineering, Legal & Administration Costs	20%	$7,275,000
	TOTAL ESTIMATED PROJECT COST		**$44,000,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

[1] *Total in Q3 2024 Dollars*

Alternative C – Thermophilic Digestion Annual Cost Comp.

Parameter	Alt A - Mesophilic	Alt C- Thermophilic
Power	$41,000	$45,000
Parts and Maintenance	$114,000	$125,000
Natural Gas	$0	$0
Labor (1)	$0	$61,000
Hauling Savings	$0	$0
Annual Cost	**$160,000**	**$230,000**

(1) Additional labor (over and above labor to run existing mesophilic digester process)

- Costs in 2024 dollars
- Assumes digester gas is used for plant heating

Alternative C – Expand with Thermophilic Digestion Non-Cost Considerations

Consideration	Comment	
Proven Solids Process Performance	orange	Not as common
O&M Staff Familiarity	orange	Not as familiar, though similar operations
Overall Process Compatibility	orange	Compatibility concerns for dewatering, heating, digester gas handling, etc
Digester Gas Beneficial Use	orange	Requires more digester gas for digester heating
Biosolids Classification	green	Class B, but easier to integrate Class A in future
Future Regulations (e.g., PFAS)	red	Less compatible with future PFAS removal due to high heat demand
Sidestream Impacts	orange	Higher temperature/load sidestream may impact Ostara
Odor Concerns	orange	Higher (relative to mesophilic)
Constructability/Site Impacts	green	Same as mesophilic

New Alternative – Add Thermal Drying

State actions about PFAS in biosolids

Monitoring
Source Control Screening Level(s)
Biosolids Land Application Ban
Proposed Biosolids Land Application Ban

Michigan – Tiered approach. PFOA or PFOS:
> 100 ppb - land application not allowed
>20 ppb - source control required and limited land application
< 20 ppb – no restrictions
PFOA+PFOS < 20 ppb "Exceptional Quality" eligible

Minnesota – Proposing study of solids levels and PFAS fate/transport after land application.

Wisconsin -- Tiered approach like Michigan.

Illinois – bill proposing ban like Maine

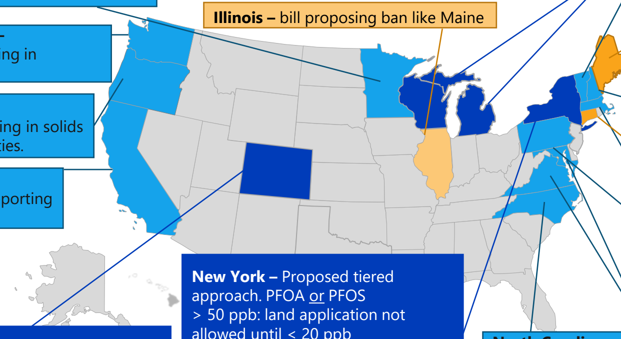
Vermont - Sampling/reporting of biosolids req'd. Similar data assessment as Michigan studies. Monitoring of imported biosolids.

Maine – Ban on land app/biosolids due to PFAS concern.

Washington – PFAS monitoring in biosolids.

Oregon – Voluntary PFAS testing in solids by some larger utilities.

California - Sampling and reporting req'd.



New Hampshire - Solids monitoring required. General interim best management practices guidance for solids developed.

Connecticut – Ban on biosolids that contain PFAS.

Massachusetts/Pennsylvania – PFAS testing required for solids in permit renewal process.

Colorado -- PFAS monitoring in biosolids req'd; PFOS > 50 ppb requires source investigation.

New York – Proposed tiered approach. PFOA or PFOS
> 50 ppb: land application not allowed until < 20 ppb
> 20 ppb: 1 year to reduce to <20 ppb
< 20 ppb: land app allowed

North Carolina – Biosolids monitoring at targeted facilities.

Virginia and Maryland- Considering sampling/reporting Michigan's studies.

Updated June 2024.
Not intended to be comprehensive due to ongoing changes.

Biosolids Treatment/PFAS Destruction Research is Ongoing.

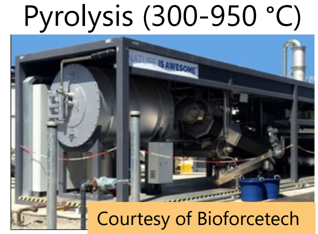
Incineration (700-900°C)

Courtesy of Suez

Gasification (700-1000 °C+)

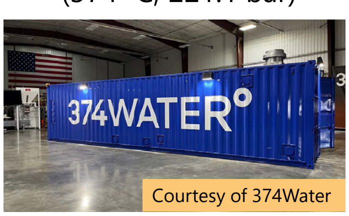
Courtesy of Aries

Pyrolysis (300-950 °C)



Courtesy of Bioforcetech

Supercritical Water Oxidation
(374 °C; 221.1 bar)



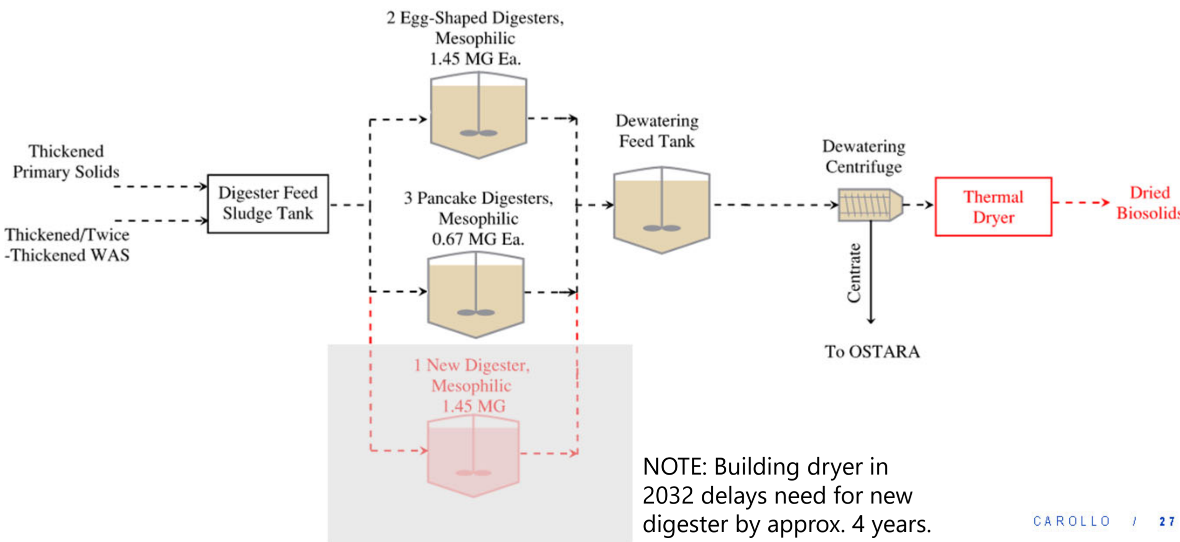
Courtesy of 374Water

Hydrothermal Alkaline Treatment
(350 °C; 250 bar; 1M NaOH)

Courtesy of Aquagga

Cheat Sheet:
- *350 deg C ~ 660 deg F*
- *374 deg C ~ 705 deg F*
- *700 deg C ~ 1,300 deg F*
- *1000 deg C ~ 1,830 deg F*
- *221 bar ~ 3207 psi*
- *250 bar ~ 3630 psi*

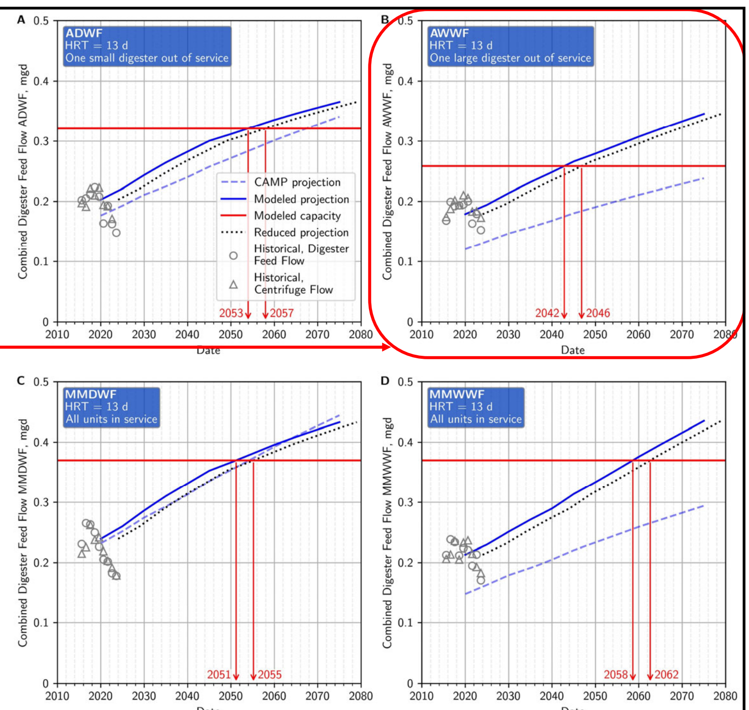
New Alternative – Thermal Drying Schematic



NOTE: Building dryer in 2032 delays need for new digester by approx. 4 years.

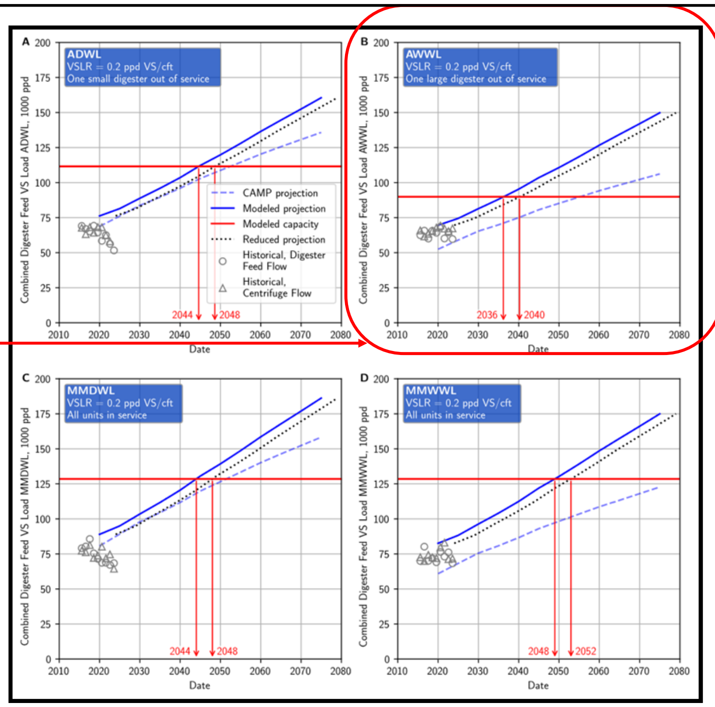
Trigger Plots (Hydraulic Loading) With New Dryer

Hydraulic Limitation: 2042



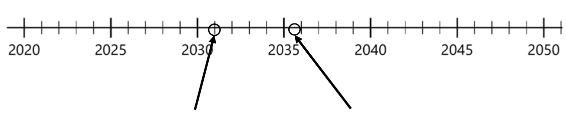
Trigger Plots (Organic Loading)

New Organic Limitation: 2036



Dryer Alternatives Timeline

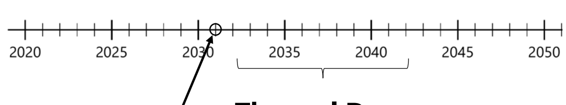
» **Dryer + Digester**



Thermal Dryer in 2032

1 New Digester (1.45 MG) in 2036

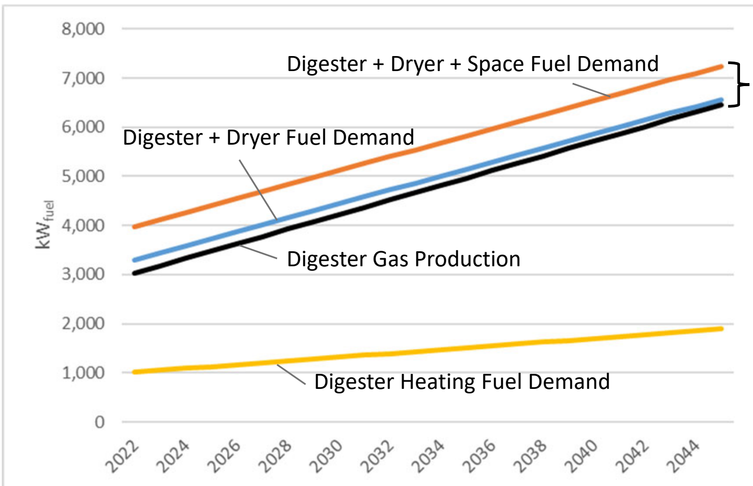
» **Digester + Dryer**



1 New Digester (1.45 MG) by 2032

Thermal Dryer anytime as needed

New Alternative – Thermal Drying Heat Balance



Most of the Dryer Fuel Demand is Provided by Digester Gas

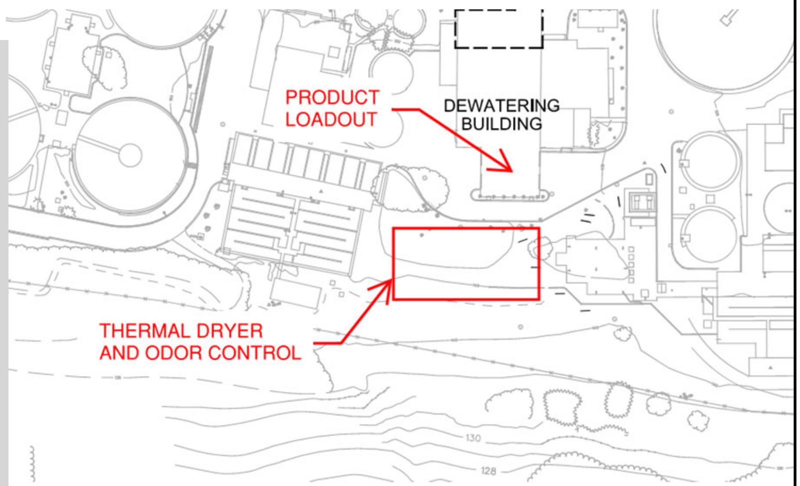
New Alternative – Thermal Drying Preliminary Design Criteria/Assumptions

Design Criteria	Unit	Value
Dryer Feed	ton TS/day	49
Dryer Feed	% TS	22%
Dryer Operation	-	24/7
Evaporation Rate	ton H_2O/hr	7

New Alternative – Thermal Drying Preliminary Site Layout

Siting Challenges

- Seismically unstable area needing ground improvements
- Buried pipes in the area that may require relocation
- Occupies space that could otherwise be used for tertiary expansion
- No space for a future thermal decomposition facility



New Alternative – Thermal Drying Preliminary Capital Cost Estimate (For Dryer Only)

1	Cake Pump		$1,518,251
2	One Dryer Unit		$19,987,500
3	Dryer Building		$5,625,000
4	Dried Product Loadout		$2,758,939
5	Regenerative Thermal Oxidizer/Odor Control		$1,460,458
6	Piles		$2,500,000
7	Pipe Relocation		$300,000
8	Site Work Allowance	20%	$1,968,879
9	E&IC	30%	$7,717,544
	Subtotal		*$43,836,571*
	Contingency	30%	$13,150,971
	Material Pricing Uncertainty Allowance	10%	$4,383,657
	Total Direct Cost		**$61,371,199**
	General Conditions (mobilization, permits, bonds/insurance, etc	10%	$6,137,120
	Subtotal		*$67,508,319*
	General Contractor Overhead and Profit	12%	$8,100,998
	Subtotal		*$75,609,318*
	Tax	0%	$0
	TOTAL ESTIMATED CONSTRUCTION COST		**$75,609,318**
	Engineering, Legal & Administration Costs	20%	$15,122,000
	TOTAL ESTIMATED PROJECT COST		**$91,000,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

[1] *Total in Q3 2024 Dollars*

New Alternative – Thermal Drying Preliminary Operating Cost Estimate

Parameter	Alt A - Mesophilic	Alt C- Thermophilic	New Alt - Digestion + Drying
Power	$41,000	$45,000	$190,000
Parts and Maintenance	$114,000	$125,000	$412,000
Natural Gas	$0	$0	$109,000
Labor (1)	$0	$61,000	$123,000
Hauling Savings	$0	$0	-($728,000)
Annual Cost	**$160,000**	**$230,000**	**$110,000**

(1) Additional labor (over and above labor to run existing mesophilic digester process)

- Costs in 2024 dollars
- Assumes digester gas is used for drying and natural gas is needed for space heating

New Alternative – Thermal Drying Non-Cost Considerations

Consideration	Comment	
Proven Solids Process Performance		More difficult to operate than digestion
O&M Staff Familiarity		Not familiar
Overall Process Compatibility		Limited compatibility concerns
Digester Gas Beneficial Use		Eliminates digester gas for Cogen (100% of digester gas needed for sludge heating and drying)
Biosolids Classification		Class A product
Future Regulations (e.g., PFAS)		Compatible with a future plan to address PFAS, which would include dryers and additional thermal treatment on/off site.
Sidestream Impacts		Minimal sidestream impacts
Odor Concerns		Robust odor control required
Constructability/Site Impacts		More complicated, requires significant relocation of large diameter piping

Initial Conclusions and Recommendations

Non-Economic Comparison

Consideration	Mesophilic	Thermophilic	Thermal Drying
Proven Solids Process Performance	Green	Orange	Orange
O&M Staff Familiarity	Green	Orange	Orange
Overall Process Compatibility	Green	Orange	Green
Digester Gas Beneficial Use	Green	Orange	Orange
Biosolids Classification	Orange	Green	Green
Future Regulations (e.g., PFAS)	Orange	Red	Green
Sidestream Impacts	Green	Orange	Green
Odor Concerns	Green	Orange	Orange
Constructability/Site Impacts	Green	Red	Red

Life Cycle Cost Comparison

	Mesophilic Digestion	Thermophilic Digestion	Thermal Drying
Capital Cost ($)			
Anaerobic Digester System	$41,000,000	$44,000,000	$41,000,000
Thermal Drying	$0	$0	$91,000,000
TOTAL CAPITAL COST	**$41,000,000**	**$44,000,000**	**$132,000,000**
Annual Cost ($/yr)			
ADDITIONAL ANNUAL COST	**$160,000**	**$230,000**	**$110,000**
LIFE CYCLE COST	**$44,000,000**	**$49,000,000**	**$134,000,000**

Initial Conclusions/Recommendations

- Additional solids processing capacity needed by 2032
- Gaining capacity by adding a thermophilic digester is less attractive based on cost and non-cost criteria
  - Less proven, potential for process compatibility issues
  - Does not eliminate the need for new digester (requires parallel digestion processes)
  - Converting existing mesophilic digesters to thermophilic is risky and not needed to meet projected flows and loads
- Gaining capacity by adding a mesophilic digester in 2032 provides flexibility
  - Provides necessary process capacity through planning period
  - Digester could be constructed to operate as thermophilic (predesign decision)
  - Consistent with a plan to add thermal drying in the future, either at Rock Creek or at a regional facility

Thank you!

carollo

APPENDIX 6B CAPITAL COST ESTIMATES

PROJECT SUMMARY

Project:	**WBMP**	**Estimate Class:**	**5**
Client:	**Clean Water Services**	**PIC:**	**B. Matson**
Location:	**Hillsboro, OR**	**PM:**	**B. Matson**
Zip Code:	**97123**	**Date:**	**7/31/2023**
Carollo Job #	**200908**	**By:**	**M. Neyestani**
		Reviewed:	**C. Clark**

Mesophilic Digestion

NO.	DESCRIPTION		TOTAL
1	New Anaerobic Digester and Control Building		$11,404,540
2	Excavation and Dewatering		$1,400,000
3	Shoring		$500,000
4	Piles		$371,429
5	Site Work Allowance	20%	$2,280,908
6	E&IC	30%	$3,421,362
	Subtotal		*$19,378,239*
	Contingency	30%	$5,813,472
	Material Pricing Uncertainty Allowance	10%	$1,937,824
	Total Direct Cost		**$27,129,534**
	General Conditions (mobilization, permits, bonds/insurance, etc.)	10%	$2,712,953
	Subtotal		*$29,842,487*
	General Contractor Overhead and Profit	12%	$3,581,098
	Subtotal		*$33,423,586*
	Tax	0%	$0
	TOTAL ESTIMATED CONSTRUCTION COST		**$33,423,586**
	Engineering, Legal & Administration Costs	20%	$6,685,000
	TOTAL ESTIMATED PROJECT COST		**$41,000,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

[1] *Total in Q3 2024 Dollars*

PROJECT SUMMARY

Project:	**WBMP**	**Estimate Class:**	**5**
Client:	**Clean Water Services**	**PIC:**	**B. Matson**
Location:	**Hillsboro, OR**	**PM:**	**B. Matson**
Zip Code:	**97123**	**Date:**	**7/31/2023**
Carollo Job #	**200908**	**By:**	**M. Neyestani**
		Reviewed:	**C. Clark**

Thermophilic Digestion

NO.	DESCRIPTION			TOTAL
1	New Anaerobic Digester and Control Building			$12,544,994
2	Excavation and Dewatering			$1,400,000
3	Shoring			$500,000
4	Piles			$371,429
5	Site Work Allowance		20%	$2,508,999
6	E&IC		30%	$3,763,498
		Subtotal		*$21,088,920*
	Contingency		30%	$6,326,676
	Material Pricing Uncertainty Allowance		10%	$2,108,892
	Total Direct Cost			**$29,524,487**
	General Conditions (mobilization, permits, bonds/insurance, etc.)		10%	$2,952,449
		Subtotal		*$32,476,936*
	General Contractor Overhead and Profit		12%	$3,897,232
		Subtotal		*$36,374,168*
	Tax		0%	$0
	TOTAL ESTIMATED CONSTRUCTION COST			**$36,374,168**
	Engineering, Legal & Administration Costs		20%	$7,275,000
	TOTAL ESTIMATED PROJECT COST			**$44,000,000**

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[1] *Total in Q3 2024 Dollars*

PROJECT SUMMARY

Project:	WBMP	Estimate Class:	5
Client:	Clean Water Services	PIC:	B. Matson
Location:	Hillsboro, OR	PM:	B. Matson
Zip Code:	97123	Date:	7/31/2023
Carollo Job #	200908	By:	M. Neyestani
		Reviewed:	C. Clark

Belt Dryer Capital Costs

NO.	DESCRIPTION		TOTAL [1]
1	Cake Pump		$1,518,251
2	One Dryer Unit		$19,987,500
3	Dryer Building		$5,625,000
4	Dried Product Loadout		$2,758,939
5	Regenerative Thermal Oxidizer/Odor Control		$1,460,458
6	Piles		$2,500,000
7	Pipe Relocation		$300,000
8	Site Work Allowance	20%	$1,968,879
9	E&IC	30%	$7,717,544
	Subtotal		*$43,836,571*
	Contingency	30%	$13,150,971
	Material Pricing Uncertainty Allowance	10%	$4,383,657
	Total Direct Cost		**$61,371,199**
	General Conditions (mobilization, permits, bonds/insurance, etc.)	10%	$6,137,120
	Subtotal		*$67,508,319*
	General Contractor Overhead and Profit	12%	$8,100,998
	Subtotal		*$75,609,318*
	Tax	0%	$0
	TOTAL ESTIMATED CONSTRUCTION COST		**$75,609,318**
	Engineering, Legal & Administration Costs	20%	$15,122,000
	TOTAL ESTIMATED PROJECT COST		**$91,000,000**

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